

THE GENUS *CANCER* (CRUSTACEA:  
BRACHYURA): SYSTEMATICS, BIOGEOGRAPHY  
AND FOSSIL RECORD

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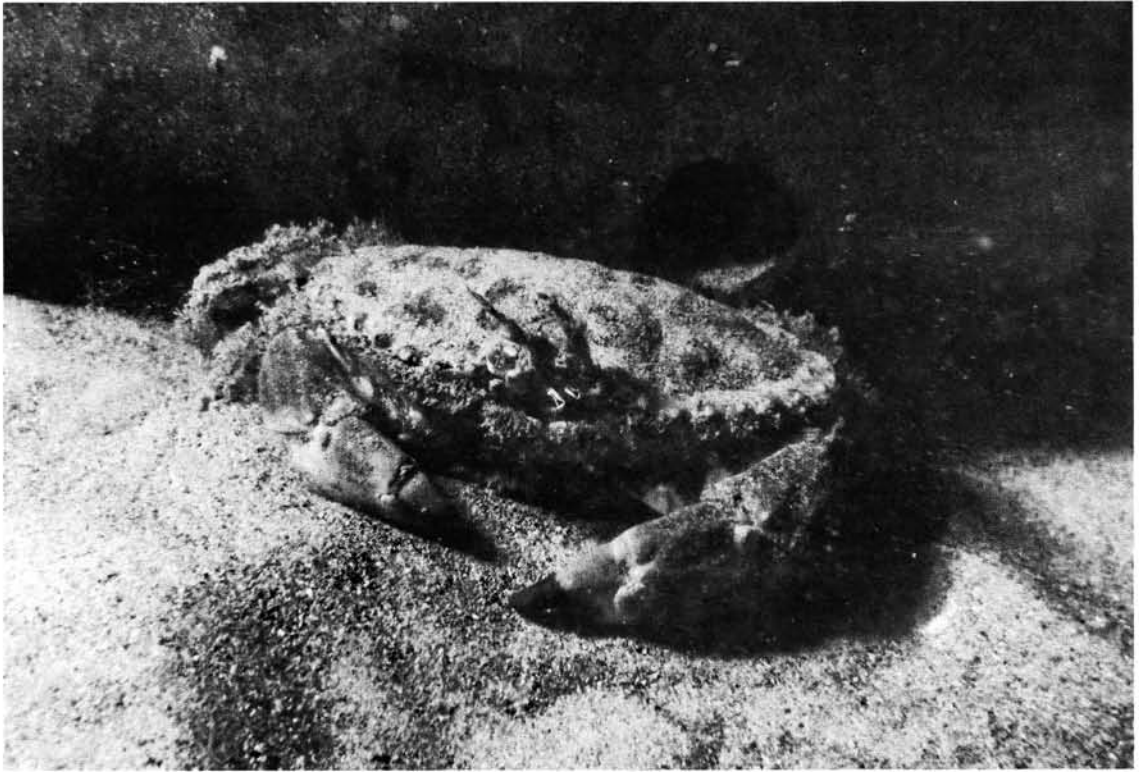
*By* J. DALE NATIONS



NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY  
SCIENCE BULLETIN 23. June 30, 1975



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FRONTISPIECE. A member of the genus *Cancer*. Photograph by T. Hobson.

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# THE GENUS *CANCER* (CRUSTACEA: BRACHYURA): SYSTEMATICS, BIOGEOGRAPHY AND FOSSIL RECORD<sup>1</sup>

By J. DALE NATIONS<sup>2</sup>

**ABSTRACT:** The Genus *Cancer* (Crustacea: Brachyura) is represented by 23 living species and at least 32 species known only as fossils. All reports of fossil occurrences of *Cancer* are reviewed. The 23 named living species of *Cancer* are described and illustrated and their geographic and stratigraphic ranges are given. Their geographic distributions are correlated with water temperatures and migrational barriers.

*Cancer* is most diversified on the west coast of North America where nine of the 23 living species occur. Detailed descriptions and illustrations of claw parts of living and fossil species found in this area are given. Interspecific variation in shape and ornamentation of isolated claw parts is adequate for species identification. A biometrical analysis of intraspecific variation provides quantitative data to aid in identification of species and in definition of new taxa.

The time and area of origin of the genus *Cancer*, phylogenetic relationships of its species, and their patterns of dispersal are discussed. Four subgenera, *Cancer* (*Cancer*) Linnaeus 1758; *Cancer*, (*Glebocarcinus*) new subgenus; *Cancer* (*Romaleon*) Gistel 1848; and *Cancer* (*Metacarcinus*) A. Milne-Edwards 1862, are recognized based on characters of the carapace.

The stratigraphic distribution of all North and South American west coast species is given in modern stratigraphic terminology. The oldest accepted record of *Cancer* is in the Miocene, when the genus had a worldwide distribution. On the west coast of North America six species are known from the Miocene, 18 from the Pliocene, and 13 from the Pleistocene. All Recent west coast species are known as fossils, seven of which range into the Pliocene. Three living species are reported as fossil for the first time and the stratigraphic ranges of five others are extended. One recent South American species is reported from the Pliocene of California, its first known occurrence in the Northern Hemisphere. Additional material of two extinct species is described, extending their geographic and stratigraphic ranges.

Ten new species of *Cancer* are named, described, and illustrated; 2 Miocene, 1 Miocene-Pliocene, 4 Pliocene, 2 Miocene-Pleistocene, and 1 Pleistocene. These are *C. allisoni*, *marri*, *danai*, *dereki*, *yanceyi*, *garthi*, *durhami*, *coosensis*, *jenniferae*, and *chaneyi*. Four of the new species, *C. allisoni*, *dereki*, *coosensis*, *chaneyi*, are interpreted as ancestral to the four subgenera proposed here. Two Lower Tertiary west coast species, *C. gabbi* Rathbun 1926 and *C. bainbridgensis* Rathbun 1926 are assigned to other genera.

## INTRODUCTION

### Purpose

The purpose of this study is basically two-fold. First, to up-date the fossil record of the decapod crustacean genus *Cancer*, and to interpret the biogeography and stratigraphic significance of the group. Second, to describe and evaluate the taxonomic significance and ranges of variation of certain isolated parts (e.g., hands, fingers) of the decapod exoskeleton.

### Scope and Method of Study

The fossils assigned to the genus *Cancer* were prepared for study by standard preparation techniques, i.e., hammer and chisel, vibratools, air-abrasive equipment, and needles. Regular sewing needles were found to be best for cleaning matrix from delicate specimens. Each specimen was then compared with the corresponding parts of Recent and fossil species to determine its specific identity. Biometrical techniques were used where direct comparison did not show unquestionable similarity with existing species and the proposal of new species seemed necessary.

The literature on both Recent and fossil crabs usually is inadequate for identification of fossil material because emphasis is placed on the characters of the carapace, which is rarely preserved, and the illustrations of the chelipeds are generally inadequate for detailed comparison. For this reason, identification of fossil material must be preceded by detailed studies on the morphology and variation of various parts (particularly the chelipeds) of Recent species. Much of the research was devoted to the recognition of species using only cheliped characters.

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Biometrical analysis has been employed in the comparison of all the species on the west coast of North America to establish reasonable limits of variation and to assist in the identification of poorly preserved material. A standard series of measurements has been established and tested for validity. This provides several parameters for the comparison of the parts of the crab skeleton that most commonly occur as fossils. These measurements and parameters are discussed in the section on Statistical Data and Analysis.

The standard series of measurements was established by carefully measuring between well-defined points on each portion of the skeleton commonly found as fossil, e.g., movable finger, fixed finger, manus, and carpus. These measurements were made on Recent specimens of varying size and sex, and the ratios of pairs of measurements were plotted graphically to test their consistency, thereby evaluating their taxonomic significance. Those ratios which varied widely were discarded as taxonomically insignificant and those which varied within limited ranges and tended to differentiate the previously established species were retained as taxonomically significant. Some species overlap in one or more of the ranges of parameters but can be differentiated on others (see Table 1).

These parameters are not considered as definitive proof of specific identity by themselves, but are to be used more as guides to the degree of similarity between specimens, as a means of quantitatively expressing the normal variation within a species, and, in the case of fragmentary fossil specimens, as a means of comparing isolated parts with those of more complete or better preserved specimens. The final analysis of the identity of fossil material must be based upon the comparison with other specimens in details of shape and ornamentation, but these may be strongly supplemented by the parameters mentioned above.

The following characters are used in the identification of west coast of North America species of *Cancer*.

1. Number, size and shape of anterolateral teeth on carapace. A convenient quantitative expression of these characters can be made by plotting the width of each tooth against its position on the carapace, and is useful in differentiating fossil carapaces.

2. Size, shape and distribution of granules on the carapace and chelipeds.

3. Number, size, shape and distribution of cutting teeth on movable and fixed fingers. Occasionally these will vary markedly from the normal and cannot be used alone. It is my opinion that these variations are, at least in some instances, found on regenerated limbs. In all observed cases, these

variants have more and smaller cutting teeth than normal.

4. Number and shape of spines on upper margin of movable finger, manus and carpus. This character is quite constant and useful in identifying spiny species such as *C. magister*, *polyodon*, *branneri* and *plebejus*.

5. Ratio of length of upper margin to height of manus (Lu/H).

6. Ratio of thickness to height of manus (T/H).

7. Ornamentation and sculpturing of movable and fixed fingers, particularly the presence and arrangement of ridges, grooves, spines, granules and pits. These characters can be definitive, even in the case of anomalous cutting-tooth form and arrangement noted above.

8. Frontal region:

a. Ratio fronto-orbital width to carapace width.

b. Shape, relative length and distance between the five frontal teeth.

c. Shape of supra- and suborbital lobes or teeth.

d. Shape and size of orbits.

e. Degree of production of front.

9. Areolation of carapace, i.e., the division of the carapace into distinct regions, separated by grooves.

Intraspecific variability is greater in characters of the carapace than in those of the chelipeds especially between molt stages, therefore, caution must be used to make direct comparisons only between specimens of similar size. Ontogenetic and sexual variation in the characters of the carapace may lead to misidentification of Recent as well as fossil material. The above noted features of the cheliped appear to remain relatively constant in the ontogeny of *Cancer*. The only significant variation observed due to growth in the cheliped is the increased smoothness (reduction of prominence of carinae) on the manus of large specimens of certain large species (e.g., *C. productus*). No significant sexual dimorphism in cheliped characters has been observed. The chelipeds of *Cancer* are equal and symmetrical.

#### ACKNOWLEDGMENTS

I wish to express my thanks to J. Wyatt Durham of the University of California for his advice during the course of this study; to John S. Garth of the Allan Hancock Foundation, University of Southern California for his advice on decapod crustacean taxonomy and ranges of living species and for providing numerous specimens of *Cancer*; to Jack A. Wolfe for his criticism of the manuscript and to Donald E. Savage and Joseph T. Gregory for their advice

TABLE 1.  
STRATIGRAPHIC DISTRIBUTION OF SPECIES OF *CANCER*  
IN WESTERN NORTH AND SOUTH AMERICA

AGE	FORMATION																									
		<i>C. amphioetus</i>	<i>C. antennarius</i>	<i>C. anthonyi</i>	<i>C. branneri</i>	<i>C. gracilis</i>	<i>C. jordani</i>	<i>C. magister</i>	<i>C. oregonensis</i>	<i>C. productus</i>	<i>C. polyodon</i>	<i>C. davidi</i>	<i>C. fissus</i>	<i>C. granti</i>	<i>C. urbanus</i>	<i>C. allisoni</i>	<i>C. marri</i>	<i>C. danae</i>	<i>C. dereki</i>	<i>C. yanceyi</i>	<i>C. garthi</i>	<i>C. durhami</i>	<i>C. coosensis</i>	<i>C. jenniferae</i>	<i>C. chaneyi</i>	
PLEISTOCENE	1 Terrace deposits, Baja, Calif.		⊗																							
	1 Bay Point Formation		⊗																							
	1 Palos Verdes Sand		⊗																							
	1 Millerton Formation		⊗																							
	9 unnamed, Bandon Quad., Ore.		⊗																							
	2 Elk River Beds																									
	1 San Pedro Sand		⊗																							
	1 Timms Point Silt		⊗																							
	1 Lomita Marl		⊗																							
	1 Saugus Formation		⊗																							
	2 Santa Barbara Formation																									
7 San Joaquin Formation																										
PLIOCENE	unnamed (Pico ?), Rustic Canyon																									
	1 Pico Formation																									
	2 Cascajo Conglomerate																									
	2 Merced Formation																									
	3 San Diego Formation																									
	4 Purisima Formation at Capitola																									
	2 Scotia Bluffs Sandstone																									
	1 Etchegoin Formation																									
	10 unnamed, Moonstone Beach, Calif.																									
	2 Coos Conglomerate																									
MIOCENE	U 1 Neroly Formation																									
	1 Briones Sandstone																									
	6 Monterey Formation																									
	1 Round Mountain Silt																									
	1 Olcese Sand																									
	5 unnamed, dredged, Coos Bay, Ore.																									
	8 Sobrante Formation																									

Note: This table is composite and some formations shown superposed may be laterally equivalent.

⊗ = Southern extension of geographic range

⊠ = Northern extension of geographic range

Age references:

1. Weaver, *et al.*, 1944
2. Keroher, 1966
3. Zullo, 1969a
4. California Division of Mines, 1958
5. Moore, 1963
6. Cummings, *et al.*, 1954
7. Durham, *et al.*, 1954
8. Lutz, 1951
9. Zullo, 1969b
10. Hertlein and Grant, 1943
11. Zullo, Wolfe and Durham (oral communication, July 9, 1969)

⊠ = Upper Pleistocene, San Juan Bay, Peru

during the course of this investigation; and to numerous staff members of the National Museum of Natural History, U.S. Geological Survey at Menlo Park, San Diego State College, University of California at Los Angeles, Natural History Museum of Los Angeles County, Stanford University, California Academy of Sciences, University of Oregon, University of Washington, University of British Columbia, and the University of California at Berkeley for supplying specimens of fossil crabs for study. The drawings of text figures were made by Pat Lufkin, staff artist in the University of California Museum of Paleontology. Photography was done by Ron Wolff, formerly in the Department of Paleontology, University of California, Berkeley.

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#### THE GENUS *CANCER* LINNAEUS 1758

##### Recent species

The genus *Cancer* is widely distributed in temperate oceans, being represented by the following 23 Recent species:

	Atlantic Ocean	
<i>Cancer bellianus</i> Johnson 1861		Iceland to N.W. Africa
<i>Cancer pagurus</i> Linnaeus 1758		Western and southern Europe
<i>Cancer borealis</i> Stimpson 1859		Eastern North America
<i>Cancer irroratus</i> Say 1817		Eastern North America
	Pacific Ocean	
<i>Cancer amphioetus</i> Rathbun 1898		Western North America and E. Asia
<i>Cancer antennarius</i> Stimpson 1856		Western North America
<i>Cancer anthonyi</i> Rathbun 1897		Western North America
<i>Cancer branneri</i> Rathbun 1926		Western North America
<i>Cancer gracilis</i> Dana 1852		Western North America
<i>Cancer jordani</i> Rathbun 1900		Western North America
<i>Cancer magister</i> Dana 1852		Western North America
<i>Cancer oregonensis</i> Rathbun 1898		Western North America
<i>Cancer productus</i> Randall 1839		Western North America
<i>Cancer edwardsii</i> Bell 1835		Western South America
<i>Cancer plebejus</i> Poepfig 1836		Western South America
<i>Cancer polyodon</i> Poepfig 1836		Western South America
<i>Cancer porteri</i> Rathbun 1930		Western South America Gulf of California
<i>Cancer sakaii</i> Takeda and Miyake 1972		Eastern Asia
<i>Cancer gibbosulus</i> (De Haan 1835)		Eastern Asia
<i>Cancer japonicus</i> Ortmann 1893		Eastern Asia
<i>Cancer nadaensis</i> Sakai 1969		Eastern Asia
<i>Cancer tumifrons</i> Yokoya 1933		Eastern Asia
<i>Cancer novaezealandiae</i> (Jacquinot) [In: Jacquinot and Lucas 1853]		New Zealand, Tasmania and Australia

#### Fossils--a general evaluation

At least 58 fossil species have been assigned to *Cancer*, ranging in age from Upper Cretaceous to Pleistocene (Glaessner 1929; Zoological Record 1926 to 1969). However, Glaessner (1969) recognizes none older than Miocene because "most of the pre-Miocene species listed as *Cancer* in the Fossilium

Catalogus (Glaessner 1929) are unrecognizable or undocumented" (personal communication, April 28, 1969). Sixteen of the 58 reported species are thereby eliminated. I have been able to verify 22 and eliminate four of the remaining 42 species, leaving 16 unverified Miocene or younger species of *Cancer*. Specimens or illustrations of these 16 species must be examined to determine their validity.

The following list includes all reports of fossil species of *Cancer* in the Fossilium Catalogus and in the Zoological Record through 1969. The numbers in parentheses on the left margin indicate my evaluation of the reliability of the generic assignment, and the reason for it. The significance of the numbers

is given below:

- (1) eliminated by Glaessner (see above).
- (2) eliminated by examination of specimen, illustration, or description.
- (4) unverified by me.
- (5) acceptable.

Species listed in Fossilium Catalogus (Glaessner 1929)

(1) <i>C. aldenardensis</i> Delvaux 1887 nom.nud.	Ypresian	Belgium
(5) <i>C. anthonyi</i> Rathbun 1926	Pleist.-Rec.	N. America
(1) <i>C. archiaci</i> H.M. Edwards 1850 nom.nud.	Lutetian	Austria
(2) <i>C. bainbridgensis</i> Rathbun 1926	Oligocene	N. America
(4) <i>C. bittneri</i> Toulou 1904	Tortonian	Austria
(5) <i>C. branneri</i> Rathbun 1926	Pleist.-Rec.	N. America
(1) <i>C. burtini</i> Galeotti 1837	M.&U. Eocene	Belgium
(4) <i>C. carniolicus</i> Bittner 1883	Miocene	Yugoslavia
(4) <i>C. cf. carniolicus</i> Bittner 1898	Tortonian	Hungary
(5) <i>C. fissus</i> Rathbun 1908	Pliocene	California
(1) <i>C. flandricus</i> Delvaux 1884 nom.nud.	Ypresian	Belgium
(1) <i>C. fraasi</i> Lorenthey 1909	U. Eocene	Egypt
(2) <i>C. gabbi</i> Rathbun 1926	Eocene	N. America
(5) <i>C. gracilis</i> Dana 1852	Pleist.-Rec.	N. America
(4) <i>C. illyricus</i> Bittner 1883	Miocene	Yugoslavia
(5) <i>C. jordani</i> Rathbun 1900	Pleistocene	N. America
(5) <i>C. magister</i> Dana 1852	Pleist.-Rec.	N. America
(1) <i>C. meticurensis</i> Thurmann 1853	Oligocene	E. France
(1) <i>C. modestus</i> Fritsch 1887	Cenomanian	Bohemia
(1) <i>C. monodactylus</i> Michelotti 1861 nom.nud.	Oligocene	N. Italy
(4) <i>C. nodosulus</i> (Reuss 1867)	Helvetian	Galizien
(2) <i>C. paguroides</i> Desmarest 1822	Subfossil	E. Asia?
(5) <i>C. pagurus</i> Linne' 1758	Pliocene	England
	Recent	Atlantic, Mediterranean Sea, Black Sea
(1) <i>C. pratti</i> H.M. Edwards 1850 nom.nud.	Lutetian	S. France
(5) <i>C. proavitus</i> Packard 1900	Miocene	N. America
(5) <i>C. productus</i> Randall 1839	Plio.-Rec	N. America
(1) <i>C. ?reversus</i> Fritsch 1887	Cenomanian	Bohemia
(4) <i>C. rietmanni</i> Mayer 1872 nom.nud.	Helvetian	Switzerland
(1) <i>C. rotnacensis</i> Delvaux 1887 nom.nud.	Ypresian	Belgium
(5) <i>C. sismondai</i> v. Meyer 1843	Pliocene	England, Italy, Algeria
	U. Miocene	Sardinia
	Tortonian	Austria
	Helvetian	Spain
	Burdigalian	Sardinia
(4) <i>C. cf. sismondai</i> v. Meyer 1843	Tortonian	Austria
(1) <i>C. ?solitarius</i> Fritsch 1887	Cenomanian	Bohemia
(4) <i>C. spinosus</i> (Ristori 1886)	Pliocene	Italy
(4) <i>C. styriacus</i> Bittner 1883	Tortonian	Steiermark, Austria
	Tortonian	Hungary
(4) <i>C. szontaghi</i> Lorenthey 1898	Miocene?	S. America
(2) <i>C. tyro</i> Philippi 1887	Pliocene	California
(5) <i>C. urbanus</i> Rathbun 1917	Eocene	S. France
(1) <i>C. villabersiani</i> Gary 1907	U. Cretaceous	N. America
(1) <i>C. ?whitfieldi</i> Pilsbry 1901	Miocene	Burma
(2) <i>C. species</i>	Burdigalian	S. France
(4) <i>C. species</i>	Miocene	S. France
(4) <i>C. ?species</i>	M. Miocene	Bavaria
(4) <i>Cancerites molassicus</i> Quenstedt 1867		

## Fossil species listed in Zoological Record 1926-1969

(5) <i>C. deshayesi</i> A. Milne-Edwards 1861	Miocene	Spain, Netherlands, France
	Pliocene	England, Algeria
	L. Pleist.	Netherlands
(4) <i>C. sp. indet.</i> Lorenthey and Beurlen 1929	(?)	Hungary
(5) <i>C. granti</i> Rathbun 1932	Pliocene	California
(5) <i>C. javanicus</i> Van Straelen 1938	Pliocene	Java
(5) <i>C. minutiserratus</i> Nagao 1940	Pliocene	Japan
(4) <i>C. species</i> Bernhauser 1955	?	?
(5) <i>C. novaezealandiae</i> (Jacquinot) [In: Jacquinot and Lucas 1853]	Plio.-Pleist.	New Zealand
(5) <i>C. sanbonsugii</i> Imaizumi 1962	Miocene	Japan
(5) <i>C. odosensis</i> Imaizumi 1962	Miocene	Japan
(2) <i>C. ?imamurae</i> Imaizumi 1962	Miocene	Japan

## Additional species not listed in either source

(5) <i>C. beaumonti</i> Milne-Edwards 1850	Cenozoic	Europe
(5) <i>C. polyodon</i> Poepfig 1836	U. Pliocene	California
	U. Pleistocene	Peru
(5) <i>C. davidi</i> Nations 1968	M. Pliocene	California
(5) <i>C. species</i> (Van Straelen 1938:98)	U. Miocene	Java
(5) <i>C. irroratus</i> Say 1817	Plio.-Pleist.	N. America
(4) <i>C. borealis</i> Stimpson 1859	U. Miocene	N. America

The two pre-Miocene species of *Cancer* in western North America which were recognized by Rathbun (1926:56-60) have been examined and are not referable to *Cancer*. *Cancer gabbi* Rathbun 1926 was based on two incomplete right chelipeds from the Eocene of California. Additional preparation of the holotype (Phil. Acad. Nat. Sci., No 4099) revealed that it had a short, broad carpus; a smooth outer surface of the manus with no longitudinal carinae; and a long, laterally and proximally inclined tooth on the dactylus. These characters are unlike those of *Cancer* and are very similar to *Lophopanopeus* Rathbun 1898 (Xanthidae Dana 1851). *Cancer bainbridgensis* Rathbun 1926 was based on two incomplete dactyli from the Upper Oligocene of Washington. Examination of the holotype (Stanford Univ, No 5061) shows a nearly circular cross-section at the proximal cutting tooth (T/H dactylus = .97) and a basal portion which is 2.0 times the height of the finger at the proximal tooth (27.1 mm vs 13.5 mm). This is in strong contrast to the corresponding features of *Cancer productus*, with which it was originally compared (T/H dactylus = .683 and height at base only 1.30 times the height at proximal tooth). The size and shape of *C. bainbridgensis* are very similar to those of *Loxorhynchus grandis* Stimpson 1857 (T/H dactylus = .783 and height at base is 1.83 times the height at proximal tooth). It probably is referable to *Loxorhynchus* Stimpson 1857 (Majidae Samouelle 1819).

The elimination of these two species from *Cancer* confirms Glaessner's belief that Rathbun's material

did not justify its generic assignment (personal communication, April 28, 1969), and verifies his exclusion of the species from the genus in the Treatise of Invertebrate Paleontology. The rejection of *C. gabbi* and *bainbridgensis* invalidates all reports of pre-Miocene occurrence of *Cancer* on the west coast of North America.

Currently there are nine recognized Recent species of *Cancer* on the west coast of North America, only one of which ranges into another province (*C. amphioetus*). One South American species, *Cancer porteri*, previously known as far north as the Bay of Panama, has been reported by Garth (1960:120) in the Gulf of California. All of these species (except *C. porteri*) are now known in the fossil record, with five of them recognizable in the Middle Pliocene. One other Recent species (*C. polyodon*) is known in the Upper Pliocene of North America but is now living only in the southern Hemisphere (Ecuador to Chile). Four extinct species are re-described here. Ten new species of *Cancer* are proposed and described here, five of Pliocene age, three Miocene, one Miocene-Pliocene, and one Miocene(?) - PlioPleistocene. The oldest occurrence of a *Cancer* is that of *C. coosensis* in the Middle Miocene So-brante Formation.

## STATISTICAL DATA AND ANALYSIS

## Purpose

An examination of all west coast species of *Cancer* has shown that there are many characters observable

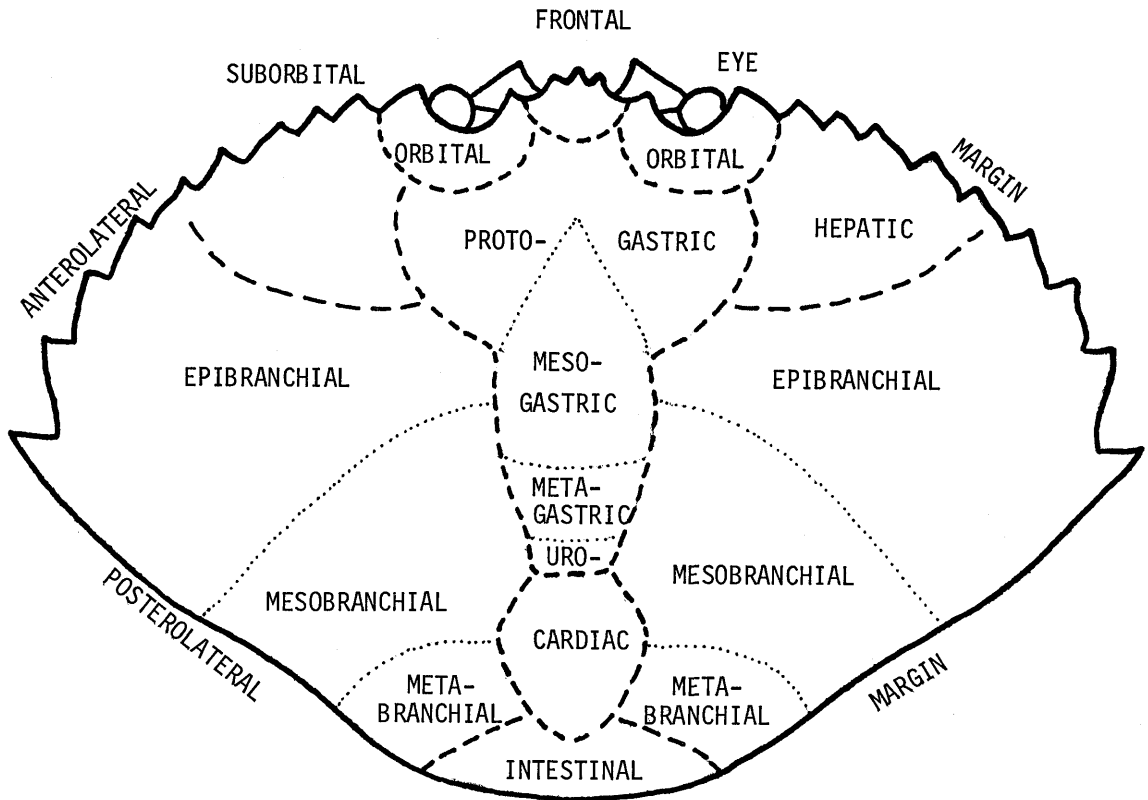


FIGURE 1. Morphological terms for regions of the carapace.

and measurable on crab skeletons that have not been used in the description and comparison of specimens. Recent specimens have been classified into species on a combination of characters including: shape and areolation of carapace, number and shape of anterolateral and posterolateral teeth, general shape of chelipeds and walking legs, shape of antennae, coloration, and setation. These characters, which are adequate to differentiate living species, are inadequate for identification of most fossil material because fossil crabs generally are incomplete (most commonly represented only by fingers), and altered to some degree from their original coloration.

The usefulness and reliability of the identifications of fossil crabs from fragmentary remains depends upon the accurate description of homologous parts of known species. This not only aids the identification of fossil representatives of those species but yields data on the amount of variability which may be expected for extinct species.

To provide a sound basis for the identification of fragmentary fossil crabs, the writer has described the

chelipeds of all Recent and fossil species of *Cancer* of the west coast (see section on Systematics). A standard series of measurements has been utilized to provide some quantitative data from which ranges of variation could be calculated (see Fig. 3).

#### Measurements and statistical data

The number of specimens measured for each species varied from 1 to 15, and was determined by the size and number of specimens available. Specimens of some species, e.g., *C. amphioetus*, were so small that accurate measurements using standard calipers were impossible on all but the largest. Measurements were made to the nearest tenth of a millimeter and ratios calculated to three decimal places. These measurements were made only on western North American species. The measurements, calculated ratios, observed ranges of variation, 95% confidence interval for range of variation (Simpson, Roe and Lewontin 1960:152), coefficient of variation ( $v$ ) (Simpson et al. 1960:90), and standard deviation ( $s$ ) are recorded in tables (see systematics of each species). Information on size, sex, and locality of specimens is also given.

The numerical parameters chosen for comparison and analysis were: 1) ratios of pairs of measurements of commonly fossilized parts of the chelipeds, 2) number and position of cutting teeth on dactylus and fixed finger, 3) widths of anterolateral teeth on carapace. Ratios of cheliped measurements were plotted on graphs and statistically analyzed to predict ranges of variation to the 95% confidence interval following the method of Simpson et al. (1960:87-152) (See Table 1). Anterolateral tooth widths vs tooth position have been plotted on graphs without statistical analysis (see Figs. 23 and 26). The number of cutting teeth on the fingers is highly consistent within each species, does not require statistical analysis, and has been used only descriptively.

Graphical presentation of data

Two types of graphs have been used in this study for the presentation and comparison of data:

*Variation of cheliped characters (Table 1)*—A bar graph showing: 1) ratios of selected pairs of cheliped measurements, plotted individually by short vertical lines on the graph, and 2) the 95% confidence interval of range of variation of those parameters, plotted by a solid line above the observed ratios. Visual inspection of the graph shows the probable range of variation in several parameters for each species. Unidentified material can be compared with the species in the graph by using ratios of the standard measurements (see Fig. 3). The range of variation of some species overlaps for some parameters, but usually can be differentiated on others.

This method is particularly useful in the identification of fossil mani, carpi, and fixed fingers because they are not as distinct morphologically as are the movable fingers. Fortunately, the parameters of these less distinctive parts show better separation on the graph than those of the movable fingers.

This technique is valuable because several parameters are made available for the determination of degrees of similarity between specimens. For example, *Cancer durhami*, represented by a complete cheliped, closely resembles *Cancer magister*. However, in comparing its standard parameters with those of *C. magister* it is found that the two species differ significantly (beyond 95% confidence interval) in 1) Lu/H manus, 2) T/H manus, 3) T/H fixed finger and 4) H/L carpus. On closer inspection, differences in details of ornamentation further support the separation of this specimen from *C. magister*. See following pages for definitions of abbreviations.

*Anterolateral tooth-width graph (Fig. 23)*.—A graph of relative width of anterolateral teeth on the carapace. This graph is not as well established statistically as the "variation of cheliped characters (Table 1)," but is useful in comparison of fossil carapaces, which often are only partially preserved. The con-

stancy of relative widths of anterolateral teeth through growth stages has been tested on *C. magister* by measuring four different-sized specimens and plotting the data on a single graph (see Fig. 23). There is general uniformity in the curves, but they differ in the relative width of the 8th tooth, which becomes wider relative to the 7th and 9th teeth, with increasing carapace width. However the uniformity of the curves is adequate for empirical use and is very helpful in differentiating carapaces which may appear quite similar (see *C. magister* vs *C. danai*, Fig. 23; and *C. davidi* vs *C. jenniferae* vs *C. fissus*,

Abbreviations used in tabulation of statistical data

Measurements and ratios (see Fig. 3)

H	— height
Lu	— length of upper margin of manus
Lm	— length of manus from proximal end of lower margin to extremity of sinus between fingers
Ll	— length of lower margin of manus and fixed finger
T	— thickness
L	— length
L/H m	— ratio length to height of manus.
T/H m	— ratio thickness to height of manus.
Hf/Hm	— ratio height of fixed finger to height of manus.
H/L mf	— ratio height to length of movable finger
H/L f	— ratio height to length of fixed finger
T/H f	— ratio thickness to height of fixed finger
H/L c	— ratio height to length of carpus
S	— standard deviation
V	— coefficient of variance

#### STRATIGRAPHIC DISTRIBUTION

The stratigraphic distribution of Recent and extinct species of *Cancer* of the west coast of North and South America is presented in Table 2. Fossil occurrences of the genus in western North America extend from Coos Bay, Oregon (43°30' N) to Bahia del Rosario, Baja California, Mexico (30°N). Age assignments for formations follow Weaver et al. (1944) except for subsequent changes called for by the establishment of the Pliocene-Pleistocene boundary at the base of the Calabrian in Italy by the International Geological Congress decision of 1948 (see Durham, Hahns and Savage 1954:69). Authorities for the ages of units not included in Weaver et al. (1944) are indicated in Table 2.

Each of the nine Recent species of *Cancer* on the west coast of North America, and one of the four South American species, also are known as fossils.



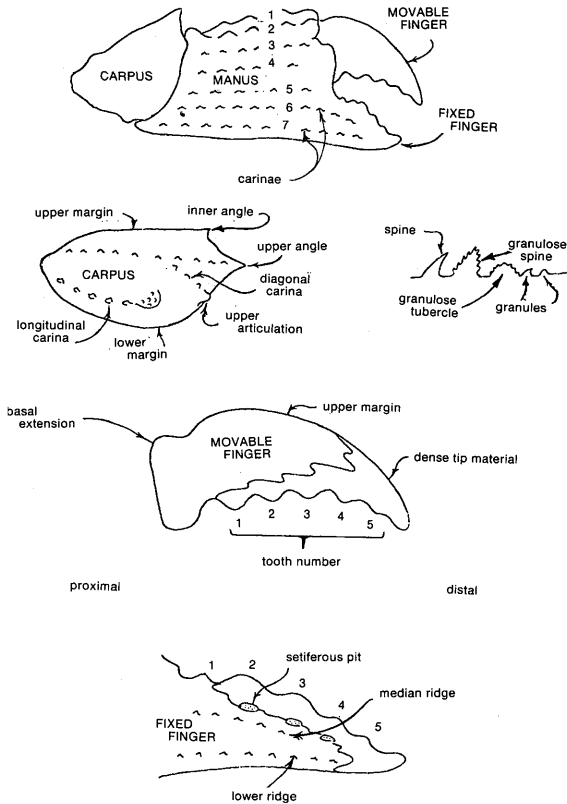


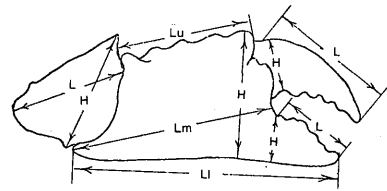
FIGURE 2. Morphological terms used in supplementary descriptions.

Two living species, *Cancer amphioetus* and *Cancer polyodon* (living only in South America), are reported as fossils for the first time.

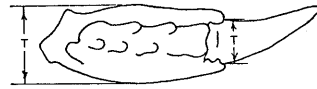
*Cancer amphioetus* is represented by parts of two individuals (1 finger, 1 carpus and manus) from the Timms Point Silt and Lomita Marl of San Pedro, California. These occurrences extend its stratigraphic range to the Lower Pleistocene and its Pleistocene geographic range in North America further north than its present northern limit (La Jolla, California).

*Cancer antennarius* is known from 123 fossil fingers in several Upper and Lower Pleistocene formations ranging geographically from Baja California to the San Joaquin Basin. Pliocene occurrences are known in the San Diego Formation (72 fingers, 1 carapace), Etchegoin Formation (3 fingers), and at San Ysidro, Baja California (1 finger). The geographic range of the species in the Pliocene and Pleistocene was no greater than at present.

*Cancer polyodon* lives today only along the west coast of South America. Fossil specimens have been found in the Upper Pliocene Pico (?) Formation (24 fingers) at Los Angeles, the San Diego Formation (15 fingers, 1 manus) of San Diego, and in the Upper Pleistocene of San Juan Bay, Peru (1 complete cheliped). The California occurrences extend the stra-



A. Cheliped, side view



B. Cheliped, top view

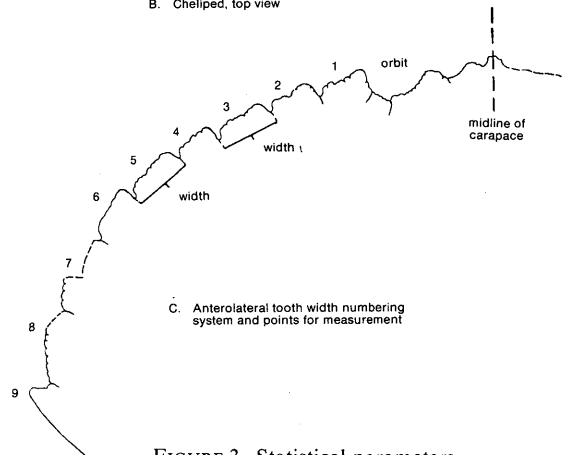


FIGURE 3. Statistical parameters.

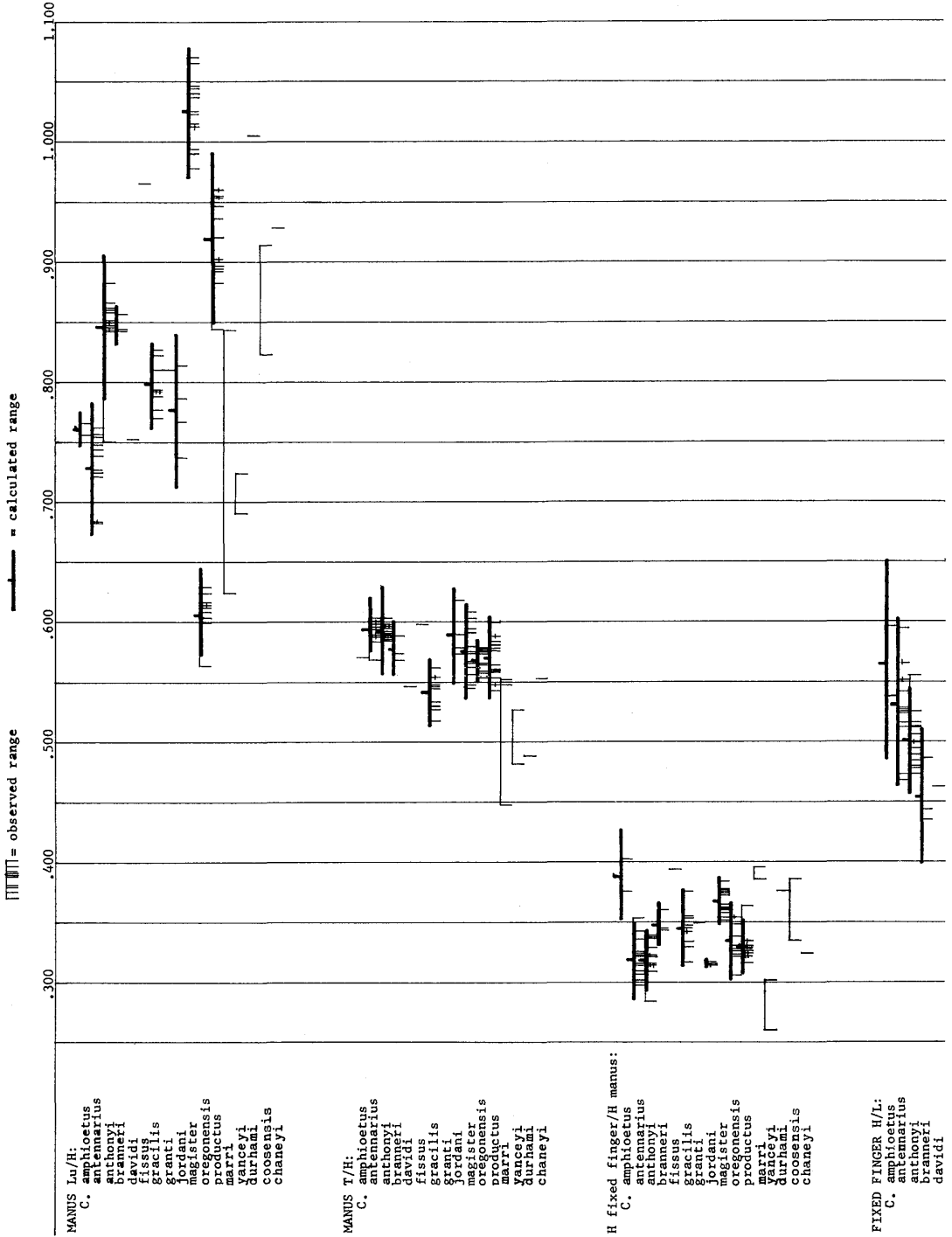
tigraphic range back into the Upper Pliocene and indicate that the species lived in the Northern Hemisphere during that time.

The stratigraphic ranges of five other Recent west coast species, *Cancer branneri*, *Cancer gracilis*, *Cancer anthonyi*, *Cancer magister*, and *Cancer oregonensis* have been extended from Pleistocene (Rathbun 1926; Menzies 1951; Zullo 1969) to Pliocene in this paper. *Cancer branneri* is known from fossil specimens (63 fingers, 1 carpus, 1 carapace) in Pleistocene beds in central and southern California, and Baja California. Six movable fingers have been found in the Upper Pliocene Pico Formation at Santa Barbara. The Pleistocene occurrence in Baja California represents a southward extension beyond the present southern limit of the species.

*Cancer gracilis* is represented in the Pleistocene of southern California by 246 fingers. Occurrences in the Merced Formation (3 fingers), Pico (?) Formation (1 finger), and San Diego Formation (12 fingers) extend the known stratigraphic range of this species back into the Upper Pliocene. None of the fossil occurrences are outside the present geographic limits.

*Cancer magister* has been found in the Pleistocene Palos Verdes Sand (13 fingers), San Pedro Sand (5

TABLE 2.  
 VARIATION OF CHELIPED CHARACTERS  
 Measurement expressed as ratios

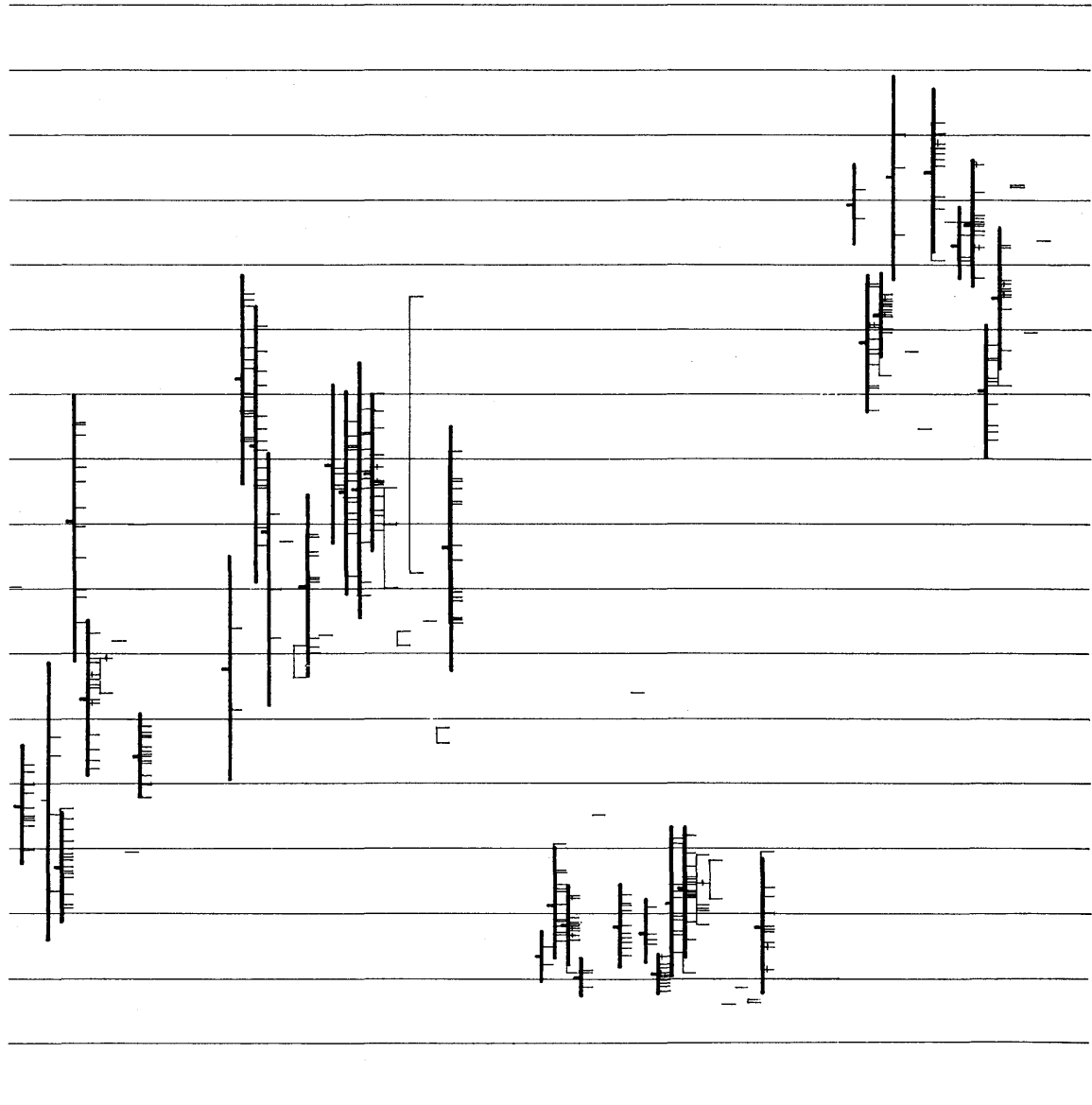


fissus  
 gracilis  
 granti  
 jordani  
 megister  
 oregonensis  
 productus  
 allisoni  
 marri  
 durhami  
 chaneyi

FIXED FINGER T/H:  
*C. amphioetus*  
*C. antennarius*  
 anthonyi  
 bramneri  
 fessidi  
 gracilis  
 granti  
 jordani  
 megister  
 oregonensis  
 productus  
 allisoni  
 vanceyi  
 durhami  
 coosensis  
 chaneyi

MOVABLE FINGER H/L:  
*C. amphioetus*  
*C. antennarius*  
 anthonyi  
 bramneri  
 davidi  
 fessidi  
 gracilis  
 granti  
 jordani  
 megister  
 oregonensis  
 productus  
 allisoni  
 marri  
 garthi  
 durhami  
 coosensis  
 chaneyi

CARPUS H/L:  
*C. amphioetus*  
*C. antennarius*  
 anthonyi  
 bramneri  
 davidi  
 fessidi  
 gracilis  
 granti  
 jordani  
 megister  
 oregonensis  
 productus  
 marri  
 durhami  
 chaneyi



fingers), San Joaquin Formation (1 finger, 2 mani), and the Elk River Formation (19 fingers). Excepting the latter, all these occurrences are south of the present southern limits (Monterey Bay) of this species. Pliocene occurrences are now known in the Etchegoin Formation (1 finger, 1 carapace), Merced Formation (17 fingers, 1 manus), Coos Conglomerate (2 fingers, 1 cheliped), Wildcat Group (1 finger) and in unnamed beds at Moonstone Beach, Humboldt County, California (5 fingers). The Etchegoin localities indicate a more southerly range of *C. magister* during the Pliocene.

