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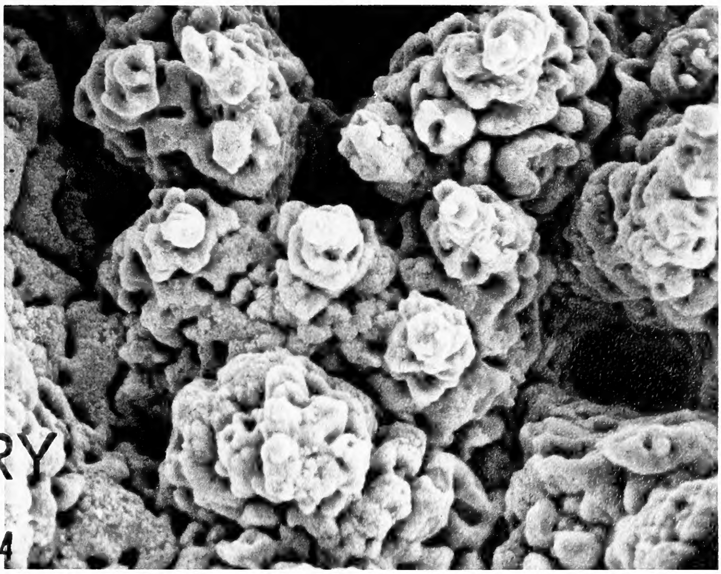

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Redescription of *Janaria mirabilis,* a Calcified Hydroid from the Eastern Pacific

Stephen D. Cairns and J. Laurens Barnard

Abstract.—Redescription of *Janaria mirabilis,* a calcified hydroid from the Eastern Pacific by Stephen D. Cairns and J. Laurens Barnard. *Bull. Southern California Acad. Sci.,* 83(1):1–11, 1984. *Janaria mirabilis* is redescribed and illustrated based on scanning electron microscopy (SEM) of the corallum, SEM of critical-point-dried decalcified specimens, and histology of decalcified specimens. Three types of gastrozooids are distinguished and the gonozooids were found to be superficial stalked structures, not ampullate as previously suggested. The resemblance of *J. mirabilis* to certain bryozoans is discussed and it is also compared to the other two Recent calcified hydractiniids now known. *J. mirabilis* is considered an important evolutionary link between the hydractiniid hydroids and the stylasterid hydrocorals in that both probably had a common ancestor in the Paleocene. The commonly occurring vesicles of *J. mirabilis* are hypothesized to be symbionts of some kind. Twenty new records of *J. mirabilis,* including 118 specimens, are reported, extending its distribution south to Panama.

Janaria mirabilis Stechow, 1921, one of three Recent species of calcified hydroids (exclusive of the milleporids and stylasterids), is known from Baja California to Panama and off Fiji. Although described in 1921, it had never come to the attention of American naturalists. Because of its bryozoan-like growth form and the lack of available literature on the species, it has been misidentified as a bryozoan or a hydrocoral or has remained unidentified in most museum collections.

Janaria is a significant phylogenetic intermediate between the hydractiniid hydroids and stylasterid hydrocorals and thus study of its morphology sheds light on the early evolution of the Stylasterina. *Janaria* also possesses enigmatic structures, called vesicles in this paper, of unknown function. It is for these reasons this paper was written: to more completely describe this peculiar hydroid, to compare it to the early stylasterids, and to speculate on the function of its vesicles.

The specimens examined are deposited in the collections of the United States National Museum (USNM), the Allan Hancock Foundation (AHF), and the California Academy of Sciences (CAS).

Class Hydrozoa
Subclass Athecata
Order Filifera
Suborder Pandeida Petersen, 1979
Superfamily Hydractinoidea Bouillon, 1978
Family Hydractiniidae Agassiz, 1862

Diagnosis.—Stoloniferous hydrorhiza either naked, covered by perisarc, or covered by calcium carbonate. Gastrozooids with one or more whorls of filiform tentacles. Dactylozooids, when present, simple and noncapitate. Gonozooids are sporosacs or free medusae. ?Triassic–Recent. Nine genera.

Genus *Janaria* Stechow, 1921

Diagnosis.—Calcified hydractiniids encrusting gastropod shells, producing branches radiating from encrustation. Gastrozooids polymorphic. Recent. Monotypic.

Janaria mirabilis Stechow, 1921
Figs. 1–6, 8–12, 14–25

"polypier" Bouvier, 1898:382.
Cyclactinia sp. Douvillé, 1908:14–17, pl. 1, figs. 1–2.—André and Lamy, 1936: 96–97, text-fig. 2, pl. 1, figs. 3–4.
Hydractinia calcarea: Fraas, 1911:73, text-figs. 2–5.—Abel, 1912:88, text-figs. 37a–b.
"Hydractinie" Abel, 1920:71–72, text-fig. 78.
"Hydrozoe" Dacqué, 1921:text-figs. 226 A, C.
Janaria mirabilis Stechow, 1921:29–30; 1923:100–102.—Thomas, 1937:62–63.—Stechow, 1962:424–426, text-figs. 4–7.
Hippoporidra sp.? Snyder-Conn, 1980:284–285, pl. 11 (color fig.).
"Hydrocoral" Ingle, 1982:468 (upper color fig.).

Description.—Corallum: Coralla always encrust gastropod shells, which invariably house living pagurid crustaceans—usually *Manucomplanus varians* or *M. cervicornis.* The species of gastropod shell is variable, but is usually a low-spired form such as a naticid. The hydroid produces a thin encrustation over the entire shell, including the internal cavity, and eventually chemically erodes the shell. The hydroid often enlarges domain of hermit crab by elongating the shell beyond its original aperture (Fig. 5).

In addition to basal encrustation, the hydroid also produces a series of three to eight branches, which radiate outward from the peripheral whorl of gastropod shell, herein termed radial branches (Fig. 4). These branches 10–30 mm long, straight to slightly curved, and about 3.0 mm in basal diameter, each tapering to a blunt tip about 1.5 mm in diameter. Branches of robust colonies measure 8.5 mm in basal diameter and 3.5 mm in apical diameter. One to three branches, termed axial branches (Fig. 2), form perpendicular to the radials: one originates at the apex of gastropod shell, the apical axial, and 0–2 (usually one) originates at umbilical area of gastropod shell, the umbilical axials. Branches usually simple; however, umbilical axial often bifurcate. Only one lot of specimens, those from *Albatross* 2794, contain coralla encrusting high-spired gastropod shells, the radial branches forming three or four whorls corresponding to whorls of gastropod shell (Fig. 1).

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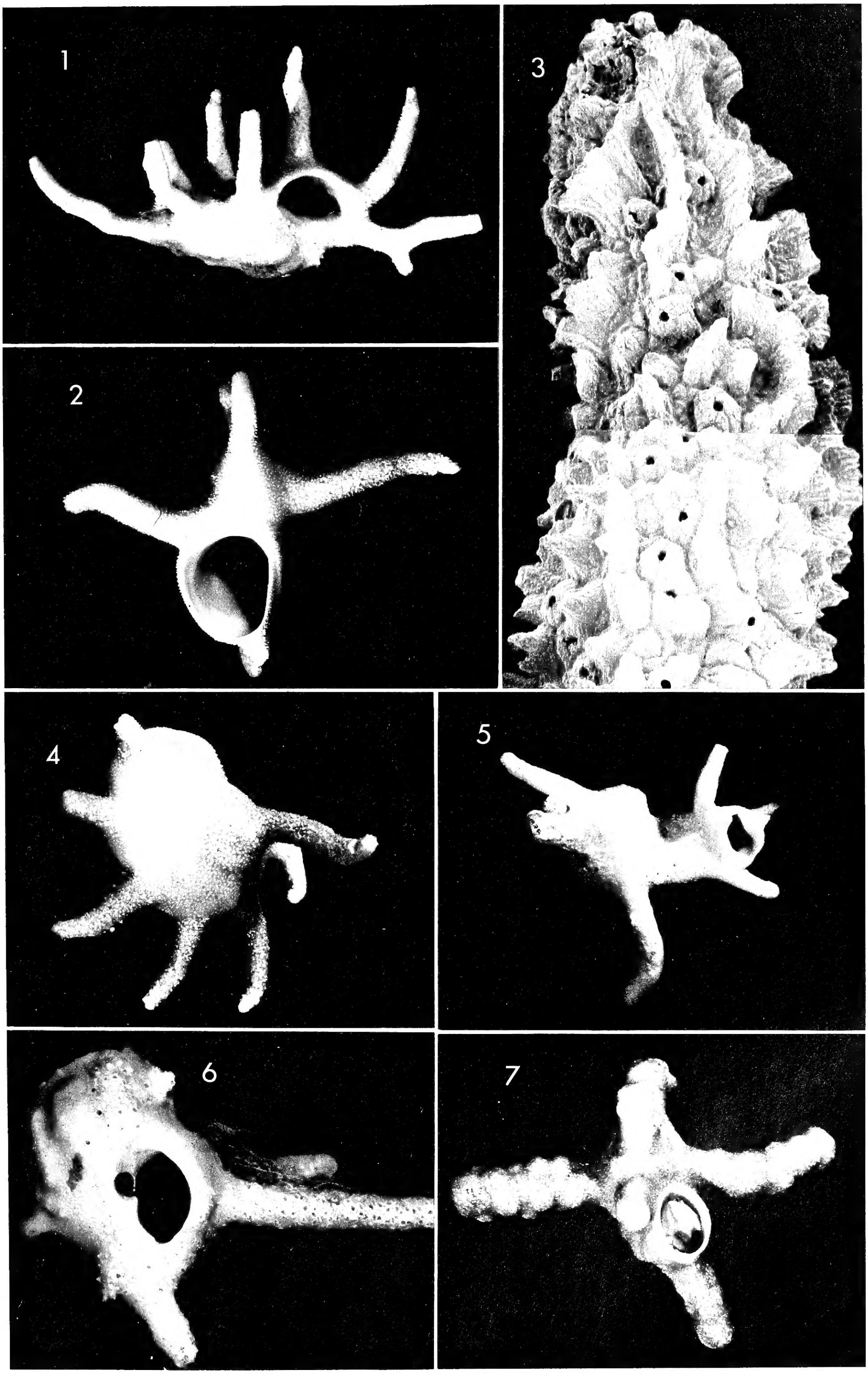
Figs. 1–6. *Janaria mirabilis*: 1, Specimen encrusting a high-spired gastropod shell, ×1.3; 2, 4, Typical growth form, ×1.6; 3, Branch tip, ×23; 5, Specimen that has elongated the shell aperture, ×3.2; 6, Sipunculid pore (?) shown just left of aperture, ×2.2 (Figs. 1, 5–6 from *Albatross* 2794; Figs. 2–4 from *Albatross* 2829).—Fig. 7, The bryozoan *Hippoporidra calcarea, Albatross* 2363 (off Yucatan Peninsula, 38 m).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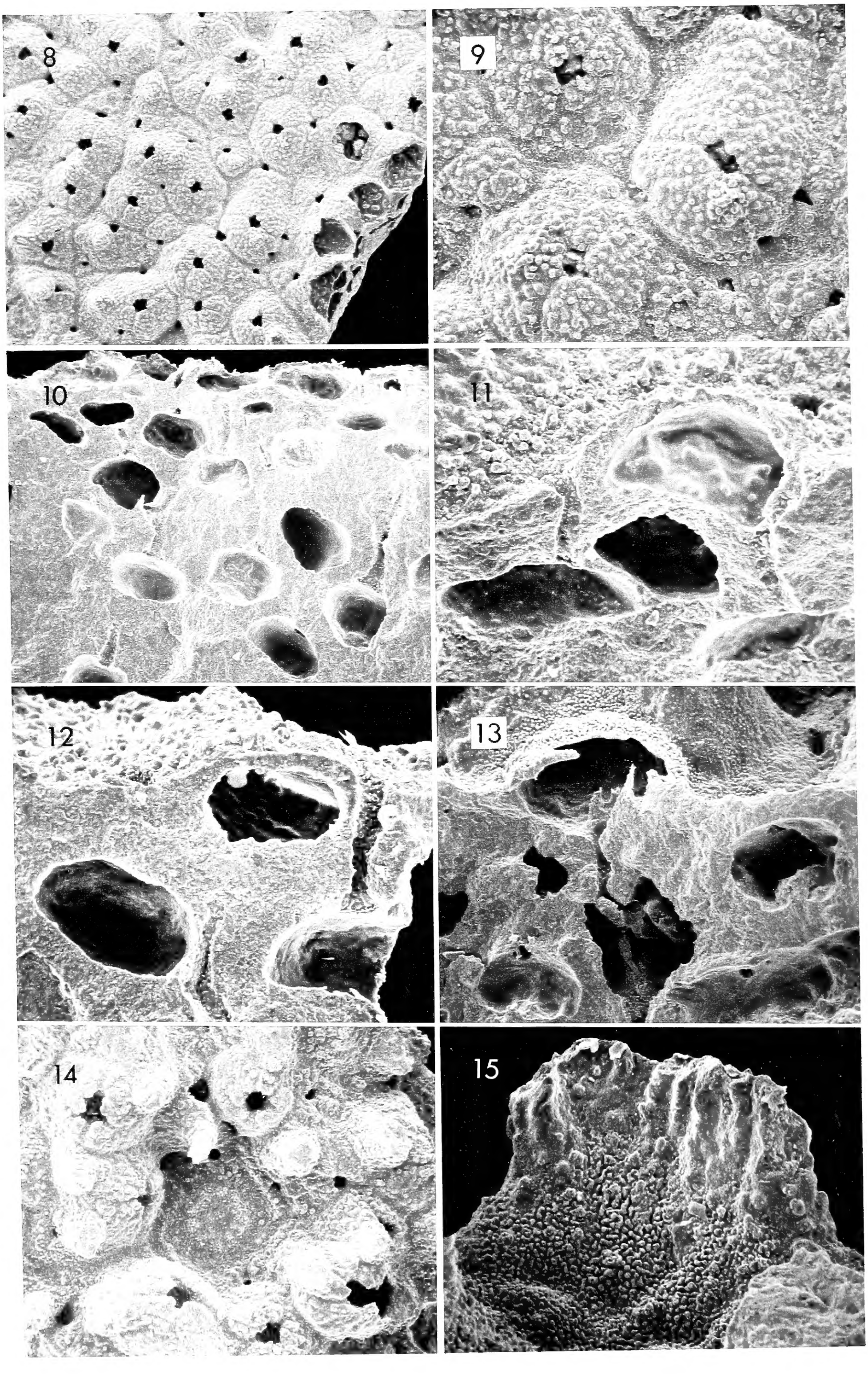
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Coenosteum overlaying gastropod shell covered by low, individualized, sharp or blunt spines up to 0.25 mm tall. About one-third distance from base of branch the spines begin to increase in height and coalesce (Fig. 15). On distal half of branches spines are often united into long meandering ridges 2–3 mm long and up to 0.55 mm tall (Fig. 3). Microarchitecture of this coenosteum composed of ornate granules and spines 4–6 μm in diameter (Fig. 16). Coenosteum inside gastropod shell, adjacent to crab, has much less relief, composed of low, rounded granules 25–35 μm in diameter (Fig. 17).

Ordinarily there is little or no skeletal evidence of gastrozooid placement. At most, there is a shallow, round coenosteal depression about 0.4 mm in diameter, surrounded by a concentration of vesicles and spines (Fig. 14). However, in specimens from *Albatross* 2794, gastrozooid concavities very pronounced and abundant, each one surrounded by five or six sharp spines. These concavities approximate shallow gastropores.

On all specimens there are numerous hemispherical vesicles, 0.3–0.4 mm in diameter, occurring on both gastropod shell encrustation and on branches. Sometimes vesicles completely cover coenosteum overlaying shell (Figs. 8–9). At apex of each vesicle is an irregularly shaped pore, 50–70 μm in diameter. From this pore radiate three or four shallow grooves, each running to base of vesicle. As the hydroid adds coenosteum to its skeleton these vesicles are slowly buried beneath the surface, but they always maintain communication to the surface via a narrow efferent duct 25–27 μm in diameter and up to 1 mm long (Figs. 11–12). As old vesicles are buried, new ones are formed on the surface such that, in a cross section of coenosteum (Fig. 10), several layers of vesicles are revealed, each vesicle having a tube leading to the surface.

On six of the specimens, 5% of total, there was a 1 mm diameter pore located at inner aperture of shell (Fig. 6), which is hypothesized to serve as an efferent pore for a sipunculid.

Soft Parts: Soft parts of *J. mirabilis* consist of gastrozooids, dactylozooids, gonozooids, vesicles, and a stoloniferous canal system that interconnects the polyps.

