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A REVISION OF THE BRACHYURAN GENUS  
*LOPHOPANOPEUS*

(PLATES 1-6, 3 GRAPHS)

by

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DIVISION MARINE  
INVERTEBRATES

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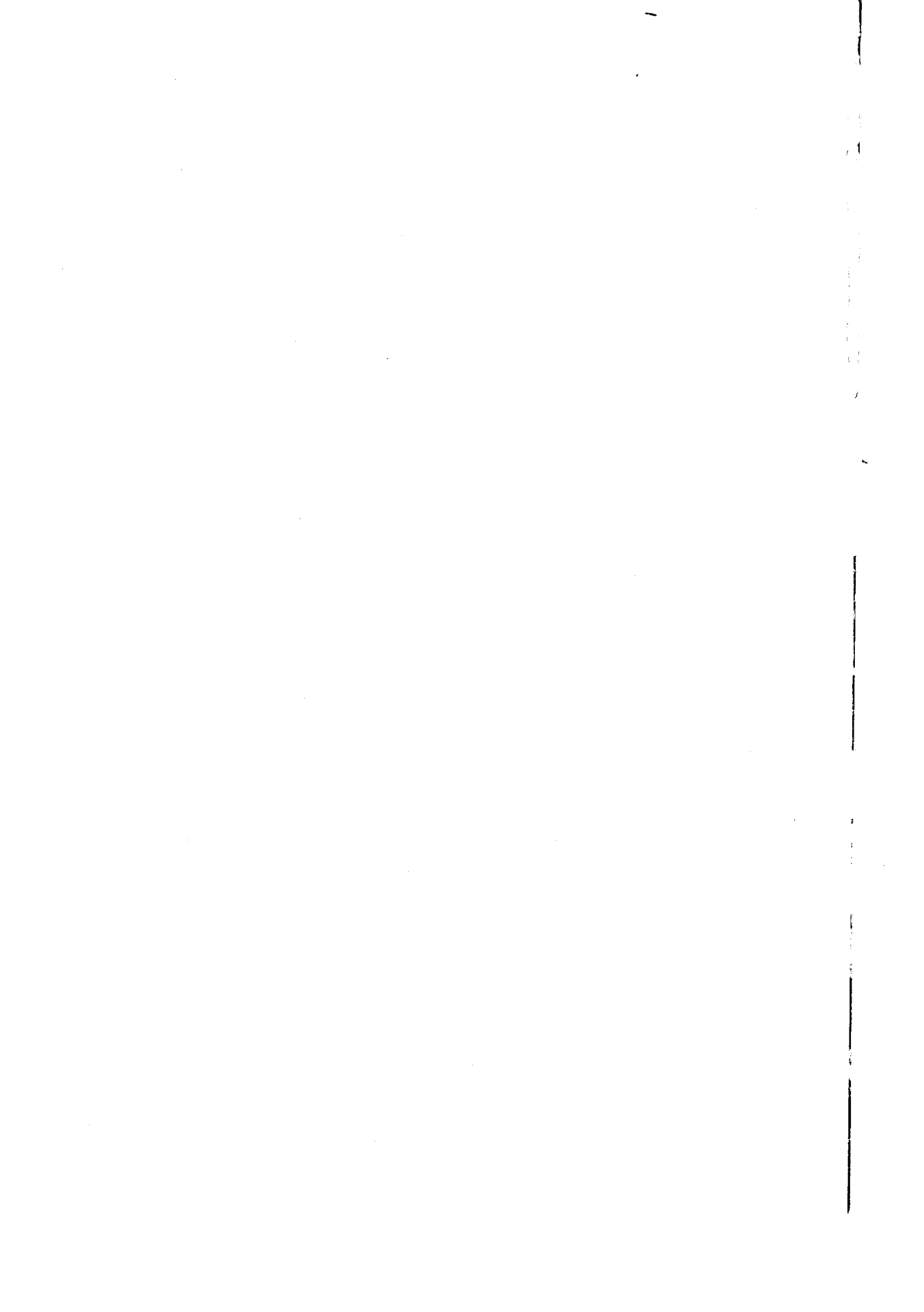
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A REVISION OF THE BRACHYURAN GENUS  
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(Plates 1-6, 3 graphs)

By ROBERT J. MENZIES

INTRODUCTORY REMARKS

The present study is a review of the taxonomic status of all of the species, known to the writer, to have ever been placed in the genus *Lophopanopeus*. It includes a key and diagnosis of the species considered as belonging in the genus, together with a discussion of the variation, ecology, distribution, and relationships of the species.

The synonymy has been listed in full because the synonymy of earlier writers was found to be unreliable. The need of the revision stemmed from the writer's inability prior to this study to identify specifically the common species of the genus found on the California coast. As the study progressed it became evident that it was well justified in that specimens were found to be misidentified in every large collection examined.

I would like to acknowledge indebtedness to: Dr. Waldo L. Schmitt, Head Curator, Department of Zoology, and Dr. Fenner A. Chace Jr., Curator, Division of Marine Invertebrates, of the United States National Museum for the loan of specimens from their institution; to Mr. Laurence M. Huey, Acting Director, San Diego Natural History Museum, for the loan of specimens; to Dr. Theodore Monod, Director, Institut de l'Afrique, Dakar, Africa and Dr. Isabella Gordon, Crustacea Section, British Museum for valuable information concerning the status of *Xantho sexdentatus* (Miers); to Dr. Bruno Parisi, Director, Museo Civico Di Storia Naturale, Milan, Italy for information concerning *Lophoxanthus erosus* and the drawing of the male Plps-I of the type which is reproduced here (p. 41); to Dr. Elisabeth Deichmann of the Museum of Comparative Zoology, Harvard, Massachusetts for her pleasant cooperation in supplying me with indispensable information on the types of *Lophopanopeus bellus* and *Hexapanopeus lobipes*. The following members of the research staff of the Allan Hancock Foundation aided materially in the construction of this paper through their helpful criticisms: Mr. Anker Petersen, Drs. John Mohr and Floyd Durham. Special thanks are due Dr. John Garth, under whose direction this investigation was made, for helpful counsel and critical reading of the manuscript. Finally I would

like to thank the director of the Allan Hancock Foundation, Captain Allan Hancock, for the use of the vast collections, and for providing the space and facilities needed during this investigation.

### EXPLANATION OF MEASUREMENTS, TERMS AND ABBREVIATIONS USED

#### *Explanation of measurements:*

1. The length of the carapace is measured on the median line, from the anterior to the posterior margin.
2. The width of the carapace is measured at the widest point.
3. The length of the segments of the ambulatory legs is measured on the dorsal margin. The width is measured at the widest point of the distal  $\frac{1}{3}$  of the segment if it is bilobed; if it is not bilobed at the widest point.
4. The ~~length~~ <sup>width</sup> of the front is measured from the outer or lateral angles of the frontal margin.

#### *Explanation of terms:*

5. Distal carpal lobe—the lobe on the dorsal surface of the carpus of the cheliped formed by the juncture of the antero-lateral and ~~medio-lateral~~ <sup>antero-medial</sup> surfaces.
6. Proximal carpal lobe—the lobe on the dorsal surface of the cheliped formed by the juncture of the postero-lateral and postero-medial surfaces.
7. Carpal number—the greatest number of pits, spines or bumps countable along a straight line from the proximal to the distal carpal lobe.

#### *Abbreviations used:*

8. Plp—pleopod.
- PMS—the Pacific Marine Station, Dillon Beach, Marin County, California.
- RJM—specimens in the author's collection.
- Sta.—Station number, Allan Hancock Foundation collections.
- USNM—the United States National Museum, Washington, D.C.

### A SUMMARY OF THE TAXONOMIC CHANGES

The left column is a list of all of the species, to the author's knowledge, ever placed in the genus *Lophopanopeus*. The right column lists the species as they are now designated, together with the authority for the change.

<i>Lophopanopeus bellus</i> (Stimpson), Rathbun 1898, p. 272.	<i>Lophopanopeus bellus bellus</i> (Stimpson), new combination, this paper p. 4.
<i>Lophopanopeus diegensis</i> Rathbun 1900, p. 137.	<i>Lophopanopeus bellus diegensis</i> (Rathbun), new combination, this paper p. 7.
<i>Lophopanopeus leucomanus</i> (Lock- ington), Rathbun 1898, p. 272.	<i>Lophopanopeus leucomanus leuco- manus</i> (Lockington), new combin- ation, this paper p. 10.
<i>Lophopanopeus heathii</i> Rathbun 1900, p. 137.	<i>Lophopanopeus leucomanus heathii</i> (Rathbun), new combination, this paper p. 13.

- Lophopanopeus frontalis* (Rathbun) 1896, p. 274.      *Lophopanopeus frontalis* (Rathbun), this paper p. 16.
- Lophopanopeus lockingtoni* Rathbun 1900, p. 137.      *Lophopanopeus frontalis* (Rathbun), this paper p. 16.
- Lophopanopeus olearis* Rathbun 1926, p. 57.      *Lophopanopeus olearis* Rathbun, this paper p. 21.
- Lophopanopeus erosus* (Parisi 1916), Balss 1921, p. 125.      *Lophoxanthus erosus* Parisi, this paper p. 21.
- Lophopanopeus somaterianus* Rathbun 1930, p. 332.      *Cancer oregonensis* (Dana), this paper p. 22.
- Lophopanopeus japonicus* Rathbun 1926, p. 272.      *Medaeus granulatus* (Haswell), Gordon 1931, p. 543.
- Lophopanopeus sexdentatus* (Miers 1881), Rathbun 1900a, p. 287.      *Xantho sexdentatus* (Miers), Monod 1938, p. 59.
- Lophopanopeus lobipes* (A. Milne Edwards), Rathbun 1930, p. 329.      *Hexapanopeus lobipes* (A. Milne Edwards), this paper p. 23.
- Lophopanopeus maculatus* Rathbun 1898, Rathbun 1930, p. 330.      *Micropanope?* *maculatus* (Rathbun), this paper p. 24.
- Lophopanopeus distinctus* Rathbun 1930, p. 331.      *Micropanope distinctus* (Rathbun), this paper p. 24.

### Genus LOPHOPANOPEUS

*Type.*—*Lophopanopeus bellus* (Stimpson), Rathbun 1898, p. 272.

The relationships and affinities of the genus *Lophopanopeus* to related world genera of the Family Xanthidae are not at all clear and a redefinition of the majority of the genera is certainly needed before these can be made evident. The genus appears, from this study, to be restricted in range to the Pacific coast of North America from the Gulf of California, Mexico to Alaska.

The following characteristics can be used to distinguish the genus from all other xanthid genera occurring within its range.

