

PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES
FOURTH SERIES

Vol. XXX, No. 14, pp. 265-284, figs. 1-17

November 30, 1966.

PLIOCENE FOSSILS FROM
RANCHO EL REFUGIO, BAJA CALIFORNIA,
AND CERRALVO ISLAND, MEXICO

BY

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INTRODUCTION

Sedimentary deposits along the east coast of Baja California as well as on many of the islands in the Gulf of California are abundantly fossiliferous. Studies of fossils from that area have yielded information concerning the age and distribution of the strata enclosing them as well as information concerning the paleobiology of the organisms represented.

The occurrence of fossil bearing strata on Rancho El Refugio, about 17 kilometers southeast of Santiago, Baja California, Sur, came to the attention of Mr. Victor J. Bergeron, a member of the Board of Trustees of the California Academy of Sciences. His interest in the locality was aroused and later he generously furnished his airplane and other logistic support for an expedition to that area by Academy personnel. Mr. Cesar Osuna Peralta, Mayor of Santiago, and Mr. Walter R. Heyneman of Sonoma, California, had previously visited this locality on Rancho El Refugio and communicated with the writer concerning a collection of fossils which they had assembled there.

The field party was composed of Dr. George Lindsay, Director; Dr. Robert T. Orr, Associate Director; Dr. G. Dallas Hanna, Curator of the De-

partment of Geology, all of the staff of the California Academy of Sciences; and Dr. J. Wyatt Durham, Department of Paleontology, University of California. The party left San Francisco, California, April 23 and returned April 26, 1965. A general account of this expedition was published by Lindsay (1965).

On April 24, Mr. Harry ("Bing") Crosby and Mr. Cesar Osuna Peralta took the party to Rancho El Refugio where fossils were collected at four localities.

On April 25, Drs. Lindsay, Orr, Hanna, and Durham, investigated the strata at Ruffo's Ranch on the west coast of Cerralvo Island where invertebrate fossils were known to occur. This trip was made possible through the generosity of Mr. Crosby, who furnished his yacht *True Love* for transportation to that area.

The field work and the fossils collected during this expedition add considerably to the knowledge of the stratigraphic succession of the beds and their age. This work also furnished information for a basis of comparison with the results of similar earlier studies made in the southern portion of the Gulf of California region. Two subspecies in the fauna are described as new in the present paper.

All specimens illustrated in this paper are in the collection of type specimens in the Department of Geology in the California Academy of Sciences.

ACKNOWLEDGMENTS

The writer here expresses his appreciation to Dr. G Dallas Hanna and to Dr. J. Wyatt Durham for the privilege of studying and preparing a report on the present collection and for making available their field notes. Photographs used to illustrate the fossils were prepared by Mr. Maurice Giles.

RANCHO EL REFUGIO

Rancho El Refugio was visited by geologists of the Marland Oil Company in 1920 or 1921 (see anonymous, 1924, p. 33; Beal, 1948, p. 81) who made observations on the geology of that region where strata of Pliocene age were reported (Beal, p. 117) to occur to an elevation of 1400 feet. They collected various invertebrate fossils which were reported by Hertlein (1925) and by Beal (1948). More recently (1964) Mr. Walter R. Heyneman, accompanied by Mr. Cesar Osuna Peralta, visited the area containing fossiliferous strata on Rancho El Refugio. The fossils collected at that time were generously donated to the California Academy of Sciences. These are indicated in the present list of fossils under Locality 38849 (CAS).

According to Dr. Durham, the strata in the vicinity of the ranch house dip 20° to 25° SE., strike N. 30° E. This dip prevails for a considerable

distance over the ranch and the section apparently is several thousand feet thick. In the vicinity of the ranch the sequence is composed of silty beds, poorly sorted sandstone and gravelly and cobbly sandstone, mostly not well sorted. Sands vary from fine to coarse, sometimes white but otherwise the color is gray, grayish green, yellow, and brown. Fossils are scattered throughout the sequence. Concretions of various shapes, to a length of two feet, are present. Fossil whale bones occur abundantly.

Durham mentioned that the localities visited by the field party were apparently in the same area where fossils reported by Beal were collected. He mentioned, however, that "according to Beal's map (1948), if our distances and directions are correct, we collected fossils in sediments which he mapped as 'Ysidro sandstone' (Miocene), but in his text (1948, p. 66) he notes that fossils reported by Hertlein were from localities (not shown on the map) in an area mapped as Salada, about 4 kilometers northwest of the Ysidro-Salada contact. Either the distance estimated from the ranch to the localities is wrong or the contact is not correctly located on the map."

The following information concerning the localities where fossils were collected is taken from field notes furnished by Dr. J. W. Durham.

Locality 39411 (CAS). On ridgetop, about 200 meters east of the ranch house. Fossils from silty and sandy beds, strike N. 30° E., dip 20-25° SE.

Locality 39412 (CAS). Along the trail about 100 meters to the south-east, fossils from similar beds \pm 100 feet higher stratigraphically

Locality 39413 (CAS). Along the trail about 200 meters to the south-east, higher stratigraphically, gravelly beds with abundant oysters. Slightly lower topographically than the preceding locality. An apparent unconformity visible on side of hill 250-300 meters to the west, with overlying nearly flat gravels.