Three types of gastrozooids occur in *J. mirabilis*. It is acknowledged that the nutrition of a polyp and its state of preservation can greatly influence the shape and dimensions of a gastrozooid; however, the three types described below also differ with regard to the length and diameter of their tentacles, which are less subject to preservational deformation. Type 1 (Fig. 18) short, robust polyp about 0.5 mm tall and 0.38 mm in diameter in contracted state. Hypostome dome shaped and prominent. Each zooid has a whorl of 6–11 tentacles of equal size, each about 0.15 mm long and 0.05 mm in diameter, which barely extend beyond hypostome. Type 2 (Fig. 19) similar to type 1 but more elongate, about 0.65 mm long and 0.13 mm in diameter. It may be simply an elongate version of type 1;

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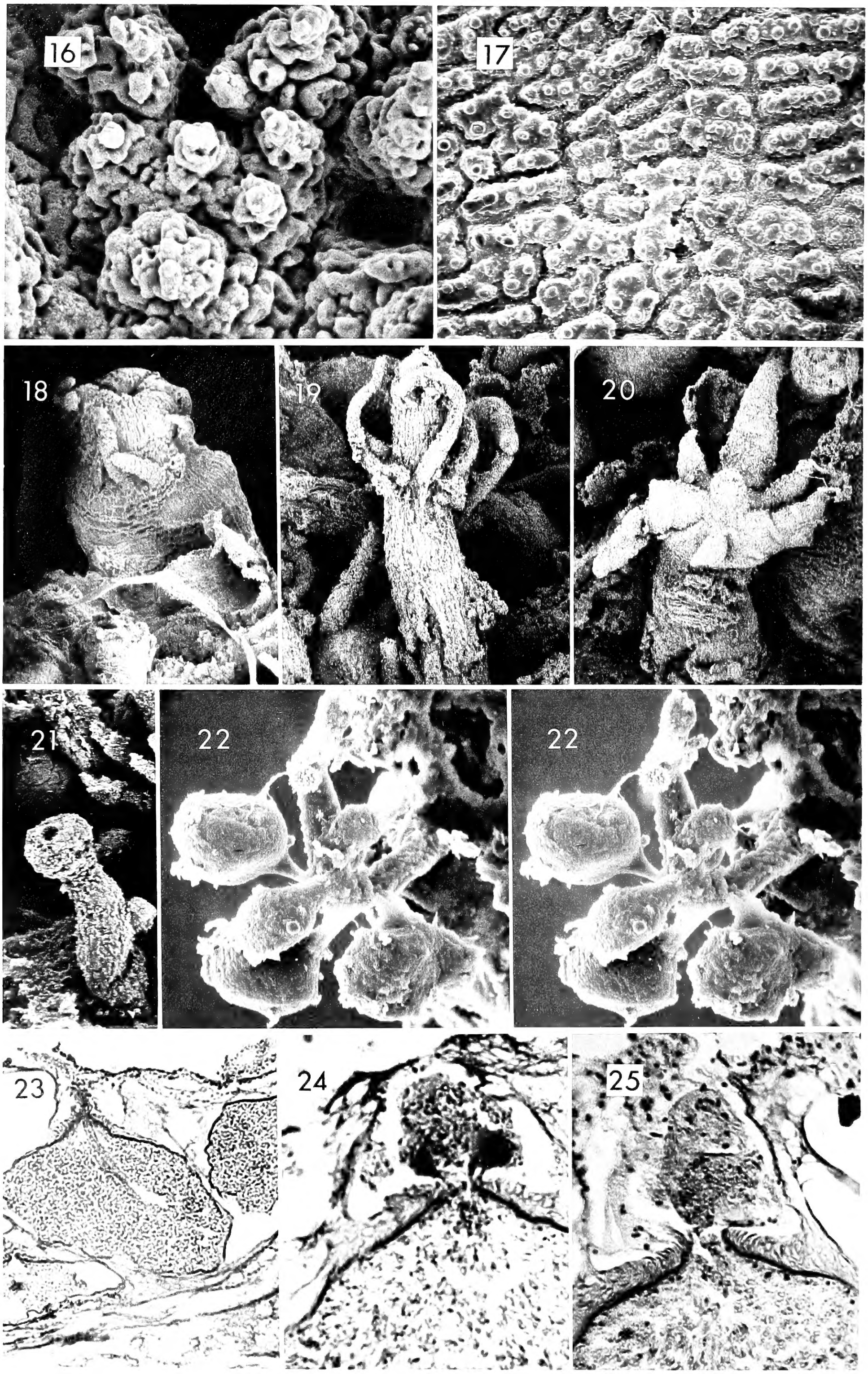
Figs. 8–12, 14–15. *Janaria mirabilis*: 8–9, Densely packed vesicles on coenosteum overlaying gastropod shell, ×27, ×66, respectively; 10–12, Cross-sections of vesicles and efferent tubes from the thick encrustation on a gastropod shell, ×43, ×130, ×120, respectively; 14, Gastrozooid depression surrounded by vesicles and spines, ×50; 15, Ridge on a radial branch, ×150 (Figs. 8–12, 14 from *Hassler* specimen, USNM 68461; Fig. 15 from *Albatross* 2829).—Fig. 13, *Hydrocorella africana*, Cross-section of superficial and buried vesicles, SAM H 408, South Africa, ×75.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however, its tentacles are longer, about 0.23 mm, and extend significantly beyond hypostome. Type 3 (Fig. 20) is quite different from the other two in that its hypostome is very short and therefore its tentacles extend far beyond hypostome. Furthermore, its tentacles appear to alternate in size: the larger ones being 0.22 mm long and 0.07 mm in diameter, the smaller being 0.08 mm long and 0.04 mm in diameter. Exploded tentacular nematocysts not available for study but unexploded capsules about 5.5 × 2.0 μm.

Male gonozooids slender cylindrical polyps without tentacles, up to 0.4 mm long and about 30 μm in diameter. Each gonozooid bears up to seven elliptical to round gonophores, the gonophores being up to 0.12 mm long in greater axis and attached to gonozooid stalk by very narrow neck about 12 μm in diameter (Fig. 22). Female gonozooids not available for study.

Dactylozooids (tentaculozooids?) not common and do not concentrate at shell aperture, as is common in many species of *Hydractinia.* They vary greatly in length, ranging from 0.23 to 1.2 mm long, and usually about 0.10 mm in diameter (Fig. 21).

Vesicles and their efferent tubes lined with thin layer of chitinous material (Fig. 23). Even most deeply submerged vesicles contain a large number of what appear to be undifferentiated cells. Tissue associated with apical pore of superficial vesicles illustrated in Figures 24–25.

New Records.—Off Baja California: *Searcher* 34, 3 colonies, off Punta Tosca, 24°07′N, 111°08′W, 27 m, 1 Feb. 1971, AHF; Off Punta Tosca, Santa Margarita Island, 1 colony, depth unknown, 8 Aug. 1932, CAS 27588; *Albatross* 2829, 16 colonies, 22°55′N, 109°55′W, 57 m, 1 May 1888, USNM 68453; Off Cabo San Lucas, 10 colonies, 37–46 m, 8 June 1932, CAS.—*Gulf of California*: *Albatross* 3025, 2 colonies, 31°21′15″N, 113°59′W, 17 m, 25 March 1889, USNM 68454; Bahia de los Ángeles, 2 colonies, 29 July 1982, USNM 68455; San Raphael Bay, 1 colony, depth unknown, 1965, CAS 37440; Cortès, B/O *Puma,* 7 colonies, 25°34.2′N, 110°59.1′W, 55–65 m, 4 May 1982, USNM 68456; Off Espiritu Santo, 3 colonies, 21 m, CAS; Off Las Ánimas, Tiburón, 2 colonies, British Museum and 8 colonies, CAS, 30 m, Aug. 1972; *Hassler,* station unknown, Tiburón, 1 colony, 18 m, 28 May 1881, USNM 68461; *Albatross* 3014, 2 colonies, 28°28′N, 112°04′30″W, 53 m, 23 March 1889, USNM 68457; *Albatross* 3013, 1 colony, 28°23′45″N, 111°58′W, 26 m, 23 March 1889, USNM 68458; Off Cabo Haro, Guaymas, 2 colonies, 27–46 m, 1960, CAS; *Velero III,* 734–37, 2 colonies, 27°59′30″N, 111°24′25″W, 137 m, 29 March 1937, AHF; *Velero IV,* 1726–49, off Cabeza Ballena, 22°52′47″N, 109°50′59″W, 6 colonies, 55 m, 11 March 1949, AHF; VS-BTT-33, off Punta Piaxtla, 6 colonies, depth unknown, 13 March 1959, AHF.—*Off Mexico*: *Velero III,* 275–34, 3 colonies, near Tanacatita Bay, 19°12′50″N, 104°49′48″W, 46–64 m, 4 March 1934, USNM 68459.—*Off Panama*: *Velero III,* 449–35, 13 colonies, Secas Islands, 7°57′N, 82°01′35″W, 46 m,

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Figs. 16–25. *Janaria mirabilis*: 16, Coenosteal texture, ×400; 17, Coenosteal texture inside gastropod shell, ×65; 18, Type 1 gastrozooid, ×65; 19, Type 2 gastrozooid, ×90; 20, Type 3 gastrozooid, ×115; 21, ?Dactylozooid, ×130; 22, Male gonozooid bearing several gonophores, stereo pair, ×165; 23–25, Histological sections of vesicles, the latter two showing only the apical area, ×90, ×360, ×360, respectively (Figs. 16, 22 from *Velero III,* 275–34; Fig. 17 from *Hassler* specimen, USNM 68461; Figs. 18–21, 23–25 from VS-BTT-33, AHF).

5 Feb. 1935, AHF; *Albatross* 2794, 28 colonies, 7°37′N, 78°46′30″W, 113 m, 5 March 1888, USNM 68460.

Distribution.—Recent: Eastern Pacific from Baja California to Panama, including Gulf of California. Also known from Fiji (Fraas, 1911). 7–137 m. Most records are from off Baja California and Gulf of California.

Discussion

Synonymy.—*Janaria mirabilis* was first mentioned in the literature as "a very robust polyp" (Bouvier 1898), which took the place of the gastropod shell that enclosed the hermit crab *Pylopagurus varians.* Douvillé (1908), Fraas (1911), and Thomas (1937) referred to it as a Recent homolog to the Eocene Egyptian fossil *Kerunia,* implying that *Kerunia* was not a cephalopod as originally described, but a calcified hydroid. Early twentieth century European paleontology textbooks (Abel 1912, 1920; Dacqué 1921) illustrated it as an example of symbiosis and also considered it as a homolog to the misinterpreted *Kerunia.* It was not until 1921 that Stechow described and named the hydroid in a very brief passage. *J. mirabilis* was better described and illustrated by Stechow (1962); however, he did not describe the stalked gonozooids and he misinterpreted the vesicles as gonophores.

André and Lamy (1936) noted the great resemblance in colony shape between *J. mirabilis* and certain hippoporidran bryozoans. The corallum of *J. mirabilis* is remarkably similar to the bryozoans *Hippoporidra calcarea* (Smitt) from the Gulf of Mexico (also called the "Texas longhorn") (Fig. 7); *H. senegambiensis* (Carter) from the tropical eastern Atlantic; and *H. picardi* Gautier, from the Aegean Sea. So similar are they in form that Snyder-Conn (1980) labelled and illustrated *J. mirabilis* as *Hippoporidra* sp.?. Undoubtedly, many have mistaken this hydroid for a bryozoan or a hydrocoral.

Comparison with other species.—Calcified hydroids, exclusive of the milleporids, stylasterids, and axoporids, are not very common. There are only two other Recent and one fossil species known, all with limited distributions: *Hydrocorella africana* Stechow, 1921; *Polyhydra calcarea* (Carter 1877); and *Kerunia cornuta* Mayer-Eymar, 1900, respectively. *J. mirabilis* is very similar to the South African *H. africana,* which is well described by Millard (1975). Both species even have the same arrangement of vesicles (Fig. 13). The only differences determined were that *H. africana* has a slightly different coenosteal microarchitecture—taller, ridged spines—and more slender gastrozooids with consistently dimorphic tentacles. *P. calcarea,* known only from the tropical eastern Atlantic, differs from *Janaria* in that it is an exclusively encrusting form with no branches. According to Thomas (1937), *Kerunia cornuta,* known only from the Middle Eocene of Egypt, is so similar in growth form to *J. mirabilis* that they probably belong to the same genus. No specimens of *Kerunia* were available for study.

Phylogenetic affinities.—Long before *J. mirabilis* was formally described, its hydractiniid nature was recognized by those who studied it (Douvillé 1908; Fraas 1911; Abel 1920). A recent classification (Bouillon 1978) places *Janaria,* along with *Hydractinia,* in the family Hydractiniidae. It was Stechow (1962), however, who suggested that *Janaria* was an evolutionary transition between the hydractiniids and the stylasterines and that the stylasterines were so similar to *Janaria* that they should be considered as a family within the athecate hydroids, not as a separate order. Stechow (1921) cited the homology of the chitinous protective spines of *Hydractinia* and the calcareous gastrostyles of stylasterines as one point of evidence. He reiterated these views in 1923, 1925, and 1962 with little variation. In 1962, however, he suggested that *Kerunia* had a chitinous skeleton that was subsequently calcified in fossilization and therefore was not as closely related to *Janaria* as previously thought.

Essentially we agree with Stechow and would like to propose the following scenario, thus far unsubstantiated by cladistic or phenetic analysis. In the early Tertiary a hydractiniid ancestor evolved the ability to calcify its skeleton. *Polyhydra,* essentially a calcified *Hydractinia echinata,* resulted. From the same or similar ancestor a line evolved differing from *Polyhydra* in that it produced branches radiating from its encrustation of gastropod shells. A tight cluster of genera, *Kerunia, Hydrocorella,* and *Janaria,* evolved from this line. The same or similar ancestor then developed an encasement for its gastrozooids (gastropores). This led to a second hypothetical ancestor from which the axoporids evolved (Cairns 1983). Finally, hypothetical ancestor 2 developed dactylopores and a branching mode, leading to the early stylasterids, probably *Lepidopora* (see Cairns in press). This evolution is hypothesized to have occurred in the late Cretaceous to early Paleocene.

Identity of the vesicles.—The vesicles, which are very common in all specimens examined, are of unknown identity and function. Hydroids have, at most, three types of polyps: gastrozooids, dactylozooids, and gonozooids. The vesicles are clearly not gastrozooids because they have no tentacles, nematocysts, or mouths, and no intercommunication with the rest of the colony by which tc transport captured food. They are not dactylozooids because they lack nematocysts and do not occur in a defensive or offensive position on the colony, especially after being submerged in the coenosteum. Stechow (1962) thought that they might be gonozooids because of their similarity to stylasterid ampullae. They do resemble ampullae in shape and position; however, a stylasterid ampulla begins as a completely enclosed structure, rupturing its calcareous mold only to release its gametes. The vesicles of *Janaria* always have an apical pore. Also, the male gonozooids are known to be superficial, stalked structures (Fig. 22), much like those of *Hydractinia.* Female gonozooids are not known but the closely related *Hydrocorella africana* has both superficial, stalked male and female gonozooids. Furthermore, according to W. Vervoort (pers. comm. 1982), the vesicular tissue is not reproductive tissue. Finally, the efferent duct leading to the surface is probably too small in diameter to allow the release of eggs, even if the eggs were very small.

The final conclusion is that the vesicles are either: (1) a new type of zooid of unknown function, perhaps a storage vesicle that aids in the calcification process, or (2) a symbiont of some kind. We favor the second alternative because the chitinous linings of the vesicles seem to completely isolate them from any activity of the rest of the colony. If they are symbionts, they have little or no effect on the health of the hydroid colony.

We strongly recommend the capture and observation of living colonies in an effort to observe the functioning of the vesicles, followed by histological analysis of fresh material. Our histological sections were made of poorly preserved material and revealed little structure to the cells within the vesicles.

Thus, *Janaria,* once used as an example of symbiosis involving a gastropod shell, a pagurid, and a hydroid, may now be expanded to include a sipunculid and possibly a vesiculate symbiont of some kind.

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Early Twentieth Century Records of Marine Decapod Crustaceans from Los Angeles and Orange Counties, California

Mary K. Wicksten

Abstract.—Early twentieth century records of marine decapod crustaceans from Los Angeles and Orange counties, California by Mary K. Wicksten. *Bull. Southern California Acad. Sci.,* 83(1):12–42, 1984. During 1900–1930, 100 species of decapod crustaceans were collected along the coasts of Orange and Los Angeles counties, California. Records from the published literature, the files of the Allan Hancock Foundation, and the collections of the U.S. National Museum are presented. Checklists for major areas of collecting are provided. Thirty-four other species, not reported during 1900–1930, are listed.

One of the most difficult problems facing marine ecologists is assessing the impacts of environmental alterations after they have occurred. A comparison of modern maps of the coast of Los Angeles and Orange counties, California will show that much of the area has been dredged, filled or otherwise altered. (Compare, for example, the maps in Figures 3 and 5). The extensive tidal marshes and beds of eelgrass (*Zostera* sp.) of San Pedro Bay, reported by early collectors such as Williamson (1829), are gone. Deadman's Island in San Pedro has been demolished and incorporated into Terminal Island. The tidelands of Ballona Creek, Anaheim Bay, Alamitos Bay, and upper Newport Bay have been reduced in size. The beds of giant kelp (*Macrocystis pyrifera*) off the Palos Verdes Peninsula have fluctuated in size (Wilson 1982). The stands of elk kelp (*Pelagophycus porra*) reported off Laguna Beach and San Pedro (Guernsey 1912, as *Nereocystis gigantea*; Parker and Bleck 1965) have not been found in recent years. Undoubtedly, the marine fauna of these areas has been altered, but the absence of historical data makes comparison difficult.

From 1900 to 1930, extensive collections of marine decapod crustaceans were made along the coasts of the two counties. In 1901–1902, workers from the University of California maintained a marine station at San Pedro. They collected in the intertidal zone and subtidally as deep as 100 fathoms (Raymond 1903; Ritter 1905). Percy S. Barnhart and his students collected along the shores of Santa Catalina Island and near the Venice Marine Biological Station. Emery P. Chace and Elsie M. Chace took specimens along shore in Anaheim Bay, the Cerritos Channel, and San Pedro. Elmer and Lena Higgins collected in Anaheim Bay. At Santa Catalina Island, H. N. Lowe dredged animals. William A. Hilton, his students, and associates of the Laguna Marine Laboratory collected and reported on the fauna of Laguna Beach.

Dredges and trawls were employed from the R.V. *Anton Dohrn* (Fig. 1), the first research vessel of the University of Southern California. Samples were collected extensively from Point Dume to Newport Bay and Santa Catalina Island, to a depth of 40 fathoms (74 m). This 38-foot (12 m) launch, built in 1911, served the university until 1930.

Fig. 1. The R. V. *Anton Dohrn.*

Most of the specimens taken by workers from the University of Southern California were sent to the U.S. National Museum for verification of identifications. Some material, however, remained to become part of the holdings of the Allan Hancock Foundation. I have not been able to locate the specimens taken by W. A. Hilton. Records of many of these specimens were published in the works of Rathbun (1918, 1925, 1930, and 1937), Schmitt (1921), and Hilton (1916, 1918). A map of the stations of the *Anton Dohrn* was given with a description of its operations (Ulrey 1917). The map later was included in the work on fishes by Ulrey and Greeley (1928).

