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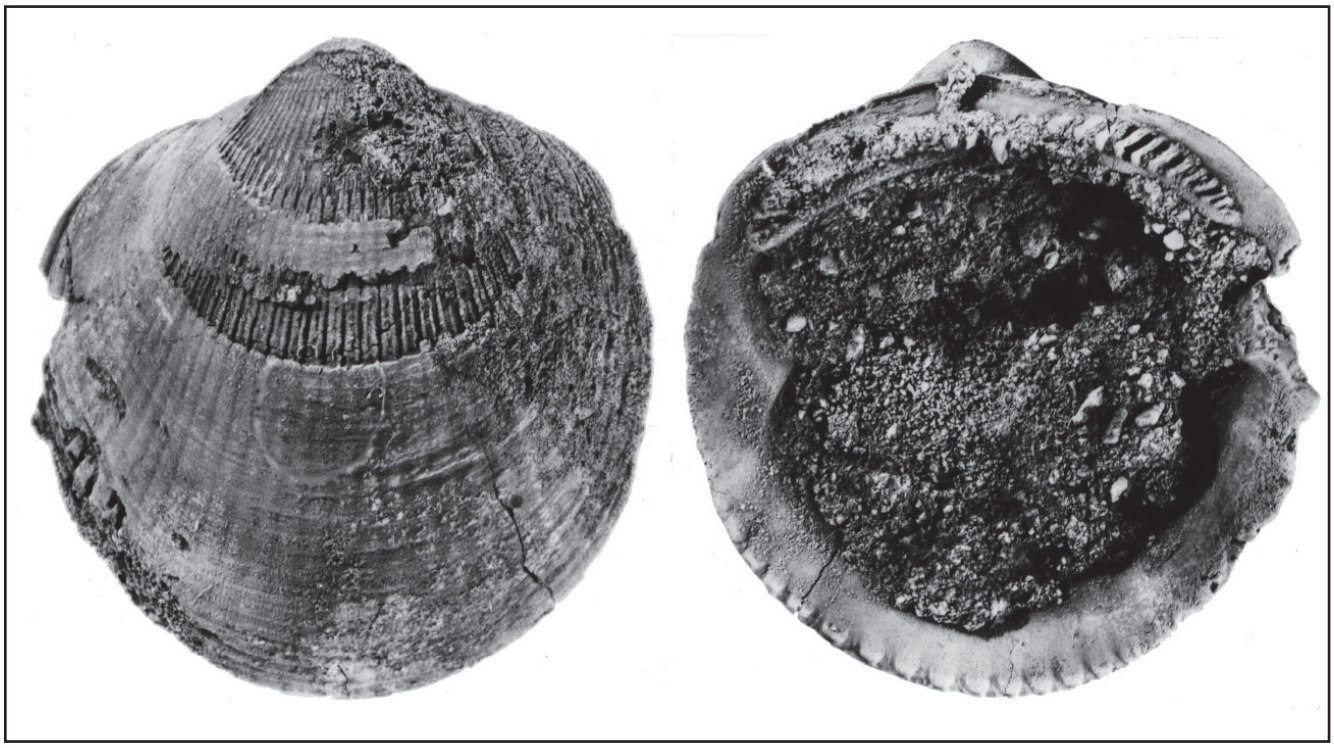
Pliocene Invertebrates From the Travertine Point Outcrop of the Imperial Formation, Imperial County, California



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By Charles L. Powell II

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FRONT COVER—The Bivalvia *Glycymeris (Glycymeris) gigantea* (Reeve) from the Travertine Point outcrop of the Imperial Formation.

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Pliocene Invertebrates From the Travertine Point Outcrop of the Imperial Formation, Imperial County, California

By Charles L. Powell II

Abstract

Forty-four invertebrate taxa, including one coral, 40 mollusks (30 bivalves and 10 gastropods), and three echinoids are recognized from a thin marine interval of the Imperial Formation near Travertine Point, Imperial County, California. The Travertine Point outcrop lies about midway between exposures of the Imperial Formation around Palm Springs, Riverside County, and exposures centered at Coyote Mountain in Imperial and San Diego Counties. Based on faunal comparisons, the Travertine Point outcrop corresponds to the Imperial and San Diego outcrops.

The Travertine Point fauna is inferred to have lived in subtropical to tropical waters at littoral to inner sublittorial (<50 m) water depths. Coral and molluscan species from the Travertine Point outcrop indicate a Pliocene age. Two extant bivalve mollusks present have not previously been reported as fossils *Anadara reinharti* and forms questionably referred to *Dosinia semiobliterata*.

Introduction

The Imperial Formation consists of marine sediments deposited at the head and western margin of the proto-Gulf of California during the late Neogene (late Miocene and Pliocene). Molluscan fossils have been reported from the Imperial Formation for more than 150 years (Blake, 1855) but are still largely unstudied. This paper describes an invertebrate assemblage composed mostly of mollusks from an Imperial Formation outcrop near Travertine Point, Imperial County, just west of the Salton Sea and very near the boundary between San Diego, Riverside, and Imperial Counties (fig. 1). The only published record of fossils from this area is that of Dibblee (1954) who, as part of his regional study of the Imperial Valley, mentions briefly fossils from the Imperial Formation at Travertine Point.

The Imperial Formation has been informally divided into “northern” and “southern” exposures that differ in provenance of sediments, location in the proto-Gulf of California, age, and macrofauna (Powell, 1986, 1988). Most outcrops from the “northern” exposures are considered Miocene in age (Powell, 1986, 1988; McDougall and others, 1994; Rymer and others, 1994) and include outcrops at Cabazon (=Lions Canyon area of earlier reports), Whitewater (=Super Creek area of earlier reports), and Garnet Hill. Outcrops from the “southern” exposures are generally Pliocene (Johnson and others, 1983; Opdyke and others, 1977), but some recent work suggests that the “southern” exposures are, in part, late Miocene (Winker, 1987). The “southern” exposures include outcrops at the Ocotillo Wells State Vehicle Recreation Area (=San Felipe Hills of earlier reports), Supersitition Mountain, Fish Creek-Vallecitos Wash area, Coyote Mountain, Yuha Buttes, and northern Cucupa Mountains, east of Mexicali, Mexico (Ingle, 1974). One exception to this north-south division of the Imperial Formation are exposure at Willis Palms, where the age of the fauna appears to be Pliocene (Powell, 1986). Outcrops at Travertine Point lie about midway between the "northern" and "southern" outcrops of the Imperial Formation, but its fauna correlates with the "southern" outcrops.

Fossils from the Travertine Point area were first collected in the 1930s by students from the University of California at Berkeley (UCMP localities A1705, A1706, A1707; see appendix for locality information). Two additional collections at or near Travertine Point are known. The first is a single specimen of the bivalve *Pycnodonte? heermanni* at the San Diego Museum of Natural History from a questionable locality vaguely stating as “...area where Riverside/San Diego/Imperial counties meet” (SDSNH locality 1012), which is herein assigned generally to the Travertine Point area. The second is small collection from “Garnet Wash 1.5 mi W of Travertine Point” at the California Academy of Sciences (CAS locality 2718). This later site does not correspond to the Travertine Point directly, but to the area west and northwest of Travertine Point in the Santa Rosa Mountains, where fossils from the Imperial Formation have been recently rediscovered (King and others, 2002).

Geologic Setting

The Imperial Formation at Travertine Point, referable to the lower part of the Latrania Sand Member of Hanna (1926) and Keen and Bentson (1944), consists of about 17 m of tan to yellow, fossiliferous, medium- to coarse-grained sandstone with abundant calcareous cement. Grains are generally subrounded and the outcrop commonly contains well rounded,

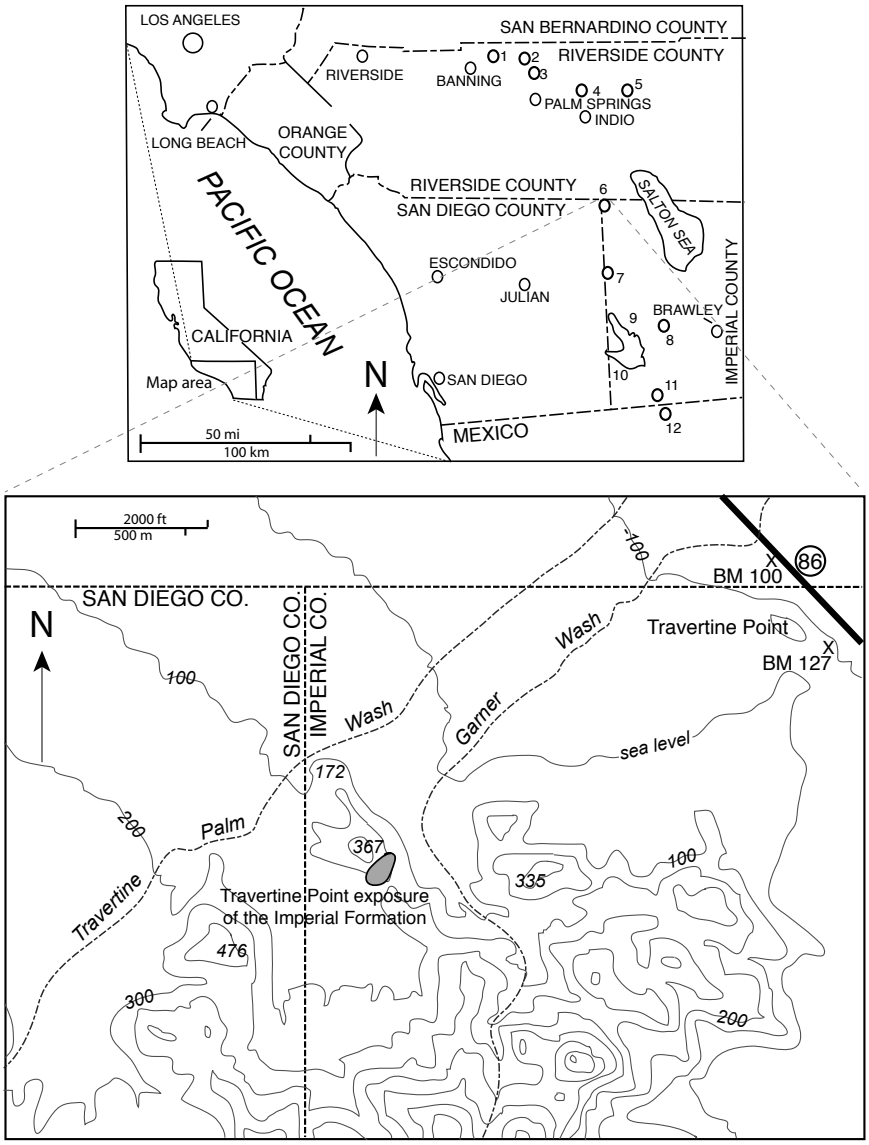


Figure 1. Map of the Travertine Point study area. Small insert map shows outcrop areas of the Imperial Formation (black dots) in southern California and Baja California Norte: 1, Cabazon; 2, Whitewater (Super Creek); 3, Garnet Hill; 4, Mt. Edom; 5, Willis Palm; 6, Travertine Point; 7, Ocotillo Wells State Vehicle Recreation area; 8, Superstition Mountain; 9, Fish Creek Mountains; 10, Coyote Mountains; 11, Yuha Buttes; 12, northern Cucupa Mountains, east of Mexicali, Baja California Norte, Mexico.

granitic and metamorphic pebbles up to about 3 cm diameter. Bedding is indistinct, but the Imperial Formation here appears to be in fault contact with the underlying metasedimentary rocks. The upper contact with the overlying brown-colored Canebrake Conglomerate (Dibblee, 1954) appears to be graditional and is placed above the last occurrence of fossils where a slight color change occurs. Specimens recovered from the Travertine Point area are only moderately well preserved, as they are commonly covered with well-cemented sand that obscures many features of the shells.

Two members of the Imperial Formation have been traditionally recognized (Hanna, 1926, Stump, 1972; Powell, 1986, 1988)—a lower basal sandstone and conglomerate and an upper fine-grained sandstone and siltstone. Unfortunately none of the member names proposed for the Imperial Formation have been properly described and so are used in the informal sense here. The lower, Latrania Sand Member of Hanna (1926) and Keen and Bentson (1944) is generally composed of coarse- to medium-grained sandstone, with scattered conglomerate and coral reef beds. The molluscan assemblage is characterized by euhaline species that lived in a moderate- to high-energy, intertidal to inner shelf, rocky to sandy habitat. The Coyote Mountain Clays of Hanna 1926 (Burrobend Member of Stump, 1972, and Foster, 1979, and,

in part, the same as Yuha Reefs of Hanna, 1926) is composed of sandstone and siltstone with associated oyster biostromes and bioherms. The molluscan assemblage is characterized by species that live in euryhaline to euhaline conditions and low- to moderate-energy, intertidal to shallow subtidal, sandy to muddy habitats. In general the Latrania Sand Member of Hanna (1926) and Keen and Bentson (1944) represents a pre-Colorado River influenced proto-Gulf of California and the Coyote Mountain Clays of Hanna (1926) represents a Colorado River influenced proto-Gulf of California.

Winker (1987) subdivided the Imperial Formation in the Valecitos-Fish Creek Basin, Imperial County, into six informal members and related them to rifting of the proto-Gulf of California and development of the Colorado River in the Salton Trough. Later Winkler and Kidwell (1996) elevated the Imperial Formation to a group containing, from young to old, the Deguynos Formation with Camel Head, Yuha, Mud Hills, and Lavender Canyon Members, and the Latrania Formation with Wind Caves, upper Megabreccia, Lycium, Jackson Fork, Stone Wash, and Andrade Members. Though useful, the stratigraphy of Winker (1987) and Winkler and Kidwell (1996) has never been formally described and is not used here.

Age and Correlation

Mollusks from the Imperial Formation are of limited use in determining the age of the formation because many of their stratigraphic ranges are poorly documented and supporting radiometric age control in the Gulf and proto-Gulf of California region is generally lacking. Of the one coral, one echinoid, and 22 mollusks identified to species (table 1) from Travertine Point, nine have been previously reported from the Miocene, 19 from the Pliocene, 11 from the Pleistocene, and 17 from the Holocene. The coral *Solenastrea fairbanksi* and bivalve mollusk *Pinna latrania* are known elsewhere only in the Pliocene part of the Imperial Formation in its "southern" outcrops. A maximum age of Pliocene is also supported by the occurrence of *Arca pacifica*, *Glycymeris gigantea*, *G. multicostata*, *Strophocardia megastropha*, *Codakia distinguenda*, *Miltha xantusi*, and *Polinices uber* which have their oldest occurrence in the Pliocene of southern California and Baja California. Species ranging into units older than Pliocene include *Dendostrea? vespertina* and *Lucina nuttallii nuttallii*, which both occur in the Miocene of central California (Moore, 1988), and *Dendostrea angelica* and *Pegophysema edentuloides*, which occur in the Miocene "northern" exposures of the Imperial Formation in Riverside County (Powell, 1986, 1988). The bivalves *Anadara reinharti* and *Dosinia semiobliterata* (questionably reported here) have not previously been reported as fossils. A Pliocene age is further supported by faunal correlations with other Imperial Formation outcrops. Twenty of 22 specifically identified species from Travertine Point also occur in the "southern" Imperial County outcrops, whereas only 12 of 22 also occur in the "northern" deposits in Riverside County (table 2).

Paleoecology

Seventeen of the 22 specifically identified species from the Travertine Point outcrop presently live in the eastern Pacific Ocean. The latitudinal ranges of these molluscan species, as well as the remaining Travertine Point genera, mostly overlap between latitudes 25°N and 28°N (fig. 2), or 4° to 7° south of the latitude of the fossil locality today. Three species occur outside these latitudes; *Codakia distinguenda* and *Divalinga eburnea* (questionably reported here) live south of 25°N, whereas *Pegophysema edentuloides* resides north of 28°N. This discrepancy in latitudinal ranges may be due to the moderately thick stratigraphic interval from which the Travertine Point mollusks were collected (17 m), which may represent more than one temperature regime or because the ecological tolerances of some of these species may have changed since the Pliocene. In any case, it appears that the Travertine Point faunule was deposited in water conditions similar to those present in the modern Gulf of California at latitudes between 25°N and 28°N. According to Robinson (1973), near-shore surface water temperatures for this region during the winter (January) range from about 15°C to 19°C, and summer (August-September) water temperatures are between 28°C to 31°C.