*Cancer anthonyi* is represented in the Pleistocene Palos Verdes Sand (13 fingers), San Joaquin Formation (25 fingers, 1 manus), Saugus Formation (1 finger) and in Pleistocene beds at San Quintin Bay, Baja California (1 finger, 1 carpus, 2 mani). Its occurrence in the Etchegoin Formation is an extension of its stratigraphic range into the Middle Pliocene. None of the fossil occurrences have extended the geographic range of the species.

*Cancer oregonensis* is known from the Lower Pleistocene San Pedro Formation (3 fingers) and Pleistocene beds at Rincon del Potrero (2 fingers), both in the Los Angeles area. It is also found in unnamed Pleistocene beds near Bandon, Oregon. Pliocene occurrences are known in the Merced Formation (1 finger), San Diego Formation (2 fingers), and unnamed beds at Moonstone Beach, California (129 fingers). The Pleistocene occurrences at Los Angeles and the Pliocene at San Diego indicate a more southerly geographic extent in the past than the southern limit (Santa Barbara) of the species today.

Many new occurrences of *Cancer jordani* and *Cancer productus* are reported but they do not alter significantly the previously known stratigraphic or geographic ranges of these species (see Table 2).

New occurrences of two previously named extinct species are reported, altering their stratigraphic and geographic distribution. *Cancer davidi*, previously known only from its type locality (Middle Pliocene, Etchegoin Formation, near Coalinga, California) has been found in the Etchegoin Formation (1 carapace) near San Benito, in the Middle Miocene Round Mountain Silt (7 fingers, 1 manus) and Olcese Sand (69 fingers) near Bakersfield. These new occurrences extend the stratigraphic range of *C. davidi* from Middle Pliocene to Middle Miocene. Its geographic range now extends from near the southern end of the San Joaquin Basin into the San Benito Trough (Wilson 1943: 222-246), which connected the San Joaquin embayment with the Pacific Ocean during the Miocene and Pliocene.

*Cancer fissus* was previously known only from its type locality, the Middle Pliocene Etchegoin Forma-

tion near Coalinga, California. New occurrences in the Etchegoin Formation near the type locality (7 carapaces, 1 cheliped) and near San Benito (3 carapaces), extends its Middle Pliocene geographic range. Upper Pliocene occurrences in the Purisima Formation near Santa Cruz (1 carapace) and in the Cascajo Conglomerate (1 nearly complete specimen) near the type locality, further extend its geographic range and increase its stratigraphic range from Middle to Upper Pliocene.

Ten new species of *Cancer* are proposed herein. Two of them, *Cancer danai* (1 carapace) and *Cancer dereki* (2 carapaces) are known only from Miocene rocks, the Briones Sandstone and Monterey Shale respectively. Three new species, *Cancer marri* (7 fingers, 1 carpus, 2 mani, 1 cheliped), *Cancer garthi* (1 finger) and *Cancer durhami* (1 cheliped), are known only from Pliocene rocks. Two previously named extinct species, *Cancer granti* (1 carapace) and *Cancer urbanus* (1 carapace), are still known only from their Pliocene type localities. *Cancer yan-ceyi* (2 mani) is known only from its type locality, in the Lower Pleistocene part of the San Joaquin Formation. *Cancer allisoni* (8 fingers, 1 manus) occurs in rocks ranging from Middle Miocene to Upper Pliocene. Two species, *Cancer coosensis* (5 fingers, 1 carpus, 2 mani) and *Cancer chaneyi* (187 fingers, 1 carpus, 2 mani) range from Middle Miocene to Pleistocene. The geographic distribution of the former extends from Coos Bay, Oregon to San Francisco Bay and of the latter from the San Joaquin Basin (Middle Miocene) to Baja California (Upper Pleistocene).

#### BIOGEOGRAPHY

The genus *Cancer* is entirely marine and is represented by 23 living species in the Atlantic and Pacific Oceans. MacKay (1943: 113-115) discussed the distribution of Recent species of *Cancer* and the limiting factor of temperature. He concluded that the genus was restricted to the "temperate zone" with mean annual surface water temperatures between 40° and 75° F. (4.4° to 23.9°C.). This temperature range corresponds roughly to mid-latitudes in the northern and southern hemispheres, except for western South America where temperatures less than 75° (23.9°C.) prevail as far north as the equator, due to the cooling effect of the Humboldt Current. Two species, *C. porteri* and *borealis*, have been found in tropical regions at depths of more than 200 fathoms and 100 fathoms respectively (Garth 1957: 122; MacKay 1943: 113). The temperature at those depths is below 20°C. (Sverdrup 1942: Chart IV), therefore within the tolerances of *Cancer*.

The distribution reported by MacKay is generally correct except that there is no acknowledgment of

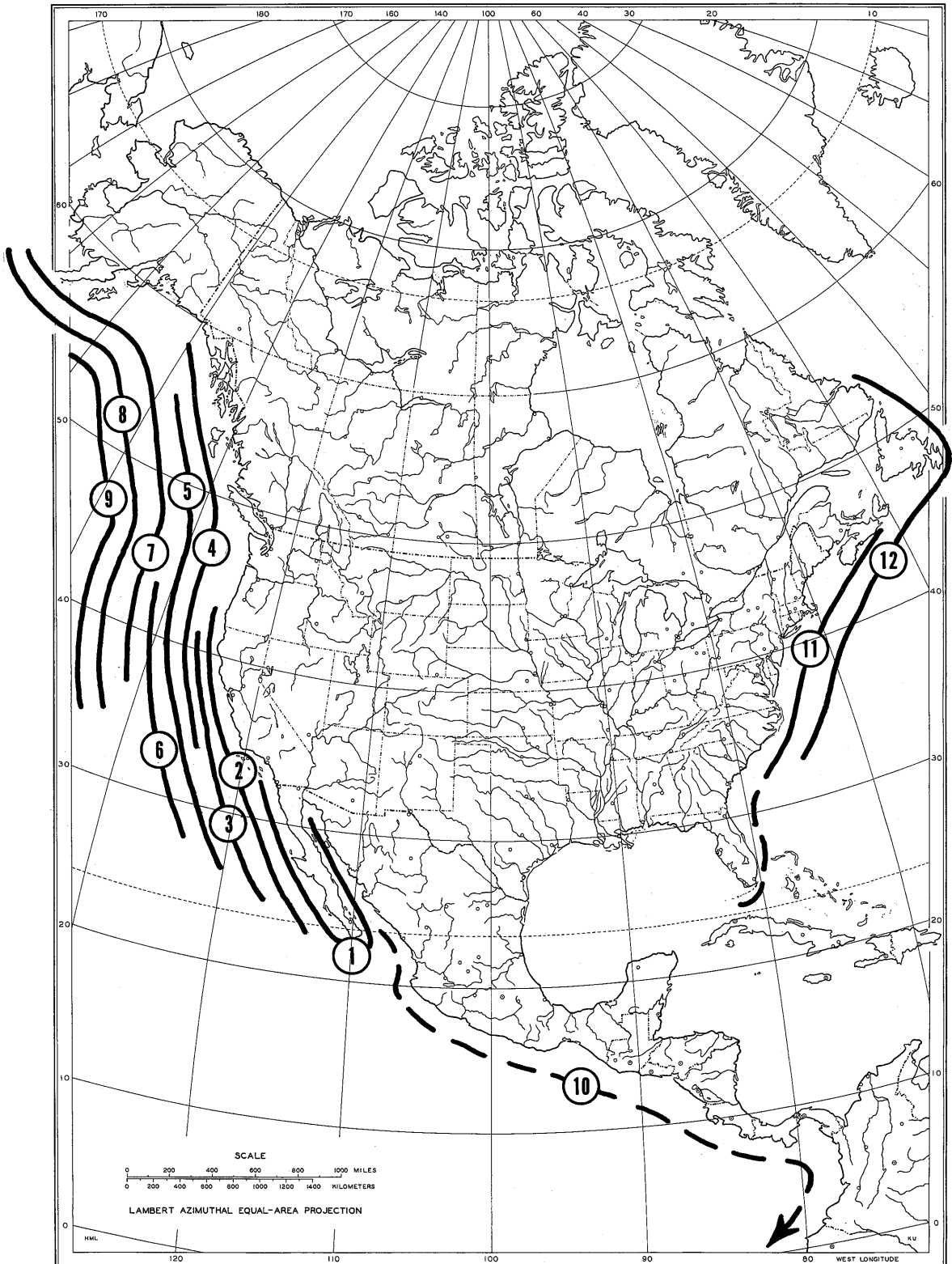


FIGURE 4. Geographic ranges of living species of *Cancer* in North America: 1, *C. amphioetus*; 2, *C. antennarius*; 3, *C. anthonyi*; 4, *C. branneri*; 5, *C. gracilis*; 6, *C. jordani*; 7, *C. magister*; 8, *C. oregonensis*; 9, *C. productus*; 10, *C. porteri*; 11, *C. borealis*; 12, *C. irroratus*. Found only below thermocline-----.

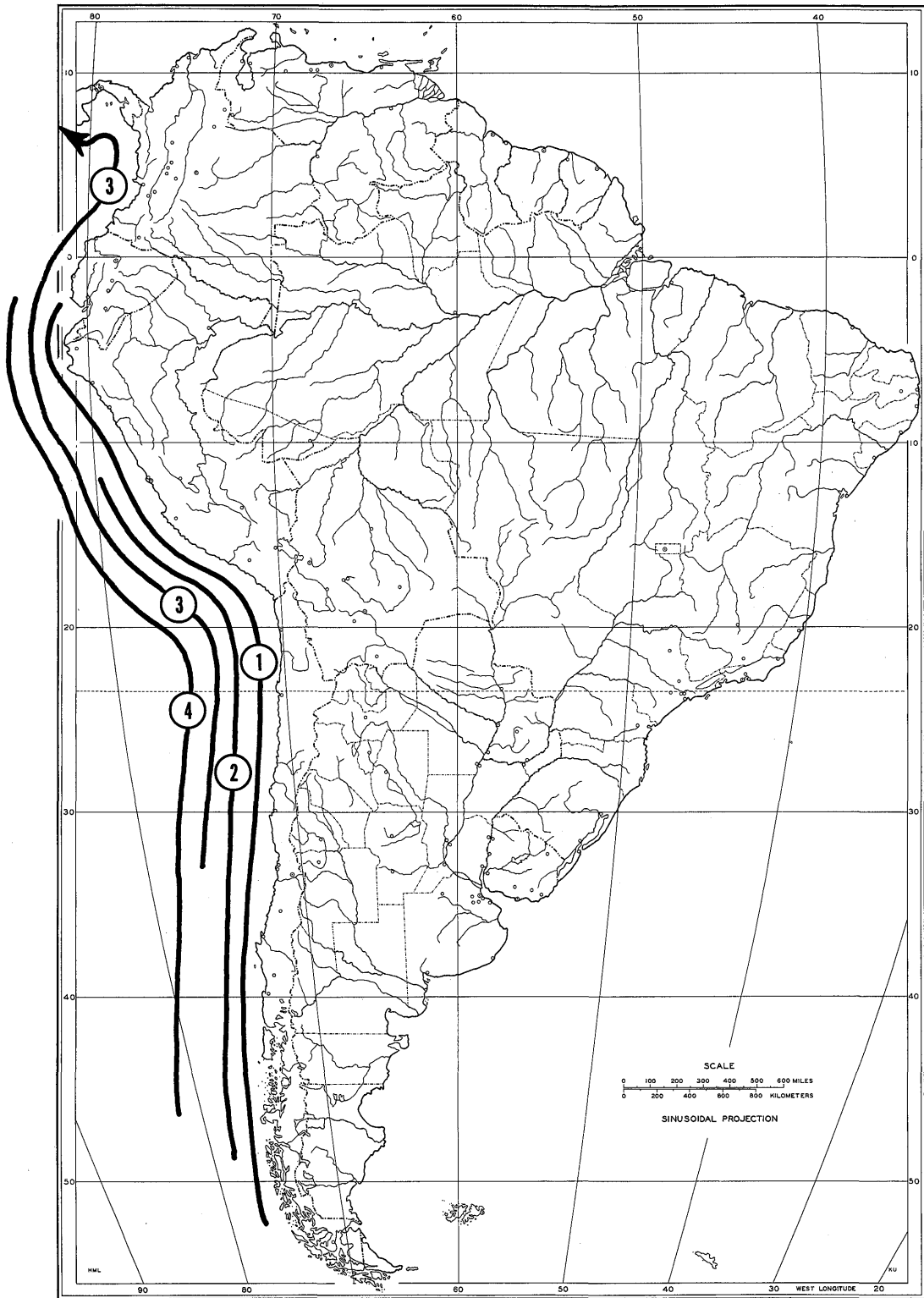


FIGURE 5. Geographic ranges of living species of *Cancer* in South America: 1, *C. edwardsii*; 2, *C. plebejus*; 3, *C. porteri*; 4, *C. polyodon*.

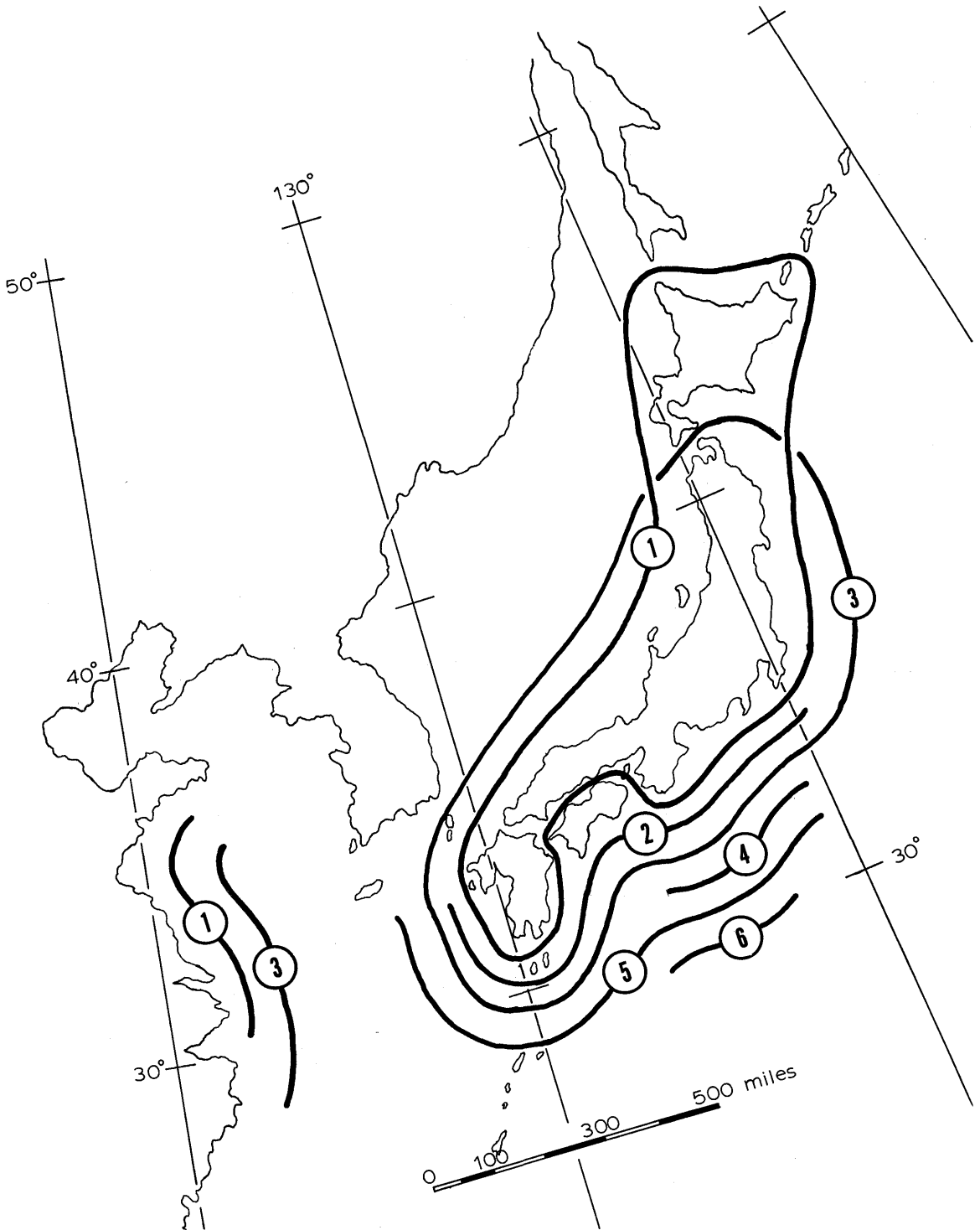


FIGURE 6. Geographic ranges of living species of *Cancer* in Eastern Asia: 1, *C. amphioetus*; 2, *C. sakaii*; 3, *C. gibbosulus*; 4, *C. japonicus*; 5, *C. tumifrons*; 6, *C. nadaensis*.

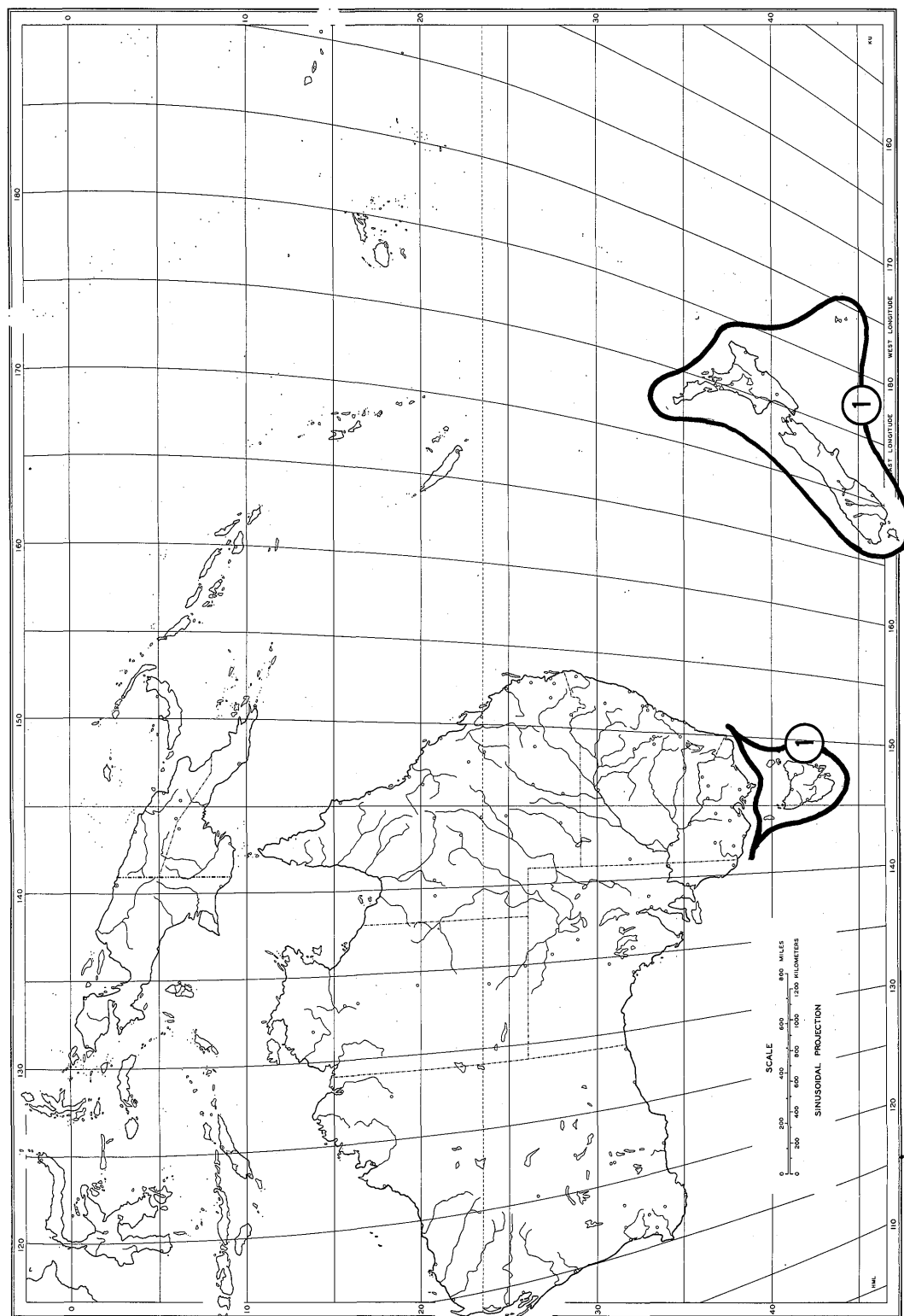


FIGURE 7. Geographic ranges of living species of *Cancer* in Australia–New Zealand: 1, *C. novaezealandiae*.



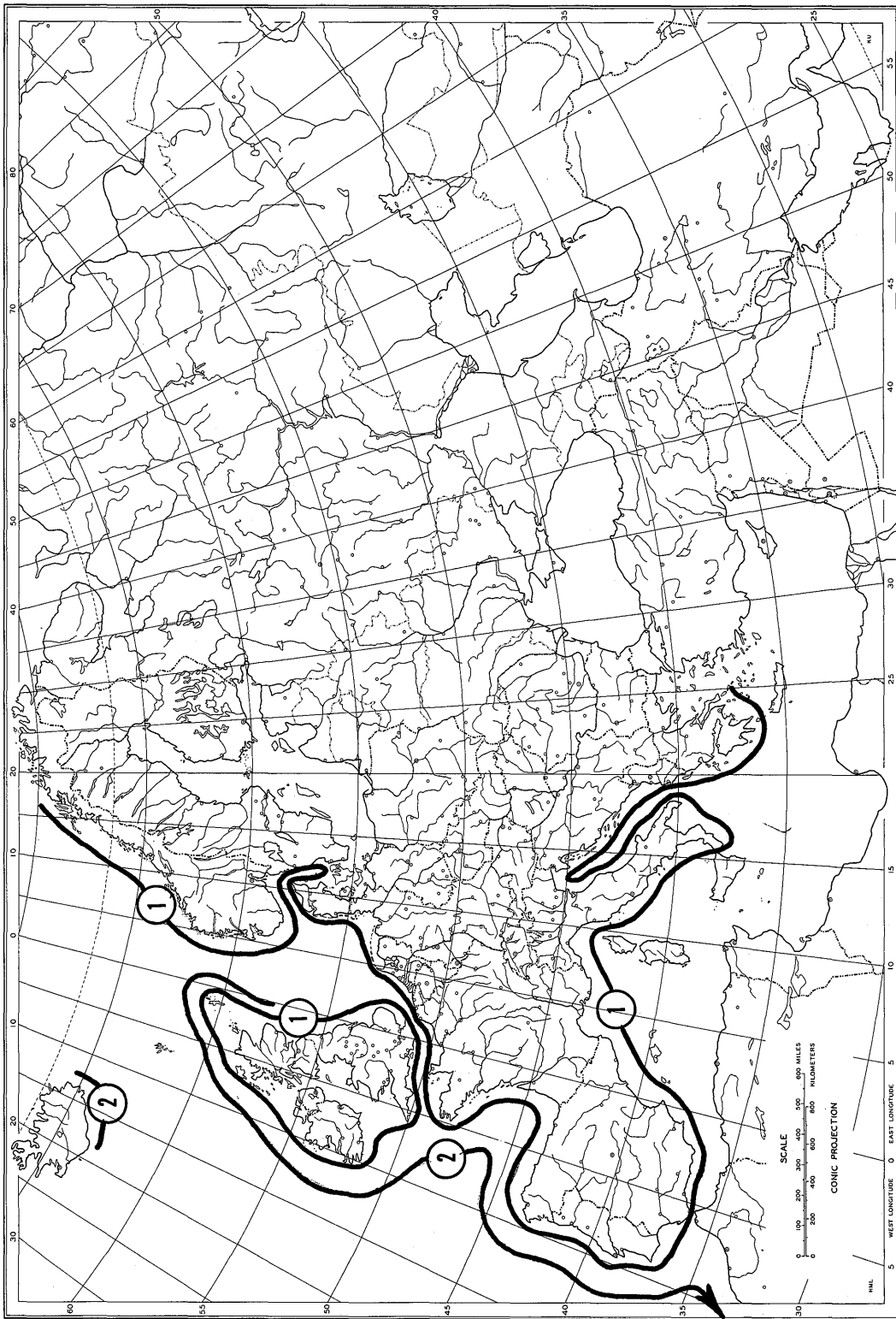


FIGURE 8. Geographic ranges of living species of *Cancer* in Europe: 1, *C. pagurus*; 2, *C. bellianus*.

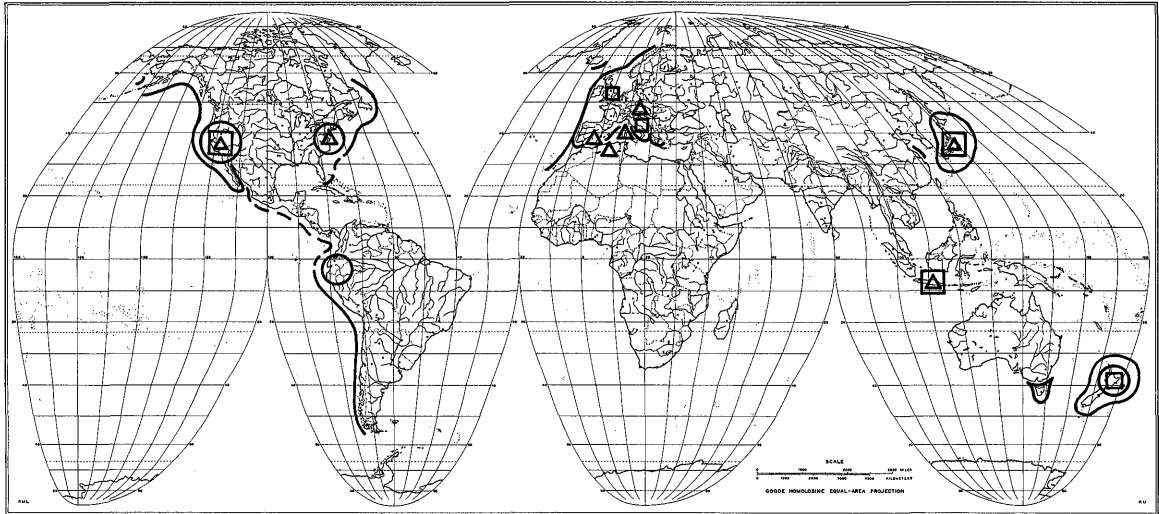


FIGURE 9. Recent fossil occurrences of *Cancer*: ~ Range of living species, ○ Below thermocline only, ● Pleistocene occurrence, ■ Pliocene occurrence, ▲ Miocene occurrence.

several reports (Desmarest 1825: 102; Glaessner 1929: 105; Pesta 1918: 389; Heller 1863: 63) of *Cancer pagurus* in the Mediterranean, Adriatic, and Black Seas. He also did not mention two Recent species, *C. tumifrons* Yokoya 1933 and *C. bellianus* Johnson 1861.

Ekman (1953: 160, fig. 56) discussed the distribution of species of *Cancer*, recognizing its presence in the Mediterranean as well as the areas previously shown by MacKay. However, he apparently overlooked *C. bellianus* because he indicated only one European species and did not include the Madeira Islands in the range of the genus. A current list of Recent species of *Cancer* and their ranges is given in figures 4-8.

PALEOBIOGEOGRAPHY

The following list of species known as fossils and their occurrence have been used in developing the following discussion of paleobiogeography (also Fig. 9).

- Western North America*
- C. allisoni* M. Miocene-U. Pliocene
  - C. amphioetus* L. Pleist.-Recent
  - C. antennarius* M. Pliocene-Recent
  - C. anthonyi* M. Pliocene-Recent
  - C. branneri* U. Pliocene-Recent
  - C. chaneyi* M. Miocene-U. Pleistocene
  - C. coosensis* M. Miocene-U. Pliocene
  - C. danai* M. Miocene
  - C. davidi* M. Miocene-M. Pliocene
  - C. dereki* M. Miocene

- C. duryami* M. Pliocene
- C. fissus* U. Pliocene
- C. garthi* U. Pliocene
- C. gracilis* M. Pliocene-Recent
- C. granti* U. Pliocene
- C. jenniferae* M. Pliocene
- C. jordani* L. Pleistocene-Recent
- C. magister* L. Pliocene-Recent
- C. marri* M. Pliocene-U. Pliocene
- C. oregonensis* M. Pliocene-Recent
- C. polyodon* U. Pliocene-Recent
- C. productus* M. Pliocene-Recent
- C. urbanus* U. Pliocene
- C. yanceyi* L. Pleistocene

*Western South America*

- C. polyodon* U. Pleistocene, Peru

*Japan*

- C. minutoserratus* Pliocene
- C. odosensis* Miocene
- C. sanbonsugii* Miocene

*Java*

- C. javanicus* Pliocene
- C. species* U. Miocene

*New Zealand*

- C. novaezealandiae* L. Pliocene-M. Pleistocene

*Eastern North America*

- C. borealis* U. Miocene(?)—Recent
- C. irroratus* M. Miocene-Recent
- C. proavitus* U. Miocene

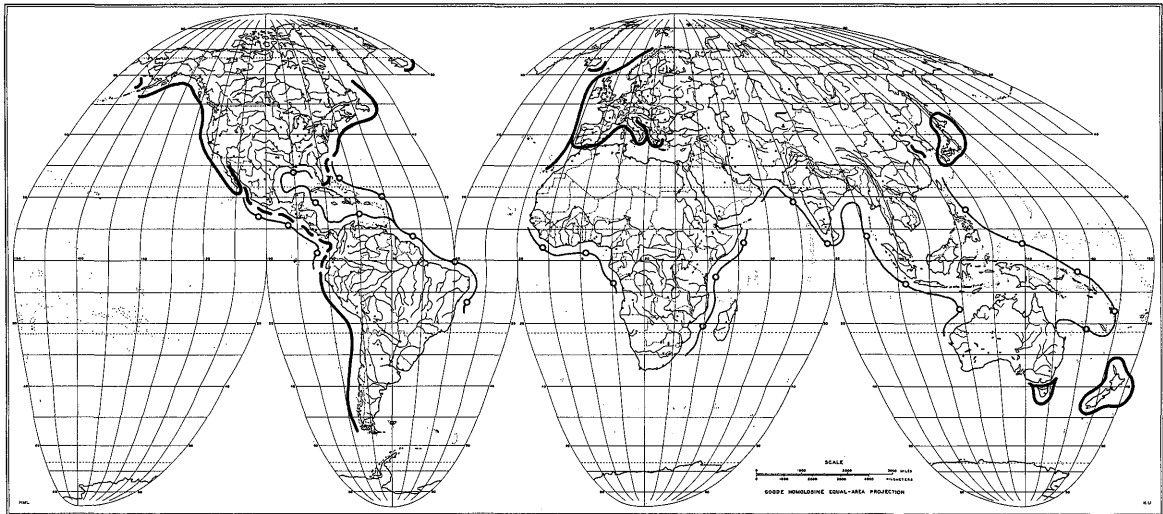


FIGURE 10. Distribution of *Cancer* and surface water temperatures: — Living species, - - - Below thermocline only, ○ Temperature greater than 24°C.

	<i>Europe</i>
<i>C. deshayesi</i>	Miocene, Spain, Netherlands, France
<i>C. pagurus</i>	Pliocene, England, Algeria Pliocene, England L. Pleistocene, Netherlands
<i>C. sismondai</i>	Pliocene, England and Mediterranean

Note: Several other Miocene and Pliocene species listed in Glaessner (1929) have not been verified, therefore, they are not included here. They would not alter the Miocene–Pliocene geographic ranges in any case.

The oldest accepted occurrence of *Cancer* is in the Miocene (Glaessner 1969: R509; and this paper). Species of *Cancer* of this age are known from southern Europe (2 species at least), eastern North America (2 species at least) and western North America (6 species), Japan (2 species), and Java (1 species). The diversity and wide distribution in the Miocene indicate that the genus had an earlier origin, probably in one of those areas. The fossil record of *Cancer* at this writing neither confirms nor contradicts the suggestion by Ekman (1953: 159) that the genus had its origin in the North Pacific, because no pre-Miocene record of the genus has been found. However, the number of fossil species known indicates that the diversity has been greater in the eastern North Pacific than in any other region throughout the known record of the genus.

The relative amount of study in the areas included in Table 3 has not been evaluated; therefore, it may influence the number of species recognized in different areas. The principle of biogeography that “in

the absence of evidence to the contrary, the area in which the genus has undergone the greatest amount of evolution is its probable area of origin” (Cain 1944) would suggest the eastern North Pacific as the area of origin of *Cancer* (See Fig. 12).

The genus is represented in Pliocene rocks of those regions with Miocene occurrences with the exception of eastern North America, where marine Pliocene rocks are poorly represented. However, it is almost certain that species of *Cancer* were present in eastern North America during the Pliocene because three species are known in Miocene rocks of the region, two of which were identified as living species (Rathbun 1935:109). First occurrences are noted in two areas during the Pliocene—England (Glaessner 1929:105) and New Zealand (Glaessner 1960:20, 21); and the last occurrence (Pliocene) in the East Indies (Van Straelen 1938:97-98). There is no valid record of pre-Pleistocene *Cancer* in South America but it is almost certain that the genus was there because of the diversity of Recent species (4), and the probability that it is the ancestral home (Miocene?) of Lower Pliocene New Zealand species. None of the Pliocene species of Japan are recognized as extant (see Imaizumi 1962) while seven of the nine western North American living species are recognized in Pliocene rocks. One South American species, *Cancer polyodon*, is here reported in the Pliocene of southern California.

Pleistocene occurrences (Fig. 9) of *Cancer* are reported from eastern and western North America, western South America, and New Zealand. All are extant species except for two reported herein from western North America.

TABLE 3:  
Diversity of species of *Cancer* during the Neogene

	Recent	Pleistocene	Pliocene	Miocene
Western N. Amer.	9	12	18	6
Japan	5	0	1	2
Western S. Amer.	4	1	0	0
Australia-N.Z.	1	1	1	0
Java	0	0	1	1
Eastern N. Amer.	2	1	0	2 (+ 1?)*
Europe	2	0	1	2 (+ 10?)**

\**C. borealis*, a finger tip only; considered unidentifiable by Henry B. Roberts, U.S. Nat. Mus. (personal communication, March 10, 1969).

\*\*Reported in Fossilium Catalogus (Glaessner 1929). These are considered questionable until verified because of typically unrestricted use of the term *Cancer* for fossil crabs in late 19th and early 20th centuries when most of these were reported; also because they are inconsistent with the European Pliocene record of three species.

The geographic range of *Cancer* and pertinent mean annual surface water temperatures are given in figure 10. Two areas where the range extends into water with mean surface temperatures above 24°C. are; 1) the northwestern coast of South America, and 2) the east coast of Florida to the Bermuda Islands. In both cases the crabs are found only in deep water where the temperatures are cooler than surface temperatures; e.g., *C. borealis* has been collected at 170 and 263 fathoms off Florida but occurs in the intertidal of the northeast coast of North America (Rathbun 1930a:197), and *C. porteri* at 210 and 286 fathoms in the Bay of Panama whereas it ranges into the sublittoral from Peru to Chile (Garth 1957:122). This submergence of *C. porteri* has enabled it to transgress the tropics and move as far north as the Gulf of California (Garth 1961:120-122). In all other areas where the water temperature exceeds 24°C, no species of *Cancer* have been found, presumably because that temperature is a limiting factor.

Three continental shorelines are not inhabited by *Cancer* even though temperatures are within its range of tolerance (see Fig. 10). The southeastern coast of South America, from 27° to about 52°S is one such area. A single dead specimen of *Cancer* was collected from Santos, State of Sao Paulo, Brazil and reported as a new species, *Cancer luederwaldti* by Rathbun (1930a:200) but was recognized later to be a transported specimen of *Cancer pagurus* Linnaeus 1758 from Europe (Rathbun 1930b:528). The temperature and salinity are within the tolerance of *Cancer* and there is no apparent reason why it could not migrate "around the Horn" and populate the southeastern coast of South America. Migration of eastern North American species into this area is prevented by a high temperature barrier in the Caribbean. The entire southern coast of Australia and its eastern and western coasts up to 20° S should be habitable, based

on the maximum temperatures tolerated elsewhere (see Fig. 10). *Cancer novaezealandiae* apparently prefers cooler water or lower salinity, as is evidenced by its greater abundance "in the south island than in the north island" of New Zealand (Chilton and Bennett 1929:745). Temperature and salinity are higher in the north island and in Tasmania and South Australia, where *C. novaezealandiae* has been introduced successfully (Bennett 1964:64), than in the south island of New Zealand. The southwestern coast of Africa has favorable temperature and salinity ranges but migration of species from either Europe or eastern Asia is blocked by high temperature barriers in the equatorial regions. Presumably the European species could transgress the tropics by submergence, as *C. porteri* has done in the eastern Pacific (Garth 1961:120), but there is no evidence that this has happened.

The presence of *Cancer* in New Zealand and southeastern Australia is difficult to explain. It is separated from Asia by the tropical waters of the East Indies and from South America by the broad expanse of the Pacific Ocean and the cold waters of the Antarctic. The two possible routes for migration of *Cancer* into New Zealand and Australia are: 1) from China-Japan region through the East Indies by submergence to depths of about 200 meters where the temperature is about 20°C. (Sverdrup et al. 1942: Chart IV); or 2) from South America along the coast of Antarctica to New Zealand, during the warmer period in the Miocene or Early Pliocene, (see Fig. 11). The fossil record indicates that both hypotheses are possible inasmuch as two species occur in the Miocene and Pliocene of Java (Van Straelen 1938:97-98) while *C. novaezealandiae* is known in the Pliocene and Pleistocene of New Zealand (Glaessner 1960:21). The feasibility of the first is shown by Garth's (1961:122) report that *C. porteri*

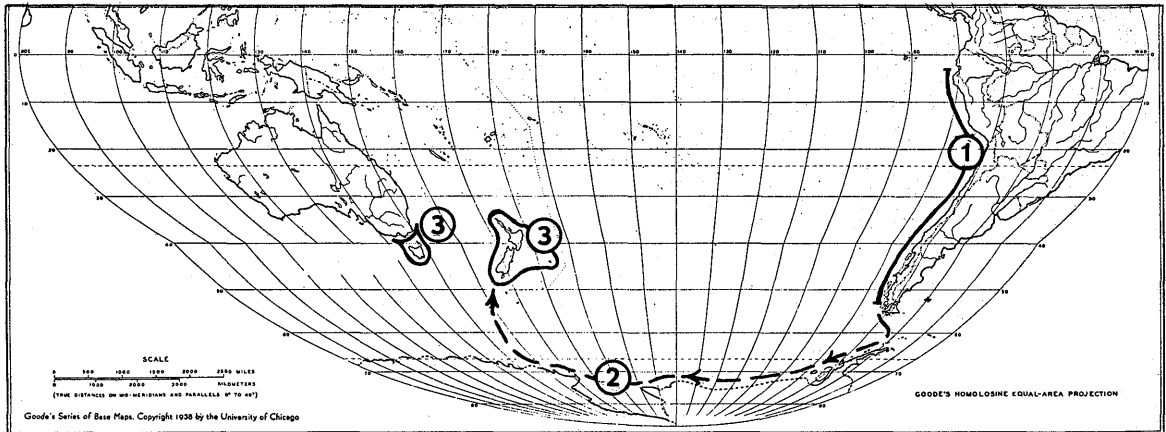


FIGURE 11. Suggested migration route of *Cancer* to New Zealand: ① present range of *C. edwardsii*, ② suggested migration in Late Miocene or Early Pliocene, ③ present range of *C. novaezealandiae*.

“transgresses the tropics by submergence, being found in the Gulf of California, the Bay of Panama in 210 to 286 fathoms, and from Peru to Chile in the sublittoral.” The ancestors of *C. novaezealandiae* might have crossed the tropical East Indies region in that way.

However, if *C. novaezealandiae* is compared with possible ancestors it is apparent that it is most similar to *C. plebejus* and *edwardsii* which range to the southernmost tip of South America, the most likely point of departure for migration along the Antarctic coast and ultimately to New Zealand. In comparing these species, Milne-Edwards (1865:190) wrote: “this species [*C. novaezealandiae*] resembles *Cancer plebeius* of the coast of Chile.” He then differentiated the two species on the characters of the chelipeds and anterolateral teeth. Chilton and Bennett (1929:744-745) quoted a personal communication by W. T. Calman of the British Museum of Natural History on additional differences between the species.

*Cancer novaezealandiae* is quite different from any of the Japanese Recent or fossil species, therefore, it is unlikely that it or its immediate ancestors came from that area. More probably, it was derived from *C. edwardsii* (which it resembles more than *C. plebejus*) or a common ancestor in South America. The lack of any Miocene or Pliocene record of *Cancer* in South America precludes definite proof of such a migration, but the morphological similarities of *C. edwardsii* and *novaezealandiae* strongly suggest that it has occurred.

Extensions southward beyond the Recent ranges are noted for *C. branneri*, *magister* and *oregonensis*, in the Upper Pliocene and Pleistocene. Occurrences of *C. amphioetus* in the Lower Pleistocene of Los

Angeles and *C. polyodon* in Upper Pliocene rocks of Los Angeles and San Diego, are northward extensions of their present ranges (see Figs. 4 and 5, and Table 2).

The fossil occurrences of *Cancer* along the west coast of North America range from Oregon to Baja California, Mexico and are known only in Miocene and younger rocks. This should not be interpreted as evidence for narrow paleogeographic ranges, but a function of a scarcity of exposed Miocene and younger rocks outside that region, and of the greater amount of investigation in other areas.

## SYSTEMATICS

### Introduction

A prerequisite for the interpretation of fossil material is the knowledge of Recent representatives of similar taxa, and of the ranges of variation in the characters used for their classification. Specimens of all currently recognized Recent species of *Cancer* and of all the fossil species reported from the west coast of North America have been examined by me.

The number of specimens that I have examined, both Recent and fossil, are noted after the synonymy for each of the west coast of North America species. I have examined and illustrated Recent specimens of all other extant species except *C. nadaensis* (for which I could only acquire a photograph), and have included their fossil occurrences from the literature. I have designated hypotypes for all extant species except *C. nadaensis* which is known only from its holotype. Types and type localities are designated for all new species.

All Recent species of *Cancer* are illustrated photographically (Figs. 30-42). Those now living on the

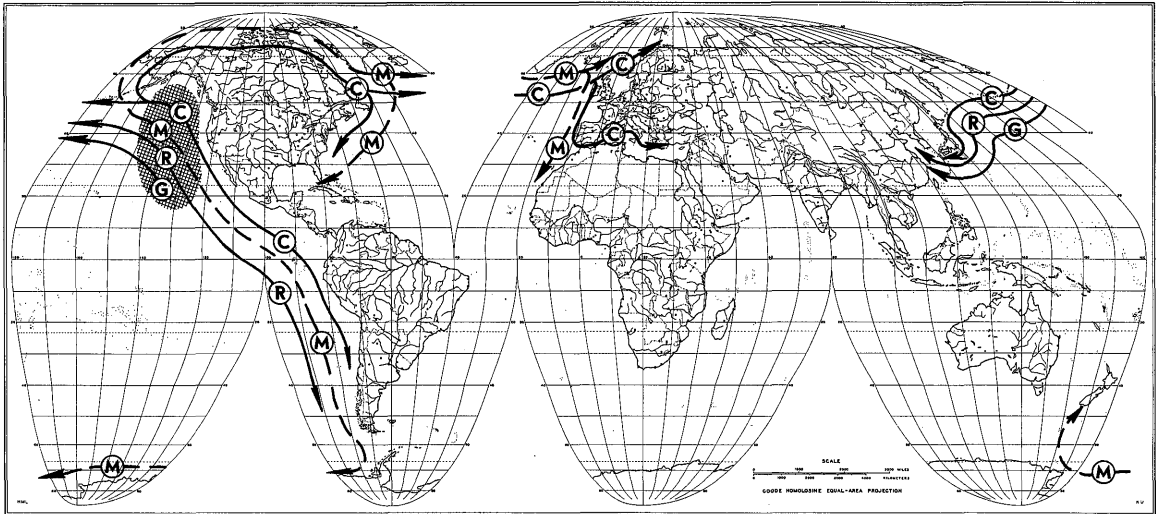


FIGURE 12. Suggested area of origin and dispersal pattern of subgenera of *Cancer*: (R)—*Romaleon*, (G)—*Glebocarcinus*, (M)—*Metacarcinus*, (C)—*Cancer*. Probable area of origin indicated by hatching.

west coast are also illustrated by enlarged drawings of the dactyli and fixed fingers (Figs. 13-18). Photographs and drawings of all known extinct species from the west coast are also presented (Figs. 19-29).

A published description has been quoted for each species other than those found in western North America. Additional discussion and synonymy for these species can be found in the reference from which the description is quoted. For west coast species, both Recent and extinct, a detailed description of typical cheliped morphology is presented in addition to the best published description. The emphasis in this study has been on cheliped morphology because most fossil material consists of cheliped parts and because those parts are diagnostic of the species. Statistical measurements and calculations are tabulated and inserted after the discussion of each species (see Tables 4-21). Supplementary descriptions of carapace morphologies of extinct species have been made if the carapace is known. A graphic technique for comparison and presentation of differences in carapace characters is suggested (Figs. 23 and 26). The synonymies for Recent species are abbreviated by reference to published synonymies, but are complete for extinct North American species.

Diagnostic characters of each of the extinct species are discussed and compared with those of other closely related species. These are brief because the differences between species can best be observed by reference to the figures, and tables. The stratigraphic record of each west coast species is reviewed with the age, formation, and location of every known occurrence being presented with mod-

ern age assignments and terminology where possible. Geographic ranges and ecologic observations of all Recent species are summarized and collecting localities and specimen numbers are noted by reference to the abbreviations listed in the section on locality descriptions.

#### EVOLUTION OF *CANCER* AND ITS SUBGENERA

The 23 named living species of *Cancer* and all known extinct species from western North and South America are here assigned to four subgenera, which are phylogenetic groups. The subgenera are based primarily on characters of the carapace, particularly the frontal region, with characters of the chelipeds being relegated to secondary importance. Emphasis is placed on characters of the carapace because it is believed to have evolved more slowly since it serves primarily a passive, protective function and is not likely to undergo adaptive changes as rapidly as the chelipeds. The chelipeds are used actively for food gathering, locomotion, and protection and would subject to modification through more rapid evolution. If this assumption is correct, characters of the carapace can be considered conservative and of more phylogenetic significance than the more highly adaptive chelipeds. The subgenera and their diagnostic characters are discussed below.

##### *Glebocarcinus* new subgenus

Type species, *Cancer oregonensis* Rathbun 1898  
Included species:

*C. sakaii*  
*C. amphioetus*  
*C. tumifrons*  
*C. allisoni*

Description and diagnosis: Typically small adult size. Carapace with sharply differentiated, elevated regions; the elevations with very coarse, rounded granules. Anterolateral teeth separated to bases; tips rounded, with granules clumped rather than arranged in a row along margins of teeth. Chelipeds short, high; with granulated tubercles or bulbous spines on upper part of manus and carpus.

*Cancer tumifrons* exhibits pronounced areolation of the carapace which suggests placement in this group. *Cancer allisoni* (Middle Miocene-Upper Pliocene) of California is the oldest member of this group and is the best candidate among the known species for its ancestor.