Carapace hexagonal. Antero-lateral teeth 4-5. Ratio of width of ~~front~~ *front* to ~~carapace~~ *carapace* width not less than 2.7 and not greater than 3.9. Segments of appendages lack spines; carpal segment of ambulatory legs bilobed and crested dorsally. In the male the third, fourth and fifth segments of the abdomen coalesced; Plp-1 longer than Plp-2; tip of flagellum of Plp-1 with a spinulate lateral projection, a spinulate hood, and at least one medial spine.

A KEY TO THE SPECIES OF THE GENUS *Lophopanopeus*

- A<sup>i</sup>. No enlarged tooth present at the proximal end of cutting edge of dactylus of major cheliped. *Lophopanopeus frontalis* (p. 16)
- A<sup>ii</sup>. An enlarged tooth present at the proximal end of cutting edge of dactylus of major cheliped.
- B<sup>i</sup>. Ambulatory legs with carpal and meral segments not pubescent. Carapace smooth, not pubescent. Carpus of chelipeds smooth or pitted never covered with bumps.
- C<sup>i</sup>. Carpus of ambulatory legs markedly bilobed. Carpus of cheliped covered with pits; carpal number for pits 7-11. *Lophopanopeus leucomanus leucomanus* (p. 10)
- C<sup>ii</sup>. Carpus of ambulatory legs not markedly bilobed. Carpus of cheliped smooth or slightly rough, never with pits; carpal number for pits 0-0 . . . .  
. . . . *Lophopanopeus leucomanus heathii* (p. 13)
- B<sup>ii</sup>. Ambulatory legs with carpal and meral segments covered with a dense pubescence. Carapace pubescent. Carpus of cheliped smooth or covered with irregular raised bumps.
- C<sup>i</sup>. Carpal segment of ambulatory legs markedly bilobed. Carpus of cheliped covered with irregular raised bumps; carpal number for bumps 5-7. . . . .  
. . . . . *Lophopanopeus bellus diegensis* (p. 7)
- C<sup>ii</sup>. Carpal segment of ambulatory legs not markedly bilobed. Carpus of cheliped smooth or rugose, but never with irregular raised bumps; carpal number for bumps 0-0 . . . *Lophopanopeus bellus bellus* (p. 4)

***Lophopanopeus bellus bellus*** (Stimpson 1862), new combination

Pl. 1, figs. 1-5; pl. 5, fig. 38

*Xantho bella* Stimpson 1860, pl. v, fig. 2; Not *Xantho bella* Stimpson 1860, pp. 204-205.*Xanthodes Hemphillii* Lockington 1876 (1877), pp. 31-32.*Xantho Hemphilliana* Lockington 1876 (1877), p. 100.*Lophoxanthus bellus* (Stimpson). A. Milne Edwards 1879, p. 257; Not *Lophoxanthus bellus* (Stimson), A. Milne Edwards 1879, pl. 46, figs. 4-4c. Holmes 1900, p. 60, pl. 1, fig. 3.*Lophopanopeus bellus* (Stimpson) Rathbun 1898, p. 272; 1900, p. 137; 1930, pp. 320-322, pls. 150 and 151. Weymouth 1910, p. 51, pl. 12, fig. 37. Schmitt 1921, p. 241, text-fig. 143, pl. 37, fig. 4. Johnson and Snook 1935, p. 387, fig. 343. Ricketts and Calvin 1939, p. 171.



*Diagnosis.*—Ambulatory legs with dorsal and lateral surfaces of carpus and propodus covered with a pubescence; carpus slightly bilobed. Carpus of cheliped smooth or rugose; carpal number for bumps 0-0; a deep sulcus located on the dorsal surface of carpus near its antero-lateral margin. Lobe at proximal dorso-medial surface of manus small. An enlarged tooth present at the proximal end of cutting edge of dactylus of major cheliped. Dorsal surface of carapace conspicuously pubescent. Morphology of tip of flagellum of male Plp-1 characteristic, see Pl. 1, fig. 1.

*Type.*—A cotype, an ovigerous female, is deposited in the Museum of Comparative Zoology, Harvard, Massachusetts, Cat. No. 1292.

*Type locality.*—“Found at Monterey, Cal., by Mr. A. S. Taylor, and at Ft. Townsend, Puget Sound, by Dr. Suckley.” (Stimpson 1860, p. 205). The cotype was collected from Monterey, California (Rathbun 1930, p. 322).

*Original description.*—Northern specimens are more transverse, rougher, more pubescent, and more sober in coloration than those found in warmer latitudes. (Stimpson 1860, p. 205, last paragraph of description).

Stimpson clearly described two different species when he described his *Xantho bella* (= *Lophopanopeus bellus*). The first paragraph and body of his description pertains to what is now known as *Lophopanopeus leucomanus heathii* (p. 13). The second paragraph (transcribed above) describes the “Northern specimens” or what is now known as *Lophopanopeus bellus bellus*. It is an example of the “Northern specimens” that Stimpson figures. The cotype (as indicated in a communication with Dr. Elisabeth Deichmann) is clearly of the same species as what was called the “Northern specimens” by Dr. Stimpson.

The retention of the name *Lophopanopeus bellus bellus* for the cotype and figure permits the least changes in existing nomenclature in that writers subsequent to Stimpson, apparently in disregard of the description (paragraph one), have considered the “Northern specimens” to be the species.

## SUPPLEMENTARY DESCRIPTIVE NOTES

### DISCUSSION OF CONSTANT FEATURES.

The tip of the flagellum of the male Plp-1 (Pl. 1, fig. 1) is characterized by a hooked, spinulate, antero-medially directed lateral projection (L); hood (H) narrow elongate and pointed, located at tip in the mid-

line; medial spines (S-1) 2-4 in number and located in a longitudinal row along the medial border near the hood origin; a longitudinal row of spines (S-2) located on the abdomino-lateral surface and are irregular in number; spinules (S-3) 3-5 in number and situated on sternal surface near hood origin; spinules (S-4) numerous, clustered at juncture of medio-lateral origin of both hood and lateral projection.

The dorsal and lateral surfaces of the carpus and propodus of the ambulatory legs (Pl. 1, figs. 2-3) are densely pubescent. The carpus is slightly bilobed and the propodus, though not lobed, has a convex dorsal margin. The length/width ratios of the segments of the second ambulatory leg are as follows: merus 2.5-2.8(2.7), carpus 1.4-2.3(1.8), propodus 0.9-1.2 (1.1), the L/W ratio of the dactylus was found to be too variable to be of much specific diagnostic value.

The carapace (Pl. 5, fig. 38) is characteristically pubescent in the areas separating the areolations of the lateral portions of the dorsal surface and at the origin of the antero-lateral teeth. The dorsal surface has minute hairs scattered irregularly over it. The antero-lateral teeth are bluntly triangular. The ratio of the carapace width/front width is 3.4-3.8 (3.65).

The dactylus of the major cheliped (Pl. 1, fig. 4) has an enlarged tooth at the proximal end of the cutting edge. Not all specimens were found to have a major cheliped. In such cases other characteristics must be relied upon for identification.

The large triangular lobe at the proximo-medial part of the dorsal surface of the manus which characterizes specimens of *Lophopanopeus leucomanus leucomanus* and *L. l. heathii* is reduced in specimens of *L. bellus bellus* so that it is scarcely noticeable. The dark color of the manus is restricted to the fingers and is not continued up onto the palm in specimens of either sex.

#### DISCUSSION OF VARIABLE FEATURES.

The carpus of the ambulatory legs is subject to considerable variation in its degree of bilobation. Generally it is but slightly bilobed in contrast to the markedly bilobed carpus of specimens of *L. bellus diegensis*. This feature shows up well on Graph 1 where the ratio of the length/width (L/W ratio) of the carpus of the third ambulatory leg is plotted against the carapace width. It is clear that although the ratio is variable it is on an average much larger for specimens of *L. bellus bellus* than for specimens of *L. bellus diegensis*. It is further demonstrated that juvenile specimens of both subspecies tend to exhibit a similar degree of bilobation on the carpus of the third leg.

The carpus of the cheliped varies considerably in the degree of rugosity of its dorsal surface. Although typically smooth, some very rough carpal segments have been observed. The roughest of carpal segments examined does not however have the isolated, elevated, irregular bumps that are characteristic of specimens of *L. bellus diegensis*.

*Material examined.*—A total of 290 specimens of which 161 were males and 129 were females were examined in this study. They were collected at 14 different localities from Cayucos, San Luis Obispo County, California to Alaska (exact locality not known).

*Geographical distribution.*—As is shown on Chart 2 this species is the northern form of a subspecies complex which breaks sharply with the southern subspecies, *L. bellus diegensis*, between Point Sur, California and Point Conception, California and extends as far northward as Alaska.

*Ecology.*—All of the specimens examined by the writer were collected from under rocks and stones in the intertidal zone of the protected and unprotected rocky coast.

The intertidal preference of *L. bellus bellus* is in contrast to that of the southern subspecies *L. bellus diegensis* the majority of which were collected from 20-60 fathoms.

*Breeding notes.*—Female specimens were collected during the months of January, February, June, July, and August. Of these only the months of June and July showed any ovigerous specimens. Certainly more specimens must be examined from the other months of the year before a definite breeding period may be ascertained.

***Lophopanopeus bellus diegensis* Rathbun 1900, new combination**

Pl. 1, figs. 6-8

*Lophopanopeus diegensis* Rathbun 1900, p. 137; 1904, p. 184, pl. 9, fig. 3; 1930, pp. 327-328, pl. 153, figs. 6-7 and 10, text-fig. 49. Weymouth 1910, p. 52, pl. 12, fig. 39. Schmitt 1921, p. 245, text-fig. 146, pl. 37, fig. 5. Johnson and Snook 1935, p. 387.

*Diagnosis.*—Ambulatory legs with dorsal and lateral surfaces, except on the lobations, covered with a pubescence; carpus markedly bilobed. Carpus of cheliped covered with irregular generally isolated elevated bumps; carpal number for bumps 4-6; a deep sulcus is located on dorsal surface of carpus near its antero-lateral margin. Lobe at proximo-medial part of dorsal surface of manus small. An enlarged tooth is present at the proximal end of cutting edge of dactylus of major cheliped. Dorsal surface of carapace pubescent as in *L. b. bellus*. Morphology of tip of flagellum of male Plp-1 identical with that of *L. b. bellus* (Pl. 1, fig. 1).

*Type*.—The type, a male, is deposited in the United States National Museum, Cat. No. 4281.

*Type locality*.—San Diego, 10 fathoms (Rathbun 1900, p. 137).

*Original description*.—The following characteristics given in the key (Rathbun 1900, p. 137), in which the species was designated as new, constitute the original description.

Upper margin of meral joints of ambulatory legs not spinulose. Hands with one or more lobes or teeth on upper margin. Carpus of cheliped very rough. Carpal joints of ambulatory legs strongly bilobed. Carpus of chelipeds covered with tubercles. (Rathbun 1900, p. 137).