The paleobathymetry of the Travertine Point fauna can be inferred based on modern depth records from Bernard (1983) for the Bivalvia, Marincovich (1977) for *Polinices uber* and Keen (1971) for *Strombus galeatus*. *Codakia distinguenda*, *Glycymeris gigantea*, and *Myrakeenea angelica* (tentatively identified here) are restricted to littoral depths of 5 m or less. In contrast, *G. multicostata* (40–90 m), *Miltha xantusi* (55–80 m), *Pegophysema edentuloides* (35–170 m), and *Strophocardia megastropha* (30–150 m) occur in deeper water, and suggests water depths of 55 to 80 m, possibly more for the Travertine Point faunule. This combination of representatives from several depth zones is common in death assemblages from mixed ecological habitats. Considering the abundance of individual species, the Travertine Point faunule was likely deposited between below the intertidal zone and above 55 m, or at littoral to inner sublittoral water depths (of Valentine, 1961).

Table 1. Fossils collections from the Travertine Point outcrop of the Imperial Formation, Imperial County, southern California.
[There is no stratigraphic difference between collections. Numbers outside brackets are of more or less complete specimens; numbers in brackets are of fragments. See appendix for explanation of localities.] [x, present -, absent; cf. compared with; sp., species]

TAXA/LOCALITY	UCMP A1705	UCMP A1706	UCMP A1707	UCMP A1708	USGS M9778	USGS M9779
COELENTERATA						
ANTHOZOA						
Solenastrea fairbanksi (Vaughan)	–	–	–	–	–	1
MOLLUSCA						
BIVALVIA						
Americardium sp.	–	–	–	–	–	1
Anadara reinharti (Lowe)	–	–	1 as cf	–	2	3
Arca cf. *A. pacifica* Sowerby	–	–	1(2 as cf)	–	(1 as cf)	3(5)
"Arca" sp. indeterminate A	–	–	–	–	(2)	–
"Arca" sp. indeterminate B	–	–	–	(2)	–	–
"Arca" sp. indeterminate form	–	–	(2)	–	(2)	(2)
Arcinella cf. *A. californica* (Dall)	(4)	–	(2)	–	5	(1)
Argopecten sp. indeterminate	–	–	6	8(2)	7(6)	3(4)
Barbatia sp. indeterminate	–	–	(1)	(1)	–	(3)
Chama sp. indeterminate	–	–	–	–	–	1
Chione? sp. indeterminate	–	–	–	–	–	(1)
Chlamys cf., *C. corteziana* Durham	–	–	–	–	1(1)	–
Codakia distinguenda (Tryon)	(2)	–	18(18)	2	29(12)	3(21)
Cyclinella sp. indeterminate	–	–	–	–	1	–
Dendostrea? *vespertina* (Conrad)	–	–	1(3)	–	–	1
Dosinia cf. *D. semiobliterata* Deshayes	–	–	4(10)	(1)	2(3)	(7)
Divalinga cf. *D. eburnea* (Reeve)	–	–	–	–	1	2(1)
Eucrassatella cf. *E. antillarum* (Reeve)	2	–	16(29)	–	18(8)	3(31)
Euvola cf. *E. keepi* (Arnold)	–	1	1	1	1 (4)	2(1)
Glycymeris gigantea (Reeve)	–	–	2(9)	–	6(1)	(7)
G. multicostata (Sowerby)	–	–	–	–	1	1
Lithophaginae, indeterminate	–	–	–	–	–	mold
Lucina nuttalli nuttalli Conrad)	–	–	9	2	6	(2)
Miltha xantusi (Dall)	–	–	–	1 as cf.	(3)	1
Myrakeenae cf. *M. angelica* (Rochebrune)	–	–	–	–	1 cf	(1 as cf)
Mytilus? sp. indeterminate	–	–	1	–	–	–
Pegophysema edentuloides (Verrill)	2	–	24	7(1)	11(2)	49(4)
Pinna cf. *P. latrania* Hanna	2	–	–	–	(2)	1(1)
Pleurolucina sp. indeterminate	–	–	–	–	–	1
Pycnodonte? *heermanni* (Conrad)	–	–	1(1)	2	(5)	1
Spondylus sp. indeterminate	–	–	(3)	–	(3)	(2, 1 as cf)
Strophocardia megastropha (Gray)	–	–	8(12)	(1)	2(4)	(3)
GASTROPODA						
Araronia? sp. indeterminate	–	–	–	–	1	1
Atys sp. indeterminate	–	–	–	–	1(1)	7
Conus sp. indeterminate	–	–	–	–	(1)	–
Naticidae, indeterminate	–	–	–	–	4	2

Table 1. Fossils collections from the Travertine Point outcrop of the Imperial Formation, Imperial County, southern California—Continued.
[There is no stratigraphic difference between collections. Numbers outside brackets are of more or less complete specimens; numbers in brackets are of fragments. See appendix for explanation of localities.] [x, present -, absent; cf. compared with; sp., species]

TAXA/LOCALITY	UCMP A1705	UCMP A1706	UCMP A1707	UCMP A1708	USGS M9778	USGS M9779
Polinices cf. *P. uber* (Valenciennes)	–	–	–	–	5	–
Strombus galeatus Swainson	–	–	–	1	–	–
Strombus obliteratus Hanna	–	–	–	–	–	1
Strombus? sp. indeterminate	–	–	–	–	(1)	(2)
Turritella? sp. indeterminate	–	–	(1)	–	–	–
ECHINODERMATA						
ECHINOIDEA						
Toxopneustes cf. *A. roseus* (Agassiz)	–	–	–	(2)	–	
Clypeaster sp. indeterminate	–	–	–	(2)	–	–
indeterminate sand dollar	–	–	–	–	(1)	–

Table 2. Occurrence of specifically identified mollusks from the Travertine Point faunule from the "northern" and "southern" outcrops areas of the Imperial Formation in southern California.
[x, present -, absent]

TAXA	Northern exposures	Southern exposures
MOLLUSCA		
BIVALVIA		
Arca pacifica (Sowerby)	x	x
Arcinella californa (Dall)	–	x
Chlamys corteziana Durham	x	x
Codakia distinguenda (Tryon)	–	x
Dendostrea? vespertina (Conrad)	x	x
Divalinga eburnea (Reeve)	x	x
Euvola keepi (Arnold)	x	x
Glycymeris gigantea (Reeve)	–	x
G. multicostata (Sowerby)	cf.	x
Lucinisca nuttallii (Conrad)	x	x
Miltha xantusi (Dall)	–	x
Myrakeena angelica (Rochebrune)	x	x
Pegophysema edentuloides (Verrill)	x	x
Pinna latrania Hanna	x	x
Pycnodonte heermanni (Conrad)	x	x
Strophocardia megastropha (Gray)	–	x
GASTROPODA		
Polinices uber (Valenciennes)	x	x
Strombus galeatus Swainson	–	x
S. obliteratus Hanna	–	x
ECHINODERMATA		
ECHINOIDEA		
Toxopneustes roseus (Agassiz)	–	x

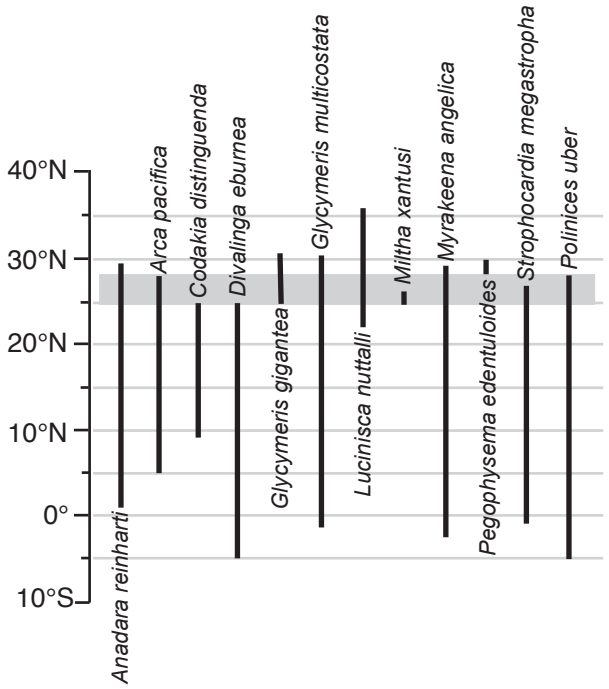


Figure 2. Latitudinal distribution of selected mollusks recovered from the Travertine Point outcrop of the Imperial Formation. The gray range bar shows the zone of maximum overlap of mollusk distributions at 25°N to 28°N, or from 4° to 7° south of the latitude from which the fossils were collected.

Systematic Paleontology

Phylum Coelenterata Frey and Leuckart, 1847
Class Anthozoa Ehrenberg, 1834
Family Faviidae Gregory, 1900

***Solenastrea fairbanksi* (Vaughan, 1900)**

Figure 3*e*

Stephanocaenia fairbanksi Vaughan, 1900, p. 151, pl. 17, figs. 11, 11a.

Solenastrea fairbanksi (Vaughan). Vaughan, 1917 s.l., p. 372-374, pl. XCV, figs. 3, 3a; pl. SCVI, figs. 1, 1a, 2, 2a, 2b, 2c; pl. XCVII, figs. 1, 1a, 2, 2a, 2b, 2c.

This species is represented by a single, very well preserved, irregularly globular specimen about 7 cm maximum diameter, attached to a cobble.

Vaughan (1917) illustrates and describes several subspecies of *S. fairbanksi* that differ in overall shape, size, and number of calices. Later Foster (1979) showed that (1) all morphological characters overlap suggesting continuous variation; (2) the magnitude of interpopulation variability is equal to intracolony variability, indicating that interpopulation variation is not more than that produced by a single genotype; and (3) colony morphology is nearly always facies restricted. This suggests that the subspecies of Vaughan (1917) are ecological morphotypes and of no taxonomic significance (Foster, 1979).

Solenastrea fairbanksi was previously known only from the southern outcrops of the Imperial Formation (Vaughan, 1917). Its occurrence at Travertine Point supports correlation with the southern outcrops of the Imperial Formation in Imperial County.

Travertine Point faunule occurrence: USGS M9779 (1).

Phylum Mollusca Linnaeus, 1758
Class Bivalvia Linnaeus, 1758
Family Arcidae Lamarck, 1809

***Arca* cf. *A. pacifica* (Sowerby, 1833)**

Figure 3*f*

Compare:

Byssoarca pacifica Sowerby, 1833, p. 17; Carpenter, 1856, p. 138; Carpenter, 1857a, p. 310.

Arca pacifica (Sowerby). Reeve, 1844, pl. 11, fig. 75; Hanley, 1842-1856, p. 156, pl. 18, fig. 59; Orbigny, 1846, p. 639; Lamy, 1907, p. 19-20; Lamy, 1909, p. 209; Dall, 1909, p. 251; Maury, 1922, p. 166, pl. 1, fig. 15; Jordan, 1924, p. 152-153; Hanna and Hertlein, 1927, p. 144.

Arca (Navicula) pacifica (Sowerby). Grant and Gale, 1931, p. 143.

Arca (Arca) pacifica (Sowerby). Hertlein and Strong, 1943, p. 155; Reinhart, 1943, p. 26-27, pl 14, figs. 3, 4; Rost, 1955, p. 179-180; Olsson, 1961, p. 76, pl. 4, figs. 2, 2a-2d; Keen, 1971, p. 38, fig. 67.

Arca (Arca) sp. A., Reinhart, 1943, p. 24, pl. 10, figs. 2, 5.

Specimens from Travertine Point are not well preserved, but appear to fall within the morphologic variability of *A. pacifica*. *Arca pacifica* is similar to *A. mutabilis* (Sowerby, 1833), but is distinguished by its larger adult size, different shell outline, and incised lines on the ligamental area. Specimens of *Arca* from the Imperial Formation in the Coyote Mountains in Imperial County (Reinhart, 1943) are, for the most part, referable to *A. pacifica*.

Keen (1971) reports this species from Scammon's Lagoon, Baja California to Paita, Peru. Rost (1955) reports living specimens dredged in water depths from 4 to 91 m on rocks, shells, and coral rubble. Bernard (1983) reports living specimens from the intertidal zone to 150 m.

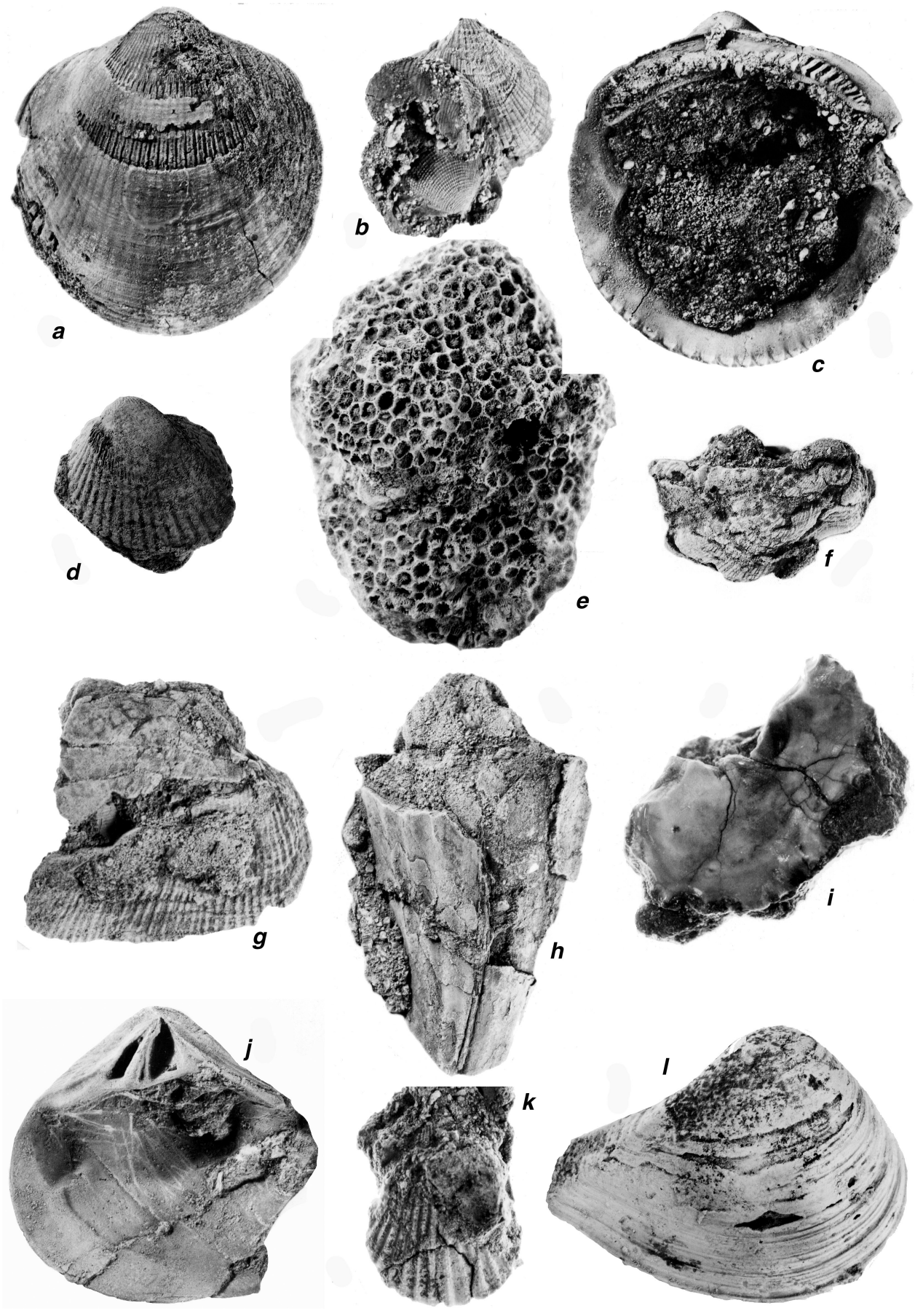
Travertine Point faunule occurrence: UCMP locality A1707 (1 valve, 2 fragments); USGS M9778 (1 fragment); USGS M9779 (3 valves, 5 fragments).