No complete list was compiled of the specimens taken by any of the collectors working between 1900 and 1930. The log of the Venice Marine Biological Station often listed animals as "crabs," "macrurans," etc. rather than by species. Inconsistencies in identification in the log prevent modern workers from being sure which species was intended. Many of the original specimens have been lost or dehydrated to the point of being unrecognizable. Other specimens have not been located. Data on exact location, depth, date of collection, and number of individuals taken was not given for many lots of specimens.

This paper provides a list of decapods taken in 1900–1930, as compiled from original records at the Allan Hancock Foundation, specimens at the Allan Hancock Foundation and the U.S. National Museum, and references in the literature. For comparison, records are given of other species found in the two counties but not reported in that time period.

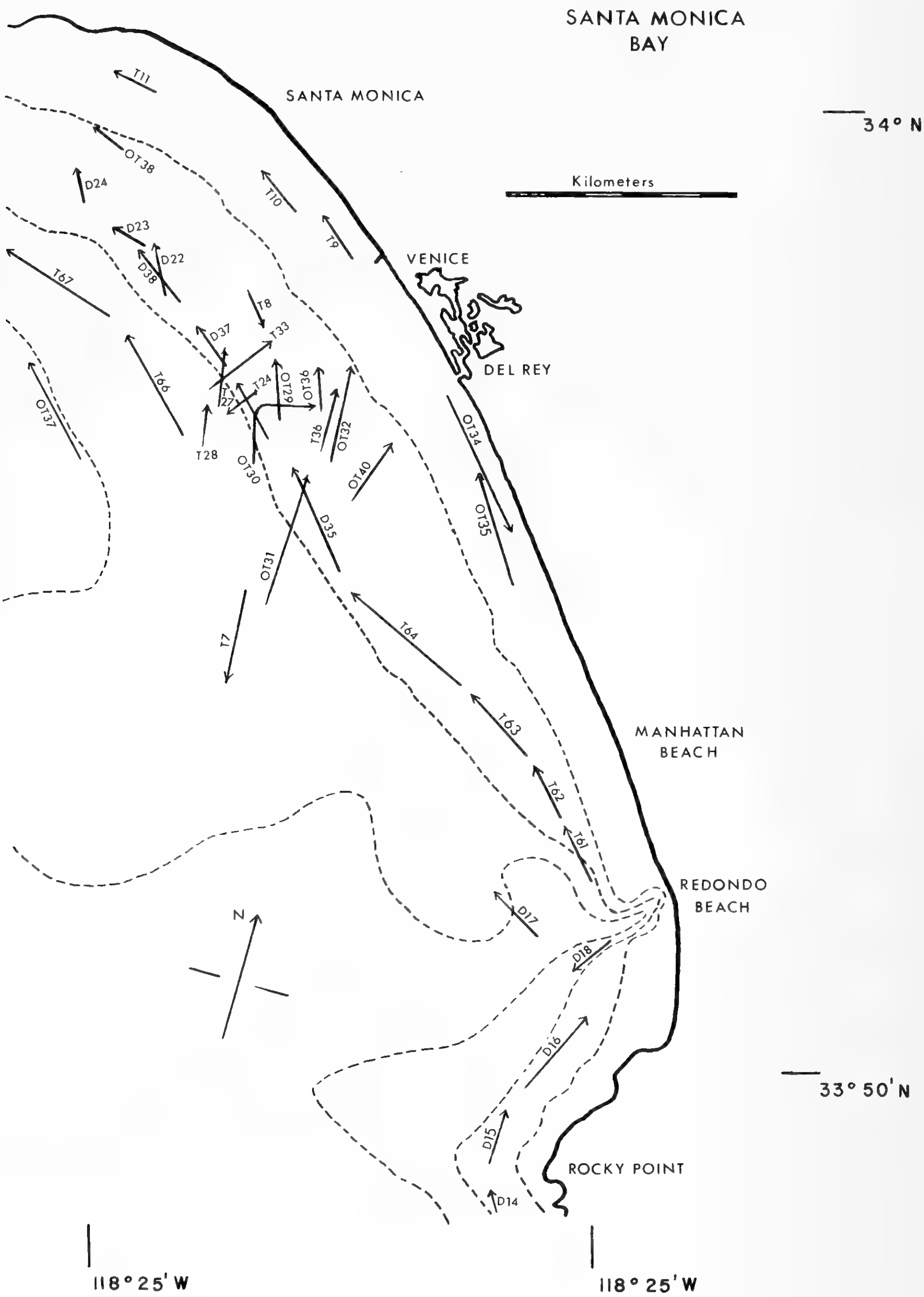

Fig. 2. Map of Santa Monica Bay, showing stations of the R.V. *Anton Dohrn.*

Methods

The species recorded in the literature or given in the station log of the Venice Marine Biological Station were listed by locality. The specimen catalogue of the Allan Hancock Foundation also was searched for material taken during 1900–

Fig. 3. Map of Los Angeles Harbor and the Palos Verdes Peninsula, showing stations of the R.V. *Anton Dohrn.*

1930. Specimens of *Pagurus armatus* and *Petrolisthes cabrilloi* were borrowed from the U.S. National Museum to check earlier identifications.

Records from the literature are included in the appropriate columns of Tables 1–3. Unpublished records from the station log and the specimen catalogue are noted as "AHF." None of the early sampling was quantitative; therefore the records should be viewed only as indicating presence of the species in the general area.

The maps of the stations of the *Anton Dohrn* are reproduced in Figs. 2–4. A recent map of Los Angeles-Long Beach Harbors is provided for comparison (Fig. 5). Trawl stations are indicated by "T" or "OT," dredge stations are labelled "D."

Except as cited, the list of additional species in Table 4 is based on records in the collections of the Allan Hancock Foundation. There is no checklist of decapods of Los Angeles and Orange counties. Only species usually found at 50 fathoms (90 m) or less are included. Species noted as accidental (A) are known to migrate, have been collected less than five times in the area, or are pelagic.

Systematic List of Species Taken in 1900–1930

Suborder Dendrobranchiata

Family Peneidae

Penaeus californiensis Holmes

Between Long Beach and Belmont Pier, 10 m, 17 July 1926, T231.

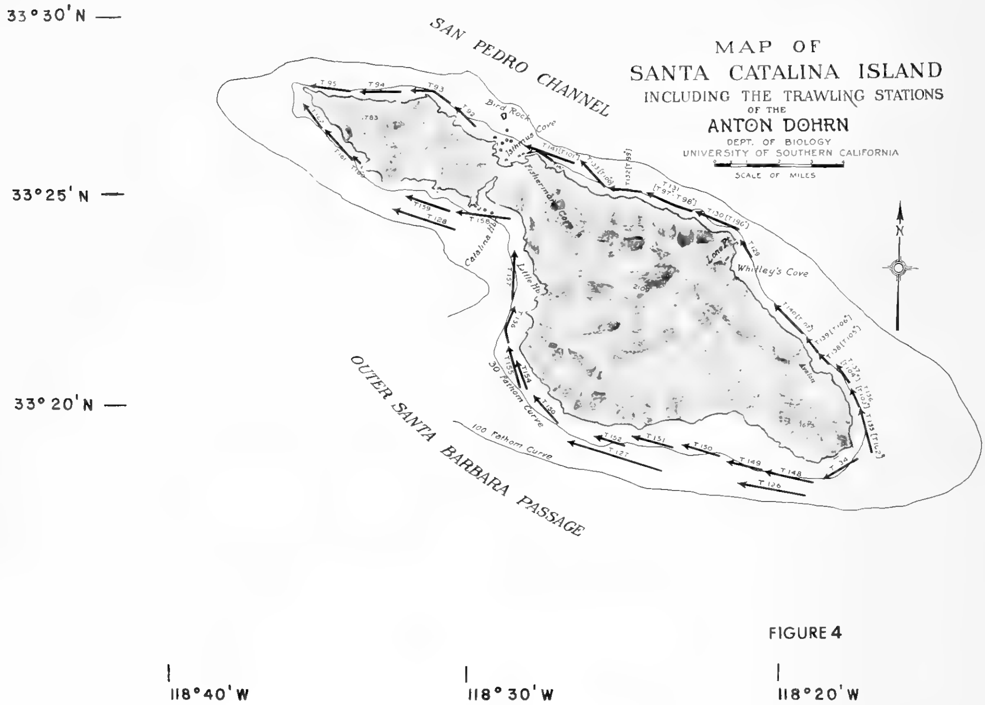

Fig. 4.

Suborder Pleocyemata

Infraorder Caridea

Family Palaemonidae

Palaemonetes hiltoni Schmitt

San Pedro, Stout and Stafford, collectors (Schmitt 1921).

Family Pandalidae

Pandalus danae Stimpson

East of Santa Barbara Island, 29 and 30 July, 1919.

Pandalus gurneyi Stimpson

Off Portuguese Bend, 27 December 1913, T47; Isthmus Harbor, 19 August 1913, T42.

Pandulus platyceros Brandt

Off Long Point, Palos Verdes Pensinula, 55 m, 27 December 1913, T48; off Portuguese Bend, 46 m (Schmitt 1921).

Family Hippolytidae

Hippolyte clarki Chace

From kelp at Portuguese Bend, shore, 14 July 1914 (Chace 1951).

Heptacarpus carinatus Holmes

Laguna Beach, dredged, 18–28 m, W. A. Hilton, collector (Schmitt 1921, as *Spirontocaris carinata*).

Heptacarpus decorus (Rathbun)

Along Long Point, west of Avalon, Santa Catalina Island, 74 m, 19 July 1924, D103; off Long Beach, 14 March 1914, T54.

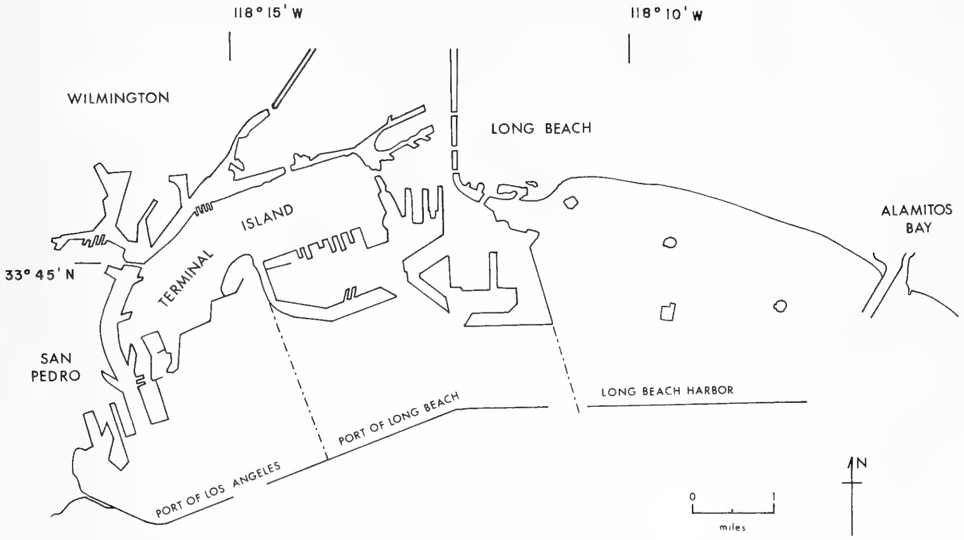

Fig. 5. Map of Los Angeles-Long Beach harbors in 1979, showing development of Terminal Island and Long Beach Harbor.

Heptacarpus franciscanus (Schmitt)
Laguna Beach, W. A. Hilton, collector (Schmitt 1921, as *Spirontocaris franciscana*).

Heptacarpus kincaidi (Rathbun)
South of Point Fermin, 29–30 November 1912; off Venice Beach, 19 September 1911.

Heptacarpus palpator (Owens)
Piling of Long Wharf, 18 July 1912; opposite Long Point, 27 December 1913, T49; east end of Santa Catalina Island, 1 April 1915, T102.

Heptacarpus pictus (Stimpson)
Between base of Government Breakwater and second point toward Point Fermin, low tide, 2 April 1913; west shore of Isthmus Harbor, 27 November 1913; west shore of Isthmus Cove, 29 March 1915. Laguna Beach (Baker 1912; Hilton 1916; as *Spirontocaris pictus*).

Heptacarpus stimpsoni Holthuis
5 miles south of Venice Pier, 26 July 1913, T28; Rocky Point to Point Vicente, 26 m, 10 July 1926; D152; South of Point Fermin, 29–30 November 1914; ¼ mile east of Long Beach, 7–18 m, 7 July 1923, D67; off Seal Beach, 24 April 1926; southwest of Newport, 32 m, 16 June 1915, T113; entrance to Catalina Harbor, 30 December 1912, T19.

Heptacarpus taylori (Stimpson)
Beach west of Long Wharf, 5 December 1911; off Venice Beach, 19 September 1911; west end of Venice Breakwater, 29 October 1913; off Playa del Rey, 2 August 1913; T36; west basin, San Pedro, 15 July 1913.

Heptacarpus tenuissimus Holmes

Off Santa Monica, 52 m, 13 August 1914, T67; 5 miles off Newport, 20 March 1915; east of Santa Barbara Island, 30 July 1919.

Lebbeus lagunae (Schmitt).

Laguna Beach, 22–28 m, 27 August 1917, W. A. Hilton, collector (Schmitt 1921, as *Spirontocaris lagunae*). TYPE LOCALITY.

Lysmata californica (Stimpson)

Venice canals, 16 October 1911; in live fish box off Venice Pier, 7 December 1912. Laguna Beach (Baker 1912; Hilton 1916, 1918; as *Hippolysmata californica*).

Spirontocaris synderi Rathbun

Piles at Long Wharf, 18 July 1912; south of Point Fermin, 29–30 November 1912; entrance to Catalina Harbor, 30 December 1912, T19.

Family Alpheidae

Alpheopsis equidactylus (Lockington)

In holdfast of *Pelagophycus porra* at Venice Beach, 3 October 1911; shore of Catalina Harbor, 28 November 1913. Laguna Beach (Baker 1912; Hilton 1916; as *Alpheus equidactylus*).

Alpheus bellimanus Lockington

In holdfast of *Pelagophycus porra* at Venice Beach, 3 October 1911; entrance to Catalina Harbor, 30 December 1912, T19; west shore of Catalina Harbor, 28 November 1913; west shore of Catalina Harbor, 28 November 1913.

Alpheus clamator Holmes

Piles at Long Wharf, 18 July 1913; ½ mile north of Long Wharf, storm debris, 23 July 1913; under Venice Aquarium, 19 February 1913; west end of Venice Breakwater, 29 October 1913; Venice Beach, 3 October 1911; Venice Breakwater, 26 April 1912; Portuguese Bend, shore, 26 June 1914; Point Fermin to White's Point, 30 November 1912; south of Point Fermin, 29–30 November 1912; north side of Santa Catalina Island, 30 March 1915; west shore of Catalina Island, 28 November 1913; west shore of Isthmus Harbor, low tide, 27 November 1913; between Bird Rock and east shore of Isthmus Cove, 37 m, 28 January 1927, T240; east of Santa Barbara Island, 30 July 1919. Laguna Beach (Baker 1912; Hilton 1916; as *Alpheus dentipes*).

Betaeus harfordi (Kingsley)

Isthmus Harbor, low tide, 27 November 1913; Catalina Harbor, from shell of green abalone, 27 November 1913; entrance to Little Harbor, low tide rocks, 27 December 1912; Rocky Point, from mantle of abalone, 2 February 1912. Laguna Beach (Hilton 1916).

Betaeus longidactylus Lockington

First rocky beach west of Long Whart, 5 December 1911; Rocky Point, 2 February 1912; Portuguese Bend, shore, 26 June 1914; near Point Fermin, shore, 31 July, 1923, Clarke, collector; between base of Government Breakwater and second point toward Point Fermin, low tide, 2 April 1913; Catalina Harbor, 28 November 1913, shore, P. S. Barnhart and party; Catalina Island, shore, 26 April 1916; west

Table 1. Natant decapods taken in 1900–1930.

	Santa Barbara Island	Isthmus area: Santa Catalina Island	Other Areas: Santa Catalina Island	Laguna Beach	Newport Bay	Huntington Beach	Anaheim Slough	Seal Beach	Long Beach	San Pedro	White's Point-Point Fermin	Portuguese Bend-Point Vicente	Rocky Point-Redondo Beach	El Segundo	Playa del Rey	Venice	Santa Monica	References
Alpheopsis equidactylus (Lockington)		x		x												x		Hilton 1918; AHF
Alpheus bellimanus Lockington		x														x		AHF
Alpheus clamator Holmes	x	x	x	x							x	x						Baker 1912; Hilton 1916; AHF
Betaeus harfordi (Kingsley)		x	x	x														Hilton 1916; AHF
Betaeus longidactylus Lockington		x	x	x						x		x	x			x		Baker 1912; Hilton, 1916; AHF
Crangon alaskensis Lockington			x			x		x	x	x	x	x	x	x			x	AHF
Crangon alba Holmes				x							x				x	x		Hilton 1918; AHF
Crangon holmesi Rathbun		x		x								x			x	x		Hilton 1918; AHF
Crangon munitellus Walker			x	x							x	x				x		Hilton 1918; AHF
Crangon munitus Dana		x																AHF
Crangon nigricauda Stimpson					x													Hilton 1918
Crangon nigromaculata Lockington					x				x			x		x		x		Baker 1912; Hilton 1916; AHF
Crangon spinosissima Rathbun											x	x				x		Schmitt 1921; AHF
Heptacarpus carinatus Holmes				x														Schmitt 1921

Table 1. Continued.