## SUPPLEMENTARY DESCRIPTIVE NOTES

### DISCUSSION OF CONSTANT FEATURES.

In features exhibiting no apparent variability such as the morphology of the tip of the flagellum of the male Plp-1, the presence of an enlarged tooth at the proximal end of the cutting edge of the dactylus of the major cheliped, the presence of pubescence on the lateral surface of the carpus and propodus of the ambulatory legs, and of a sparsely hairy and pubescent carapace *L. bellus diegensis* appears to be identical with *L. bellus bellus*. Only two characteristics: (1) the presence of irregular, elevated, isolated bumps on the dorsal surface of the carpus of the cheliped and (2) the presence of markedly bilobed carpal segments of the ambulatory legs serve to distinguish specimens of *L. bellus diegensis* from specimens of *L. bellus bellus*.

### DISCUSSION OF VARIABLE CHARACTERISTICS.

Both the degree of bilobation of the carpus of the ambulatory legs (Pl. 1, figs. 7-8) and the extent of the elevation of the bumps on the dorsal surface of the carpus of the cheliped (Pl. 1, fig. 6) are subject to variation. The variation in the L/W ratio of the carpus of the second ambulatory leg is demonstrated on Graph 1. Here it is further apparent that the average L/W ratio is much smaller for specimens of *L. bellus diegensis* than for specimens of *L. bellus bellus*. The ratios of the carapace width/front width and the L/W ratios of merus, carpus, and propodus of the second ambulatory leg are all within the range of variability given for specimens of *L. b. bellus*. Their averages are as follows: 2.7 carapace width/front width, 2.7 merus, 1.5 carpus, 1.8 propodus.

*Remarks*.—Adult specimens of *L. bellus diegensis* average approximately  $\frac{1}{2}$  the size in carapace width of adults of *L. bellus bellus*.

*Material examined.*—The writer has examined 517 specimens, of which 338 were males, 161 females, 1 fragment, and 17 juvenile specimens. These were collected at 54 different localities from Mission Bay, San Diego to Monterey Bay, California.

*Geographical distribution.*—On Graph 2 is shown the percent of specimens of *L. bellus diegensis*/*L. bellus bellus* plotted against degrees latitude. It is clear from the graph that *L. bellus diegensis* is the southern form and breaks sharply with the northern form, *L. bellus bellus*, between Point Sur and Point Conception. The zone of intergradation between the two species appears to be between those points.

Two specimens from Alaska and one from Washington, a total of 50 per cent of the specimens examined from those areas, resembled *L. bellus diegensis* more than *L. bellus bellus*. More specimens certainly need to be examined before a relationship can be established between such far removed faunas, although the occurrence of a single specimen of *L. bellus diegensis*, of an unusually large size, from 31 fathoms at Monterey Bay, California (---line on Graph 2) may be indicative of a subtidal connection with the Alaskan form.

*Ecology.*—Specimens collected from the intertidal zone constituted 14 per cent of the specimens examined. Of these 60 per cent were collected from under rocks at the protected and unprotected rocky coast where the substratum consisted mostly of coarse sand. Of the shore collected specimens 40 per cent were collected from bay localities such as Newport and Mission Bay where the substratum consisted of mud and sand.

A total of 85 per cent of the specimens were found between 10 and 60 fathoms with the following distribution at the various substrata: mud 32 per cent, rock 12 per cent, sand 26 per cent, sand and rock 16 per cent, sand and gravel 14 per cent. No specimens were observed from depths greater than 100 fathoms and only a fraction of 1 per cent were collected between 80-100 fathoms.

It appears clear from the above data that the species is not restricted to any single situation and is capable of living in a wide variety of habitats. Below 20 fathoms *L. bellus diegensis* was frequently taken in the same haul with *L. leucomanus leucomanus*.

The collections suggest that the intertidal specimens are in general much larger than specimens found below 10 fathoms. The average carapace width of twenty specimens collected from the intertidal zone was 13.2 mm. This is in contrast to an average carapace width of 8.9 mm for twenty of the largest specimens collected from below 10 fathoms.

*Breeding notes.*—Females were examined that had been collected during every month of the year. Ovigerous females were noted during the months, from February to July inclusive and September.

**Lophopanopeus leucomanus leucomanus** (Lockington 1876),  
new combination

Pl. 2, figs. 9-14; pl. 5, fig. 35

*Xanthodes leucomanus* Lockington 1876 (1877), p. 32. Not *Xanthodes leucomanus* Lockington 1876 (1877), p. 100.

*Lophoxanthus leucomanus* (Lockington). Holmes 1900, pp. 61-63.

*Lophopanopeus leucomanus* (Lockington). Rathbun 1898, p. 272; 1904, p. 182; 1930, pp. 324-325, pl. 153, figs. 5 and 9, pl. 154, fig. 4. Weymouth 1910, p. 52. Baker, 1912, p. 100, fig. 53. Hilton 1916, p. 71. Ninniger 1918, p. 41, figs. 22-24. Schmitt 1921, p. 243, fig. 145, pl. 37, fig. 6. Johnson and Snook 1935, p. 386, fig. 341.

*Diagnosis.*—Ambulatory legs with dorsal and lateral surfaces of carpus and propodus without pubescence; lateral surface of carpus with raised lines and pits; carpus markedly bilobed. Carpus of cheliped with reticulating ridges and pits; carpal number for pits 7-11; no deep sulcus located on dorsal surface of carpus near its antero-lateral margin. Lobe at proximal dorso-medial surface of manus large. Enlarged tooth present at proximal end of cutting edge of dactylus of major cheliped. Dorsal surface of carapace not pubescent. Tip of flagellum of male Plp-1 is diagnostic, see Pl. 2, fig. 9.

*Type.*—The original types have been lost. I have designated a male collected November 9, 1946 at Corona del Mar, California from under rocks in the intertidal zone as the neotype and a female collected at the same place as the paraneotype. These are deposited in the Allan Hancock Foundation collections, Cat. no. 461.

*Type locality.*—Lockington (1876 [1877], p. 32) lists the type locality as Santa Rosa Island; Monterey and San Diego, California. In view of the facts that the species is certainly rare at Monterey, California; that Santa Rosa Island is inaccessible to the majority of collectors, and that no single type locality was listed it is suggested that the locality of the neotype be taken as the type locality.

*Original description.*—This species appears to be very nearly allied to *X. Hemphillii*, having the front antero-lateral teeth, and areolation of that species. If there is any value in the subdivision *Xanthodes*, both should be included in it, as both have the first antennal joint connected with the front by a process. The principal difference between the two forms, size

excepted, will be found in the network of raised lines upon the upper portions of the hand and carpus of the chelipeds in the present form; and the almost entire absence of the tomentosity upon the four hinder pair, which characterizes *X. Hemphillii*. The dactyli of the chelipeds are of a shining, leucous tint when recent . . . . The carapax of the largest specimen measures half an inch in width, and 0.34 in length. (Lockington 1876 [1877], p. 32.)

#### SUPPLEMENTARY DESCRIPTIVE NOTES

Subsequent authors added little to the brief description of Lockington; in fact, one significant feature, the absence of hairs on the segments of the ambulatory legs, was omitted.

##### DISCUSSION OF CONSTANT FEATURES.

In its constant features *L. leucomanus leucomanus* appears to be identical with *L. leucomanus heathii* and it is primarily for that reason that I have considered them to be subspecies. The features in which the two subspecies differ are listed in tabular form on page 15.

The tip of the flagellum of the male Plp-1 (Pl. 2, fig. 9) is characterized by an alate, spinulate lateral projection (L) which is compressed proximo-distally and hooked at the tip; an enlarged swollen hood (H); a single medial spine (S-1) located at the medio-distal angle of the tip of the flagellum; a cluster of spines (S-2) located lateral to the midline of the abdominal surface at the origin of L; a transverse row of spinules (S-3), 3-5 in number and located on the distal part of the flagellum, being sternal to and in a line with the sternal origin of the hood; a cluster of sub-hood spinules (S-4) located at the base of hood origin on the midline of the abdominal surface.

The carpus of the cheliped (Pl. 2, fig. 14) is characterized by a carpal number for pits of from 7-11. The pits are always present on specimens of *L. leucomanus leucomanus* and it is in this feature that the subspecies is most easily distinguished from *L. leucomanus heathii*. The strength of the development of the pits is variable and specimens must be examined with extreme care when there is a doubt as to the subspecific identity.

The absence of pubescence on the carpal and propodal segments of the ambulatory legs (Pl. 2, fig. 13) is characteristic of specimens of both *L. l. leucomanus* and *L. l. heathii*. The L/W ratios for the segments of the second ambulatory leg are as follows: 2.6-3.3 (2.8) merus, 1.3-1.6 (1.5) carpus, 0.9-1.2 (1.0) propodus.

## DISCUSSION OF VARIABLE FEATURES.

The antero-lateral margin (Pl. 5, fig. 35), characterized in general by well developed, sharp-pointed antero-lateral teeth, is certainly variable in this feature. Most frequently the teeth are pointed and narrow in contrast to the bluntly triangular teeth of *L. l. heathii*. Subhepatic granulations may be so well developed as to give the appearance of a tooth in that region. The ratio of the carapace width/front width is 2.7-3.1 (2.9).

Reticulating ridges in the hepatic region of the carapace (Pl. 5, fig. 35) appear to be constant in location but not in degree of development.

Holmes (1900, pp. 61-63) noted the characteristic elevated mid-part of the merus of the third maxilliped and also that the degree of its development was variable. When well developed it is a diagnostic feature. The third maxillipeds of *L. l. leucomanus* and *L. l. heathii* are very similar and I could find no conspicuous differences between them.

The manus of the cheliped (Pl. 2, figs. 10-11) varies considerably as to the degree of development of the pits on its dorsal and lateral surfaces. At least two varieties are recognizable.

1. A manus (fig. 11) with its dorsal and lateral surfaces covered with deep pits was observed in 10 per cent of the males and in 73 per cent of the females.

2. A manus (Pl. 2, fig. 10) which is pitted on the dorsal but not on the lateral surface was observed in 90 per cent of the males and 27 per cent of the females examined.

*Material examined.*—In this study a total of 311 specimens were examined of which 107 were males, 105 females, 1 fragment, and 98 juveniles.

*Geographical distribution.*—The subspecies has been recorded as far north as Monterey Bay, California (Lockington 1876 [1877], p. 32) and as far south as Mission Bay, San Diego, California. The writer has seen specimens of *L. l. leucomanus* from Rosarito Beach, Lower California, Mexico.

On Graph 3 is shown the per cent of specimens of *L. l. leucomanus*/*L. l. heathii* plotted against the degrees north latitude. As in the case of *L. bellus diegensis* (Chart 2) *L. l. leucomanus* is the southern form of a subspecies complex. It shows a narrow zone of intergradation between Cambria and Point Arguello, California. Unlike the *L. bellus bellus*-*L. b. diegensis* complex, where none of the northern form occurred at the Channel Islands or at La Jolla, the per cent of *L. l. leucomanus* is lowered at those points by the occurrence of the northern form. Although the curves



for the complementary southern species, *L. l. leucomanus* and *L. bellus diegensis*, are not identical the similarities in their geographical distribution are striking.