***Barbatia* sp. indeterminate**

Figure 3*g*

This taxon is represented by four shell fragments, one of which shows a portion of taxodont hinge. These fragments all have coarsely reticulate radial ribs with narrow interspaces reminiscent of *B. (Cucullaearca) reeveana* (d'Oribgny, 1846). Their fragmentary nature makes a confident identification impossible.

Figure 3. Selected fossils from the Travertine Point exposure of the Imperial Formation. ***a, c***, *Glycymeris (Glycymeris) gigantea* (Reeve), USGS Cenozoic locality M9778, Smithsonian National Museum of Natural History Museum (USNM) 486898, ***a***, exterior, ***c***, interior, height 55.5 mm, width 53.1 mm. ***b***, *Glycymeris (Tucetona) multicostata* (Sowerby), USGS Cenozoic locality M9779, USNM 486905, height 27.1 mm, width 21.7 mm, associated with *Lucina nuttallii nuttallii* (Conrad) and *Duvalinga* cf. *D. eburnea* (Reeve). ***d***, *Anadara (Esmerarca) reinharti* (Lowe), UCMP locality A1705, UCMP 39868, photograph about x1, height and width not measured as specimen has been misplaced at UCMP. ***e***, *Solenastrea fairbanksi* (Vaughan), USGS Cenozoic locality M9779, USNM 94782, height 72.0 mm, maximum width 52.3 mm. ***f***, *Arca* cf. *A. pacifica* (Sowerby), UCMP locality A1707, UCMP 39867, height 22.4 mm, width 38.5 mm. ***g***, *Barbatia* sp., UCMP locality A1707, UCMP 39871, photograph about x1, height and width not measured as specimen has been misplaced at UCMP. ***h***, *Pinna* cf. *P. latrania* Hanna, UCMP locality A1705, UCMP 39869, photograph about x1, height and width not measured as specimen has been misplaced at UCMP. ***i***, *Myrakeena* cf. M. angelica (Rochebrune), USGS Cenozoic locality M9778, USNM 486902, height 39.7 mm, width 42.4 mm. ***j, l***, *Eucrassatella* sp. cf. *E. antillarum* (Reeve), hinge, UCMP locality A1707, UCMP 39874, photograph about x1, height and width not measured as specimen has been misplaced at UCMP. ***l***, left valve, UCMP locality A1707, UCMP 39872, height 42.5 mm, width 57.4 mm. ***k***, *Chlamys* cf. *C. corteziana* Durham, USGS Cenozoic locality M9778, USNM 486903, height 20.5 mm, width 24.5 mm. (See appendix for locality information).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The genus *Barbatia* occurs in the eastern Pacific from the intertidal zone to 120 m (Keen, 1971).

Travertine Point faunule occurrence: UCMP locality A1707 (1 fragment), UCMP locality A1708 (1 fragment); USGS M9779 (3 valves, 5 fragments).

Anadara (Esmerarca) reinharti (Lowe, 1935)

Figure 3*d*

Arca (Anadara) reinharti Lowe, 1935, p. 16, pl. 1, figs. 3a, b, c; Hertlein and Strong, 1943, p. 157.

Anadara (Scapharca) reinharti (Lowe). Reinhart, 1943, p. 47; ?Rost, 1955, p. 198-200, pl. 13, figs. 18a-c, 19a-b, pl. 14, figs. 20a-c; text-figs. 85a-d.

Anadara (Esmerarca) reinharti (Lowe). Olsson, 1961, p. 100, pl. 8, fig. 4, pl. 9, fig. 1, pl. 10, figs. 4a-d; Keen, 1971, p. 46, fig. 88.

Travertine Point specimens of *A. reinharti* are fairly well preserved but have sediment cemented to the outer surface that obscures a number of ribs on most specimens. The shells show square ribs with rounded corners, narrow interspaces, and a shell outline consistent with *A. reinharti*. One specimen, a left valve, from USGS M9778, shows small nodes on the anterior slope that serves to identify this species.

This common eastern Pacific species has often been confused with *A. (Larkinia) multicostata* (Sowerby, 1833), which differs in its larger, less elongate adult shell and narrower ventral margin (Lowe, 1935; Rost, 1955).

The present specimens are the first fossil occurrences of this species. Modern occurrences are from Punta Peñasco in the Gulfo de California, south to Ecuador at depths from 2 to 91 m. Bernard (1983) reports this species from the intertidal zone to about 95 m.

Travertine Point faunule occurrence: UCMP locality A1707 (1 valve; 2 fragments as "cf"). USGS M9778 (2 valves); USGS M9779 (3 valves).

Arcidae? indeterminate

Two different species represented by fragmentary specimens are questionably assigned to the family Arcidae. Although the hinges are obscured, the specimens are placed in the Arcidae based on their shell shape and strong, square, radial sculpture similar to several species of *Anadara* from the eastern Pacific. Two distinct forms are recognized: form A has wide, square ribs with narrow interspaces, and form B, which has narrow, square ribs with narrow interspaces. Two fragments are also present that cannot be assigned to either form.

Travertine Point faunule occurrence: UCMP locality A1708 (2 valves, form B); USGS M9778 (2 valves, form A), USGS M9778 (2 valves, indeterminate form).

Family Glycymerididae Newton, 1922

Glycymeris (Glycymeris) gigantea (Reeve, 1843)

Figures 3*a*, 3*c*

Pectunculus gigantea Reeve, 1843, pl. 1, figs. 3a, 3b; Hanley, 1853, p. 164, pl. XIX, fig. 33; Valenciennes, 1846, pl. 20, figs. 1-1a; Carpenter, 1857a, p. 310; Lamy, 1909, p. 208.

Punctunculus (Axinaea) giganteus (Reeve). Stearns, 1894, p. 147.

Glycymeris gigantea (Reeve). Hanna, 1926, p. 466; Durham, 1950, p. 56, pl. 2, figs. 1, 8.

Glycymeris maculata (Reeve). Grant and Gale, 1931, p. 136 (in part).

Not *Pectunculus maculata* Broderip, 1832.

Glycymeris (Glycymeris) gigantea (Reeve). Hertlein and Strong, 1943, p. 150; Olsson, 1961, p. 106, pl. 11, fig. 1; Keen, 1971, p. 55, fig. 110; Moore, 1983, p. A52, pl. 11, figs. 1, 3.

Glycymeris gigantea is moderately common at Travertine Point, although in most cases, it is represented by single valves that are commonly broken, partially decorticated, and with the hinge obscured with sediment. Reconstructed specimens range from about 20 mm to 60 mm in height, and are identified by their very faint radial ribs, large size, and generally narrow umbo. Fossil specimens of *G. gigantea* are very similar to *G. maculata* (Broderip, 1932) but are distinguished by having different hinge teeth (see Durham, 1950) and a narrower umbo.

Moore (1983) reports *G. gigantea* as a fossil from southern California and Baja California Sur, Mexico. Its modern occurrence is from Bahia Magdalena, Baja California Sur to Acapulco, Mexico (Keen, 1971), in water depths from 5 to 20 m (Bernard, 1983).

Travertine Point faunule occurrence: CAS 2718 (1 valve as "species indet."); UCMP locality A1707 (2 valves; 9 fragments); USGS M9778 (6 incomplete valves with umbonal region), USGS M9779 (7 fragments).

Glycymeris (Tucetona) multicostata (Sowerby, 1833)

Figure 3*b*

Pectunculus multicostata Sowerby, 1833, p. 195. Reeve, 1843, *Plectunculus*, pl. 5, figs. 2, 6.

Glycymeris (Tuceta) multicostata (Sowerby). Hertlein and Strong, 1943, p. 151.

Tucetona multicostata (Sowerby). Olsson, 1961, p. 107.

Glycymeris (Tucetona) multicostata (Sowerby). Keen, 1971, p. 57, fig. 116.

Two specimens of *G. multicostata* were found at Travertine Point. The exterior of one specimen is partially covered with sand and other shells and the interior is obscured by sediment. The other specimen is poorly preserved and partially covered with sediment. Both are assigned to *G. multicostata* based on the numerous, flat-topped, radial ribs, and the small size (about 30 mm high). These specimens are distinguished from small, decorticated specimens of *G. gigantea* (Reeve) by very narrow, radial rib present on better-preserved portions of decorticated shell.

Glycymeris multicostata is easily distinguished from other eastern Pacific Glycymerididae by its numerous radial ribs. *Glycymeris strigilata* (Sowerby, 1833) most closely resembles *G. multicostata* in size and shape, but differs in

having about 25 ribs whereas *G. multicostata* generally has 35 to 40 ribs.

Moore (1983) reports the fossil occurrence of *G. multicostata* from the Pliocene and Pleistocene of the Baja California Peninsula. Keen (1971) reports its modern occurrence from Punta Peñasco, Sonora, Mexico, to Guayaquil, Ecuador, at depths of up to 90 m.

Travertine Point faunule occurrence: USGS M9778 (1 valve), USGS M9779 (1 partial valve).

Family Mytilidae Rafinesque, 1815

***Mytilus*? sp. indeterminate**

The genus *Mytilus* may be represented by a single incomplete cast with portions of the interior of the original shell material attached to its surface. It is 28.3 mm long and 14.4 mm high and consisting of the umbo and nearly half the shell. Although the general shell outline it is very similar to the genus *Mytilus*, the poor preservation prevents positive identification.

Travertine Point faunule occurrence: UCMP locality A1707 (1 fragment).

Family Lithophaginae indeterminate

The occurrence of this family at Travertine Point is based on long, tear-drop shape borings in an upper valve of *Pycnodonte? heermanni*. Lithophaginae borings are distinguished from pholadid borings by their much more elongate shape (G. Kennedy, 1985, oral commun.).

Travertine Point faunule occurrence: USGS M9779 (several molds in the thick shell of *P? heermanni*).

Family Pinnidae Leach, 1819

***Pinna* cf. *P. latrania* Hanna, 1926**

Figure 3*h*

Compare:

Pinna latrania Hanna, 1926, p. 475, pl. 27, fig. 1, text-fig. 1.

Pinna (Pinna) latrania Hanna. Grant and Gale, 1931, p. 145; Moore, 1983, p. A79-A80, pl. 22, fig. 4.

Specimens from Travertine Point lack both the umbo and the exterior of the valves but still show moderately strong, rounded radial ribs extending the length of the shell. These fragmentary specimens closely match the original description of *P. latrania* in having an acute apical angle (about 27°), but Hanna (1926) stated that his specimens lacked external sculpture except for a heavy longitudinal mid-rib so the identification here are questionly identified. *Pinna mendenhalli* Hanna (1926), also described from the Imperial Formation, is easily distinguished by its obtuse apical angle (47°). *Pinna latrania* is distinguished from *Atrina stephensi* Hanna (1926), also found in the Imperial Formation, by its longitudinal mid-rib lacking in the genus *Atrina*.

Pinna latrania has been questionably reported (cf.) from the Miocene Imperial Formation in Riverside County (Powell, 1986), and definitely from the Pliocene Imperial Formation in Imperial County (Hanna, 1926) and unnamed Pliocene strata in Baja California Sur (Durham, 1950).

Travertine Point faunule occurrence: UCMP locality A1705 (2 articulate specimens); USGS M9778 (2 larger fragments), USGS M9779 (1 valve, 1 fragment).

Family Gryphaeidae Vialov, 1936

***Pycnodonte? heermanni* (Conrad, 1855)**

Ostrea heermanni Conrad, 1855a, p. 267; Conrad, 1855b, p. 55; Conrad, 1857a, p. 325; Gabb, 1869, p. 107; Hanna, 1926, p. 467, pl. 22, figs. 7, 8, pl. 23, figs. 1, 2; Woodring, 1931, p. 11; Grant and Gale, 1931, p. 151; p. 366, 367; Woodring, 1938, p. 46; Hertlein, 1957, p. 58; Emerson and Hertlein, 1964, p. 354.

Ostrea hermanni Conrad. Orcutt, 1901, p. 12 [sic *heermanni*].

Ostrea veatchii Gabb, 1869, pl. 17, figs. 21-21a.

Not *Ostrea veatchii* Gabb, 1866.

Pycnodonte? (Pycnodonte?) heermanni (Conrad). Moore, 1987, p. C21, pl. 13, figs. 1, 4, 6, 7, pl. 14, fig. 4, pl. 16, fig. 4, pl. 17, figs. 6, 7.

A single well-preserved valve, several poorly preserved valves, and several fragments of valves are attributed to this species. It is abundant in other parts of the Imperial Formation in San Diego and Imperial Counties and its occurrence may be facies related. The species is easily recognized, even as small fragments, by its large, very thick shell with variable plications and a broad, well-developed hinge.

The thick valves serve to distinguish it from other Gulf of California oysters, but it is very similar to *P.? loeli* (Hertlein, 1927) from the Oligocene and Miocene Vaqueros Formation in southern California to Baja California Sur (Moore, 1987). *Pycnodonte? heermanni* is distinguished from *P.? loeli* by having a more quadrate outline, thicker shell, and fewer and heavier plications which are prominent only on the ventral part of the shell; the former also has a distinctly depressed body cavity and longer hinge line (Hertlein, 1928); it also attains a larger size.

Pycondonte? heermanni ranges in age from Miocene to Pliocene and is found in southern California to Baja California Sur (Moore, 1987).

Travertine Point faunule occurrence: CAS 2718 (1 valve); SDSNH 1012 (1 valve); UCMP locality A1707 (1 valve, 1 fragment), UCMP locality A1708 (2 single, partial valves); USGS M9778 (1 articulate valve and 3 fragments), USGS M9779 (a single valve).

Family Ostreidae Rafinesque, 1815 [ICZN 356]

***Myrakeena* cf. *M. angelica* (Rochebrune, 1895)**

Figure 3*i*

Compare:

Ostrea angelica Rochebrune, 1895, p. 241; Emerson and Hertlein, 1964, p. 353, figs. 3a-3c; Keen, 1971, p. 82, fig. 167; Hertlein and Grant, 1972, p. 216-217, pl. 38, figs. 2, 3.

Ostrea cumingiana Dunker. Durham, 1950, p. 58, pl. 5, fig. 6.

Not *O. cumingiana* Dunker, 1846.

Dendostrea? angelica (Rochebrune). Moore, 1987, p. C26-C27, pl. 32, figs. 1, 8, 9, pl. 34, figs. 2, 7, 9, 10 (and references therein).

The large size and circular outline of specimens from Travertine Point are reminiscent of *M. angelica* from the "northern" outcrops of the Imperial Formation (Powell, 1986), but poor preservation prevents positive identification. Unfortunately these specimens, a single broken valve and a small fragment, only show the interior of the shell and are therefore questionably identified.

Dendostrea? vespertina from the Miocene and Pliocene of California and Baja California is similar, but smaller and has a tear-drop shaped shell. *Myrakeena angelica* is also similar to the Pliocene *M. veatchii* (Gabb, 1866) as redefined by Squires and others (2006) from central California to Baja California, differing in having bifurcating ribs and occasionally hyote spines. It is also similar to a new species of *Pycnodonte (Pegma*?) from the Miocene Imperial Formation at Whitewater, Riverside County (Powell, 1986), but *P. (Pegma?)* n. sp., is easily distinguished by its vesicular shell structure, a feature that has only been recorded in the family Pycnodonteinae (Stenzel, 1971).

Myrakeenae angelica is reported by Powell (1986) from the late Miocene of the Gulfo de California, Mexico (J.T. Smith, oral commun., 1984), and the Imperial Formation in Riverside County. It is also been reported from the Pliocene and early Pleistocene San Diego Formation (Hertlein and Grant, 1972) and from Pliocene strata in the Gulf of California, Mexico (Durham, 1950; Emerson and Hertlein, 1964). The modern range is from the Gulf of California to Ecuador (Keen, 1971) from water depths of 1 to 5 m (Bernard, 1983).

Travertine Point faunule occurrence: USGS M9778 (1 valve), USGS M9779 (1 fragment).