Subgenus *Romaleon* Gistel 1848

Type species, *Cancer gibbosulus* Rathbun 1898

Included species:

*C. branneri*  
*C. jordani*  
*C. antennarius*  
*C. polyodon*  
*C. nadaensis*  
*C. urbanus*  
*C. granti*  
*C. dereki*  
*C. yanneyi*

Description: Carapace moderately areolated, with small sharp granules concentrated on, but not restricted to, higher regions. Front moderately produced, medial tooth acute. Anterolateral teeth separated to bases, forward curving with sharp granules along margins and a single sharp spine at the tips; first tooth (outer margin of orbit) acute. Chelipeds with sharp spines or granules along carinae of outer and upper surfaces of manus and carpus.

*Cancer antennarius* lacks the cheliped characters mentioned above, but is placed in this group on: 1) spiny and forward curving anterolateral teeth, 2) acute first anterolateral tooth, and 3) moderately produced front. This species is quite similar to *Cancer anthonyi* of the subgenus *Metacarcinus* in some aspects and is interpreted as convergent with it. *Cancer dereki* (Middle Miocene of California) is the oldest species of this group and is the best candidate among the known species for its ancestor.

Subgenus *Metacarcinus* Milne Edwards 1862

Type species, *Cancer magister* Dana 1852

Included species:

*C. gracilis*  
*C. anthonyi*  
*C. davidi*  
*C. bellianus*

*C. borealis*  
*C. plebejus*  
*C. edwardsii*  
*C. novaezealandiae*  
*C. marri*  
*C. danai*  
*C. garthi*  
*C. durhami*  
*C. coosensis*  
*C. jenniferae*

Description: Carapace oval, with posterolateral margins less concave than in other groups. Anterolateral teeth not strongly produced nor forward curving, shape varying from truncate to blunt pointed; first tooth triangular (not acute), with a blunt point at outer angle of orbit, not as wide as second tooth. Front slightly, if at all, produced; medial tooth acute. Chelipeds variable, ranging from those with spiny upper margins (*C. magister*) to coarsely granulate (*C. novaezealandiae* and *C. borealis*) or smooth (*C. anthonyi*).

*Cancer coosensis* (Middle Miocene of Oregon and California) is the oldest member of this subgenus and is the best candidate among the known species for its ancestor. *Cancer danai* (Middle Miocene of California) is slightly younger, but it has carapace characters which indicate an ancestral relationship to *Cancer magister*.

Subgenus *Cancer, sensu stricto*

Type species, *Cancer pagurus* Linnaeus 1758

Included species:

Group A

*C. bellianus*  
*C. productus*  
*C. japonicus*  
*C. porteri*  
*C. irroratus*  
*C. chaneyi*

Group B

*C. fissus*

Description: Front produced; frontal teeth rounded, medial one not acute but forming a rounded lobe nearly as wide or wider than those of the adjacent pair. Anterolateral teeth broad, truncate to slightly produced, separated by closed fissures; first tooth wider than second. The species assigned to this subgenus fall into two groups characterized as follows:

Group A: Outer margin of anterolateral teeth forming an obtuse angle. Carapace and chelipeds coarsely granulated.

Group B: Outer margin of anterolateral teeth truncate to concave. Chelipeds smooth and elongated; carapace smooth.

*Cancer irroratus* differs from other members of the subgenus by having an acute medial frontal tooth and in lacking the closed fissures between

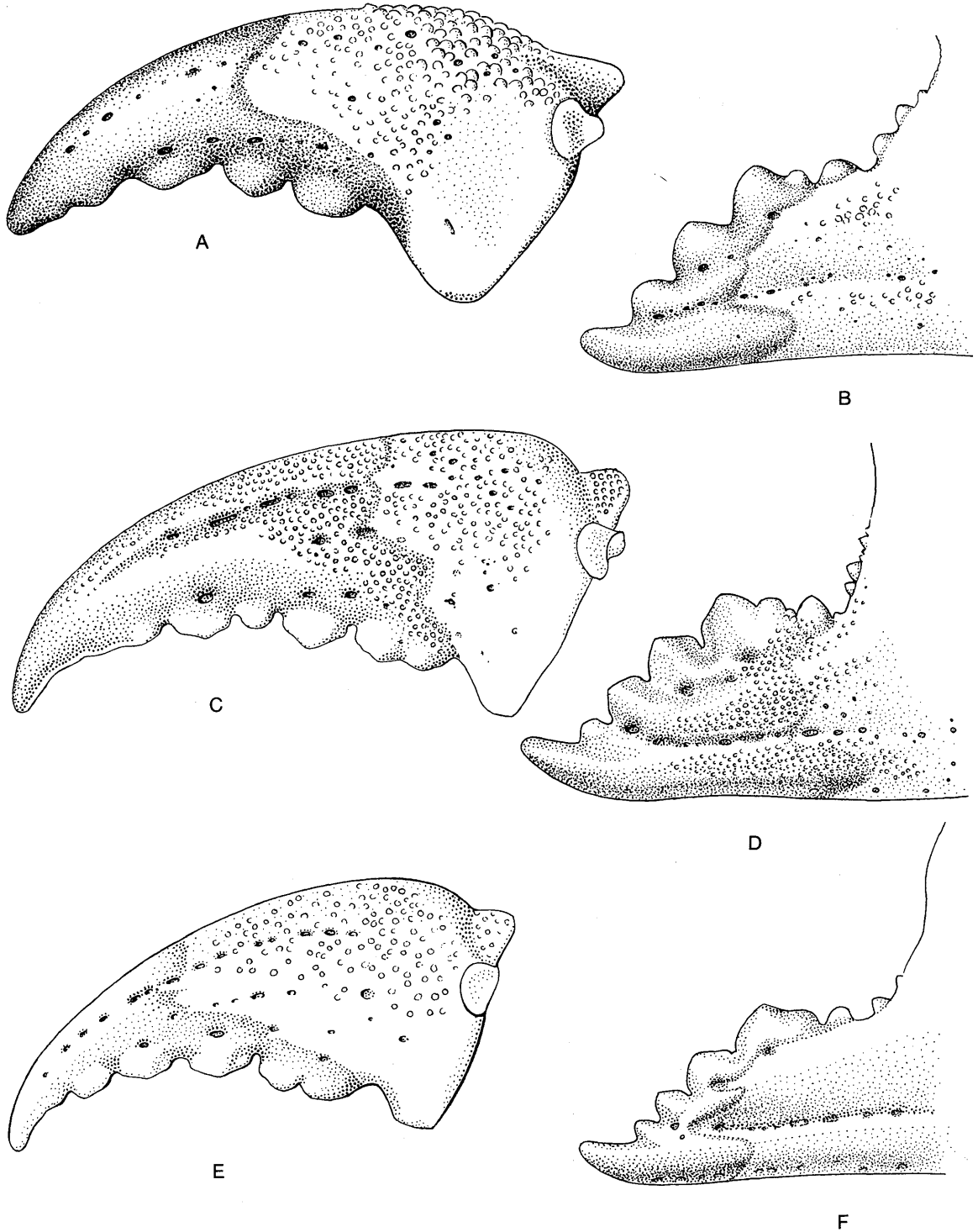


FIGURE 13. *Cancer productus* Randall, x 6, hypotype, UCMP 10734; A. left movable finger, outer view; B. left fixed finger, outer view. *Cancer antennarius* Stimpson, x 6, hypotype, UCMP 32092; C. left movable finger, outer view; D. left fixed finger, outer view. *Cancer anthonyi* Rathbun, x 6, hypotype, UCMP 11390; E. left movable finger, outer view; F. left fixed finger, outer view.



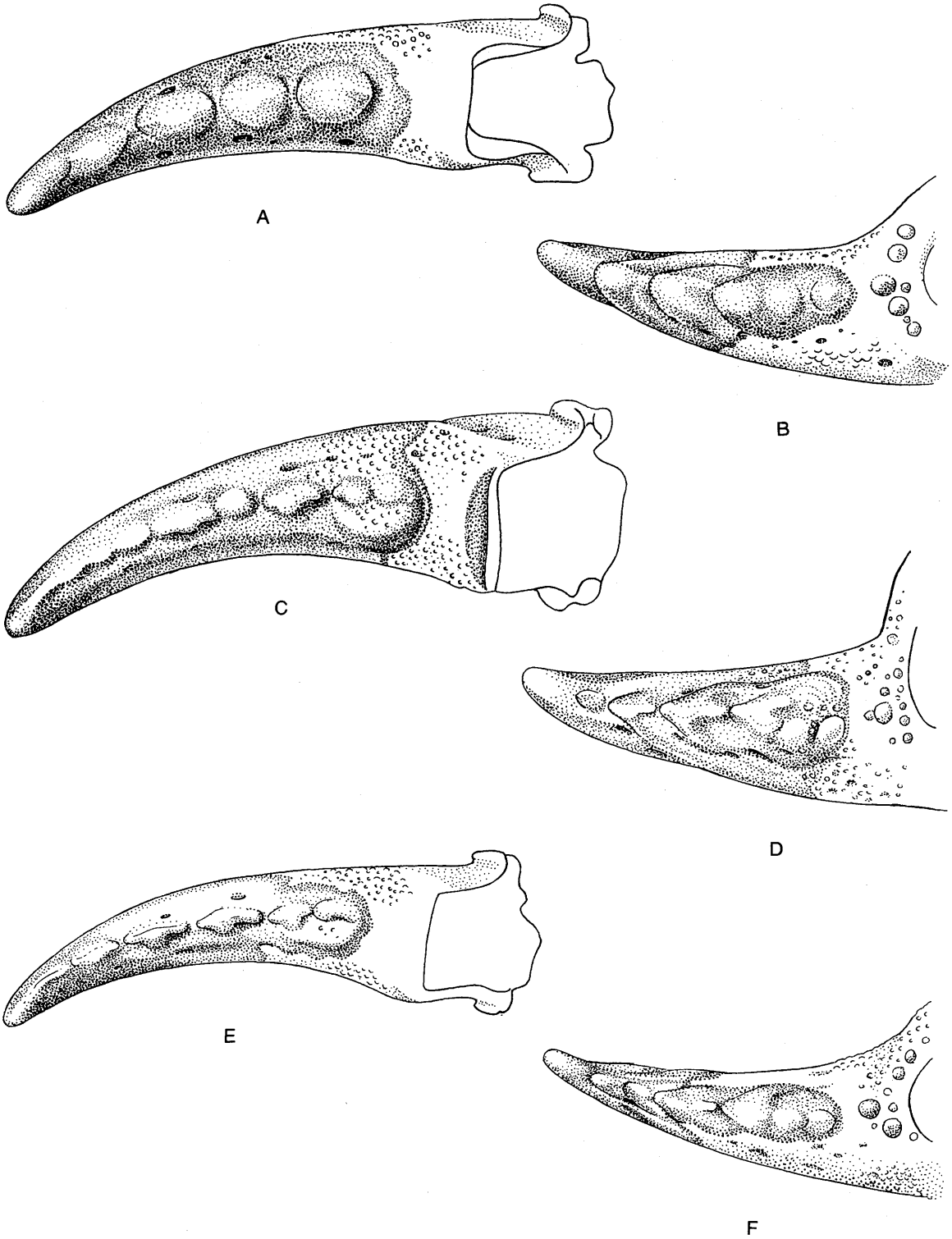


FIGURE 14. *Cancer productus* Randall, x 6, hypotype, UCMP 10734; A. left movable finger, occlusal view; B. left fixed finger, occlusal view. *Cancer antennarius* Stimpson, x 6, hypotype, UCMP 32092; C. left movable finger, occlusal view; D. left fixed finger, occlusal view. *Cancer anthonyi* Rathbun, x 6, hypotype, UCMP 11390; E. left movable finger, occlusal view; F. left fixed finger, occlusal view.

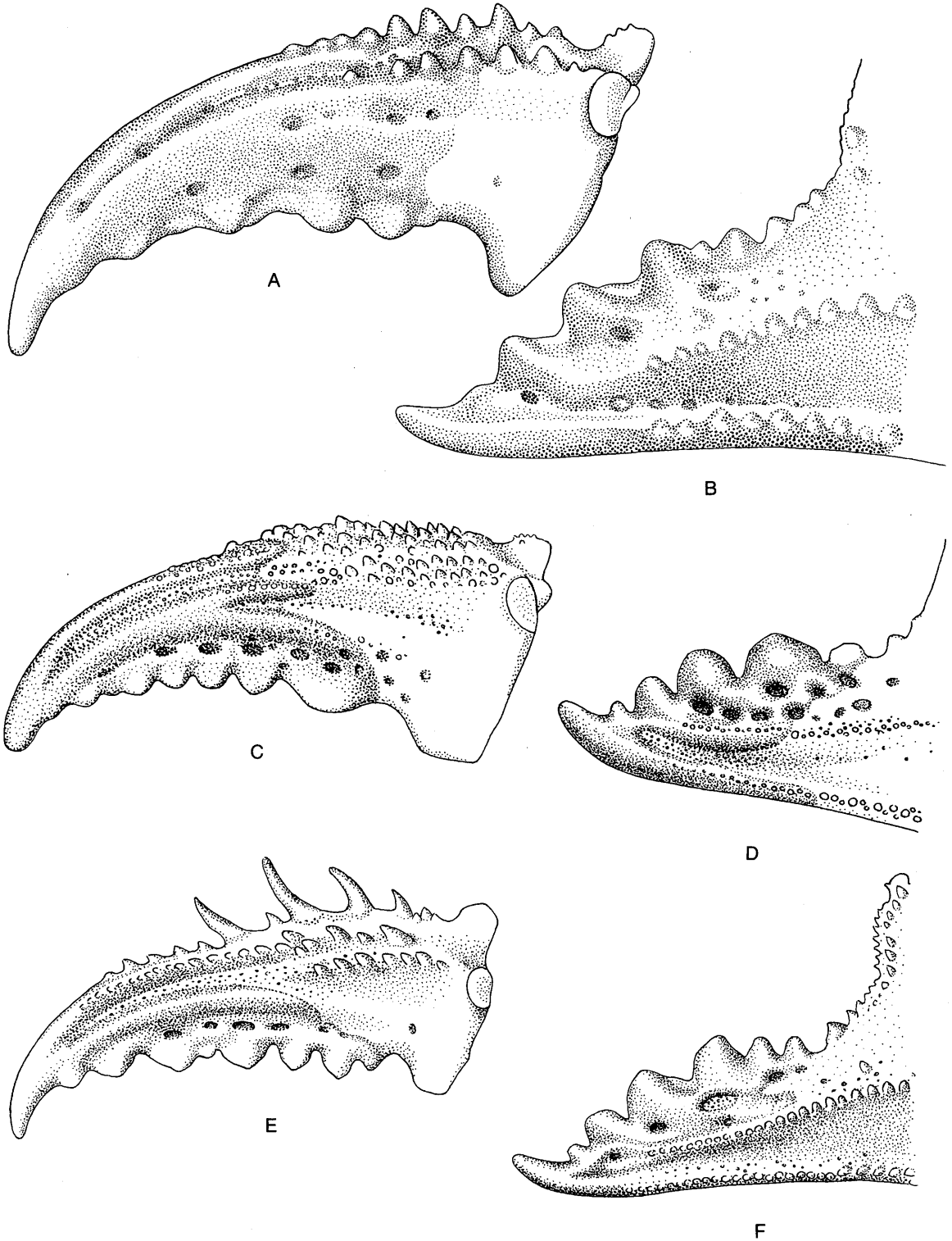


FIGURE 15. *Cancer amphioetus* Rathbun, x 18, hypotype, UCMP 32709; A. left movable finger, outer view; B. left fixed finger, outer view. *Cancer jordani* Rathbun, x 12, hypotype, UCMP 10731; C. left movable finger, outer view; D. left fixed finger, outer view. *Cancer branneri* Rathbun, x 12, hypotype, UCMP 10756; E. left movable finger, outer view; F. left fixed finger, outer view.

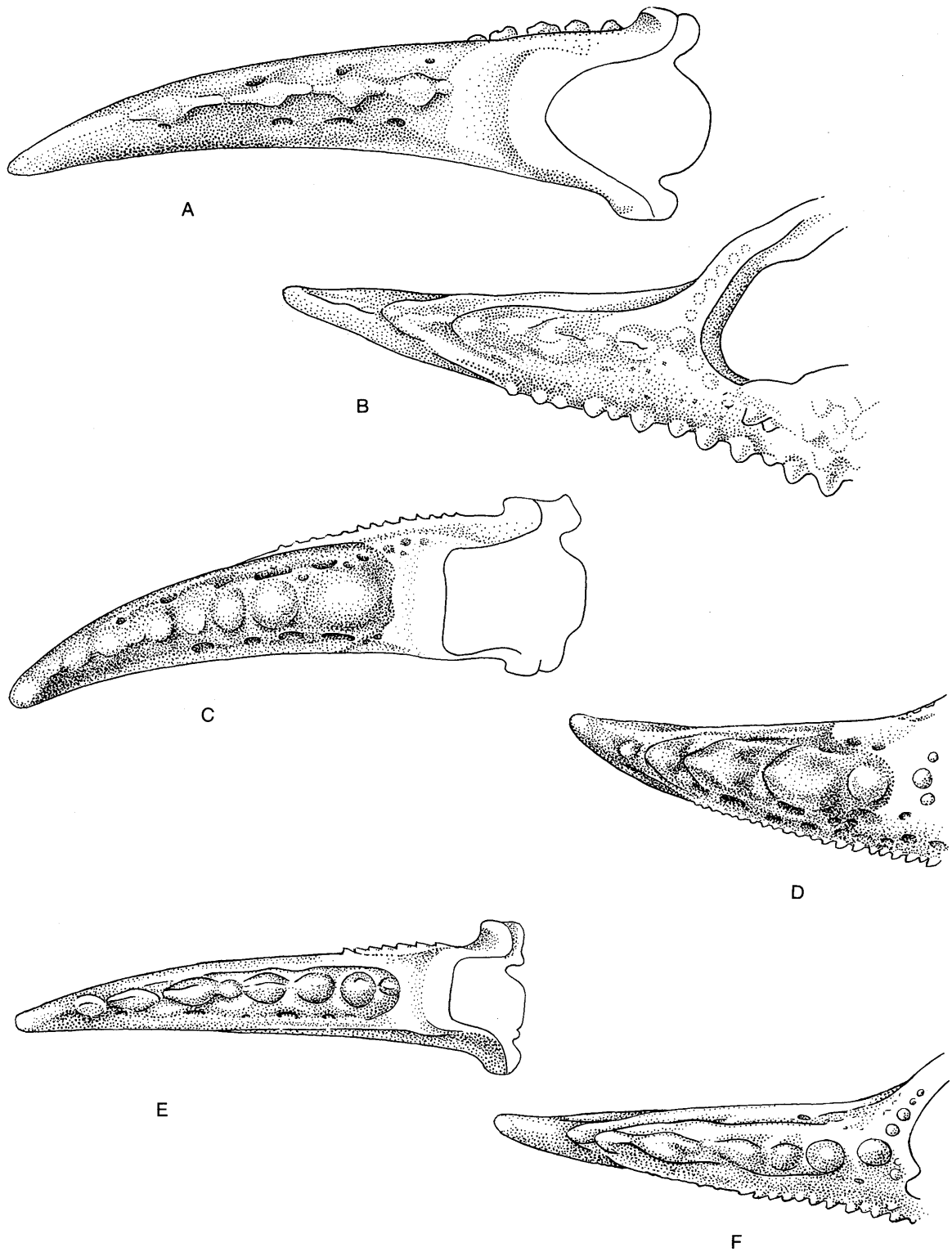


FIGURE 16. *Cancer amphioetus* Rathbun, x 18, hypotype, UCMP 32709; A. left movable finger, occlusal view; B. left fixed finger, occlusal view. *Cancer jordani* Rathbun, x 12, hypotype, UCMP 10731; C. left movable finger, occlusal view; D. left fixed finger, occlusal view. *Cancer branneri* Rathbun, x 12, hypotype, UCMP 10756; E. left movable finger, occlusal view; F. left fixed finger, occlusal view.

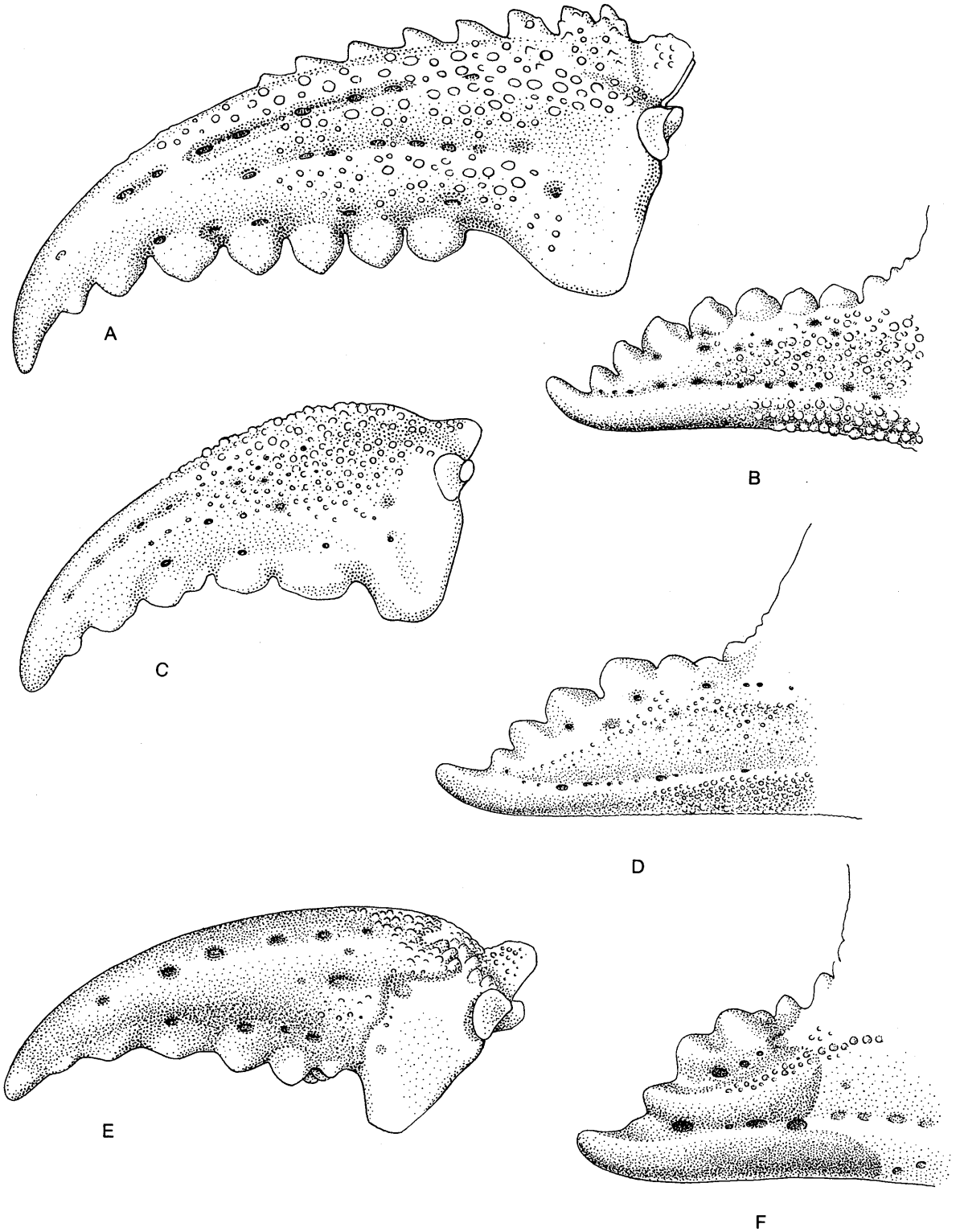


FIGURE 17. *Cancer magister* Dana, x 4, hypotype, UCMP 10732; A. left movable finger, outer view; B. left fixed finger, outer view. *Cancer gracilis* Dana, x 6, hypotype, UCMP 37888; C. left movable finger, outer view; D. left fixed finger, outer view. *Cancer oregonensis* Rathbun, x 12, hypotype, UCMP 10733; E. left movable finger, outer view; F. left fixed finger, outer view.

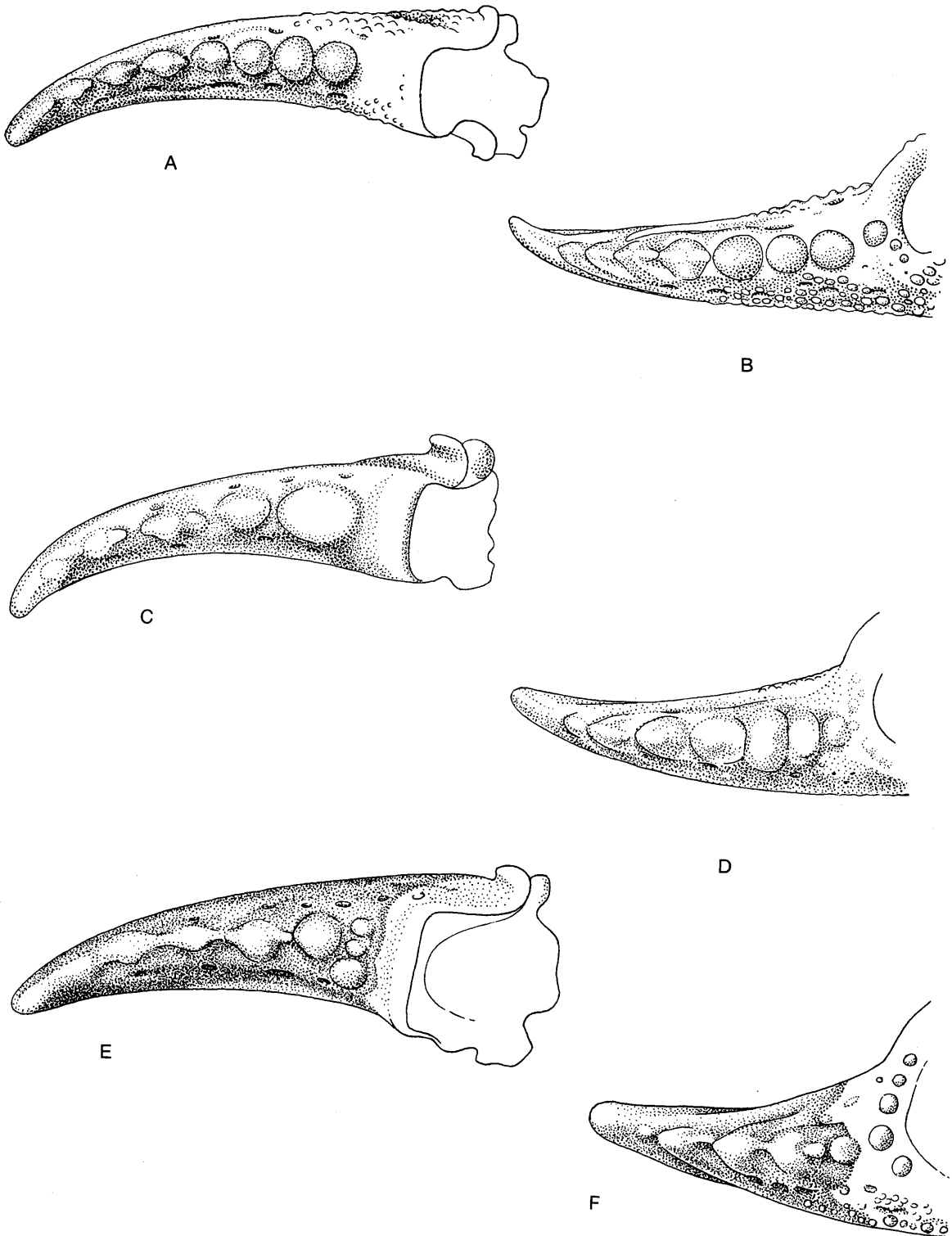


FIGURE 18. *Cancer magister* Dana, x 4, hypotype, UCMP 10732; A. left movable finger, occlusal view; B. left fixed finger, occlusal view. *Cancer gracilis* Dana, x 6, hypotype, UCMP 37888; C. left movable finger, occlusal view; D. left fixed finger, occlusal view. *Cancer oregonensis* Rathbun, x 12, hypotype, UCMP 10733; E. left movable finger, occlusal view; F. left fixed finger, occlusal view.

teeth, but is placed in this subgenus on: 1) produced front, 2) width of first anterolateral tooth greater than the second, and 3) shape of anterolateral teeth. Convergence of the truncate and deeply fissured form of the anterolateral teeth of Group B with four species (*C. plebejus*, *C. edwardsii*, *C. novaezealandiae* and *C. borealis*) of the subgenus *Metacarcinus* should be noted. These species can be differentiated from those of the subgenus *Cancer*, *sensu stricto*, on characters of the frontal region. *Cancer pagurus* has been modified by expansion of the anterolateral teeth so that the front is not produced as much as other species of this subgenus.

*C. chaneyi* (Middle Miocene-Upper Pleistocene) of California and Baja California is the oldest member of this subgenus but is known only from chelipeds. The chelipeds resemble those of *C. productus* and it is assumed that the carapace would also be similar. Based on this assumption, *C. chaneyi* is interpreted as being ancestral to *C. productus* and the other species of this group.

The four subgenera may reflect evolutionary development of *Cancer*. Species of the nominate subgenus *Cancer*, *sensu stricto*, are probably more modified than those of the other subgenera. The typically large size, smooth margins, pronounced lateral expansion of the carapace and unornamented chelipeds are in strong contrast to the species in *Romaleon*. The latter is interpreted as the most primitive of the subgenera because of its early record, small size and its possession of many characters from which those of other species of *Cancer* could have been derived.

The highly ornate *Glebocarcinus* represents an evolutionary development away from the *Romaleon-Metacarcinus-Cancer* trend of increasing size and lateral expansion of carapace, along with reduction of ornamentation and degree of production of anterolateral teeth. *Metacarcinus* appears to be intermediate in development between *Romaleon* and *Cancer*.

#### DISCUSSION OF THE SPECIES OF *CANCER* Family CANCRIDAE Latreille 1803

##### Genus *CANCER* Linnaeus 1758

- Cancer* Linnaeus 1758: 625. Type species *C. pagurus* Linnaeus 1758.  
*Alpheus* Weber 1795: 91. Type species *A. pagurus* (Linnaeus 1758). Not *Alpheus* Fabricius 1798: 380.  
*Pagurus* Berthold 1827: 255. Type species *P. pagurus* (Linnaeus 1827). Not *Pagurus* Fabricius 1775: 410.  
*Trichocera* De Haan 1833: 4, 16. Type species *T. gibbosula* (De Haan 1833). Not *Trichocera* Meigen 1803: 2.

- Platycarcinus* Milne Edwards 1834: 412. Type species *P. pagurus* (Linnaeus 1834).  
*Romaleon* Gistel 1848: 11. Substituted for *Trichocera*.  
*Metacarcinus* Milne Edwards 1862: 33. Type species *M. magister* (Dana 1862).  
*Trichocarcinus* Miers 1879: 34. Type species *T. gibbosula* (De Haan 1833). Substituted for *Trichocera*.

##### Description (Glaessner 1969: R509)

"Carapace very wide, finely granulate, anterolateral margins very long, curved, with about 10 denticulate lobes; gastroducardiac regions marked; orbits small, deep, with 2 fissures; front narrow, with 3 teeth, epistome narrow, chelae subequal, with 5 longitudinal blunt ridges on their outer surfaces."

##### *Cancer amphioetus* Rathbun 1898

Figures 4, 6, 15, 16, 30-7, 30-8; Tables 1, 2, 4

*Cancer amphioetus* Rathbun 1898: 582, new name for *Trichocarcinus dentatus* Miers 1879. Rathbun 1930a: 205 (contains prior synonymy).

Material: Recent—1 male, 1 female; fossil—1 finger, 1 carpus, and manus.

Hypotype: UCMP 32709.

##### Description (Rathbun 1930a: 205)

"*Diagnosis*: Antero-lateral teeth broadly triangular, moderately produced, subequal. Carapace not pubescent, strongly areolated, especially in the female.

*Description: Male*: Carapace smooth, bare, strongly areolated, the highest elevations occupying the protogastric and mid-branchial regions. Surface composed of close-set granules. Antero-lateral margin with 9 flat, broadly triangular, not strongly produced, subequal teeth with granulate margins; last 2 or 3 teeth acute or sharp-pointed. On postero-lateral margin a blunt tooth formed by a distinct emargination and followed by one and sometimes two less distinct. The frontal teeth between the antennae subtriangular, blunt or subtruncate, the middle one narrower and more produced than the next pair. Inner tooth of orbit very broad, shallow, separated from the outer tooth by a small, slightly projecting tooth or lobe. Tooth of basal antennae article broad, oblong; adjacent orbital tooth about half as long. Merus of cheliped armed above with two small, sharp spines, distal and subdistal; carpus with a triangular spine at inner angle and a granulated tubercle at articulation with manus; the latter has five carinae outside, and two above which are furnished with 2 or 3 tubercles each. Fingers granulated, dark color reaching nearly to base. Legs hairy, tips of dactyli bent downward.

*Female*: Much more uneven than the male, the elevations forming large bosses, one occupying the whole of each protogastric region, two across the middle of each branchial region, of which the inner is the smaller, the outer one pear-shaped and obliquely transverse in position. Lesser but distinct bosses are on the hepatic region and the widest part of the mesogastric. The cardiac region has a tendency to split up into a 4 or 6 rayed fan. This sexual form is the *bullatus* of Balss (Balss, 1922, p. 1), described from two females. Between it and the male described above there are intermediate forms of both sexes.

*Young*: In the very young the antero-lateral teeth are longer, thicker, more curved and separated than in the adult and show greater alternation in size; the first of the postero-lateral teeth is pronounced."

## SUPPLEMENTARY DESCRIPTION

*Manus.* Outer-upper surface with 7 carinae: upper margin (1st carina) with 3 long, sharp, distally curving spines, one at distal angle, the other two in proximal half, small sharp granules between them, 2nd carina with 3 very large, coarsely granulate tubercles, one at distal end, the other two elongated, joined at base and centrally located; third to seventh carinae are single rows of short, thick spines. Area between carinae smooth except for a few scattered tiny, sharp granules; distal margin bordered by coarse sharp granules. Inner surface smooth, evenly and finely granulated.

*Carpus.* Upper surface bounded by a coarsely granulate carina; a long blunt-tipped but coarsely and sharply granulated tubercle at upper articulation; a similar tubercle, but half the height, on the diagonal carina. Two longitudinal carinae, both prominently raised and very coarsely granulate, the upper shorter than the lower. Upper angle with a very sharp, elongated spine; inner angle slightly raised, with a few sharp granules.

*Fixed finger.* Typically 4 very sharp-edged cutting teeth, connected by a sharp ridge; first tooth conical, the others elongated, sharp-edged. Outer surface with two sharply granulate carinae, the upper one forming a prominent medial ridge with the smooth surface sloping gently away from it; the lower carina with a single row of sharp granules. Setiferous pits at base of teeth 2, 3, and 4. Inner surface very smooth, a broad medial ridge with a row of setiferous pits below it and 2 above. Dense, dark tip material extending to proximal tooth.

*Movable finger.* Typically 5 subequal, sharp-edged cutting teeth, the proximal 2 close together, equal; 3rd and 4th further apart but connected by a sharp ridge. Outer surface with 2 longitudinal ridges with short, sharp spines; the upper ridge narrow, separated from lower by a narrow groove; lower ridge not sharply raised; spines extend half the distance to tip of finger. Upper margin squared-off with a few sharp granules along inner edge. Inner surface very smooth, rounded, with a medial row of small setiferous pits. Dense, dark tip material extends to proximal tooth.

## Occurrence

*Pleistocene.* Timms Point Silt: LACMIP 130-7 (1 l.m.f.). Lomita Marl: LACMIP 435 (1 left carpus, 1 distal 1/4 of left manus).

*Summary.* Lower Pleistocene to Recent; northern China to Gulf of California, Mexico.

## Ecology

*Living.* La Jolla, California to Gulf of California, Mexico; Japan and Korea (Rathbun 1930a:208); northern China (Shen 1932:97). 4.5-169 fathoms; 48-63.5° F; rock, pebbles, sand, broken shells, mud (Rathbun 1930a:208).

*Cancer antennarius* Stimpson 1856

Figures 4, 13, 14, 32-5, 32-6; Tables 1, 2, 5

*Cancer antennaria* Stimpson 1856:88.

*Cancer antennarius* Stimpson 1857:462; Rathbun 1930a:210 (contains prior synonymy).

*Cancer productus* Randall 1839; Rathbun 1926:62, 63 (in part).

*Cancer anthonyi* Rathbun 1897; Rathbun 1926:64 (in part).

*Cancer jordani* Rathbun 1900; Rathbun 1926:64 (in part).

Material: Recent—6 female, 5 male, 3 indet.; fossil—199 fingers, 1 carapace.

Hypotype: UCMP 32092.

Description (Rathbun 1930:210)

*“Diagnosis:* Carapace widest at 8th antero-lateral tooth; two posterolateral teeth. Under parts spotted or blotched with reddish. A single tooth or spine on wrist.

*Description:* Marginal teeth thick, high in the middle, deeply separated, edges finely spinulose. The three frontal teeth between the antennae are narrow, the median smallest and considerably lower than the next pair. Between the large inner and outer orbital teeth there is a smaller but prominent narrow tooth. Nine antero-lateral teeth are more or less acute and curving forward. Postero-lateral teeth two, the first short but deeply marked the second slightly indicated. Dorsal surface very uneven, lumpy, granulations fine, uniform; surface typically devoid of hair except in the very young. Antennae unusually stout and long. Lower orbital margin cut into two teeth between the outer and the antennal tooth. Chelipeds heavy, nearly smooth; merus with a short distal and subdistal spine-tipped tooth; inner tooth of carpus short, a conical tubercle near the distal articulation; outer-upper surface of palm obscurely costate. Legs rough and hairy; dactyli with fine longitudinal rows of bristles.

Variable as to hairiness, roughness of the hand, size of granules, and thickness and sharpness of teeth.”

## SUPPLEMENTARY DESCRIPTION

*Manus.* Outer-upper surface broadly rounded, smooth, evenly granulated; seven carinae, the upper five inconspicuous, marked only by an alignment of slightly coarser granules and small pits, in large specimens unrecognizable as carinae. The lower two carinae slightly raised and marked by a regular alignment of pits just above them. Inner surface rounded, the first two carinae more coarsely granulate than those of the outer surface.

*Carpus.* Margin of outer surface rounded and poorly defined by a band of coarse granules. Longitudinal carina broad, terminating distally in a low granulated elevation; a zig-zag pattern of coarse granules between it and the upper margin. Diagonal carina marked only by a bluntly pointed, coarsely granulated tubercle behind the upper articulation

and a low, coarsely granulated elevation half the distance between it and the upper margin. Upper angle with a sharp, conical spine. Inner angle raised into a rounded projection with two or three coarse granulations on it.

*Fixed finger.* Cutting teeth typically four; high, sharp-edged with the edge centered on each tooth (vs *C. productus*, which has edge displaced to inside margin). Proximal tooth rather complex with a sharp-edged cusp at the distal end and two smaller conical cusps behind and displaced to the outside edge of the tooth; a broad corrugated shelf on the inner side of the tooth, opposite the two cusps (these features often abraded and not visible). Outer surface with a broad medial ridge and a lower ridge sharply defined by a groove and row of setiferous pits just above it. Four setiferous pits in a row at base of cutting teeth 1, 2 and 3. Lower edge with a row of setiferous pits, not forming a groove. Inner surface with a prominent medial and lower ridge separated by a row of about 5 setiferous pits in a groove; two pits at base of cutting teeth 1 and 2. Dark, dense tip material extends to base of finger (best character for separating it from *C. anthonyi*).

*Movable finger.* Cutting teeth typically five; the proximal one large and rounded, the others smaller, elongate and blade-like, and aligned with the outer edge of the proximal one; the 3rd smaller than 2 and 4. Proximal tooth, if unworn, with three cusps, two conical ones on outer side and an elongate one on inner side; if worn, a broad rounded tooth. Outer surface broadly rounded, evenly granulated; a rather prominent groove with setiferous pits parallel to upper margin and half distance between it and base of teeth; a less prominent medial groove on inner surface. Thicker and more coarsely granulate than *C. anthonyi*.

#### Occurrence

*Pleistocene.* Palos Verdes Formation: UCLA 5264 (1 r.m.f.); LACMIP 440 (1 r.m.f., 1 l.m.f.); LACMIP 136 (1 r.f.f.); LACMIP 66-2 (4 l.m.f., 3 l.f.f., 2 r.m.f., 2 r.f.f.); LACMIP 229 (1 l.m.f.); USNM 353390 (1 r.m.f. referred to *C. productus* by Rathbun 1926:62). Rustic Canyon (U. Pleistocene); UCLA 4853 (1 r.m.f.). Playa del Rey (Palos Verdes Fm): UCLA 667 (1 r.f.f.); UCLA L-2413 (1 l.m.f.); LACMIP 59 (1 r.m.f., 3 l.m.f.). Point Loma (Palos Verdes Fm): UCLA 1-3605 (1 l.m.f., 1 l.f.f., 3 r.m.f., 3 r.f.f.); USNM 372800 (1 r.m.f., referred to *C. productus* by Rathbun 1926:63); SDSNH L-2419 (1 r.m.f., 1 r.f.f.). Pacific Beach (U. Pleistocene, Bay Point Fm?): UCMP A-1487 (2 r.m.f.). Millerton Formation: UCMP B-6355 (1 r.m.f.). Deadman Island (San Pedro Formation); UCLA 8627 (1 r.m.f., 1 l.f.f.). Rincon del Potrero; USNM 353391 (3 l.m.f., 2 l.f.f., 3 r.m.f., 1 r.f.f., referred to *C. productus* by Rathbun

1926:63). Spanish Bight (Palos Verdes Fm): USNM 353380 (2 r.m.f., referred to *C. anthonyi* by Rathbun 1926:64); USNM 372801 (1 r.m.f., referred to *C. jordani* by Rathbun 1926:64); SDSNH L-56 (1 l.m.f.). San Pedro Formation: USNM 353393 (1 r.m.f., referred to *C. productus* by Rathbun 1926:63); USNM 353385 (1 r.f.f., referred to *C. jordani* by Rathbun 1926:64); LACMIP 332 (3 r.m.f.); LACMIP 142-B (2 l.m.f., 1 r.f.f.).

*Baja California.* Punta China: UCMP A-9595 (1 r.m.f.); UCMP A-9002 (1 l.m.f.). Bahia Rosario: UCMP A-9591 (1 r.m.f.). Punta Cabras: UCMP A-9587 (1 r.m.f.). Punta Descanso Bay: UCMP B-3090 (1 l.m.f.). San Quintin Bay: UCLA L-2411 (2 l.m.f., 1 l.f.f., 1 r.m.f.); USNM 353392 (1 r.m.f., referred to *C. productus* by Rathbun 1926:62). San Joaquin Formation: UCMP A-7586 (1 l.m.f.); UCMP B-7727 (14 l.m.f., 8 l.f.f., 17 r.m.f., 12 r.f.f.).

*Pliocene.* Etchegoin Formation: UCMP A-3166 (1 r.m.f.); UCMP D-2384 (1 r.m.f.); UCMP D-1166 (1 l.m.f.). San Diego Formation: LACMIP 305 (1 l.m.f., 1 l.f.f., 1 r.f.f.); LACMIP 305-C (21 l.m.f., 15 l.f.f., 15 r.m.f., 14 r.f.f., partial left merus, partial carapace with antero-lateral teeth no. 1, 2 and 3); LACMIP 449 (1 r.m.f., 1 l.m.f.).

*Baja California.* San Ysidro: SDSC 32 (1 r.f.f.).

*Summary.* Middle Pliocene to Recent: Coos Bay, Oregon to Todos Santos Island, Baja California, Mexico.

#### Ecology

*Living.* Coos Bay, Oregon (unpublished), to Todos Santos Island, Baja California, Mexico (Garth 1969). Shore to 49 fathoms. 60.36-67.1° F; mud, sand, gravel, under rocks along shore (Rathbun 1930a: 212-213).

#### *Cancer anthonyi* Rathbun 1897

Figures 4, 13, 14, 35-5, 35-6; Tables 1, 2, 6

*Cancer anthonyi* Rathbun 1897:111. Rathbun 1926:64. Rathbun 1930a:218 (contains prior synonymy).

*Cancer gracilis* Dana 1852. Rathbun 1926:65 (in part).

*Cancer productus* Randall 1839. Rathbun 1926:62 (in part).

Material: Recent—5 female, 9 male; fossil—40 fingers, 1 carpus, 3 mani.

Hypotype: UCMP 11390.

#### Description (Rathbun 1930a:218)

*“Diagnosis:* Carapace widest at ninth antero-lateral tooth; posterolateral teeth inconspicuous. Intermediate supra-orbital tooth shallow. Under parts of uniform light color.

*Description:* Carapace very convex, uneven, furrows at middle well marked; surface smooth to the touch, formed by a pavement of flat, close-set granules. Marginal teeth thick, blunt or subacute. Antero-lateral margin very arcuate, nine-toothed, lateral tooth projecting little beyond the preceding. Postero-lateral margin with two rudimentary non-projecting teeth or emarginations. Median tooth or front small and narrow. Upper margin of orbit between sutures dentiform or lobiform; tooth low. Basal antennal tooth



large, advanced beyond front. Distal margin of merus of outer maxilliped slightly curved and at right angles to outer margin, outer angle rounded. Chelipeds and legs nearly smooth; merus with short distal and subdistal spines; carpus with a broad, inner tooth and a tubercle on upper surface just behind articulation with palm. The latter is obscurely carinated; immovable finger deflexed.

Allied to *C. antennarius*, but antero-lateral teeth broader and less projecting, front narrower and legs less hairy."

#### SUPPLEMENTARY DESCRIPTION

*Manus and carpus.* Very similar to those of *C. antennarius*. Differentiated most reliably on the Lu/H manus ratio which varies from .672-.784 in *antennarius* and .786-.906 (calculated ranges) in *anthonyi*. The manus of *C. anthonyi* is longer and not as high as *C. antennarius*. The carpi of these two species cannot be easily or reliably differentiated.

*Movable finger.* Cutting teeth typically four with a large, round, proximal one and 3 widely spaced distal teeth, diminishing gradually in size toward tip. Tooth pattern similar to *C. antennarius* but varying in the following details: 1) proximal tooth less broad, with a more elongate basal shape, 2) typically four teeth. Finger longer, thinner and more finely granulose; lacking a distinct groove on outer surface but with a row of closely spaced setiferous pits in the same position.

*Fixed finger.* Cutting teeth with basically the same pattern as in *C. antennarius* with four teeth; the most proximal is large, rounded with 3 cusps on outer side and 3 distal teeth decreasing rapidly in size toward the tip. Differing from *C. antennarius* in 1) proximal tooth not as broad, 2) finger longer and thinner, 3) dark, dense tip material extending less than half the length of finger, 4) granulations finer than in *antennarius*.

#### Occurrence

*Pleistocene.* Playa del Rey (Palos Verdes Fm): LAC-MIP 59 (5 l.m.f., 3 r.m.f.). Palos Verdes Formation: LACMIP 66-2 (1 r.m.f.); LACMIP 227 (1 r.m.f.); UCMP 2047 (1 r.m.f., 2 r.f.f.). Rincon del Potrero: USNM 353391 (2 l.m.f., 3 l.f.f.); USNM 353382 (2 l.m.f., 3 r.m.f.). San Joaquin Formation: UCMP A-7586 (1 left hand); UCMP B-7727 (8 l.m.f., 3 l.f.f., 11 r.m.f., 3 r.f.f.). Saugus Formation: UCMP 7095 (1 l.f.f.).

*Baja California.* San Quentin Bay: UCMP B-3071 (1 l.f.f., 1 right carpus, 1 left hand less proximal half, 1 right hand less movable finger).

*Pliocene.* Etchegoin Formation: UCMP D-2506 (1 left merus, 1 r.f.f., 2 r.m.f.).

*Summary.* Middle Pliocene to Recent; Humboldt Bay, California to Magdalena Bay, Baja California, Mexico.

#### Ecology

*Living.* Humboldt Bay, California to Magdalena Bay, Baja California, Mexico. Shore to 57 fathoms (Garth 1969); 55.4-67.6° F; fine sand, shells, mud and stones (Rathbun 1930a:218-219).