*Ecology*.—A total of 26 per cent of the specimens of *L. l. leucomanus* examined by the writer were collected from the shore in the intertidal zone. All of these were collected from the protected and unprotected rocky coast where the substratum consisted mostly of sand.

The specimens, found between 10-60 fathoms, constituted 74 per cent of the total. These showed the following distribution with regards to substratum: 94 per cent sand, 1 per cent mud, 2 per cent rock, 1 per cent shell, 0.5 per cent sand and rock, 1.5 per cent sand and gravel.

As with *L. bellus diegensis* only a small fraction of one per cent of the specimens were collected between 80-110 fathoms and no specimens were observed from below 110 fathoms.

It is clear from the above that shore specimens tend to be restricted to the open rocky coast and that those taken from depths offshore are most frequently associated with a sandy habitat.

Also as with *L. bellus diegensis* intertidal specimens of *L. l. leucomanus* were of a larger size than offshore specimens. The average carapace width of ten of the largest shore specimens was 13.9 mm; whereas, ten of the largest offshore specimens measured only 7.7 mm in carapace width.

*Breeding notes*.—Female specimens were examined that had been collected during every month of the year and ovigerous specimens were observed that had been collected during the months of January to August, inclusive.

***Lophopanopeus leucomanus heathii* Rathbun 1900,**  
new combination

Pl. 2, figs. 15-16; pl. 5, fig. 34

*Xantho bella* Stimpson 1860, p. 204, paragraph 1. Not *Xantho bella* Stimpson 1860, p. 204, paragraph 2, pl. 5, fig. 2.

*Lophoxanthus bellus* (Stimpson). A. Milne Edwards, 1876, p. 46, figs. 4a-4c. Not A. Milne Edwards, 1876, p. 257-258.

*Lophopanopeus heathii* Rathbun 1900, p. 137; 1904, p. 182, pl. 7, fig. 9; 1930, pp. 322-323, pl. 149. Weymouth 1900, p. 51, pl. 7, fig. 38. Schmitt 1921, p. 37, fig. 1. Johnson and Snook 1935, pp. 386-387, fig. 343. Ricketts and Calvin 1939, p. 94, fig. 50.

*Lophoxanthus leucomanus* (Lockington). Holmes 1900, pp. 61-62, pl. 1, fig. 4.

*Lophopanopeus heathi* Rathbun, Hewatt 1946, pp. 191, 193-196, 200, 202.

*Diagnosis.*—Ambulatory legs with dorsal and lateral surfaces of carpus and propodus not pubescent; lateral surface of carpus smooth, without raised lines and pits; carpus slightly bilobed. Carpus of cheliped without reticulating ridges and pits; carpal number for pits 0-0; no deep sulcus located on dorsal surface near antero-lateral margin of carpus. Enlarged tooth present at proximal end of cutting edge of dactylus of major cheliped. Dorsal surface of carapace without pubescence. Morphology of tip of flagellum of male Plp-1 identical with that of *L. l. leucomanus*.

*Type.*—The type, a male, is located in the United States National Museum, Cat. No. 22870.

*Type locality.*—Monterey Bay, California (Rathbun 1900, p. 137).

*Original description.*—*Lophopanopeus heathii* was designated as a new species in 1900 by Dr. M. J. Rathbun in a key to the species of the genus *Lophopanopeus*. The following characteristics given in the key constitute the original description.

Upper margin of meral joints of ambulatory legs not spinulose. Hands with one or more lobes or teeth on upper margin. Carpus of cheliped smooth or nearly so. Color of pollex not running back on hand. (Rathbun 1900, p. 137).

## SUPPLEMENTARY DESCRIPTIVE NOTES

### DISCUSSION OF CONSTANT FEATURES.

The tip of the flagellum of the male Plp-1 is identical in its morphology with that of *L. l. leucomanus* (p. 10).

The ambulatory legs (Pl. 2, fig. 15) of *L. l. heathii* differ from those of *L. l. leucomanus* only in that the carpal segments are less strongly bilobed and lack lateral reticulating lines and pits. The propodal segments are less lobed on their dorsal margin.

The carapace (Pl. 5, fig. 34) is characterized by the absence of any pubescence. It differs from that of *L. l. leucomanus* in that it is less rugose. The ratio of the carapace width/front width is 2.8-3.5 (3.0).

The carpus of the chelipeds (Pl. 2, fig. 16) is smooth and lacks the reticulating ridges and pits peculiar to the carpus of *L. l. leucomanus*. The carpal number for pits for *L. l. heathii* is 0-0. As with *L. l. leucomanus* the carpus lacks a deep sulcus on its dorsal surface near the antero-lateral border of the carpus. The L/W ratios of the segments of the second ambulatory leg are 2.2-2.6 (2.4) merus, 1.3-1.8 (1.6) carpus, 1.0-1.1 (1.09) propodus.

The dactylus of the major cheliped has an enlarged tooth at the proximal end of the cutting edge. In this respect and in other minute features it is identical with that of *L. l. leucomanus*.

DISCUSSION OF VARIABLE FEATURES.

The antero-lateral teeth (Pl. 5, fig. 34) are constant in location and number. They are usually broad and triangular although they vary and intergrade with the sharply pointed teeth of *L. l. leucomanus*.

The manus of *L. l. heathii* is characteristically smooth and has a large medial lobe at the proximal part of the dorsal surface. The dorsal surface of the manus varies and intergrades with the heavily pitted surface of the manus of specimens of *L. l. leucomanus*.

The subspecies *L. l. heathii* can not be clearly separated from *L. l. leucomanus* on any single character, save that of the pitted carpus. The usual diagnostic features of the two are as follows:

	<i>L. l. heathii</i>	<i>L. l. leucomanus</i>
Carpal number	0-0	7-11
Manus	smooth	heavily pitted
Hepatic region	fairly smooth	rough
Ambulatory legs	carpus slightly bilobed; lateral surface not reticulate.	carpus markedly bilobed; lateral surface reticulate.

*Material examined.*—A total of 154 specimens have been examined of which 84 were males and 70 were females. They were collected at 9 different localities from La Jolla to Monterey, California. The Lower California, Mexico, record for the subspecies (Rathbun, 1930, p. 323) appears to be incorrect in that a re-examination of the specimens (Cat. No. 50635 USNM) on which that record was based has shown them to be *Lophopanopeus frontalis*.

*Geographical distribution.*—(See material examined.) It is clear from Graph 3 that *L. l. heathii* is the northern form of the *L. l. leucomanus-L. l. heathii* complex. Its occurrence at the Channel Islands and at La Jolla is certainly interesting in that no such range prevails for its complementary northern species, *L. b. bellus*. Hewatt (1946) reports *L. l. heathii* (*L. heathi* of Hewatt) to be common at Santa Cruz Island, which distribution is contrary to my data. His collections were, however, much larger than the ones I have examined from that island.

*Ecology.*—The great majority of the specimens examined were collected from the intertidal zone of the protected and unprotected rocky

## DISCUSSION OF CONSTANT FEATURES.

The tip of the flagellum of the male Plp-1 (Pl. 4, fig. 31) is characterized by a lanceolate, spinulate lateral projection (L) originating at the lateral angle of the tip of the flagellum; a narrow truncate hood (H) located at the tip medial to the mid-line of the abdominal surface; a single medial spine (S-1) on the medial surface, located proximally on the flagellum the length of L from the tip; a row of spines (S-2) located in a longitudinal row in the mid-line of the abdominal surface; the presence of spinules (S-3), 4-7 in number, distal to S-1 and located on the lateral border; spinules (S-4) located opposite to L at the medio-distal angle of the flagellum.

The ambulatory legs (Pl. 3, fig. 26) present certain features that are specific. The carpus is characterized by its slight bilobation and by the presence of short dense hairs situated on the dorsal margin and extending distally, in most cases, along the lateral surface of the distal border of the carpus. The carpus of the first leg is most bilobed, whereas the carpus of the last leg shows no bilobation and little lobation. The propodus, never lobate, also has a dorsal margin of pubescence extending onto the lateral surface at the distal border. The characteristics of the merus and dactylus are not specifically distinctive. The ratio of the L/W of the segments of the second walking leg are as follows: 2.0-3.0 (2.7) merus, 1.4-1.8 (1.7) carpus, 1.1-1.6 (1.3) propodus, that of the dactylus is too variable to be of intrageneric value.

The carapace (Pl. 5, fig. 37) is characterized by the absence of pubescence and by the presence of tufts of hairs on the areolations of the epi-branchial and frontal regions. It is very similar in its general morphology to the carapace of specimens of *L. bellus diegensis* (p. 7). The ratio of the carapace width/front width is 2.9-3.3 (3.0).

The teeth of the movable finger of both chelae (Pl. 3, figs. 17-23) are subequal in size, there being no enlarged tooth located at the proximal end of the cutting edge of the dactylus of the major cheliped. In this feature the species is most easily separated from the other species of the genus.

## DISCUSSION OF VARIABLE FEATURES.

The antero-lateral teeth (Pl. 5, figs. 36-37), although constant in location and number, vary as to the strength of their development. Figure 36 shows the short truncate teeth found in 6 per cent of the specimens and Figure 37 shows the typical expression of pointed, anteriorly directed teeth.

The frontal margin (Pl. 3, figs. 27-29) is subject to considerable variation. The produced front (fig. 27) from whence the species derived its

name, is not characteristic of all of the specimens. In fact, two kinds of frontal margins are occasionally found on a single specimen (fig. 28), the front being not bilaterally symmetrical. The produced front was found in 69 per cent of the males and in 33 per cent of the females examined. The front which is not produced (fig. 29) was observed in 22 per cent of the males and in 46 per cent of the females. An intermediate front was noted in 13 per cent of all specimens. No correlation of this variation was observed with locality and specimens taken at the same place showed all three variations.

The carpus (Pl. 3, figs. 24-25) is a feature subject to extreme variation and appears in four recognizable variants, separated from one another only in degree of rugosity.

1. The smooth type (fig. 24) was found in 19 per cent of the males and 5 per cent of the females.

2. A variation of the above, designated as the smooth-rough type in that it shows but slightly elevated ridges, was observed in 49 per cent of the males and in 11 per cent of the females.

3. A rough-smooth carpus which differs from the smooth-rough carpus only in that the ridges are more highly elevated was noted in 14 per cent of the males and 16 per cent of the females.

4. A rough carpus (fig. 25) having deep pits surrounded by sharply elevated ridges was found in 18 per cent of the males and 68 per cent of the females.

Thus more than 50 per cent of the males possessed a smooth or smooth-rough carpus, whereas 84 per cent of the females had a rough or rough-smooth carpus. It follows that the rugosity of the carpus is predominately a female characteristic and that the tendency for a smooth carpus is associated with male specimens. The carpal number for pits, which is 4-4 in this species, is usually countable with the unaided eye on female specimens. In most male specimens it is visible only with the aid of a microscope.