***Dendostrea? vespertina* (Conrad, 1854)**

Ostrea vespertina Conrad, 1854, p. 300; Conrad, 1855b, p. 7, 15; Conrad, 1857a, p. 317, 325, 326, pl. 5, figs. 36-38; Conrad, 1857b, p. 160, pl. 17, figs. 1a-1d; Gabb, 1869, p. 107. Heilprin *in* White, 1884, p. 315, pl. 71, figs. 2-4; Hanna, 1926, p. 468, pl. 26, figs. 1-3; Jordan and Hertlein, 1926, p. 428; Grant and Gale, 1931, p. 152-153 (in part), pl. 12, figs. 1a, 1b; Durham, 1950, p. 59, pl. 5, figs. 1, 2, 5, 7.

Ostrea haitensis, Dall, 1898, p. 685 [in part = *D. vespertina*].

Ostrea haitensis subsp. *vespertina* Conrad. Stewart, 1930, p. 128, [in part; not pl. 14, fig. 4 = *Myrakeenae veatchii*].

Dendostrea? vespertina (Conrad). Moore, 1987, p. C25-C26 (in part), pl. 11, fig. 2, 5, pl. 12, figs. 2, 5, 6, pl. 13, fig. 5, pl. 14, fig. 2, pl. 15, figs. 2, 3, 6, 7, pl. 16. figs. 6, 7.

Although common and well preserved elsewhere in the Imperial Formation, specimens from Travertine Point are poorly preserved and rare. This is attributed to an unfavorable environment for this species as it is common nearby in the Santa Rosa Mountains.

Dendostrea? vespertina is easily confused with several eastern Pacific Neogene oysters. The Pliocene oyster, *Myrakeena veatchii,* as redefined by Squires and others (2006), from central California to Baja California Norte, has been confused with this species but is generally larger, has bifurcating ribs, and hyolate spines (Hertlein and Grant, 1972; Moore, 1987; Squires and others, 2006). Specimens of *D. folium* (Linnaeus) ecomorph 1 (of Stenzel, 1971) from the late Miocene Imperial Formation in Riverside County and middle Miocene to Holocene of the Caribbean is similar differing from *D? vespertina* in having smaller, more abundant plications only near the shell margins, and a much thinner shell. As pointed out by Hertlein and Grant (1972), some forms of *D? vespertina* (Conrad) are virtually indistinguishable from the Pliocene to Holocene species *Saccostrea palmeri* (Carpenter) from the Gulf of California to Ecuador and *Ostrea conchaphila* (Carpenter) (=*Ostrea lurida* Carpenter) from the Pliocene to Holocene of Alaska to Panama (Moore, 1987).

Travertine Point faunule occurrence: CAS 2718 (1 valve); UCMP locality A1707 (1 valve, 3 fragments); USGS M9779 (1 valve).

Family Pectinacea Rafinesque, 1815 [emended Waller, 1978]

***Euvola* cf. *E. keepi* (Arnold, 1906)**

Compare:

Pecten (Pecten) keepi Arnold, 1906, p. 60-61, pl. 5, fig. 1; pl. 6, fig. 1

Pecten keepi Arnold. Hanna, 1926, p. 471.

Pecten (Janira) keepi Arnold. Grant and Gale, 1931, p. 229.

Pecten (Euvola) keepi Arnold. Durham, 1950, p. 61, pl. 6, figs. 5, 6.

Euvola keepi (Arnold). Moore, 1984, p. B70-B71, pl. 30, figs. 5, 6.

Euvola keepi is represented by three partial left valves all of which show 18 radial ribs. It is the only eastern Pacific Neogene taxa in the *Pecten* group with 18 radial ribs on the left valve. Similar species with flat left valves include *E. refugioensis* (Hertlein, 1925), *Flabellipecten carrizoensis* (Arnold, 1906), *F. bosei* (Hanna and Hertlein, 1927), and *F. beali* (Hertlein, 1925). *Euvola refugioensis* is reported to have 19 radial ribs in the right valve, but no rib count could be found for the left valve. However, Hertlein (1925) reports that the left valve has a depressed area that is lower than the margins of the shell and extends from the beak to about one-half the height of the shell. This feature is missing in the specimens from Travertine Point, which have flat shells. Other Gulf of California taxa that are similar include *F. carrizoensis,* which has 16 to 17 radial ribs on its left valve, *F. bosei* (Hanna and Hertlein) which has 24 or 25, and *F. beali*, which has about 21.

Travertine Point faunule occurrence: UCMP locality A1706 (1 valve), UCMP locality A1707 (1 valve), UCMP locality A1708 (1 valve); USGS M9778 (1 valve, 1 fragment), M9779 (2 valves, 1 fragment).

***Argopecten* sp. indeterminate**

Valves attributed to this genus show rounded to inverted v-shaped ribs with interspaces that are about the width of the ribs and are otherwise smooth. Because of the crushed and fragmentary nature of these specimens they cannot be assigned specifically.

Travertine Point faunule occurrence: CAS locality 2718 (1 valve); UCMP locality A1707 (6 broken valves), UCMP locality A1708 (8 broken valves, 2 fragments); USGS M9778 (7 broken valves, 6 fragments), USGS M9779 (6 broken valves).

***Chlamys* cf. *C. corteziana* Durham, 1950**

Figure 3*k*

Compare:

Chlamys corteziana Durham, 1950, p. 64-65, pl. 10, figs. 2, 3, 6; Moore, 1984, p. B22, pl. 5, fig. 5.

Pecten sancti-ludovici Anderson and Martin. Hanna, 1926, p. 473, pl. 22, figs. 1-3.

Not *Pecten sancti-ludovici* Anderson and Martin, 1914.

This species is questionably reported from Travertine Point based on two crushed, fragmentary specimens that are separated from the genus *Argopecten* solely by the presence of equally spaced, fine beading on the radial ribs. This fine beading is not present on any eastern Pacific Argopectinid but is present on *C. corteziana*.

Travertine Point faunule occurrence: USGS M9778 (2 broken valves).

Family Spondylidae Gray, 1826

***Spondylus* sp. indeterminate**

Moderately thin to thick shell fragments with spine bases on the exterior of its valves make this genus easily recognizable. The fragments from Travertine Point are small; two of them appear to represent the upper (left) valve based on their thinner shell and the presence of spine bases. One other specimen from USGS M9779 is very thick and worn and is only questionably referred to this genus.

Travertine Point faunule occurrence: UCMP locality A1707 (3 fragments); USGS M9778 (3 fragments), USGS M9779 (2 fragments, 1 as "cf.")

Family Crassatellidae Férussac, 1822

***Eucrassatella* cf. *E. antillarum* (Reeve, 1842)**

Figures 3*k*, 3*l*

Compare:

Crassatella undulata Sowerby *in* Broderip and Sowerby, 1832, p. 56; Reeve, 1842, p. 44; Reeve, 1843, pl. 1, figs. 2a, 2b; Hanley, 1843, p. 37, pl. 12, fig. 24; Carpenter, 1857a, p. 297.

Not *Crassatella undulata* Lamarck, 1801.

Crassatella antillarum Reeve, 1842, p. 44-45; Reeve, 1843, pl. 2, fig. 8.

Eucrassatella antillarum. (Sowerby). Coan, 1984, p. 160, 162-163, figs. 12-16 (and references therein).

Travertine Point *Eucrassatella* appear to fall within the range of variability for *E. antillarum* as outlined by Coan (1984). They differ in their smaller adult size, about 60 mm long verses a maximum size of about 105 mm reported by Draper (1982). The Travertine Point specimens are also very similar to the holotype of *E. subgibbosus* (Hanna, 1926) (figs. 4m, 4n, 4o). The holotype of *E. subgibbosus*, however, is worn making many features obscure and the original shell material is mostly missing. The Travertine Point specimens differ from the holotype of *E. subgibbosus* in the following ways: (1) the umbo is wider, more inflated and located in a slightly more posterior position; (2) the shell is more inflated; and (3) the lunule appears thinner and of slightly different shape, but all these differences may be the result of preservation of *E. subgibbosus*. Although the Travertine Point specimens are regarded as distinct from *E. subgibbosus*, it is possible that better preserved material will show that it does not differ significantly from *E. antillarum*. If this should prove correct then *E. subgibbosus* should be placed in synonymy with *E. antillarum* not with *E. gibbosa* as suggested by Coan (1984).

Coan (1984) reports this species in the eastern Pacific from Cabo San Lucas, Baja California, Mexico, throughout the Gulf of California, and south to Playas, Guayas Province, Ecuador, in water depths from 5 m to 206 m.

Travertine Point faunule occurrence: CAS locality 2718 (2 valves); UCMP locality A1705 (1 fragment), UCMP locality A707 (16 valves, 29 fragments); USGS M9778 (2 articulate specimens, 14 single valves, and 14 fragments), USGS M9779 (3 valves, 3 fragments).

Family Carditidae Fleming, 1820

***Strophocardia megastropha* (Gray, 1825)**

Figure 4*t*

Venericardia megastropha Gray, 1825, p. 137; Lamy, 1922, p. 294, two text-figs., p. 296.

Venericardia flammea Michelin, 1831, pl. 6.

Cardita tumida Broderip, 1832, p. 56; Reeve, 1843, *Cardita*, pl. 5, fig. 26.

Cardita varia Broderip, 1832, p. 56; Reeve, 1843, *Cardita*, pl. 5, fig. 25a.

Cardita megastropha (Gray). Hertlein and Strong, 1946, p. 106.

Cardita (Strophocardia) megastropha (Gray). Olsson, 1961, p. 187, pl. 26, figs. 5, 5a; Keen, 1971, p. 109, fig. 244; Moore, 1992, p. E12, pl. 7, figs. 1, 2, 11, 14.

The high pointed umbo, large hinge, and low, thick, rounded ribs make this an easily identified species, even with poorly preserved material. The present specimens are poorly preserved and incomplete but otherwise are identical to modern shells from the Gulf of California.

Fossil occurrences of *Strophocardia megastropha* are from the Pliocene of Baja California Sur, Mexico (Moore, 1992). Its modern occurrence is reported by Keen (1971) as from the Gulf of California to Ecuador and the Galápagos Islands and from offshore environments as deep as 100 m. Bernard (1983) in water depths from 30 to 150 m.

Travertine Point faunule occurrence: UCMP locality A1707 (8 valves, 12 fragments), UCMP locality A1708 (1 hinge fragment); USGS M9778 (2 valves, 4 fragments), USGS M9779 (3 fragments).

Family Lucinidae Fleming, 1828

***Lucinisca nuttallii nuttallii* (Conrad, 1837)**

Figure 4*u*

Lucina nuttallii Conrad, 1837, p. 255, pl. 20, fig. 2. Arnold, 1903, p. 132-133.

Phacoides nuttallii (Conrad). Oldroyd, 1924, p. 5.

Lucina (Myrtea) nuttallii Conrad. Grant and Gale, 1931, p. 288, pl. 14, figs. 4a-b, 18.

Lucina (Lucinisca) nuttallii Conrad. Durham, 1950, p. 76, pl. 18, figs. 4, 5; Hertlein and Grant, 1972, p. 245-246, pl. 45, figs. 1-4; pl. 46, fig. 21.

Lucina (Lucinisca) nuttallii nuttallii Conrad. Moore, 1988, p. D9, pl. 1, figs. 3-6, 9, 12.

Specimens from Travertine Point are identical to modern specimens found off of southern California. They are distinguished from the form typically found in the modern Gulf of California, *L. nuttalli centrifuga* Dall (1901), by their narrow, evenly cancellate sculpture that is unlike the widely spaced concentric lamellae and flat spinules of typical modern Gulf of California specimens.

Abbott (1974) reports the species from Santa Barbara, California, to Manzanillo, Mexico. Ecologically, *L. nuttalli* is a shallow-water species reported by Hertlein and Grant (1972) to live intertidally to 46 m and from 10 to 75 m by Bernard (1983).

Travertine Point faunule occurrence: UCMP locality A1707 (9 valves), UCMP locality A1708 (2 valves); USGS M9778 (6 valves), USGS M9779 (2 fragments).

***Pleurolucina* sp.**

Figure 4*s*

This apparently new lucinid is represented by a single, well preserved specimen with the interior filled with sediment. The single, right valve is rounded-triangular in outline and has a distinct anterior umbonal ridge. The posterior surface of the umbonal ridge has three, indistinct, broadly rounded radial ribs. The center rib is twice the size of the anterior and posterior ribs. The shell surface shows distinct, square-shaped concentric ribs with narrow, shallow interspaces. The specimen is partially crushed and measures about 18.3 mm high and 15.1 mm wide.

The present specimen is distinctive enough to be differentiated from other fossil and modern lucinids from the eastern Pacific but is not described here because it is represented by only a single individual and the obscured interior of the shell and hinge cannot be described. Therefore it seems prudent to wait until more specimens are available to describe this species.

This *Pleurolucina* sp. is easily distinguished from the three living eastern Pacific *Pleurolucina*: *P. cancellaris* (Philippi, 1846), *P. leucocymoides* (Lowe, 1935), and *P. undata* (Carpenter, 1865) [= *P. undatoides* (Hertlein and Strong, 1945) *fide* Coan and Valentich-Scott, 2008], by having a rounded triangular outline rather than the rounded to oval outline of the latter three taxa. *P. leucocymoides* is most similar to the Travertine Point specimen but differs in shell shape, and in having concentric sculpture that is much more widely spaced. The genus *Pleurolucina* is found in water depths of intertidal to 110 m (Keen, 1971).

Travertine Point faunule occurrence: USGS M9779 (1 valve).

***Codakia (Codakia) distinguenda* (Tryon, 1872)**

Figure 4*p*

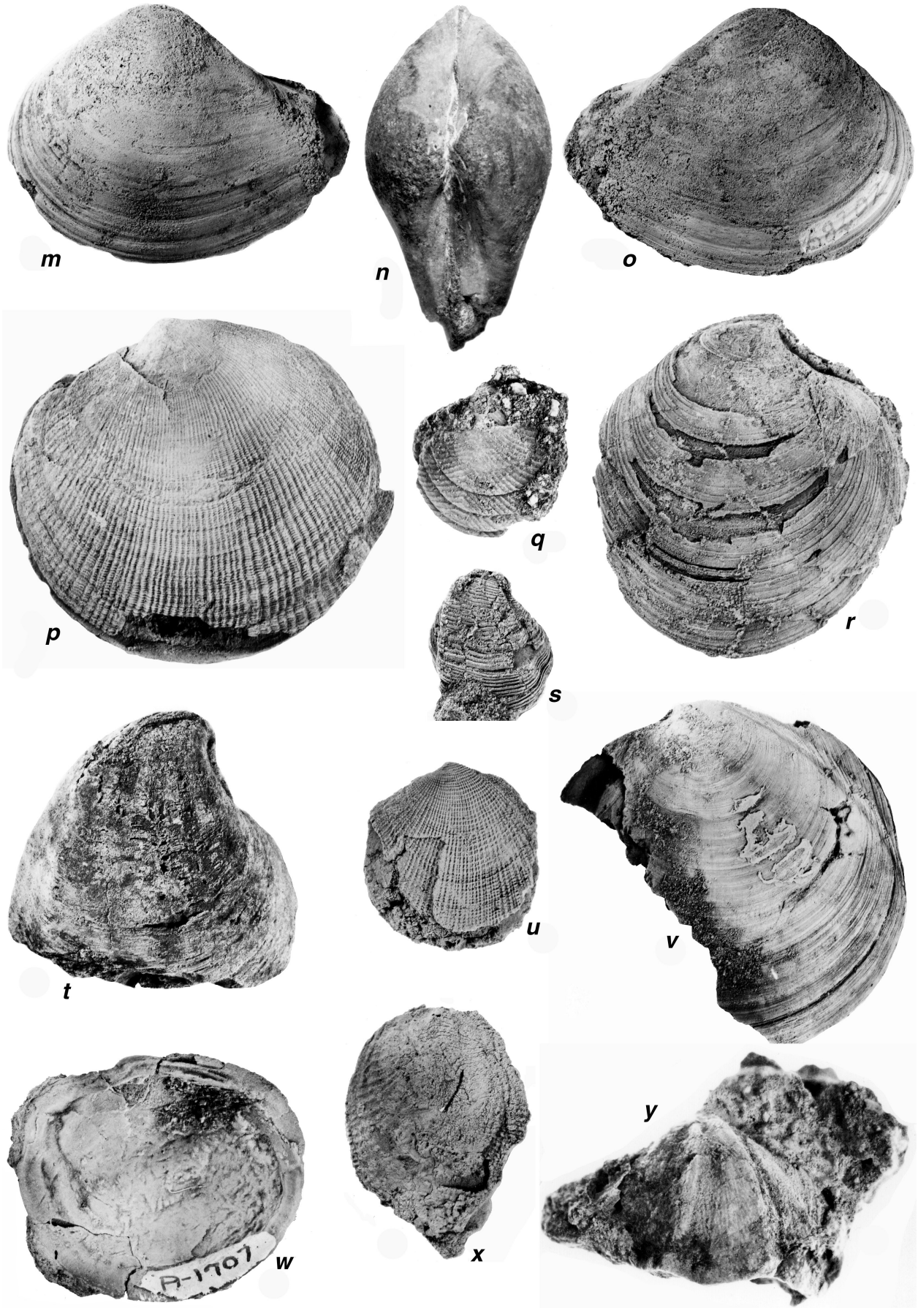
Lucina (Codakia) distinguenda Tryon, 1872, p. 130, pl. 6, fig. 3.