	Santa Barbara Island	Isthmus area: Santa Catalina Island	Other Areas: Santa Catalina Island	Laguna Beach	Newport Bay	Huntington Beach	Anaheim Slough	Seal Beach	Long Beach	San Pedro	White's Point-Point Fermin	Portuguese Bend-Point Vicente	Rocky Point-Redondo Beach	El Segundo	Playa del Rey	Venice	Santa Monica	References
Heptacarpus decorus (Rathbun)			x															AHF
Heptacarpus franciscanus (Schmitt)				x														Schmitt 1921
Heptacarpus kincaidi (Rathbun)											x					x		AHF
Heptacarpus palpator (Owen)			x	x								x				x		Hilton 1916; AHF
Heptacarpus pictus (Stimpson)		x		x						x								Baker 1912; Hilton 1916; AHF
Heptacarpus stimpsoni Holthuis		x			x			x	x		x	x				x		AHF
Heptacarpus taylori (Stimpson)				x						x						x		Hilton 1916; AHF
Heptacarpus tenuissimus Holmes	x				x													AHF
Hippolyte clarki Chace												x						Chace 1951
Lebbeus lagunae (Schmitt)				x														Schmitt 1921
Lysmata californica (Stimpson)				x												x		Baker 1912; Hilton 1916, 1918; AHF
Neocrangon communis (Rathbun)			x		x													AHF
Neocrangon resima (Rathbun)			x		x							x				x		AHF

Table 1. Continued.

	Santa Barbara Island	Isthmus area: Santa Catalina Island	Other Areas: Santa Catalina Island	Laguna Beach	Newport Bay	Huntington Beach	Anaheim Slough	Seal Beach	Long Beach	San Pedro	White's Point-Point Fermin	Portuguese Bend-Point Vicente	Rocky Point-Redondo Beach	El Segundo	Playa del Rey	Venice	Santa Monica	References
Ogyrides sp.								x										AHF
Palaemonetes hiltoni Schmitt										x								Schmitt 1921
Pandalus danae Stimpson	x																	AHF
Pandalus gurneyi Stimpson		x										x						AHF
Pandalus platyceros Brandt												x						Schmitt 1921
Penaeus californiensis Holmes									x									AHF
Spirontocaris snyderi Rathbun		x									x					x		AHF
Synalpheus lockingtoni Coutière	x	x		x												x		Schmitt 1921; AHF

shore near entrance of Catalina Harbor, 28 December 1912; west shore of Isthmus Harbor, 27 November 1913; shore of Catalina Harbor, 28 November 1913. Laguna Beach (Baker 1912; Hilton 1916).

Synalpheus lockingtoni Coutiere

East of Santa Barbara Island, 30 July 1919. West shore of Catalina Island, littoral; Venice Beach (Schmitt 1921).

Family Ogyrididae

Ogyrides sp.

Off Seal Beach pier, 24 April 1926, D147.

Family Crangonidae

Crangon alaskensis Lockington

Off Santa Monica, 46 m, 13 August 1914; T67; off Playa del Rey, 2 August 1913; T36; 2 miles south by east of Playa del Rey, 37 m, 8 August 1913; OT40; ½ mile out between El Segundo and Playa del Rey, 10 m, 2 August 1913, T35; east by northeast of Redondo Beach, 29 July 1916, T169; off Point Vicente, 22 July 1922, T207; Point Vicente, 26 m, 10 July 1926, D151; off Long Point, 5 m, 27 December 1913, T48; opposite Long Point, 27 December 1913; T49; off Portuguese Bend, 55 m, 27 December 1913, T46; off Portuguese Bend, 55 m, 27 December 1913, T47; off Portuguese Bend, 15 July 1922, T205; off White's Point, 55 m, 26 December 1912, T45; White's Point to San Pedro, 29–30 November 1912; southwest of Point Fermin and south of White's Point, 65 m, 26 April 1924, D89; off Point Fermin, 18 November 1922, D51; off San Pedro and Long Beach, 15 July 1927; southeast of Los Angeles Breakwater light, 65 m, 14 May 1928, D164; east of Fish Harbor, Wilmington, and west of Edison Power Plant, 7–9 m, 7 July 1923, D64; south of Long Beach, 24 July 1926, D154; Alamitos Bay, 31 March 1913, T23; off Seal Beach pier, 24 April 1926, D147; across from end of pier, Huntington Beach, 24 February 1923; Huntington Beach, 24 February 1922; southwest of Newport, 42 m, 16 June 1915, T111; off Santa Catalina Island, 1913; along Long Point, west of Avalon, 19 July 1924, D103.

Crangon alba Holmes

5 miles south of Venice Pier, 26 July 1913, T28; 2 miles south by east of Playa del Rey, 37 m, OT40; off Point Fermin, 31 m, 25 March 1912, T5; off Long Beach, 1 March 1914, T54. Laguna Beach (Hilton 1918, as *Crago alba*).

Crangon communis Rathbun

Off Newport, 63 m, 6 April 1917, T176; along Long Point, west of Avalon, 74 m, 19 July 1924, D103.

Crangon holmesi Rathbun

2 miles south by east from Playa del Rey, 37 m, 8 August 1913, P. S. Barnhart and party; off Point Vicente, 37 m, 17 December 1926, D153; entrance to Catalina Harbor, 30 December 1912, T19. Laguna Beach (Hilton 1918, as *Crago holmesi*).

Crangon munitellus Walker

Rocky Point to Point Vicente, 26 m, 10 July 1926, D152; south of Point

Table 2. Macrura and Anomura taken in 1900–1930.

	Santa Barbara Island	Isthums area: Santa Catalina Island	Other areas: Santa Catalina Island	Laguna Beach	Newport Bay	Huntington Beach	Anaheim Slough	Seal Beach	Long Beach	San Pedro	White's Point-Point Fermin	Portuguese Bend-Point Vicente	Rocky Point-Redondo Beach	El Segundo	Playa del Rey	Venice	Santa Monica	References
Callianassa affinis Holmes		x		x						x	x	x						Baker 1912; Hilton 1916; AHF
Callianassa californiensis Dana				x														Hilton 1916
Callianassa longimana Stimpson										x								AHF
Panulirus interruptus (Randall)				x												x		Baker 1912; Hilton 1916; AHF
Blepharipoda occidentalis Randall				x	x													Baker 1912; Hilton 1916; AHF
Emerita analoga (Stimpson)				x												x		Baker 1912; Hilton 1916; AHF
Isocheles pilosus (Holmes)				x		x	x		x							x		Hilton 1918; AHF
Lepidopa californica Efford				x														Baker 1912
Munida quadrispina Benedict				x														Hilton 1916
Orthopagurus minimus (Holmes)				x							x				x			Hilton 1918; AHF
Pachycheles holosericus Schmitt				x												x		Nininger 1918; Schmitt 1921
Pachycheles rudis Stimpson				x					x							x		Baker 1912; Hilton 1916; AHF

Table 2. Continued.

	Santa Barbara Island	Isthums area: Santa Catalina Island	Other areas: Santa Catalina Island	Laguna Beach	Newport Bay	Huntington Beach	Anaheim Slough	Seal Beach	Long Beach	San Pedro	White's Point-Point Fermin	Portuguese Bend-Point Vicente	Rocky Point-Redondo Beach	El Segundo	Playa del Rey	Venice	Santa Monica	References
Paguristes bakeri Holmes				x								x			x	x	x	Hilton 1916; AHF
Paguristes ulreyi Schmitt				x							x	x	x		x	x		Hilton 1918; AHF
Pagurus armatus (Dana)												x				x		AHF
Pagurus hirsutiusculus (Dana)				x									x					Hilton 1916; AHF
Pagurus samuelis (Stimpson)		x	x	x						x	x							Hilton 1916; AHF
Petrolisthes cabrilloi Glassell		x	x	x							x					x		Baker 1912; Hilton 1916; AHF
Petrolisthes manimaculis Glassell				x														Hilton 1916; Haig 1960
Petrolisthes rathbunae Schmitt		x	x	x														Hilton 1916; AHF
Phimochirus californiensis (Benedict)		x	x															AHF
Pylopagurus holmesi Schmitt		x																Schmitt 1921

Table 3. Brachyura taken in 1900–1930.

	Santa Barbara Island	Isthmus area: Santa Catalina Island	Other areas: Santa Catalina Island	Laguna Beach	Newport Bay	Huntington Beach	Anaheim Slough	Seal Beach	Long Beach	San Pedro	White's Point-Point Fermin	Portuguese Bend-Point Vicente	Rocky Point-Redondo Beach	El Segundo	Playa del Rey	Venice	Santa Monica	References
Cancer antennarius Stimpson					x				x	x	x					x		Hilton 1916; Rathbun 1930; AHF
Cancer anthonyi Rathbun				x			x	x	x		x	x			x	x		Rathbun 1930, AHF
Cancer branneri Rathbun					x			x				x				x		Nininger 1918; Rathbun 1930; AHF
Cancer gracilis Dana					x	x			x	x	x	x			x	x	x	Rathbun 1930; AHF
Cancer jordani Rathbun			x		x	x	x	x	x	x	x	x		x	x	x		Rathbun 1930; AHF
Cancer productus Randall					x				x									Nininger 1918; Rathbun 1930
Clythrocerus planus Rathbun					x						x	x	x					Schmitt 1912; Rathbun 1937
Cycloxanthops novemdentatus Holmes			x	x	x				x	x	x	x	x			x		Baker 1912; Hilton 1916; Rathbun 1930
Epialtoides hiltoni Rathbun					x													Hilton 1916; Rathbun 1925
Erileptus spinosus Rathbun			x	x														Rathbun 1925; AHF
Fabia lowei Rathbun										x	x							Rathbun 1918
Fabia subquadrata (Dana)				x														Rathbun 1918
Hemigrapsus nudus (Dana)										x	x							AHF
Hemigrapsus oregonensis (Dana)					x	x				x					x			Nininger 1918; Rathbun 1918; AHF
Herbstia parvifrons Randall			x	x		x			x	x						x		Hilton 1916; Nininger 1918; Rathbun 1925

Table 3. Continued.

	Santa Barbara Island	Isthmus area: Santa Catalina Island	Other areas: Santa Catalina Island	Laguna Beach	Newport Bay	Huntington Beach	Anaheim Slough	Seal Beach	Long Beach	San Pedro	White's Point-Point Fermin	Portuguese Bend-Point Vicente	Rocky Point-Redondo Beach	El Segundo	Playa del Rey	Venice	Santa Monica	References
Heterocrypta occidentalis (Dana)			x	x	x			x	x	x	x				x	x	x	Hilton 1916; Nininger 1918; Rathbun 1925; AHF
Lophopanopeus bellus diegensis Rathbun		x						x	x	x	x	x				x		Rathbun 1930; AHF
Lophopanopeus frontalis (Rathbun)			x	x	x	x			x	x								Rathbun 1930; AHF
Lophopanopeus leucomanus heathi Rathbun				x					x							x		Hilton 1916; Rathbun 1930
Lophopanopeus leucomanus leucomanus (Lockington)		x	x	x				x		x	x	x				x		Baker 1912; Hilton 1916; Nininger 1918; Rathbun 1930; AHF
Loxorhynchus crispatus Stimpson		x	x	x						x		x	x			x		Hilton 1916; Rathbun 1925; AHF
Loxorhynchus grandis Stimpson				x						x					x			Hilton 1916; Rathbun 1925; AHF
Malacoplax californiensis (Lockington)						x	x			x								Rathbun 1918
Mursia gaudichaudii (Milne Edwards)			x										x					Rathbun 1937
Opisthopus transversus Rathbun			x	x			x			x					x			Rathbun 1918

Table 3. Continued.

	Santa Barbara Island	Isthmus area: Santa Catalina Island	Other areas: Santa Catalina Island	Laguna Beach	Newport Bay	Huntington Beach	Anaheim Slough	Seal Beach	Long Beach	San Pedro	White's Point-Point Fermin	Portuguese Bend-Point Vicente	Rocky Point-Redondo Beach	El Segundo	Playa del Rey	Venice	Santa Monica	References
Pachygrapsus crassipes Randall			x	x	x			x		x	x	x					x	Baker 1912; Hilton 1916; Rathbun 1918; AHF
Parapinnixa affinis Holmes											x							Schmitt 1921
Paraxanthias taylori (Stimpson)			x	x	x				x	x	x		x				x	Baker 1912; Hilton 1916; Rathbun 1930; AHF
Pelia tumida (Lockington)			x	x	x						x	x	x				x	Hilton 1916; Rathbun 1925
Pilumnus spinohirsutus (Lockington)					x					x	x	x					x	Hilton 1916; Rathbun 1930, AHF
Pinnixa barnharti Rathbun											x						x	Rathbun 1918
Pinnixia littoralis Holmes				x														Rathbun 1918
Pinnixia longipes (Lockington)					x													Nininger 1918
Planes cyaneus Dana				x														AHF
Podochela hemphilli (Lockington)			x	x	x						x					x	x	Rathbun 1930; AHF
Portunus xantusii (Stimpson)			x			x	x	x	x	x	x		x	x	x	x	x	Rathbun 1930; AHF
Pugettia dalli Rathbun			x	x	x						x	x	x	x		x		Rathbun 1925

Table 3. Continued.

	Santa Barbara Island	Isthmus area: Santa Catalina Island	Other areas: Santa Catalina Island	Laguna Beach	Newport Bay	Huntington Beach	Anaheim Slough	Seal Beach	Long Beach	San Pedro	White's Point-Point Fermin	Portuguese Bend-Point Vicente	Rocky Point-Redondo Beach	El Segundo	Playa del Rey	Venice	Santa Monica	References
Pugettia producta (Randall)			x	x						x		x				x		Baker 1912; Hilton 1916; Rathbun 1925
Pugettia richi Dana			x	x					x	x			x		x	x		Hilton 1916; Rathbun 1925; AHF
Pugettia venetiae Rathbun			x		x													Rathbun 1925
Pyromaia tuberculata (Lockington)				x	x			x	x	x	x	x		x	x	x	x	Hilton 1916; Rathbun 1925; AHF
Randallia ornata (Randall)		x	x	x	x				x	x	x	x	x		x	x	x	Baker 1912; Hilton 1916; Rathbun 1937; AHF
Scyra acutifrons Dana				x	x				x		x				x	x		Hilton 1916; Rathbun 1925; AHF
Taliepus nuttalli (Randall)		x	x	x						x		x				x		Hilton 1916; Rathbun 1925

Fermin, 29–30 November 1912; 25 miles southeast of Santa Catalina Island light, 26 m, 17 December 1926, D156; entrance to Catalina Harbor, 30 December 1912, T19. Laguna Beach (Hilton 1918, as *Crago munitellus*).

Crangon munitus Dana

Off first cove east of Catalina Harbor, 23 June 1916, T159.

Crangon nigricauda Stimpson

Balboa (Hilton 1918, as *Crago nigricauda*).

Crangon nigromaculata Lockington

Off Venice Beach, 19 September 1911; 3 miles south of Venice Pier, 26 m, 29 July 1913; T32; ½ mile out between El Segundo and Playa del Rey, 10 m, 2 August 1913, T35; southwest of El Segundo, 4 August 1917, T188; north of Portuguese Bend, 11 July 1928, D3; off Long Beach, 24 July 1926, T236. Laguna Beach (Baker 1912; Hilton 1916).

Neocrangon resima (Rathbun)

Off Long Point, 55 m, 27 December 1913, T48; off Portuguese Bend, 55 m, 27 December 1913, T47; off Newport, 63 m, 6 April 1917, T176; along Long Point, west of Avalon, 74 m, 19 July 1924, D103.

Crangon spinosissima Rathbun

Off Long Point, 55 m, 27 December 1913, T48. Point Fermin, 28 m (Schmitt 1912, as *Crago spinosissima*).

Infraorder Palinura

Family Palinuridae

Panulirus interruptus (Randall)

Venice, in storm debris, 23 July 1914. Laguna Beach (Baker 1912; Hilton 1916).

Infraorder Anomura

Family Callianassidae

Callianassa affinis Holmes

Portuguese Bend, 26 June 1914; Portuguese Bend, shore, 10 April 1915; Point Fermin, in burrows with "blind goby," 1911; between base of Government Breakwater and second point toward Point Fermin, low tide, 2 April 1913; west shore of Isthmus Harbor, 27 November 1913. Laguna Beach (Baker 1912; Hilton 1916, as *Callianassa longimana*).

Callianassa californiensis Dana

Laguna Beach (Hilton 1916).

Callianassa longimana Stimpson

Sand and mud banks of West Basin, San Pedro, 15 June 1913.

Family Paguridae

Pagurus armatus Dana

3 miles southwest by south of Venice Pier, 41 m, 2 August 1913, T33; northwest of Point Vicente, 46 m, 24 June 1914, D14.

Pagurus hirsutiusculus (Dana)

Rocky Point, 4 January 1912. Laguna Beach (Hilton 1916).

Pagurus samuelis (Stimpson)

West of Long Wharf, 14 January 1911; near foot of breakwater to Point Fermin, San Pedro, 21–22 February 1913, P. S. Barnhart; near base of Government Breakwater and second point toward Point Fermin, shore, 2 April 1913; between Government Breakwater and Point Fermin, 1 April 1913; Avalon, littoral, 22 October 1910; Sugar Loaf Rock (Casino Point), Avalon, 19 June 1913; entrance to Little Harbor, 27 December 1912; Catalina Harbor, 28 December 1912.

Orthopagurus minimus (Holmes)

Off Del Rey, 42 m, 11 August 1914, D36; off Point Vicente, 46 m, 23 June 1914, D13. Laguna Beach (Hilton 1918, as *Parapagurus minimus*).

Phimochirus californiensis (Benedict)

Between Bird Rock and East shore, Isthmus Cove, 37 m, 28 January 1927, T240; Isthmus Harbor, 19 August 1913, T44; west shore of Isthmus Harbor, 27 November 1913; west of Avalon, 65 m, 1 April 1915, T106.

Family Diogenidae

Isocheles pilosus (Holmes)

Between Aquarium and end of breakwater, Venice, 11 December 1912; off Venice Beach, 19 September 1911; off Venice Pier, 7 December 1912; under Venice Aquarium, 9 December 1912; off inlet to Long Beach Harbor, 24 March 1912; about 1 mile east of Anaheim Landing, 28 July 1926; across from end of pier, Huntington Beach, 24 February 1912, D55. Laguna Beach (Hilton 1918, as *Holopagurus pilosus*).