Locality 39414 (CAS). From bottom of arroyo about 200 meters north-east of Locality 39411 (CAS). Similar strata, but slightly lower stratigraphically.

The entire sequence is thick, poorly bedded, and poorly sorted, composed of silts, sands, gravels, and pebble conglomerates. Marine shells and occasional whale bones are scattered higher and thither on the surface. Only shells such as oysters and pectens (with MgCo_3 in shell) are well preserved; others are usually leached.

Locality 39415 (CAS). From outcrops along north bank of main arroyo, on return trip to Santiago, said to be about 8 kilometers southeast of the village. Here outcrops of diatomite \pm 100 feet thick, with silty interbeds overlies other silts. Quite low dipping generally to the southeast, these beds are believed to be stratigraphically below the beds at Rancho El Refugio.

The following list represents the identified fossil fauna collected by Hanna and Durham, also those reported from that area by Hertlein and Beal and those collected by Heyneman.

TABLE 1. *List of Fossils from Rancho El Refugio*

	LOCALITIES					
	Hertlein & Beal	38849	39411	39412	39413	39414
BRACHIOPODA						
<i>Glottidia</i> cf. <i>G. audebarti</i> Broderip			×		×	
ECHINOIDEA						
? <i>Centrostephanus</i> species		×				
PELECYPODA						
<i>Amusium</i> species		×				
<i>Anomia peruviana</i> d'Orbigny	×	×	×	×		
<i>Atrina</i> species		×				
<i>Chione</i> cf. <i>C. californiensis</i> Broderip . . .			×			
<i>Chlamys mediacostata grewingki</i>						
Hertlein, new subspecies				×		
<i>Chlamys (Aequipecten)</i> cf. <i>C. (A.) palmeri</i>						
Dall				×		
<i>Chlamys (Argopecten) abietis</i>						
E. K. Jordan and Hertlein				×		
<i>Chlamys (Argopecten) calli</i> Hertlein . . .	×	cf.				
<i>Chlamys (Argopecten) circularis</i>						
Sowerby	×					
<i>Chlamys (Leptopecten) latiaurata</i> Conrad			×			
<i>Chlamys (Nodipecten) subnodosa</i>						
Sowerby			×			
<i>Chlamys (Pacifipecten) tumbezensis</i>						
d'Orbigny		×				
<i>Lucina</i> species		×				
<i>Ostrea californica osunai</i>						
Hertlein, new subspecies		×	×	×		
<i>Ostrea fisheri</i> Dall					×	
<i>Ostrea megodon</i> Hanley	×	×	×	×		
<i>Ostrea palmula</i> Carpenter (as <i>O mexicana</i>						
Sowerby by Hertlein and Beal)	×	cf.				
<i>Pecten (Pecten) aletes</i> Hertlein	×				×	
<i>Pecten (Pecten)</i> cf. <i>P. (P.) lunaris</i>						
Berry		×				
<i>Pecten (Pecten) species</i>		×	×			
<i>Pecten (Euvola) keepi</i> Arnold	×					
<i>Pecten (Euvola) refugioensis</i> Hertlein . .	×	×	×	×		
? <i>Placunanomia</i> species			×			
<i>Spondylus princeps</i> Broderip		×				
<i>Teredo</i> species		×				

TABLE 1. *List of Fossils from Rancho El Refugio*
(Continued).

	LOCALITIES					
	Hertlein & Beal	38849	39411	39412	39413	39414
GASTROPODS						
<i>Calyptraea</i> species			×			
<i>Crepidula</i> cf. <i>C. arenata</i> Broderip		×				
<i>Ficus</i> cf. <i>F. ventricosus</i> Swainson	×					
<i>Fusinus</i> species		×				
<i>Malea ringens</i> Swainson		×				
<i>Murex</i> species	×					
<i>Oliva spicata</i> Röding in Bolten				×		
<i>Strombus</i> cf. <i>S. granulatus</i> Swainson				×		
<i>Strombus</i> species	×					
<i>Turbo</i> species					×	
<i>Turritella</i> cf. <i>T. gonostoma</i>						
Valenciennes		×				
<i>Vasum</i> cf. <i>V. muricatum</i> Broderip					×	
ARTHROPODA						
Geocarcinidae	×					
SHARK TEETH						
<i>Carcharodon arnoldi</i> Jordan	×					
<i>Hemipristis heteropleurus</i> Agassiz	×					
? <i>Carcharhinus</i> species	×					
WHALE JAW	×					
WOOD	×					

This list contains 29 species of which 19 are positively identified and 10 are provisionally identified. In addition to there there are 13 forms identified only as to genus, one as to family, and two of general classification.

Of the 29 species, 20 are living in the adjacent warm, shallow waters in the Gulf of California and 9 are extinct. All these species except two, *Chlamys* (*Argopecten*) cf. *C. (A.) palmeri* and *Pecten* cf. *P. (P.) lunaris* have been reported previously from strata of Pliocene age.

Study of the present assemblage leads the writer to the opinion that the age is Pliocene, probably middle Pliocene.