Codakia distinguenda (Tryon). Grant and Gale, 1931, p. 283; Hertlein and Strong, 1946, p. 117-118; Keen, 1971, p. 123, fig. 279.

Codakia (Codakia) distinguenda (Tryon). Durham, 1950, p. 74, pl. 18, figs. 2, 5; Olsson, 1961, p. 217, pl. 29, fig. 3; pl. 33, figs. 4a-b; Bretsky, 1976, p. 282, pl. 31, figs. 6, 7; Moore, 1988, p. D11, pl. 1, fig. 14; pl. 2, figs. 1-3.

Codakia distinguenda is probably the most common species from Travertine Point, but this may be a function of its easy identification even with small shell fragments, which have a distinctive sculpture of small, finely beaded or cancellate, radial ribs crossed by numerous small, closely

Figure 4. Selected fossils from the Travertine Point exposure of the Imperial Formation. ***m, n, o***, *Eucrassatella subgibbosus* (Hanna), Holotype, CAS locality 682, CAS type 682.2, ***m***, right valve, ***n***, top view, ***o***, left valve (exterior), height, width, and thickness not measured, specimen misplaced at CAS. ***p***, *Codakia distinguenda* (Tryon), UCMP locality A1707, UCMP 39876, height 56.6 mm, width 63.8 mm. ***q***, *Duvalinga* sp. cf. D. *eburnea* (Reeve), USGS Cenozoic locality M9778, USNM 486912, height 18.2 mm, width 19.1 mm. ***r***, *Dosinia* cf. *D. semiobliterata* Deshayes, UCMP locality A1707, UCMP 39877, height 55.0 mm, width 50.4 mm. ***s***, *Pleurolucina* sp., USGS Cenozoic locality M9778, USNM 486901, height 18.6 mm, width 14.9 mm. ***t***, *Strophocardia megastropha* (Gray), USGS Cenozoic locality M9778, USGS 486907, height 45.5 mm, width 49.6 mm. ***u***, *Lucina nuttallii nuttallii* (Conrad), USGS Cenozoic locality M9779, USNM 486910, height 19.4 m, width 18.2 mm. ***v***, *Miltha xantusi* (Dall), USGS Cenozoic locality M9778, USNM 486911, height 56.8 mm, width 56.0 mm. ***w***, *Pegophysema edentuloides* (Verrill), UCMP locality A1707, UCMP 39875, photograph about x1, height and width not measured as specimen has been misplaced at UCMP. ***x***, *Chama* sp. USNM 48604, USGS Cenozoic locality M9779, USNM 486906, height 23.5 mm, width 19.2 mm. ***y***, *Arcinella* cf., *A. californica* (Dall), USGS Cenozoic locality M9779, USNM 486908, height 30.2 mm, width 36.3 mm. (See appendix for locality information).


m
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set raised radial riblets. The sculpture and large size of this species easily distinguishes it from any other eastern Pacific lucinids. It is very similar to *C. (C.) orbicularis* (Linnaeus, 1758) from Florida to Texas and the West Indies. Bretsky (1976) thought that these species might be conspecific noting the only consistent difference was the larger size of the eastern Pacific species, although she also noted different lunule, but they were only developed on larger individuals.

The oldest occurrence of this species is from the "southern" outcrops of the Imperial Formation (Hanna, 1926). Keen (1971) reports modern specimens from Magdalena Bay in Baja California to Panama, in shallow water, on tide flats from extreme high tide, whereas Bernard (1983) reports it in water depths from the intertidal zone to 2 m.

Travertine Point faunule occurrence: CAS locality 2718 (1 valve); UCMP locality A1705 (2 fragments), UCMP locality A1707 (18 valves, 18 fragments), UCMP locality A1708 (2 broken valves); USGS M9778 (29 valves, 12 fragments), M9779 (3 valves, 21 fragments).

Divalinga cf. *D. eburnea* (Reeve, 1850)

Figure 4*q*

Compare:

Lucina eburnea Reeve, 1850, pl. 8, fig. 49; Carpenter, 1857b, p. 101.

Lucina (Cyclas) eburnea Reeve. Adams and Adams, 1857, p. 467.

Divaricella eburnea (Reeve). Dall, 1901, p. 815; Hanna, 1926, p. 464, pl. 26, figs. 8, 9; Hanna and Hertlein, 1927, p. 140; Olsson, 1961, p. 220, pl. 31, fig. 2.

Divaricella lucasana Dall and Ochsner, 1928, p. 122, pl. 2, figs. 17, 21, 24; Hertlein and Strong, 1946, p. 119-120; Durham, 1950, p. 78, pl. 19, figs. 5, 15. [New name for *D. eburnea* thought preoccupied by *D. eburnea* Deshayes, 1835 (nomen nudum)].

Divaricella dentata eburnea (Reeve). Grant and Gale, 1931, p. 296, pl. 14, figs. 1a, b.

Divaricella columbiensis Lamy, 1934, p. 433.

Divaricella (Divaricella) eburnea (Reeve). Bramkamp, 1935, unnumbered pages.

Divalinga (Divalinga) eburnea (Reeve). Keen, 1971, p. 129, fig. 285; Moore, 1988, p. D22-D23, pl. 7, figs. 10, 11, 13, 14.

Divaricella (Divalinga) eburnea (Reeve). Bretsky, 1976, p. 310-311, pl. 36, figs. 8-10.

This genus is easily distinguished by its strong, distinctive divaricated incised lines. The present specimens are only tentatively referred to *D. eburnea* because they are poorly preserved. *Divalinga comis* (Olsson, 1964) from the Pliocene of Ecuador is similar and future study may show it to be the same species. Two species of *Divalinga* occur in the Caribbean: *D. quadrisulcata* (Orbigny, 1846) and *D. dentata* (Wood, 1815). Bramkamp (1935) distinguished *D. eburnea* from *D. quadrisulcata* "...by the obsolesence of the anterior lateral, the shorter, wider, more cordate lunule, and the usually more arcuate sculpture of the former." Smith (1885) considered eastern Pacific material indistinguishable from *D. quadrisulcata*, although Dall (1901), Hertlein and Strong (1946), Olsson (1961), Keen (1971) and Moore (1988) did not make this distinction. *Duvalinga eburnea* can be easily distinguished from *D. dentata* by the dentate margins characteristic of the latter species.

Keen (1971) and Bernard (1983) report *D. eburnea* from Magdalena Bay, Baja California to Peru and in water depths from the intertidal zone to 55 m.

Travertine Point faunule occurrence: CAS locality 2718 (1 valve); USGS M9778(1 valve), USGS M9779 (2 valves, 1 fragment).

Miltha xantusi (Dall, 1905)

Figure 4*v*

Phacoides (Miltha) xantusi Dall, 1905, p. 111.

Phacoides xantusi (Dall). Hanna, 1926, p. 474-475, pl. 28, fig. 7; pl. 29, fig. 1.

Miltha xantusi (Dall). Durham, 1950, p. 77, pl. 19, figs. 3, 8; Olsson, 1961, p. 215, pl. 30, fig. 4.

Miltha (Miltha) xantusi (Dall). Hertlein and Grant, 1972, p. 250-251, pl. 45, figs. 14-17; Keen, 1971, p. 125-126, fig. 287; Bretsky, 1976, p. 289-290, pl. 33, figs. 1-3; Moore, 1988, p. D18-D19, pl. 5, figs. 1-4, pl. 6, figs. 1, 2, 11.

P[hacoides] joannis Dall, 1905, p. 110-112.

Specimens from Travertine Point are well preserved and show the hinge and large, smooth shell with a radial ridge that distinguish this species from other lucinids in the eastern Pacific. This species is probably under represented in collections because of its nearly featureless shell, ovate-long, flat, with one radial ridge and a large hinge plate, not allowing precise identification of fragments.

According to Dall (1905) this species is similar to *M. childreni* (Gray, 1825) from the Holocene of the Atlantic coast, but the latter has a smaller adult shell, is more rounded, has a shorter ligament, and unequal valves. Olsson (1961) suggested that this distinction might be negated when large collections of both species are examined. *Miltha caloosaensis* (Dall, 1898) from the Pliocene of Florida differs from the present species in attaining a much larger adult size, a thicker shell with deeply inset adductor scars and a more convex left valve.

According to Moore (1988) *Miltha xantusi* has been reported from the Miocene and Pliocene of the central Valley in California and the Pliocene of southern California and Baja California Sur, Mexico. Living specimens are restricted to the southern part of the Gulf of California and Keen (1971) states that it occurs mostly off Cabo San Lucas in depths to 55 m, whereas Hertlein and Grant (1972) report it from water depths of 33 to 101 m.

Travertine Point faunule occurrence: UCMP locality A1708 (1 fragment as "cf."), USGS M9778 (1 broken articulate specimen, 1 valve), USGS M9779 (1 fragment as "cf.").

***Pegophysema edentuloides* (Verrill, 1870)**

Figure 4*w*

Loripes edentuloides Verrill, 1870, p. 226.
Lucina edentuloides (Verrill). Hanna, 1926, p. 466.
Anodontia edentuloides (Verrill). Grant and Gale, 1931, p. 292; Durham, 1950, p. 75, pl. 18, figs. 11, 16.
Anodontia (Anodontia) edentuloides (Verrill). Olsson, 1961, p. 221, pl. 30, figs. 1-1b.
Pegophysema edentuloides (Verrill). Keen, 1971, p. 126, fig. 288.
Pegophysema (Pegophysema) edentuloides (Verrill). Moore, 1988, p. D21-D22, pl. 11, figs. 7, 8, 11.

If well preserved, this taxon is easily identified by its oval shape, swollen valves, and weak, toothless hinge. Unfortunately, mostly specimens from Travertine Point are not well preserved and are commonly crushed and (or) partially to wholly encrusted with sediment. Fortunately, there are enough specimens in the present collections to be fairly confident about its identification.

Pegophysema spherica (Dall and Ochsner, 1928) from the Pleistocene of the Galapagos Islands is similar but can be distinguished by its less inflated valves and deeply impressed posterior-dorsal area (Olsson, 1961).

Keen (1971) reports *Pegophysema edentuloides* living from Cedros Island, Baja California and through the Gulf of California to Tenacatita Bay, Mexico, in water depths from 33 to 165 m.

Travertine Point faunule occurrence: UCMP locality A1705 (1 articulate specimen), UCMP locality A1707 (24 valves), UCMP locality A1708 (7 articulate specimens, 1 fragment); USGS M9778 (13 articulate specimens, 1 single valve, 1 fragment), USGS M9779 (49 valves, 4 fragments).

Family Chamidae Bainville, 1825 [ICZN 484]

***Archinella* cf. *A. californica* (Dall, 1903)**

Figure 4*y*

Compare:
Echinochama californica Dall, 1903a, p. 950, pl. 62, fig. 5; Dall, 1903b, p. 1404; Hanna, 1926, p. 465.
Arcinella californica (Dall). Keen, 1971, p. 149, fig. 353; Moore, 1988, p. D31, pl. 10, fig. 13.

Specimens referred to *Archinella* cf. *A. californica* are poorly preserved, commonly decorticated and often encrusted with sediment making identification tentative at best. The Travertine Point specimens have a rounded outline with a produced posterior margin, strong prosogyrate beaks and a major radial ribs near the center of the disk followed by various secondary ribs on either side of the primary. Most specimens also show faint, incomplete radial riblets between the larger ribs that give the appearance of finger prints.

This species has been previously reported as a fossil from the Pliocene Imperial Formation in Imperial County (Hanna, 1926). Bernard (1983) distinguished *A. californica* from the western Atlantic *Echinochama arcinella* (Linnaeus, 1767) by the more produced anterior lobe, longer spines and more distinct surface pattern. Keen (1971) reports the modern occurrence of *A. californica* from Cedros Island, Baja California to Panama, in water depths from 22 to 46 m, although Bernard (1983) reports it in water depths from 25 to 80 m.

Travertine Point faunule occurrence: UCMP locality A1705 (4 fragment), UCMP locality A1407 (2 fragments); USGS M9778 (5 valves), USGS M9779 (1 fragment).

***Chama* sp.**

Figure 4*x*

This genus is represented by a single upper (right) valve that is moderately well preserved. The interior of the valve is obscure, but the recrystilized exterior shows radiating ribs that appear to extend the margins. The specimen is not well enough preserved to assign it to species.

Travertine Point faunule occurrence: USGS M9779 (1 valve).

Family Cardiidae Lamarck, 1809

***Americardium* sp.**

Americardium is represented at Travertine Point by a single partial left valve that is missing most of its posterior end and is attached to another shell so that the interior is inaccessible. It shows about 10 flat topped, radial ribs, with very narrow interspaces anterior of the umbonal ridge, and at least 6 narrower radial ribs posterior of the umbonal ridge. The specimen is about 13.5 mm high and 12.6 mm wide.

The Travertine Point specimen is easily distinguished from other eastern Pacific *Americardium* by their small size and few ribs and likely represent a new species. A similar, possibly identical, and as yet undescribed *Americardium* from the "Imperial" Formation at Whitewater, Riverside County (Powell, 1986) may prove to be the same species. The Riverside County specimens (1 valve and 2 fragments) show about 11 broad, flat-topped radial ribs anterior of the umbonal ridge and 8 to 10 posterior to the ridge, the complete valve measures 5.4 mm high and 6.0 mm wide and may fall within the range of variability of this likely new species.

The genus *Americardium* has been reported from water depths from intertidal to 155 m in the eastern Pacific.

Travertine Point faunule occurrence: USGS M9779 (1 valve).

Family Venerinae Rafinesque, 1815

***Dosinia* cf. *D. semiobliterata* Deshayes, 1853**

Figure 4*r*

Compare:
Dosinia semiobliterata Deshayes, 1853, p. 6; Keen, 1971, p. 178, fig. 428.
Dosinia annae Carpenter, 1857b, p. 61; Olsson, 1961, p. 262, pl. 42, figs. 2-2b.

Specimens from Travertine Point generally are poorly preserved, but one articulated specimen from UCMP locality A1707 is well preserved and illustrated. In general outline it is most similar to *D. semiobliterata*, differing from *D. dunkeri* Philippi (1844), by its subtruncated posterior end and weak sculpture, especially in the middle of the shell. *Dosinia pon-*

derosa (Gray, 1838) is easily distinguished by its larger size, heavier hinge, rounded outline and coarse concentric sculpture.

Dosinia semiobliterata has not previously been reported as a fossil. Keen (1971) cites its modern geographic range as mainly in the southern end of the Gulf of California to Panama.

Travertine Point faunule occurrence: CAS locality 2718 (1 valve as "species indet."); UCMP locality A1707 (1 articulated specimen, 2 valves, 10 fragments), UCMP locality A1708 (1 fragment); USGS M9778 (2 valves and 3 fragments of umbonal region), USGS M9779 (7 fragments).

Cyclinella sp.

The genus *Cyclinella* is represented by a single, crushed left valve, that shows a narrow hinge plate serving to separate it from *Dosinia*. The specimen is rounded in outline with the posterior end encrusted with sand. The umbo is cracked and shows a very narrow hinge plate with a small rounded ridge running parallel with the hinge plate on either side of the umbo. Keen (1971) records six species of *Cyclinella* from the eastern Pacific Holocene but the Travertine Point specimen is too poorly preserved to place it with any species. Bernard (1983) reports the genus in water depths of intertidal to 50 m in the eastern Pacific.