A conspicuous feature common to the carpal segments of both male and female specimens is the large sulcus (figs. 24-25), angular in form, and located parallel to the antero-lateral margin of the carpus.

Previously *L. frontalis* was separated from the other species of the genus on the basis that the dark color of the immovable finger ran well up onto the palm. This character is not constant and four variations of color pattern are recognizable.

1. One in which the dark color of the immovable finger runs far up onto the palm both laterally and medially (figs. 17 and 21), was ob-

served in 20 per cent of the male and none (00 per cent) of the females.

2. A manus in which the color extended on both sides of the palm (fig. 22), but not as far as in 1, was observed in 40 per cent of the males and 8 per cent of the females.

3. One in which the color continued onto the medial surface of the palm but not onto the lateral surface (figs. 19-20) was noted in 30 per cent of the males and in none (00 per cent) of the females.

4. A manus in which the dark color did not extend onto the palm either medially or laterally (figs. 18 and 23) was noted in 10 per cent of the males and in 98 per cent of the females.

The manus (Pl. 3, figs. 17, 20, and 23) varies considerably in the strength and development of tuberculations, lobations and ridges on its dorsal and lateral surfaces. In general the manus of large males is smooth and has a characteristic large, medially directed lobe on the proximal medial surface. In females this lobe is either relatively much increased in size or is reduced. The dorsal surface of the female manus is generally tuberculate in contrast to the smooth dorsal surface predominating in males. The lateral as well as the dorsal surface showed at least three recognizable variations.

1. A smooth manus (fig. 17) having neither tubercles nor ridges formed from tubercles arranged in a reticulating pattern was found in 60 per cent of the males and in 5 per cent of the females.

2. A manus, smooth except for reticulating ridges of tubercles (fig. 20), was found in 33 per cent of the males and 69 per cent of the females.

3. A manus having a tuberculate lateral surface (fig. 23) with or without the reticulating ridges was found in 7 per cent of the males and 36 per cent of the females. It is clear that the tuberculate manus is characteristic of females whereas the smooth manus dominates in males.

No correlation of manus rugosity or color pattern with geographical distribution was noted.

Remarks.—Were the predominating characteristics of female specimens of *L. frontalis* compared with the description of *Lophopanopeus lockingtoni* Rathbun 1900, they would be found to be strikingly similar. A comparison of homoeotypes and hypotypes of *L. lockingtoni* with specimens of similar status of *L. frontalis* clearly showed that they were identical. Thus *L. lockingtoni* is simply the female of *L. frontalis*, a species exhibiting a pronounced sexual dimorphism.

*Material examined.*—The writer has examined 53 specimens of which 33 were males and 20 were females. They were collected at 17 different

localities ranging from the Gulf of California, Mexico and the west coast of Lower California, Mexico to San Pedro Bay, California.

*Geographical distribution.*—(See material examined.) The species appears to be rare throughout its range. The data indicate that it is most common near San Diego, California.

*Ecology.*—All specimens examined by the writer were collected from bay localities. Frequently the specimens were found in sponges; most, however, were collected from under stones and debris in the intertidal zone. Here the substratum varied from sand to sand-mud, and although the tidal currents were fairly swift no extensive wave action was apparent.

No specimens were collected below 20 fathoms and the data indicate that the species is predominately intertidal in habitat.

*Breeding notes.*—Although female specimens were collected during the months of January, February, March and August, only the months of January and February showed any ovigerous specimens. These were all from the Gulf of California, Mexico.

Certainly many more specimens, collected during the other months of the year, are desired before an accurate breeding time can be established.

***Lophopanopeus olearis*** Rathbun 1926, pp. 57-58, pl. 11, fig. 4.

This is an Oligocene species and for that reason is not included in the key to the species of the genus. It is at present not clearly separated from the other species of the genus. A redescription is certainly necessary before the relationship between the recent and fossil species can be determined.

***Lophoxanthus erosus*** Parisi 1916, pp. 181-182, fig. 4.

Pl. 4, fig. 33

The figure of the male Plps-1 drawn from the type by Dr. Bruno Parisi and reproduced here with his permission clearly shows that the species is not a *Lophopanopeus*.

Balss (1922, p. 125) believed it to be a synonym of *Lophopanopeus japonicus* Rathbun which species has since been shown to be a synonym of *Medaeus granulatus* (Haswell 1882), (Gordon 1931, p. 543). Odhner (1925, p. 81) considered Parisi's species to be a synonym of *Medaeus distinguendus* De Haan (= *Xantho*).

The pleopods of *Lophoxanthus erosus* are sufficiently different from those of *M. granulatus* and *X. distinguendus* (Gordon 1931, fig. 22A and C) that the species can be considered valid.

The species was originally taken from the Bay of Japan.

**Cancer oregonensis** (Dana 1852)

Pl. 6, figs. 39-42

*Lophopanopeus somaterianus* Rathbun 1930, p. 332, pl. 153, figs. 3-4.

The species *Lophopanopeus somaterianus* was based on two dactyls of the right chela which were taken from the stomachs of the duck *Somateria* at St. George Island, Pribilof Islands, Bering Sea, Alaska. The holotype was taken from *Somateria spectabilis* and the paratype from *Somateria v-nigra*.

The paratype (Pl. 6, figs. 39-40) was found to have little in common with the dactyls of the chelipeds of the existing species of *Lophopanopeus*. It did however show striking similarities with those of *Cancer oregonensis* which species has a range extending to the locality whence *Lophopanopeus somaterianus* was taken.

The fact that the specimen of *Cancer oregonensis* shown in Plate 6, figs. 41-42, was not entirely identical in certain respects with the paratype of *L. somaterianus* necessitated that the range of variability of the characteristics in which they were not identical be determined. This was done by the examination of the dactyls of the chelipeds of twenty specimens of *Cancer oregonensis* (Station numbers 1463-42 and 1492-42, Coos County, Oregon), including 18 females and 2 male specimens. The variations noted are given, together with a comparison of the same features on the paratype and the type (when possible from the figures given by Rathbun 1930, Pl. 153, figs. 3-4) of *Lophopanopeus somaterianus*.

1. The location of the inner tooth (a, figs. 39-40) varied from being located opposite tooth 1, between teeth 1 and 2, between the first accessory tooth and tooth 1, or it was absent. In the paratype it is located between tooth 1 and 2 as it also is in the type. Here, however, it is nearer tooth 1 than it is in the paratype.

2. The number of teeth along the cutting edge of the dactylus varied from 4-6. The type has 6 as does the paratype.

3. Seven rows of punctae were present on all specimens examined. Three rows are present laterally, one dorsally and three medially. They are numbered consecutively starting with the most ventro-lateral row as number one. The fourth, or dorsal row, though present on the paratype, was not mentioned in the description of *Lophopanopeus somaterianus*.

4. The number of punctae present in each row was subject to considerable variation. The range of variation is given in the following tabulation in which the average is given in parenthesis.



Row 1.	2-6(3)	.....type	?.....paratype	3
Row 2.	1-9(4)	.....type	?.....paratype	4
Row 3.	6-12(8)	.....type	?.....paratype	8
Row 4.	2-7(5)	.....type	?.....paratype	5
Row 5.	0-3(2)	.....type	?.....paratype	7
Row 6.	2-7(5)	.....type	?.....paratype	5
Row 7.	3-5(4)	.....type	?.....paratype	4

It is to be noted that in every case except one (that of row 5) the number of punctae of the rows of the paratype is well within the range of variability; indeed, it is in most cases average in number. The writer believes that the deviation in the number of punctae in excess of the average is simply a case of extreme variation, as was evidenced in the number of punctae present in some of the other rows.

Frequently, especially in rows 2, 6, and 7, the punctae are so indented and elongated that a furrow is formed.

In other features little variability was exhibited and the specimens figured appear to be identical in those respects. Such features include the fine granulation and the extent of the dark coloring of the dactyls, the nature of the joint mechanism, the presence of pit X (figs. 39-42), and their general shape.

In view of the above considerations, it is the writer's recommendation that *Lophopanopeus somaterianus* be henceforth considered a synonym of *Cancer oregonensis*.

**Hexapanopeus lobipes** (A. Milne Edwards 1880),  
new combination

*Lophopanopeus lobipes* (A. Milne Edwards), Rathbun 1930, pp. 329-330, pl. 155, figs. 3-5, text-fig. 50.

This species does not fit the generic diagnosis of *Lophopanopeus*. The fronto-orbital width is greater than ~~the~~<sup>1/2</sup> the width of the carapace; the meral segments of the ambulatory legs have a spinulate dorsal margin; the general carapace shape is more ovoid than hexagonal, and the tip of the flagellum of the male Plp-1 has few features comparable with the tip of the flagellum of the male Plp-1 of the species of the genus *Lophopanopeus*. The tip of Plp-1 has one lateral spinulate spine, one medial spinulate spine and a pointed hood. It has no lateral projection and no medial spine (s) which is (are) non spinulate as is the case of *Lophopanopeus* species.

I have placed it in the genus *Hexapanopeus* because it seems to fit the diagnosis of that genus better than that of any other American genus.

*Material examined.*—One homoeotype male, USNM Cat. No. 76199, from Tortugas, Florida. Drawings of the tip of the flagellum of Plp-1 of the type which drawings were sent to me by Dr. Elisabeth Deichmann.

**Micropanope(?) maculatus** (Rathbun 1898),  
new combination

*Lophopanopeus maculatus* Rathbun 1930, pp. 330-331, text-fig. 51.

The examination of a homoeotype male of this species in the collections of the Allan Hancock Foundation showed that the species does not belong in the genus *Lophopanopeus*. In Rathbun's monograph (1930, pp. 234-239) it keys out to the genus *Micropanope*, the generic diagnosis of which it also fits.

**Micropanope distinctus** (Rathbun 1898),  
new combination

*Lophopanopeus distinctus* Rathbun 1930, pp. 131-132, pl. 155, figs. 1-2.

This species seems more closely related to *Micropanope* than to *Lophopanopeus* in that it has five distinct antero-lateral teeth, spinulate legs and a fronto-orbital width that is much greater than the carapace width. It appears closely related to *Micropanope sculptipes* Stimpson (Rathbun 1930, pp. 148-149) from which it is doubtfully distinct.

*Material examined.*—One female homoeotype, USNM Cat. No. 20717.

1/2

## LIST OF THE TYPES DESIGNATED IN THIS STUDY

This list is provided for the benefit of future workers on the genus and tells where the specimens are located together with their catalogue number, accession number or station number.