ISLA CERRALVO

Fossils from the west side of Cerralvo Island at El Mostrador (Ruffo's Ranch) have been reported by several authors including Hanna and Hertlein (1927), Hertlein (1957), Emerson (1960), and Emerson and Hertlein (1964).

Collections were assembled by Hanna and Durham from outcrops in sea cliffs to the north and to the south of "Farallones Blancos." According to Durham "the total length of outcrops of sediments along the beach is perhaps a mile. These sediments appear to be small inliers dipping toward the interior of the island where, perhaps, they may be bounded by two faults. A terrace face is present at an elevation of 20 to 25 feet.

"The island as a whole appears to be composed of granites and metamorphics overlain by volcanics with an inlier of sediments in the vicinity of 'Farallones Blancos.' However, the sediments may continue on into the island underneath some of the volcanics.

"The oldest beds south of the arroyo at Ruffo's Ranch, are exposed at the mouth of the arroyo. ...The total thickness of the section investigated is approximately 550 feet."

The following are localities where fossils were collected by Hanna and Durham.

- Locality 39405 (CAS). 250 feet above base of section.
- Locality 39406 (CAS). 170 feet above base of section.
- Locality 39407 (CAS). 160 feet above base of section.
- Locality 39408 (CAS). 125 feet above base of section.
- Locality 39409 (CAS). 85 feet above base of section.
- Locality 39409A (CAS). Same beds as Locality 39409 (CAS)
±100 yards to the north.

Locality 39410 (CAS). The distance is uncertain but probably 300 to 400 yards north of the arroyo near the base of the sedimentary sequence. The strike is N. 20° E., the dip 15° SE., near base of conglomerates. Some sandy and silty beds are present but the sequence is predominantly cobble-boulder conglomerate for some distance. Occasional beds of *Pocillopora*, algae, and echinoids are present.

"The outcrop ends at the next (to north) small arroyo, the beds dipping steeply to the southeast. Metamorphics occur to the north, dipping steeply to the northwest. Faulting may exist along the contact." (Durham.)

In addition to the species collected by Hanna and Durham, those reported earlier from that area are indicated in the left hand column in the list.

Fourteen species and subspecies are recorded in this list. Of these nine are positively identified and five are only provisionally identified. Three other forms are identified only as to genus and two as to phylum.

Nine of the 14 species and subspecies are Recent and five are extinct. All of these have been reported previously from strata of Pliocene age. Judging from the known occurrence of the forms represented in this faunule and their associated fauna elsewhere, a middle Pliocene age can be assigned to this assemblage. This is in agreement with the opinion expressed by Emerson and Hertlein (1964, p. 347) who studied a faunule from the same area.

TABLE 2. List of Fossils from Isla Cerralvo.	LOCALITIES							
	Earlier Records	39405	39406	39407	39408	39409	39409A	39410
BRYOZOA								
<i>Conopeum commensale</i> Kirkpatrick and Metzelaar	x							
ECHINOIDEA								
<i>Clypeaster bowersi</i> Weaver	x							
<i>Clypeaster</i> cf. <i>C. speciosus</i> Verrill	x							
<i>Clypeaster</i> species	x							
<i>Meoma</i> species		x	x					x
PELECYPODA								
<i>Ostrea angelica</i> Rochebrune				x				
<i>Ostrea</i> aff. <i>O. heermanni</i> Conrad	x							
<i>Pecten</i> (<i>Oppenheimopecten</i>) <i>vogdesi</i> Arnold	x				x			
<i>Chlamys</i> (<i>Argopecten</i>) <i>abietis</i> E. K. Jordan and Hertlein	x	x	x	x		x		
<i>Chlamys</i> (<i>Argopecten</i>) <i>revellei</i> Durham . .	x			x				
<i>Chlamys</i> (<i>Nodipecten</i>) <i>subnodosa</i> Sowerby .	x	x		x				
<i>Chlamys</i> (<i>Nodipecten</i>) <i>subnodosa</i> <i>intermedia</i> Conrad	x							
<i>Spondylus princeps</i> Broderip	x		x	x	x			
GASTROPODA								
<i>Turritella marcosensis</i> Durham		x						
CIRRIPIEDIA								
<i>Balanus tintinnabulum californicus</i> Pilsbry	x							
<i>Balanus trigonus</i> Darwin	x							
<i>Balanus</i> species	x				x			
COELENTERATA								
Colonial stony coral of undetermined generic affinity	x							
<i>Parona</i> species			x					
<i>Pocillopora</i> species								x
<i>Porites</i> species			x					
ALGAE								
Calcareous algae	x	x	x	x	x	x		

The general composition of this assemblage is similar to that now living in warm, shallow waters in the same region.