Travertine Point faunule occurrence: USGS M9778 (1 valve).

Chione? sp.

This genus may be represented by a single, poorly preserved, right valve. Its general shell outline indicates the genus *Chione*, but it is too poorly preserved for precise identification. The specimen has faint rounded radial ribs over the entire shell surface and fainter concentric ridges near the anterior and posterior margins, features found in *Chione*.

Travertine Point faunule occurrence: USGS M9779 (1 valve).

Class Gastropoda Cuvier, 1797

Family Turritellidae Woodward, 1851

Turritella cf. *T. imperialis* Hanna

Four crushed, fragment with turritelliform shape and poorly preserved sculpture are similar to *T. imperialis* Hanna (1926), but the poor preservation prevents precise identification.

Travertine Point faunule occurrence: UCMP locality A1707 (1 fragment); UCMP locality A1708 (3 specimens).

Family Strombidae Rafinesque, 1815

Strombus galeatus Swainson, 1823

Figures 5*z*

Strombus galeatus Swainson, 1823, p. 401. Reeve, 1850, *Strombus*, pl. 3, fig. 3; Hanna, 1926, p. 454; Hanna and Hertlein, 1927, p. 143; Grant and Gale, 1931, p. 756; Keen, 1971, p. 421, fig. 609.

This taxon is represented by a single, large specimen measuring about 175 mm long and about 145 mm wide. It consists mostly of a slightly crushed internal mold missing most of the body whorl, but the outer lip is well preserved. Its large size, small, low spire and large body whorl make it easily distinguishable from other extant and extinct eastern Pacific Strombidae.

Durham (1950) reports *S. galeatus* from the Pliocene and Pleistocene in the Gulf of California, whereas Keen (1971) reports its modern occurrence from the northern end of the Gulf of California to Ecuador, from just below the low-tide line.

Travertine Point faunule occurrence: UCMP locality A1708 (1 broken specimen).

Persististrombus obliteratus (Hanna, 1926)

Figure 5*bb*

Strombus obliteratus Hanna, 1926, p. 454-455, pl. 20, fig. 7; Grant and Gale, 1931, p. 755.

A latex cast of an internal mold shows a well-preserved specimen with a row of prominent spines on the shoulder succeeded low on the body whorl by another row of spines. This matches the description and illustrations of *S. obliteratus* in Hanna (1926), although the present specimen is slightly smaller than the type.

This species was recently assigned to the new genus *Persististrombus* Kronenberg and Lee (2007). *Persististrombus granulatus* Swainson is most similar to *P. obliteratus* Hanna, but is distinguished by its lack of spines on the body whorl. *Strombus gracilior* Sowerby (1825), also reported from the Imperial Formation (Hanna, 1926), differs in a similar manner.

Travertine Point faunule occurrence: USGS M9779 (1 internal mold).

Strombus? sp.

Two partial internal molds show the upper part of the body whorl and most of the penultimate whorl may belong to the genus *Strombus*. The body whorl shows a generally flat platform at the top of the whorl and a single, spiral rib, located at about the upper-third of the body whorl.

Travertine Point faunule occurrence: UCMP locality A1707 (1 broken specimen), UCMP locality A1708 (1 broken specimen as "?"); USGS M9778 (1 broken specimens as "?").

Family Naticidae Gray, 1840

Polinices cf. *P. uber* (Valenciennes, 1821)

Compare:

Natica uber Valenciennes, 1821, p. 266; Hanna, 1926, p. 451-452.

Polinices (Polinices) uber (Valenciennes). Marincovich, 1977, p. 246-251, pl. 22, figs. 2-4 (and references therein).

Five mostly decorticated specimens with a maximum height of about 20 mm, are comparable with this species. Three of the specimens show a broadly open umbilicus where the shell, and probably the columbella, have been dissolved away. All but one of the specimens shows a moderately high spire. This, along with the open umbilicus and small size suggests *Polinices uber*, which has been reported elsewhere in the Imperial Formation (Powell, 1988).

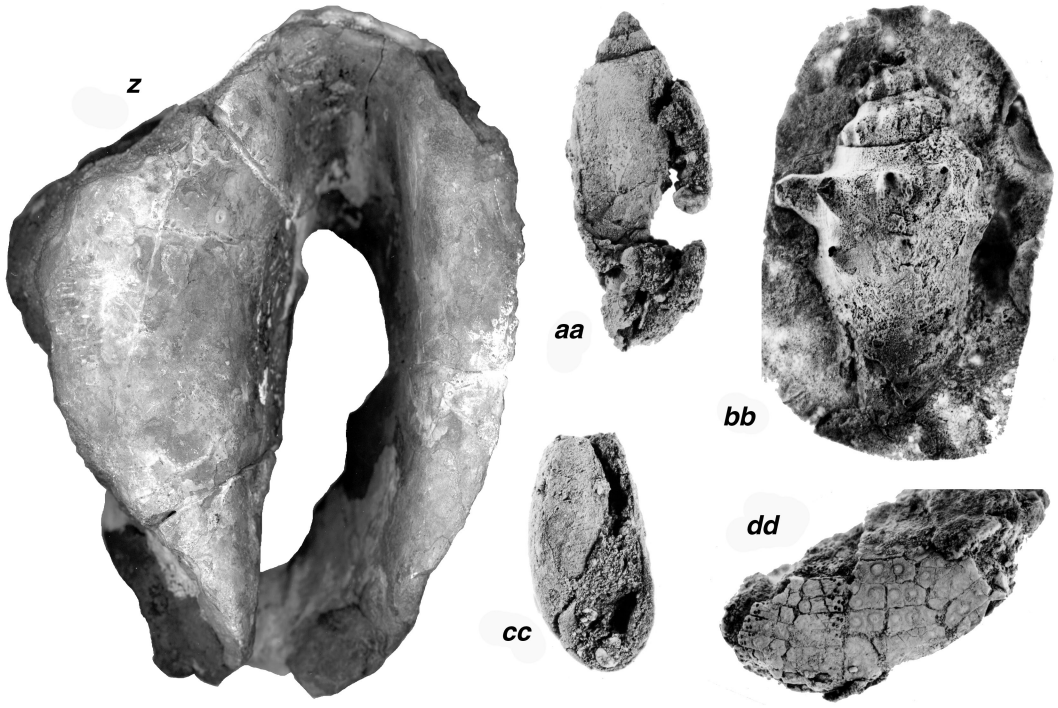

Figure 5. Selected fossils from the Travertine Point exposure of the Imperial Formation. ***z***, *Strombus galeatus Swainson*, UCMP locality A1708, UCMP 29878, height 184.5 mm, width 131.3 mm. ***aa***, *Agaronia*? sp., USGS Cenozoic locality M9779, USNM486906, height 30.3 mm, width 13.0 mm. ***bb***, latex cast of *Strombus obliteratus Hanna*, USGS Cenozoic locality M9779, USNM 486909, height 45.7 mm, width 29.7 mm. ***cc***, *Atys*? sp., USGS Cenozoic locality M9779, USNM 486900, height 24.5 mm, width 13.4 mm. ***dd***, *Toxopneustes* cf. *T. roseus* (Agassiz), UCMP locality A1707, UCMP 39879, photograph about x1, height and width not measured as specimen has been misplaced at UCMP. (See appendix for locality information).

Polinices uber is a member of a morphologic group described by Marincovich (1977) to include *P. uber*, *P. intemeratus* (Philippi, 1853), *P. panamaensis* (Recluz, 1844), and *P. otis* (Broderip and Sowerby, 1829). All of these species live in the tropical eastern Pacific and exhibit overlapping variation in form and umbilical morphology. As a result, the present poorly preserved Imperial Formation specimens can only be questionably assigned to *P. uber*.

Marincovich (1977) reports *P. uber* from Cedros Island, western Baja California, Mexico (28°10'N), throughout the Gulf of California, and south to the Galapagos Islands, Ecuador, and Paita, Peru (5°S) on sand bottoms, intertidally and to depths of at least 100 m.

Travertine Point faunule occurrence: USGS M9778 (4 specimens).

Naticidae, indeterminate

These Naticid specimens are too poorly preserved to determine genus, but might be referable to *Polinices* cf. *P. uber*, being the same general size and shape.

Travertine Point faunule occurrence: UCMP locality A1707 (5 specimens); USGS M9778 (4 specimens).

Family Tonninae Peile, 1926

***Malea*? sp.**

One incomplete steinkern about 20 mm high is questionably assigned to this genus. The specimen shows spiral ribs that are similar to *M. ringens* (Swainson, 1822), but the small size and poor preservation prevent a precise identification. Another poorly preserved specimen of about the same size but in poorer condition in present from UCMP locality A1708. *Malea ringens* is common in the "southern" outcrops around Alverson (Fossil) Canyon, southern Coyote Mountain, and has been questionably reported from the Whitewater area (Bramkamp, 1935).

Travertine Point faunule occurrence: UCMP A1707 (1 specimen), UCMP A1708 (1 specimen).

Family Olividae Latereille, 1825

***Argaronia*? sp.**

Figure 5*aa*

Two incomplete steinkerns are questionably assigned to this genus. The better preserved of the two is illustrated here. The specimen is about 30 mm high and resembles the genus *Agaronia*, in general outline and in having a high pointed

spire and an apparent flaring aperture. *Agaronia* occurs in the eastern Pacific from the head of the Gulf of California to Peru (Keen, 1971).

Travertine Point faunule occurrence: CAS 2718 (1 specimen); UCMP locality A1707 (2 specimens); USGS M9778 (1 specimen), USGS M9779 (1 specimen).

Family Conidae Rafinesque, 1815

***Conus* sp..**

This genus is poorly represented by a single fragment of a body whorl, too small to identify.

Travertine Point faunule occurrence: USGS M9778 (1 fragment).

Family Atyidae Thiele, 1926

***Atys*? sp.**

Figure 5*cc*

Several poorly preserved specimens from Travertine Point are similar in general outline to the genus *Atys* but are more than twice the length (about 25 mm) of any extant eastern Pacific species (Keen, 1971). They differ from tropical west America species of *Bulla* illustrated by Keen (1971) in having a narrower shell with a flat top and nearly straight sides.

Travertine Point faunule occurrence: UCMP locality A1705 (1 specimem), UCMP locality A1707 (3 specimen); USGS M9778 (1 specimens and 1 fragment), USGS M9779 (7 specimens).

Phylum Echinodermata Linnaeus, 1758

Class Echinoidea Leske, 1778

Family Toxopneustidae Troschel, 1872

***Toxopneustes* cf. *T. roseus* (Agassiz, 1863)**

Figure 5*dd*

Compare:

Boletia rosea Agassiz, 1863, p. 24.

Toxopneustes roseus (Agassiz). Grant and Hertlein, 1938, p. 26, pl. 17, figs. 1, 2 (and references therein).

A small fragment measuring about 36 mm x 22.5 mm compares closely with the illustration of this species in Grant and Hertlein (1938). A similar specimen, also referred to this species, was collected in Alverson (Fossil) Canyon, southern Coyote Mountains, Imperial County (LACMIP loc. 27273). All Imperial Formation specimens of *T.* cf., *T. roseus* (Agassiz) are easily distinguished from other Imperial Formation Echinoidea on the basis of their tubercle and pore arrangement.

Maluf (1988) reports this species from Guaymas, Mexico, to La Plata Island, Ecuador and in water depths from intertidal to 55 m.

Travertine Point faunule occurrence: UCMP locality A1708 (2 fragment).

Family Clypeastridae L. Agassiz, 1836

***Clypeaster* sp.**

Two fragments from the margin of a large *Clypeaster* were recovered from Travertine Point. The larger of the two fragments is better preserved and shows a number of individual plates and tubercles. The following three species of *Clypeaster* are recorded from the Imperial Formation: *C. bowseri* Weaver (1908), *C. carrizoensis* Kew (1914) and *C. deserti* Kew (1914). *Clypeaster carrizoensis* is a small, circular species that is easily separated from present material by its much smaller size. The present fragments cannot be separated with certainty from either *C. bowseri* or *C. deserti* and, so, are assigned only to genus.

Travertine Point faunule occurrence: UCMP locality A1708 (2 fragments).

Family uncertain

Sand dollar

This taxon is represented by the cross section of a single specimen exposed on two sides of a cobble. The four centimeter, fragmentary specimen is flat through out its entire length and is therefore suggestive of a sand dollar.

Travertine Point faunule occurrence: CAS 2718 (3 fragments); USGS M9778 (1 fragment).

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References Cited

Abbott, R.T., 1974, American seashells, the marine Mollusca of the Atlantic and Pacific coasts of North America: New York, Van Nostrand Reinhold Co., p. 1–663.

Adams, H., and Adams, A., 1853-1858, The genera of recent Mollusca, arranged according to their organization: London, v. 1, 1–484; v. 2, 1–661; v. 3, pls. 1–138 (dating of parts, v. 2, p. 661).

Addicott, W.O., and Galehouse., J.S., 1973, Pliocene marine fossils in the Paso Robles Formation, California: Journal of Research, U.S. Geological Survey, v. 1, p. 509–514.

Adegoke, O.S. 1969, Stratigraphy and paleontology of the marine Neogene formations of the Coalinga region California: University of California Publications in Geological Sciences, v. 80, p. 1–241.

Agassiz, A., 1863, List of the echinoderms sent to different institutions in exchange for other specimens, with annotations: Bulletin Museum of Comparative Zoology, v. 1, p. 17–28 [not seen].

Agassiz, A., 1872-1874, Revision of the Echini, illustrated catalogue of the Museum of Comparative Zoology at Harvard College, no. VII: Cambridge, Mass., University Press, p. 1–761.

Agassiz, L., 1836, Prodrome d'une monographie des radiares ou echinoderms: Mémoires de la Société Neuchâteloise des Sciences Naturelles, v. 1, p. 168–199 [not seen].

Anderson, F.M., and Martin, B., 1914, Neocene record in the Temblor Basin, California, and Neocene deposits of the San Juan District, San Luis Obispo County: Proceedings California Academy of Sciences, Fourth Series, v. 4, p. 15–112.

Arnold, R., 1903, The paleontology and stratigraphy of the marine Pliocene and Pleistocene of San Pedro, California: Memoirs California Academy of Sciences, v. 3, p. 1–420.

Arnold, R., 1906, The Tertiary and Quaternary pectens of California: U.S. Geological Survey Professional Paper 47, p. 1–264.

Arnold, R., 1909 (1910), Paleontology of the Coalinga District, Fresno and Kings Counties, California: U.S. Geological Survey Bulletin 396, p. 1–173.

Arnold, R., and Anderson, R., 1907, Geology and oil resources of the Santa Maria oil district, Santa Barbara County, California: U.S. Geological Survey Bulletin 322, p. 1–161.

Arnold, R., and Anderson, R., 1910, Geology and oil resources of the Coalinga District, California: U.S. Geological Survey Bulletin 398, p. 1–354.

Bainville, H.M.D. de, 1825, Manuel de Malacologie et de Conchyliologie: Paris, France, p. 1–541 [not seen].

Bernard, F.R., 1983, Catalogue of the living bivalvia of the eastern Pacific Ocean; Bering Strait to Cape Horn: Canadian Special Publication of Fisheries and Aquatic Sciences 61, p. 1–102.

Blake, W.P., 1855, Preliminary geologic report: U.S. 33d Congress, 1st Session, House Exec. Doc. 129, p. 1–80.

Bramkamp, R.A., 1935, Stratigraphy and molluscan fauna of the Imperial Formation of San Gorgonio Pass, California: Berkeley, Calif., University of California, Ph.D. dissertation, p. 1–86 and unnumbered p.

Bretsky, S.S., 1976, Evolution and classification of the Lucinidae (Mollusca: Bivalvia): Palaeontographica Americana, v. 8, p. 117–337.

Broderip, W.J., 1832-1833, Characters of new species of Mollusca and Conchifera, collected by Mr. Cuming: Proceedings Zoological Society of London, for 1832, p. 25–33 (April 21, 1832), p. 50–61 (June 5, 1832), p. 104–108 (July 31, 1832), p. 124–126 (August 14, 1832), p. 173–179 (January 14, 1833), p. 194–202 (March 13, 1833).