#### *Cancer branneri* Rathbun 1926

Figures 4, 15, 16, 31-1, 31-2; Tables 1, 2, 7

*Cancer branneri* Rathbun 1926:63. Rathbun 1930a:211 (contains prior synonymy). Menzies 1951:170.

*Material:* Recent—1 female, 3 males; fossil—69 fingers, 1 carpus, 1 carapace.

*Hypotype:* UCMP 10756.

#### Description (Rathbun 1930a:211)

*"Diagnosis:* First postero-lateral projection spiniform, not projecting sideways beyond the carapace margin and followed by a minor tooth. Carapace strongly areolate. Dactyl of cheliped spiny.

*Description:* Carapace markedly areolate, sparsely pubescent, hairs rather coarse and harsh, granules scabrous, somewhat scattered; antero-lateral margin armed with 9 strongly produced, forward-curving, sharp teeth, all except the first two tipped with a spine; postero-lateral margin with a well marked tooth directed upward and not laterally, and behind it an indistinct tooth or notch. Fronto-orbital width one-third that of carapace; medial tooth of front sub-oblong, depressed; next pair small, triangular, sub-acute, and widely separated from the broad orbital pair. Three superior orbital teeth, of which the middle one is similar in shape to the outer one but less advanced. Tooth of basal antennal article narrow, produced beyond the front; adjacent tooth of suborbital margin small. Merus of outer maxilliped truncate, anterior margin shorter than outer margin and forming a slightly obtuse angle; inner angle slightly produced inward in a blunt tooth. Chelipeds hairy; merus with two spines above, distal and subdistal; carpus spinulose above, a spine at articulation with manus, a larger spine at inner angle with a small one below it. Upper surface of hand with 2 rows of 3 to 5 spines each, outer surface with 5 rows marked with hair and spinules; a spine at articulation with carpus; upper margin of dactylus spinous, outer surface with 2 strong carinae the upper of which is spinous and between them a tuberculated carina on proximal half only. Legs hairy; dactyli longer than propodi, straight, tipped with nearly straight corneous spines. Abdomen of male very long and narrow, especially the terminal segment; sixth segment slightly wider than long."

#### Description of fingers (Menzies 1951:170)

*"Dactyl:* almost hexagonal in cross-section. Superior surface with a medial and lateral row of large spines. Lateral surface with two rows of large spines. Lateral and medial surfaces lack setiferous pits except above teeth but have large setiferous sulci. These are perforated by numerous holes which represent the setae attachment points on Recent specimens. Teeth about six.

*Propod:* about four teeth. Lateral and medial areas with setiferous sulci and ridges bearing fairly large spines."

#### SUPPLEMENTARY DESCRIPTION

*Manus.* Outer-upper surface with 7 spinose carinae; the upper margin (1st carina) with 3 slender, very sharp spines, the largest at distal angle; the second

carina with 5 spines, the largest at distal angle, all smaller than those on first carina; carinae 3 through 7 with spines decreasing in length and increasing in number; the areas between all carinae except 1 and 2 with a medial row of smaller spines. A single spine on the tubercle at the articulation with carpus and several smaller spines at distal end of manus around the alveolus of movable finger. Inner surface with 4 longitudinal rows of sharp granules in lower half.

*Carpus.* Outer surface bounded by a row of short spines; longitudinal carina with a row of spines, the longest one at distal end; diagonal carina with a high, spinulose spine behind the upper articulation, several small spines along the carina with a larger one midway between the articulation and the upper margin. Another row of spines paralleling the upper margin and the diagonal carina, repeating the angle formed by the junction between them. Upper angle with a large, sharp, triangular spine, inner angle with a very long slender spine.

*Fixed finger.* Cutting teeth typically six, very sharp-pointed and sharp-edged; teeth 1 and 2 equal, conical; third tooth largest, pointing directly upward; teeth 4, 5 and 6 slightly inclined distally, decreasing rapidly in size, tooth 6 at terminus of the medial ridge. Outer surface with a thin, spinulose medial ridge and a similar lower ridge, separated by a broad groove with numerous tiny, setiferous pits; five oval setiferous pits between medial ridge and cutting teeth, the largest at base of cutting tooth 3. Lower margin with a prominent longitudinal groove with numerous tiny setiferous pits. Inner surface with a narrow medial and lower ridge separated by a narrow groove with tiny setiferous pits; an upper ridge at base of cutting teeth separated from medial ridge by about five oval, setiferous pits, the largest below cutting teeth 3 and 4.

*Movable finger.* Cutting teeth typically 7; first very small, conical; teeth 2 and 3 twice as large as 1 but similar in shape; 4, 5, 6 and 7 elongate and sharp-edged with 5 larger than 4 but 6 and 7 decreasing in size distally. Outer surface with an upper spinulose ridge and a lower smooth ridge just above the cutting teeth, separated from each other by a deep groove with numerous tiny setiferous pits; this groove bifurcating proximally, divided by a medial, spinulose ridge extending proximally from the articulation with the manus to the fourth cutting tooth, about half the length of the finger. A row of about 6 oval, setiferous pits at base of teeth 2 through 4. The upper and lower ridges coalescing near the tip. Upper edge with a groove in the middle, but squared off toward the base of the finger, with a row of spines along each edge. The spines on the outer edge (upper ridge of outer surface) relatively small but

with three very long slender spines on the inner edge. Inner surface smooth and rather broadly rounded except for a narrow medial groove separating two broad ridges; about 5 oval setiferous pits at base of teeth.

#### Occurrence

*Pleistocene.* Palos Verdes Formation: USNM 496710 (2 r.m.f.); USNM 353594 (1 r.m.f., figured by Rathbun 1926:pl. 16, fig. 4); LACMIP 66-1 (3 l.f.f., 2 r.f.f.). Playa del Rey (Palos Verdes Fm): LACMIP 59 (1 l.f.f., 1 r.f.f.). San Pedro Formation: UCMP A-1503 (1 l.f.f.); LACMIP 332 (2 l.m.f., 3 l.f.f., 3 r.m.f., 2 r.f.f., 1 left carpus, 1 partial carapace); LACMIP 226 (3 l.m.f., 3 r.m.f., 1 r.f.f.); USNM 353381 (1 l.m.f., 1 l.f.f., referred by Rathbun 1926:63); LACMIP 300 (1 r.f.f.). Timms Point Formation: LACMIP 130-4 (1 l.m.f., 1 l.f.f., 1 r.m.f., 1 r.f.f.); LACMIP 130-7 (5 l.m.f., 2 l.f.f., 3 r.m.f.); SDSC 234 (1 r.m.f.). Lomita Marl: LACMIP 435 (7 l.m.f., 1 l.f.f., 4 r.m.f., 2 r.f.f.). Millerton Formation: UCMP B-6353 (1 r.f.f.).

*Baja California.* Punta Descanso: UCLA 2716 (1 r.m.f.).

*Pliocene.* Santa Barbara Formation: UCMP B-4964 (1 l.m.f.). Pico Formation: LACMIP 181 (2 l.m.f., 1 l.f.f., 3 r.m.f.).

*Summary.* Upper Pliocene to Recent; Port Althorp, Alaska, to Santa Catalina Island, California.

#### Ecology

*Living.* Port Althorp, Alaska, to Santa Catalina Island, California. Low tide to 40 fathoms; 46.7-53.3° F; sandy mud, coarse sand, shells (Rathbun 1930a:214-215).

#### *Cancer gracilis* Dana 1852

Figures 4, 17, 18, 36-1, 36-2; Tables 1, 2, 8

*Cancer gracilis* Dana 1852: 73. Rathbun 1926:65. Rathbun 1930a:219 (contains prior synonymy). Menzies 1951:166.

*Cancer anthonyi* Rathbun 1897. Rathbun 1926:64 (in part).

*Cancer magister* Dana 1852. Rathbun 1926:64 (in part).

*Cancer productus* Randall 1839. Rathbun 1926:62 (in part).

Material: Recent—8 female, 2 male; fossil—262 fingers, 1 carapace.

Hypotype: UCMP 37888.

#### Description (Rathbun 1930a:219)

*Diagnosis.* Nine low antero-lateral teeth, one postero-lateral. Fingers of cheliped without dark color. Merus of outer maxillipeds elongate, anteriorly rounded.

*Description.* Carapace strongly convex, very slightly areolated, densely granulated, widest at ninth (sometimes eighth) tooth. Antero-lateral teeth low, 9 in number, of unequal width, projecting less than one-third width of base, not spiny pointed. One small blunt postero-lateral tooth. Medial tooth of front smaller than those of the next pair but advanced well beyond them. Outer and distal margins

of merus of outer maxilliped forming a single curve without angulation. Arm with a small distal and subdistal spine or spinule; wrist with two inner spines or teeth, the smaller below the other. Propodus with nearly horizontal margin, outer-upper surface with seven longitudinal carinae some of which are incomplete, the upper one bispinulous, the next one similar; upper edge of dactylus finely roughened at its middle. Legs relatively narrow, merus finely rugose above, dactyls long and narrow."

#### Description of fingers (Menzies 1951:166)

*"Dactyl.* Laterally compressed, very high and oval in cross-section. Superior surface with a single marginal row of sharp irregular spines. Lateral and medial surfaces covered with small tubercles. Setiferous pits scattered over lateral surface but tending to be in rows. Teeth about six, the most proximal (first) of which has three apical teeth; third tooth smaller than second and fourth; fifth smaller than fourth and sixth.

*Propod.* Teeth about six, triangulate and laterally compressed. Lateral and medial areas covered with tubercles. Lateral surface with setiferous pits scattered but tending to be in rows."

#### SUPPLEMENTARY DESCRIPTION

*Manus.* Outer-upper surface with six granulated carinae; upper margin (1st carina) with two short granulated spines, one at distal angle, the other about half the distance back along the margin; second carina marked by three granulated tubercles in a row, one at distal margin, one immediately below the medial spine on the upper margin, and the third half way between the medial tubercle and the articulation with carpus; third, fourth carinae extending from proximal end of the manus to a point below the medial tubercles on the 1st and 2nd carinae, there gradually disappearing; fifth and sixth carinae extending from proximal end of manus onto the fixed finger there gradually losing their sharply granulated character and forming a medial and lower ridge. Area between carinae sparsely and finely granulated. Inner surface evenly and finely granulated.

*Carpus.* Outer surface bordered by a slightly raised carina of coarse granules, surface sparsely and finely granulated. Longitudinal and diagonal carinae slightly raised and evenly granulated; a low, coarsely granulated tubercle at upper articulation. Upper angle with a sharp, triangular spine; inner angle with a sharp, conical spine.

*Movable finger.* Very high and laterally compressed; upper margin forming a sharp edge with several irregularly arranged sharp granules, outer surface broadly rounded and unevenly granulated. Granules grading from coarse at the upper margin to very fine just above the cutting teeth; no linear arrangement. Numerous small pits scattered over the outer surface, aligned in a medial groove in distal half of both inner and outer surfaces. Cutting teeth typically five; a large proximal one with three cusps;

the second and third elongate and sharp-edged; the fourth and fifth more elongate and smaller. Tip quite long and gradually tapering; dense tip material extending back to the third cutting tooth, about half the length of the finger.

*Fixed finger.* Typically six teeth: the first two (proximal) low and transversely elongated, when worn, forming a broad platform with the third tooth; teeth 3 through 6 high, sharp-edged, and decreasing gradually in size toward the tip of the finger. Outer surface broadly rounded over the medial ridge; medial ridge separated from the lower ridge by a shallow groove with a row of small pits. Other small pits scattered over the outer surface.

#### Occurrence

*Pleistocene.* Palos Verdes Formation: LACMIP 66-1 (5 l.f.f., 5 l.m.f., 2 r.m.f., 13 r.f.f.); LACMIP 66-2 (1 l.m.f., 3 r.m.f.); LACMIP 229 (1 l.f.f.); LACMIP 440 (1 l.m.f., 2 l.f.f., 5 r.m.f., 5 r.f.f.); UCMP 2047 (8 l.m.f., 18 l.f.f., 10 r.m.f., 14 r.f.f., 1 partial carapace); USNM 496485 (1 r.m.f.); USNM 496181 (1 r.f.f.). Playa del Rey (Palos Verdes Fm): LACMIP 59 (9 l.m.f., 15 l.f.f., 7 r.m.f., 7 r.f.f.). Spanish Bight (Palos Verdes Fm): USNM 353380 (2 r.m.f., 1 l.f.f., referred to *C. anthonyi* by Rathbun 1926:64); USNM 353383 (2 l.m.f., 1 r.m.f., 2 r.f.f., referred by Rathbun 1926:65); USNM 372802 (2 r.m.f., 1 r.f.f., referred by Rathbun 1926:65); SDSNH L-56 (1 l.m.f., 3 l.f.f., 4 r.m.f., in part referred to *C. anthonyi* by Rathbun 1926:64). Rincon del Potrero: USNM 353382 (1 l.m.f., 3 l.f.f., 3 r.f.f., referred by Rathbun 1926:65); USNM 353391 (1 l.m.f., referred to *C. productus* by Rathbun 1926:62). San Pedro Formation: USNM 353389 (2 l.f.f., referred to *C. magister* by Rathbun 1926:64); USNM 353384 (2 r.m.f., referred by Rathbun 1926:65); LACMIP 332 (15 l.m.f., 6 l.f.f., 17 r.m.f., 16 r.f.f.); LACMIP 142-B (3 r.f.f., 4 l.f.f.); LACMIP 131 (1 r.m.f.); LACMIP 300 (6 r.m.f., 3 r.f.f., 4 l.m.f., 5 l.f.f.). Timms Point Formation: LACMIP 130-7 (1 r.m.f.). Lomita Marl: LACMIP 435 (1 r.m.f.).

*Pliocene.* Merced Formation: UCMP D-3389 (1 l.m.f., 1 l.f.f., 1 r.m.f.). Pico Formation: LACMIP 466 (1 r.m.f.). Palm City: (San Diego Fm?) LACMIP 305-C (5 r.m.f., 2 r.f.f., 4 l.m.f., 1 l.f.f.).

*Summary.* Upper Pliocene to Recent; Prince of Wales Island, Alaska, to Playa Maria Bay, Baja California, Mexico.

#### Ecology

*Living.* Kasaan Bay, Prince of Wales Island, Alaska, to Playa Maria Bay, Lower California, Mexico. Low tide to 56 fathoms; 48.5-52.8° F; mud, sand, broken shells (Rathbun 1930a: 220-222).

*Cancer jordani* Rathbun 1900

Figures 4, 15, 16, 31-3, 31-4; Tables 1, 2, 9

*Cancer jordani* Rathbun 1900:133. Rathbun 1930a:215 (contains prior synonymy). Menzies 1951:169.*Cancer antennarius* Stimpson 1856. Rathbun 1926:64 (in part).

Material: Recent—4 males; fossil—806 fingers, 4 mani.

Hypotype: UCMP 10731.

## Description (Rathbun 1930a:215)

*Diagnosis:* Carapace hairy; antero-lateral teeth spiniform, curved, alternating in size; one postero-lateral tooth.

*Description:* Carapace slightly areolated, hairy, and covered with small crowded scabrous granules; antero-lateral teeth separated to their bases, curved forward, tips spiniform, very slender; second, fourth, sixth and eighth teeth smaller than the others; alternation in size of teeth varying with age, most noticeable in young specimens, less so in large ones; ninth tooth scarcely more prominent than eighth; one postero-lateral tooth is indicated in older specimens and less conspicuously so in younger ones by a slight gap in the spinules marking that margin. Fronto-orbital width nearly half width of carapace; inner orbital tooth very slightly produced; margin of upper intermediate orbital lobe almost transverse, scarcely dentiform. Tooth of basal antennal article and the adjoining tooth of the orbital margin acute. Movable part of antennae half as long as carapace. Merus of outer maxilliped obliquely truncated, margin at a slightly obtuse angle to outer margin, corner rounded; the merus considerably overlaps the epistome and the basal article of the antenna. Seven carinae on upper-surface of palm are fringed with hair, the two superior carinae with several spines. Upper surface of basal half of movable finger rough with sharp granules. Tips of fingers light; the dark color runs along the prehensile margins to the base or nearly so, but about 3/5 or 2/3 of the outer margin. Legs hairy.

## Description of fingers (Menzies 1951:169)

*Dactyl.* Almost hexagonal in cross-section. Superior surface with several rows of small spines. Lateral and medial surfaces lacking setiferous pits except above teeth but having conspicuous setiferous sulci. Teeth about seven.

*Propod.* Teeth about five. Lateral area with a deep sulcus bordered by elevated spinulate ridges. The dactyls and propods of this species in general resemble those of *C. branneri* considerably. These species differ primarily only in the more numerous and smaller spines present on specimens of *C. jordani*.

*Remarks.* The average ratio of the carapace width to the dactyl length of three Recent specimens is about 4.7. The largest fossil dactyl in the collections is 11 mm in length. If the above ratio holds true for large crabs, this indicates an individual having a carapace width of about 51.7 mm, which is considerably larger than any Recent specimens thus far recorded. This accords with Miss Rathbun's statement (1926, p. 64), These fingers (Pleistocene, Nob Hill, Lower San Pedro formation) are of unusual size indicating that the species was much larger in the Pleistocene than now."

## SUPPLEMENTARY DESCRIPTION

*Manus.* Outer-upper surface with seven granulat-

ed carinae: the first, second and third poorly defined by an irregular alignment of sharp-pointed, distally inclined granules. Upper margin (1st carina) with one small spine about one-third distance back from the upper distal angle; upper distal angle rounded as is the whole upper surface of the manus. Fourth, fifth, sixth and seventh carinae becoming increasingly prominent on raised ridges and with regular alignment of sharp granules interspersed with very small setiferous pits; area between carinae sparsely and finely granulated with coloration forming a reticulate pattern. Inner surface sparsely and finely granulated, with a reticulate color pattern.

*Carpus.* Outer surface broadly rounded with border and carinae poorly defined. Longitudinal and diagonal carinae broad ridges with irregularly aligned sharp granules; a sharply granulated tubercle at upper articulation. Upper distal angle with a sharp triangular spine; inner angle with a single, small conical spine.

*Movable finger.* Cutting teeth usually six; typically with the most proximal tooth a large, rounded, oval shape; second smaller but similar shape, third very small, rounded, fourth and fifth intermediate in size but elongate and sharp-edged, sixth very small, sharp-edged. Upper surface squared-off: a medial ridge of coarse, sharp-pointed, distally inclined granules interspersed with small setiferous pits; the medial ridge tapering distally and disappearing one-third distance from tip into a V-shaped groove with setiferous pits; the groove reaching its apex near the tip and dividing proximally to form the boundary of the medial ridge, extending along the inner upper edge of the finger to its base. Laterally from the V-shaped groove, two prominent, sharply granulated ridges form the boundaries of the upper surface and converge distally at the tip of finger. Outer surface with a prominent setiferous groove just below the granulated ridges; below it a second longitudinal ridge extending from the tip proximally half the length of finger, there bifurcating, forming two granulated ridges extending to base of finger, becoming broader and more coarsely granulate toward the base; a short setiferous groove separates the two branches of the ridge as it bifurcates. A row of about 8 large, elongate oval setiferous pits between the longitudinal ridge and the cutting teeth. Inner surface with a smooth upper longitudinal ridge, a narrow medial setiferous groove, and a lower smooth longitudinal ridge separated from the cutting teeth by a row of 4 or 5 small, oval, setiferous pits. All longitudinal ridges converging distally to form the tip of the movable finger. Dense, dark tip material extending more than half the length of upper margin.

*Fixed finger.* Cutting teeth typically five: first

small, conical; second largest, sharp-edged and high (height=length); 3, 4 and 5 similar in shape but decreasing in size rapidly; fourth same size as first, but fifth very small. Outer surface marked by two sharply raised and granulated ridges, one medial and another at lower margin. Five large, oval, setiferous pits above medial ridge at the base of teeth 2 and 3; the surface below it sloping gently into a setiferous groove lying just above the lower ridge. Lower edge with a sharp setiferous groove, widening proximally, replaced distally by the two converging lower ridges of the inner and outer surfaces. Inner surface with a lower and a medial ridge, separated by a deep setiferous groove; above the medial ridge 5 elongate, oval, setiferous pits separating it from the teeth. Dense, dark tip material extends more than half length of fixed finger.

#### Occurrence

*Pleistocene*. Palos Verdes Formation: UCLA 5264 (2 l.m.f., 4 r.m.f.); LACMIP 440 (8 l.m.f., 4 l.f.f., 8 r.m.f., 5 r.f.f.); LACMIP 66-1 (12 l.m.f., 5 r.m.f.); LACMIP 66-2 (3 l.m.f., 1 l.f.f., 1 r.f.f.); UCMP 2047 (1 l.m.f., 4 r.m.f.); USNM 496177 (2 l.m.f., 4 r.m.f.). Playa del Rey (Palos Verdes Fm): LACMIP 59 (12 l.m.f., 2 l.f.f., 17 r.m.f., 3 r.f.f.). Newport Beach: UCMP A-3101 (1 r.m.f.). San Pedro Formation: UCLA L-1055 (1 l.m.f.). Spanish Bight (Palos Verdes Fm): USNM 372801 (2 l.m.f., referred by Rathbun 1926:64). Deadman Island (San Pedro Fm): USNM 353387 (3 l.m.f., 3 r.m.f., referred by Rathbun 1926:64). Rincon del Potrero: USNM 353386 (1 l.m.f., 1 r.m.f., referred by Rathbun 1926:64). Timms Point Formation: LACMIP 62 (1 r.m.f., 1 r.f.f.). San Pedro Formation: UCMP A-1503 (6 l.m.f., 10 r.m.f., 1 r.f.f.); USNM 353388 (5 l.m.f., 1 l.f.f., 5 r.m.f., 1 r.f.f., referred by Rathbun 1926:64); USNM 353385 (4 l.m.f., 3 r.m.f., referred by Rathbun 1926:64); LACMIP 332 (183 l.m.f., 67 l.f.f., 187 r.m.f., 93 r.f.f., 3 left manus, 1 with moveable finger); LACMIP 131 (2 l.f.f.); LACMIP 142-B (39 l.m.f., 15 l.f.f., 41 r.m.f., 14 r.f.f., 1 right hand); LACMIP 228 (2 l.m.f., 2 l.f.f., 2 r.m.f., 1 r.f.f.); LACMIP 300 (1 r.m.f.); LACMIP 226 (6 l.m.f., 2 r.m.f.).

Baja California. San Quintin Bay: UCMP B-3071 (1 l.m.f., 2 r.m.f.).

*Summary*. Lower Pleistocene to Recent; Coos Bay, Oregon to Thurloe Head, Baja California, Mexico.

#### Ecology

*Living*. Coos Bay, Oregon (unpublished), to Thur-

loe Head, Baja California, Mexico; shore to 57 fathoms (Garth 1969). 67.6° F; under rocks at low tide, kelp, fine sand, sand broken shells (Rathbun 1930a:215-217).

#### *Cancer magister* Dana 1852

Figures 4, 17, 18, 23, 34-1, 34-2; Tables 1, 2, 10

*Cancer magister* Dana 1852:73. Rathbun 1926:64. Rathbun 1930a:222 (contains prior synonymy). Menzies 1951:168.

*Cancer productus* Randall 1839. Rathbun 1926:62 (in part).

*Cancer breweri* Gabb 1869. Lawson 1894:261.

*Material*: Recent—7 female, 7 male; Fossil—54 fingers, 3 mani, 1 cheliped, 1 carapace.

*Hypotype*: UCMP 10732.

#### Description (Rathbun 1930a:222)

*“Diagnosis*. Carapace widest at tenth or last antero-lateral tooth. Postero-lateral margin unbroken, entire. Antero-lateral with more or less prominent serrations anteriorly. Fingers of chelipeds without dark color.

*Description*. Carapace with 10 antero-lateral teeth, counting the orbital tooth, each acutely pointed at the anterior end, teeth 2 to 8, inclusive, increasing successively in width; edges denticulate; lateral tooth large, strongly projecting. Postero-lateral margin rimmed, entire. Middle tooth of front slightly larger than those of outer pair and more advanced. Inner orbital tooth considerably larger, less produced and separated from the front by a broad interval. Dorsal surface uneven, the elevated spots coarsely granulate. Basal article of antenna very broad and well advanced. Merus of outer maxilliped widened distally, its anterior margin forming a very obtuse angle with the outer margin. Merus of cheliped with a distal and a subdistal spine above; wrist with a strong inner spine; hand with six carinae on upper outer surface, the uppermost spinous, as is also the upper margin of the dactyl for two-thirds of its length. Propodal finger much deflexed. Fingers without dark color. Legs rough above and very broad and flat, especially the propodus and dactylus of the last pair.”

#### Description of fingers (Menzies 1951:168)

*“Dactyl*. Reniform in cross-section. Superior surface with a conspicuous row of fairly large, often spinulate, spines. Lateral and medial surfaces covered with tubercles and having low, tuberculate or spinulate ridges. Setiferous pits generally confined to rows in depressed areas between low ridges. Teeth about eight. Tips of fingers usually white.

*Propod*. Teeth about ten. Setiferous pits generally confined to sunken areas. Lateral and medial surfaces with elevated tuberculate ridges.”

#### SUPPLEMENTARY DESCRIPTION

*Manus*. Six carinae on outer-upper surface, each extending length of manus and bearing a row of coarse, sharp, distally inclined granules. Upper margin (first carina) with a row of large, granulated, distally inclined spines; spines variable in number from 6 to 9, but 8 most common; also variable in

size, some fused at base with 2 or 3 tips (counts made only of the larger spines reaching an accordant height because the number of minor spines too variable). Second carina sharply elevated and spinulose. Areas between carinae sparsely and coarsely granulated; granules randomly scattered between upper margin and the second carina, those between other carina roughly aligned transversely; granules of the fifth carina (medial ridge) becoming dispersed on the fixed finger, and nearly cover its outer surface above the sixth carina (lower ridge). Inner surface ungranulated except for two single rows of coarse granules extending the length of manus along the most elevated part, corresponding to the fourth and fifth carinae on outer surface; lower margin marked by closely spaced granules, a row of setiferous pits between it and the fifth carina.

*Carpus*. Outer surface bounded by a band of coarse, sharp, distally inclined granules; smaller granules evenly distributed over upper surface. Longitudinal and diagonal carinae evenly and coarsely granulated; a single, sharp, large granule behind the upper articulation (all other North American species with a granulated tubercle or large spine in this position). Coarse, sharp granules evenly distributed on surface, from upper margin to lower articulation with the manus. Upper angle with a large, sharp, triangular spine; inner angle marked only by two sharp, coarse granules.

*Fixed finger*. Cutting teeth typically seven; 1 and 2 conical, equal; 3-5 subequal, largest, sharp-edged, 6 and 7 decreasing in size, sharp; 3-7 increasingly sharper and bladeliike. Outer surface with two coarsely granulated, longitudinal ridges; the medial one with coarse granules on most elevated part and granules of decreasing size away from it; the lower one with uniformly coarse granules. Setiferous pits concentrated along base of row of teeth and in a groove above the lower ridge. Lower edge with a distinct groove from base of finger to tip, containing about 12 setiferous pits. Inner surface with two granulated, longitudinal ridges; setiferous pits between medial ridge and the teeth, and in a groove between the two ridges. Dense material of tip extending proximally to fifth tooth.

*Movable finger*. Cutting teeth typically 7, 1-5 subequal, 1-3 rounded, 2 largest, 3-7 gradually decreasing in size and becoming more bladeliike distally, 7 quite small. Outer surface with sharp granules of varied size scattered evenly over proximal half, generally decreasing in size toward tip, lacking any linear arrangement except along upper margin. Two distinct grooves converge toward tip with rows of setiferous pits along them (these are less prominent on very large specimens). Upper margin with about 9 large granulated spines, largest at proximal end

and decreasing distally. Basal extension with several low, rounded tubercles on upper part.

#### Occurrence

*Pleistocene*. Palos Verdes Formation: LACMIP 66-1 (3 r.m.f., 2 r.f.f., 3 l.f.f., 2 l.m.f.); LACMIP 440 (1 r.f.f.). Playa del Rey (Palos Verdes Fm): UCMP 2413 (1 l.f.f.). Rincon del Potrero: USNM 353391 (1 r.m.f., 1 l.m.f., referred to *C. productus* by Rathbun 1926:62). Elk River Formation: UCMP B-7371 (1 r.m.f., 1 l.m.f.); UCMP B-7374 (2 l.m.f., 3 r.m.f.); UCMP B-7380 (1 r.m.f., 1 r.f.f., 1 l.m.f.); UCMP B-7372 (1 l.m.f., 2 l.f.f., 3 r.m.f., 3 r.f.f.). San Pedro Formation: LACMIP 332 (2 l.m.f., 1 r.f.f., 1 r.m.f.); LACMIP 300 (1 l.f.f.). San Joaquin Formation: UCMP B-7727 (1 l.f.f., 2 poorly preserved mani).

*Pliocene*. Moonstone Beach: UCMP B-7346 (1 l.m.f., 2 r.m.f., 1 l.f.f.); UCMP B-7345 (1 l.f.f.). Wildcat Group: UCMP 18-1610 (1 r.f.f., referred to *C. breweri*(?) Gabb by Lawson 1894:261). Merced Formation: UCMP B-4808 (1 r.m.f.); UCMP D-1973 (2 l.m.f.); UCMP D-1972 (2 l.m.f.); UCMP D-3389 (4 l.m.f., 1 l.f.f., 4 r.m.f., 2 r.f.f., 1 left manus, less fingers); UCMP D3799 (1 l.f.f.). Etchegoin Formation: UCMP B-5046 (1 l.m.f.); LACMIP 1902.92 (1 partial carapace). Piru Quad: UCMP A-3400 (1 l.m.f.). Coos Conglomerate: UCMP A-8715 (1 l.m.f., 1 l.f.f., 1 right cheliped).

*Summary*. Lower Pliocene to Recent; Unalaska, Alaska to Monterey Bay, California.

#### Ecology

*Living*: Iliuliuk, Unalaska, Alaska to Monterey Bay, California; low water to 50 fathoms (Garth 1969). 47.4-64.9° F; mud, sand, gravel, stones, shells (Rathbun 1930a:223-227).

#### *Cancer oregonensis* Rathbun 1898

Figures 4, 17, 18, 30-1, 30-2; Tables 1, 2, 11

*Cancer oregonensis* Rathbun 1898:581. Rathbun 1930a:226 (contains prior synonymy). Zullo 1969:347-361.

*Cancer productus* Randall 1839. Rathbun 1926:62 (in part). *Lophopanopeus somaterianus* Rathbun 1930a:332. Menzies 1948:22.

*Material*: Recent—8 female, 2 male; fossil—137 fingers.

*Hypotype*: UCMP 10733.

*Description* (Rathbun 1930a:226)

*“Diagnosis*. Antero-lateral and postero-lateral margins not meeting at a distinct angle. Carapace widest at seventh or

eighth tooth. Merus of outer maxillipeds with antero-external angle produced.

*Description.* Carapace elliptical, more or less evenly rounded at sides, antero-lateral and postero-lateral margins not meeting at a distinct angle, carapace widest at seventh or eighth tooth; 12 or 13 teeth; fronto-orbital width nearly one-half width of carapace. All teeth with granulated edges. Front between antennae truncate, advanced slightly beyond line of outer orbital angles and separated by a rounded sinus from inner orbital angles; median tooth very small. Middle tooth of orbit lobiform, reflexed. The first 10 lateral teeth of carapace similar, curved, forward, spine-tipped except for the first 2; last 2 or 3 teeth small and blunt. Surface coarsely and densely granulate and lumpy, the granulation coarser on the elevations. Carpus of chelipeds tuberculate above and with a short spine at inner angle and a tooth below it; hand thick and high, the short upper edge of palm with 2 rows of tubercles, outer surface with 5 finely granulate lines; dark color of fingers reaching nearly to their bases. Legs hairy."

Rathbun (1930:228) has reported that this species exhibits considerable variation in the sculpturing of carapace and chelipeds.

#### SUPPLEMENTARY DESCRIPTION

*Manus.* Very short and high. Outer-upper surface with seven longitudinal carinae; the first and second consisting of three distinctly separated, coarsely granulated tubercles, the distal 2 merging laterally to form a single, coarsely granulated elevation at the distal angle; the third consisting of a group of coarse granules just above the articulation with movable finger and two separate, coarse granules located by positions about one-third and two-thirds the length of manus; the fourth carina a line of coarse granules extending about half the length of manus from its proximal margin; the sixth and seventh carinae forming finely granulated lines extending the length of manus onto the fixed finger. Lower edge and inner surface broadly rounded, evenly and finely granulated.

*Carpus.* Outer surface broadly rounded and coarsely granulate with granules scattered over lower half of outer surface; the upper margin rounded and indistinct. A large, rounded, granulated tubercle behind the upper articulation. No distinct longitudinal or diagonal carinae as in other species of *Cancer*. Upper angle with a short, sharp spine projecting from a low triangular, granulated base; inner angle only slightly raised and with a single short spine.

*Fixed finger.* Very short, high and thick. Cutting teeth typically four: first small and conical; 2 and 3 joined at base but forming separate cusps; fourth smaller, on the terminus of the medial ridge. Outer surface broadly rounded with very broad medial and lower ridges separated by a shallow groove with 4 oval setiferous pits; 4 setiferous pits at base of teeth 1-3; granulation very fine except for a row of coarse

granules on medial ridge near base of finger. Lower edge broadly rounded but with a shallow groove with 3 or 4 pits. Inner surface with a broad medial ridge separated from a narrower lower ridge by a narrow groove with a large, oval, setiferous pit just behind the fourth tooth; a small ridge at base of teeth 2 and 3, separated from medial ridge by a broad depression and 2 pits. Dense, dark tip material extending nearly to base of finger.

*Movable finger.* Very thick and low at base. Cutting teeth typically four in a row near the outer edge of finger with another offset toward the inner side and slightly proximal to first of the outer row. The teeth small, conical; 1, 2 and 3 with a small depression on their proximal side; all connected by a sharp-edged ridge along the outer side of the row. Offset tooth very diagnostic of the species. Outer and upper surface broadly rounded, coarsely granulated at base with granules rapidly becoming finer toward tip and teeth; three rows of oval setiferous pits, one with 6 pits along upper edge, one with 7 pits one-third distance down on outer surface and 3 pits at base of teeth 1-3; a short row of 2 pits near base and half-way down the outer surface. Inner surface broadly rounded, with granulations similar to outer surface; a medial row of 6 pits and a row of 5 pits at base of teeth. Dense, dark material extends nearly to base of finger.

#### Occurrence

*Pleistocene.* Rincon del Potrero: USNM 353391 (1 r.m.f., 1 r.f.f., referred to *C. productus* by Rathbun 1926:62). Bandon Quad; Oregon: USGS M-1012 (9 l.m.f., 6 r.m.f., 1 r.f.f.). Elk River Formation: UCMP B-7380 (1 l.m.f.). San Pedro Formation: LACMIP 332 (1 r.m.f., 1 l.f.f., 1 r.f.f.).

*Pliocene.* Moonstone Beach; California: UCMP B-7346 (27 l.m.f., 5 l.f.f., 37 r.m.f.); UCMP B-7345 (25 l.m.f., 4 l.f.f., 15 r.m.f., 3 r.f.f.); UCMP B-7348 (2 l.m.f., 1 l.f.f., 9 r.m.f., 1 r.f.f.). Merced Formation: UCMP D-3389 (l.r.m.f.). Palm City (San Diego Fm ?): LACMIP 305-C (2 r.m.f.).

*Summary.* Middle Pliocene to Recent; Pribilof Islands, Alaska to Santa Barbara, California.

#### Ecology

*Living.* St. George Island, Pribilof Islands, Alaska, to Santa Barbara, California; low water to 238 fathoms (Garth 1969). 40.7-52.3° F; mud, sand, gravel, broken shells, kelp (Rathbun 1930a:226).

*Cancer productus* Randall 1839

Figures 4, 13, 14, 39-1, 39-2; Tables 1, 2, 12

*Cancer productus* Randall 1839:116. Rathbun 1926:62. Rathbun 1930a:203. *not* Menzies 1951:168.

*Cancer breweri* Gabb 1869:1. Cooper 1887:227. Arnold 1903:345. Holotype, UCMP 14741.

*Cancer antennarius* Stimpson 1856. Rathbun 1926:62, 63 (in part).

Material: Recent—7 female, 5 male, 3 indet.; fossil—465 fingers, 2 carpi, 2 mani.

Hypotype: UCMP 10734.

## Description (Rathbun 1930a:203)

*Diagnosis.* Front markedly produced beyond outer orbital angles, forming five subequal teeth. Merus of chelipeds unarmed, fingers dark tipped.

*Description.* The five interorbital teeth are flat, obtuse, closely placed, and markedly produced beyond the outer orbital angles; fronto-orbital width about one-fifth width of carapace. Antero-lateral teeth ten, shallow, outer orbital tooth small, next one rounded, succeeding teeth becoming larger and more acute posteriorly; between the teeth the margin is marked with short closed fissures. A single obscure postero-lateral tooth. Carapace slightly convex, very uneven. Inner lower orbital tooth flat, pressed close to the upper tooth; next to it a small acute tooth. Merus of outer maxilliped about as broad as long, its anterior margin very oblique and forming a right angle with outer margin. Chelipeds rough above; merus unarmed; carpus rugose and lumpy, a single broad blunt tooth at inner angle, a large tubercle near articulation with manus; manus with four granulated carinae on outer surface; rugose above and with three rows of more or less obscure tubercles. Dactyli of legs thickly fringed above and below."

## Description of fingers (Menzies 1951:168)

*Dactyl.* Ovoid in cross section. Superior area with numerous small spines which are largest near the superior medial margin. Lateral and medial areas tuberculate, but lacking sulci or elevated areas. Setiferous pits present, no setiferous sulci. Teeth about five. Tips of fingers black.

*Propod.* Teeth about four. Lateral and medial surfaces tuberculate; longitudinal grooves fairly prominent. Setiferous pits present; tend to be arranged in longitudinal rows."

## SUPPLEMENTARY DESCRIPTION

*Manus.* Outer-upper surface with 6 coarsely granulated carinae. First and second with 4 granulated tubercles; third, fourth, fifth and sixth forming prominent ridges. Granules of carinae decreasing in size and increasing in density from first to sixth carinae. Areas between carinae with a reticulate pattern of granules, coarse in upper part, finer toward lower margin of manus. Inner surface with 4 inconspicuous carinae of smaller granules, connected by transverse rows of granules, forming a reticulate pattern. Larger specimens (1u of manus greater than

25 mm) with a concentration of deep pits on the upper surface of the manus and distal end of the upper surface of the carpus; the pits about diameter of coarsest granules.

*Carpus.* Outer surface bounded by a broad band of coarse granules on an elevated carina. Longitudinal carina prominent, coarsely granulated; a second, shorter, parallel carina between it and the upper margin. Diagonal carina discontinuous with a coarsely granulate tubercle behind upper articulation and a smaller tubercle half-way between it and the upper margin. Surface ornamented by a reticulate pattern of coarsely granulate ridges connecting the well-defined carinae. Upper angle with a thick, triangular, blunt spine; inner angle smooth, only slightly raised.

*Fixed finger.* Typically 4 teeth; first small, conical; second largest, elongate, two-cusped with a small proximal, conical cusp and a large conical distal cusp; third slightly smaller than 2; fourth slightly smaller than 3. Outer surface broadly rounded with only a shallow depression separating the medial ridge from the lower ridge. Lower edge rounded with no groove but with a row of pits. Inner surface broadly rounded with only a shallow depression and a row of setiferous pits separating the medial ridge from the lower ridge. Three small, oval, setiferous pits below teeth 2 and 3. Dense, dark tip material extending back half the length of finger.

*Movable finger.* Outer and upper surface broadly rounded and coarsely granulate, granules coarsest near base and gradually becoming finer toward tip and teeth; a medial row of small setiferous pits, but no groove. Cutting teeth typically four; the first two conical, subequal, with only a slight longitudinal edge near their midpoints; third slightly smaller, elongated with a distinct cutting edge, the apex in the distal one-third of tooth; fourth smaller than third but similar in shape. Inner surface smooth, slightly concave with a medial row of pits but no groove. Dense, dark tip material extending back half the length of finger.

## Occurrence

*Pleistocene.* Palos Verdes Formation: LACMIP 66-1 (2 l.m.f., 1 l.f.f., 3 r.m.f., 4 r.f.f.); LACMIP 66-2 (2 l.m.f., 4 r.m.f., 1 r.f.f.); LACMIP 440 (1 r.m.f.); UCMP 2047 (14 l.m.f., 8 l.f.f., 22 r.m.f., 11 r.f.f.); USNM 353390 (1 l.m.f., referred by Rathbun 1926:62); USNM 496241 (3 l.m.f., 1 l.f.f.). Playa del Rey (Palos Verdes Fm): LACMIP 59 (12 l.m.f., 4 l.f.f., 16 r.m.f., 1 r.f.f.). Elk River Formation: UCMP B-7379 (partial left manus). San Pedro For-



mation: UCLA 6827 (1 r.f.f.); UCLA 6829 (1 l.m.f.). Sunset Cliffs, Point Loma: SDSC 86 (1 r.f.f.). Miller-ton Formation: UCMP B-6355 (1 l.f.f., 1 r.m.f.); UCMP B-6354 (1 l.m.f.). San Pedro Formation: UCLA 2825 (1 l.m.f.); LACMIP 332 (32 l.m.f., 13 l.f.f., 34 r.m.f., 14 r.f.f., 2 carpus fragments); LAC-MIP 131 (1 l.f.f.); LACMIP 228 (2 r.m.f.); LACMIP 300 (11 l.m.f., 4 r.f.f., 7 l.m.f., 5 l.f.f.); LACMIP 142-B (11 l.m.f., 6 l.f.f., 6 r.m.f., 4 r.f.f.); LACMIP 226 (1 l.m.f., 1 r.f.f., 1 l.f.f.); UCLA L-1055 (1 l.m.f.); SDSNH L-1898 (1 l.m.f., 1 r.m.f., referred by Rathbun 1926:62); UCMP A-1503 (5 l.m.f., 2 l.f.f., 3 r.m.f., 1 r.f.f.); USNM 353393 (3 l.m.f., 1 l.f.f., 5 r.m.f., 2 r.f.f., referred by Rathbun 1930a:63). Timms Point Formation: LACMIP 62 (1 l.f.f.); LACMIP 130-7 (4 r.m.f., 2 r.f.f., 5 l.m.f., 2 l.f.f.); UCMP D-3404 (1 l.m.f.); LACMIP 130-4 (1 l.m.f., 1 l.f.f., 1 r.m.f.). Lomita Marl: LACMIP 435 (4 l.m.f., 6 l.f.f., 1 r.m.f., 3 r.f.f.).

Baja California. Punta Descanso: UCLA L-2716 (2 r.f.f.).

*Pliocene*. Pico Formation: UCMP 7100 (1 l.f.f.); LACMIP 332 (1 l.m.f., 1 r.f.f.); LACMIP 34 (1 l.f.f.); LACMIP 183-B (1 l.m.f., 1 r.m.f.); LACMIP 466 (10 l.m.f., 4 l.f.f., 13 r.m.f., 3 r.f.f.). Cantil Costero Formation: SDSC 446 (3 l.m.f., 1 r.m.f.). Moonstone Beach: UCMP B-7346 (1 r.m.f.). Etche-goin Formation: UCMP B-5046 (1 l.m.f.); UCMP D-1138 (1 r.m.f.). San Diego Formation: UCMP 3624 (1 l.m.f.); LACMIP 305-C (21 l.m.f., 12 l.f.f., 38 r.m.f., 15 r.f.f.); SDSC 230 (1 r.m.f.).

Baja California. San Ysidro: SDSC 32 (1 r.m.f.).

*Summary*. Middle Pliocene to Recent; Kodiak, Alaska to Laguna Beach, California

### Ecology

*Living*. Kodiak, Alaska to Laguna Beach, California; shore to 43 fathoms; 53.13° F; under rocks, mud, sand, gravel, broken shells, stones (Rathbun 1930a:205-207).

#### *Cancer polyodon* Poëppig 1836

Figures 5, 29, 33-1 to 33-6; Table 2

*Cancer polyodon* Poëppig 1836:133. Rathbun 1930a:202 (contains prior synonymy).

*Material*: Recent-1 male; fossil-39 fingers, 1 manus, 1 cheliped.

*Hypotypes*: AHF 358, 5622; LACM 4435.

#### Description (Rathbun 1930a:202)

*Diagnosis*. Hairy. Marginal teeth triangular, spinous. Three marginal spines on carpus. Two rows of spines above chelae.

*Description*. Carapace convex, hairy and finely granulate, granules not crowded, regions fairly delimited; marginal teeth triangular, prominent, acute, edges coarsely spinous; antero-lateral teeth 9, the first or orbital tooth the smallest; postero-lateral teeth 2, well marked, the first much the larger. Frontal teeth thick, those between the antennae small, the median one much slenderer and more produced than outer pair; a shallow lobe between inner and outer supra-orbital teeth; antennal teeth long, inclined toward each other; two very sharp infero-orbital spines, the inner one the larger but much smaller than the antennal spine. Outer maxillipeds overlapping epistome. Chelipeds rough above; two spines on merus; two large spines of carpus, one at articulation, one at inner angle, smaller scattered spines besides one below inner angle; two rows of spines above palm and proximal half of dactyl. Five carinae on outer surface of palm are granulate and hairy. Black of fingers occupies the distal two-thirds. Ventral surface of body and margins of legs coarsely hairy; legs broad and flat, dactyls with 4 or 5 rows of hair."

### SUPPLEMENTARY DESCRIPTION

*Manus*. Outer-upper surface with seven carinae; the first two with 5 large, sharp, non-granulate spines, the size gradually diminishing proximally; two smaller spines on each carina located behind the first and fifth large spines; the other 5 carina with a uniform row of sharp granules, each extending the length of manus. Areas between carinae very finely and sparsely granulate. Inner surface evenly and finely granulate, with no alignment of granules into carinae.

*Carpus*. Outer surface bounded by a coarsely granulate carina; a large, conical, granulated spine behind upper articulation; longitudinal carina broad with several sharp granules, two spines at distal end; diagonal carina marked only by 2 large spines at its mid-point, two more similar spines between it and the longitudinal carina. Upper angle with a large, sharp, triangular spine; inner angle with a smaller, outward curving, sharp spine.

*Movable finger*. Similar to that of *C. branneri*. Cutting teeth typically 7; first large, rounded; second slightly smaller, similar shape; third about half-size of 2; fourth rounded, larger than 3, smaller than 2; fifth smaller than 6; sixth somewhat elongate, larger than 5 or 7. Outer surface with 3 very coarsely granulate to spinous ridges: the upper ridge with 3 or 4 short spines at proximal end, and coarse, sharp granules extending distally nearly to tip, those in distal half coarse and rounded; medial ridge coarsely granulate, extending the length of finger and merging with the lower ridge at a point above the fourth tooth (they are not separated as in *C. branneri* and *jordani*); lower ridge coarsely granulate, curving down to base of first tooth, separated from medial ridge in proximal half of finger by a groove which

widens proximally, and from tooth row by 5 setiferous pits above teeth 1-5. Upper and medial ridges separated by a narrow, deep groove which extends distally to seventh tooth. (This is narrower than in *branneri*.) Upper surface with two rows of sharp, nearly straight, large spines; an outer row (described above) and an inner row with three long spines in proximal third of finger and coarse, sharp granules extending to tip; a V-shaped groove bounding the inner row of spines. Inner surface with spines and sharp granules at top; a narrow groove below them; a broad upper ridge and a lower ridge separated by a narrow medial groove; the lower ridge separated from the tooth row by about five setiferous pits. Dense, dark tip material extending half the length of finger, characteristically extending further on ridges than in grooves.

*Fixed finger*: Cutting teeth 5: first very small, conical; second the largest, elongated; 3, 4 and 5 decreasing in size rapidly toward the tip. Outer surface with two narrow, coarsely and sharply granulated ridges, much like *C. branneri*. A narrow groove on the lower edge, extending nearly to tip of finger.