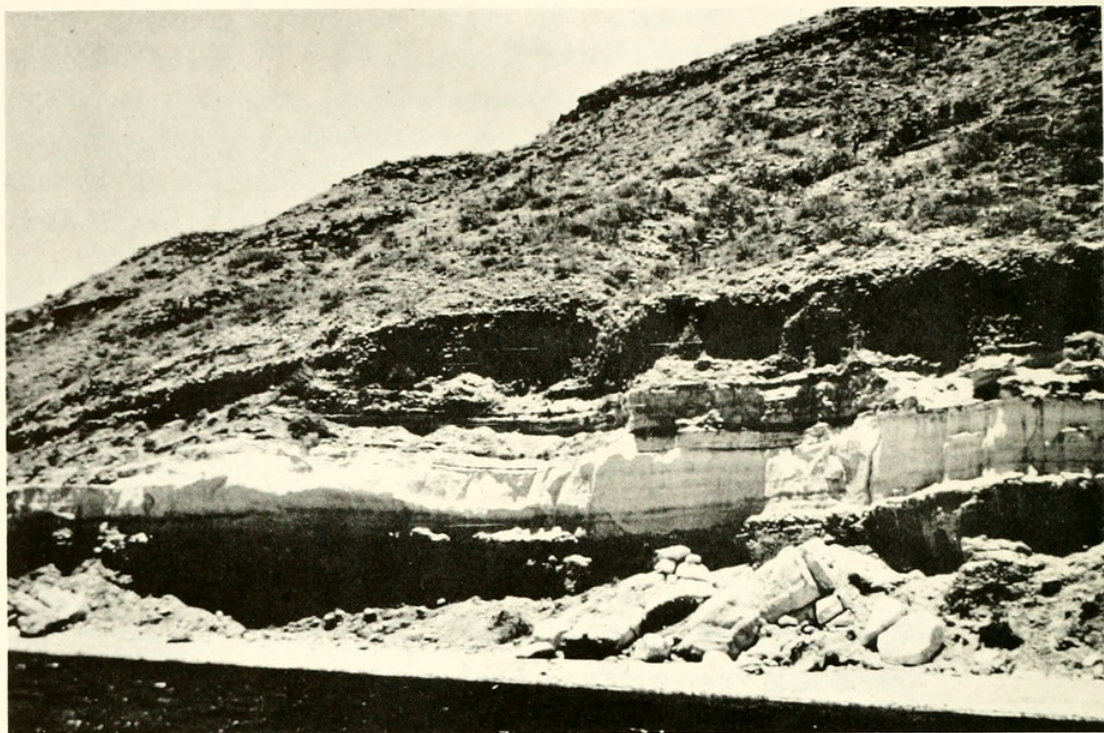


FIGURE 1. View of west shore of Isla Cerralvo at El Mostrador (Ruffo's Ranch). The white stratum is composed of calcareous algae of Pliocene age. (Photograph by G Dallas Hanna.)

DESCRIPTION OF SPECIES

***Ostrea californica osunai* Hertlein, new subspecies.**

(Figures 2, 3, 4, 5, 6, 8, 9.)

Ostrea cf. *O. californica* MARCOU, EMERSON AND HERTLEIN, Trans. San Diego Soc. Nat. Hist., vol. 13, no. 17, pp. 337, 353, 354, 1964. "Northwest side of Isla Salsipuedes." Also "Concepcion Peninsula, Concepcion Bay, Baja California." Pliocene.

DESCRIPTION. Shell, a left valve, elongated, longer than wide, thick with uneven, wavy growth laminae; exterior flattish, lacking ornamentation; interior with a shallow body cavity; ligamental pit rather wide, concave, elongate, the laminae of growth form a nearly straight line across the pit; muscle impression on the type specimen indistinct, apparently at about one third the length of the shell from the ventral margin. Dimensions: Length (apex lacking), 393 mm., maximum width, 140 mm., maximum thickness, 84 mm.

Right valve, a paratype, ventral portion lacking; a raised, convex ridge corresponds to the ligamental pit of the opposite valve. Dimensions: length (ventral portion lacking), 238 mm., maximum width, 133 mm., maximum thickness, 53 mm.

HOLOTYPE, left valve, no. 12823 and paratype, a right valve, no. 12822, California Academy of Sciences, Department of Geology Type Collection, from Locality 38855 (CAS), from the **southwest end of Concepcion Peninsula, Baja California**; C. C. McFall, collector, March, 1964; Pliocene.

COMMENTS. This elongate oyster was reported by Emerson and Hertlein from Salsipuedes Island and from the southeast end of Concepcion Peninsula, Baja California (1964, p. 354, footnote), under the name of *Ostrea* cf. *O. californica* Marcou. Specimens from Rancho El Refugio, Baja California, are believed to be identical. One lower and three upper valves were collected at Locality 39413 (CAS). One thick lower valve, rectangular in outline, was taken at Locality 39411 (CAS). Similar variation in the shape and thickness of the shells of various individuals of *Ostrea puelchana* d'Orbigny from the late Miocene of Trinidad was illustrated by Maury (Bull. Amer. Paleo., vol. 10, no. 42, p. 239 (79), pl. 21 (10), figs. 1, 2; pl. 22 (11), figs. 1, 2; pl. 23 (12), figs. 9, 10, 1925).

The type specimen of the new subspecies described here was collected by Dr. C. C. McFall from strata on Concepcion Peninsula at Concepcion Bay on the east coast of Baja California. It is selected as holotype because the state of preservation is better than that of specimens from other localities. According to Dr. McFall (oral communication), banks composed of the shells of this oyster occur in the strata on Concepcion Peninsula. The associated fauna of Pliocene age includes *Chlamys* (*Nodipecten*) *subnodosa* Sowerby, *Chlamys* (*Argopecten*) *abietis* E. K. Jordan and Hertlein, *Ostrea heermanni* Conrad, *Hanetia* cf. *H. pallida* Broderip and Sowerby, *Turritella* cf. *T. imperialis* Hanna.