Broderip W.J., and Sowerby, G.B., 1829, Observations on new or interesting Mollusca contained, for the most part, in the Museum of the Zoological Society: Zoological Journal (London, England), v. 4, p. 359–379.

Broderip, W.J., and Sowerby, G.B., 1832, [..the new species of Mollusca and Conchifera collected by Mr. Cuming,..] [one section only]: Proceedings Zoological Society of London for 1832 [pt. 2], v. 17, p. 50–61.

Carpenter, P.P., 1856, Description of new species of shells collected by Mr. T. Bridges in the Bay of Panama and its vicinity, in the collections of Hugh Cuming, Esq.: Proceedings Zoological Society of London, p. 159–166.

Carpenter, P.P., 1857a, Report on the present state of our knowledge with regard to the mollusca of the west coast of North America: British Association for the Advancement of Science, for 1856, p. 159–368.

Carpenter, P.P., 1857b, Catalogue of the collections of Mazatlan shells in the British Museum; collected by Frederick Reigen: London (British Museum), England. P. 1–522 [reprinted by Paleontological Research Institution, 1967].

Coan, E.V., 1984, The Recent Crassatellinae of the eastern Pacific, with some notes on *Crassinella*: The Veliger, v. 26, p. 153–169.

Coan, E.V., and Valentich-Scott, P., 2008, Three nomenclatural notes on Panamic bivalves: The Festivus, v. 40, p. 49–54.

Conrad, T.A., 1837, Description of new marine shells from upper California, collected by Thomas Nuttall, Esq.: Journal Academy of Natural Sciences, Philadelphia, v. 7, p. 227–268.

Conrad, T.A., 1854, Descriptions of new fossil shells of the United States: Journal Academy of Natural Sciences, Philadelphia, Second series, v. 2, p. 299–300.

Conrad, T.A., 1855a, Descriptions of eighteen new Cretaceous and Tertiary fossils, etc.: Proceedings Academy of Natural Sciences, Philadelphia, v. 7, p. 265–268.

Conrad, T.A. 1855b, Report on the fossil shells collected by W.P. Blake, geologist to the expedition under the command of Lieut. R.S. Williamson, U.S. Topographical Engineers, 1852, *in* Blake, W.P., Preliminary geological report, append; U.S. Pacific Railroad Exploration: U.S. 33d Congress, 1st session, House Ex. Doc. 129, p. 5–20.

Conrad, T.A., 1857a, Descriptions of new fossil shells (Williamson's reconnaissance in California); Report of explorations and survey for a railroad route from the Mississippi to the Pacific: U.S. 33d Congress, 2d session, Senate Ex. Doc. 91, v. 5, p. 317–329 [separate in 1856].

Conrad, T.A., 1857b, Descriptions of three new genera; twenty-three new species middle Tertiary fossils from California, and one from Texas: Proceedings Philadelphia Academy of Natural Sciences, Philadelphia, v. 8, p. 312–316.

Cuvier, G., 1797, Tableau Elémentaire de l'Histoire Naturelle des Animaux: Paris, France. P. 1–710 [not seen].

Dall, W.H., 1890-1903, Contributions to the Tertiary fauna of Florida, with especial reference to the Miocene *Silex*-beds of Tampa and the Pliocene beds of Caloosahatchie River; Tertiary mollusks of Florida: Transactions Wagner Free Institution, v. 3, pt. 1, p. 1–200 (1890); pt. 2, p. 201–473 (1892); pt. 3, p. 474–570 (1895); pt. 4, p. 571–947 (1898); pt. 5, p. 949–1218 (1900); pt. 6, p. 1219–1654 (1903a).

Dall, W.H., 1901, Synopsis of the Lucinacea and of the American species: Proceedings U. S. National Museum, v. 23, p.779–833.

Dall, W.H., 1903b, Synopsis of the family Astartidae, with a review of the American species: Proceedings U. S. National Museum, v. 26, p. 933–951.

Dall, W.H. 1905. Notes on *Lucina (Miltha) childreni* Gray and on a new species from the Gulf of California: The Nautilus, v. 18, p. 110–112.

Dall, W.H., 1909, Report on a collection of shells from Peru, with a summary of the littoral marine Mollusca of the Peruvian zoological province: Proceedings U.S. National Museum, v. 37, p. 147–294.

Dall, W.H., and Ochsner, W.H., 1928, Tertiary and Pleistocene Mollusca from the Galapagos Islands: Proceedings California Academy of Sciences, ser. 4, v. 17, p. 89–139.

Deshayes, G.P., 1835–1845, Histoire naturelle des animaux sans vertebras: Paris, France. Deuxiéme edition, v. 1–11 [not seen].

Deshayes, G.P., 1853–1855, Catalogue of the Conchifera or bivalve shells in the British Museum: London, England; pt. 1, Veneridae, Cyprinidae and Glauconomidae, p. 1–216 (1853); pt. 2, Petricoladae (concluded), Corbiculadae, p. 217–292, "1854" (1855) [not seen].

Dibblee, T.W., Jr., 1954, Geology of the Imperial Valley region, California, chap. II, *in* Jahns, R.H., ed., Geology of southern California: Bulletin California Division of Mines and Geology 170, p. 21–28.

Draper, B.C., 1982, Lost operculum club list of champions: Los Angeles, Calif., Conchological Club of southern California, p. 1–32.

Dunker, W., 1846, Diagnosen neuer Conchylien (*Ostrea Cumingiana, Tellina Meyeri*): Zeitschriff fur Malakozoologie, v. 52, p. 48.

Durham, J.W., 1950, 1940 E.W. Scripps cruise to the Gulf of California; part II, Megascopic paleontology and marine stratigraphy: Memoir Geological Society of America 43, p. 1–216.

Ehrenberg, G.G., 1834, Beiträge zur physiologischen kenntniss der corallenthiere im allgemeinen und besonders des Rothen Meeres: Kaiserliche Akademie der Wissenschaften Berlin, Abhandlungen, 1832, p. 250–380 [not seen].

Emerson, W.K., and Hertlein, L.G., 1964. Invertebrate megafossils of the Belvedere Expedition to the Gulf of California: Transactions San Diego Society of Natural History, v. 13, p. 333–368.

Férussac, A.E., 1822, Tableaux systématiuques des animaux Mollusques classés en famillies naturelles, dans lesquels on a établi la concordance et tous les Systémes; suivis d'un Prodrome général pour tous les Mollusques terrestres ou fluviatiles, vivants ou fossils: Paris, France and London, England, p. 1–110 [not seen].

Fleming, J., 1820, Conchology: D. Brewster's Encyclopaedia (Edinburgh, Scotland), v. 12, p. 55–107 [not seen].

Fleming, J., 1828, A history of British animals, exhibiting the descriptive characters and systematical arrangement of the genera and species of quadrupeds, birds, reptiles, fishes, Mollusca and Radiata of the United Kingdom; including the indigenous, extirpated, and extinct kinds; together with periodical and occasional visitants: Edinburgh, Scotland. P. 1–554 [not seen].

Foster, A.B., 1979, Environmental variation of a fossil scleractinian coral: Lethaia, v. 12, p. 245–264.

Frey, H., and Leuckart, C.G.F.R., 1847, Beitrage zur Kenntniss wirbelloser Thiere mit besonderer Berucksichtigung der Fauna des Norddeutschen Meeres: Verlag von Friedrich Vieweg und Sohn, Braunschwig, p. 1–170 [not seen].

Gabb, W.M., 1866–1869, Tertiary invertebrate fossils: California Geological Survey, Paleontology, v. 2, Cretaceous and Tertiary fossils, sec. 1, pt. 1, p. 1–38 (1866); sec. 1, pt. 2, p. 39–63 (1869).

Grant, U.S., IV, and Gale, H.R., 1931, Catalogue of the marine Pliocene and Pleistocene Mollusca of California and adjacent regions: Memoir San Diego Society of Natural History 1, p. 1–1036.

Grant, U.S., IV, and Hertlein, L.G., 1938, The west American Cenozoic Echinoidea: Publications University of California at Los Angeles in Mathematical and Physical Sciences, v. 2, p. 1–225.

Gray, J.E., 1825, A list and description of some species of shells not taken notice of by Lamarck: Annals of Philosophy, v. 9, p. 134–140, 407–415.

Gray, J.E., 1826, On a recent species of the genus *Hinnita* of DeFrance, and some observations on the shell of the Monomyaires of Lamarck: Annals of Philosophy, new series, v. 12, p. 103–106 [not seen].

Gray, J.E., 1838, Catalogue of the species of the genus *Cytherea*, of Lamarck, with the description of some new genera and species: The Analyst, a Quaterly Journal of Science, Literature, Natural History, and the Fine Arts, v. 8, no. 24, p. 302–309 [not seen].

Gray, J.E., 1840, Synopsis of the contents of the British Museum, ed. 42: London, England, p. 1–370 [not seen].

Gregory, J.W., 1900, The corals. Jurassic fauna of Cutch: Palaeontologica Indica, Series 9, v. 2, p. 1–195 [not seen].

Hanley, S.C.T., 1842–1856, An illustrated and descriptive catalogue of Recent marine shells: London, England, Williams and Norgate, p. 1–392 (p. 1–32 [1842]; p. 33–272 [1843]; p. 273–392 [1856] and plates [1843–1856]).

Hanna, GD., 1926, Paleontology of Coyote Mountains, Imperial County, California: Proceedings California Academy of Sciences, Fourth Series, v. 14, p. 427–503.

Hanna, GD., and Hertlein, L.G., 1927, Expedition of the California Academy of Sciences to the Gulf of California in 1921; Geology and Paleontology: Proceedings California Academy of Sciences, Fourth Series, v. 16, p. 137–157.

Heilprin, A., 1884, North American Tertiary Ostreidae, *in* White, C.A., A review of the fossil Ostreidae of North America; and a comparison of the fossil with the living forms: U.S. Geological Survey, Fourth Annual Report, appendix 1, p. 281–431.

Hertlein, L.G., 1925., Pectens from the Tertiary of Lower California: Proceedings California Academy of Sciences, Fourth Series, v. 14, p. 1–35.

Hertlein, L.G., 1928, Preliminary report on the paleontology of the Channel Islands, California: Journal of Paleontology, v. 2, p. 142–157.

Hertlein, L.G., 1957, Pliocene and Pleistocene fossils from the southern portion of the Gulf of California: Bulletin Southern California Academy of Sciences, v. 56, p. 57–75.

Hertlein, L.G., and Grant, U.S., IV, 1972, The geology and paleontology of the marine Pliocene of San Diego, California (Paleontology: Pelecypoda): Memoir San Diego Society of Natural History, v. 2, p. 1–409.

Hertlein, L.G., and Strong, A.M., 1943–1951, Eastern Pacific expedition of the New York Zoological Society; Mollusks from the west coast of Mexico and Central America (parts I–X): Zoologica, New York, N.Y.; v. 25, p. 369–430 (December 31, 1940); v. 28, p. 149–168 (December 6, 1943); v. 31, p. 53–76 (August 20, 1946); v. 31, p. 93–120 (December 5, 1946); v. 31, p. 129–150 (February 21, 1947); v. 33, p. 163–198 (December 31, 1948); v. 34, p. 63–97 (August 10, 1949); v. 34, p. 239–258 (December 30, 1949); v. 35, p. 217–252 (December 30, 1950); v. 36, p. 67–120 (August 20, 1951).

Ingle, J. C., 1974, Paleobathymetric history of Neogene marine sedimens, northern Gulf of California: Geology of Peninsular California; A guidebook for the 49th annual meeting of the Pacific Section, AAPG-SEG-SEPM, p. 121–138.

Johnson, N.M., Officer, C.B., Opdyke, N.D., Woodward, G.D., Zeitler, P.K., and Lindsay. E.H., 1983, Rates of late Cenozoic tectonism in the Vallecito-Fish Creek basin, western Imperial Valley, California: Geology, v. 11, p. 664–667.

Jordan, E.K., 1924, Quaternary and recent molluscan faunas of the west coast of Lower California: Bulletin Southern California Academy of Sciences, v. 23, p. 145–156.

Jordan, E.K., and Hertlein, L.G., 1926, Expedition to the Revillagigedo Islands, Mexico, in 1925, VII; Contributions to the geology and paleontology of the Tertiary of Cedros Island and adjacent parts of Lower California: Proceedings California Academy of Sciences, ser. 4, v. 15, p. 409–464.

Keen, A.M., 1971,. Sea shells of tropical west America; marine mollusks from Baja California to Peru: Stanford, Calif., Stanford University Press, p. 1–1064.

Keen, A.M., and Bentson, H., 1944, Check list of California Tertiary marine Mollusca: Special Paper Geological Society of America, v. 56, p. 1–280.

Kew, W.S.W., 1914, Tertiary echinoids of the Carrizo Creek region in the Colorado Desert: University of California Publications Bulletin Department of Geology, v. 8, p. 39–60.

King, T., Cox, B.F., Matti, J.C., Powell, C.L., II, Osterman, L.E., and Bybell, L.M., 2002, Previously unreported outcrops of Neogene Imperial Formation in southern Santa Rosa Mountains, California, and implications for tectonic uplift [abs.]: Geological Society of America Abstracts with Program, v. 34, p. 124.

Kronenberg, G.C., and Lee, H.G., 2007, Genera of American Strombid gastropopds (Gastropoda: Strombidea) and remarks on their phylogeny: The Veliger, v. 49, p. 256–264.

Lamarck, J.B.P.A. de M. de, 1801, Systéme des animaux sans vertébres, ou tableau général des classes, des ordres et des genres de ces animaux;…: Paris, France, Chez l'auteur & Deterville, p. 1–432 [not seen].

Lamarck, J.B.P.A. de M. de, 1809, Philosophie zoologique, ou exposition des considérations relatives á l'histoire naturelle des animaux, la diversité de leur organisation et des facultés qu'ils en obtinnent, aux causes physiques qui main tiennent en eux la vie, et donnent lieu aux mouvements qu'ils exécutent; enfin, á celles qui produisent les unes les sentiments, et les autres l'intelligence de ceux qui en sont doués: Paris, France, v. 1, p. 1–422; v. 2, p. 1–472 [not seen].

Lamy, P.E., 1907, Revision des *Arca* vivants du Museum d'Histoire Naturelle de Paris: Journal de Conchyliologie, v. 55, p. 1–111 (June); v. 55, p. 199–307 (September).

Lamy, P.E. 1909, Pelecypodes recueillis par M.L. Diguet dans la Golfe de Californie (1894–1905): Journal de Conchyliologie, v. 57, p. 207–254.

Lamy, P.E., 1922, Révision des Carditacea vivants du Muséum national d'histoire naturelle de Paris: Journal de Conchyliologie, v. 66, p. 218–368.

Lamy, P.E., 1934, Coquilles marines recueillies par M. E. Aubertde la Rue dans l'Amerique du Sud: Bulletin du national Museum d'Histoire naturelle, series 2, v. 6, p. 432–435.

Latereille, P.A., 1925, Familles naturelles du régne animal exposées soccintemente dt dans un ordre analytique, avec l'indication de leurs genres: Paris, France, J. B. Bailliere, 2nd ed., p. 1– 570 [not seen].

Leach, W.E., 1819, A voyage of discovery by John Ross, appendix II, a list of invertebrate animals: London, England, p. 61–63.

Leske, N.G., 1778, Jacobi Theodori Klein naturalis dispositio Echinodermatum, edita et descriptionibus novisque inventis et synonomis auctorum aucta [additamenta ad Kleinii dispositionem Echinodermatum]: Leipzig, Germany. P. 1–278 [not seen].

Linnaeus, C., 1758, Systema naturae per tria regna naturae: Stockholm, Sweden, Editio decima. Reformata, v. 1, Regnum animale, p. 1–824.

Linnaeus, C., 1766–1767, Systema naturae per regna tria naturae: Stockholm, Sweden, Editio duodecima, Reformata, v. 1, Regnum animale, pt. 1, p. 1–532 (1766); pt. 2, p. 533–1327 (1767).