#### Occurrence

*Pleistocene*. Upper Pleistocene, San Juan Bay, Peru: USC Hancock Foundation (1 right cheliped with carpus, manus, fixed finger, movable finger).

*Pliocene*. San Diego Formation? LACMIP 305-C [1 partial right manus (with both fingers), 1 r.m.f., 7 r.f.f., 7 l.m.f.]. Pico (?) Fm: LACMIP 466, (14 r.m.f., 6 l.m.f., 4 l.f.f.).

*Summary*. Upper Pliocene to Recent; southern California to Chile.

#### Discussion

This is the first report of *C. polyodon* in the Northern Hemisphere.

#### Ecology

*Living*. From Guayaquil (market purchase?), Ecuador, to the peninsula of Taitao, Chile. 0-12 fathoms (Garth 1957:51).

*Cancer edwardsii* Bell 1835

Figures 5, 11, 37-3, 37-4

*Cancer edwardsii* Bell 1835:87. Rathbun 1930a:193 (contains prior synonymy).

Material: Recent—2 specimens; fossil—none known. Hypotype: USNM 81042.

#### Description (Rathbun 1930a:193)

*Diagnosis*. Carapace very convex, teeth not prominent. Outer orbital angle not forming a tooth. Basal article of antenna twice as long as broad. Legs naked.

*Description*. Carapace very convex, except for the marginal rim; cardiac region deeply outlined; otherwise the surface is slightly uneven: granulation visible to naked eye, coarser on elevations; antero-lateral margin multidenticulate or lobulate, divided by closed fissures into 9 rather obscure teeth. One well defined, postero-lateral tooth followed by one or two slight emarginations. The three frontal teeth between the antennae are short, thick and lobiform, the median the smallest and very little overreaching the adjacent pair. Outer orbital angle not advanced in a tooth; extremity of basal article of antennae thick and blunt, followed by a small lobe on the orbital margin. Outer margin of merus of outer maxilliped oblique, forming a slightly obtuse angle with the anterior margin. Palm with 5 outer and 2 upper carinae; interspaces crossed by transverse rugae. Black color of fingers reaching two-thirds their length from the tips. Legs of moderate length, bare, coarsely granulate; dactyls thick, tapering regularly to the long, curved tips."

#### Ecology

*Living*. From Guayaquil (market purchase?), Ecuador, to Strait of Magellan; 0-25 fathoms (Garth 1957:48).

*Cancer plebejus* Poeppig 1836

Figures 5, 37-1, 37-2

*Cancer plebejus* Poeppig 1836:134. Rathbun 1930a:198 (contains prior synonymy).

Material: Recent—1 specimen; fossil—none known.

Hypotype: AHF 3822.

#### Description (Rathbun 1930a:198)

*Diagnosis*. First antero-lateral (orbital) tooth narrower than any of the others. Basal antennal article about two-thirds as broad as long. Chelipeds narrow, merus widening distally very little. Black of fingers restricted on outer margin to one-fourth or less of their length.

*Description*. Carapace very broad-oval, nearly smooth, having a fine depressed granulation, convex, not very uneven; antero-lateral teeth 9, shallow, edge crenate or denticulate, first 7 teeth truncate, lobiform, last two dentiform; one strong postero-lateral tooth, followed sometimes by a slight notch. Fronto-orbital distance less than one-fourth width of carapace; frontal teeth between the antennae triangular, median one narrower and more projecting; inner orbital tooth short, outer tooth little advanced, forming part of the first antero-lateral tooth. Tooth of basal antennal article large, triangular in cross-section, flat below, well advanced. The outer maxillipeds overlap and conceal the epistome; the truncate distal margin of the merus makes a slightly acute angle with the outer margin, the outer corner rounded. Merus of cheliped with 2 triangular acute teeth at end or upper margin; inner tooth of carpus acute; palm

with 4 outer and 2 upper carinae, the uppermost spinous, the next spinulose; upper surface of movable finger also spinulose; dark color of fingers covering prehensile edge and extending but a short distance on outer margins. Legs nearly naked."

#### Ecology

*Living.* Ancon, Peru to Picton Channel, Chile; 0–15 fathoms (Garth 1957:49).

#### *Cancer porteri* Rathbun 1930

Figures 4, 5, 42–1, 42–2

*Cancer porteri* Rathbun 1930a:199 (contains prior synonymy).

*Material:* Recent—3 specimens; fossil—none known. *Hypotype:* UCMP 10735.

#### Description (Rathbun 1930a:199)

*“Diagnosis.* Branchial regions nearly meeting on median line. First antero-lateral (orbital) tooth wider than any of the next 7 teeth. Basal article of antennae nearly as broad as long.

*Description.* Similar to *C. plebejus*. Carapace narrower and more convex; inner branchial regions swollen and nearly meeting in the median line; cardiac and metagastric regions correspondingly depressed; surface densely granulate, granules visible to naked eye. Antero-lateral margin with a coarsely granulate or crenulate edge, cut into 9 teeth or lobes which are shallower than in *plebejus*, each tooth having a slightly projecting point; first tooth broadest, composed of the small, triangular outer tooth of the orbit joined to a truncate strip of the anterior margin; 2 postero-lateral teeth, the outer one better defined. Teeth of front broadly triangular, the blunt median tooth only slightly depressed and overreaching the adjacent pair but little; the teeth of this pair directed obliquely outward. Inner orbital tooth subacute, tooth of basal antennal article narrower and more produced, and followed by a small tooth on the suborbital margin. The outer maxillipeds fit into the buccal cavity, the extremity of the merus is obliquely placed. Merus of cheliped widening considerably to the distal end, 2 small, sharp spines above; carpus with the customary short pyramidal tooth at inner angle; 4 outer granulated carinae on palm separated by a shallow depression from the pair of superior carinae which are near together and rough with acute granules; dactyl sharply granulate, non-carinate. Dark color of fingers extending the whole length of the prehensile edge and but a short distance from the tip along the outer edge. Chelae much smoother in the old, carinae faint. Legs long and narrow.”

#### Ecology

*Living.* Gulf of California (off Rio San Lorenzo, 59–70 fathoms); Bay of Panama (210–286 fathoms); and from Peru to Chile in the sublittoral (Garth 1960:120–122).

#### *Cancer sakaii* Takeda and Miyake 1972

Figures 6, 30–5, 30–6

*Platypistoma anaglyptum* Balss 1922:96.

*Cancer anaglyptus*, Sakai 1965:105.

*Cancer sakaii* Takeda and Miyake 1972:254.

*Material:* Recent—1 specimen; fossil—none known.

*Hypotype:* UCMP 10736.

#### Description (H. Balss 1922)

“Der Carapax ist schwach konvex, etwas breiter wie lang, mit sehr starken, wulstartigen Erhabenheiten auf der Oberfläche versehen, welche beiderseits der Mediane symmetrisch verlaufen. Sie bilden Bänder von perlenartigen grossen Granula, ähnlich wie sie *Actumnus margarodes* Mac Gilchrist zeigt. Die Zwischenräume zwischen den Erhebungen sind mit einem feinen Haarfilz bedeckt. Die Stirn trägt einen grossen, auf dem medianen Septum stehenden Zahn; darüber befinden sich die Lobulen der Antennularfacetten, welche kleine Dörnchen besitzen. Der Oberrand der Orbiten trägt einen Kranz kleiner Perlen, der Unterrand endet innen, neben dem Antennalglied mit einem Dorn. Eine Kerbe ist nur am Unterrande, hinter dem Exorbitalzahne deutlich. Der Anterolateralrand ist länger als der posterolaterale, beide sind nicht scharf von einander abgesetzt; der erstere trägt 9–10 scharfe Spitzen, denen am Hinterrande 3–4 Granula in Abständen folgen. Das basale Antennalsegment ist wie bei *P. macrophthalmum* R. gebaut; das der Antenne ist lang, distal bedornt, seine Seiten subparallel. Der bewegliche Teil der Antennen ist etwa ein Drittel so lang wie der Carapax. Das Epistom ist kurz, der Hinterrand scharf, mit einer schwachen Kerbe in der Mitte und je einer aussen. Zwei deutliche Gaumenleisten sind vorhanden, die aber den Vorderrand nicht erreichen. Die dritten Maxillärfüsse sind deckelförmig, der merus etwas breiter wie lang, der Anteroexternalrand etwas ausgezogen; der Exopodit ist so lang wie der Endopodit. Die Scherenfüsse sind gleich; der Merus ist dreikantig, der obere Rand trägt kurz vor dem distalen Ende einen Dorn und das Gelenk mit dem Carpus ist mit Haaren besetzt. Der Carpus trägt vier Reihen kleiner Granula, die Palma fünf bis sechs, die aber durch einen dichten Haarfilz verdeckt sind. Die obere Kante der Palma besitzt zwei grössere Dornen. Die Finger schliessen gut. Der feste trägt vier grössere Zähne, der bewegliche nur der oberen Kante zwei Dornenreihen und dünne Haare. Die Schreitfüsse sind lang, kurz behaart, die obere Kante von Merus und Carpus ist bedornt, der Dactylus trägt eine lange Hornspitze. Das Abdomen ist schmal, lang und zugespitzt.—Länge des Carapax 17, Breite 20 mm.

Die Art gehört wohl sicher in diese von Rathbun aufgestellte Gattung, welche von der Autorin mit Recht zu den Cancriden gerechnet wird. Vielleicht bildet sie unter diesen eine besondere, durch das deutlich begrenzte Epistomfeld und die Gaumenleisten charakterisierte Unterfamilie.”

#### Ecology

*Living.* Japan, endemic; Sagami Bay and Tosa Bay (Sakai 1965:106).

#### *Cancer gibbosulus* (DeHaan 1835)

Figures 6, 31–5, 31–6

*Corystes (Trichocera) gibbosulus* DeHaan 1835:45.

*Cancer gibbosulus*, Sakai 1965:105 (contains prior synonymy).

Material: Recent—1 specimen; fossil—none known.  
Hypotype: UCMP 10737.

#### Description (Sakai 1939:436)

"The entire animal is covered with soft piles especially in juvenile specimens, the regions are only feebly defined, the convex surface of each region is covered with a pavement of fine granules. The front is narrow and composed of three teeth, of which one is slender and elongated. The preorbital and supraorbital teeth are also well defined; the antero-lateral borders are cut into nine teeth including the external orbital one, all being rather acuminate and alternately large and small; in juvenile specimens, these teeth are much sharper and deeply cut and are more pronouncedly unequal alternately. Just behind the last tooth follows a rudimentary tooth on either postero-lateral border. The basal segment of antenna has a slender and large projection at the antero-external angle, it can be seen in dorsal aspect in front of the preorbital tooth.

The wrist and palm are armed with spinules mixed with soft hairs; the spinules on the outer surface of palm are arranged in longitudinal series. The dactyli of ambulatory legs are very slender and longer than the propodi."

#### Ecology

Habitat. Inhabits sandy mud or shelly sand between depths of 30 to 100 meters.

Type locality. Japan (Sakai 1939:436).

Distribution. Japan—entire coasts around Honsyu, Shikoku and Kyusyu, also ranging to north China (Sakai 1965:105).

#### *Cancer japonicus* Ortmann 1893

Figures 6, 41-3, 41-4

*Cancer japonicus* Ortmann 1893:427. Sakai 1965:104 (contains prior synonymy).

Material: Recent—1 specimen; fossil—none known.  
Hypotype: UCMP 14105.

#### Description (Sakai 1939:438)

"*Diagnosis.* A rather large species, the carapace is extremely broad and the antero-lateral borders extremely arched and cut into 12 teeth, which are low triangular in shape and are basally fused with each other. The front is composed of three obtuse teeth which are not much unequal in size; the upper orbital border has two deep notches. The dorsal surface of carapace is thickly covered with pavement of fine microscopic granules; the gastric, cardiac and branchial regions are markedly convex. The wrist has its inner angle produced into a sharp tooth and the dorsal surface has a few projections; the palm has three spinules along the upper border and several processes on outer surface."

#### Ecology

Habitat. Similar to that of *C. amphioetus* on sandy mud or shelly sand between depths of 30 to 100 meters.

Type locality. Tokyo Bay (Sakai 1939:438).

Distribution. Japan, endemic—Tokyo Bay, Sagami Bay, Izu Peninsula, off Mikowa, Kii Province and Tosa Bay (Sakai 1965:104).

#### *Cancer tumifrons* Yokoya 1933

Figure 30-9

*Cancer tumifrons* Yokoya 1933:169. Sakai 1965:104 (contains prior synonymy).

Material: Recent—1 specimen; fossil—none known.  
Hypotype: UCMP 10754.

#### Description (Sakai 1939:439)

"*Diagnosis.* An immature male specimen obtained from Kumanonada by Mr. I. Kubo of the Fisheries Institute, Tokyo, much probably agrees with Yokoya's species. The carapace is rather narrower than in Yokoya's figure but it is probably due to immaturity; the convex portions of each region of carapace is covered with a patch of frosted granules. The front well produced and trilobate, the lobes being in close contact and not at all dentate; the preorbital tooth also not pointed and fused with the frontal lobe. The antero-lateral borders are cut into 12 broadish lobes, all being finely serrate and closely in contact with each other but the first or external orbital one is acuminate unlike that in Yokoya's figure.

The eye-stalks bear two spinules, one near the middle and the other at the apex of the anterior border. The outer surface of wrist and palm are coarsely tuberculated."

#### Ecology

Type locality. Southwest of Goto Islands (Sakai 1939:439).

Distribution. Japan, endemic—Sagami Bay, Tosa Bay and Goto Islands (Sakai 1965:104).

#### *Cancer nadaensis* Sakai 1969

Figures 6, 38-5, 38-6

*Cancer nadaensis* Sakai 1969:258.

Material: Recent—1 photograph; fossil—none known.

Holotype: USNM 125871.

#### Description (Sakai 1969:258)

"*Diagnosis.* The new species is distinguished from any other of the Japanese species of this genus by its well-cut anterolateral teeth, and also by the sharply and uniformly spinulated carpus and propodus of the chelipeds. The carapace is about 1.5 times as broad as long and its dorsal surface is slightly areolated, with a few obscure scattered tubercles near the anterior and lateral surfaces. The front is cut into three teeth, the middle one of which is thin and on a lower level. The preorbital tooth is prominent and sharp.

The anterolateral borders are well arched and divided into nine teeth. All of the teeth are well cut and separated from each other, their tips being acuminate and the last one largest of all and projecting sideways. On the posterolateral border, there is a small tooth just behind the last anterolateral tooth, followed by a series of tiny teeth.

The chelipeds are symmetrical. The merus is short and scarcely visible from above; the carpus and propodus are rather thickly and uniformly spinulated on the upper and outer surfaces, the spinules variable in size and irregularly arranged.

The anterior three pairs of ambulatory legs are subequal in size, the last pair being a little smaller. The anterior margins of the merus, carpus and propodus are obscurely spinulated. Measurements: Length of carapace 32 mm, width of same 48 mm."

#### Ecology

Type locality. Japan, Shimogusui, Kii Province.

Distribution. One specimen only (holotype), type locality only, muddy bottom, depth 30 m

#### *Cancer novaezealandiae* (Jacquinot 1853)

Figures 7, 11, 37-5, 37-6

*Platycarcinus novaezealandiae* Jacquinot, in Jacquinot and Lucas 1853:34.

*Cancer novaezealandiae*, Milne-Edwards 1865:189. Chilton and Bennett 1929:744.

Material: Recent—4 specimens; fossil—none known. Hypotype: UCMP 14118.

Description (Chilton and Bennett 1929:744)

"Carapace wide, moderately flattened in the male, much more in the female. Surface covered with little granulations; regions scarcely distinct; antero-lateral margins with ten lobes, which project very slightly beyond their lines of coalescence; each lobe with 2 to 5 crenulations. The posterior lateral margin, which commences immediately behind the tenth lobe, is closely granulous. First lobe small, on upper orbital margin; the latter has no tooth or spine except the point at the inner corner, which is less prominent than the front. Front with three other teeth, of which the median is much smaller and more depressed than the rest. Anterior legs with the wrist very granulous externally, usually with a large tubercle near the margin, and a strong tooth on the inner side; hand granulous above, with two parallel lines, each having three or four tubercles larger than the granulations, and with five granulous lines on the outer side, of which the lower four are well marked. Movable finger granulous above, both fingers strongly denticulate within, black within and at the tips. Ambulatory legs robust and of moderate length. Seventh joint of the abdomen of the male slender and elongate.

#### Ecology

Type locality. New Zealand (Chilton and Bennett 1929:744)

Distribution. New Zealand; North, South, Auckland and Chatham Islands. Tasmania and Victoria, Australia (introduced). 0-60 fathoms (Bennett 1964:64).

#### *Cancer borealis* Stimpson 1859

Figures 4, 38-2, 38-3

*Cancer borealis* Stimpson 1859:50. Rathbun 1930a:182 (contains prior synonymy). Rathbun 1935:109.

Material: Recent—1 specimen; fossil—1 finger reported, probably erroneous.

Hypotype: USNM 78530.

Description (Rathbun 1930a:182)

"*Diagnosis*. Teeth of lateral margins with denticulate edges. Carapace very rough with irregular granules.

*Description*. Similar to *C. irroratus*. Antero-lateral margins more broadly rounded; surface much rougher with coarse uneven granules; carapace higher, the convexity ending rather steeply at the dentate rim; lateral teeth with denticulate edges; behind the two postero-lateral teeth there are in old specimens one or two more smaller teeth indicated by slight notches. Chelipeds heavier and rougher; hand high, 7 coarsely granulate carinae on outer-upper surface, the uppermost one denticulate; movable finger with a very rough upper margin; ambulatory legs correspondingly rough, side margins of 5th-6th abdominal segments in male more nearly parallel than in *irroratus*."

#### Ecology

Type locality. Nova Scotia; types not extant (Rathbun 1930a:182).

Distribution. Nova Scotia to Florida; Bermuda. Shore to 435 fathoms (MacKay 1943:114).

#### *Cancer irroratus* Say 1817

Figures 4, 37-3, 37-4

*Cancer irroratus* Say 1817:59. Rathbun 1930a:180 (contains prior synonymy).

Material: Recent—1 specimen; fossil—29 fingers, 2 mani, 3 chelipeds, 11 undifferentiated specimens reported.

Hypotype: USNM 78528.

Description by Rathbun (1930a:180)

"*Diagnosis*. Nine antero-lateral and two postero-lateral teeth, the last one obscure; edges entire. Chelipeds granulate not denticulate.

*Description*. Carapace convex, uneven, finely granulate. Antero-lateral teeth 9, the first one broad and in part produced to form the orbital tooth; teeth shallow, edge granulate, the notches between them continued on the carapace as short, closed fissures giving a pentagonal aspect to the teeth. Postero-lateral margin a raised, granulate carina furnished with two teeth, the one nearest the lateral angle small, the other obscure. The median tooth of the front is the most advanced and depressed.

Chelipeds shorter than first pair of legs, granulate; upper margin of merus ending in a short, subdistal tooth; carpus with granulated ridges and a sharp pyramidal inner tooth; manus with 6 longitudinal costae, the two lower ones continued on the finger, the upper one cristate. Legs rather long, compressed; merus of first and second pairs extending

well beyond carapace. Side margins of 5th-6th abdominal segment in male converging distally."

Ecology

*Distribution.* Oceanic, Labrador to South Carolina; low tide to 314 fathoms; type not extant (Rathbun 1930a:180).

*Cancer bellianus* Johnson 1861

Figures 8, 38-1

*Cancer bellianus* Johnson 1861:240. Christiansen 1969:44.

Material: Recent—1 specimen; fossil—none known.

Hypotype: BM(NH) 1972:532.

Description (Johnson 1861)

"Description. Carapace of a pale brown, suffused and spotted with red; its surface rough, with small tubercles, and strongly marked with the regional divisions; transversely oblong, with the middle portion moderately elevated. Latero-anterior margin divided into ten quadrate lobes, alternately broad and narrow; the outer edge of each lobe armed with three teeth, of which the middle one is larger. On the broader lobes the lateral teeth are frequently bifid. The hindmost lobe on each side has only one principal tooth, but there are three or four small ones. This lobe passes into the posterior marginal line of the carapace, and this line is beaded with a series of tubercles. The front of the carapace has two dotted lobes or flattened teeth, with a narrow triangular tooth projecting between and beyond them. The superior margins of the ocular orbits are denticulated, and have a strong triangular tooth over the inner canthus, which does not project quite so far as the two

principal lobes of the interocular front. The margin between the two superior fissures is denticulated, but has no predominating tooth. Inferior margin of the ocular orbit armed with three teeth, of which the innermost is large and stout. The external antennae have their basal joints much elongated, and terminating forwards in an obtuse tooth. The second joint is club-shaped, and the third cylindrical. The anterior half of the internal antennae is folded directly backwards when at rest.

The sternum is minutely punctated, and its entire surface in the male is set with longish stiff hairs; in the female the hairs are chiefly confined to the posterior portion.

*Feet.* First pair subequal, stout, and longer in the male than in the female. Fingers black, marked with longitudinal furrows, and having two or three large tubercles near the extremity of their prehensile edges. Upper surface of hand marked with seven low longitudinal crests or rows of tubercles, some of which bear minute spines; and in the female with a good deal of stiffish hair; under surface minutely punctated. The wrist has the superior surface studded with three or four rows of short sharp spines with broad bases. The inner inferior edge has two stout black spines, the strongest of which is near the anterior extremity of the joint. The arm bears two sharp spines on its upper edge near the anterior extremity, and these are separated by a deep transverse furrow which crosses each of the adjacent surfaces. Remaining feet slightly compressed, irregularly angular, marked with longitudinal spinous crests, and clothed with long stiff hairs. The last joint is remarkably long, spineless, but marked with deep longitudinal grooves, in some of which is a dense line of hair. The terminating spine is reddish. The order of length of the feet in the male is 1, 3, (2, 4), 5.

*Abdomen.* The third segment is the broadest in the male, the sixth in the female. In both, the sides of the seventh segment are somewhat sinuated. In the female the margins of the abdomen are thickly fringed with hair, and the surface also bears a good deal of shorter stiff hair.

The measurements of two specimens, a male and female, are subjoined, the figures signifying inches.

	Male	Female
Carapace: Length.....	4-3/8	4-3/16
Breadth.....	7	6-3/16
Feet: First pair—Length.....	7	5
Width of hand.....	2	0
Third pair.....	6-3/8	5
Abdomen: Total length.....	3	3-2/3
Width of third segment.....	1-5/16	
Width of sixth segment.....		1-7/8

This species will take its place in the neighborhood of *Cancer plebeius*, Poeppig, a Chilean species, from which however, it is distinguished by the stoutness of the first pair of feet, the less prominence of the tubercular spines on the hand, the greater prominence of the middle tooth of the lobes at the margin of the carapace, the greater abundance of hair, the absence of the scroll of white spots which paint each side of the upper surface of the carapace in *Cancer plebeius*, and the much greater unevenness of the carapace, arising from the deeper cutting of the divisions between the regions.

Only two specimens of this Crab have fallen in my way. One is in the British Museum, and the other is in my own collection in Madeira."

Ecology

Type locality. Off the coast of Madeira (Christiansen 1969:44).

Distribution. Southeast Iceland to the Canary Islands; 37 to 620 meters (Christiansen 1969:44).

*Cancer pagurus* Linnaeus 1758

Figures 8, 41-1, 41-2

*Cancer pagurus* Linnaeus 1758:627. Bell 1853:59.

Material: Recent—2 specimens; fossil—none known. Hypotype: USNM 125425.

## Description (Bell 1853)

"Description. The carapace is transversely oblong, flattened, slightly elevated in the middle, somewhat rounded before and behind; the surface minutely granulated, smooth, with the regions but slightly marked. The latero-anterior margin is slightly recurved, divided into ten quadrate lobes, the sides of which are contiguous, and the margins entire; the last lobe inconspicuous, and passing into the posterior marginal line, which terminates immediately anterior to the posterior marginal ridge. The front trifold, the teeth nearly equal. The orbits are round, with a strong triangular tooth over the inner canthus, which does not project as far as the front, and a smaller one between the two superior fissures. The external antennae have the basal joint much elongated, and terminating forwards in an obtuse tooth; the first joint of the moveable portion club-shaped, the second cylindrical. The internal antennae stand forwards, the anterior half being folded directly backwards when at rest. The sternum minutely punctated, and furnished with small patches and lines of short scanty hair. The abdomen in the male has the margin fringed with short hair, and the surface with numerous small tufts of short stiff hair; the last joint forming an equilateral triangle: in the female the sixth joint is very large, the terminal one triangular, the sides slightly sinuated. The anterior pair of feet large, robust smooth, without spines or tubercles, minutely granulated; the hand rounded, without spines or tubercles, minutely granulated, without any ridges; the fingers with strong rounded teeth. The remaining feet slightly compressed, irregularly angular, and furnished with numerous bundles of stiff hairs.

The colour above reddish brown, in younger individuals with a purplish tint; the legs more red; the claws black; beneath nearly white."

## Ecology

Type locality. Marstrand, north of Goteborg, west coast of Sweden; type probably lost (restricted by selection of lectotype, Christiansen 1969:42).

Distribution. Atlantic Ocean, from northwest coast of Norway, south to Portugal; Mediterranean Sea (Christiansen 1969:44).

*Cancer davidi* Nations 1968

Figures 19, 26, 28, 36-5 to 38-6; Tables 1, 2, 13

*Cancer davidi* Nations 1968:33.

Material: Fossil only—2 carapaces, 2 mani, 1 carpus, 76 fingers.

Hypotypes: LACMIP 4427, 4428.

Holotype: UCMP 37889.

## Description (Nations 1968)

"Carapace. Carapace broadly oval, moderately convex, very slightly granulated. Fronto-orbital border about one-third the width of carapace; with five teeth, the outer pair forming the inner angles of the orbits, and the three median teeth extending more anteriorly than the other two. Orbits small (3.5 mm in diameter) with two fissures in each dorsal and ventral margin; inner angles more produced anteriorly than the outer ones. Antero-lateral margin of carapace

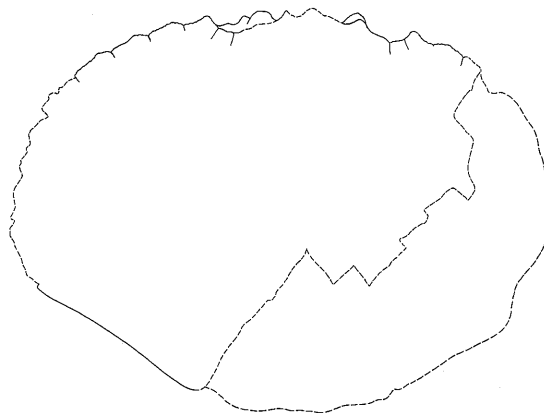


FIGURE 19. *Cancer davidi*, holotype, x4.

slightly indented at closed fissures separating the teeth; evenly beaded with granulations approximately two to three times as large as those on the dorsal surface, but less than half than those on the margin of *Cancer gracilis* Dana.

Antero-lateral teeth sub-truncate with a small granulated tubercle which is usually located one-third the distance from the anterior fissure of each tooth. Four left and two right antero-lateral teeth preserved. The first tooth, with its prominent granulated tubercle forming the outer angle of the orbit, is two-thirds the width of the others. Second, third and fourth teeth of equal width; with a prominent granulated tubercle one-third the distance back from the anterior fissure bordering each tooth.

*Carpus*. Upper surface of carpus bounded by a band of coarse granules. Three high granulated tubercles on upper surface, one near the articulation with the upper manus and the other two arranged transversely about one-third the length of the carpus from the anterior end. The tubercle nearest the lower margin is on an elevated, granulated carina which extends nearly the length of the carpus. This closely resembles the carpus of *C. gracilis* except that the spines are lacking.

*Manus*. Outer surface with six distinct and one less distinct longitudinal, beaded carinae. Upper one with two short spines, one at the upper distal angle and one slightly anterior of the middle of the upper margin; also with a small pustulose elevation midway between the latter spine and the posterior end of the manus at about the point of downward curvature of the upper margin.

Second carina (from the upper margin of manus) with four prominent granulated tubercles equally spaced along its length; the largest, most proximal tubercle terminates the carina just above the articulation with the carpus. A prominent pustule is located one millimeter proximally from each of the two middle tubercles.

The third carina originates at the articulation with the dactylus and extends proximally only one-third the length of the manus. The fourth, fifth, sixth and seventh carinae are evenly beaded and distinct, with the sixth and seventh continuing onto the surface of the fixed finger.

Inner surface of manus smooth with faint, evenly distributed granulations.

*Movable finger*. Incomplete, broken anteriorly just beyond the first cutting tooth which consists of two sub-equal, conical cusps that are joined in a common base. The more

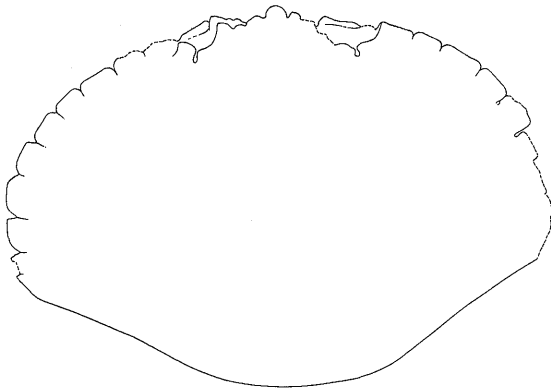


FIGURE 20. *Cancer fissus*, holotype, x4.

distal cusp is slightly elongate due to the presence of a subsidiary cusp on its distal side. The cutting teeth are darker brown and appear to be more dense than the skeletal material in which they are set. The outer and inner surfaces of the finger are uniformly granulated.

*Fixed finger.* Incomplete, broken anteriorly just beyond the first cutting tooth which is a small conical structure of the same material on the movable finger."

#### SUPPLEMENTARY DESCRIPTION

Several specimens of movable and fixed fingers occurring in the Miocene of the Kern River area are closely similar to *Cancer davidi* and are tentatively included in that species. Positive identification depends on the discovery of a complete cheliped of *C. davidi*.

*Movable finger.* (Hypotype, LACMIP 4427). Upper margin with a row of about 10 short spines, along proximal two-thirds of margin. Outer surface rounded; three broad, low ridges, separated by shallow grooves; the upper one with coarse, sharp granules; central one with medium granules and finer granules on the lower ridge. The distinct linear arrangement of granules and more numerous spines differentiate this species from *C. gracilis*. Inner surface smooth, featureless, except for fine, evenly spaced granules. Six cutting teeth; first tooth elongate with two subequal conical cusps identical to the proximal tooth on holotype of *C. davidi*; second slightly smaller, conical; third very small; fourth, fifth and sixth elongate, sharp-edged and decreasing in size toward the tip of finger. Ornamentation of proximal part comparable to that preserved on holotype of *C. davidi*.

*Fixed finger.* (Hypotype, LACMIP 4428). Cutting

teeth five, all elongate: first smaller than second or third; second and third of equal size, both with a subsidiary cusp on proximal side; fourth smaller but similar in shape; fifth very small, simple. Outer and inner surfaces smooth, finely granulate, with a median ridge; lower edge smoothly rounded.

*Measurements.* (For holotype). Carapace width, 47.0 mm (est); carapace length, 35.0 mm; fronto-orbital width, 17.0 mm; anterolateral tooth widths, numbered in sequence, 1-2.3 mm, 2-3.4 mm, 3-3.4 mm, 4-3.4 mm, 5-3.4 mm, 6-9 missing.

#### Discussion

*Cancer davidi* can be differentiated easily from other North American species by the equal widths of antero-lateral carapace teeth numbers 2-5 (see Fig. 26). The cheliped resembles that of *C. gracilis* but can be differentiated by the lack of spines on the carpus and the differences in the movable finger as discussed above (supplementary description). It resembles *C. marri* in several characters (see *C. marri*) but can be differentiated from that species by the lack of an upper angle spine on carpus and the Lu/H ratio.

#### Occurrence

*Pliocene.* Etchegoin Formation: UCMP D-2506 (1 carapace, 1 left cheliped with carpus, manus and partial movable finger); UCMP B-6821 (partial carapace).

*Miocene.* Round Mountain Silt: USGS M1611 (1 l.m.f.); LACMIP 456 (3 r.m.f., 1 right manus with fixed finger, 1 r.f.f., 1 l.m.f., 1 l.f.f.). Olcese Sand: LACMIP 463 (23 l.m.f., 11 l.f.f., 19 r.m.f., 16 r.f.f.).

*Summary.* Middle Miocene to Middle Pliocene; San Joaquin Basin, California.

#### *Cancer fissus* Rathbun 1908

Figures 20, 26, 40-1 to 40-5; Tables 1, 2, 14

*Cancer fissus* Rathbun 1908:343. Rathbun 1926:60 (not pl. 16, figs. 5-6).

*Material:* Fossil only—1 nearly complete specimen, 12 partial carapaces, 1 manus with fingers.

*Hypotype:* UCMP 10738.

*Holotype:* USNM 165477.

#### Description (Rathbun 1926:60)

*"Carapace.* Described from a carapace only. Lateral teeth subtruncate, separated from one another by shallow V-shaped notches and long closed fissures; teeth eight [8], including tooth at outer angle of orbit, irregular in size and



shape; the first, third, fifth and seventh larger than intervening teeth, ninth tooth very narrow; the fifth, sixth, seventh, and eighth teeth have a small horny point at their anterior angle."

Two "incomplete palms" included in this species by Rathbun (1926:61) are discussed below.

#### SUPPLEMENTARY DESCRIPTIONS

##### *Holotype*

*Carapace.* Rather flat with regions only moderately defined; surface along margin with fine, closely spaced granules, more sparse on upper surface.

*Front.* Median tooth broadly rounded, flat and twice as wide as the two adjacent ones; produced the length of median tooth beyond the outer orbital teeth. No suborbital-subhepatic ridge.

*Measurements.* Carapace length, 30.5 mm; carapace width, 42.7 mm (est); fronto-orbital width, 15.9 mm; frontal width, 8.6 mm; tooth widths, numbered in sequence, 1-2.8 mm, 2-2.2 mm, 3-3.2 mm, 4-2.6 mm, 5-3.0 mm, 6-2.8 mm, 7-3.5 mm, 8-2.9 mm, 9-1.9 mm.

##### Discussion of *Additional occurrence* by Rathbun (1926:61)

With the discovery of the hypotype (UCMP 10738) of *C. fissus* (see below) it can be shown that the two left palms assigned to this species by Rathbun are in error. The preservation of the palms is so poor that they should not have been linked with an unas-associated carapace. Measurements on one of the specimens yields a Lu/H manus ratio of 0.803 which is considerably less than the ratio of 0.965 for the cheliped of the hypotype of *C. fissus* (see Table 1). The T/H manus ratio of 0.551 compared with 0.598 of *C. fissus* would be outside the expected range of variation in some Recent species, but not all of them. The two palms in question (UCMP 15488 and UCMP 30035) are relatively too short and high to be placed in *C. fissus*. They most closely resemble *C. anthonyi* in their dimensions and the character of the upper surface but their preservation is too poor to justify placing them in any existing species. They are not good enough to establish a new species.

##### *Hypotype*

*Locality.* Upper Pliocene, Cascajo Conglomerate, La Cima Quad, Kings County, California.

*Description.* Carapace low; covered with evenly distributed fine granules; regions very poorly defined. Nine antero-lateral teeth, alternating in width with number 1, 3, 5, and 7 wider than the others;

separated by a prominent closed fissure and a small notch; teeth 1, 2 and 3 truncate, the rest with a small point at their anterior angle, tooth number 9 terminating on the postero-lateral margin at a small notch in the carina. Orbits small, round with a truncate superorbital lobe and two fissures above each; a broad suborbital lobe with a concave front margin forming two acute angles; no suborbital-subhepatic ridge. Abdomen very broad (female) with six segments.

Chelipeds not as well preserved as the carapace. Manus elongate, thick; outer surface broadly rounded, carinae not evident; covered with evenly spaced, fine granules. Fixed finger rather strongly deflexed. Movable fingers absent.

*Carpus.* Outer surface smooth, evenly covered with fine granules, lower margin broadly rounded with no distinct carinae, a low rounded tubercle at upper articulation with manus, upper angle with a triangular spine, inner angle evenly rounded with no tubercle or spine.

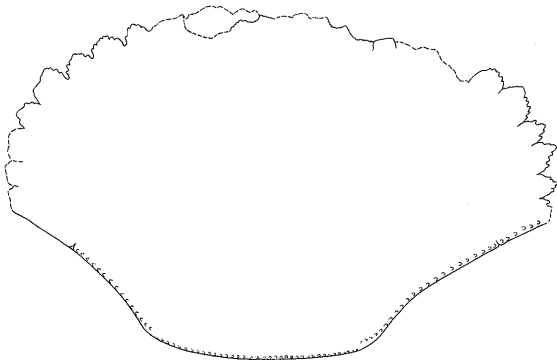
*Measurements.* Carapace length, 53.0 mm (est); carapace width, 71.9 mm; fronto-orbital width, 26.5 mm; anterolateral tooth widths, numbers in sequence, 1-4.7 mm, 2-3.9 mm, 3-4.8 mm, 4-4.1 mm, 5-4.8 mm, 6-4.2 mm, 7-5.2 mm, 8-4.0 mm, 9-2.7 mm; cheliped measurements (see Table 13).

#### Discussion

The hypotype is much more complete than the holotype, with the carapace, antero-lateral teeth, ventral surface, proximal segments of the walking legs and most of both chelipeds preserved. The upper surface of both mani are badly weathered and the frontal region is absent, as are the movable fingers.

The chelipeds of *C. fissus* can be differentiated most easily from those of *C. anthonyi* and *C. antennarius* by the Lu/H manus ratios and from *C. magister* and *C. productus* by the lack of prominent carinae, spines and tubercles on the manus and carpus.

*Cancer fissus* differs from: 1) *C. marri* in: a) Lu/H manus, T/H manus, H/L carpus, (see Table 1); b) morphology of carpus, i.e., a raised ridge on lower border of upper surface of *marri* whereas *fissus* has a broadly rounded border. 2) *C. jenniferae* in: a) antero-lateral tooth outline of teeth 1-5 (granulated point in anterior half but truncated in *fissus*); b) first tooth narrower than 2nd, vice versa in *fissus* (see Table 3); c) median frontal tooth equal in width to adjacent ones, wider in *C. fissus*; d) a subhepatic ridge in *C. jenniferae*, none in *C. fissus*; e) outer suborbital fissure short in *jenniferae*, longer in *fissus*; f) carapace distinctly convex in *jenniferae*, but low

SUPPLEMENTARY DESCRIPTION OF  
HOLOTYPEFIGURE 21. *Cancer granti*, holotype, x4.

in *fissus*. 3) *C. davidi* in relative widths of antero-lateral teeth; teeth no. 2-5 of *davidi* equal, but alternating in *fissus* (see Fig. 26).

## Occurrence

*Pliocene*. Cascajo Conglomerate: UCMP D-362 (1 complete carapace with abdomen, walking legs and 2 incomplete chelipeds), hypotype. Etchegoin Formation: USNM 165477 (1 incomplete carapace, *Holotype*); UCMP B-6821 (3 partial carapaces); UCMP D-1138 (7 partial carapaces, 1 external mold of cheliped with 2 rubber casts). Purisima Formation: UCMP B-5194 (1 partial carapace).

*Summary*. Middle to Upper Pliocene; San Joaquin Basin to Santa Cruz, California.

*Cancer granti* Rathbun 1932

Figures 21, 33-7, 33-8; Tables 1, 2, 15

*Cancer granti* Rathbun 1932:19.

Material: fossil only—1 carapace with right cheliped. *Holotype*: UCLA 1096.

## Description (Rathbun 1932)

"*Description*. A portion of the anterior half of the carapace is exposed; surface thickly covered with minute punctae; granules visible to the naked eye are loosely scattered in groups on the protogastric, mesogastric, hepatic and epibranchial regions; a tubercle behind inner angle of orbit; interregional grooves shallow; anterior and antero-lateral margins bordered by elongate granules or blunt spinules; lateral teeth upturned; the second tooth from the orbit is narrow, little more than half as wide as the third tooth; fourth and fifth teeth subequal, slightly narrower than third; the surface of the front between orbits has 3 longitudinal furrows, the margin is obscure. Estimated width of carapace 56.5 mm."

*Carapace*. Broadly expanded and gently arched laterally; strongly arched on the anterior-posterior axis. Surface smooth except for clusters of small granules on elevated portions; regions poorly defined.

*Anterolateral teeth*. Nine triangular teeth, separated to their bases by "V" shaped notches; margins with 2 to 6 short spines on each edge; width of teeth varying with no. 1, 3 and 5 widest, no. 2 and 8 narrowest and 4, 6, 7 and 9 intermediate and subequal; teeth 1-5 rounded at extremity, 6 to 9 more acute.

*Manus*. Outer surface with six carinae bearing rows of sharp, evenly spaced, spines. Areas between carinae smooth in proximal half but with vertical rows of very small granules in distal half, carina on lower margin not spiny but composed of closely spaced tiny granules.

*Carpus*. Broad and short; upper surface bounded by a row of sharp spines and traversed by three raised carinae, each bearing a single row of spines; one spine at upper angle and one large spine at upper articulation. Inner angle inaccessible.

*Movable finger*. Upper margin incomplete in proximal half; outer surface broad with small granules evenly distributed along a single longitudinal groove. Six cutting teeth, the proximal one largest and conical, as are numbers 2 and 3; teeth 4, 5 and 6 are more elongate, forming a sharp edge.

*Fixed finger*. Incomplete, but probably had 4 sharp-edged teeth; outer surface finely granulate.

*Measurements*. Carapace width, 35.0 mm; carapace length, 56.0 mm; fronto-orbital width, 21.3 mm; anterolateral tooth widths, numbered in sequence, 1-3.6 mm, 2-2.0 mm, 3-3.7 mm, 4-3.1 mm, 5-3.9 mm, 6-2.8 mm, 7-3.2 mm, 8-2.0 mm, 9-2.7 mm. Cheliped measurements: (see Table 15).

## Discussion

*Cancer granti* differs markedly from other known species of *Cancer*. It is unique in the 1) pronounced lateral expansion of carapace, 2) the configuration of antero-lateral teeth, and 3) the size and arrangement of spines on the carpus and manus.

## Occurrence

*Summary*. Known only from type locality, Pico (?) Formation, Upper Pliocene, Los Angeles, California.

*Cancer urbanus* Rathbun 1917

Figures 22, 32-4; Table 2

*Cancer urbanus* Rathbun 1917:451. Rathbun 1926:61, not plate 16, fig. 1.

Material: fossil only—1 carapace.

Holotype: USNM 324300.

## Description (Rathbun 1926:61)

"Description. Surface of carapace about equally convex from side to side and from front to back; uneven, closely granulate, granules larger and more prominent on the most elevated portions; interregional depressions deep. Antero-lateral teeth 9, including the tooth at lateral angle of carapace and at outer angle of orbit; teeth acute, margins straight, anterior margin usually considerably shorter than posterior margin; margins of seventh or widest nearly equal. Furrows leading back from sinuses of anterior margin deep.

*Measurements.* Estimated width of carapace (holotype) measured between antero-lateral sinuses 48 mm, length of carapace about 34 mm."

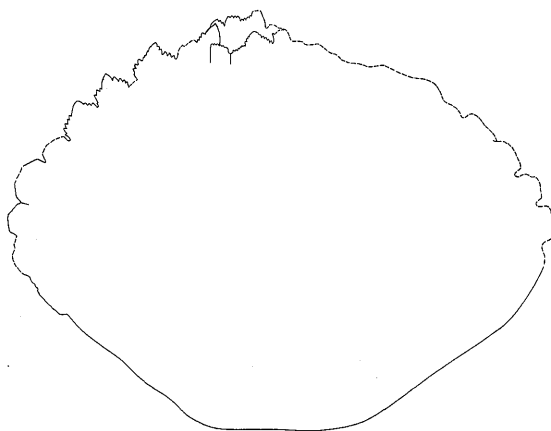
The cheliped assigned to this species by Rathbun (1926:61-62) is discussed here and re-assigned to *Cancer chaneysi*.

SUPPLEMENTARY DESCRIPTION OF  
HOLOTYPE

Surface of carapace uneven, about equally convex from side to side and from front to back. Densely granulate, with granules larger and more prominent on the most elevated portions; all inclined anteriorly, terminating in a sharp point. The most prominent sharp granules clustered only on high areas in the branchial regions but rather uniformly distributed in the proto-, meso- and meta-gastric and cardiac regions. Interregional depressions deep with only scattered, small granules also inclined anteriorly and terminating in sharp points. Antero-lateral teeth 9; teeth acute, spinulose with 3 relatively large spinules in a row on margin near base and a rounded, spinulose tip deflected anteriorly; anterior margin usually considerably shorter than posterior margin and somewhat concave; margins of 7th and widest tooth nearly equal. Furrows leading back from sinuses of anterior margin deep.

Front markedly produced, base of outer orbital tooth produced farther than tip of 3rd; margin of orbit bordered by spinules; inner orbital tooth broad with inner half produced considerably more than outer half, separated from outer orbital tooth by a small, slightly projecting, truncated lobe; sub-orbital tooth broad, truncated except for a small point on inner side and markedly produced beyond upper margin of orbit.

Sub-orbital and sub-hepatic regions covered by

FIGURE 22. *Cancer urbanus*, holotype, x4.

closely spaced, anteriorly inclined, sharp pointed granules similar to those on dorsal surface. Sub-branchial region smooth.

*Measurements.* Carapace width, 47.1 mm (est); carapace length, 35.0 mm (est); fronto-orbital width incomplete; anterolateral tooth widths, numbered in sequence, 1-2.9 mm, 2-2.7 mm, 3-3.9 mm, 4-3.1 mm, 5-3.7 mm, 6-3.0 mm, 7-4.1 mm, 8-2.7 mm, 9-3.5 mm.

## Discussion

*Cancer urbanus* is markedly different from any other known species of *Cancer*, fossil or Recent, on the west coast of North America. Based on similarities in carapace shape, areolation, surface texture and configuration of antero-lateral teeth, *C. urbanus* appears to be closely related to *C. gibbosulus* of Japan. However, the frontal region is produced more and the edges of the antero-lateral teeth are serrated in the former.

## Occurrence

*Summary.* Known only from type locality, Pico (?) Formation, Upper Pliocene, Los Angeles, California.

*Cancer allisoni* new species

Figures 29, 30-3, 30-4; Tables 1, 2, 16

Material: fossil only—1 manus, 8 fingers.

Holotype: LACMIP 4434.

Paratypes: LACMIP 4429-4433; USNM 70550-17055.

Type locality: LACMIP 449.

*Diagnosis:* Similar to *C. oregonensis* in extent of dense tip material on fingers, coarse granulation and shape of fingers, but differing in 1) tooth arrangement, i.e., lacking triangular arrangement of proximal teeth found in *oregonensis*, 2) much coarser granulation on distal part of manus and on proximal one-fourth of movable and fixed finger, coarser than any known species of *Cancer*, 3) H/L fixed finger outside the 95% probable range of variation in *C. oregonensis* (see Tables 1 and 4) maximum size considerably larger than *oregonensis*.

Isolated movable fingers could be confused with those of *C. productus* because they have a nearly identical tooth arrangement and the H/L movable finger ratios are coincident (see Table 1). They differ in several ways; e.g., the dense tip material is more extensive, the upper margin more broadly rounded, and granules are finer in *C. allisoni* than in *productus*.

#### Description

*Manus.* Only distal margin preserved, upper surface missing. Distal margin studded with very coarse, conical, hollow granules resembling those along upper margin of the manus of *C. oregonensis*. The granules apparently extended proximally on the manus as carinae.