Paguristes bakeri Holmes

Off Santa Monica, 46 m, 11 August 1914; beneath Venice Aquarium, 9 December 1912; under Venice Aquarium (no date); 3½ miles southwest from Venice, 44 m, 29 July 1913; off Del Rey, 48 m, 12 August 1914; Hyperion, Santa Monica Bay, 28 July 1917, T186; off Portuguese Bend, 55 m, 27 December 1913; T47; off Portuguese Bend, 55 m, 27 December 1913.

Paguristes ulreyi Schmitt

3 miles south of Venice Pier, 26 m, 29 July 1913, T32; south by east of Playa del Rey, 37 m, 8 August 1913; OT40; Hyperion, Santa Monica Bay, 28 July 1917, T186; Off Redondo Beach, 42 m, 12 August 1914, T61; Rocky Point to Point Vicente, 26 m, 10 July 1926, D152; Point Vicente, 26 m, 10 July 1926, D151; off Long Beach, 14 March 1914, T54. Laguna Beach (Hilton 1918).

Family Galatheidae

Munida quadrispina Benedict

Laguna Beach (Hilton 1918).

Family Porcellanidae

Pachycheles holosericus Schmitt

Venice (Schmitt 1921). TYPE LOCALITY. Laguna Beach (Nininger 1918).

Pachycheles rudis Stimpson

From piles of Long Wharf, 15 July 1914; piles of Long Wharf, 10 July 1914; off piles of Long Wharf, 18 July 1914; under Venice Aquarium, 9 March 1913, Ross Beck; under Venice Aquarium, 19 February 1913, J. Ross Beck; end of Venice breakwater, 25 October 1912;

north end of Venice breakwater, 26 April 1912; Venice breakwater, 13 March 1913; west end of Venice breakwater, 29 October 1913; off inlet to Long Beach Harbor, 24 March 1912. Laguna Beach (Baker 1912; Hilton 1916).

Petrolisthes cabrilloi Glassell

Venice pier and breakwater, 3 January 1912; under Venice Aquarium, 24 January 1913, J. Ross Beck; west end of Venice breakwater, 29 October 1913; under Venice Aquarium, 9 March 1913, Ross Beck; near foot of breakwater to Point Fermin, 21–22 February 1913, P. S. Barnhart; Catalina Harbor, shore, 28 November 1913, P. S. Barnhart; west shore near entrance of Catalina Harbor, 28 December 1912; Catalina Harbor, 28 December 1912; Sugar Loaf Rock, Avalon Bay, 18 June 1913. Laguna Beach (Baker 1912; Hilton 1916, as *Petrolisthes cincitipes*).

Petrolisthes manimaculis Glassell

Laguna Beach (Hilton 1916, as *Petrolisthes eriomerus*).

Petrolisthes rathbunae Schmitt

West shore near entrance of Catalina Harbor, 28 December 1912; Sugar Loaf Rock, Avalon Bay, 18 June 1913; Catalina Harbor, shore, low tide, 28 November 1913; west shore of Isthmus Cove, 29 March 1915. Laguna Beach (Hilton 1916).

Family Hippidae

Emerita analoga (Stimpson)

1–1½ miles north of Long Wharf, from storm debris, 23 July 1914; 1 mile west of Long Wharf, 1 August 1914. Laguna Beach (Baker 1912; Hilton 1916).

Family Albuneidae

Blepharipoda occidentalis Randall

On bar in main channel, Balboa, Newport Bay, 15 December 1914, Higgins, Hobbs, and Burnight. Laguna Beach (Baker 1912; Hilton 1916).

Lepidopa californica Efford

Laguna Beach (Baker 1912; as *Lepidopa myops*).

Infraorder Brachyura

Family Dorippidae

Clythrocerus planus Rathbun

Off Point Vicente, 37 m, 31 July 1926, D153; Point Fermin to White's Point, 29–30 November 1912. Near Rocky Point, 22 m, 10 May 1924; near Rocky Point, 17 May 1924; Long Beach, 18 m, 25 October 1924; Laguna Beach (Rathbun 1937).

Family Leucosiidae

Randallia ornata (Randall)

Off Point Dume, 25 July 1914; near Point Dume, 25 July 1914; off Malibu Cove, 34 m, 1 August 1914; off Santa Monica, 42 m, 8 August 1914; off Santa Monica, 46 m, 11 August 1914; off Long Wharf, 46 m, 1 August 1914; about 2 miles southwest of Venice, 46 m, 11 July 1914; 1½ miles southwest of Venice, 46 m, 11 July 1914; 2 miles south by east of Playa del Rey, 37 m, 8 August 1913;

off Del Rey, 42 m, 11 August 1914; off Point Vicente, 46 m, 23 June 1914; off Point Vicente, 46 m, 23 June 1914; northwest of Point Vicente, 46 m, 24 June 1914; Portuguese Bend, 3 July 1926; Point Fermin to White's Point, 30 November 1912; due south from Point Fermin buoy, 29 November 1912; Santa Catalina Island to San Pedro Hill, 25 March 1912; off Government Breakwater, San Pedro, 2 April 1913; outer harbor, San Pedro, 3 April 1913; Long Beach, 21 July 1923; entrance to Catalina Harbor, 30 December 1912. Between Long Wharf and Venice, 8 August 1914; off Long Wharf, Venice, 1 August 1914; southwest of Venice, 11 July 1914; between Venice and Rocky Point, 11 August 1914; near Rocky Point, 10 May 1924, 22 m, D93; Point Vicente, 15 m, 5 July 1924; Point Vicente, 28 m, 5 November 1924; near Portuguese Bend, 23 June 1914; near Portuguese Bend, 24 June 1914; off Point Fermin, 18 November 1922; 3 miles south of Point Fermin, 29 November 1912; south of San Pedro Breakwater, 37 m, 24 September 1924, D105; Long Beach, 3 October 1925, 17 October 1925, 21 November 1922; just east of beach, Long Beach, 4 November 1922; Newport, 42 m, 16 June 1915, T109; Newport, 5 April 1917; Catalina Harbor, 23 June 1916; southwest of Catalina Harbor, 23 June 1916 (Rathbun 1937). Laguna Beach (Baker 1912; Hilton 1916).

Family Calappidae

Mursia gaudichaudii (Milne Edwards)

Near Rocky Point, 17 May 1924; off Santa Catalina Island, 92 m, H. N. Lowe (Rathbun 1937).

Family Majidae

Erileptus spinosus Rathbun

Entrance to Catalina Harbor, 30 December 1912, T17; entrance to Catalina Harbor, 39 December 1912, T19; 1½ miles south of Catalina Harbor, 30 December 1912, T18; Isthmus Harbor, 1 January 1913, T20; north side of Santa Catalina Island, 30 March 1915, T94. Off Santa Catalina Island, 92 m, H. N. Lowe (Rathbun 1925).

Podochela hemphilli (Lockington)

Venice, 5 August 1922; south by west of Venice, 44 m, 29 July 1913, T30; south by east from Playa del Rey, 37 m, 8 August 1913, OT40; south of Los Angeles Breakwater lighthouse, 12 July 1924; D102; Terminal Island, San Pedro Bay, 31 March 1915; Seal Rock, Santa Catalina Island, 15 June 1916, T135; southeast of Avalon, 15 June 1916, T136; entrance to Catalina Harbor, 30 December 1912, T17; entrance to Catalina Harbor, 30 December 1912, T19; Isthmus Harbor, 1 January 1913, T20; west shore of Isthmus Harbor, 27 November 1913; north side of Santa Catalina Island, 33 m, 31 March 1915, T99. North side of Santa Catalina Island, 31 March 1915, T96; Venice, 8 August 1913; Laguna Beach (Rathbun 1925). Laguna Beach (Niniger 1918).

Pyromaia tuberculata (Lockington)

Off Santa Monica, 46 m, 11 August 1914; about 2 miles southwest of Venice, 46 m, 11 July 1914, D23; off Del Rey, 42 m, 11 August

1914; 2–3 miles off Playa del Rey, 29 July 1913, T29; 2 miles southeast from Playa del Rey, 37 m, 8 August 1913, OT40; off Playa del Rey, 2 August 1913, T36; ½ mile out between El Segundo and Playa del Rey, 10 m, 2 August 1913; off El Segundo, 37 m, 12 August 1914, T64; southwest of El Segundo, 4 August 1917; T188; off Point Vicente, 37 m, 31 July 1926, D153; Point Fermin to White's Point, 29–30 November 1912; south of Point Fermin, 59 m, 19 April 1924, D87; from bend in breakwater to buoy, San Pedro, 17 m, 16 February 1924, D81; off Wilmington and Long Beach, 5 August 1922, T212; off Long Beach (no date); center of Long Beach, 18–22 m, 29 July 1922, T209; between Seal Beach and Long Beach, 4 November 1922, D44; ¼ mile north of Point Orange, Balboa, Newport Bay, 28 November 1914, Rittenhouse and party; southwest of Newport, 32 m, 16 June 1915, T113; southwest of Newport, 16 June 1915, T112. Off Venice, 2 August 1913; off Venice, 29 July 1913; southwest of Venice, 11 July 1914; between El Segundo and Playa del Rey, 2 August 1913; San Pedro, H. N. Lowe and E. P. Chace; Long Beach, H. N. Lowe; Alamitos Bay, H. N. Lowe; Balboa, Laguna, W. A. Hilton (Rathbun 1925). Balboa Beach (Hilton 1916 as *Dasygius tuberculatus*).

Epialtoides hiltoni (Rathbun)

Laguna Beach (Hilton 1916; as *Epialtus bituberculatus*; Rathbun 1925; as *Epialtus hiltoni*).

Taliepus nuttalli (Randall)

Off Venice pier, 7 December 1912; ¼ mile west of Venice pier, live fish trap, 7 December 1912; kelp in Portuguese Bend, 14 July 1914; San Pedro, H. N. Lowe; Avalon Bay (no date); Avalon Bay, 22 October 1910; west shore of Isthmus Harbor, 27 November 1913; west shore of Isthmus Cove, 29 March 1915 (Rathbun 1925). Laguna Beach (Hilton 1916, as *Epialtus nuttalli*).

Pugettia dalli Rathbun

Off Del Rey, 42 m, 11 August 1914; 3 miles south of Government Breakwater, San Pedro, 14 March 1914, T51; Avalon Bay, 22 October 1910; west shore of Isthmus Harbor, 27 November 1913. Between Venice and Rocky Point, 11 August 1914; Point Vicente, February 1918; off Point Fermin, 14 March 1914; Laguna Beach, W. A. Hilton (Rathbun 1925).

Pugettia producta (Randall)

Venice Breakwater and below Aquarium, February 1911; Venice breakwater, 25 October 1912; under Venice Aquarium, 24 January 1913; Venice breakwater, 13 March 1913; Portuguese Bend, 26 June 1914; Portuguese Bend, 14 July 1914; near foot of San Pedro Breakwater, 21–22 February 1913; San Pedro Breakwater, 30 October 1917, E. P. Chace; Laguna Beach, W. A. Hilton; west shore of Isthmus Harbor, 27 November 1913; west shore of Isthmus Cove, 29 March 1915; Avalon Bay, 22 October 1910 (Rathbun 1925). Laguna Beach (Baker 1912; Hilton 1916; as *Epialtus productus*).

Pugettia richi Dana

Under Venice Aquarium, 24 January 1913; Venice breakwater, 16 October 1913; southwest from Venice, 44 m, 29 July 1913, T30; 2 miles south by east from Playa del Rey, 8 August 1913, 37 m, P. S. Barnhart and party; off Playa del Rey, 2 August 1913; T36; Rocky Point, south of Redondo, 2 February 1912; off Long Beach (no date). Venice, 2 February 1911; under Venice Aquarium, 16 October 1913; off Venice, 2 August 1913; San Pedro, 15 December 1918, E. P. Chace; Long Beach wharf, H. N. Lowe; Laguna Beach, W. A. Hilton; off Santa Catalina Island, 92 m, H. N. Lowe (Rathbun 1925). Laguna Beach (Hilton 1916).

Pugettia venetiae Rathbun

5 miles off Newport Beach, 20 March 1915, T89. TYPE LOCALITY. Off east end of Santa Catalina Island, 55 m, 1 April 1915 (Rathbun 1925).

Scyra acutifrons Dana

Venice breakwater, 25 October 1922; end of Venice breakwater, 25 October 1912; 3 miles south of Venice pier, 26 m, 29 July 1913, T32; 2 miles south by east from Playa del Rey, 37 m, 8 August 1913, OT40; off Long Beach, 18 m, 14 March 1914, T55; southwest of Newport, 42 m, 16 June 1915, T111. Off Venice, August 1913–1914; off Point Fermin, 14 March 1914; Laguna Beach, W. A. Hilton (Rathbun 1925). Laguna Beach (Hilton 1916).

Loxorhynchus crispatus Stimpson.

Southwest of Venice, 28 July 1917, T186; southwest by south of Venice pier, 41 m, 2 August 1913, T33; 3½ miles south by west from Venice, 44 m, 29 July 1913, T30; 2 miles south by east of Playa del Rey, 37 m, 8 August 1913, P. S. Barnhart and party; off Manhattan Beach, 30 m, 12 August 1914, T63; off Portuguese Bend, 15 July 1922, T205; ¼ mile from Government Breakwater, San Pedro, 2 April 1913, D10a; entrance to Catalina Harbor, 30 December 1912, T19; Isthmus Cove, 29 March 1915, T90. Between Venice and Rocky Point, 12 August 1914; San Pedro, 7 m, H. N. Lowe; entrance to Catalina Harbor, 30 December 1912; off Santa Catalina Island, 92 m, H. N. Lowe (Rathbun 1925). Laguna Beach (Hilton 1916).

Loxorhynchus grandis Stimpson

2 miles south by east of Playa del Rey, 8 August 1913, 37 m, P. S. Barnhart and party; San Pedro, June 1911; Alamitos Bay (no date). San Pedro Bay, 18 m, H. N. Lowe; San Pedro Breakwater, June 1911 (Rathbun 1925). Laguna Beach (Hilton 1916).

Pelia tumida (Lockington)

Venice pier and breakwater, 3 January 1912; under Venice Aquarium, 19 February 1913; Venice breakwater, 16 October 1913; west end of Venice breakwater, 29 October 1913; Avalon Bay, 22 October 1910. Venice breakwater, 29 October 1913; between Venice and San Pedro, 18 June 1913; Point Vicente, February 1918, H. N. Lowe; Reef Point, 6 July 1917, E. P. Chace; San Pedro, H. N. Lowe; Long

Beach, H. N. Lowe; Isthmus Harbor; off Santa Catalina Island, 92 m, H. N. Lowe (Rathbun 1925). Laguna Beach (Hilton 1916, as *Pelia clausa*; Nininger 1918).

Herbstia parvifrons Randall

San Pedro, H. N. Lowe; Long Beach, H. N. Lowe; Laguna Beach, W. A. Hilton; San Pedro to Catalina Island, 27 November 1913; west shore of Isthmus Harbor, 27 November 1913; Isthmus Harbor (Rathbun 1925). Laguna Beach (Hilton 1916; Nininger 1918).

Family Parthenopidae

Heterocrypta occidentalis (Dana)

Santa Monica Bay, 10 May 1912; Hyperion, Santa Monica Bay, 28 July 1917, T186; southwest of El Segundo, 4 August 1917, T188; off Point Vicente, 22 July 1922, T207A; off Point Vicente, 37 m, 31 July 1926, D153; Portuguese Bend, 3 July 1926; off Point Fermin, San Pedro, 17 m, 29 March 1924, D82; from bend in breakwater to buoy, San Pedro, 17 m, 16 February 1924, D81; San Pedro, 27 May 1901; Long Beach, 24 March 1912; ½ mile off San Pedro Breakwater, 24 February 1928, T248; northeast of breakwater light, Long Beach, 12 July 1924, D102; off Wilmington and Long Beach, 5 August 1922, T212; Seal Beach, 26 April 1926; south of Seal Beach, 26 m, 3 November 1923, D77; on bar in main channel, Balboa, Newport Bay, shore, 15 December 1914, Higgins, Hobbs, and Burnight. Off Venice, 1913–1914; off San Pedro, 1912–1924; San Pedro, M. Baldridge and H. N. Lowe; off Santa Catalina Island, H. N. Lowe (Rathbun 1925). Laguna Beach (Hilton 1916; Nininger 1918).

Family Cancridae

Cancer antennarius Stimpson

Venice, 27 June 1926; Venice, 27 March 1913; Venice pier and breakwater, 3 January 1912; end of Venice breakwater, 25 October 1912; under Venice Aquarium, 19 February 1913; west end of Venice breakwater, 29 October 1913; 1–1½ miles north of Long Wharf, storm debris, 23 July 1914; between base of Government Breakwater and second point toward Point Fermin, low tide, 2 April 1913. Under Venice Aquarium, 9 March 1913, J. Ross Beck; Venice Aquarium, 29 October 1913, Venice Aquarium, 13 March 1913; White's Point, 18 May 1919, E. P. Chace; San Pedro Breakwater, 18 m, 30 November 1912; San Pedro, Baker, collector; off Long Beach, 10 m, 16 May 1925; Los Angeles-Long Beach Harbor, 10 July 1914; Long Beach, H. N. Lowe; Laguna, W. A. Hilton (Rathbun 1930). Laguna Beach (Hilton 1916).

Cancer anthonyi Rathbun

West end of Venice breakwater, 16 April 1912, P. S. Barnhart; 3 miles south of Venice pier, 26 m, 29 July 1913, T32; Venice pier and breakwater, 3 January 1912; off Playa del Rey, 2 August 1913, T36; 2 miles south by east from Playa del Rey, 37 m, 8 August 1913, OT40; Point Fermin, 9 June 1926; center of Long Beach, 18–22 m, 29 July 1922, T209. Off Venice, 2 August 1912; White's Point, 18 May 1919, E. P. Chace; San Pedro, 18 May 1919, E. P. Chace, Long

Beach, H. N. Lowe; off Long Beach, 10 m, 16 May 1925; Seal Beach, 28 July 1923; Anaheim Bay, 18 November 1918, E. P. Chace; about 1 mile east of Anaheim Landing, 28 July 1926; off Santa Catalina Island, 92 m, H. N. Lowe (Rathbun 1930).