Lowe, H.N., 1935, New marine Mollusca from west Mexico, together with a list of shells collected at Punta Penasco, Sonora, Mexico: Transactions San Diego Society of Natural History, v. 8, p. 15–35.

Maluf, L.Y., 1988, Composition and distribution of the central eastern Pacific Echinoderms: Technical Reports Natural History Museum of Los Angeles County 2, p. 1–242.

Marincovich, L.N., Jr., 1977, Cenozoic Naticidae (Mollusca: Gastropoda) of the northeastern Pacific: Bulletins of American Paleontology, v. 70, p. 165–494.

Matti, J.C., Morton, D.M., and Cox, B.F., 1985, Distribution and geologic relations of fault systems in the vicinity of the central Transverse Ranges, southern California: U.S. Geological Survey Open-File Report 85-365, p. 1–23 p.

Maury, C.J., 1922, The Recent arcas of the Panamic Province: Palaeontographica Americana, v. 1, p. 163–208.

McDougall, K., Powell, C.L., II, Matti, J.C., and Poore, R.Z., 1994, The Imperial Formation and the opening of the ancestral Gulf of California [abs.]: Geological Society of America Abstracts with Programs, v. 26, p. 71.

Michelin, H., 1831, *Venericardia flammae*: Magasin de Zoologie, v. 1, Moll., pl. 6 [not seen].

Moore, E.J., 1983, Tertiary marine pelecypods of California and Baja California; Nuculidae through Malleidae: U.S. Geological Survey Professional Paper 1228A, p. 1–108.

Moore, E.J., 1984, Tertiary marine pelecypods of California and Baja California; Propeamussiidae and Pectinidae: U.S. Geological Survey Professional Paper 1228B, p. 1–112.

Moore, E.J., 1987, Tertiary marine pelecypods of California and Baja California; Plicatulidae to Ostreidae: U.S. Geological Survey Professional Paper 1228C, p. 1–53.

Moore, E.J., 1988, Tertiary marine pelecypods of California and Baja California; Lucinidae through Chamidae: U.S. Geological Survey Professional Paper 1228D, p. 1–46.

Moore, E.J., 1992, Tertiary marine pelecypods of California and Baja California; Erycinidae through Carditidae: U.S. Geological Survey Professional Paper 1228E, p. 1–37.

Newton, R.B., 1922, Eocene Mollusca from Nigeria: Geological Survey of Nigeria Bulletin, v. 3, p. 1–114.

Oldroyd, I.S., 1924, The marine shells of the west coast of North America: Stanford, Calif., Stanford University Publications in Geological Sciences, v. 1, p. 1–247.

Olsson, A.A., 1961, Mollusks of the tropical eastern Pacific, particularly from the southern half of the Panamic-Pacific faunal province (Panama to Peru): Ithica, New York, Paleontological Research Institution, p. 1–574.

Opdyke, N.D., Lindsay, E.H., Johnson, N.M., and Downs, T., 1977, The paleomagnetism and magnetic polarity stratigraphy of the mammal-bearing section of Anza Borrego State Park, California: Quaternary Geology, v. 7, p. 316–329.

Orbigny, A.d', 1841–1846, Mollusques, *in* Sagra, R., Histoire physique, politique, et naturelle de l'Ile de Cuba: 2 volumes and atlas, issued as of 1853, but published in parts earlier, as follows: V. 1, p. 1–208 (1841); p. 209–264 (1842); v. 2, p. 1–112 (1842); p. 113–380 [probably 1853 (imprinted date 1846, p. 149 ff.)]; Atlas (1842). Spanish ed., title page dated 1845 (p. 149 ff. probably 1846, as imprinted] [not seen].

Orcutt, C.R., 1901, The Colorado Desert: West American Scientist, v. 12, p. 2–14.

Peile, A.J., 1926, The Mollusca of Bermuda: Proceedings Malacological Society of London, v. 17, p. 71–98.

Phillippi, R.A., 1845–1851, Abbildungen und beschreiburgen neuer oder wenig gekannter Conchylien, unter Mithulfe mehrerer Deutscheer Conchyliologen, mit beitragen der Herren Anton, Dr. von dem Busch, Dr. Dunker, Dr. Jonas, Bergrath Koch, Dr. Pfeiffer, Dr. Troschel: band 1–III: This work appeared in 24 parts, which are issued as follows: b. 1, lief. 1, p. 1–20 (1845); lief. 2, p. 21–46 [1842(1843)]; lief. 3, p. 47–76 [1844(1843)]; lief. 4–7, p. 77–178 (1844); lief. 8, p. 179–204, title and index, [1845(1844)]; b. 2, lief. 1, p. 1–32 [1844(1845)]; lief. 2, p. 33–64 (1845); lief. 3–4, p. 65–122 [1845(1846)]; lief. 5, p. 123–152 [N.D. (1846)]; lief. 6–8, p. 153–232; title and index [N.D. (1847)]; b. 3, lief. 1–2, p. 1–50 [N.D. (1847)]; lief. 3, p. 51–82 [N.D. (1848)]; lief. 4–6, p. 1–88 [N.D. (1849)]; lief. 7–8, p. 89–138, title and index [N.D., (1850)].

Phillippi, R.A., 1849–1853. Die Gattungen *Natica* und *Amaura*, *in* Martini, F.H.W., and Chemitz, J.H., Systematisches Conchylien–Cabinet: v. 2, p. 1–164 [not seen].

Powell, C.L., II, 1985, Bivalve molluscan paleoecology of northern exposures of the marine Neogene Imperial Formation in Riverside County, California. Annual Report Western Socielty of Malacologists 7, p. 29–32.

Powell, C.L., II, 1986, Stratigraphy and bivalve molluscan paleontology of the Neogene Imperial Formation in Riverside County, California: San Jose, Calif., San Jose State University, M.S. thesis, p. 1–325.

Powell, C.L., II, 1988, The Miocene and Pliocene Imperial Formation of southern California and its molluscan fauna; an overview: Annual Report Western Society of Malacologists 20, p. 11–18.

Rafinesque, C.S., 1815, Analyses de la nature ou tableau de l'universe et des corps organisées: Palermo, Italy. P. 1–224 [not seen].

Reeve, L.A., 1842, Monograph of *Crassatella*, a genus of acephalous mollusks (Family Mactracea): Proceedings Zoological Society of London for 1842 [pt. 10], p. 42–46.

Reeve, L.A., 1843–1878, Conchologia iconica: or, illustrations of the shells of molluscous animals: London, England, v. 1–20, with supplement to *Conus*. [Continued by G.B. Sowerby, II, beginning with the genus *Pyramidella* in vol. 15, October, 1865].

Reinhart, P.W., 1943, Mesozoic and Cenozoic Arcidae from the Pacific slope of North America: Special Paper Geological Society of America 47, p. 1–117.

Robinson, M.K., 1973, Atlas of monthly sea surface and subsurface temperatures in the Gulf of California, Mexico: Memoir San Diego Society of Natural History 5, p. 1–97.

Rochebrune, A.T. de, 1895, Diagnoses de mollusques nouveaux, provanant du voyage de M. Diguet en Basse-Californie: Bulletin du national Museum d'histoire naturelle, v. 1, p. 239–243.

Rost, H., 1955, A report on the family Arcidae (Pelecypoda): Los Angeles, Calif., Allan Hancock Pacific Expeditions, v. 20, p. 177–249.

Récluz, C.A., 1844, Descriptions of new species of *Navicella, Neritina, Nerita*, and *Natica* in the cabinet of H. Cuming, Esq.: Proceedings Zoological Society of London, v. 11, p. 197–214 [not seen].

Rymer, M.J., Sarna–Wojcicki, A.M., Powell, C.L., II, and Barron, J.A., 1994. Stratigraphic evidence for late Miocene opening of the Salton Trough in southern California [abs.]: Geological Society of America Abstracts with Programs, v. 26, p. 87.

Smith, E.A., 1885, Report on the Lamellibranchiata collected by H.M.S. Challenger, during the years 1873–76—Report of the scientific results of the H.M.S. Challenger during the years 1873–76 under the command of Captain George S. Nares, R.N.F.R.S. and the late Captain Frank Tourle Thomson, R.N., prepared under the superintendence of the late Sir. C. Wyville Thomson, Knt., F.R.S., &c., Regius Professor of natural history in the University of Edinburgh; director of the civilian scientific staff on board, and now of John Murray, LL.D., Ph.D. &c., one of the naturalists of the expedition, Zoology Volume XXXIV: London, H.M.S. Challenger Reports: p. 1–341.

Sowerby, G.I., 1825, A catalogue of the shells contained in the collections of the late Earl of Tankerville: London, England, p. 1–92 [not seen].

Sowerby, G.I., 1833–1834, Characters of new genera and species of Mollusca and Conchifera, collected by Mr. Cuming, *Byssoarca* and *Arca* genera: Proceedings Zoological Society of London, v. 1, p. 16–22.

Squires, R.L., Groves, L.T., and Smith, J.T., 2006, New information on molluscan paleontology and depositional environments of the upper Pliocene Pico Formation, Valencia area, Los Angeles County, southern California: Contributions in Science Natural History Museum of Los Angeles County 511, p. 1–24.

Stearns, R.E.C., 1894, The shells of the Tres Marias and other localities along the shore of Lower California and the Gulf of California: Proceedings U.S. National Museum, v. 17, p. 139–204.

Stenzel, H.B., 1971, Oysters, *in* Moore, R.C., ed., part N, vol. 3 (of 3), Mollusca 6, Treatise on Invertebrate Paleontology: Geological Society of America, Inc., and the University of Kansas, publishers, p. N953–N1224.

Stewart, R.B., 1930, Gabb's California Cretaceous and Tertiary type lamellibranches: Special Publication Academy of Natural Sciences of Philadelphia, v. 3, p. 1–314.

Stump, T.E., 1972, Stratigraphy and paleontology of the Imperial Formation in the western Colorado Desert, San Diego, California: San Diego, Calif., California State University, M.S. thesis, p. 1–132.

Swainson W., 1822, A catalogue of the rare and valuable shells, which formed the celebrated collection of the late Mrs. Bligh: London, England, p. 1– 58 and 20 unnumbered pages [not seen].

Swainson, W., 1823, The specific characters of several rare and undescribed shells: Philosophical Magazine, v. 61, p. 401–403 [not seen].

Thiele, J., 1926, Opisthobranchia, *in* Kükenthal, W., and Krumbach, T., Handbuch der Zoologie: Berlin and Leipzig, Germany, W. de Gruyter, v. 5, p. 95–115 [not seen].

Troschel, F.H., 1872, Die familie der Echinocidaren: Archiv für Naturgeschichte 1872, p. 293–356 [not seen].

Tryon, G.W., Jr., 1872, Catalogue and synonymy of the recent species of the family Lucinidae: Proceedings Academy of Natural Sciences of Philadelphia, for 1872, p. 82–96.

Valenciennes, A., 1821, Coquilles marines bivalves de l'Amérique Équinoxiale, recueillies pendant le voyage de M. M. de Humboldt et Bonpland, *in* Humboldt, F.H.A. and Bonpland, J.A., Voyage aux regions équinoxialis du nouveau continent, part 2, Recueil d'observations de zoologie dt d'anatomie compareefaites dans l'Océan Atlantique, dans l'intérieur années 1799 … 1803: Paris, France, Smith and Gide v. 2, p. 217–224. [sometimes dated as 1827 or 1832; not seen].

Valenciennes, A., 1846, Atlas de Zoologie, mollusques, *in* Abel du Petit-Thouars, Voyage autour du monde sur la frégate La Vénus, pendant les années 1836–1839: Paris, France, Gide, pls. 1–24 (no text) [not seen].

Valentine, J.W., 1961, Paleoecologic molluscan geography of the California Pleistocene: University of California Publications in Geological Sciences, v. 34, p. 309–442.

Vaughan, T.W., 1900, The Eocene and Oligocene coral fauna of the United States: U. S. Geological Survey Monograph 39, p. 1–263.

Vaughan, T.W., 1917, The reef-coral fauna of Carrizo Creek, Imperial County, California, and its significance: U. S. Geological Survey Professional Paper 98T, p. 355–376.

Verrill, A.E., 1870, Descriptions of shells from the Gulf of California: American Journal of Science, series 2, v. 49, p. 217–227.

Vialov, O.S., 1936, Sur la classification des huîtres: Académie des Sciences URSS, Comptes rendus (Doklady), new series, v. 4, p. 17–20 [not seen].

Waller, T.R., 1978, Morphology, morphoclines and a new classification of the Pteriomorphia (Mollusca: Bivalvia): Philosophical Transactions, Royal Society London, B, v. 284, p. 345–365.

Weaver, C.E., 1908, New echinoids from the Tertiary of California: University of California Publications Bulletin of the Department of Geology, v. 5, p. 271–272.

Winker, C.D., 1987, Neogene stratigraphy of the Fish Creek-Vallecito section, southern California; implications for early history of the northern Gulf of California and Colorado Delta: Phonenix, Ariz., University of Arizona, Ph.D. dissertation, p. 1–494.

Winker, C.D., and Kidwell, S.M., 1996. Stratigraphy of a marine rift basin: Neogene of the western Salton Trough, California, *in* Abbott, P.L., and Cooper, J.D., eds., Field conference guide 1996 (Annual meeting American Association of Petroleum Geologists, Society of Economic Paleontologists and Mineralogists): Pacific Section A.A.P.G., guide book 73; Pacific Section S.E.P.M., book 80, p. 295–336.

Wood, W., 1815, General conchology; or a description of shells: London, England, p. 1–246 [not seen].

Woodring, W.P., 1931, Distribution and age of the marine Tertiary deposits of the Colorado Desert: Carnegie Institute of Washington Publication 418, p. 1–25.

Woodring, W.P., 1938, Lower Pliocene mollusks and echinoids from the Los Angeles Basin, California and their inferred environments: U.S. Geological Survey Professional Paper 190, p. 1–67.

Woodring, W.P., and Bramlette, M.N., 1950, Geology and paleontology of the Santa Maria district, California: U.S. Geological Survey Professional Paper 222, p. 1–185.

Woodring, W.P., Stewart, R., and Richards, R.W., 1940 (1941), Geology of the Kettlemen Hills oil field, California: U.S. Geological Survey Professional Paper 195, p. 1–170.

Woodward, S.P., 1851, A manual of the Mollusca: or a rudimentary treatise of recent and fossil shells, part 1: London, England, p. 1–158 [not seen].

Appendix—Locality Information

Museum of Paleontology, University of California, Berkeley

UCMP locality A1705: About ? feet S 67° W of tip of Travertine Point, on hill slope about 150 ft northwest of saddle, Oasis 7.5' quadrangle, San Diego County, California. Collector: R.W. Burger, 1934. [No measurement was recorded of the distance between Travertine Point and the saddle.]

UCMP locality A1706: About 100 ft northeast of UCMP locality A1705 in bottom of small gully, about 20 ft above base of marine bed, Oasis 7.5' quadrangle, San Diego County, California. Collector: R. Bramkamp, 12/28/1937. Field No.: RAB370A.

UCMP locality A1707: Same as UCMP locality A1705. Collector: R. Bramkamp, 12/28/1937. Field No.: RAB370B.

UCMP locality A1708: About 75 ft east and 50 ft south of UCMP locality A1707 and probably stratigraphically higher. Collected by R.A. Bramkamp, 12/28/1935. Field No.: RAB370C.

U. S. Geological Survey, Menlo Park, California Cenozoic register (now housed at the Museum of Paleontology, University of California, Berkeley)

M9778: Surface sample collected above saddle on southeast slope of Hill 367 between Garner and Travertine Palms washes at an elevation between 200 and 300 ft, west–northwest of Desert Shores and west–southwest of Travertine Rock, San Diego County, California. Latitude: 33.412° N; longitude: 116.062° W. Collectors: C. Powell II and J. Laney, August 5, 1991.

M9779: Surface sample collected above saddle on southeast slope of Hill 367 between Garner and Travertine Palms washes at an elevation between 200 and 300 ft, west–northwest of Desert Shores and west–southwest of Travertine Rock, San Diego County, California. Latitude: 33.412° N; longitude: 116.062° W. Same locality as M9778. Collectors: C. Powell II, E. Kohnen, and P. Remeika, July 30, 1992.

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