*Movable finger.* Cutting teeth typically four; the proximal two nearly equal, round at base, with conical points; third elongate, equal size to first two, but connected by a sharp ridge along outer side to the fourth, smallest tooth, the ridge extending distally to tip. Shape thick, robust; upper margin broadly rounded; surface finely granulated from first tooth to tip; inner surface bisected by a shallow, distinct groove from base to tip, a setiferous pit above each cutting tooth. Outer surface with a similar groove located one-third distance from upper margin and a shorter row of setiferous pits two-thirds distance from upper margin which extends only one-half distance to tip. Distal three-fourths composed of dense tip material from tip to including first tooth, the proximal one-fourth of less dense material and covered with a medium to very coarse granules like those on manus. This less dense material is typically broken away from isolated dactyli, leaving only the dense tip.

*Fixed finger.* Short and thick, dense tip material extending from behind first tooth along lower margin to tip; very finely granulated. Cutting teeth four, badly worn but appearing much like those of *C. oregonensis*. Inner surface concave; medium granules from base to first tooth, a groove of setiferous pits one-third distance from lower margin; a setiferous pit below and at proximal end of teeth 2 and 3;

lower edge with a groove of setiferous pits. Outer surface strongly convex with a broad ridge just above center; a groove of pits, one-third distance from lower edge, and 2 setiferous pits below teeth 2 and 3. Very coarse granules extending out from manus to below the first tooth.

#### Occurrence

*Pliocene.* "Pico" Formation: LACMIP 466 (1 l.f.f.). San Diego Formation: LACMIP 449 (left manus, distal margin only with movable and fixed fingers).

*Miocene.* Unnamed formation, Coos Bay (dredged): USNM 18284 (1 r.m.f., 1 l.m.f.). Olcese Sand: LACMIP 463 (2 r.m.f., 1 l.m.f.). Round Mountain Silt: LACMIP 456 (1 l.m.f., 1 r.m.f.).

*Summary.* Middle Miocene to Upper Pliocene; Coos Bay, Oregon to San Diego, California.

#### *Cancer marri* new species

Figures 29-1, 29-4; Tables 1, 2, 17

Material: fossil only—1 cheliped, 2 mani, 1 carpus, 7 fingers.

Holotype: UCMP 10739.

Paratypes: UCMP 10746–10752.

Type Locality: UCMP D-3402.

*Diagnosis:* Resembles *C. davidi* in: 1) ornamentation of manus, with smooth, finely granulated texture and tubercles on first and second carinae; tubercles smaller than in *C. davidi*; 2) shape and arrangement of cutting teeth on movable finger. Differs in Lu/H manus and in morphology and ornamentation of carpus (presence of spine at the upper angle, no carinae or tubercles on upper surface).

Differs from *C. fissus* in Lu/H, T/H of manus, and H/L carpus. Carpus also differs in morphology, i.e., *marri* having raised ridge on lower border of upper surface whereas *fissus* has a broadly rounded border.

#### Description

*Manus.* Six finely granulated carinae on outer surface; surface smooth, sparsely granulated, granules very fine. Upper margin smoothly rounded with a short spine midway along its length, another at distal angle; second carina with two low, granulated tubercles dividing it into thirds. Granules separated by distances of 3X their diameters, but coarser and closer together along the carinae. Inner surface very smooth.

*Carpus*. Upper surface bordered by an elevated, finely granulated carina; the central part gently elevated with no carinae or tubercles, surface sparsely granulated with fine granules as on the manus. Upper angle with a large, triangular spine; inner angle smoothly rounded. A granulated tubercle at upper articulation.

*Movable finger*. High at base, tapering rapidly to a point distally, relatively flattened. Outer and inner surfaces broadly rounded; ornamented only by sparse, fine granules as on carpus and manus. Upper margin high and sharp as in *C. gracilis*, granules more concentrated on upper margin. Cutting teeth about seven, (5 preserved): first and second mounted on common base with second biparite as in *C. davidi*; third and fifth like second with a large proximal and a small distal cusp; fourth small; teeth slightly elongate with a ridge through their centers.

*Fixed finger*. None well preserved; short and thick; outer surface finely and sparsely granulated, granules closer along carinae. Cutting teeth about five with third and fourth elongate; first and second conical. Inner surface smooth, with a few fine granules on the medial ridge.

Occurrence

*Pliocene*. Merced Formation: UCMP D-3389 (1 r.m.f., 1 r.f.f., 1 l.m.f.). Purisima Formation: UCMP D-3403 (1 partial right manus); UCMP D-3402 (1 right manus with carpus, f.f., m.f. *Holotype*; 1 right manus with f.f.; 1 l.f.f., 1 r.f.f., 1 right carpus). Etchegoin Formation: UCMP B-6821 (1 r.f.f., 1 partial right manus); UCMP D-2506 (1 l.m.f.).

*Summary*. Middle to Upper Pliocene; San Joaquin Basin to San Francisco, California.

*Cancer danai* new species

Figures 23, 24, 34-4; Table 2

Material: Fossil only—1 carapace.

Holotype: UCMP 10740.

Type Locality: UCMP D-3800.

*Diagnosis*: *Cancer danai* resembles *Cancer magister* in: 1) shape of carapace; 2) areolation and texture; 3) shape of antero-lateral teeth; 4) structure of frontal region. They can be differentiated by: 1) number of antero-lateral teeth (9 vs 10); 2) relative widths of antero-lateral teeth (see Fig. 23); 3) greater elevation of gastric ridge in *C. danai*; 4) downturned ninth antero-lateral tooth in *C. danai*.

Description

Carapace strongly arched along an anterior-pos-

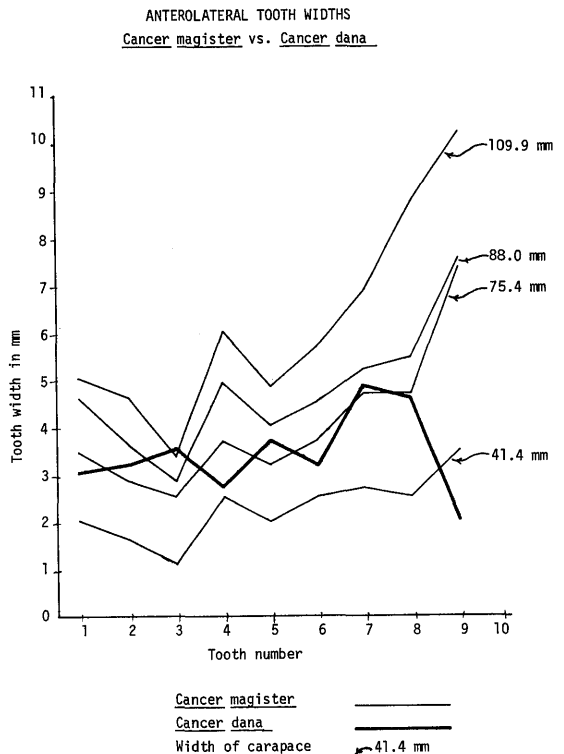


FIGURE 23. Anterolateral tooth widths. *Cancer magister* versus *Cancer dana*.

terior line; a prominent, narrow ridge through the meta- and meso-gastric regions; meso-branchial region also inflated but not as high as the ridge. Front with five teeth; middle tooth larger than and produced beyond the outer pair; inner orbital teeth broader than the medial three but less produced, also less produced than the outer orbital teeth. Dorsal surface densely covered with coarse granules; granules larger on elevations. Antero-lateral margin with nine teeth of varying widths (see Fig. 23), teeth coarsely granulate, separated by a "V" shaped notch and closed fissures, a blunt point at the anterior angle of each; first and second teeth with an indentation in margin; seventh tooth widest, ninth narrowest and turned downward. Postero-lateral margin entire, marked with a coarsely granulated carina. A prominent trough behind antero-lateral teeth 1 to 5 (possibly due to post-depositional deformation).

*Measurements*. Carapace width, 54.2 mm; carapace length, 37.0 mm; fronto-orbital width, 16.0 mm; tooth width, numbered in sequence, 1-3.0 mm, 2-3.2 mm, 3-3.5 mm, 4-2.6 mm, 5-3.7 mm, 6-3.2 mm, 7-4.8 mm, 8-4.5 mm, 9-2.0 mm.

Occurrence

*Summary*. Known only from type locality, Briones

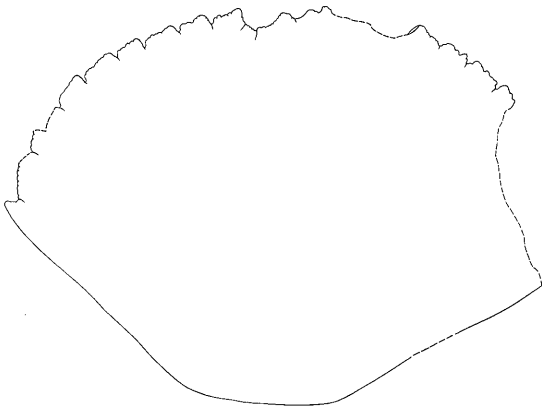


FIGURE 24. *Cancer danai*, holotype, x4.

Formation, Middle Miocene, Contra Costa County, California.

***Cancer dereki* new species**

Figures 25, 31-7, 31-8, 32-1; Table 2

Material: fossil only—2 carapaces.

Holotype: UCMP 10741.

Paratype: UCMP 10753.

Type locality: UCMP A-6884.

*Diagnosis:* *Cancer dereki* resembles three Recent species *C. branneri*, *jordani*, and *gibbosulus* in: 1) shape, areolation, and granulation of the carapace; 2) shape and size of antero-lateral teeth; 3) shape and arrangement of postero-lateral teeth.<sup>9</sup> It differs from all three in: 1) equal length of median frontal tooth to the adjacent pair, and 2) has a narrower gap separating the medial pair of frontal teeth from the inner supra-orbital teeth (equal to width of orbit in the Recent species, but only two-thirds that width in *C. dereki*.)

More specifically, *C. dereki* can be differentiated from those species as follows:

1) Antero-lateral teeth more acute, and fronto-orbital width less (1/2.4 vs 1/2.8 than in *C. branneri*.)

2) Areolation more pronounced; postero-lateral tooth sharper, longer; granulations on carapace more spinulose and clustered; and frontal teeth more strongly produced in *C. dereki* than in *C. jordani*.

3) Areolation more distinct; granulations on carapace finer; antero-lateral teeth more acute in *C. dereki* than in *C. gibbosulus*. Postero-lateral tooth

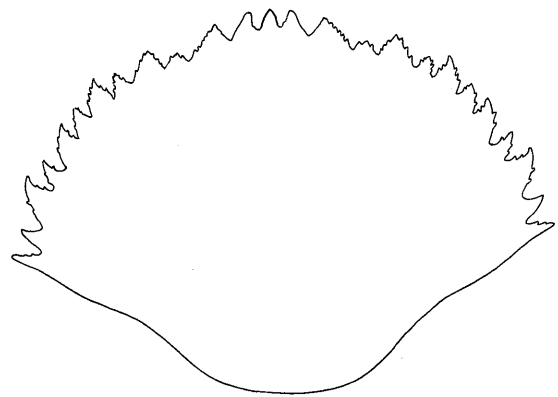


FIGURE 25. *Cancer dereki*, holotype, x5.

more prominent and projects outwardly from the margin of carapace in the latter species.

*Cancer dereki* resembles *C. branneri* and *C. jordani* in several characters of the carapace more closely than it does *C. gibbosulus*. The overall similarity to these species strongly suggests that it is closely related to both while the Middle Miocene age suggests that it is the ancestor of both. The most fundamental difference is in the shape of the frontal region. No comparison of chelipeds is possible because they are not known for *C. dereki*.

**Description**

Regions of carapace sharply defined, more so in smaller specimen. Surface covered with fine pores and bearing scattered clusters of spinules on the higher regions, especially in the posterior half of carapace. Nine antero-lateral teeth, separated to their bases, curved forward, tips spiniform, flattened toward the base with spinules along their margins; second, fourth, sixth and eighth smaller than the others with the ninth only slightly larger than the eighth. Teeth less spiniform in the larger specimen, especially toward the front and not noticeably curved forward. Postero-lateral margins marked by a spinulose carina extending to the tips of the ninth antero-lateral tooth; two postero-lateral projections, the first more spinose and prominent than the second; neither projecting laterally beyond the carapace margin.

	Holotype	Paratype
Carapace length	15.7 mm	22.5 mm
Carapace width	21.2 mm	32.3 mm (est)
Fronto-orbital width	9.0 mm	14.0 mm (est)

Five fronto-orbital teeth, the median one depressed, acute and equal in length to next pair which are also acute; all produced beyond the supra-orbital teeth. Three supra-orbital teeth, triangular shape less produced than the others. Inner supra-orbital teeth close to median pair. Median supra-orbital tooth distinctly pointed.

#### Occurrence

*Summary.* Known only from the type locality; Monterey Formation, Middle Miocene, San Mateo County, California.

#### *Cancer yanceyi* new species

Figures 32-2, 32-3; Tables 1, 2, 18

Material: fossil only—2 mani.

Holotype: UCMP 10742.

Paratype: UCMP 10755.

Type locality: UCMP B-7727.

*Diagnosis:* *Cancer yanceyi* differs from all other species, except *C. antennarius*, in Lu/H manus. It differs from the latter in: 1) presence of tubercles on first and second carinae; 2) sharpness of upper margin; 3) T/H manus; 4) Hf/Hm (see Table 1).

#### Description

*Manus.* Short, high and laterally compressed. Outer surface poorly preserved; seven carinae; upper margin level, bounded by carinae no. 1 and 2 at equal heights; the first forming a rather sharp edge which overhangs the inner surface of manus, a prominent tubercle at mid-point and a smaller one half way between it and the proximal end; the second carina with two prominent tubercles equally spaced one-third distance from each end; upper distal end of manus broadly rounded and forming the highest point on manus; the third carina apparently had three or four small tubercles, the other four carinae recognizable only as slightly raised fine ridges. Granulation not preserved.

*Fixed finger.* Short, thick and low compared to height of manus; no teeth or ornamentation preserved; tip broken from both specimens; strongly deflexed from manus.

#### Occurrence

*Summary.* Known only from the type locality; San

Joaquin Formation, Upper Pliocene or Lower Pleistocene, Fresno County, California.

#### *Cancer garthi* new species

Figures 28, 35-11, 35-12; Tables 1, 2

Material: fossil only—1 finger.

Holotype: UCMP 10743.

Type locality: UCMP B-7880.

*Diagnosis.* *Cancer garthi* resembles *Cancer magister*, *C. coosensis*, and *C. durhami* in the elongated movable finger with numerous granulated spines along the upper margin, and numerous cutting teeth. It can easily be differentiated from them because of the greater number of spines and cutting teeth and the greater curvature of the distal half, in addition to lesser differences in granulation and tooth pattern.

#### Description

Dactylus strongly curved, extremely flattened; upper margin with 14 long, granulated spines, largest at proximal end and gradually decreasing distally. Surface coarsely granulate; granules separated from each other by distance approximately equal to diameter to largest ones; coarsest in proximal half, decreasing distally. Two prominent, longitudinal grooves arising near the proximal end, dividing dactylus roughly into thirds, and converging distally. Twelve cutting teeth, sharply pointed; teeth 3, 5 and 6 the largest and elongate, no. 1 rounded, no. 2 subdivided into two rounded points, nos. 7-12 smaller and more bladelike, no. 4 with two small rounded points. Basal extension with at least 6 small but high granules; granules much higher than in *C. magister*.

*Measurements.* Length, 33.6 mm; height (to base proximal spine), 11.1 mm.

#### Occurrence

*Summary.* Known only from the type locality; Scotia Bluff Sandstone, Upper Pleistocene, Humboldt County, California.

#### *Cancer durhami* new species

Figures 34-5, 34-6, 34-7; Tables 1, 2, 19

Material: fossil only—1 cheliped.

Holotype: UCMP 10744.

Type locality: UCMP A-9733.

*Diagnosis:* *Cancer durhami* is very similar to *Cancer magister* but differs in the following charac-

ters: 1) carpus with a spine at articulation; 2) two carinae of coarse granules on inner surface of manus. It is more easily differentiated from *C. magister* and *coosensis* by differences in form, tooth pattern, ornamentation, and numbers of teeth and spines on dactylus.

#### Description

*Manus.* Six carinae on outer surface, each extending the length of manus; granulate, but not as coarse or sharp as in *C. magister*; upper margin with a row of 7 large, granulated spines; second carina spinulose and more elevated than *C. magister*. Inner surface smooth in upper half but lower half covered with small, evenly distributed granules.

*Carpus.* Ornamentation poorly preserved but major features evident. Upper surface bordered by an elevated, granulated carina; granules on the surface smaller than in *C. magister*; two elevated carinae on upper surface similar to those in *C. magister* except the longitudinal one terminating distally in a granulated tubercle. Upper distal angle with a large, sharp, triangular spine as in *C. magister*, but with an additional prominent spine at the upper articulation not found in *C. magister*.

*Fixed finger.* Ten major cutting teeth with one subsidiary between teeth 5 and 6; subequal, similar in shape and arrangement to *C. magister*, although smaller. Outer surface badly weathered but position of 5th and 6th carinae and the setiferous groove between them much like that in *C. magister*. Inner surface with a raised longitudinal ridge in center, wider than in *C. magister*, and with smaller granules.

*Movable finger.* Seven cutting teeth; first tooth large, rounded; numbers 2 and 3 with subsidiary cusps proximally; 4-7 poorly preserved but elongated, sharp-edged and decreasing in size distally. Outer surface badly weathered, granules smaller than *C. magister*. Upper margin with 9 or 10 large, distally inclined spines decreasing regularly in size toward the tip. Inner surface with a groove down the center, bordered by two broadly rounded ridges, granules not present.

#### Occurrence

*Summary.* Known only from the type locality; Etchegoin Formation, Middle Pliocene, Kings County, California.

#### *Cancer coosensis* new species

Figures 28, 35-7, 35-8, 35-9, 35-10;  
Tables 1, 2, 20

Material: fossil only—2 mani, 1 carpus, 5 detached fingers.

Holotype: USNM 170552.

Paratypes: USNM 170553, 187692, 187691; UCMP 14116.

Type locality: USGS 18284.

*Diagnosis:* *Cancer coosensis* is similar to *Cancer magister* in general morphology and ornamentation but differs in several specific characters: 1) Lu/H of manus; 2) T/H of fixed finger (see Table 1); 3) coarseness and distribution of granules; 4) tooth number and pattern of fingers; 5) upper margin of movable finger and the attitude of its spines.

#### Description

*Manus.* Smaller specimen (holotype) with six carinae on outer surface, the first a row of large granulated spines; the second poorly preserved but appearing to be a single row of sharp granules; third and fourth broader (1 mm) bands of 4 to 5 rows of sharp granules; the fifth made up of at least 3 rows of granules, and the sixth forming the rounded granulated lower edge of the manus and fixed finger. Upper margin with a single row of 8 large granulated spines, very similar to *C. magister*. Inner surface smooth in upper half but with two irregular rows of large granules extending the length of the manus in positions corresponding to 4th and 5th carinae on outer surface; the 5th extending down the center of the fixed finger; a 6th carina also present along the lower margin. These inner carinae suggest a close relationship to *C. magister*.

Larger specimen (paratype, USNM 187692) badly crushed. Outer surface densely covered with granules smaller than those in *C. magister*; upper margin with at least seven large granulated spines very similar to those of *C. magister*; inner surface not preserved. Includes carpus described below.

*Carpus.* Paratype, USNM 187692. Poorly preserved. A large, triangular spine at upper angle; 4 sharp, coarse granules in a row between inner and upper angle; outer surface appearing more densely granulate than *C. magister*.

*Fixed finger.* Paratype, USNM 187692. Tip missing; four large cutting teeth, each preceded proximally by a smaller one; first tooth conical, teeth 2, 3 and 4 becoming progressively sharper and more



bladellike; teeth more numerous and less uniform than in *C. magister*, probably 11 teeth (8 preserved). Outer surface crushed but appearing uniformly granulated. Inner surface with coarse granules concentrated in 2 wide bands, one along lower margin and one centrally located; a few scattered granules above the central band.

*Holotype*. Distal half missing; basically the same as in paratypes.

*Movable fingers*. (2 specimens, neither attached to manus). Left finger, USNM 170553. Upper margin with a straight row of ten major, granulated spines, inclined distally and inwardly. Outer surface uniformly covered with coarse granules; two rows of small pits dividing the surface into thirds and converging toward tip, granules continuous between the pits, i.e., no grooves present. Seven cutting teeth, rounded proximally, becoming elongate and more bladellike distally, much like *C. magister*. Inner surface with two granulated ridges separated by a centrally located, broad, and smooth groove which becomes granulated in distal half. Black tip from 5th tooth to tip.

Right movable finger, USNM 187691 (not illustrated). Same as left except with 10 teeth; the proximal three joined in one base and the other 7 proportionally smaller than on left finger. Spines on upper margin (about 13) not in straight row as in left finger, but alternating in position, forming two closely spaced rows. Tip missing, but black tip material extending to 5th tooth. Based on the larger number and smaller size of teeth and the irregular arrangement of spines on upper margin, this finger is probably an aberrant specimen of the species and the left finger is normal (see discussion in Scope and Methods section).

#### Occurrence

*Pleistocene*. Elk River Formation: UCMP B-7380 (1 l.m.f.).

*Miocene*. Coos Bay dredgings: USNM 18284 (2 right mani, with fixed fingers, 1 right carpus, 1 holotype, 3 paratypes, 1 r.m.f., 1 l.m.f.). Neroly Formation: UCMP B-4941 (1 r.m.f.). Sobrante Formation: UCMP D-3864 (1 l.f.f.), paratype UCMP 14116.

*Summary*. Middle Miocene to Lower Pleistocene; Coos Bay, Oregon to Central California.

*Cancer jenniferae* new species  
Figures 26, 27, 36-3, 36-4; Table 2

ANTEROLATERAL TOOTH WIDTHS  
*C. davidi*, *C. fissus* and *C. jenniferae*

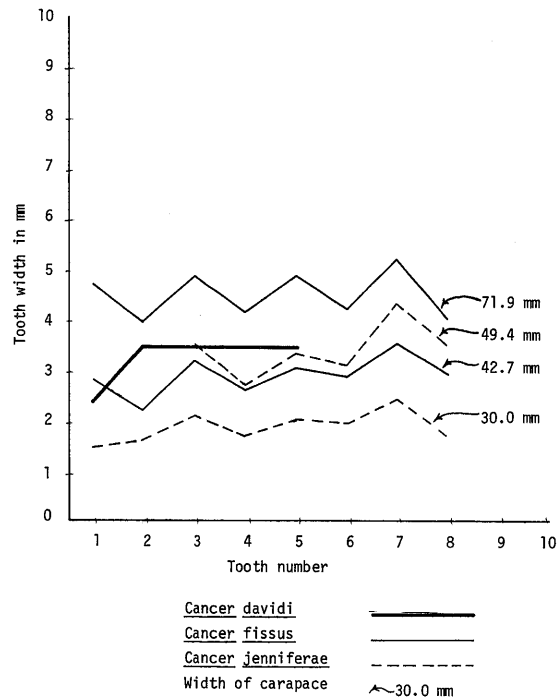


FIGURE 26. Anterolateral tooth widths. *Cancer davidi*, *C. fissus* and *C. jenniferae*.

Material: fossil only—32 carapaces.

Holotype: UCMP 10745.

Paratype: USNM 170554.

Type locality: UCMP B-6821.

*Diagnosis*: *Cancer jenniferae* resembles *Cancer davidi*, *Cancer fissus* and *Cancer gracilis*, but can be differentiated as follows:

From *Cancer gracilis*: 1) relative widths of anterolateral teeth nos. 3, 4 and 6 (see Fig. 26); 2) coarse, sharp granules around margin of carapace in *C. gracilis*, much finer in *C. jenniferae*; 3) carapace more highly arched in *C. gracilis*; 4) front not produced in *C. gracilis*. These two species are similar in outline of antero-lateral tooth margins.

From *Cancer fissus*: 1) antero-lateral teeth 1-5 truncated to concave in *C. fissus* (see Figs. 20, 27); 2) first tooth wider than second in *C. fissus*; 3) median frontal tooth wider than each of adjacent pair in *C. fissus*, about equal in *C. jenniferae*.

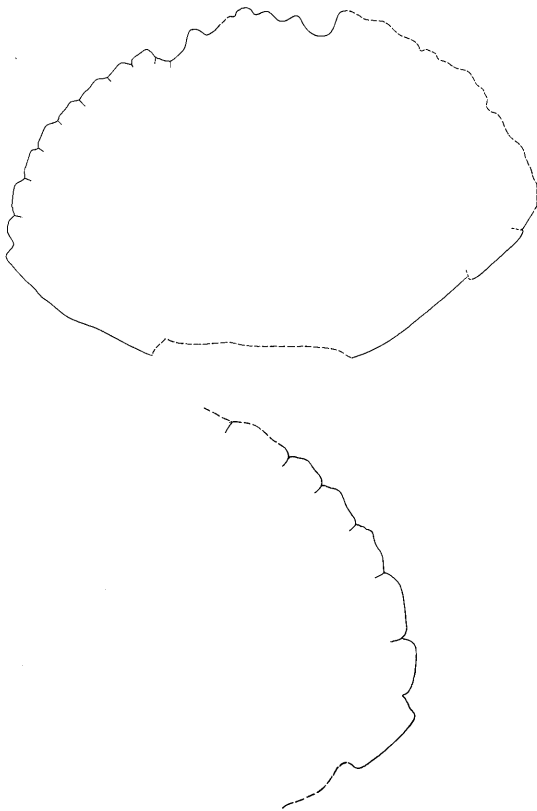


FIGURE 27. *Cancer jenniferae*: A, upper, holotype, x6; B, lower, paratype, x4.

From *Cancer davidi*: 1) antero-lateral teeth 2-5 of equal width in *C. davidi*, alternating in *C. jenniferae* with 3, 5 and 7 wider than 2 and 4 (see Fig. 26). Similar in outline of outer margin, except the points in *C. jenniferae* are more produced and the marginal granules are finer than in *C. davidi*.

#### Description

Carapace moderately convex, very slightly areolated, uniformly and finely granulated. Front with 5 teeth; middle tooth produced beyond inner orbital teeth, which are produced slightly beyond outer orbital teeth. Two fissures above orbit; supraorbital lobe truncate, the margin finely granulate; a long, narrow ridge in sub-orbital and sub-hepatic region. Antero-lateral margin with 9 teeth of varying widths, no. 2 wider than no. 1; (see Fig. 26); teeth margins finely granulate, not strongly produced, separated by a shallow notch and closed fissure; each with a blunt point in anterior 1/3 or 1/4, forming a distinct

angle in margin outline (see Fig. 27). One rudimentary tooth on postero-lateral margin.

*Measurements*: Carapace length, 20.3 mm; carapace width, 30.0 mm; fronto-orbital width, 11.0 mm; anterolateral tooth widths, numbered in sequence, holotype first with paratype in parenthesis, 1-1.4 mm, 2-1.6 mm, 3-2.1 mm (3.5 mm), 4-1.7 mm (2.7 mm), 5-2.0 mm (3.3 mm), 6-1.9 mm (3.1 mm), 7-2.4 mm (4.3 mm), 8-1.7 mm (3.5 mm), 9-2.9 mm (5.0 mm).

#### Occurrence

*Summary*. Known only from type locality; Etche-goïn Formation, Middle Pliocene, San Benito County, California. Specimens occur abundantly (32 identified) as concretions in fine sand; associated with *Cancer fissus* and *Cancer davidi*.

#### *Cancer chaneyi* new species

Figures 29, 39-3, 39-4, 39-5, 39-6, 39-7, 39-8;  
Tables 1, 2, 21

*Cancer productus* Randall 1839. Menzies 1951:168.

*Cancer urbanus* Rathbun 1926:61 (in part), additional occurrence, plate 16, fig. 1; *not* holotype, plate 15.

Material: fossil only—187 fingers, 1 carpus, 2 mani.

Holotype: LACMIP 4436.

Paratypes: LACMIP 4437-4445; USNM 184227, 186057-186058, 353394.

Type locality: LACMIP 130-7.

*Diagnosis*: This species resembles *Cancer productus* in general shape, texture, and tooth-cutting arrangement but can be differentiated easily by the following characters: 1) small spines on upper margin of movable finger and distal margin of manus; 2) sharp ridge joining cutting-teeth along their inner edge (teeth of *C. productus* are distinctly separated).

#### Description

*Manus*. Only distal one-fourth preserved. Upper margin with 2 large, coarsely granulate tubercles fused at base and raised high above the margin proximal to it: granules very coarse and sharp-pointed along upper margin and along distal margin, bordering the alveolus of the movable finger; becoming much finer proximally.

*Fixed finger*. Cutting teeth typically four: first tooth small, conical; second the largest, thick at base but sharp-edged; third and fourth similarly shaped, decreasing in size toward tip. Teeth connected by a sharp ridge along their inner edges, forming a

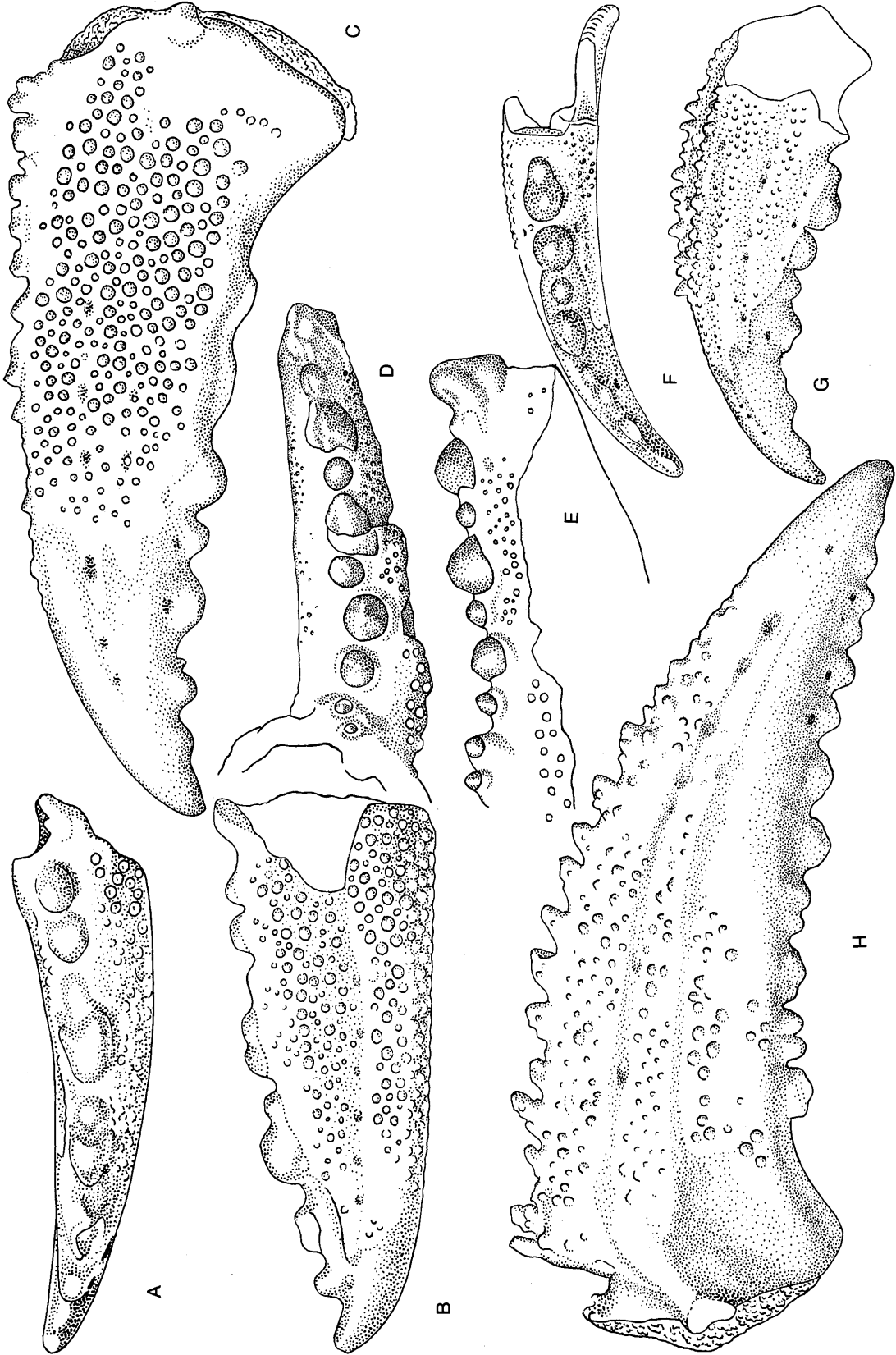


FIGURE 28. *Cancer coosensis*, paratypes, Miocene; A. and B. UCMP 14116, x 3; C. USNM 187692, x 4; D. and E. USNM 187692, x 4. *Cancer davidi*, hypotype, Miocene; F. and G. LACMIP 4427, x 5. *Cancer garthi*, holotype, Pliocene; H. UCMP 10743, x 4.

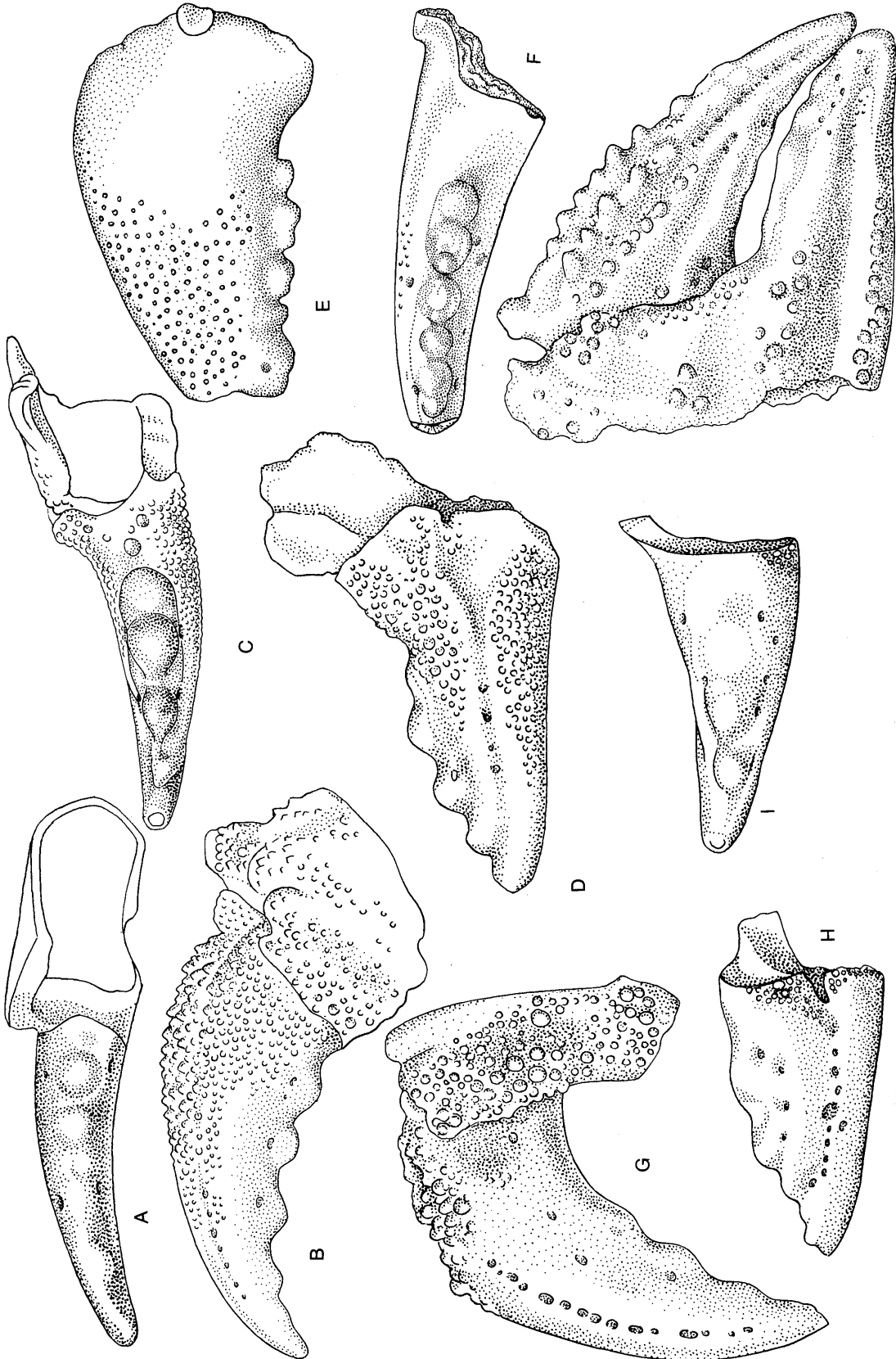


FIGURE 29. *Cancer chaneyi*, holotype, Pleistocene; A.-D. LACMIP 4436, x 3. *Cancer marri* paratype, Pliocene; E. and F. UCMP 10746, x 3. *Cancer allisoni*, holotype, Pliocene; G.-I. LACMIP 4434, x 3. *Cancer polyodon*, hypotype, Pliocene; J. LACMIP 4435, x 3.

bladellike edge, not distinctly separated at base as in *C. productus*. Outer surface with broad, coarsely granulate medial and lower ridges, separated by a very shallow groove with about 10 small pits in it. One small, round pit at base of teeth 2, 3 and 4. Lower edge broadly rounded, coarsely granulate, with a few small pits in a row, no groove. Inner surface concave, smooth in distal half, coarsely granulate in proximal half; medial and lower ridges not prominent, separated by a shallow groove with 6 or 8 small pits in a row; one pit at base of 2nd, 3rd and 4th teeth. Dense tip material extends about half the length of finger.

*Movable finger.* Cutting teeth typically four: first and second equal, conical; third and fourth elongate, sharp-edged, a pit at base of each. Outer surface broadly rounded, coarsely granulate in proximal half; granules gradually increasing in size from base of teeth to upper margin there forming small, scattered spines. A narrow groove paralleling upper margin in upper one-third of finger, a few pits along it. Upper margin narrow, with numerous small, thick spines scattered along it; inner edge relatively sharp. Inner surface smooth, densely and coarsely granulate in proximal half; a few pits in a row in center, one above each tooth.

This specimen was assigned to *Cancer productus* and figured by Menzies (1951:167-168). Description of paratype (USNM 353394).

*Carpus.* Upper surface bounded by a band of coarse granules: three high, granulated tubercles, the largest almost a spine and located near upper articulation, the other two arranged transversely, smaller and less sharp-pointed, the larger one nearer the lower margin; two irregular, granulated ridges extending proximally from these tubercles. Upper distal angle with a large triangular spine; inner angle with a rounded, granulated tubercle similar in size to the distal tubercle on the upper surface but not as sharp, a row of granules extending proximally to point of articulation with merus. Sharp granules rather uniformly distributed between tubercles and marginal bands, but tending to form transverse rows in proximal half. A reticulate pattern of dark bands around isolated white patches of carapace material readily observable, with granules restricted to the dark bands.

*Manus.* Outer surface with 7 carinae: first and second marked by 3 large, sharply granulated tubercles, the distal tubercles of each of these carinae joined to form a prominent elevation at the upper distal angle; third carina formed by alignment of enlarged granules superimposed on three transverse rows of smaller granules; fourth through seventh carinae marked by single rows of coarse granules, the transverse alignment dominant but with three

distinct, centrally located, longitudinal rows. The reticulate pattern also expressed in white and dark color as described on the carpus; granules rather uniform in size over surface except at upper and lower margins and on fixed finger.

*Fixed finger.* Moderately worn. Elongate and thick; three major cutting teeth and one small proximal tooth. Teeth joined by a sharp ridge along their inner sides forming a sharp edge. Outer surface coarsely granulate, largest granules along two carinae, one median and one lower. Setiferous pits above base of each major tooth plus a row just above each carina. Inner surface coarsely granulate; setiferous pits at base of each tooth, a row extending proximally from base of third tooth.

## Discussion

Rathbun (1926:61-62) tentatively identified a right carpus and manus, less movable finger (USNM 353394) as conspecific with the holotype of *C. urbanus*. The evidence for linking these two physically separated specimens is inadequate, and they should not be placed in the same species until there is positive evidence of their conspecificity.

Many specimens of movable and fixed fingers from various localities are morphologically similar to those of this cheliped and are assigned with it to the new species *Cancer chaneyi*.

## Occurrence

*Pleistocene.* Palos Verdes Formation: USNM 496181 (1 l.m.f., 2 r.m.f.); LACMIP 136 (1 r.m.f.); LACMIP 59 (1 r.m.f., 1 l.m.f.). Punta Descanso, Baja California: UCLA L-2716 (1 l.m.f., 2 l.f.f.). Timms Point Formation: LACMIP 130-7 (19 l.m.f., 7 l.f.f., 19 r.m.f., 12 r.f.f., 1 partial left cheliped with anterior of manus and both fingers that is Menzies' (1951) specimen of *C. productus*; LACMIP 130-4 (2 l.m.f., 2 l.f.f., 4 r.m.f., 3 r.f.f.). Lomita Marl: LACMIP 435 (14 l.m.f., 1 l.f.f., 8 r.m.f., 3 r.f.f.). San Pedro Formation: LACMIP 226 (1 l.m.f.).

*Pliocene.* Pico Formation: LACMIP 181 (3 l.m.f., 4 r.m.f., 1 r.f.f.); LACMIP 322 (1 l.f.f.). Pico (?) Formation: LACMIP 466 (20 l.m.f., 10 l.f.f., 7 r.m.f., 2 r.f.f.); UCMP 3030 (1 l.m.f., 1 r.m.f.); USNM 324300 (1 r.m.f., 1 l.f.f., occurred with holotype of *C. urbanus*). Rustic Canyon: (Pico (?) Fm) USNM 353394 (1 right carpus, 1 right manus, less m.f., tentatively identified as *C. urbanus* by Rathbun 1926:61-62); LACMIP 325 (7 l.m.f., 3 l.f.f., 6 r.m.f., 3 r.f.f.).

*Miocene.* Olcese Sand: LACMIP 463 (1 r.m.f., 1 r.f.f.).

*Summary.* Middle Miocene to Upper Pleistocene; San Joaquin Basin to Los Angeles area, California.

#### LOCALITY DESCRIPTIONS

Locality data for west coast American Recent Species

- AHF 1 — 1489-42, Cape Arago, Oregon.  
 AHF 2 — Cape Colnett, Baja California, Mexico.  
 AHF 3 — Acc. no. 633, Venice, California.  
 AHF 4 — 1656-48 Tomales Bay, California.  
 AHF 5 — 1806-49, Bodega Lagoon, California.  
 AHF 6 — Santa Barbara Island, California.  
 AHF 7 — 888-39, Monterey Bay, California.  
 AHF 8 — 1415-41, San Miguel Island, California.  
 AHF 9 — 895-38, Santa Barbara Island, California.  
 AHF 10 — Belmont Shore, California.  
 AHF 11 — San Diego Bay, California.  
 AHF 12 — 1488-42, Cape Arago, Oregon.  
 AHF 13 — 1592-47, Big Sur, California.  
 AHF 14 — 1447-42, Point Arguello, California.  
 AHF 15 — 1492-42, South Bay, Cape Arago, Oregon.  
 AHF 16 — 1251-41, Baja California, Mexico.  
 AHF 17 — P-19, Cedros Island, Baja California, Mexico.  
 AHF 18 — Yaquina Bay, Oregon.  
 AHF 19 — Charleston, Oregon.  
 AHF 20 — Anacortes, Washington.

Locality data for fossils and fossil deposits

*University of California,  
 Museum of Paleontology*

A-1487 Pleistocene, Pacific Beach, San Diego Quad, California.

A-1503 Lower Pleistocene, Lower San Pedro Formation, Nob Hill. Collected by T. S. Oldroyd. [1934 or 1935]

A-3101 Pleistocene, [Palos Verdes Fm?], Newport Beach Quad, California. 1/4" southwest of "N" in Newport Bay [map not identified]. About 10-20 feet below brow of palisade. Shell beds in loosely consolidated, cross-bedded, gray, coarse sand; below a buff-brown sandy clay. Collected by Stephen Bruff.

A-3166 Upper Pliocene, Etchegoin Formation, "Merriamaster coalingensis zone," La Cima Quad, Kings County, California, 1930, 1/24,000. NW/4, Sec 8, T 22 S, R 18 E. Class collection, April 1939.

A-3400 Pleistocene, Saugus Formation (?), Piru Quad, Ventura County, California. NE/4, SW/4, Sec 33, T 3 N, R 19 W. In bed of creek north of Somis. Collected by J. O. Nomland and E. M. Butterworth, May 1917.

A-6884 Middle Miocene, Monterey Formation, Woodhams shale member, Halfmoon Bay Quad, San Mateo County, California, 1961, 1/62,500. Sec 13, T 7 S, R 4 W. East of La Honda, on southwest side of Langley Hill. On roadcut to water reservoir for city of La Honda, within 100 yards of reservoir. [Collected by R. N. Hasher, January 1951. Probable age determination from locality data and geologic map in Cummings, Touring and Brabb (1962) plate 20, 1960.]

A-7586 Lower Pleistocene, San Joaquin Formation, *Pecten* zone, La Cima Quad, Kings County, California, 1930, 1/24,000. Sec 8, T 22 S, R 18 E, 700 feet west of east line of section, on boundary between NE/4 and SE/4. Same as locality 85, plate 3, USGS Prof. Paper 195. Class collection 1951.

A-8715 Lower Pliocene, Coos Conglomerate, Coos Bay Quad, Coos County, Oregon, 1900, 1/250,000. SW/4, SW/4, Sec 36, T 25 S, R 14 W. Fossils from well indurated conglomerate which is intraformational in Empire Formation. Class collection, September 1952.

A-9002 Pleistocene, Punta China, Baja California, Mexico. From outcrop about 20 feet above sea level on south side of Punta China, about 1 or 2 kilometers south of mouth of Rio de Santo Tomas. The outcrop is located above steeply dipping Middle Cretaceous green shales, the lowest beds of the Alisitos Formation exposed at Punta China. Collected by J. W. Durham, E. C. Allison, W. O. Addicott and W. K. Emerson, August 1952.

A-9587 Pleistocene, near Punta Cabras, Baja California, Mexico. U.S. Navy Hydrographic Chart, San Diego to Bahia San Quintin, 1945; 1/290,000; 31° 19' 03" N, 116° 26' 25" W. Terrace remnant 1/2 mile south of first point south of Punta Cabras. Collected from 4 foot thick, white coquina overlying alternating brown sandstone and pebble conglomerate of Upper Cretaceous. Fossiliferous strata forms a broad, white bench about 12 feet above sea level. Soil cover eroded away from the bench, but back from it is a 6 foot cover containing kitchen midden material. Collected by W. O. Addicott and W. K. Emerson, 7 February 1953.

A-9591 Pleistocene, Bahia Rosario, Baja California, Mexico. U.S. Navy Hydrographic Chart, San Diego to Bahia San Quintin, 1945; 1/290,000; 29° 57' 35" N, 115° 47' 15" W. About 1/4 mile east of A-9590. Collection from sea cliff at intersection of cliff and mouth of south trending ravine. Fossiliferous stratum 1-4 feet thick crops out 12 feet above sea level in face of cliff. Collected by W. O. Addicott and W. K. Emerson, 9 February 1953.

A-9595 Pleistocene, near Punta China, Baja California, Mexico. First rocky point south of first two

islands south of Punta China. Basal terrace material resting on slightly dipping Cretaceous sandstone and conglomerate; about 25 feet above sea level. Poorly sorted material including subrounded Cretaceous boulders up to 10 inches in diameter. Not very fossiliferous. Collected by W. O. Addicott and W. K. Emerson, 11 February 1952.

A-9733 Middle Pliocene, Etchegoin Formation, Priest Valley Quad, Kings County, California, 1944, 1/62,500, NW/4, Sec 24, T 21 S, R 13 E. Along state highway 198, 13 miles from Coalinga and 39 miles from San Lucas. First road cut east of junction Highway 198 and Coalinga Mineral Springs road, 200 yards east of Hot Springs Canyon bridge on Highway 198. Class collection, 21 October 1953.