*Lophopanopeus bellus bellus* (p. 4)

Allan Hancock Foundation

Male hypotype, Sta. 1580-47

Male hypotype, Sta. 1581-47

*Lophopanopeus bellus diegensis* (p. 7)

Allan Hancock Foundation

Male hypotype, Sta. 1407-40

*Lophopanopeus leucomanus leucomanus* (p. 10)

Allan Hancock Foundation

Male holoneotype, Cat. No. 461

Female alloneotype, Cat. No. 461a

Female paraneotype, Sta. 1295-41

United States National Museum

Male paraneotype, Cat. No. 50208

Pacific Marine Station

Male paraneotype, Acc. No. 625 PMS

*Lophopanopeus leucomanus heathii* (p. 13)

Allan Hancock Foundation

Male hypotype, Sta. 1576-46

*Lophopanopeus frontalis* (p. 16)

Allan Hancock Foundation

Male hypotype, RJM 53

Male hypotype, RJM 290c

Female hypotype, Sta. 1045-40

Female hypotype, Sta. 503-36

Male hypotype, Sta. 1045-40

United States National Museum

Male hypotype, Cat. No. 52628

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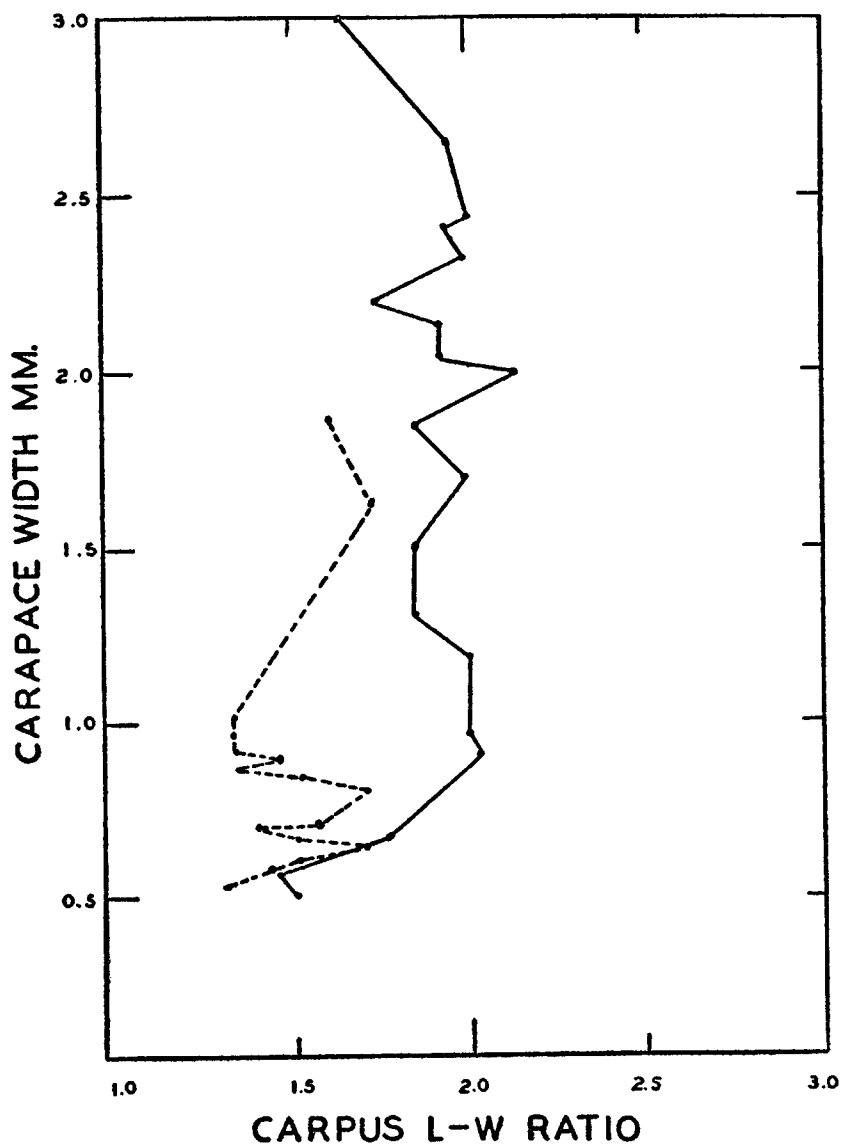
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## GRAPH 1

A graphic representation of the ratio of the length/width of the carpus of the second walking leg plotted against the carapace width.  
----- *Lophopanopeus bellus diegensis*, 16 specimens from Los Angeles County, California.  
——— *Lophopanopeus bellus bellus*, 19 specimens from Coos County, Oregon.

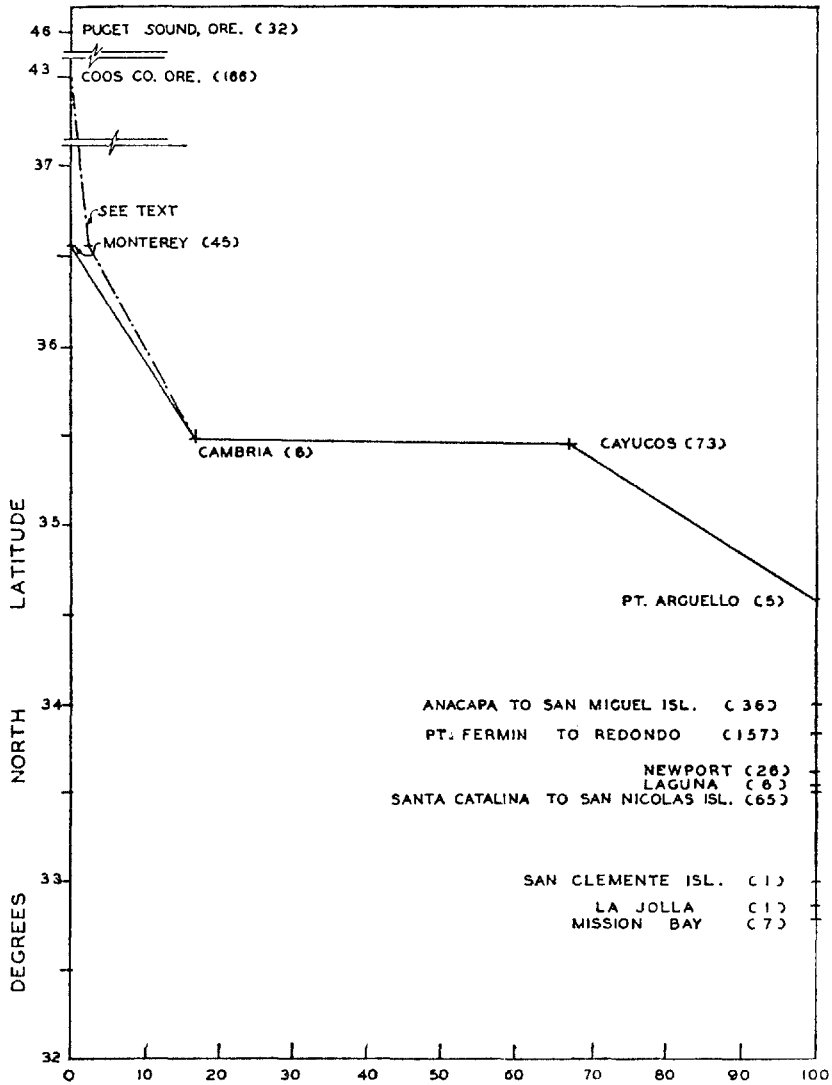


## GRAPH 2

On this graph the per cent of *Lophopanopeus bellus diegensis*/*Lophopanopeus bellus bellus* is plotted against the degrees north latitude. Were the percent of *L. b. bellus*/*L. b. diegensis* represented it would be a mirror image of that shown for *L. b. diegensis*.

The number to the right of the localities indicates the number of specimens of both subspecies examined from that locality.

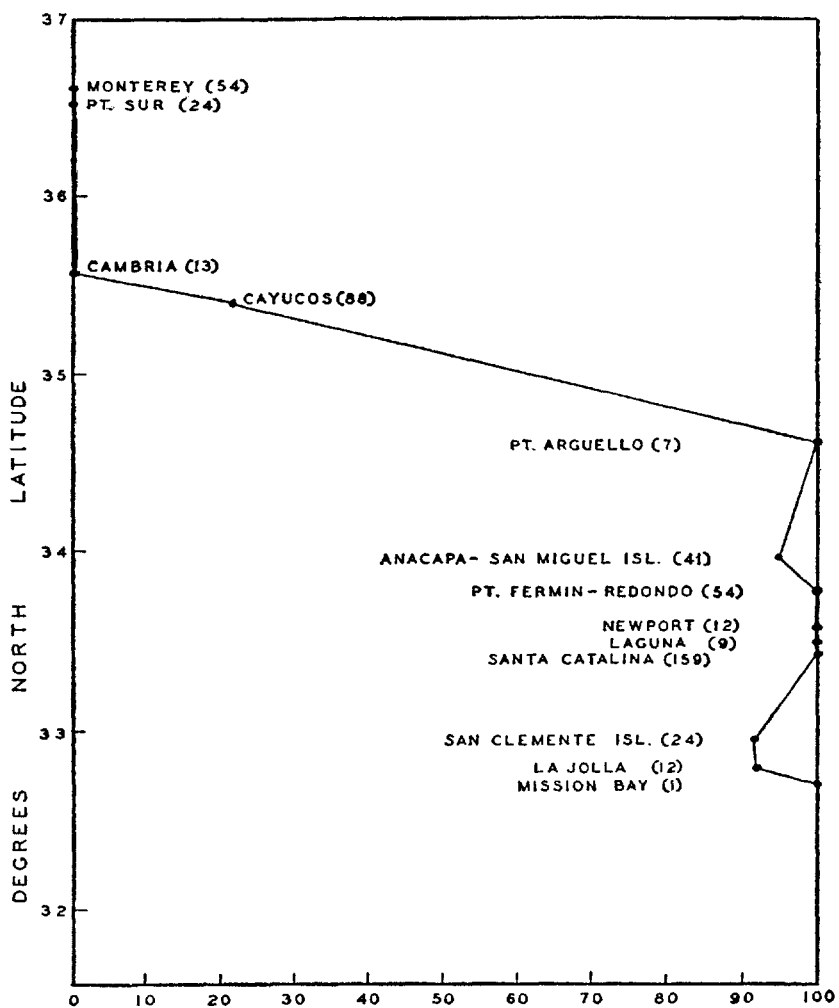




## GRAPH 3

Here the per cent of *Lophoanopeus leucomanus leucomanus*/*Lophoanopeus leucomanus heathii* is plotted against the degrees north latitude. As with Graph 2 were the per cent of *L. l. heathii*/*L. l. leucomanus* represented it would be a mirror image of that shown for *L. l. leucomanus*.

The number to the right of the localities indicates the total number of both subspecies examined from that locality.