The dorsal half of two specimens about 130 mm. long, from Locality 39413 (CAS), Rancho El Refugio, closely resemble specimens of *O. californica* Marcou [Geology of North America, p. 32, pl. 5, figs. 2, 2a, 1858. From "near Carrizo Creek;" Imperial County, California; see also Hanna, Proc. Calif. Acad. Sci., Fourth Ser., vol. 14, no. 18, p. 468, pl. 26, figs. 4, 5, 6, 7, 1926 (as *O. iridescens*)] from Locality 692 (CAS), Alverson Canyon, Imperial County, California, differing only in the larger and thicker shell. One lower valve from Rancho El Refugio is recessed under the hinge, but others are not. Similar variability can be observed among specimens of *O. californica*.

None of the valves of *Ostrea californica* observed by me are as large and thick nor is the ligamental pit and corresponding ligamental ridge on the opposite valve as large as those on valves from Concepcion Peninsula or on those from Rancho El Refugio. However, the similarities in shell characters between the fossils from Baja California and those from Imperial County California, are such that it seems best to adopt a conservative course and describe the peninsular form as a subspecies of *O. californica*.

Some of the large valves from Baja California bear a general resemblance to *Ostrea bourgeoisii* Rémond as illustrated by Clark (Univ. Calif. Publ. Bull. Dept. Geol., vol. 8, no. 22, p. 447, pl. 43, 1915) from strata of late Miocene age in central California. The present specimens differ from Rémond's species in their much more elongate, narrower outline, and broader ligamental pit.

This subspecies is named for Mr. Cesar Osuna Peralta, Mayor of Santiago, Baja California, Sur.

***Pecten (Euvola) refugioensis* Hertlein.**

(Figures 16, 17.)

Pecten (Pecten) refugioensis HERTLEIN, Proc. Calif. Acad. Sci., Fourth Ser., vol. 14, no. 1, p. 7, pl. 1, fig. 2; pl. 5, fig. 9, July 21, 1925. HANNA AND HERTLEIN, Proc. Calif. Acad. Sci., Fourth Ser., vol. 16, no. 6, p. 142. Punta Santa Antonita, Baja California; Pliocene.

Pecten (Euvola) refugioensis Hertlein, DURHAM, Geol. Soc. America, Mem. 43, pt. 2, p. 61, pl. 6, fig. 3, 1950. Punta Santa Antonita, Baja California; middle Pliocene.

Pecten refugioensis Hertlein, LINDSAY, Pacific Discovery, vol. 18, no. 6, p. 20, illustr. (p. 21), 1965. Rancho El Refugio.

TYPE LOCALITY. "Rancho Refugio, north of San Jose del Cabo, Lower California." "Upper Miocene or Lower Pliocene."

RANGE. Middle Pliocene.

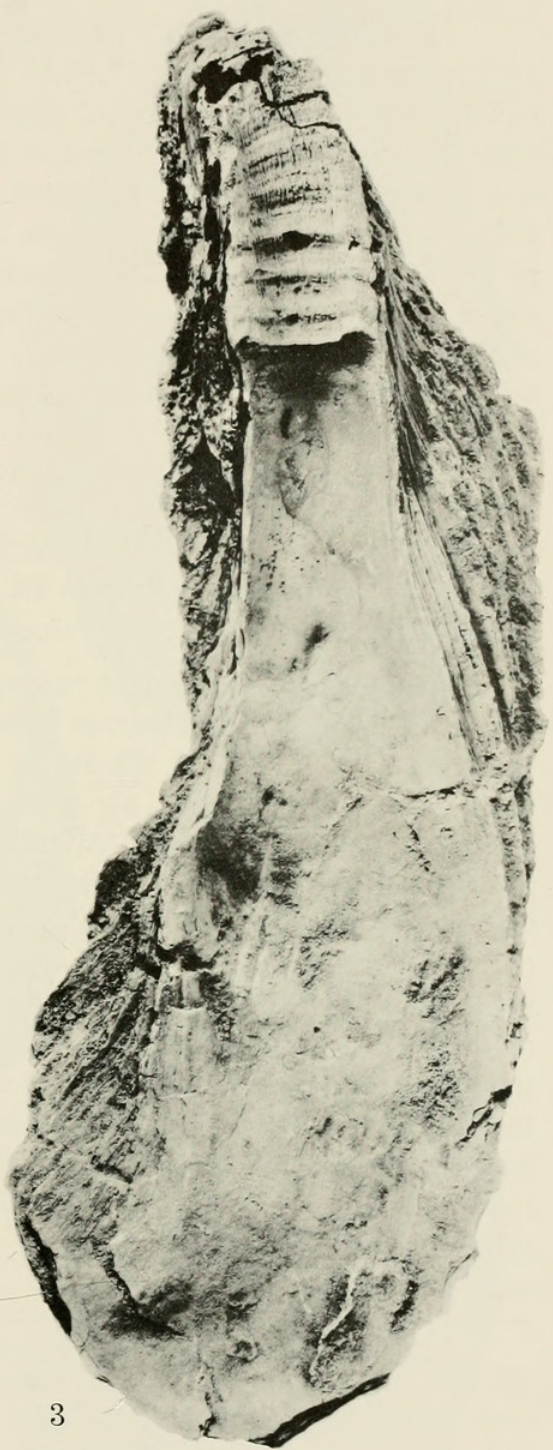
OCCURRENCE IN BAJA CALIFORNIA. Localities 38849; 39411; 39412 (CAS), Rancho El Refugio; Locality 795 (CAS), Punta Santa Antonita.