B-3071 Pleistocene, San Quintin Bay, Baja California, Mexico. Highly fossiliferous, marly sand exposed in wave-cut bluff and in nearby old railroad bed excavation across San Quintin Bay at elevation of about 1 meter. North 45° east from south summit of Mt Mazo. Collected by E. C. Allison and W. K. Emerson, July 1956.

B-3090 Pleistocene, Punta Descanso, Baja California, Mexico. South side Punta Descanso, several miles south of Rosarito Beach. Terrace at elevation of approximately 65 feet, unconformably overlies reddish and greenish sediments and volcanics. Collected by E. C. Allison and W. K. Emerson, July 1956.

B-4752 Upper Miocene, Lower Briones Formation, Briones Valley Quad, Contra Costa County, California, 1949, 1/24,000. 1.65 miles due north of BM 585, about 500 feet due east of a 950 foot hill. Fossiliferous, very coarse, hard, pebbly, poorly sorted, ridge-forming, massive sandstone. Contains well-preserved echinoids, chiefly *Remondella gabbii* associated with *Astrodapsis brewerianus*. Collected by G. Doumani, Spring 1956.

B-4808 Upper Pliocene, Type Merced Formation, San Francisco South Quad, San Mateo County, California. T 3 S, R 6 W. On beach, 7000 feet north of Merced-Franciscan contact at Mussel Rock, 850 feet due west of triangulation point just west of Edgemar Road. Collected from massive, gray-blue, medium to fine-grained sandstone in cliff face. Collected by W. Glen, Fall 1956.

B-4941 Late Miocene, Neroly Formation, Tassajara Quad, Contra Costa County, California, 1953, 1/24,000. NE/4, NE/4, Sec 28, T 1 S, R 1 E, 40 feet west and 1240 feet south of northeast corner of section. At base of sandstone ridge, elevation 1220 feet. Collected by E. S. Oestereich, June 1957.

B-5046 Middle Pliocene, Etchegoin Formation, *Patinopecten* zone, La Cima Quad, Kings County, California, 1934, 1/31,680. Midpoint of western line

of Sec 16, T 22 S, R 18 E. Along north bank and near head of Arroyo Doblegado just below the midpoint of the west boundary of the section. Collected throughout about 35 feet of light brown, silty, medium to fine-grained, friable sandstone, half way up the north bank of this dry creek. Beds strike about N 45° W and dip 20° NE; the arroyo strikes about N 75° W. Class collection, October 1957.

B-6353 Pleistocene, Millerton Formation, Tomales Quad, Marin County, California, 1954, 1/24,000. North side of Tom's Point; gray, argillaceous siltstone, about 3 feet of which is exposed above level of beach; overlain by 10 to 15 feet of pebble conglomerate, probably conformably. Collected by E. C. Allison, May 1956.

B-6354 Pleistocene, Millerton Formation, Tomales Quad, Marin County, California, 1954, 1/24,000. North side Tom's Point; buff sandstone 10 feet stratigraphically above B-6353; probably lateral equivalent to pebble conglomerate. Collected by E. C. Allison, May 1956.

B-6355 Pleistocene, Millerton Formation, Tomales Quad, Marin County, California, 1954, 1/24,000. South side of Tom's Point; Middle of 20-30 foot thick gray, fine-grained sandstone to siltstone. Collected by E. C. Allison, May 1956.

B-6821 Middle Pliocene, Etchegoin Formation, Hernandez Valley, San Benito County, California, 1944, 1/62,500. Sec 26 (?), T 17 S, R 9 E, "Gooseberry Patch," Lone Ranch, San Benito District, California. Collected by C. J. Bleifus, 3 December 1936.

B-7345 Middle Pliocene, unnamed formation, Trinidad Quad, Humboldt County, California, 1952, 1/62,500. From base of bare vertical exposure on south side of steep spur which blocks access along beach to coasts north of Moonstone Beach. Collected by E. C. Allison, J. A. Wolfe and V. A. Zullo, February 1960.

B-7346 Equivalent to B-7345 but located on north side of same point. Contact with Franciscan basement visible at this locality. Same collectors and date.

B-7348 Middle Pliocene, unnamed formation, Trinidad Quad, Humboldt County, California, 1952, 1/62,500. Composite sample taken from fossiliferous, fine-grained, unconsolidated sand beds and lenses on side of west facing slope between 30 and 100 feet above beach level. Located immediately north of the point separating Moonstone Beach from the first cove north of it. Same collectors and date as B-7345.

B-7371 Middle Pleistocene, Elk River Formation, Cape Blanco Quad, Curry County, Oregon, 1954, 1/62,500. Sec 12, T 32 S, R 16 W; south 45° east of Cape Blanco and north 45° of Best Rock at head

of southern promontory of a large gully. Fossils from upper brown sandstone directly below a pebble conglomerate about 75 feet above beach level and 20 feet above a blue argillaceous sandstone. Collected by J. A. Wolfe and V. A. Zullo, March 1960.

B-7372 Middle Pleistocene, Elk River Formation, Cape Blanco Quad, Curry County, Oregon, 1954, 1/62,500. Sec 12, T 32 S, R 16 W, 20 feet stratigraphically higher than B-7371 along the head of the gully and immediately south of the gully. Lithologically the same as B-7371, same date and collectors.

B-7374 Middle Pleistocene, Elk River Formation, Cape Blanco Quad, Curry County, Oregon, 1954, 1/62,500. Sec 12, T 32 S, R 16 W, 500 feet south of main gully in Sec 12, in the conglomerate and sandstone near the base of the blue, argillaceous sandstone. About 30 feet above sea level, in upper conglomerate beds of the lower brown sandstone member of Wolfe and Zullo. Collected by J. A. Wolfe and V. A. Zullo, March 1960.

B-7379 Middle Pleistocene, Elk River Formation, Cape Blanco Quad, Curry County, Oregon, 1954, 1/62,500. Sec 12, T 32 S, R 16 W. Blue, argillaceous sandstone about 4 feet above beach level on the south side of the southernmost large gully in the cliff at the south end of Sec 12, about 100 feet from the south end of the cliff. Collected by J. A. Wolfe and V. A. Zullo, March 1960.

B-7380 Middle Pleistocene, Elk River Formation, Cape Blanco Quad, Curry County, Oregon, 1954, 1/62,500. Sec 18, T 32 S, R 15 W. Fossils from buff sandstone about 75 feet above beach in NS/4, NW/4 of Sec 18. Collected by J. A. Wolfe and V. A. Zullo, March 1960.

B-7727 Lower Pleistocene or Upper Pliocene, San Joaquin Formation, Coalinga Quad, Fresno County, California, 1956, 1/62,500. Somewhere in the San Joaquin Formation in the Kettleman Hills. Collected by A. C. Hall, date unknown, prior to 1955.

B-7880 Upper Pliocene, Scotia Bluffs Sandstone, Fortuna Quad, Humboldt County, California, 1942, 1/62,500. NW/4, NE/4, Sec 5, T 1 N, R 1 E. Bluff along northeast side of railroad tracks. Collected by W. Faustman, Jr., August 1961.

D-362 Upper Pliocene, Cascajo Conglomerate, La Cima Quad, Kings County, California, 1963, 1/24,000. 400 feet from west line and 1000 feet from north line of Sec 16, T 22 S, R 18 E. Crab found in massive, thick-bedded, bluish, pebbly, sandstone unit 30-40 feet thick, about 15 feet below crest of ridge, southeast of summit of El Rascador. No other fossils found. Collected by Tom Yancey, Fall 1967.

D-1138 Middle Pliocene, Etchegoin Formation, *Pseudocardium* zone, Reef Ridge Quad, Kings County, California, 1950, 1/24,000. Sec 1, T 23 S,

R 16 E, 150 feet from south line and 1530 feet from east line. From 6-inch thick, bluish-gray sand dollar bed composed of fine to medium-grained silty sandstone, and overlain by 5-foot, sand dollar bearing, bluish-gray sandstone. Some fossils from the latter are included in collection. Fossil bed is overlain by bluish-gray, coarse, conglomeratic sandstone. Collected by O. S. Adegoke, 1963.

D-1166 Middle Pliocene, Etchegoin Formation, Coalinga Quad, Fresno County, California, 1956, 1/24,000. Sec 29, T 19 S, R 15 E. From coarse-grained, dull greenish-brown, pebbly sandstone bed, about 20 feet thick. Upper 2 feet of unit is hard, concretionary sandstone. Collected by O. S. Adegoke, 1963.

D-1629 Pleistocene, San Diego, California. No other information.

D-3402 Upper Pliocene, Purisima Formation, Opal Cliffs, Capitola, Soquel Quad, Santa Cruz County, California, 1954, 1/24,000. Outcrop on beach at point of land at rear of second large cove northeast of junction of 41st Avenue and East Cliff Drive, 2-3 feet above beach. Collected by J. Marr, 1968.

D-3403 Upper Pliocene, Purisima Formation, Opal Cliffs, Capitola, Soquel Quad, Santa Cruz County, California, 1954, 1/24,000. Exposure near top of sea cliff at foot of 37th Avenue. Collected by J. Marr, 1968.

D-3799 Upper Pliocene, Merced Formation, San Francisco South Quad, San Mateo County, California, 1956, 1/24,000, T 3 S, R 5 W, 37° 37' 34" N. 122° 27' W. From road cut along east side of Gellert Blvd, at crossing of highest hill south of Twelve Mile Creek and adjacent to Junipero Serra Freeway at intersection of Gellert Blvd and the next east-west street south of Derry Way. Stratigraphically above beds with *Scutellaster interlineatus*, just below Lawson's (1895) "Upper Gastropod Bed;" at top of marine part of Merced. Collected by T. Yancey, 1968.

D-3800 Middle Miocene, Briones Formation, Mare Island Quad, Contra Costa County, California, 1951, 1/24,000, T 2 N, R 4 W. From Highway 40 roadcut at the intersection with Interstate 80, about 15 miles north of University of California, Berkeley campus.

D-3864 Miocene, Sobrante Formation, Walnut Creek Quad, Contra Costa County, California, 1959, 1/24,000. Behind the Hidden Valley Elementary School, 500 Glacier Drive, Martinez, California.

2047 Upper Pleistocene, Palos Verdes Formation, San Pedro, California, near lumber yard. Collected by F. C. Clark and J. J. Rivers, 1912.

3030 Upper Pliocene, Pico Formation (?), Los Angeles, California. Exposed in excavation for the



Broadway Department Store, corner 4th and Hill Streets, 34 feet below surface. Collected by J. Z. Gilbert, 1913.

3624 Upper Pliocene, San Diego Formation, Pacific Beach, La Jolla Quad, California. Collected by E. L. Packard, 1914.

7095 Pleistocene, Saugus Formation, Santa Paula Quad, Ventura County, California. From bluff on east side of Santa Paula Canyon, 1.5 miles north of Santa Paula. Collected by L. N. Waterfall, prior to 1929.

7100 Upper Pliocene, Pico Formation, Ventura County, California. Northwest corner Sec 3, T 2 N, R 21 W, due east of farmhouse. Collected by L. N. Waterfall, prior to 1929.

*Natural History Museum of Los Angeles County*

34 Upper Pliocene, [Pico Formation], Santa Barbara, California. In a street cut at the southwest end of Victoria Street, city of Santa Barbara. Collected by A.M. Strong, August 1930.

59 Upper Pleistocene, Palos Verdes Sand, "fossiliferous stratum, from eight to twelve inches thick in most places...mainly from two to four feet below the present surface...at a point just south of the...Los Angeles Outfall Sewer...during widening of Lincoln Avenue, which crosses the outfall sewer about two miles northeast of Playa del Rey" (Willett 1937: 381), City of Los Angeles, Los Angeles Co, California. Collected by George Willett, 1935-36.

62 Lower Pleistocene, [Timms Point Silt], Timms Point, San Pedro, Los Angeles Co., California. From 2-3 feet above rock and clay layer. Collected by G. Willett, 1939.

66-1 Upper Pleistocene, Palos Verdes Sand, Newport Bay Mesa, Orange County, California. Locality in Dry Creek, 1/2 mile southeast of the salt reducing plant of Irving Company at tip of the Newport Estuary. A creek with 8 gullies running into it; result of erosion exposing numerous outcrops of Palos Verdes Sand from 2-17 feet thick, gullies named in succession 66-1 to 66-9. Collected by G. P. Kanakoff, 1945.

66-2 (See 66-1 above.)

130-4 Lower Pleistocene, Timms Point Silt, San Pedro, Los Angeles Co., California. Along the railroad tracks at Fisherman's Slip, Berth 79. Collected by G. P. Kanakoff, 8 July 1947.

130-7 (See 130-4 above.)

131 Lower Pleistocene, San Pedro Formation, San Pedro, California. A street cut on north side of 500 block on North Pacific Avenue. The stratum 10-20 feet above street level, sand bed 2-10 feet thick.

136 Upper Pleistocene, Palos Verdes Sand, New-

port Bay Mesa, Orange Co., California. Stratum from 14-22 feet thick over 500 feet along "Anomia bed," 15 feet below level of airfield and about 87 feet above water level. Collected by G. P. Kanakoff, 16 October 1947.

142-b Lower Pleistocene, [San Pedro Formation], Second and Orizaba Streets, Long Beach (?), Los Angeles Co., California. Collected by LACMIP party, 1915-16.

181 Upper Pliocene, Pico Formation, Santa Barbara, California. At crossing of Cabrillo and Castillo Streets, Santa Barbara, California. Collected by G. P. Kanakoff, 22 February 1950.

183-b Upper Pliocene, [Pico Formation], Santa Barbara, California. Exposure 1/4 mile east of main building of Santa Barbara General Hospital, Santa Barbara, California. Collected by G. P. Kanakoff, 22 February 1950.

226 Lower Pleistocene, San Pedro Formation, San Pedro, California. Eighth Street and Palos Verdes Street. Collected by G. P. Kanakoff, 29 December 1951.

227 Upper Pleistocene, Palos Verdes Sand, San Pedro, California. Stratum 7 feet above Gaffey Avenue street level at corner Gaffey Avenue and General Avenue. Collected by G. P. Kanakoff, 29 December 1951.

228 Lower Pleistocene, Lower San Pedro Formation, Nob Hill (lumber yard) northeast of San Pedro, Los Angeles Co., California. Collected by T. S. Oldroyd, 1924.

229 Upper Pleistocene, Palos Verdes Sand. West of Anaheim Street—south of its intersection with Normandie Avenue, Harbor City, Los Angeles, Los Angeles Co., California. Collection of Edna Cook.

300 Lower Pleistocene, San Pedro Sand. Mixed localities in San Pedro, Los Angeles Co., California. Collected 1925-1927.

305 Upper Pliocene, San Diego Formation, hills south of Tia Juana River, San Diego Co., California.

305-c Upper Pliocene, San Diego Formation, hills south of Tia Juana River, San Diego Co., California. Collected by G. P. Kanakoff.

322 Upper Pliocene, [Pico Formation], Santa Barbara, California. On Cathedral Oaks Road (formerly Foothill Boulevard), past the county dump on the right side of the road. Collected by G. P. Kanakoff, 3 March 1962.

325 Lower Pleistocene, Rustic Canyon, Pacific Palisades, Los Angeles, Los Angeles Co., California. 210 yards north of intersection Sunset Blvd and Pacific Palisades Road; fossils in 100 foot bluff. Collected by Mrs. Faye Howard, July 1958.

332 Lower Pleistocene, San Pedro Formation, 600 block Miraflores Avenue near junction of Pacific Avenue, San Pedro, Los Angeles Co., California.

435 Lower Pleistocene, Lomita Marl, San Pedro, Los Angeles Co., California. Forty feet long exposure on south side of gully at crossing of 1200 Park Western Drive, 1200 West Caralmount Drive and Host Place (1100 Host Place). Exposure is 35 feet below Host Place level. Collected by G. P. Kanakoff, 16 February 1965.

440 Upper Pleistocene, Palos Verdes Sand, San Pedro, Los Angeles Co., California. Material from excavation at southeast corner of North Pacific Avenue and Hards Street in San Pedro, collected at the approaches to Vincent Thomas Bridge connecting San Pedro and Terminal Island. Collected by G. P. Kanakoff, 6 April 1965.

449 Upper Pliocene, San Diego Formation, Playa Tijuana, Baja California, Mexico. Exposure along highway between Tijuana and Ensenada, 4.5 miles south of "bull ring" in Tijuana; about 50' above and 50' away from road on south side of hill with twin power line poles. Prominent ledge of shells with *Pecten dilleri*, collected 5 July 1965.

456 Lower-Middle Miocene, Round Mountain Silt, Rio Bravo Ranch Quad, Kern County, California, 1954, 1/24,000. 700 feet east and 600 feet north of southwest corner Sec 6, T 29 S, R 30 E.

463 Middle Miocene, Olcese Sand, Rio Bravo Ranch Quad, Kern County, California, 1954, 1/24,000. 750 feet south and 70 feet east of northwest corner, Sec 33, T 28 S, R 29 E, at the fence of Barker Ranch.

466 Upper Pliocene, Fernando Formation, Los Angeles, California. 6th Street and Hope Street, downtown Los Angeles excavation for Crocker Citizens Plaza Building.

4394 Pliocene, Etchegoin Formation, San Benito, California. San Benito River bed. [Exact locality unknown.]

*University of California, Los Angeles*

L-667 Upper Pleistocene, [Palos Verdes Formation], Playa del Rey, Los Angeles, California. Fossil horizon exposed along cliffs near Loyola College. Collected by Miss Bowen, Summer 1935.

L-1055 Pleistocene, San Pedro, California. Second and Beacon Streets. Class collection 1938.

1096 Upper Pliocene, Pico (?) Formation, upper part, T. T. Co, Olive Community no 1 well, NW/4, Sec 7, T 4 S, R 9 W, 3150 feet depth, Los Angeles Basin, California.

2411 Pleistocene, San Quintin Bay, Baja California, Mexico. Soft, fossiliferous sands cropping out on west face of low bluff on east side San Quintin Bay, about 1/2 mile north of small abandoned cemetery and just south of former site of village of San Quintin. Collected by W. P. Popenoe, February 1949.

L-2413 Upper Pleistocene, [Palos Verdes Formation], Playa del Rey, Los Angeles, California. Road cut 200 yards south and 100 feet east of intersection of Lincoln and Jefferson Boulevards, Baldwin Hills.

L-2716 Pleistocene, Punta Descanso, Baja California, Mexico.

2825 Pleistocene, San Pedro Formation, San Pedro, California.

L-3486 "Pliocene" [Lower Pleistocene], San Joaquin Formation, *Pecten* zone, Canoas Creek Quad, Fresno County, California, USGS 1950. 1900 feet north and 2100 feet west of southeast corner Sec 28, T 21 S, R 17 E. Collected by Takeo Susuki, April 1956.

3605 Upper Pleistocene, [Palos Verdes Formation], Sunset Cliffs, Point Loma, Point Loma Quad, San Diego County, California. Terrace sand with cobbles and boulders exposed in building site at end of Sunset Cliffs Street, about 1/4 mile south of Ladera Street. Collected by Carl Hubbs and Theodore McCown, winter 1957.

4853 Upper Pleistocene, "Rustic Canyon Marine," Los Angeles, California. Loose, pebbly, fine sand overlying Timms Point Formation (Lower Pleistocene). From upper part of bank behind residence at 606 Hightree Road. Collected by J. T. McGill, 27 March 1960.

5264 Upper Pleistocene, probable Palos Verdes Fauna, Parker Mesa, Los Angeles Co., California. From gully near top of steep bluff above Pacific Coast Highway, about 2500 feet east of Topanga Canyon Boulevard intersection. Shell breccia in pebbly, fine, sandy matrix occupying small pocket about 12-13 feet above base of marine terrace deposits and approximately 163 feet elevation. Collected by J. T. McGill, 9 June 1961.

6827 Pleistocene, Deadman Island, San Pedro, California.

*United States Geological Survey*

M913 Lower Pliocene, San Lucas Quad, California. Collected by David L. Durham, 1958-1959.

M1012 Pleistocene, unnamed formation, Bandon Quad, Oregon. NW/4, SW/4, Sec 36, T 28 S, R 15 W. Gray, unconsolidated sands along south side of sea cliff. Collected by J. Wolfe, May 1960.

M1611 Middle Miocene, Round Mountain Silt, Rio Bravo Ranch Quad, Kern County, California, 1954, 1/24,000. Bottom of gully 2,050 feet north from southwest corner of Sec 6, T 29 S, R 30 E. Collected by W. O. Addicott, July 1962.

18284 Middle (?) Miocene, Coos Bay, Oregon. Dredged from the channel adjacent to North Spit, from "mile 3.5 to mile 4.0." Collected by E. James, 1949-1950.

M2022 Upper Pliocene, Elk River Formation, Cape Blanco Quad, Curry Co., Oregon. 200 feet west of southeast corner. Sec 12, T 32 S, R 16 W; 10 foot bed of fossiliferous, fine-grained sand in sea cliff, above mouth of Elk River. About 30 feet stratigraphically above water saturated, massive bluish gray clay. Collected by W. O. Addicott, November 1958.

*San Diego Society of Natural History*

L56 Upper Pleistocene, [Palos Verdes Formation], Spanish Bight, San Diego, California.

L2419 Pleistocene, Point Loma, San Diego, California.

*California State University, San Diego*

32 Pliocene, San Ysidro Quad, California. Collected by J. P. Dwyer, 1961.

86 Pleistocene, Sunset Cliffs, Point Loma, California.

230 Pliocene, San Diego Formation, La Jolla Quad, California, 32° 48' 40" N, 117° 13' 50" W.

234 Plio-Pleistocene, Timms Point, San Pedro, California. Bottom terrace. Collected by E. P. Chase, 1950.

446 Pliocene, Cantil Costero Formation, Baja California, Mexico. Map—Lower California Guidebook map 1, scale 1" = 12 miles, 31° 32' 26" N, 116° 31' 24" W.

Catalog Entries

*National Museum of Natural History (USNM)*

165477 Middle Pliocene, Etchegoin Formation, (near base), Fresno County, California. Near Henry Spring on east face of a 1900 foot hill, four miles south of Coalinga. Collected by Ralph Arnold, prior to 1908.

324300 Upper Pliocene, [Pico (?) Formation], Los Angeles, California. In blue clay associated with large number of marine shells and is same formation that crops out on south side of Hill Street hills at 4th Street and Broadway; unconformably underlies fresh water gravel, sand and boulders, dip about 35°.

353380 Upper Pleistocene, [Palos Verdes Formation], Spanish Bight, San Diego Bay, California.

353381 Pleistocene, San Pedro, California.

353382 Pleistocene, Rincon del Potrero, Santa Monica, California.

353383 Pleistocene, (Palos Verdes Formation), Spanish Bight, San Diego Bay, California.

353384 Pleistocene, Lower San Pedro Formation, Nob Hill (lumber yard), northeast of San Pedro, California.

353385 Pleistocene, Lower San Pedro Formation, Nob Hill (lumber yard), northeast of San Pedro, California.

353386 Pleistocene, Rincon del Potrero, Santa Monica, California.

353387 Pleistocene, Deadman Island, southeast of San Pedro, California.

353388 Pleistocene, Lower San Pedro Formation, Nob Hill (lumber yard), northeast of San Pedro, California.

353389 Pleistocene, Lower San Pedro Formation, Nob Hill (lumber yard), northeast of San Pedro, California.

353390 Pleistocene, Rincon del Potrero, Santa Monica, California.

353391 Pleistocene, Rincon del Potrero, Santa Monica, California.

353392 Pleistocene, "Lava Beds," San Quintin Bay, Baja California, Mexico.

353393 Pleistocene, Lower San Pedro Formation, Nob Hill, (lumber yard), northeast of San Pedro, California.

353394 Upper Pliocene, Rustic Canyon, Santa Monica, California. Collected by D. F. Clark.

353594 Upper Pleistocene, Upper San Pedro Formation [Palos Verdes Formation], Signal Hill, northeast of Long Beach, California.

372800 Pleistocene, Point Loma, California. "Coal mine" on ocean shore of Point.

372801 Upper Pleistocene, [Palos Verdes Formation], Spanish Bight, San Diego Bay, California.

372802 Upper Pleistocene, [Palos Verdes Formation], Spanish Bight, San Diego Bay, California.

496170 Upper Pleistocene, Upper San Pedro Formation [Palos Verdes Formation], Deadman Island, southeast of San Pedro, California.

496177 Upper Pleistocene, Upper San Pedro Formation [Palos Verdes Formation], Deadman Island, southeast of San Pedro, California.

469181 Upper Pleistocene, Upper San Pedro Formation, [Palos Verdes Formation], Deadman Island, southeast of San Pedro, California.

496241 (Same as above.)

496485 Upper Pleistocene, Upper San Pedro Formation [Palos Verdes Formation], San Pedro, California.

496502 Middle Pliocene, Etchegoin Formation, North Dome, Kettleman Hills, California.

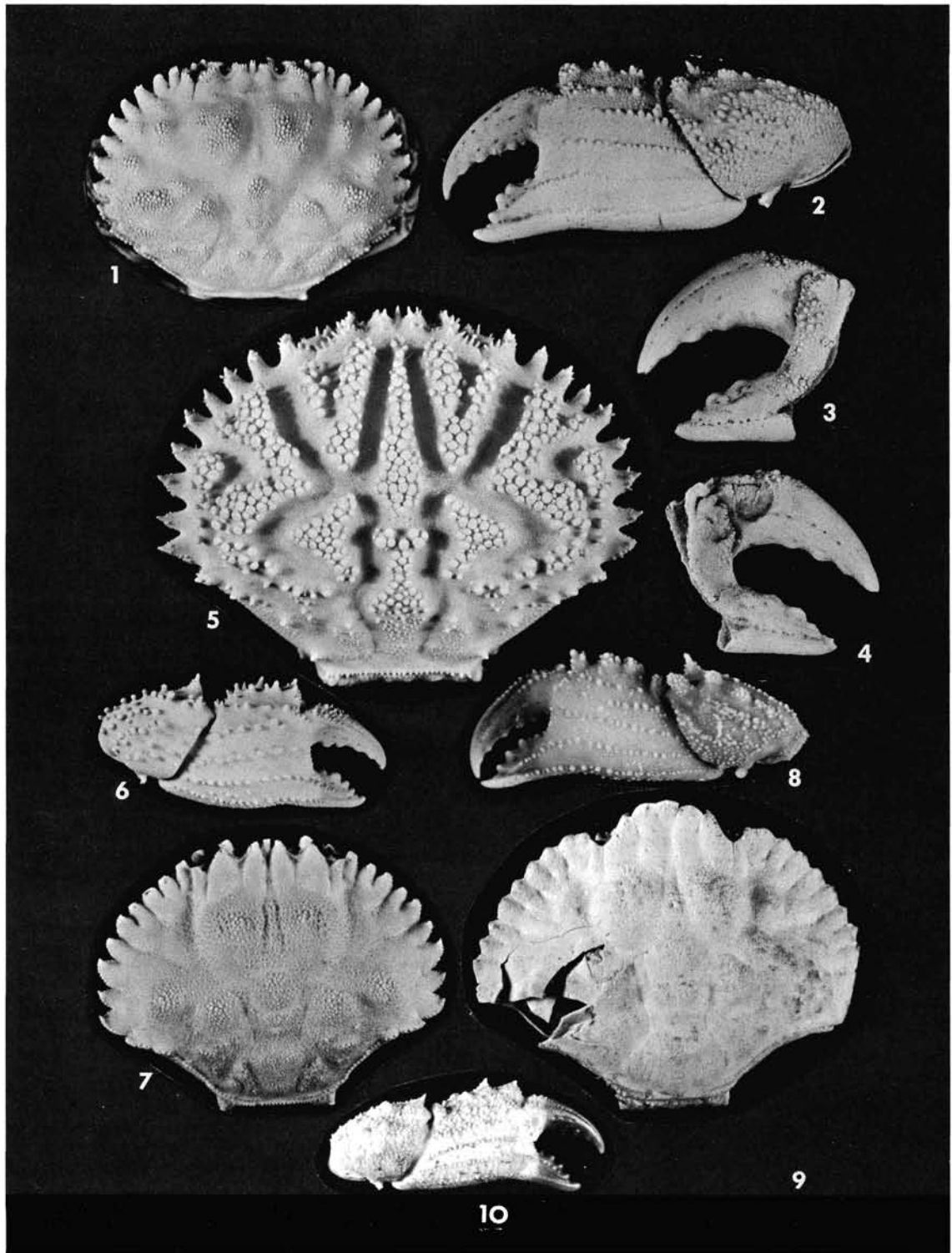


FIGURE 30. *Cancer oregonensis* Rathbun, Recent, hypotype, UCMP 10733; 1. carapace, dorsal view, x 2.4; 2. left cheliped, outer view, x 4. *Cancer allisoni* new species, Pliocene, holotype LACMIP 4434; 3. left manus, outer view, x 2; 4. left manus, inner view, x 2. *Cancer balssi* Sakai, Recent, hypotype, UCMP 10736; 5. carapace, dorsal view, x 3.2; 6. right cheliped, outer view, x 2.4. *Cancer amphioetus* Rathbun, Recent, hypotype, UCMP 32709; 7. carapace, dorsal view, x 4.1; 8. left cheliped, outer view, x 6.5. *Cancer tumifrons* Yokoya, Recent, hypotype, UCMP 10754; 9. carapace, dorsal view, x 3.4; 10. right cheliped, outer view, x 3.4.

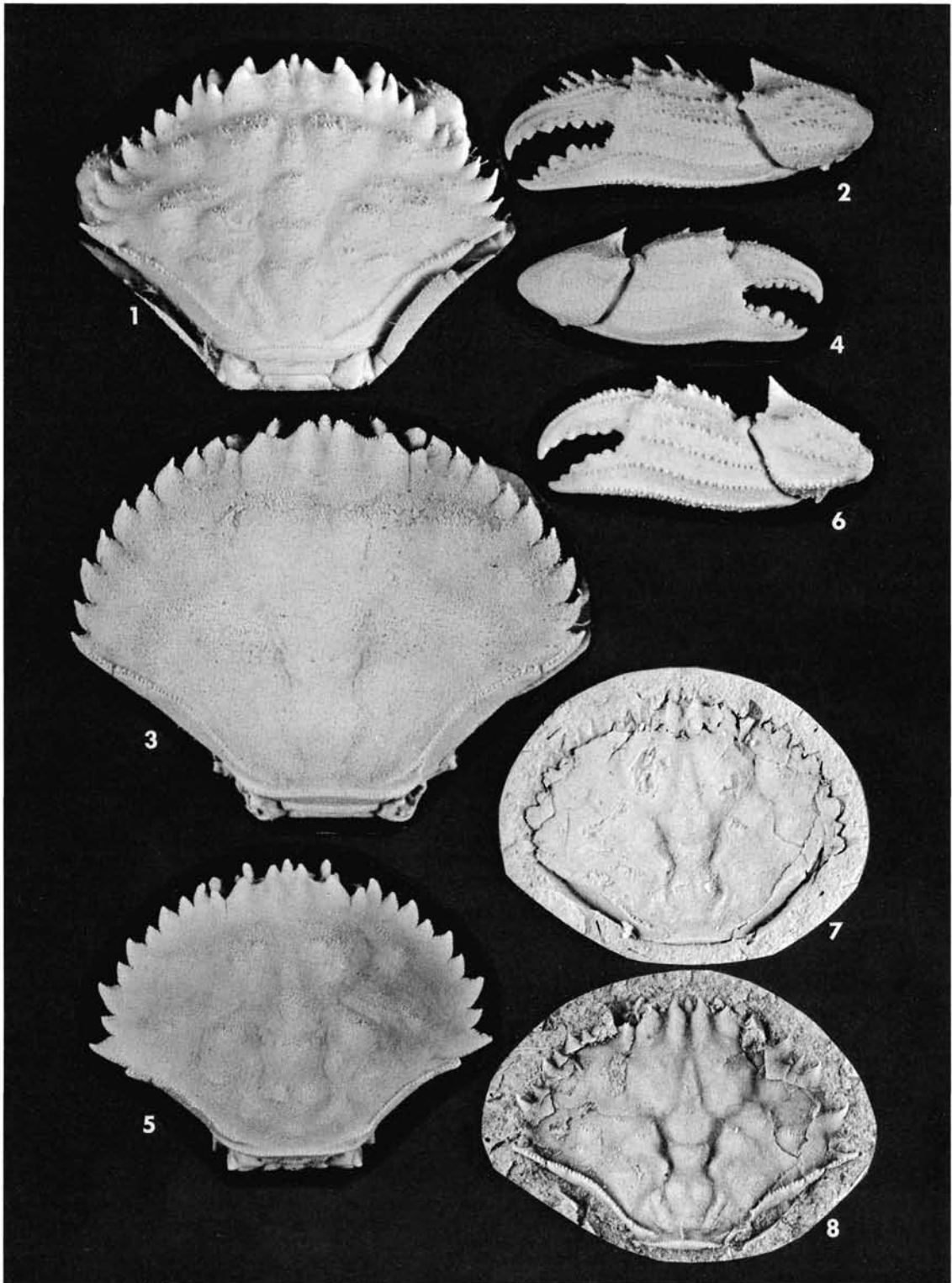


FIGURE 31. *Cancer branneri* Rathbun, Recent, hypotype, UCMP 10756; 1. carapace, dorsal view, x 5; 2. left cheliped, outer view, x 3.9. *Cancer jordani* Rathbun, Recent, hypotype, UCMP 10731; 3. carapace dorsal view, x 3.6; 4. right cheliped, outer view, x 3.2. *Cancer gibbosulus* Rathbun, Recent, hypotype, UCMP 10787; 5. carapace, dorsal view, x 3.7; 6. left cheliped, outer view, x 4.6. *Cancer dereki* new species, Miocene, holotype, UCMP 10741; 7. carapace, internal mold, dorsal view, x 3; 8. rubber cast of external mold of carapace, x 3.



FIGURE 32. *Cancer dereki* new species, Miocene, paratype, UCMP 10753; 1. internal mold of carapace, dorsal view, x 2.1. *Cancer yanceyi* new species, Pleistocene, holotype, UCMP 10742; 2. right manus, outer view, x 2; 3. right manus, upper view, x 2. *Cancer urbanus* Rathbun, Pliocene, holotype, USNM 234300; 4. carapace, dorsal view, x 1.8. *Cancer antennarius* Stimpson, Recent, hypotype, UCMP 32092; 5. carapace, dorsal view, x 1.7; 6. left cheliped, outer view, x 2.

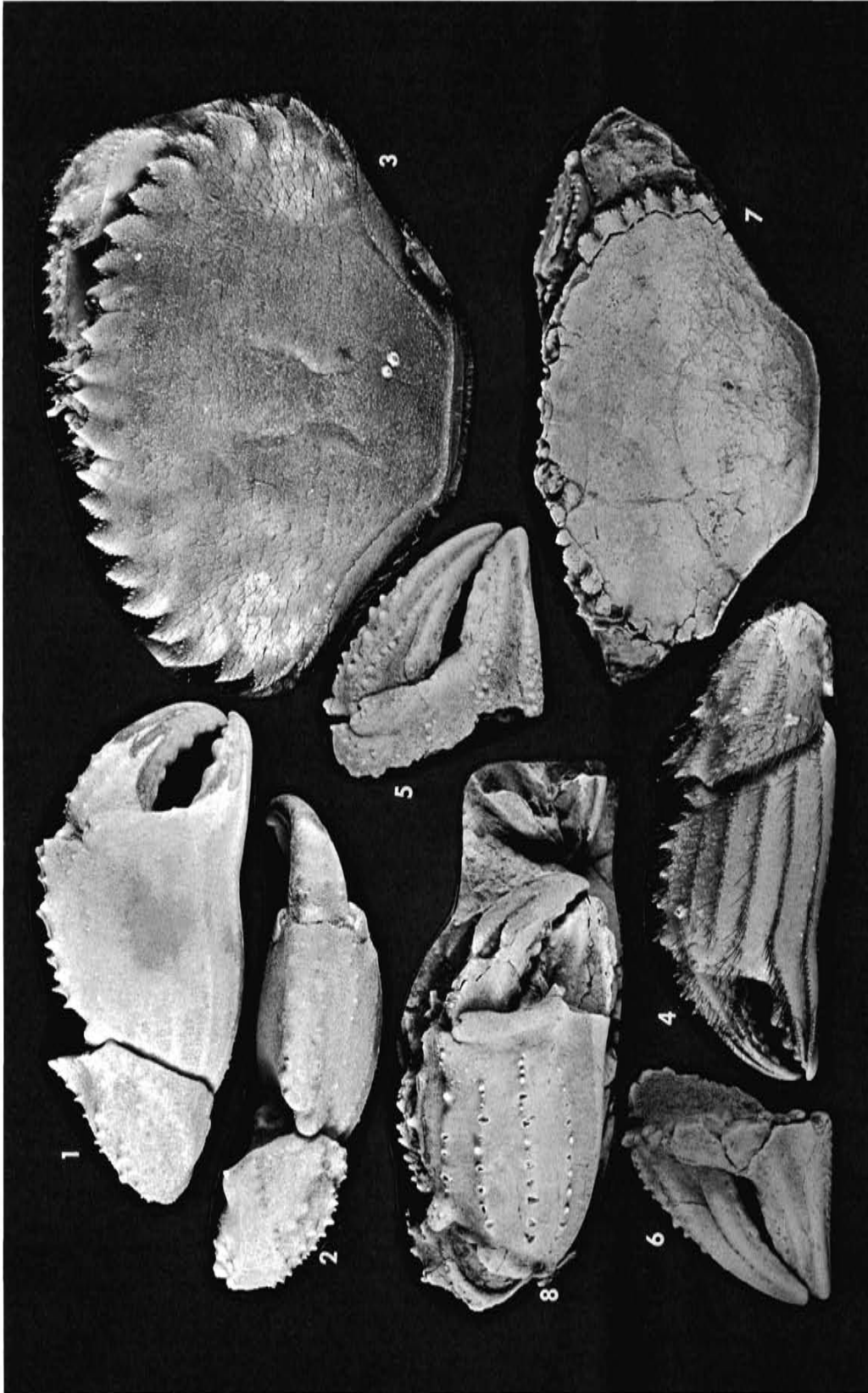


FIGURE 33. *Cancer polyodon* Poeppig, Pleistocene, AHF 5622; 1. right cheliped, outer view, x .9; 2. right cheliped, outer view, x .9; Recent, hypotype, AHF 358; 3. carapace, dorsal view, x 1.5; 4. left cheliped, outer view, x 1.5; 5. right manus, outer view, x 2.1; 6. right manus, inner view, x 2.1. *Cancer granti* Rathbun, Pliocene, holotype, UCLA 1096; 7. carapace, dorsal view, x 1.6; 8. right cheliped, outer view, x 2.4.

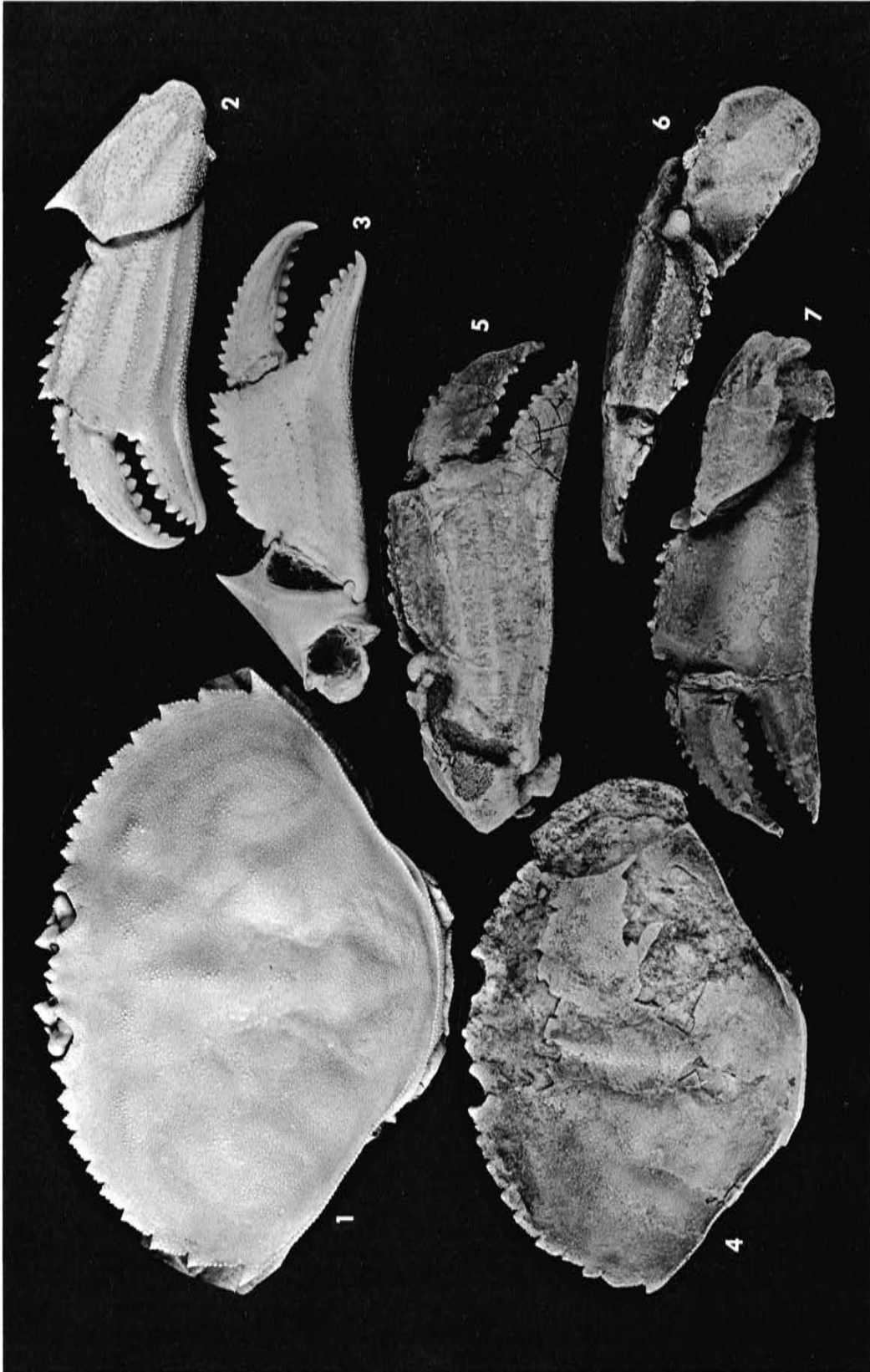


FIGURE 34. *Cancer magister* Dana. Recent, hypotype, UCMP 10732; 1. carapace, dorsal view, x 1.3; 2. left cheliped, outer view, x 1.7; 3. left cheliped, inner view, x 1.7. *Cancer danai* new species, Miocene, holotype, UCMP 10740; 4. carapace, dorsal view, x 1.7. *Cancer durhami* new species, Pliocene, holotype, UCMP 10744; 5. right cheliped, upper view, x 1.5; 6. right cheliped, inner view, x 1.5.



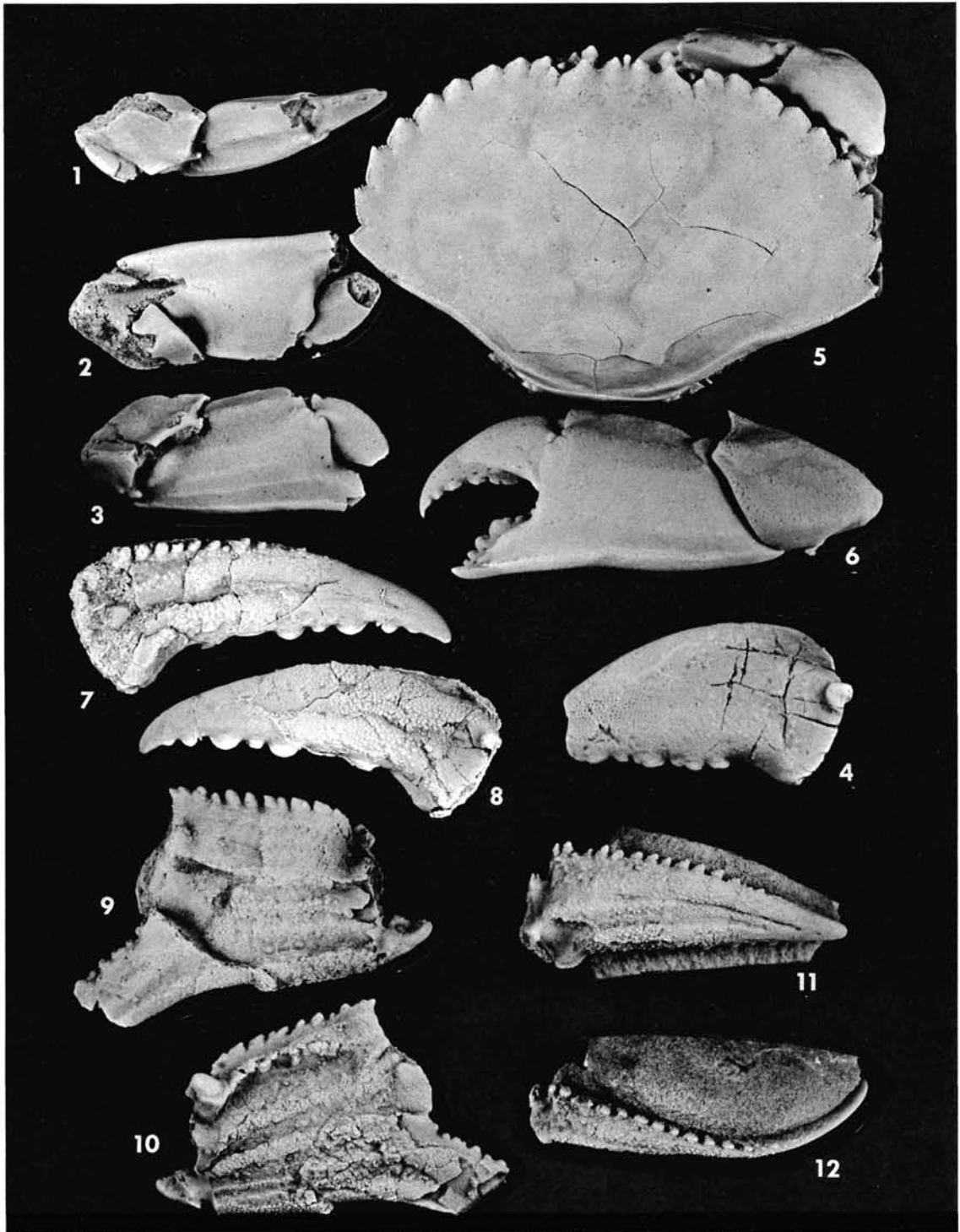


FIGURE 35. *Cancer marri* new species, Pliocene, holotype, UCMP 10739; 1. right cheliped, upper view, x 2.5; 2. right cheliped, inner view, x 2.5; 3. right cheliped, outer view, x 2.5; Pliocene, paratype, UCMP 10746; 4. left movable finger, outer view, x 2.3. *Cancer anthonyi* Rathbun, Recent, hypotype, UCMP 11390; 5. carapace, dorsal view, x 1.6; 6. left cheliped, outer view, x 2.4. *Cancer coosensis* new species, Miocene, paratype, USNM 170553; 7. left movable finger, inner view, x 2.2; 8. left movable finger, outer view, x 2; Miocene, holotype, USNM 170552; 9. right manus, inner view, x 2.2; 10. right manus, outer view, x 2.2. *Cancer garthi* new species, Pliocene, holotype, UCMP 10743; 11. right movable finger, outer view, x 1.8; 12. right movable finger, upper view, x 1.8.