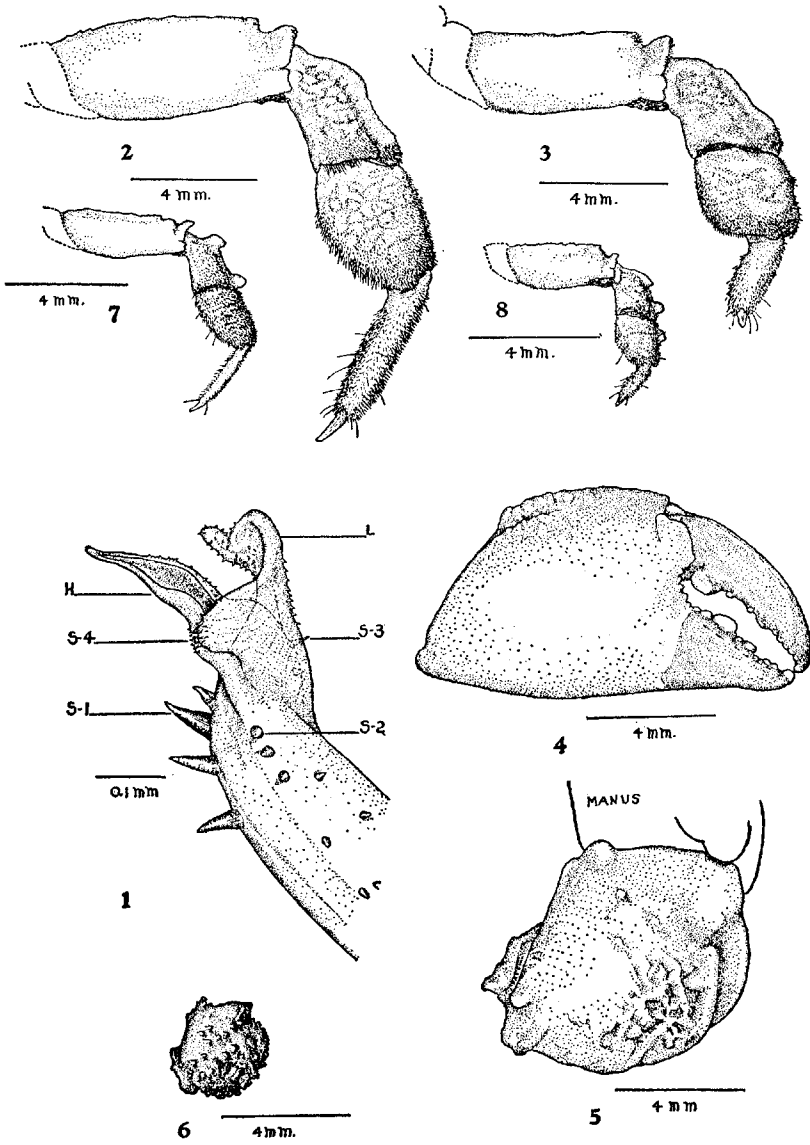
## PLATE 1

*Lophopanopeus bellus bellus* (Stimpson), (p. 4)

- Fig. 1 Plp-1, left, abdominal view of tip, male hypotype, Sta. 1581-47  
Fig. 2 Ambulatory leg 2, right, lateral view, male hypotype, Sta. 1580-47  
Fig. 3 Ambulatory leg 4, right, lateral view, male hypotype, Sta. 1580-47  
Fig. 4 Cheliped, right, lateral view, male hypotype, Sta. 1580-47  
Fig. 5 Carpus, right, dorsal view, male hypotype, Sta. 1580-47

*Lophopanopeus bellus diegensis* (Rathbun), (p. 7)

- Fig. 6 Carpus, right, dorsal view, male hypotype, Sta. 1407-40  
Fig. 7 Ambulatory leg 2, lateral view, male hypotype, Sta. 1407-40  
Fig. 8 Ambulatory leg 4, lateral view, male hypotype, Sta. 1407-40



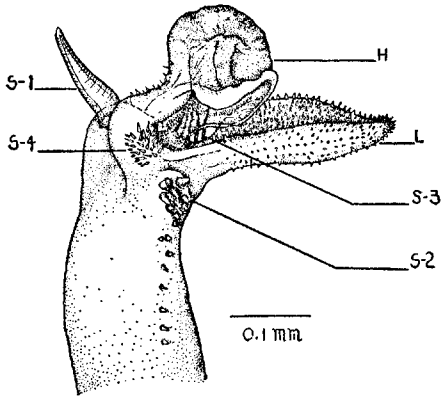
## PLATE 2

*Lophopanopeus leucomanus leucomanus* (Lockington), (p. 10)

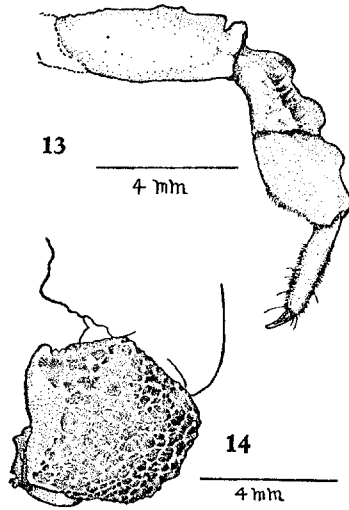
- Fig. 9 Plp-1, left, abdominal view, male paraneotype, USNM 50208  
Fig. 10 Cheliped, right, lateral view, male paraneotype, USNM 50208, smooth variety  
Fig. 11 Cheliped, left, lateral view, female paraneotype, Sta. 1295-41, rough variety  
Fig. 12 Frontal region, male paraneotype, USNM 50208  
Fig. 13 Ambulatory leg 2, lateral view, male paraneotype, USNM 50208  
Fig. 14 Carpus, right, dorsal view, male paraneotype, USNM 50208

*Lophopanopeus leucomanus heathii* (Rathbun), (p. 13)

- Fig. 15 Ambulatory leg 2, lateral view, male hypotype, Sta. 1576-46  
Fig. 16 Carpus, right, dorsal view, male hypotype, Sta. 1576-46



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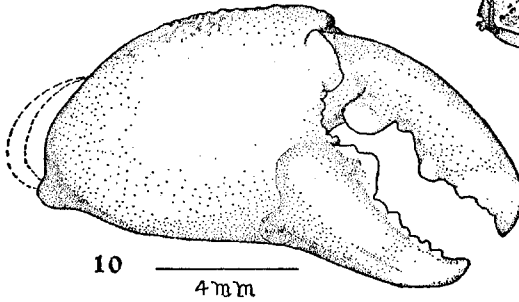


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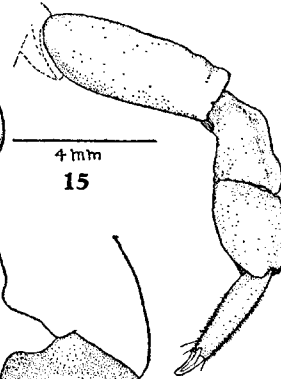
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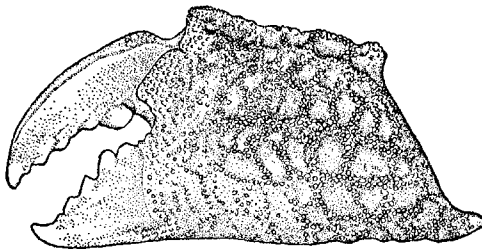
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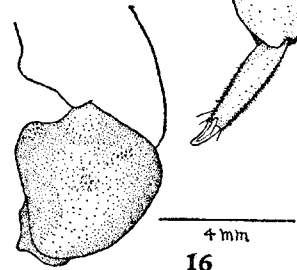
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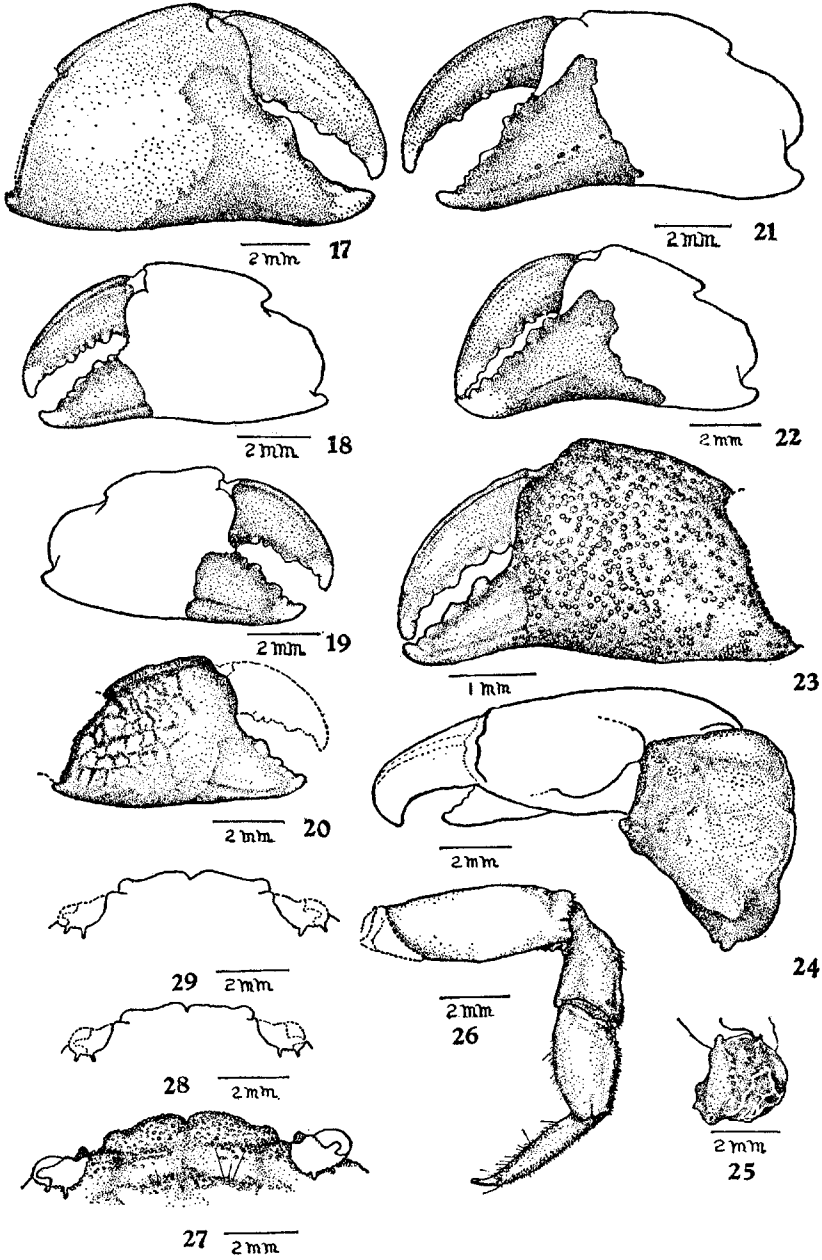
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## PLATE 3

*Lophopanopeus frontalis* (Rathbun), (p. 16)