COMMENTS. The present collection, assembled from three localities, contains about 25 valves, mostly left ones, in various degrees of preservation. The largest is a left valve collected by Walter Heyneman from Locality 38849 (CAS), which is 88 mm. high and 95 mm. long (slightly imperfect on one end). The smallest is a left valve 29 mm. high and 27.6 mm. long. The largest right valve in the collection is a fragment 75 mm. high.

The shell of this species differs from that of *Pecten (Euvola) keepi* Arnold usually in the lack of radial ribbing on the ventral half of the valves or if ribbing is present it is much more weakly developed.

FIGURE 2. *Ostrea californica osunai* Hertlein, new subspecies. Holotype no. 12823 (CAS), from Locality 38855 (CAS), Concepcion Peninsula, Concepcion Bay, Baja California; Pliocene. Length 393 mm. View of the exterior of a lower valve.

FIGURE 3. *Ostrea californica osunai* Hertlein, new subspecies. View of the interior of the specimen shown in figure 2.



***Chlamys mediacostata grewinkii* Hertlein, new subspecies.**

(Figure 12.)

DESCRIPTION. Shell, a right valve, higher than long, nearly equilateral, gently convex; with about 17 or 18 low, rounded, radial ribs widest at the middle of the ventral margin and separated by interspaces narrower than the ribs; surfaces of the ribs with traces of concentric imbricating lines of growth which loop upward; each interspace on the ventral half of the shell with a well developed riblet; the ears are imperfectly preserved but the direction of the lines of growth on the posterior ear indicate a nearly squarely truncated posterior margin, a well developed notch is present under the remnant of the anterior ear. No sculpture is visible on the ears; if originally present, it has been eroded. Dimensions: length 34.2 mm., height 39.6 mm., apical angle 81.5° .

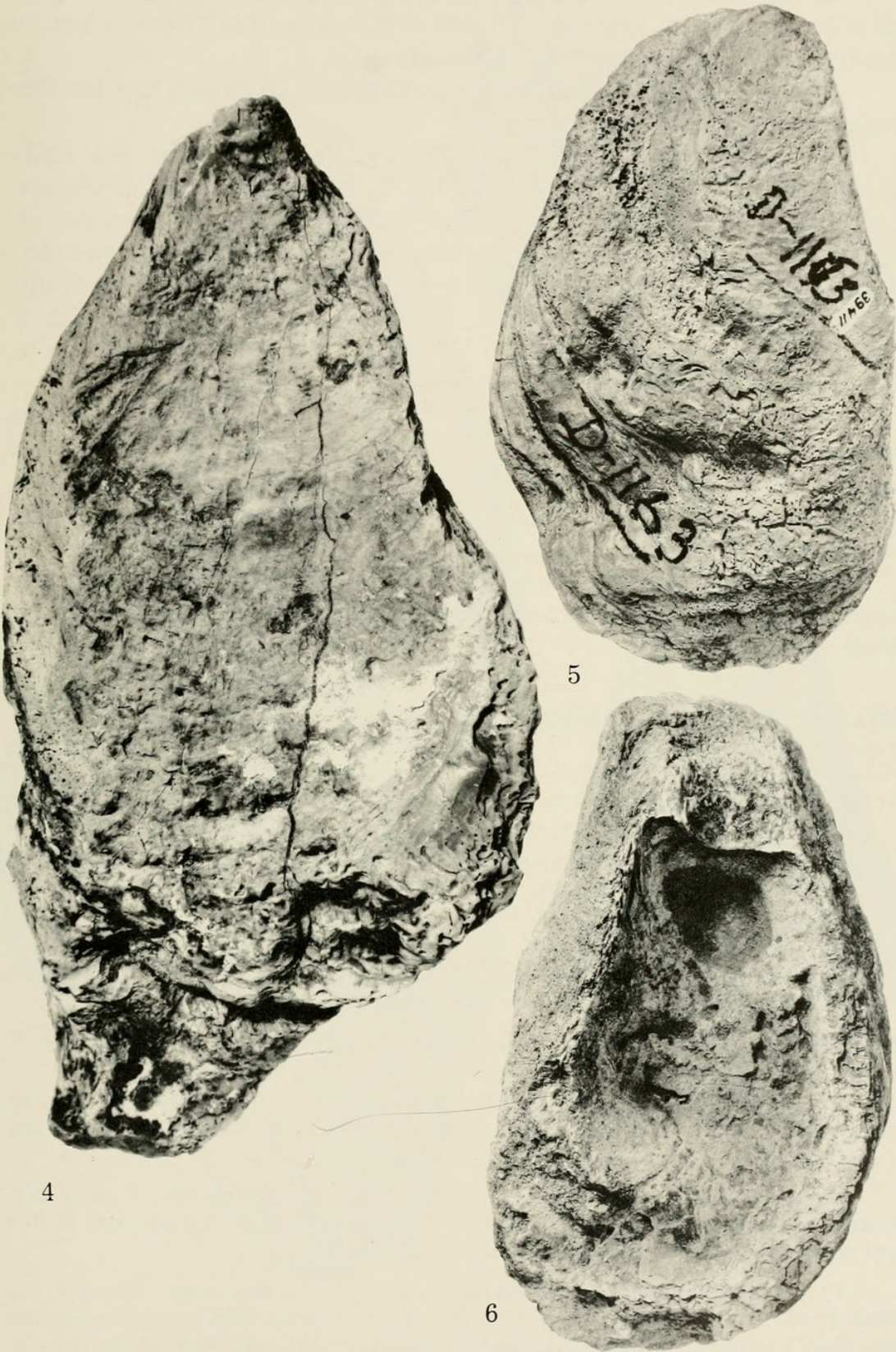
HOLOTYPE. A right valve, no. 12812, California Academy of Sciences, Department of Geology Type Collection from Locality 39413 (CAS), along the trail about 200 meters to the southeast from Locality 39412 (CAS), **south-east of the ranch house, Rancho El Refugio, Baja California**; G D. Hanna and J. W. Durham, collectors; Pliocene.