Cancer branneri Rathbun

Under Aquarium, Venice, 24 January 1913, J. Ross Beck; off Point Vicente, 37 m, 31 July 1926, D153. Seal Beach, 5 m, 24 February 1923 (Rathbun 1930).

Cancer gracilis Dana

Off Santa Monica, 46 m, 11 August 1914, D37; off Santa Monica, 46 m, 11 August 1914, D38; south of Venice pier, 26 m, 29 July 1913, T32; 3 miles southwest by south of Venice pier, 41 m, 2 August 1913, T33; off Del Rey, 42 m, 11 August 1914, D36; off Point Vicente, 37 m, 31 July 1926, D153; center of Long Beach, 18–22 m, 29 July 1922, T209; off Long Beach, 18 m, 25 October 1924, D108; Wilmington to Long Beach, 5 August 1922, T212; 5 miles off Newport, 20 March 1915, T89. Between Venice and Rocky Point, 11 August 1914; off Point Vicente, 26 m, 29 July 1913; off Point Vicente, 18 m, 1924; Point Fermin, 16 July 1923; south side of San Pedro Bay, east of Long Beach, 4 November 1922; off Long Beach, 21 October 1922; Newport Bay, 26 November 1914; Laguna Beach, W. A. Hilton (Rathbun 1930).

Cancer jordani Rathbun

3½ miles south by west from Venice, 44 m, 29 July 1913, T30; 2–3 miles off Playa del Rey, 29 July 1913, T29; south by east from Playa del Rey, 37 m, 8 August 1913, OT40; ½ mile out between El Segundo and Playa del Rey, 10 m, 2 August 1913, T35; kelp in Portuguese Bend, 14 July 1914; up channel from Point Orange in Newport Bay, 27 November 1914, T81; west shore of Isthmus Harbor, 27 November 1913. Santa Monica, E. P. Chace; off Venice, 29 July 1913; off Venice, 2 August 1913; south of Venice breakwater, 37 m; 2 miles out between Playa del Rey and El Segundo, 2 August 1913; Point Vicente, 5 July 1924, 15 m; Point Vicente, 26 m, 15 November 1924; Point Fermin, 16 July 1923; San Pedro, H. N. Lowe; San Pedro, E. P. Chace; Long Beach, 18 m, H. N. Lowe; off Long Beach, 10 m, 16 May 1925; Seal Beach, 6 m, 24 February 1923; Laguna Beach, W. A. Hilton (Rathbun 1930).

Cancer productus (Randall)

Laguna Beach, 22–28 m (Rathbun 1930). Laguna Beach (Nininger 1918).

Family Xanthidae

Cycloxanthops novemdentatus Holmes

Venice pier and breakwater, 3 January 1912; near Point Vicente, 17 July 1923; Point Fermin, 9 June 1926; between base of Government Breakwater and second point toward Point Fermin, 2 April 1913; near foot of breakwater to Point Fermin, San Pedro, 21–22 February 1913, P. S. Barnhart; Laguna Beach, April 1923, A. D. Howard; Catalina Harbor, 28 November 1913, P. S. Barnhart; north side of Santa Catalina Island, near West End, 30 March 1915, T95; Santa

Catalina Island, 26 April 1916; west shore near entrance of Catalina Harbor, 28 December 1912; Sugar Loaf Rock, Avalon Bay, 18 June 1913; west shore of Isthmus Harbor, 27 November 1913. Venice, 13 March 1913, J. R. Beck; Redondo, E. P. Chace; Point Fermin, 25 March 1918; San Pedro, H. N. Lowe, December 1924; Laguna, W. A. Hilton; Avalon, C. F. Baker (Rathbun 1930). Laguna Beach (Baker 1912; Hilton 1916).

Lophopanopeus bellus diegensis Rathbun

3 miles southwest by south of Venice pier, 41 m, 2 August 1913; off Point Vicente, 46 m, 23 June 1914, D13; from bend in breakwater to buoy, San Pedro, 16 February 1924, 17 m, D81; off Long Beach, 18 m, 14 March 1914, T55; off Seal Beach pier, 24 April 1926, D147; along Long Point, west of Avalon, 19 July 1924, D103; entrance to Catalina Harbor, 30 December 1912, T19; west shore of Isthmus Harbor, 27 November 1913. Off Santa Monica, August 1913–1914; off Venice, August 1913–1914; Venice breakwater, 19 February 1913; south of Venice breakwater, 37 m, 24 September 1924; Point Vicente, February 1918, H. N. Lowe; near Portuguese Bend, 23 June 1914; off Point Fermin, 14 March 1914; San Pedro, H. N. Lowe; Long Beach, 30 m, 26 September 1926; Long Beach, 52 m, 17 October 1925; Long Beach, 44 m, 17 October 1925 (Rathbun 1930, as *Lophopanopeus diegensis*).

Lophopanopeus frontalis (Rathbun)

Venice, March 1911; ¼ mile north of Point Orange, Balboa, Newport Bay, 28 November 1914, Rittenhouse and party; Isthmus Harbor, 1 January 1913, T20; north side of Santa Catalina Island, 33 m, 31 March 1915, T99. About 1 mile east of Anaheim Landing, 28 July 1926; Anaheim Bay, piles, February 1918, H. N. Lowe (Rathbun 1930). San Pedro, H. N. Lowe; Long Beach, H. N. Lowe; Anaheim Slough, Lena Higgins; Newport, 27 November 1914 (Rathbun 1930, as *Lophopanopeus lockingtoni*).

Lophopanopeus leucomanus heathii Rathbun

Venice, under Aquarium, February 1911, P. S. Barnhart; San Pedro, shore, 1924, E. P. Chace (Rathbun 1930, as *Lophopanopeus heathii*). Laguna Beach (Hilton 1916, as *L. heathii*).

Lophopanopeus leucomanus leucomanus (Lockington)

From haptera of *Pelagophycus porra* on Venice Beach, 3 October 1911; Venice breakwater, 13 March 1913; west end of Venice breakwater, 29 October 1913; Portuguese Bend, August 1924; Portuguese Bend, shore, 26 June 1914; between base of Government Breakwater and second point toward Point Fermin, 2 April 1913; from bend in breakwater to buoy, San Pedro, 16 February 1924, 17 m, D81; 3 miles south of Government Breakwater, 14 March 1914, T51; Fisherman's Cove, Santa Catalina Island, 25 April 1916; southeast of Avalon, 10 June 1916, T136; Isthmus Harbor, 27 July 1919; entrance to Catalina Harbor, 30 December 1912, T19; west shore of Isthmus Harbor, 27 November 1913; west shore of Isthmus Cove, 29 March 1915. Venice, in kelp holdfast at breakwater, 29 October

1913; Point Vicente, February 1918, H. N. Lowe; San Pedro, H. N. Lowe; San Pedro, 1901, T. D. A. Cockerell; San Pedro, 15 December 1918, E. P. Chace; near foot of San Pedro Breakwater, 30 October 1917; White's Point, 18 May 1918; White's Point, November 1924; Seal Beach, 2 March 1919, E. P. and E. M. Chace; Laguna Beach, W. A. Hilton; Catalina Harbor, 15 April 1915 (Rathbun 1930, as *Lophopanopeus leucomanus*). Laguna Beach (Baker 1912; Hilton 1916; Nininger 1918; as *L. leucomanus*).

Paraxanthias taylori (Stimpson)

Under Venice Aquarium, 19 February 1913; Venice breakwater, 13 March 1913; west end of Venice breakwater, 29 October 1913; near Point Vicente, 17 July 1923; Portuguese Bend, 26 June 1914; breakwater at San Pedro, 21–22 February 1913; Catalina Harbor, 28 November 1913, P. S. Barnhart and party; near West End, north side of Santa Catalina Island, 30 March 1915, T95; Fisherman's Cove, Santa Catalina Island, 25 April 1916; entrance to Little Harbor, 27 December 1912; west shore near entrance to Catalina Harbor, 28 December 1912; west shore of Isthmus Harbor, 27 November 1913; north side of Santa Catalina Island, 1 April 1915, T104; west shore of Isthmus cove, 29 March 1915. Point Vicente, 1918, H. N. Lowe; Portuguese Bend, 26 June 1914; San Pedro, 15 December 1918, E. P. Chace; San Pedro, H. N. Lowe; foot of San Pedro Breakwater, 21 February 1913; Long Beach, H. N. Lowe; Laguna Beach, W. A. Hilton; Isthmus of Santa Catalina Island, 27 December 1912; Isthmus Harbor, 27 November 1913; Catalina Harbor, 1 April 1915; Avalon Bay, 22 October 1910; Seal Beach, 2 March 1911, E. P. and E. M. Chace (Rathbun 1930). Laguna Beach (Baker 1912; Hilton 1916, as *Xanthias taylori*).

Pilumnus spinohirsutus (Lockington)

White's Point, 10 October 1911. San Pedro, 1917, E. P. Chace; Long Beach, H. N. Lowe; Santa Catalina Island, H. N. Lowe (Rathbun 1930). Laguna Beach (Hilton 1916).

Family Portunidae

Portunus xantusii (Stimpson)

3 miles south of Venice pier, 26 m, 29 July 1913; 2 miles south by east from Playa del Rey, 37 m, 8 August 1913; T40; ½ mile out between El Segundo and Playa del Rey, 10 m, 2 August 1913, T35; San Pedro, 27 May 1901; off inlet to Long Beach Harbor, 24 March 1912; Anaheim Slough, 9 January 1926; ¼ mile north of Point Orange, Balboa, Newport Bay, 15 December 1914, Higgins, Hobbs, and Burnight; east to north shore of Catalina Harbor, 28 December 1912; entrance to Catalina Harbor, 30 December 1912. 3 miles out between El Segundo and Point Del Rey, 2 August 1913; near Rocky Point, 22 m, 10 May 1924; Point Vicente, 15 m, 5 July 1924; San Pedro, H. N. Lowe; south side of San Pedro Bay, 13 October 1914; Long Beach, 24 March 1912; off Long Beach, 22 m, 21 October 1922; off Long Beach, 10 m, 16 May 1925; between Long Beach and Seal Beach, 9 m, 4 February 1922; Anaheim Bay, E. P. Chace;

Table 4. Species not reported in 1900–1930.

Species described before 1930
Alpheus californiensis Holmes
Callinectes arcuatus Ordway A (Garth and Stephenson 1966)
Cancer oregonensis (Dana) A (Word 1975)
Euphylax dovii Stimpson A (Word 1976)
Mimulus foliatus Stimpson A (Garth and Abbott 1980)
Paguristes parvus Holmes (Haig and Wicksten 1975)
Pagurus granosimanus (Stimpson) (Wicksten 1982)
Palaemon macrodactylus Rathbun A
Palaemonella holmesi (Nobili) A (Holthuis 1951)
Panulirus gracilis Streets A
Pinnixa franciscana Rathbun
Pinnixa occidentalis Rathbun
Pinnixa schmitti Rathbun
Pleuroncodes planipes Stimpson A
Podochela lobifrons Rathbun (Garth 1958)
Scleroplax granulata Rathbun
Spirontocaris prionota (Stimpson)
Uca crenulata (Lockington)
Upogebia pugettensis (Dana)
A = accidental
Species described after 1930
Betaeus ensenadensis Glassell
Betaeus macginitieae Hart, 1964
Crangon handi Kuris and Carlton, 1977
Crangon zacae (Chace)
Enallopagurus guatemoci (Glassell) (Walton 1954)
Eualus lineatus Wicksten and Butler, 1983
Haigia diegensis (Scanland and Hopkins) (Haig and Wicksten 1975)
Pagurus caurinus Hart A (Haig and Wicksten 1975)
Pagurus quaylei Hart
Pagurus redondoensis Wicksten, 1982
Pagurus spilocarpus Haig, 1977
Plesionika mexicana Chace A (Wicksten 1978)
Polyonyx quadriungulatus Glassell (Haig 1956)
Pseudocoutierea elegans Holthuis A (Holthuis 1951)
Sicyonia ingentis (Burkenroad) (Word and Charwat 1976)

Newport Bay, 26 November 1914; Newport Bay, 27 November 1914; Balboa, 16 December 1914 (Rathbun 1930).

Family Pinnotheridae

Fabia lowei Rathbun

San Pedro, H. N. Lowe; Long Beach, H. N. Lowe; Alamitos Bay (Rathbun 1918).

Fabia subquadrata (Dana)

Laguna Beach, W. A. Hilton (Rathbun 1918).

Opisthopus transversus Rathbun

2 miles south by east of Point Del Rey, 8 August 1913. San Pedro, H. N. Lowe; Anaheim Landing, H. N. Lowe; Catalina Island, H. N. Lowe; Laguna Beach, W. A. Hilton (Rathbun 1918).

Pinnixa barnharti Rathbun

Under pier at Venice. TYPE LOCALITY. San Pedro, 1901, T. D. A. Cockerell (Rathbun 1918).

Pinnixa littoralis Holmes
Off Santa Catalina Island 92 m, H. N. Lowe (Rathbun 1918).
Pinnixa longipes (Lockington)
Laguna Beach (Niniger 1918).
Family Goneplacidae
Malocoplax californiensis (Lockington)
West Basin, San Pedro, 8 June 1912; Anaheim Creek, November 1911.
Family Grapsidae
Hemigrapsus nudus (Dana)
Between Government Breakwater and Point Fermin, San Pedro, 1 April 1913; Point Fermin, 2 April 1913.
Hemigrapsus oregonensis (Dana)
West Basin, San Pedro, 8 June 1912; up channel from Point Orange, Newport Bay, 27 November 1914, T81. Playa del Rey, October 1915; Laguna Beach, W. A. Hilton; off Santa Catalina Island, H. N. Lowe (Rathbun 1918). Balboa (Nininger 1918).
Pachygrapsus crassipes Randall
1–1½ miles north of Long Wharf, storm debris, 23 July 1913; under Venice Aquarium, 17 February 1913; east of Flat Rock, 24 June 1914; Portuguese Bend, 10 April 1915; near foot of breakwater to Point Fermin, San Pedro, 21–22 February 1913; P. S. Barnhart; between base of Government Breakwater and second point toward Point Fermin, 2 April 1913; between Government Breakwater and Point Fermin, 1 April 1913; West Basin, San Pedro, 8 June 1912; off Long Beach, 30 m, 17 July 1926, T233; Anaheim Slough, 9 January 1916; Catalina Harbor, 28 December 1912; T19; Avalon Bay. About 1 mile east of Anaheim Landing, 28 July 1926 (Rathbun 1918). Laguna Beach (Baker 1912; Hilton 1916).
Planes cyaneus Dana
Avalon Bay.

Discussion

Only two species (*Ogyrides* sp. and *Palaemonetes hiltoni*) taken in the early collections have not been found in the area since then. The original collection site of *P. hiltoni* in San Pedro probably has been destroyed. *Parapinnixa affinis,* described by Holmes from a specimen at Deadman's Island, has been found only once again in Newport Bay (Glassell 1933).

A noteworthy absence from the early records is the peneid shrimp *Sicyonia ingentis.* This large shrimp has been taken frequently by trawls along the mainland coast of southern California (Word and Charwat 1976). Although the species was not described until 1938, one might expect such a common animal to have been found earlier.

Some of the old records refer to species by names no longer used for them. Schmitt (1921) mentioned receiving the grass shrimp *Hippolyte californiensis* from the Venice Marine Biological Station. These specimens later were referred to *H. clarki* (Chace 1951). Records of *Petrolisthes eriomerus* at Santa Catalina Island and Venice actually refer to *P. cabrilloi,* recognized as a distinct species in 1945. Old records of *Pagurus ochotensis* should be referred to *Pagurus armatus* (Haig and Wicksten 1975).

A few of the old records probably are based on misidentifications or inaccurate data on the collection site. Baker (1912) and Hilton (1916) reported the ghost shrimp *Callianassa longimana* from rocky tidepools at Laguna Beach. *Callianassa affinis* usually lives in such a habitat. Rathbun (1918) reported the yellow shore crab *Hemigrapsus oregonensis* at 50 fathoms off Santa Catalina Island. This crab is almost strictly intertidal.

The majority of the species taken by the early collectors inhabit shallow subtidal sandy bottoms or intertidal rocky areas. The difficulties of collecting among subtidal rocks before the invention of SCUBA gear prevented taking specimens common among kelp beds. Unfortunately, there are few records from tidal marshes and eelgrass beds.

Most of the species listed by early collectors still can be found in the same area. The vicinity of Venice, however, had a greater number of species in the past than at present. Most recent collections have yielded soft-bottom species and hardy rocky or sandy intertidal animals. In contrast, the old records show not only a soft-bottom species but also abundant rocky intertidal and subtidal species. Was there a more extensive hard bottom in the past? Were there simply more dedicated collectors in Venice than in other areas? Has the area become more turbid or more polluted? Further study may show why there seems to have been such a change in the fauna.

Of the 34 additional species known from shallow waters of Los Angeles and Orange counties, about 11 probably are not residents. Many of the others are burrowers, commensals, or rocky subtidal dwellers. The lack of many of these species from the early records probably does not indicate their absence in these years, but rather inability to collect in a particular habitat.

Acknowledgments

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Two Cretaceous Nautiloids from Baja California, Mexico, and Southern California

Frederick A. Sundberg

Abstract.—Two cretaceous nautiloids from Baja California, Mexico, and southern California by Frederick A. Sundberg. *Bull. Southern California Acad. Sci.,* 83(1):43–52, 1984. Two genera of nautiloids not previously reported from the Western Hemisphere are present in the Cretaceous of Baja California, Mexico, and southern California. *Eucymatoceras* sp. is from the Alisitos Formation (Aptian-Albian) near Arroyo El Rosario. *Anglonautilus catarinae* n. sp. is from the Rosario Group (Maastrichtian) of Santa Catarina Landing, Baja California, and Carlsbad, California, and the Williams Formation (late Campanian to early Maastrichtian) of the Santa Ana Mountains, California.