- Fig. 17 Cheliped, right, lateral view, male hypotype, Sta. 1045-40  
Fig. 18 Cheliped, left, lateral view, female hypotype, Sta. 1045-40  
Fig. 19 Cheliped, right, lateral view, male hypotype, RJM 290c  
Fig. 20 Cheliped, right, lateral view, male hypotype, Sta. 1224-40  
Fig. 21 Cheliped, left, lateral view, male hypotype, USNM 52628  
Fig. 22 Cheliped, left, lateral view, male hypotype, RJM 53  
Fig. 23 Cheliped, left, lateral view, female hypotype, Sta. 503-36  
Fig. 24 Carpus, left, dorsal view, male hypotype, USNM 52628  
Fig. 25 Carpus, left, dorsal view, female hypotype, Sta. 1045-40  
Fig. 26 Ambulatory leg 2, lateral view, male hypotype, USNM 52628  
Fig. 27 Frontal region, male hypotype, USNM 52628  
Fig. 28 Outline of front, male hypotype, RJM 290  
Fig. 29 Outline of front, male hypotype, RJM 53





## PLATE 4

*Lophopanopeus frontalis* (Rathbun), (p. 16)

Fig. 30 Plp-1, left, abdominal view, male hypotype, RJM 53

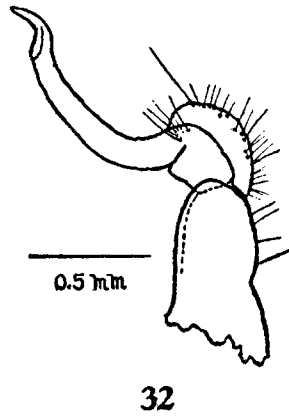
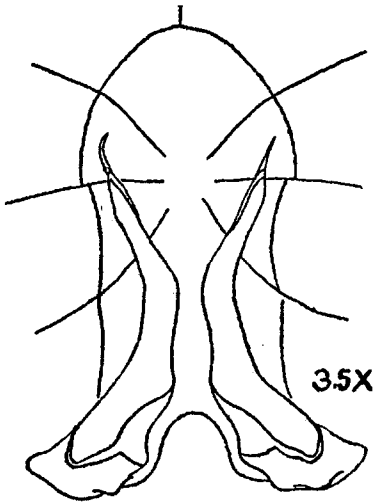
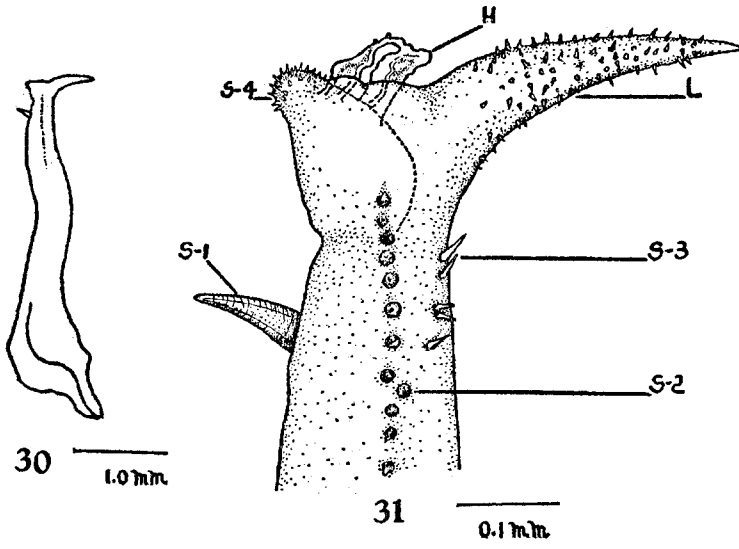
Fig. 31 Plp-1, left, abdominal view of tip, male hypotype, RJM 53

Fig. 32 Plp-1, left, abdominal view, male hypotype, RJM 53

*Lophoxanthus erosus* Parisi, (p. 21)

Fig. 33 Abdominal view of second pleopods, figures by Dr. Bruno Parisi, 3.5x

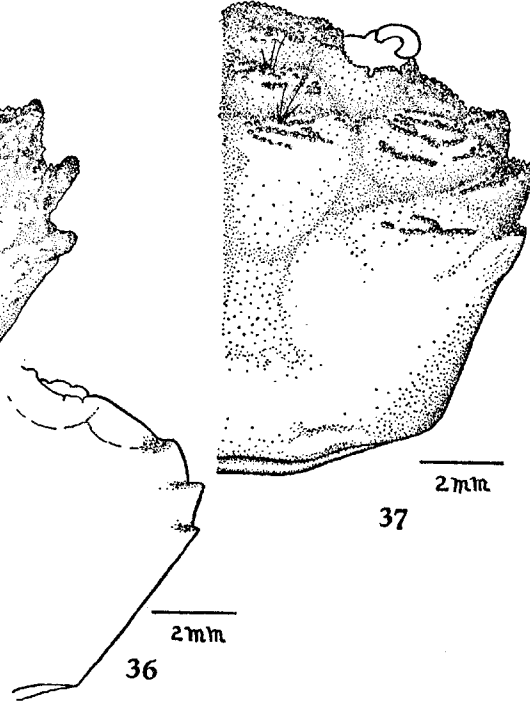
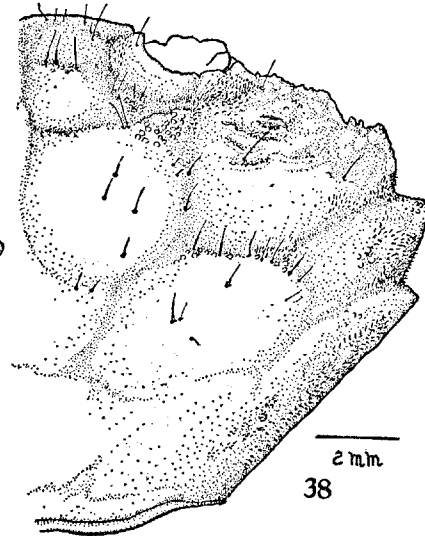
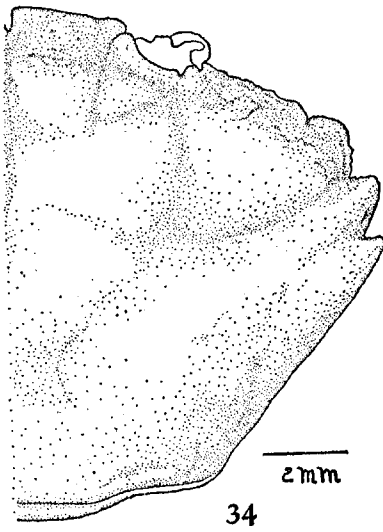
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## PLATE 5

- Lophopanopeus leucomanus heathii* (Rathbun), (p. 13)  
Fig. 34 Carapace, right side, dorsal view, male hypotype, Sta. 1576-46  
*Lophopanopeus leucomanus leucomanus* (Lockington), (p. 10)  
Fig. 35 Carapace, right side, dorsal view, male paraneotype, USNM 50208  
*Lophopanopeus frontalis* (Rathbun), (p. 16)  
Fig. 36 Carapace outline, right side, dorsal view, female hypotype, Sta. 1045-40  
Fig. 37 Carapace, right side, dorsal view, male hypotype, USNM 52628  
*Lophopanopeus bellus bellus* (Stimpson), (p. 38)  
Fig. 38 Carapace, right side, dorsal view, male hypotype, Sta. 1580-47



## PLATE 6

*Lophopanopeus somaterianus* Rathbun, (p. 22)

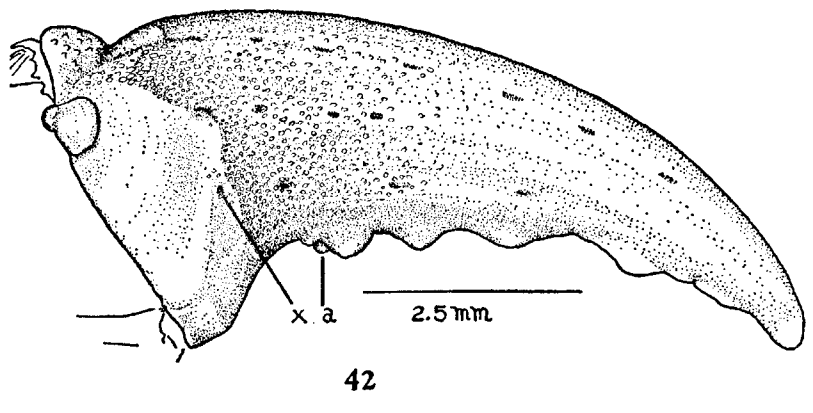
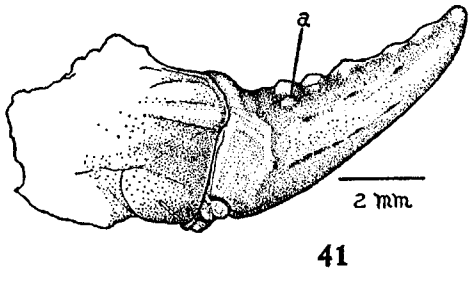
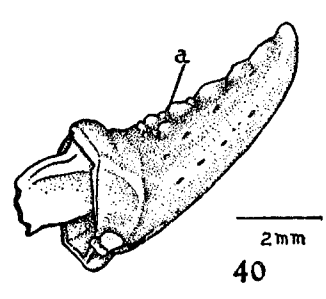
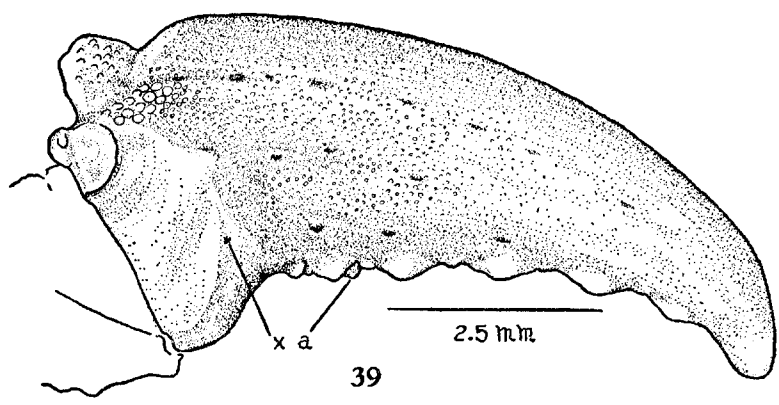
Fig. 39 Dactylus of right cheliped, lateral view, paratype, USNM 61138

Fig. 40 Dactylus of right cheliped, medial view, paratype, USNM 61138

*Cancer oregonensis* (Dana), (p. 22)

Fig. 41 Dactylus of right cheliped, medial view, male hypotype, Sta. 1492-42

Fig. 42 Dactylus of right cheliped, lateral view, male hypotype, Sta. 1492-42



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