COMMENTS. The shell of this new subspecies bears a decided resemblance to *Pecten mediacostatus* Hanna (Proc. Calif. Acad. Sci., Fourth Ser., vol. 14, no. 18, p. 472, pl. 22, fig. 6; pl. 24, fig. 2, 1926; see also Durham, Geol. Soc. America, Mem. 43, pt. 2, p. 65, pl. 7, fig. 4, 1950), which was originally described from "Alverson Canon on the south side of Coyote Mountain, Imperial County, California, in the Pliocene coral reef about mid-way up the canyon." It differs from that species in the less numerous ribs (17 or 18 rather than 23 or 24) and in the narrower apical angle. All the specimens of *C. mediacostata* in the collections of the California Academy of Sciences, many rather imperfectly preserved, have more numerous ribs than the present specimen. Durham mentioned a specimen with 24 ribs from the San Marcos formation on San Marcos Island in the Gulf of California. A species described from strata of Pliocene age in Florida, *Pecten (Lyropecten) tamiamiensis* Mansfield (U. S. Geol. Survey, Prof. Paper 170-D, p. 47, pl. 16, figs. 4, 6, 1932), 69 mm. long and 74 mm. high, with 23 ribs, is quite similar to *C. mediacostata*.

FIGURE 4. *Ostrea californica osunai* Hertlein, new subspecies. Hypotype no. 12820 (CAS), from Locality 39413 (CAS), Rancho El Refugio, Baja California; Pliocene. Length (incomplete) 273 mm. View of the exterior of a lower valve.

FIGURE 5. *Ostrea californica osunai* Hertlein, new subspecies. Hypotype no. 12821 (CAS), from Locality 39411 (CAS), Rancho El Refugio, Baja California; Pliocene. Length 224 mm. View of the exterior of a somewhat rectangular lower valve.

FIGURE 6. *Ostrea californica osunai* Hertlein, new subspecies. View of the interior of the specimen shown in figure 5.



In view of the fact that only a single valve is represented in the present collection and its decided similarity to *C. medicostata*, it seems best to describe it as a subspecies of that species.

Similar species of late Tertiary age have been described from the Caribbean region.

Pecten interlineatus Gabb (see Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, vol. 73, pt. 2, p. 411, pl. 45, fig. 3, 1922), from strata of Miocene age in Santo Domingo, 23 mm. long and 24.7 mm. high, was described as possessing 15 to 16 radial ribs and the posterior ear is said to be sculptured with coarse riblets. A subspecies, *Pecten interlineatus aidei* (Williston MS.) Harris (Bull. Amer. Paleo., vol. 13, no. 49, p. 29, pl. 15, figs. 6, 9, 1927) from beds of Miocene age in Venezuela is said to be similar to but about twice as large as the type specimen of *P. interlineatus*.

A geologically earlier member of this group of pectens is *Pecten crocus* Cooke (Carnegie Inst. Washington, Publication no. 291, p. 135, pl. 9, figs. 2a, 2b; pl. 11, fig. 9, 1919), 36 mm. long and 39 mm. high, from the island of Anguilla in the West Indies which was described as possessing 22 ribs. The age was given as Oligocene.

This subspecies is named for Constantin Grewingk, author of an early report containing observations on the geology of portions of the Gulf of California region.

***Chlamys (Argopecten) abietis* E. K. Jordan and Hertlein.**

(Figure 15.)

Pecten (Plagiectenium) abietis E. K. JORDAN and HERTLEIN, Proc. Calif. Sci., Fourth Ser., vol. 15, no. 4, p. 214, pl. 23, figs. 1, 3, 7, April 26, 1926.