Marine Cretaceous deposits of Baja California, Mexico, contain an abundant molluscan fauna, but the occurrence of nautiloids has received only brief notice in the literature (Burckhardt 1930; Anderson and Hanna 1935; Allison 1955; Anderson 1958). Two specimens of *Eucymatoceras* sp. were collected by E. C. Allison from the Aptian-Albian Alisitos Formation near Arroyo El Rosario, Mexico. Eleven specimens here described as *Anglonautilus catarinae* n. sp. have been collected from the Maastrichtian Rosario Group near the Santa Catarina Landing, Mexico. *A. catarinae* is also present in the Rosario Group at Rio del Rosario, Punta Cabra, and Punta San Jose, Mexico and Carlsbad, California and the Campanian Williams Formation, Santa Ana Mountains, California (Fig. 1). These occurrences of the genera *Eucymatoceras* and *Anglonautilus* are the first reported for the Western Hemisphere.

The following abbreviations are used:

CAS = California Academy of Science, San Francisco
LACMIP = Los Angeles County Museum, Invertebrate Paleontology
UCLA = University of California, Los Angeles
UCMP = University of California, Museum of Paleontology, Berkeley.

Systematic Paleontology

Order Nautiloida Agassiz, 1847
Superfamily Nautilaceae de Blainville, 1825
Family Cymatoceratidae Spath, 1927
Genus *Eucymatoceras* Spath, 1927
Type Species: *Nautilus plicatus* Fitton (1935)

The genus *Eucymatoceras* is a cymatocerid typified by a subglobular, involute conch with a slightly sinuous suture and prominent V-shaped ribs on the ventral and whorl sides (Kummel 1964:K454). Kummel (1956, 1964) reports the genus only from the Lower Cretaceous of Europe, but the specimens described below, from the Alisitos Formation of Baja California, Mexico, extend the geographic range to the Western Hemisphere.

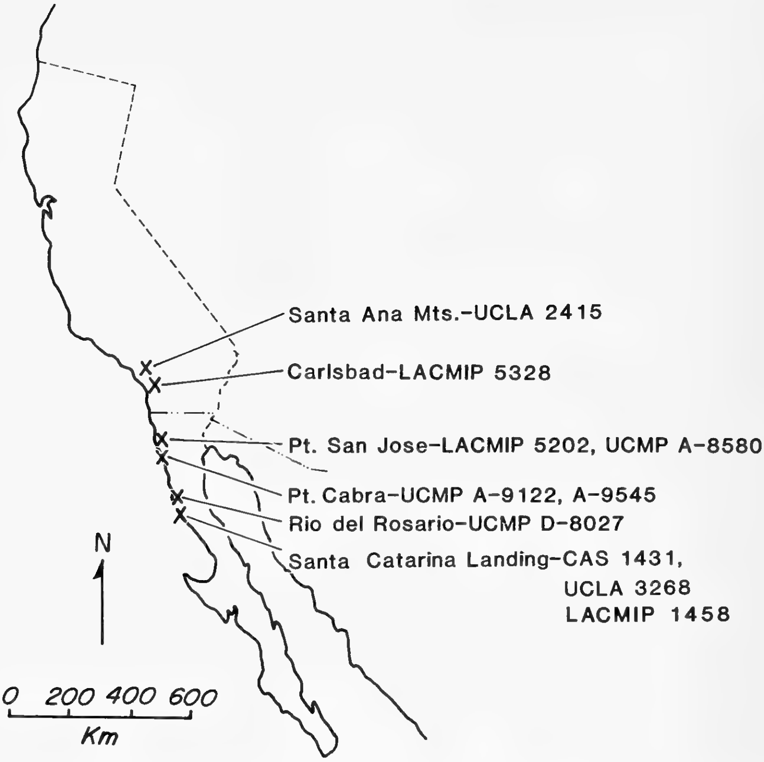

Fig. 1. Cretaceous localities in Baja California and California yielding the nautiloid samples discussed in text.

Eucymatoceras sp.
Text-figure 2

Discussion.—Two poorly preserved fragmental specimens of *Eucymatoceras* sp. show the characteristic conch shape and the ventral V-shaped ribs of the genus, but the V-shaped ribs are not apparent on the whorl sides. The suture appears to be slightly sinuous; the conch is large, involute, and rapidly expanding; and the siphuncle is subcentral.

Occurrence.—*Eucymatoceras* sp. occurs in the Alisitos Formation near Arroyo El Rosario, Baja California, Mexico (UCMP loc. D-8027).

Range.—The Alisitos Formation ranges in age from Aptian to Albian (Allison 1955).

Types.—Hypotypes UCMP 14687–14688 from UCMP loc. D-8027.

Genus *Anglonautilus* Spath, 1927
Type Species: *Nautilus undulatus* Sowerby (1813)

The genus *Anglonautilus* is a cymatocerid typified by large fold-like undulations on the venter that decrease rapidly on the flanks, sutures with shallow ventral and lateral lobes, and a subcentral siphuncle (Kummel 1964:K453). *Anglonautilus* has been previously reported only from beds of Hauterivian to Cenomanian age

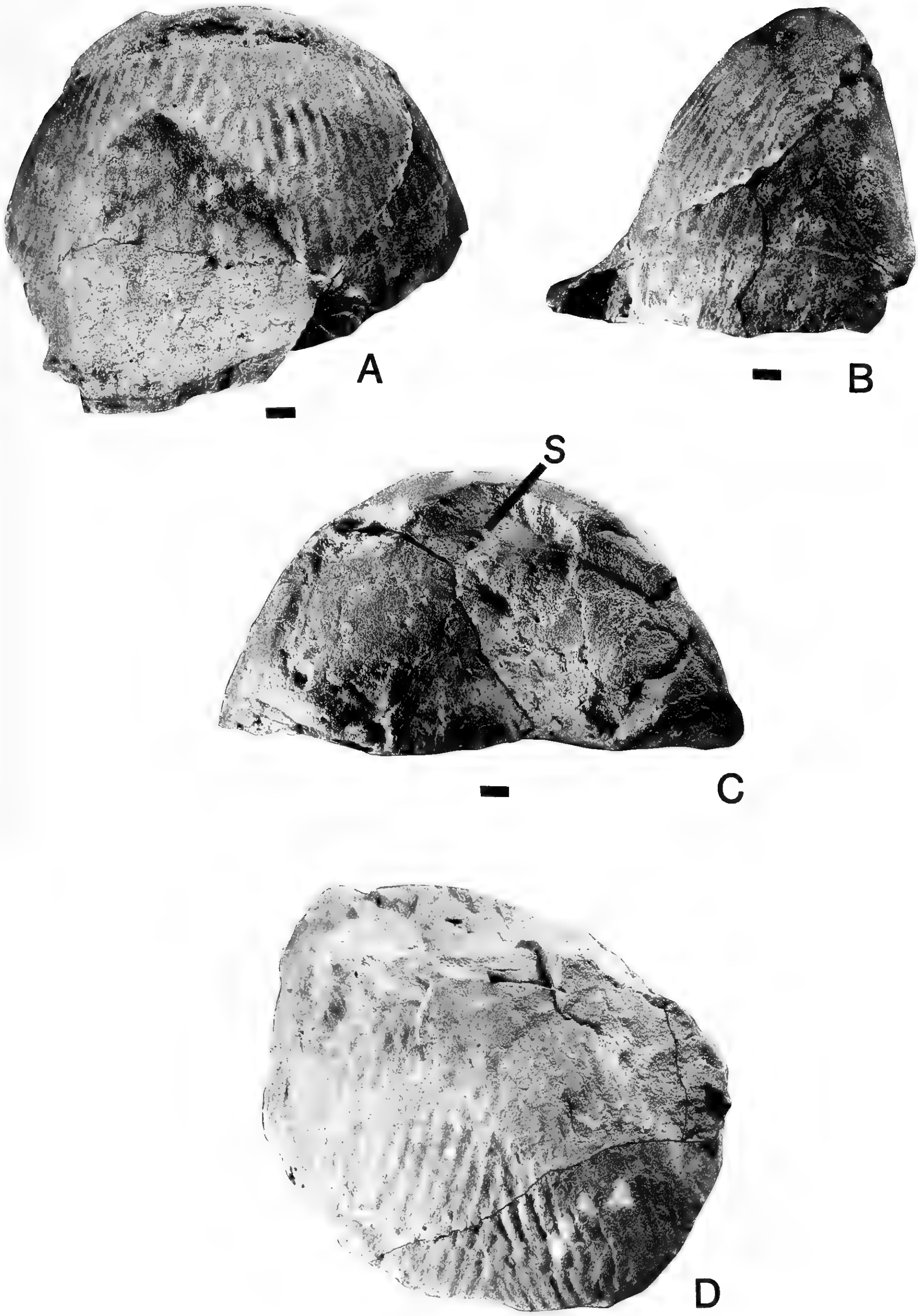

Fig. 2. *Eucymatoceras* sp., Arroyo El Rosario, Baja California, Mexico (UCMP loc. D-8027). Bar = 1 cm. (A–C) Hypotype UCMP 14687, (A) ventral view, (B) lateral view, and (C) dorsal view. S = siphuncle. (D) Hypotype UCMP 14688, ventral view.

in Europe (Kummel 1956, 1964) and Cenomanian age in Japan (Matsumoto and Takahashi 1982); the specimens from Baja California and California extend the geologic range to early Maastrichtian and the geographic distribution into the Western Hemisphere. In California *Anglonautilus* occurs in upper Campanian to lower Maastrichtian beds and in Baja California only in lower Maastrichtian beds.

Anglonautilus catarinae n. sp.
Text-figures 3–5

Diagnosis.—Ventral fold-like undulations present during brief growth period, 5.0 cm to approximately 8.3 cm in whorl height. Suture of high relief for genus.

Description.—Conch large, involute, and compressed. Whorl cross-section subquadrate to compressed, widest diameter two-thirds of whorl height from venter. Without shell, one-eighth of earlier whorl visible in umbilicus. Broad fold-like undulations present on venter in later growth stages (appearing at approximately 5.0 cm in whorl height and disappearing at approximately 8.3 cm in whorl height). Ventral undulations with a wavelength of approximately 3 cm and height of 3 to 4 mm. Living chamber occupying one-third of last whorl. Suture comprised of small, narrow saddle near umbilical shoulder, broad, relatively deep lateral lobe, relatively high, broad lateral saddle, and very shallow ventral lobe(?) (Fig. 4). Suture flatted in specimens having whorl height in excess of 11 cm. Siphuncle subcentral dorsally.

Occurrence.—*Anglonautilus catarinae* is abundant in lower Maastrichtian beds of the Rosario Group near Santa Catarina Landing, Baja California, Mexico (UCLA loc. 3268, type locality, CAS 1431). In Baja California, it is also found south of Punta San Jose (LACMIP loc. 5202 and UCMP loc. A-8580) and at Punta Cabras (UCMP loc. A-9122 and A-9545) in the Rosario Group. *A. catarinae* also occurs in California in the Williams Formation at Bee Canyon, Santa Ana Mountains, Orange County (UCLA loc. 2415) and Point Loma Formation of the Rosario Group at Carlsbad, San Diego County (LACMIP loc. 5328).

Discussion.—Cymatocerid nautiloids are divided into genera based on surface ornamentation and the genus *Anglonautilus* is typified by laterally discontinuous venter folds, as discussed above. The author includes *Anglonautilus catarinae* into this genus because of the presence of moderately well preserved ventral folds on a few specimens (UCLA 58175, 58181, and 58187 and LACMIP 5750) and suture similarity with other species of *Anglonautilus.* The absence of the ventral folds on other specimens assigned to *A. catarinae* is due to 1) abrasion of the venter or entire specimen, the folds are shallow and easily distorted or removed, 2) poor preservation, and 3) the folds are only present during a brief growth period, of approximately 180° of a whorl in the older, larger specimens. *A. catarinae* differs primarily from the other named species in the ventral folds brief occurrence, approximately 180° as opposed to 225° or greater whorl distances, and its relatively high suture relief.

Anglonautilus catarinae occurs in an unusual abundance at the type locality in Mexico (UCLA loc. 3268) from whence 17 specimens were obtained for study. These specimens and others from Mexico and California show a variation in aperture height and width in specimens with whorl height greater than 7 cm (Fig. 4, 5). This aperture shape variation is similar to that of the recent *Nautilus,* which,

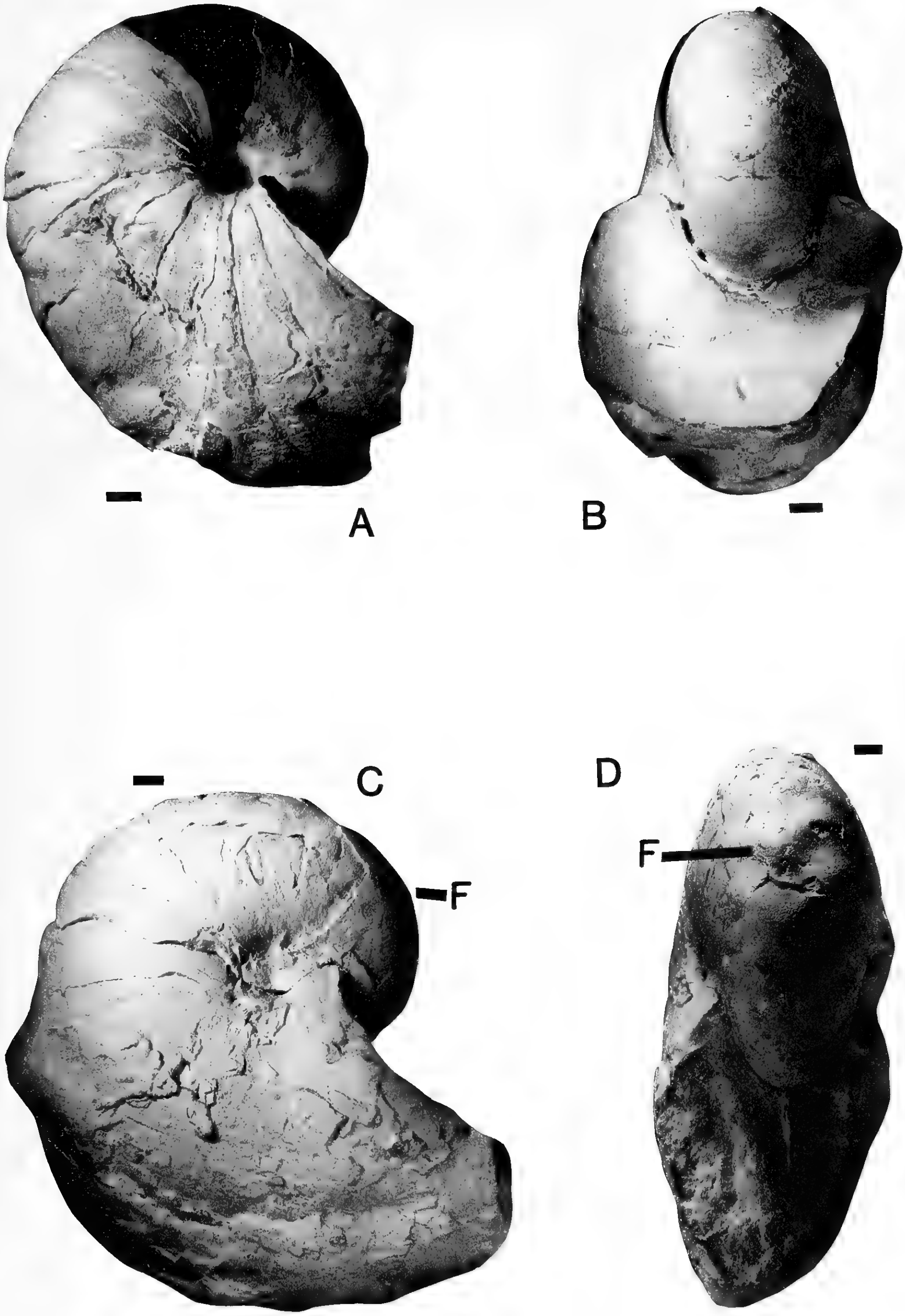

Fig. 3. *Anglonautilus catarinae* n. sp., Santa Catarina Landing, Baja California, Mexico (UCLA loc. 3268). Bar = 1 cm. (A, B) Holotype UCLA 58184, (A) lateral and (B) ventral views. (C, D) Paratype UCLA 58181, (C) lateral and (D) ventral views. F = ventral fold-like undulations.

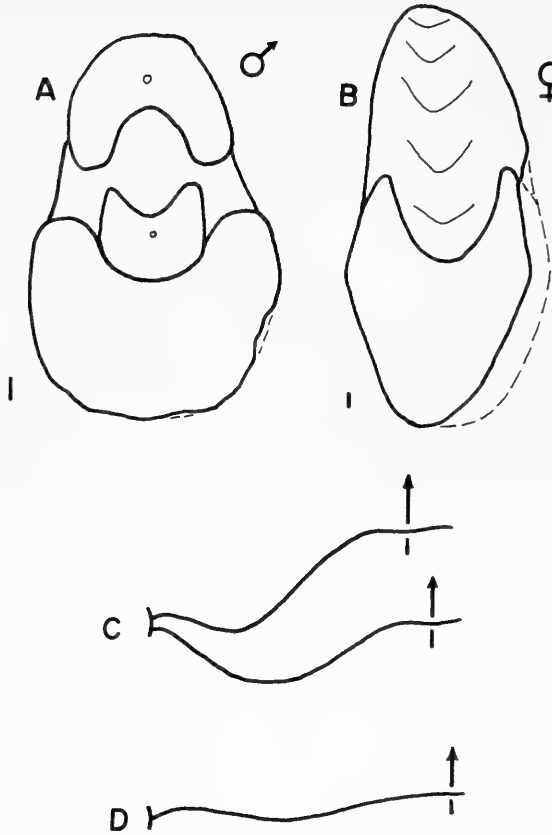

Fig. 4. Anterior views and suture of *Anglonautilus catarinae* n. sp. (A, B, C) and suture of *Anglonautilus* sp. (D). A) Paratype UCLA 58177, male; B) Paratype UCLA 58181, female; C) Sutures of holotype UCLA 58184; D) Suture of UCLA 58430. A, B, and C. are from Santa Catarina Landing, Baja California (Maastrichtian). D is from the Santa Ana Mountains (Turonian). Bar = 1 cm.

in *Nautilus,* is a sexually derived character (Sanders and Spinosa 1978). The aperture shape variation in *A. catarinae* may also be due to sexual dimorphism.