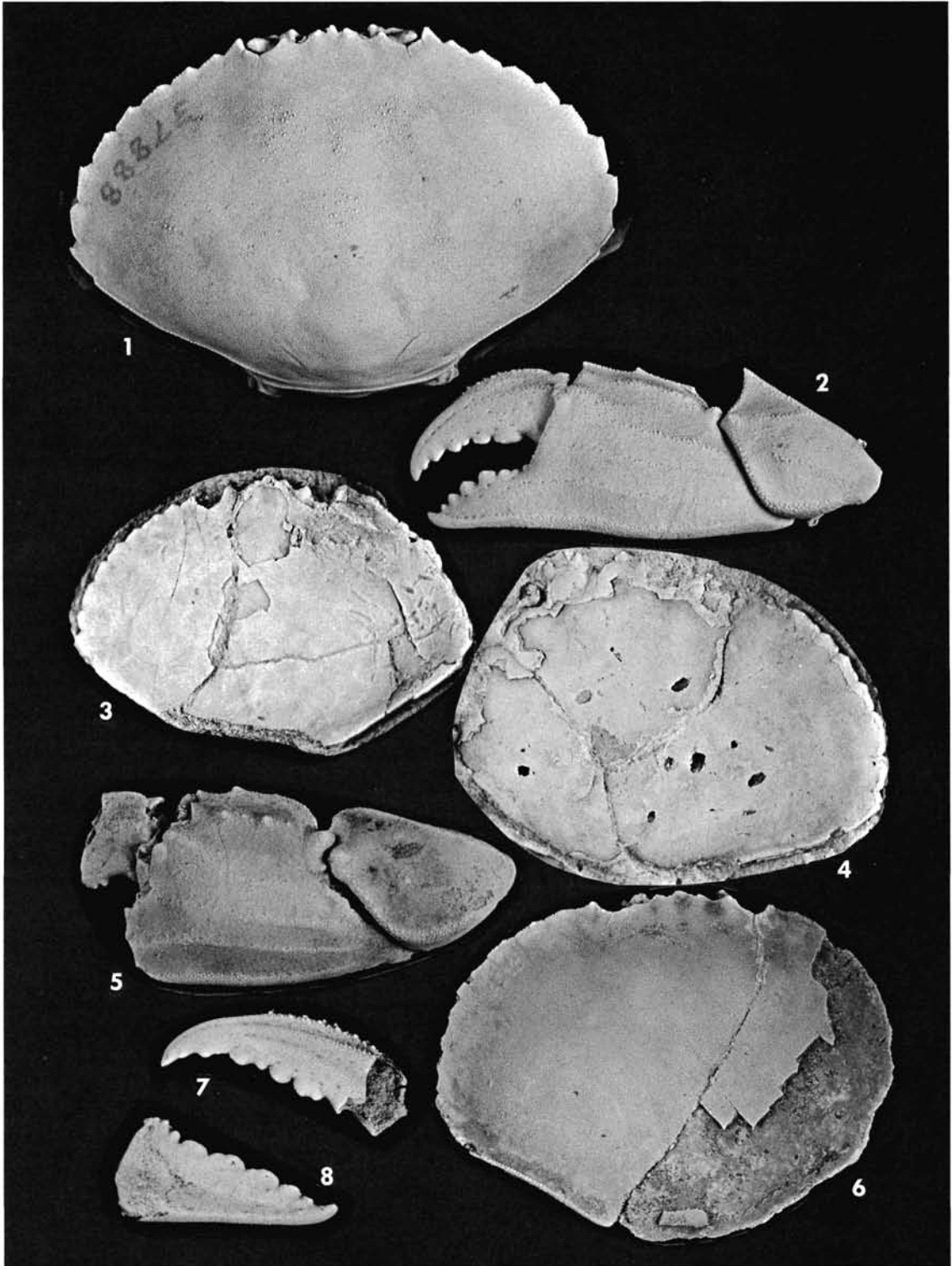


FIGURE 36. *Cancer gracilis* Dana, Recent, hypotype, UCMP 37888; 1. carapace, dorsal view, x 2; 2. left cheliped, outer view, x 2.6. *Cancer jenniferae* new species, Pliocene, holotype, UCMP 10745; 3. carapace, dorsal view, x 2.5; 4. carapace, inner view, x 2. *Cancer davidi* Nations, Pliocene, holotype, UCMP 37889; 5. left cheliped, outer view, x 3.1; 6. carapace, dorsal view, x 1.9; Miocene, hypotype, LACMIP 4427; 7. left movable finger, outer view, x 3.2; 8. right fixed finger, outer view, x 4.8.

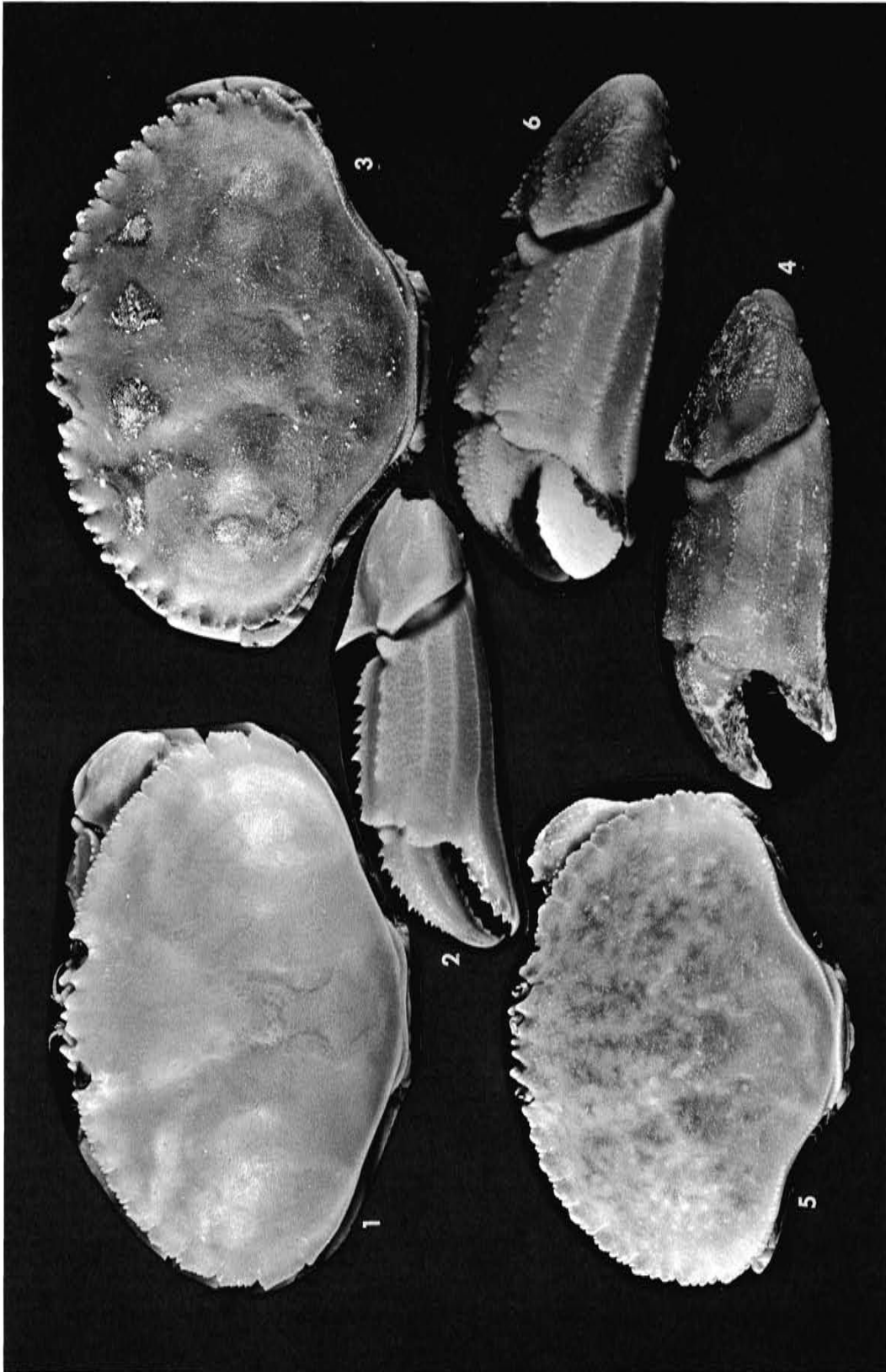


FIGURE 37. *Cancer plebejus* Poëppig, Recent, hypotype, AHF 3822; 1. carapace, dorsal view, x 1.7; 2. left cheliped, outer view, x 2.4. *Cancer edwardsii* Bell, Recent, hypotype, USNM 81042; 3. carapace, dorsal view, x 1.5; 4. left cheliped, outer view, x 2.4. *Cancer novaezealandiae* (Jacquinot and Lucas), Recent, hypotype, UCMMP 141118; 5. carapace, dorsal view, x 1.6; 6. left cheliped, outer view, x 2.7.

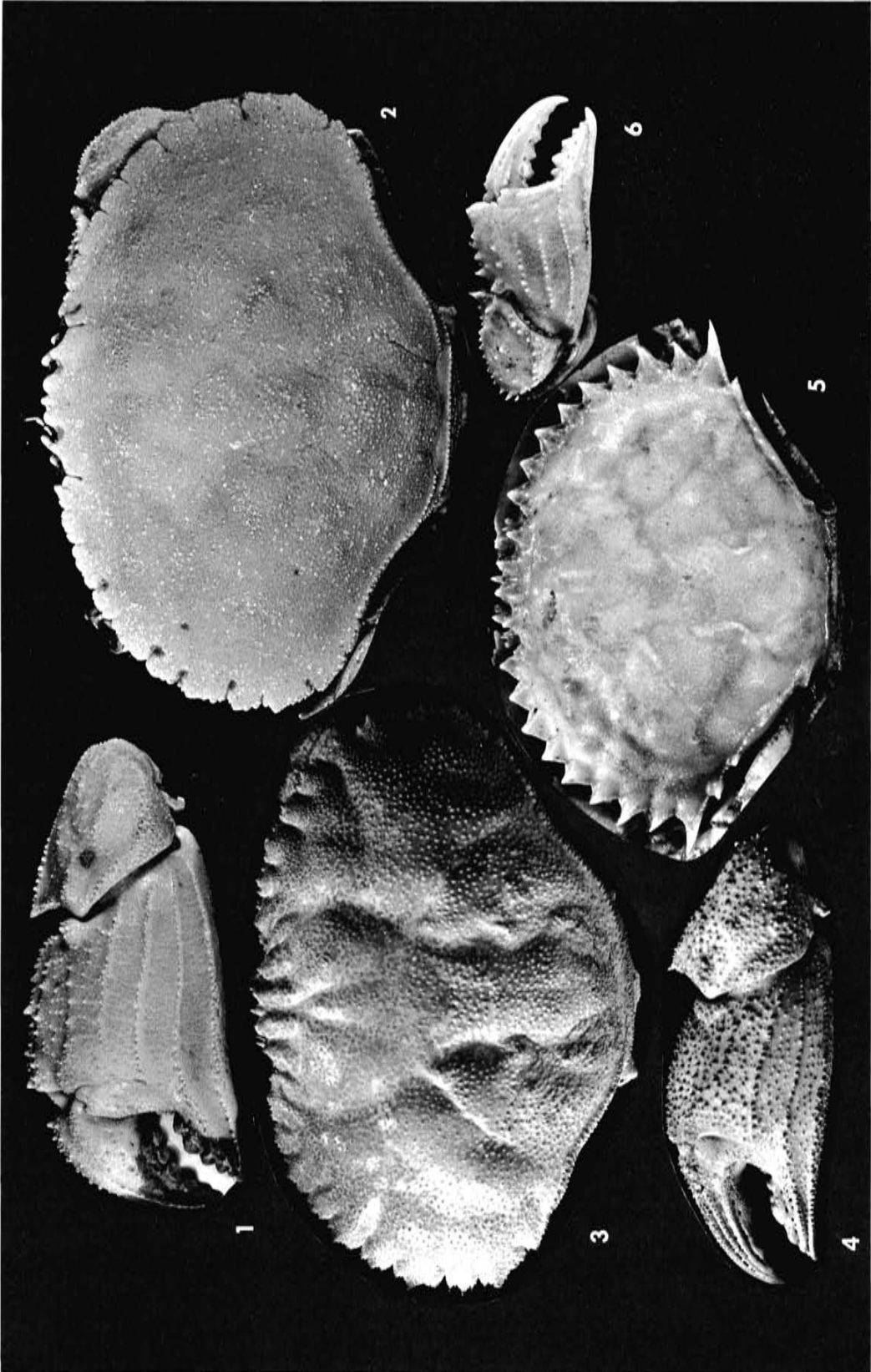


FIGURE 38. *Cancer bellianus* Johnson, Recent, hypotype, BMNH 1972:532; 1. left cheliped, outer view, x 1; 2. carapace, dorsal view, x 7. *Cancer borealis* Stimpson, Recent, hypotype, USNM 78530; 3. carapace, dorsal view, x 1; 4. left cheliped, outer view, x 1.2. *Cancer nadaensis* Sakai, Recent, holotype, USNM 125871; 5. carapace, dorsal view, x 2; 6. right cheliped, outer view, x 2.



FIGURE 39. *Cancer productus* Randall, Recent, hypotype, UCMP 10734; 1. carapace, dorsal view, x 1.5; 2. left cheliped, outer view, x 2.2. *Cancer chaneyi* new species, Pleistocene, holotype, LACMIP 4436; 3. left manus, inner view, x 1.9; 4. left manus, outer view, x 1.9; Pliocene, paratype, USNM 353394; 5. right carpus, outer view, x 1.7; 6. right manus, outer view, x 1.6; 7. right cheliped, inner view, x 1.6; 8. rubber cast of external mold of right cheliped, upper view, x 1.5. *Branchiolambrus altus* Rathbun, Miocene, holotype, USNM 165478; 9. carapace, dorsal view, x 3.4.

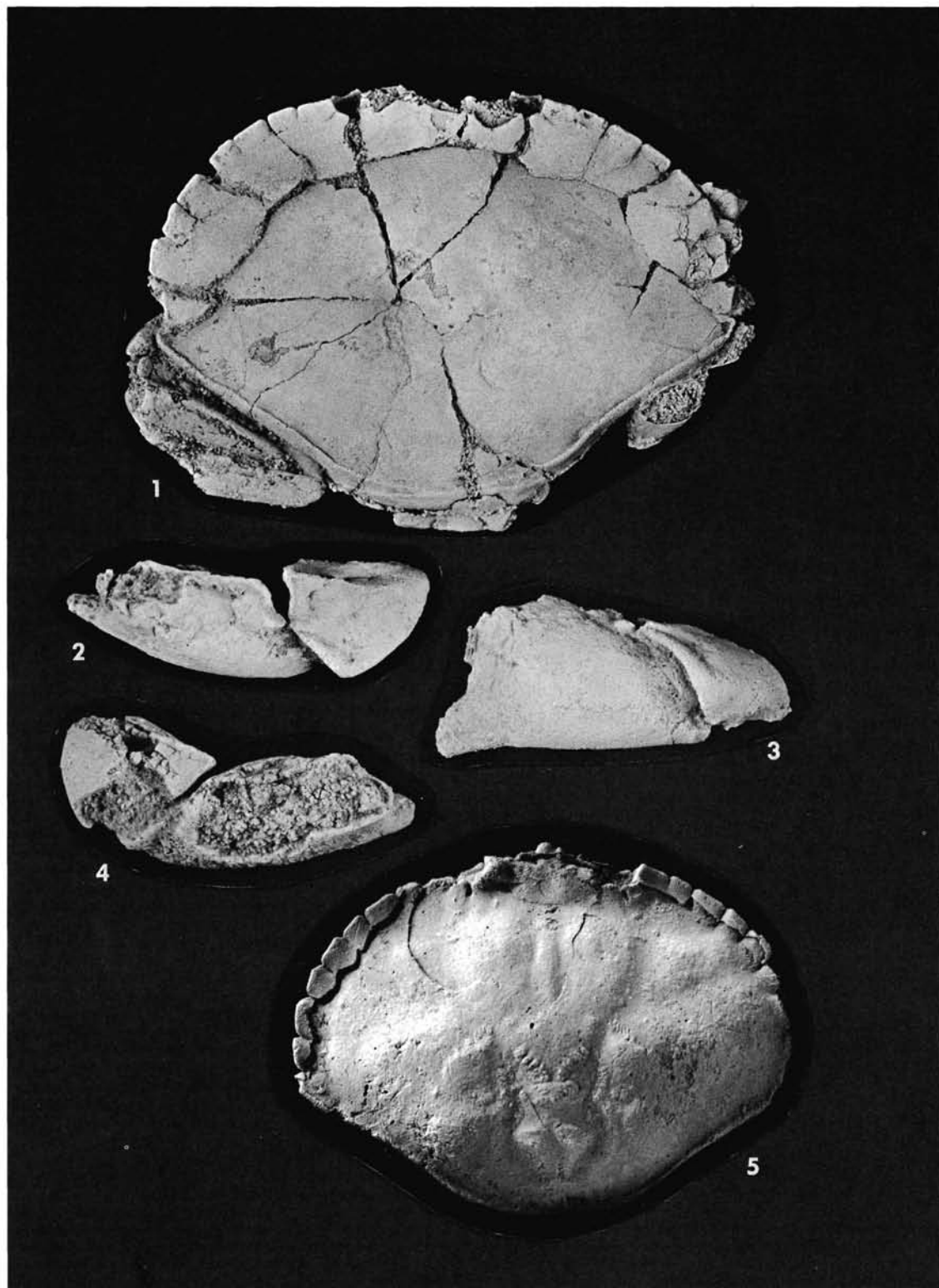


FIGURE 40. *Cancer fissus* Rathbun, Pliocene, hypotype, UCMP 10738; 1. carapace, dorsal view, x 1.6; 2. left cheliped, upper view, x 2; 3. left cheliped, outer view, x 2; 4. right cheliped, upper view, x 2.3; Pliocene, holotype, USNM 165477; 5. carapace, dorsal view, x 2.2.

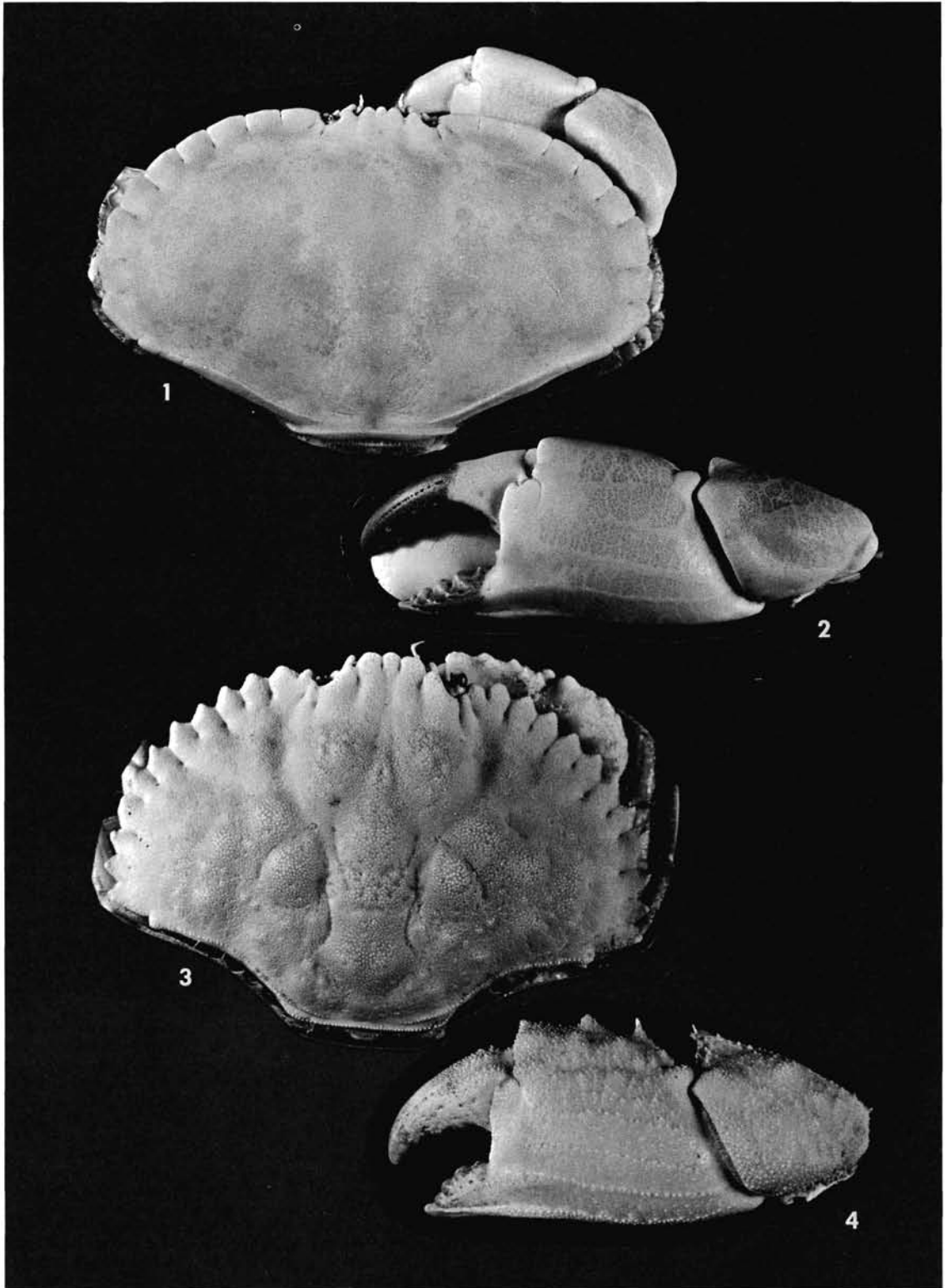


FIGURE 41. *Cancer pagurus* Linnaeus, Recent, hypotype, USNM 125425; 1. carapace, dorsal view, x .8; 2. left cheliped, outer view, x 1. *Cancer japonicus* Ortmann, Recent, hypotype, UCMP 14105; 3. carapace, dorsal view, x 1.7; 4. left cheliped, outer view, x 2.5.

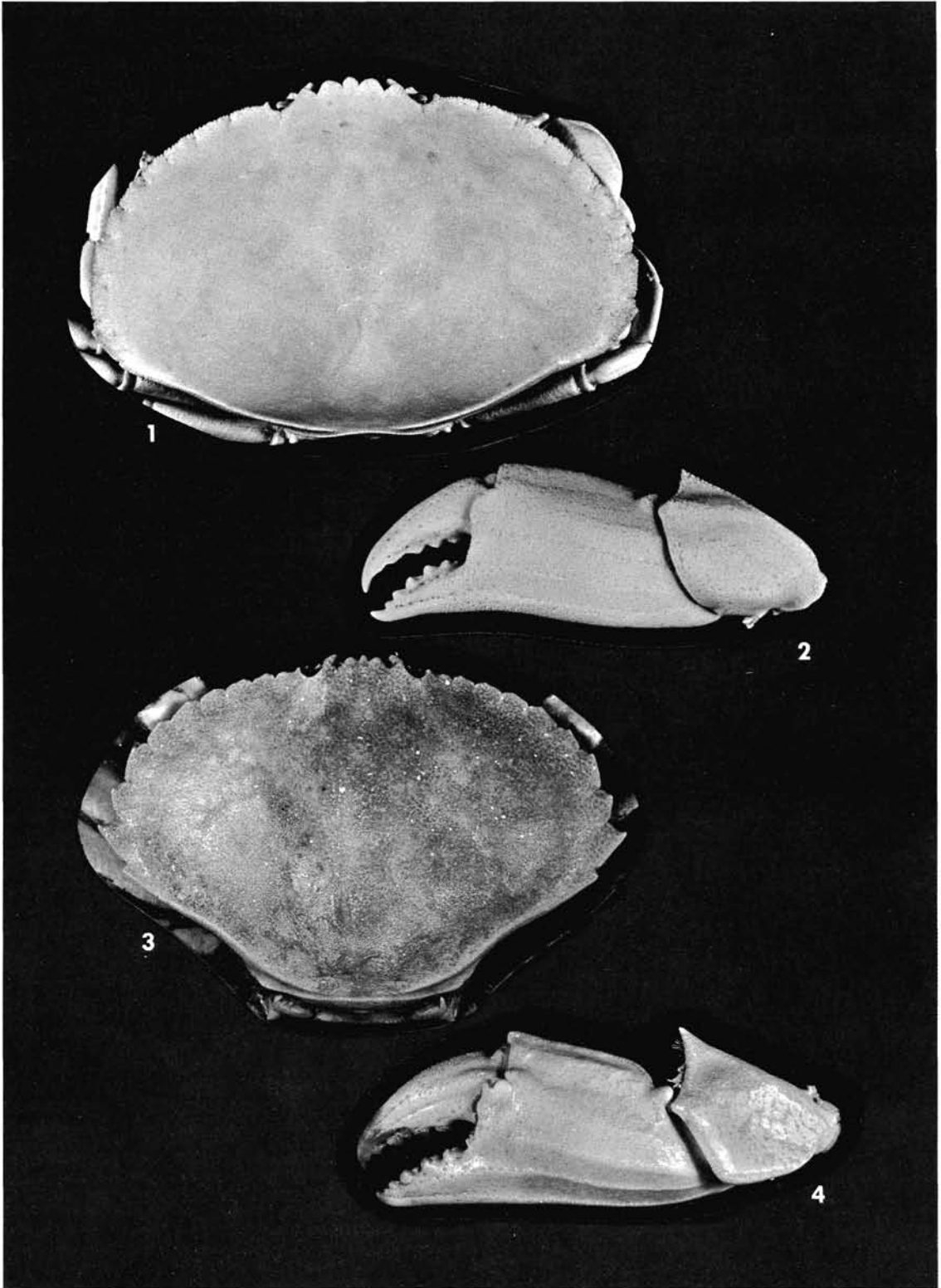


FIGURE 42. *Cancer porteri* Rathbun, Recent, hypotype, UCMP 10735; 1. carapace, dorsal view, x 1.6; 2. left cheliped, outer view, x 2.4. *Cancer irroratus* Say, Recent, hypotype, USNM 78528; 3. carapace, dorsal view, x .9; 4. left cheliped, outer view, x 1.2.



TABLE 4.  
*Cancer amphioctus*, statistical data (measurements in millimeters).

specimen no.	sex	Left or right	carapace width	Manus						Movable finger			Fixed finger			Carpus		Locality
				H	Lu	Lm	Ll	T	H	L	T	H	L	T	H	L		
1	F	L	45.0	10.7	8.1	16.3	22.3	6.1	4.3	11.5	2.6	4.3	7.2	2.4	11.2	11.7	AHF 16	
2	M	L	26.4	5.6	4.3	8.6	11.9	3.1	2.2	6.1	1.4	2.1	3.9	1.3	5.8	6.2	AHF 17	
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

RATIOS

spec. no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	S.	V.
Lu/H m	.757	.767														.0071	.928
T/H m	.570	.570														.0000	100.0
Hf/H m	.402	.375														.0191	4.91
H/L mf	.374	.360														.0099	2.69
H/L f	.597	.538														.0417	7.34
T/H f	.558	.620														.0438	7.45
H/L c	.958	.935														.0162	1.71

TABLE 5.  
*Cancer antennarius*, statistical data (measurements in millimeters).

specimen no.	sex	Left or right	carapace width	Manus												Fixed finger			Carpus			Locality			
				H			Ll			T			H			L			H				L		
				H	Ll	T	H	Ll	T	H	Ll	T	H	Ll	T	H	Ll	T	H	Ll	T				
1	?	R	?	18.5	14.1	27.0	35.0	11.0	8.1	18.7	5.5	6.0	10.9	4.6	17.2	21.3	UCMP (locality?)								
2	?	L	?	27.8	19.0	39.1	54.7	16.3	11.8	30.0	8.1	9.8	17.8	7.5	24.5	31.1	"								
3	?	R	?	30.7	23.0	43.0	55.9	18.0	12.8	30.4	8.6	9.4	16.6	7.5	25.6	31.1	"								
4	M	R	58.7	15.8	11.9	22.2	30.5	9.3	6.9	16.0	4.3	5.1	9.7	4.0	15.4	17.4	AHF 1								
5	F	R	91.5	24.0	17.4	34.0	46.8	14.0	9.9	25.4	6.5	7.2	15.2	5.5	22.2	26.1	AHF 2								
6	F	L	91.5	24.5	18.2	35.3	48.5	14.4	10.0	26.4	6.9	7.3	15.6	6.1	22.2	26.7	AHF 2								
7	M	R	102.9	34.4	23.5	47.1	63.6	20.4	13.9	36.2	10.1	10.7	20.7	8.9	28.6	33.9	AHF 3								
8	M	L	102.9	34.6	23.6	47.0	63.6	20.7	14.3	35.8	10.3	10.7	20.6	9.4	29.4	34.6	AHF 3								
9	M	R	95.4	32.3	23.5	44.4	56.7	20.0	13.7	30.2	9.6	9.7	16.3	8.5	27.0	33.5	AHF 4								
10	F	L	74.8	19.0	13.7	26.8	36.7	10.8	8.3	19.9	5.6	6.5	12.6	5.2	18.0	21.1	AHF 4								

RATIOS

spec. no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	S.	V.
Lu/H m	.762	.683	.750	.754	.726	.743	.683	.682	.727	.721	.738	.725	.756	.748		.0277	3.80
T/H m	.595	.587	.587	.588	.583	.588	.593	.598	.600	.568	.593	.598	.603	.600		.0090	1.53
Hf/H m	.324	.353	.306	.323	.300	.298	.315	.314	.301	.342	.335	.309	.321	.322		.0163	5.13
H/L mf	.433	.394	.422	.432	.390	.379	.384	.395	.453	.417	.419	.407	.400	.385		.0220	5.39
H/L f	.551	.551	.566	.526	.473	.468	.524	.527	.595	.516	.566	.542	.512	.528		.0346	6.50
T/H f	.767	.765	.798	.785	.763	.836	.820	.873	.877	.800	.827	.868	.786	.784		.0403	4.98
H/L c	.807	.788	.823	.885	.851	.832	.843	.850	.806	.853	.883	.853	.835	.853		.0266	3.17



TABLE 6.  
*Cancer anthonyi*, statistical data (measurements in millimeters).

specimen no.	sex	carapace width	Manus												Fixed finger			Carpus		Locality
			H	Lu	Lm	Ll	T	H	L	T	H	L	T	H	L	H	L			
1	F	L	63.7	15.3	12.9	23.8	32.0	9.1	6.3	16.4	4.0	4.8	9.9	3.5	14.7	17.0	AHF 6			
2	F	R	63.7	15.3	12.8	23.8	32.1	9.1	6.3	16.3	4.0	4.8	9.7	3.5	14.6	16.7	AHF 6			
3	M	L	83.5	23.9	20.3	36.6	47.6	14.2	10.2	24.8	6.3	7.7	15.2	6.3	20.9	24.1	AHF 3			
4	M	R	83.5	21.2	18.2	34.5	44.6	12.4	9.0	23.5	5.7	7.5	13.5	5.2	19.6	24.1	AHF 3			
5	F	R	98.4	24.2	20.6	37.6	49.5	14.4	10.5	25.5	6.8	7.6	15.1	6.3	22.9	26.6	AHF 3			
6	F	L	98.4	24.3	20.5	37.7	50.0	14.5	10.4	25.2	6.6	7.8	15.1	6.3	22.7	26.4	AHF 3			
7	M	R	51.5	12.7	11.0	20.2	27.2	7.5	5.5	14.0	3.4	4.3	8.4	2.9	12.3	14.5	AHF 3			
8	M	L	51.5	11.8	10.4	19.0	25.3	6.9	4.9	12.8	3.1	3.7	7.8	2.8	11.6	13.3	AHF 6			
9	M	R	54.1	12.8	10.8	20.2	27.1	7.5	5.5	14.1	3.3	4.3	8.4	3.0	12.4	14.4	AHF 6			
10	M	L	40.8	9.5	8.0	15.0	19.8	5.6	3.9	10.0	2.5	3.1	5.9	2.4	9.3	10.7	AHF 6			

RATIOS

spec. no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	S.	V.
Lu/H m	.843	.847	.850	.858	.851	.843	.866	.882	.844	.842	.850	.750	.862	.860		.0299	3.53
T/H m	.595	.595	.594	.584	.595	.597	.590	.585	.586	.589	.588	.589	.603	.592		.0053	0.895
lf/H m	.314	.314	.322	.283	.314	.321	.339	.314	.336	.327	.315	.308	.328	.322		.0131	4.12
H/L mf	.397	.387	.412	.383	.412	.413	.393	.383	.390	.390	.354	.388	.391	.380		.0156	3.99
H/L f	.485	.495	.507	.556	.490	.517	.512	.474	.513	.526	.479	.480	.500	.500		.0219	4.37
T/H f	.728	.730	.818	.693	.852	.807	.683	.757	.697	.773	.783	.833	.763	.733		.0534	7.02
H/L c	.865	.874	.868	.813	.861	.860	.848	.873	.862	.869	.850	.873	.877	.864		.0163	1.89



TABLE 7.  
*Cancer branneri*, statistical data (measurements in millimeters).

specimen no.	sex	Left or right	carapace width	Manus										Movable finger			Fixed finger			Carpus		Locality
				H	Lu	Lm	Ll	T	H	L	T	H	L	T	H	L	T	H	L			
																				H	L	
1	F	L	27.5	5.8	4.9	9.4	13.9	3.3	2.4	7.0	1.4	2.0	4.6	1.3	6.1	6.6	AHF 7					
2	F	R	33.3	7.0	6.0	11.6	16.7	4.0	3.0	8.4	1.9	2.4	5.4	1.7	7.9	7.7	AHF 8					
3	M	R	24.1	5.1	4.3	8.3	11.7	3.0	2.1	5.9	1.3	1.8	3.7	1.1	5.6	5.6	AHF 9					
4																						
5																						
6																						
7																						
8																						
9																						
10																						

RATIOS

spec. no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	S.	V.
Lu/H m	.844	.857	.843													.0081	0.957
T/H m	.568	.572	.588													.0106	1.84
Hf/H m	.345	.343	.360													.009	0.848
H/L mf	.343	.357	.356													.007	2.22
H/L f	.435	.443	.487													.028	6.15
T/H f	.650	.708	.612													.048	7.37
H/L c	.923	.975	1.000													.039	4.18

TABLE 8.  
*Cancer gracilis*, statistical data (measurements in millimeters).

specimen no.	sex	Left or right	Carapace width	Manus				Movable finger			Fixed finger			Carpus		Locality	
				H	Lu	Lm	Ll	T	H	L	T	H	L	T	H		L
1	F	R		12.6	10.0	19.5	26.7	6.9	5.4	13.0	3.2	4.3	8.5	2.9	11.5	12.2	AHF 7
2	M	R	84.3	23.4	18.0	47.6	48.0	12.4	9.4	22.7	5.7	3.4	6.6	5.0	21.1	20.5	AHF 2
3	M	L	62.5	16.8	13.6	25.8	36.0	9.3	7.1	17.7	4.4	5.8	12.3	3.8	15.8	15.9	AHF 10
4	F	L	53.4	12.9	10.2	19.7	27.7	6.8	5.3	13.9	3.1	4.4	9.4	2.9	12.1	13.4	AHF 10
5	F	R	55.0	13.9	11.0	20.8	29.3	7.2	5.7	14.8	3.2	4.9	9.8	3.0	13.0	13.1	AHF 10
6	F	R	55.5	13.3	11.0	21.0	29.0	7.1	5.6	14.8	3.2	5.0	9.8	3.0	13.5	13.4	AHF 10
7	F	L	67.7	16.1	12.5	24.6	33.5	8.8	6.6	16.2	4.0	5.0	11.0	3.6	15.0	15.2	AHF 11
8	F	L	57.6	13.2	10.4	20.5	29.0	7.3	5.4	14.5	3.3	4.5	10.0	3.1	13.0	12.7	AHF 11
9	F	R	43.2	10.1	8.0	15.6	22.3	5.5	4.3	11.0	2.5	3.5	7.4	2.3	9.9	9.8	AHF 11
10	F	L	46.1	10.7	8.8	16.7	23.4	6.0	4.3	11.7	2.6	3.8	8.0	2.3	10.6	10.4	AHF 11

RATIOS

spec. no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	S.	V.
Lu/H m	.793	.770	.810	.792	.792	.827	.777	.788	.792	.822						.0183	2.30
T/H m	.548	.530	.553	.527	.518	.533	.547	.553	.545	.561						.0141	2.60
Hf/H m	.333	.316	.345	.341	.353	.376	.329	.341	.347	.355						.0163	4.75
H/L mf	.408	.414	.402	.381	.385	.378	.407	.373	.391	.368						.0162	4.16
H/L f	.493	.515	.472	.468	.500	.510	.482	.450	.473	.475						.0229	4.74
T/H f	.691	.676	.655	.659	.612	.600	.679	.690	.657	.605						.0348	5.33
H/L c	.943	.952	.993	.903	1.010	.993	.987	.977	.990	.981						.0316	3.25

TABLE 9.  
*Cancer jordani*, statistical data (measurements in millimeters).

specimen no.	sex	Left or right	carapace width	Manus			Movable finger			Fixed finger			Carpus		Locality		
				H	Lu	Lm	Ll	T	H	L	T	H	L	H		L	
1	M	L	27.4	7.3	5.6	10.5	14.8	4.3	2.8	7.3	2.0	2.3	4.5	1.7	6.9	7.4	Loc. unknown
2	M	R	38.2	11.8	9.6	17.0	22.9	7.3	4.3	11.4	3.2	3.7	6.9	2.7	10.5	11.6	AHF 12
3	M	L	26.1	7.0	5.5	10.2	14.3	4.0	2.7	7.1	1.9	2.2	4.6	1.6	6.4	7.1	AHF 13
4	M	R	27.9	7.6	5.6	11.0	15.0	4.4	3.0	7.4	2.0	2.4	4.6	1.9	7.2	7.8	AHF 14
5																	
6																	
7																	
8																	
9																	
10																	

RATIOS

spec. no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	S.	V.
Lu/H m	.767	.813	.786	.737												.0321	4.14
T/H m	.589	.618	.572	.578												.0204	3.46
Hf/H m	.315	.314	.314	.316												.0010	0.319
H/L mf	.384	.377	.380	.405												.0127	3.29
H/L f	.418	.537	.478	.522												.0534	10.9
T/H f	.739	.730	.727	.792												.030	4.07
H/L c	.933	.907	.903	.923												.0140	1.53



TABLE 10.  
*Cancer magister*, statistical data (measurements in millimeters).

specimen no.	sex	carapace width	Manus												Fixed finger						Carpus		Locality
			H			Lu			Lm			Ll			T			H			L		
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	H	L				
1	F	R	88.0	15.9	17.0	28.4	38.5	9.0	7.0	19.9	4.9	5.6	13.5	4.3	17.4	18.7	AHF 18						
2	F	L	101.3	18.7	18.5	32.1	44.4	10.4	8.1	23.0	5.6	7.0	15.8	5.3	20.3	21.9	AHF 18						
3	F	R	101.3	18.7	18.3	32.5	44.7	10.5	8.3	23.0	5.6	6.8	15.7	5.3	19.9	21.8	AHF 18						
4	M	R	83.2	14.9	15.5	25.9	34.6	8.8	6.4	18.1	4.4	5.4	12.6	4.1	16.5	17.7	AHF 18						
5	M	L	83.2	15.0	15.4	26.4	35.0	8.6	6.4	18.2	4.5	5.6	12.7	4.1	16.6	17.7	AHF 18						
6	M	L	75.1	12.9	13.5	23.0	31.7	7.3	5.7	16.3	3.9	4.6	11.4	3.4	14.6	15.8	AHF 18						
7	M	R	76.4	13.4	13.7	23.4	31.8	7.7	5.6	16.3	4.0	5.0	11.2	3.3	14.6	15.7	AHF 18						
8	M	L	76.4	13.3	13.8	23.8	32.2	7.7	5.7	16.5	4.0	5.0	11.1	3.3	14.6	16.0	AHF 18						
9	M	R	110.0	19.7	20.6	34.8	48.3	11.7	8.7	24.6	6.0	7.4	17.2	5.3	21.7	22.9	AHF 19						
10	M	L	110.0	19.6	20.9	34.8	48.2	11.8	8.8	24.6	6.0	7.5	17.2	5.7	21.7	23.2	AHF 19						
11	F	R	75.4	13.3	13.5	23.3	32.1	7.3	5.6	16.5	3.7	4.8	11.3	3.4	14.6	16.0	AHF 20						
12	F	L	75.4	13.4	13.3	23.5	32.3	7.3	5.9	16.7	3.9	5.0	11.4	3.6	14.6	16.4	AHF 20						
13	F	R	41.7	7.5	7.6	12.4	17.4	4.5	3.3	9.0	2.2	2.7	6.4	1.9	8.5	8.9	AHF 20						
14	F	L	41.7	7.4	7.5	12.7	17.8	4.5	3.3	9.0	2.2	2.6	6.4	1.8	8.5	8.9	AHF 20						

RATIOS

spec. no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	S.	V.
Lu/H m	1.070	.990	.978	1.040	1.023	1.046	1.022	1.037	1.045	1.065	1.015	.993	1.012	1.012		.027	2.63
T/H m	.567	.557	.562	.590	.573	.566	.574	.579	.594	.602	.548	.545	.600	.608		.0202	3.51
tF/H m	.353	.374	.364	.362	.374	.357	.373	.376	.375	.383	.361	.373	.360	.351		.0097	2.66
H/L mf	.351	.352	.361	.354	.352	.350	.344	.346	.354	.358	.340	.353	.367	.367		.0078	2.34
H/L f	.415	.443	.433	.428	.441	.403	.446	.450	.431	.437	.466	.481	.423	.406		.0215	4.95
T/H f	.768	.757	.779	.758	.732	.739	.660	.660	.717	.760	.708	.720	.703	.693		.0379	5.23
H/L c	.931	.927	.913	.932	.938	.923	.930	.913	.956	.936	.913	.890	.978	.978		.0245	2.63

TABLE II.  
*Cancer oregonensis*, statistical data (measurements in millimeters).

specimen no.	sex	Left & right carapace width	Manus												Fixed finger				Carpus		Locality
			H	Lu	Lm	Ll	T	H	L	T	H	L	T	H	L	H	L				
1	F	R	24.8	8.0	4.9	10.0	12.9	4.6	2.8	7.3	2.2	2.6	4.0	2.0	7.2	8.7	AHF 15				
2	F	L	33.2	10.9	6.8	13.5	16.4	6.1	4.0	8.8	3.1	3.5	4.5	2.4	9.1	11.8	AHF 15				
3	F	R	33.2	10.8	6.8	13.5	16.2	6.1	3.9	8.5	3.0	3.3	4.5	2.6	9.1	11.9	AHF 15				
4	M	L	21.7	8.3	5.1	10.0	12.8	4.8	3.0	7.3	2.4	2.9	3.9	1.9	7.3	8.8	AHF 15				
5	M	R	21.7	8.5	5.1	10.1	13.0	4.7	3.0	7.2	2.3	3.0	3.9	2.0	7.3	8.7	AHF 15				
6	F	L	30.1	10.1	6.1	12.1	16.1	5.7	3.7	9.3	2.8	3.3	5.3	2.4	8.7	10.7	AHF 15				
7	F	R	24.6	8.0	4.9	10.0	13.2	4.6	2.7	7.3	2.3	2.7	4.2	2.0	6.9	8.7	AHF 15				
8	F	L	33.2	11.5	7.0	13.9	13.1	6.4	4.0	9.5	3.3	3.7	5.2	2.8	9.6	11.9	AHF 15				
9	F	R	27.7	9.4	5.3	11.3	14.8	5.4	3.2	8.1	2.3	3.1	4.6	2.0	8.1	10.0	AHF 15				
10	F	L	25.6	8.5	5.3	10.8	14.1	4.9	2.9	7.5	2.3	3.0	4.3	2.2	7.3	9.4	AHF 15				

RATIOS

spec. no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	S.	V.
Lu/H m	.613	.623	.629	.615	.600	.603	.613	.608	.653	.612						.0179	2.94
T/H m	.575	.559	.564	.578	.553	.565	.575	.557	.574	.577						.0092	1.63
Hf/H m	.325	.321	.305	.349	.353	.327	.338	.322	.330	.353						.0158	4.77
H/L mf	.384	.454	.458	.412	.417	.398	.370	.422	.395	.387						.0290	7.09
H/L f	.650	.777	.733	.743	.769	.623	.643	.712	.674	.698						.0538	7.67
T/H f	.769	.686	.788	.655	.770	.728	.740	.756	.645	.735						.0494	6.79
H/L c	.828	.771	.765	.829	.839	.813	.793	.807	.810	.777						.0258	3.22

TABLE 12.  
*Cancer productus*, statistical data (measurements in millimeters).

Specimen no.	Sex	Left Right	Carapace width	Manus						Movable finger			Fixed finger			Carpus		Locality
				H	Lu	Lm	Ll	T	H	L	T	H	L	T	H	L		
1	?	R		21.8	18.4	32.7	42.5	12.2	9.4	21.5	5.5	7.0	12.0	5.1	20.1	22.8	Loc. unknown	
2	?	R		31.5	28.4	48.4	62.2	18.5	13.8	31.2	8.6	10.5	17.7	7.9	28.4	31.1	Loc. unknown	
3	?	L		38.9	34.3	57.4	72.5	21.7	17.1	38.2	11.0	13.0	21.1	10.1	34.3	37.5	Loc. unknown	
4	M	R	69.1	15.5	14.8	25.0	32.0	8.5	6.8	15.9	3.9	5.1	8.9	3.6	14.9	17.0	AHF 18	
5	M	L	88.8	19.7	18.9	32.4	41.0	11.4	8.5	20.5	4.9	6.2	11.5	4.8	19.2	21.9	AHF 18	
6	M	R	88.8	19.6	18.8	32.2	41.3	11.4	8.6	20.4	4.9	6.4	11.4	4.7	19.2	21.7	AHF 18	
7	F	L	66.2	13.3	12.7	21.8	28.4	7.5	5.5	14.5	3.3	4.3	8.3	3.2	12.7	15.2	AHF 18	
8	F	R	66.2	13.3	12.7	22.1	28.9	7.8	5.6	14.2	3.2	4.3	8.4	3.2	13.2	15.2	AHF 18	
9	F	L	43.7	9.4	8.8	15.1	19.1	5.2	4.0	9.6	2.3	3.1	5.2	2.2	9.2	10.4	AHF 18	
10	F	R	43.7	9.3	8.8	14.9	19.0	5.1	4.1	9.6	2.3	3.0	5.2	2.2	9.2	10.5	AHF 18	
11	M	L	50.9	11.3	10.1	18.0	23.2	6.5	4.8	11.6	2.8	3.7	6.6	2.7	11.1	12.6	AHF 18	
12	M	R	59.0	13.4	12.0	20.9	26.7	7.5	5.7	13.5	3.3	4.3	7.5	3.1	12.7	14.3	AHF 18	
13	F	L	82.0	17.9	16.5	28.3	36.5	9.7	7.6	18.3	4.6	5.9	10.1	4.1	16.8	19.1	AHF 18	
14	F	R	38.9	8.1	7.3	13.2	16.7	4.7	3.4	8.2	2.0	2.6	4.6	1.9	7.9	9.3	AHF 18	
15	F	L	38.9	5.5	4.9	8.7	12.2	3.3	2.3	6.5	1.6	2.0	3.8	1.6	5.4	6.7	AHF 18	

RATIOS

spec. no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	S.	V.
Lu/H m	.844	.902	.882	.955	.960	.960	.954	.954	.936	.947	.893	.896	.922	.902	.892	.0356	3.87
T/H m	.560	.587	.558	.548	.578	.582	.563	.587	.553	.548	.575	.559	.542	.580	.600	.0174	3.06
Hf/H m	.321	.334	.334	.329	.315	.326	.323	.323	.330	.323	.328	.321	.330	.321	.364	.0113	3.40
H/L mf	.437	.446	.460	.428	.414	.422	.380	.394	.417	.427	.413	.423	.415	.414	.354	.0256	6.18
H/L f	.583	.593	.616	.580	.538	.562	.518	.512	.596	.577	.562	.573	.583	.565	.527	.030	5.32
T/H f	.728	.753	.787	.707	.773	.773	.744	.744	.710	.733	.730	.721	.695	.731	.800	.0291	3.94
H/L c	.882	.913	.915	.876	.877	.885	.835	.866	.885	.876	.877	.888	.880	.850	.806	.0274	3.14

























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