Several authors have briefly commented on the presence of nautiloids from the Rosario Group in Baja California, Mexico. Burckhardt (1930) was the first published note on the occurrence of nautiloids, but neither he nor later authors figured any Baja California specimens. Burckhardt's specimens were not relocated for this study. Anderson and Hanna (1935) and later Anderson (1958:65) provided a brief discussion or mention of the nautiloids from Santa Catarina Landing (CAS loc. 1431). Anderson and Hanna (1935:25) referred to the nautiloids as *Nautilus campbelli* Meek and *N.* cf. *d'orbignyanus* Forbes; Anderson (1958:65) later referred to them as *Cymatoceras* (?) *campbelli* (Meek). Inspection of the specimens from CAS loc. 1431 by the author shows that *A. catarinae* is present in the collection. Allison (1955:403) reported *Eutrephoceras* sp. from UCMP loc. A-8580; upon inspection of this locality collection *A. catarinae* was also identified. Thus the various nautiloid taxon reported by these authors are probably assignable to *A. catarinae* based on the species present in the referred locality assemblage.

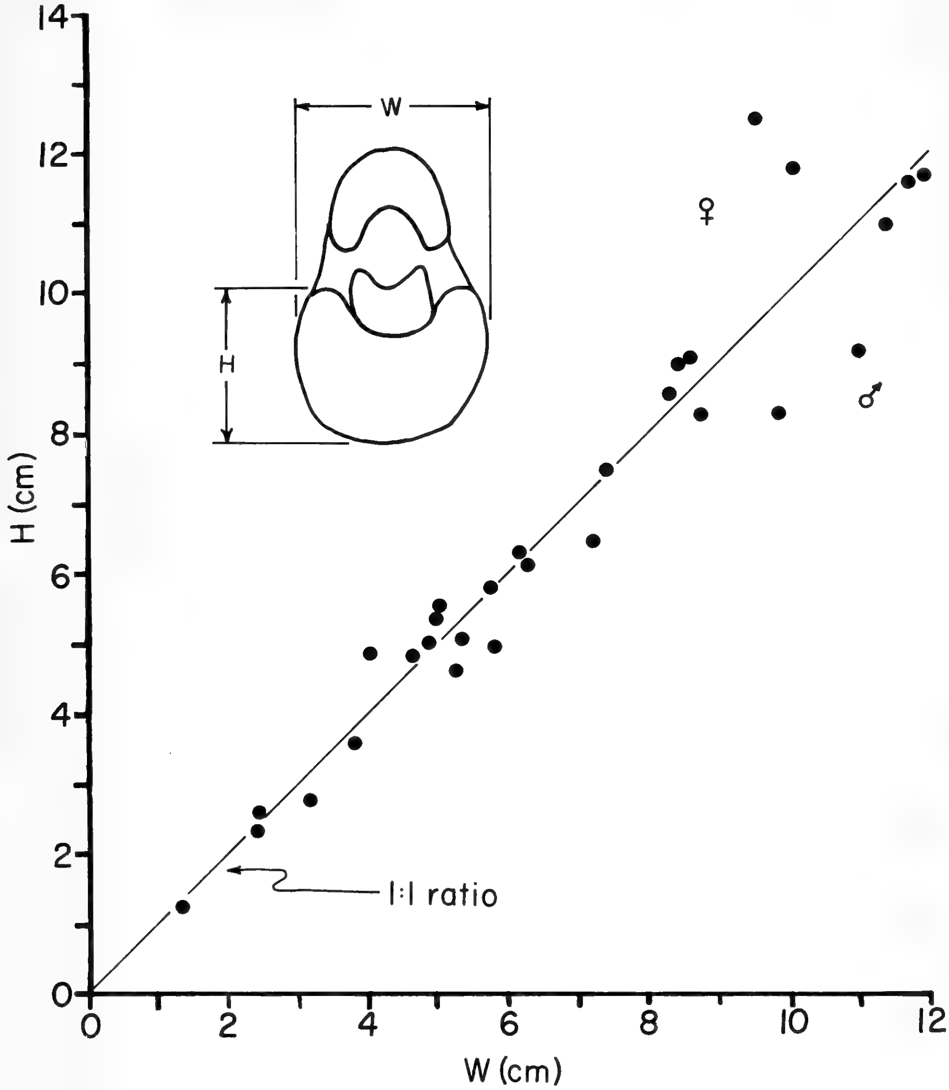

Fig. 5. Graph of height (H) and width (W) ratios for *Anglonautilus catarinae* n. sp. showing sexual dimorphism of later growth stages.

Another unnamed species of *Anglonautilus* occurs in various localities in southern California. This species differs from *A. catarinae* in that the former has less curvature to the suture (Fig. 4), and umbilical plug, and weak development of the ventral folds diagnostic of the genus. Thus *Anglonautilus* sp. occurs in sediments of Turonian to Campanian age.

Four previously named species of *Anglonautilus* are known from England, Europe, or Japan. *Anglonautilus catarinae* is most similar to *A. japonicus* Matsumoto and Takahashi (1982) from the lower Cenomanian of Japan in overall shape but differs in the latter's more numerous and relatively laterally persistent ventral fold-like undulations, the clioscaphitoid shape of the adult shell, shallow median groove on the venter and less sinuous suture. *A. subalbensis* (Sinzow 1913) from Albian beds in Crimea differs from *A. catarinae* in that the former has more abundant ventral undulations (persistent over a longer growth period), widest diameter one-third of whorl height from venter, a slight clioscaphitoid shape to the adult shell, and a more shallow lateral lobe and lateral saddle. *A. undalatus* (Sowerby 1813) from the Aptian to Cenomanian deposits of England and various localities in Europe (Foord 1891; Kummel 1956) differs from *A. catarinae* in that the former has more quadrate whorl section, shallower suture and more numerous ventral undulations which are persistent laterally. *A. begudensis* (Kilian and Reboul 1915) from the Hauterivian of France has, for the genus, the greatest lateral persistence of the ventral undulations. *A. begudensis* differs from *A. catarinae* in this lateral persistence and in having more numerous ventral undulations.

Range.—Anglonautilus catarinae is associated with *Neodemoceras catarinae* (Anderson and Hanna) at its type locality. *Neodemoceras catarinae* is of early Maastrichtian age (Popenoe *et al.* 1960), and provides an early Maastrichtian age for the occurrence of *A. catarinae* in Baja California. The occurrence of the species at the Carlsbad locality (LACMIP loc. 5328) is late Campanian or early Maastrichtian based on co-occurring faunas (Sundberg 1981). The Santa Ana Mountains (UCLA loc. 2415) specimens occur in late Campanian to earliest Maastrichtian (Matsumoto 1960; Popenoe *et al.* 1960). The range of *A. catarinae* is thus late Campanian to early Maastrichtian.

Types.—Holotype UCLA 58184 from UCLA loc. 3268; Paratypes UCLA 58175–18183, 58185–58186 all from UCLA loc. 3268; UCLA 58187–58189 from UCLA loc. 2415; LACMIP 5748 from LACMIP loc. 1458; LACMIP 5749 from LACMIP loc. 5202; LACMIP 5750 from LACMIP loc. 5328.

Etymology.—Anglonautilus catarinae is named for its abundant occurrence at its type locality in Santa Catarina Landing, Baja California, Mexico.

Localities

LACMIP 1458.—"Specimens found in the collections with labels that variously read 'Santa Catarina, Santa Catarina Landing, Santa Catarina Mission, etc.'" Nautiloid collected by M. L. Webster, April 1961. Rosario Group.

LACMIP 5202.—"Nautiloid from Punta San Jose, Baja California from the upper section of the massive lower mudstone. Second slide south of (fish) camp." Collected by Brad Riney. Rosario Group.

LACMIP 5328.—East facing roadcut on El Camino Real, opposite and south of drive to Madonna Hill Guest Home (5392 El Camino Real), just outside of the Carlsbad city limits, San Diego County, California. 1.36 km (.85 mi) north of the intersection of Palomar Airport Road and El Camino Real. Near Letter Box Canyon, San Luis Ray 7.5′ Quad. Rosario Group, Point Loma Formation.

UCMP A-8580.—Collected from dark blue-gray poorly cemented massive siltstone exposed along cliff on the beach on the south side of Punta San Jose, Baja California, Mexico. Strata nearly flat lying. Punta San Jose is about 16 km (10 mi) south of Puerto Santo Tomas and Punta China, and is about 36 km (20 mi) west of the town of Santo Tomas. 116.2°W, 31.1°N, AAF Prelim. Base Ensenada (472 B) 1/50,000 (1946), Baja California, Mexico. Rosario Group.

UCMP A-9122.—Brown silty sandstone dipping 5° seaward between first two main points immediately south of Punta Cabras. Road runs close to low sea bluffs before looping over the northern point saddle to drop down to bay before Punta Cabras. Volcanics faulted in a narrow band just south of (northern most) headland, 31.2°N and 116.s°W, Ensenada Quad., Baja California, Mexico. Rosario Group.

UCMP A-9545.—North of San Isidro and south of Punta Cabras. Approximately the same area as A-9122. Rosario Group.

UCMP D-8027.—Near Arroyo El Rosario, Baja California, Mexico. Mexico air photo #127-95. On horse trail northeast of Arroyo El Rosario, immediately north (stratigraphically below) a narrow diabase sill in gray graywacke. Alisitos Formation.

UCLA 2415.—Sandstone and siltstone on spur about 1.6 km (1 mi) northeast of Lambert Ranch, approximately 2000′ long spur is on northwest side of Bee Canyon, 2.6 km (1.6 mi) N., 5 km (3.1 mi) W of southeast corner T 5 S, R 8 W (projected), Lomas de Santiago. El Torto 7.5′ Quad., Orange County, California. Williams Formation, Pleasants Sandstone.

UCLA 3268.—Olive siltstone exposed along the banks of a small gully about 4.8 km (3 mi) northeast of Santa Catarina Landing and 0.4 km (.25 mi) south of the channel of Arroyo Santa Catarina. West coast of Baja California, Mexico. Rosario Group.

CAS 1431.—Cretaceous fossils near mouth of Arroyo Catarina, Baja California, Mexico. Collected by C. H. Sternberg. Rosario Group.

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Research Note

The Susceptibility of *Oxyjulis californica* to Attack by Ostracods on Three Substrates

Oxyjulis californica is a temperate labrid fish that ranges from Cedros Island, Baja California, to Sausalito, California (Miller and Lea 1972). This diurnal fish is often found at mid-water depths feeding on bryozoans and other invertebrates. This species is also considered a cleaner; it picks ectoparasites off the integument and out of the gill cavities of other fish species (personal observation; Fitch and Lavenberg 1975). *Oxyjulis californica* is not usually present in the water column at night and frequently burrows into the sand leaving only its head exposed. Such behavior appears to be done to avoid predation (Fitch and Lavenberg 1975).

There have been a few cases of ostracod parasitism of the gills of fishes (Schmidt and Roberts 1981), but the active predation of ostracods on fishes, such as *Oxyjulis californica,* is a recently discovered phenomenon. The susceptibility to ostracod attack could be due to a number of different factors such as the physiology of the fish, thickness of integument, presence of scales, behavior, and environmental conditions. The environmental variable was chosen for this study, specifically the type of substrate that a fish occupies during a period of potential ostracod attack. During the day few, if any, of these ostracods are seen in the water column, however at night they are seen near the bottom, where they swim intermittently and crawl (Hobson and Chess 1976). It has been reputed that members of the genus *Vargula* use a scavenger feeding mode (Barnes 1974). However, recent studies have shown that *Vargula* is an active predator on a variety of fishes. Fish left overnight in traps were often subjected to ostracod predation (S. Ralston, unpublished results). In this study similar experiments were done using *Oxyjulis californica.* To determine if there was a difference in susceptibility of fish to ostracod attack on different substrates, fish were tested on rock, sand, and eel grass.

Our experiment was conducted near Chalk Cliffs, between Fisherman's Cove and Isthmus Cove, Santa Catalina Island, California (latitude 33°27′N: longitude 118°29′W). Most of the area is open water about 2–15 meters deep with a sandy sea floor surrounded by rocky bottom with eel grass (*Phyllospadix torreyi*) growing along parts of the interior of the cove. *Oxyjulis californica* was chosen for this study after initial testing indicated it was susceptible to ostracod attack. All fish were collected from the Bird Rock area near Catalina Island, using manually controlled net traps baited with crushed sea urchins (*Centrostephanus coronatus*). Specimens were held in aquaria at the USC Marine Science Center until used.

Each ostracod trap consisted of a one gallon plastic jar with a large metal mesh screen opening on the sides toward the top of the jar. This arrangement allowed the inflow of water and ostracods, while a small mesh screen at the bottom of the jar provided an outflow for water while retaining the ostracods as the jar was raised through the water column. A small concrete block was tied to the lid of the jar to weight the trap on the chosen substrate.

Table 1. Abundance of ostracods found on *Oxyjulis californica* on three substrates. Ten observations were made for each substrate.

	Sand	Rock	Eel Grass
Range	3–59	3–14	0–4
Mean	28.5	7.2	1.1
Standard deviation	±21.9	±3.7	±1.2

The fish were tested for their susceptibility to ostracod attack on three different substrates; sand, rock, and eel grass. In order to avoid any differences in abundance of ostracods throughout the night, all traps were left on each substrate from 1900 to 2200 hours each night. Five traps were used per night to test one substrate, each substrate was tested for two nights. All tests were conducted within one week. For the rock and eel grass substrates, SCUBA divers placed the traps. The sand bottom was tested by lowering the traps to the center of the cove. A bouy marked the position of each trap for subsequent retrieval. The rock and sand traps were placed in approximately 8 m of water while the eel grass traps were located in 2 m of water. A control trap without a fish was set at each of the different substrate types. These controls yielded no ostracods.

The relative number of ostracods on each fish was determined by removing the fish from the trap, placing it in a dissecting tray and then sprinkling the fish with fresh water to stimulate bioluminescence of the ostracods. The numbers were determined in the dark by counting the luminescent ostracods that fell off. The fish was then moved to a second tray and the procedure repeated. Any ostracods remaining on the fish were counted in a third tray and these three counts were summed. The number of ostracods obtained on each of the different substrates is summarized in Table 1. The ostracods were identified as *Vargula tsujii* following Myers (1975).

After three hours of exposure to the ostracods, the fish were alive but in a weakened state. The amount of mucous covering the fish seemed in excess of that present when they were first introduced into the trap. Dissection of a fish after attack demonstrated that the ostracods not only attached to the outer integument but entered into the body cavity via the opercular openings, the mouth, and the cloaca. After three hours, parts of some of the internal organs had already been destroyed.

One-way analysis of variance (ANOVA) was used in the statistical treatment of the data. The test was performed and the statistics were generated using the computer program of Brecht and Woodward (1983). The results of the test indicate significant differences in the density of ostracods per fish over the three different substrates (Wilk's Lambda = 0.0408, $P = 0.00004$). Planned comparisons of all pair-wise situations were performed and were determined to differ significantly in each case ($P < 0.01$). Although there was a large standard deviation for the average number of ostracods at any given substrate region (Table 1), the overall difference in the number of ostracods at the different substrates is statistically significant. The rock and sand substrates were tested at similar depths but the eel grass was tested in shallower water. There was a difference in the abundance of the ostracods on the fish on the two substrates at the same depth, thus the difference in amount of ostracods in the eel grass may not be depth related. Eel grass seems to provide the most protection from ostracod attack, followed closely by the rock substrate. A fish over the open sandy bottom at night is the most susceptible to ostracod attack. However, the abundance of ostracods was measured on captive fish in a small trap, and does not account for normal predator avoidance techniques practiced by a fish under natural conditions. In the case of *Oxyjulis californica,* the mode of predator avoidance appears to be the burial of its body in the sand at night (presumably to avoid larger vertebrate predators). While we found an abundance of ostracods on sand, the burial of *O. californica* in sand, plus a secretion of a mucus net around the fish (S. Ralston, unpublished results) also (presumably) protects the animal from ostracod attack.

In general, most fishes are found in the cracks and crevices of rocks and hiding in kelp and eel grass beds during the night. The reduction of ostracod susceptibility might be one of the reasons (but by no means the only reason) for movement of fishes to these areas at night. The presence of a multitude of nocturnal predators could elicit this type of migration by prey species. However, since ostracods are present at night they should also be considered active nocturnal predators to be avoided.

Additional studies are needed to determine if nocturnally active fishes are less susceptible to ostracod attack. If this proves to be the case, then a study of the adaptations allowing these fishes to exist in ostracod areas is warranted.

Hammer and Zimmerman (1979) have studied demersal zooplankton distributions and found *Vargula* living on a variety of substrates including sand, rock, and over various marine algaes, however quantitative measures were not provided. Tests are needed to determine if the difference in susceptibilities of fish to ostracod attack is related to distributions of the ostracods and/or their relative densities in different substrate areas.

The predator-prey relationship between ostracods and fishes is new. Scott Ralston (unpublished results) has found that ostracods will kill the fish and, with the help of amphipod and isopod scavengers, the fish will be consumed from the inside out. How the ostracods are killing the fish is not known at this time and should be investigated.

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