Aequipecten abietis E. K. Jordan and Hertlein, DURHAM, Geol. Soc. America, Mem. 43, pt. 2, p. 62, pl. 10, figs. 4, 7; pl. 11, fig. 4, 1950. Various localities in the Gulf of California region, lower, middle, and upper Pliocene.

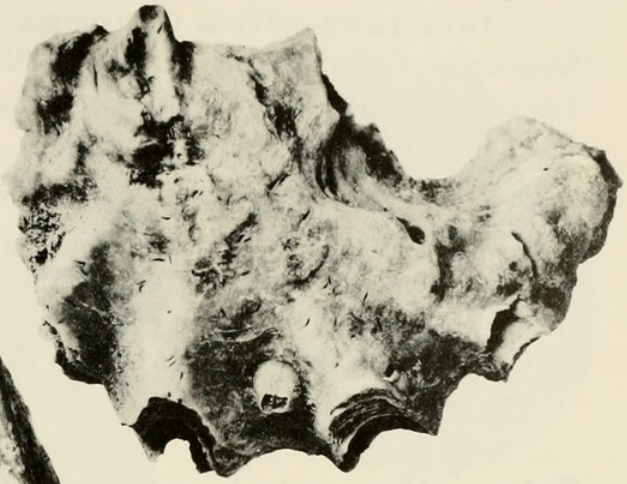
Chlamys (Argopecten) abietis E. K. Jordan and Hertlein, EMERSON and HERTLEIN, Trans. San Diego Soc. Nat. Hist., vol. 13, no. 17, pp. 349, 354, figs. 4 a-e, 1964. Early to middle Pliocene (with synonymy).

TYPE LOCALITY. "Arroyo Hondo, Maria Madre Island, Mexico; upper Pliocene."

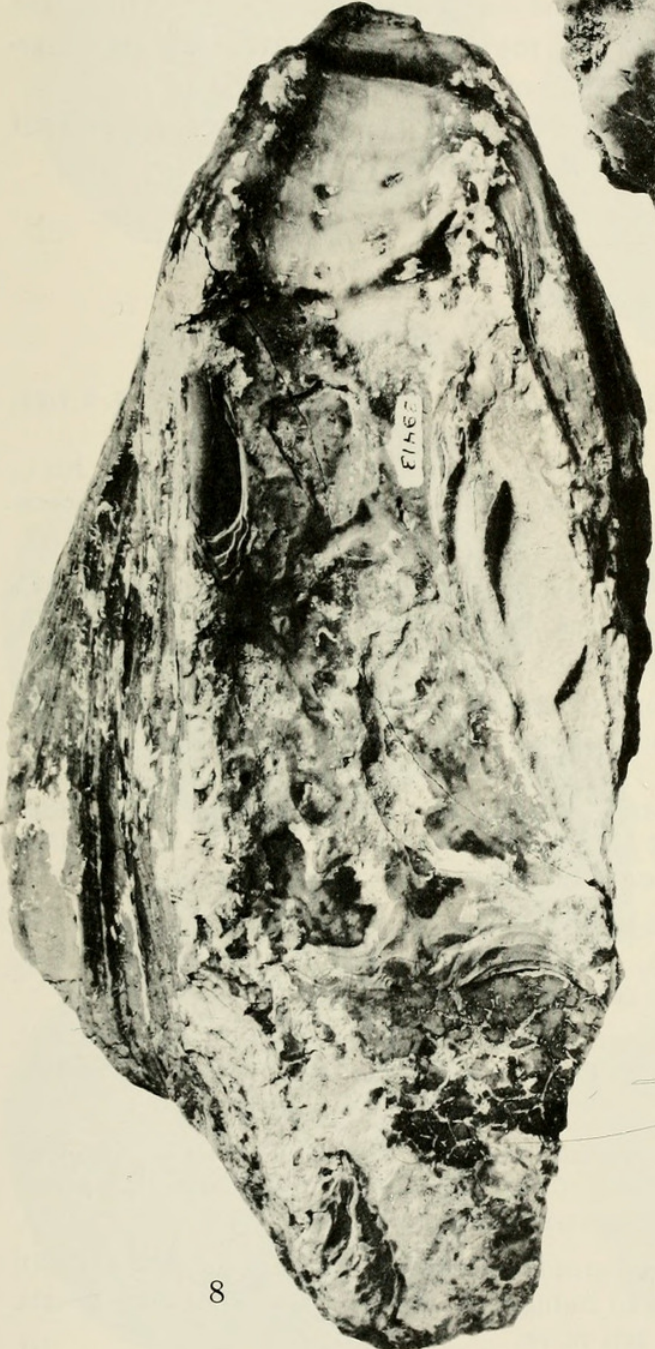
FIGURE 7. *Ostrea megodon* Hanley. Hypotype no. 12814 (CAS), from Locality 39411 (CAS), Rancho El Refugio, Baja California; Pliocene. Length 50.2 mm. View of the exterior of a lower valve.

FIGURE 8. *Ostrea californica osunai* Hertlein, new subspecies. View of the interior of the specimen shown in figure 4. Thick layers of shell material of this specimen are visible on the left side of this illustration.

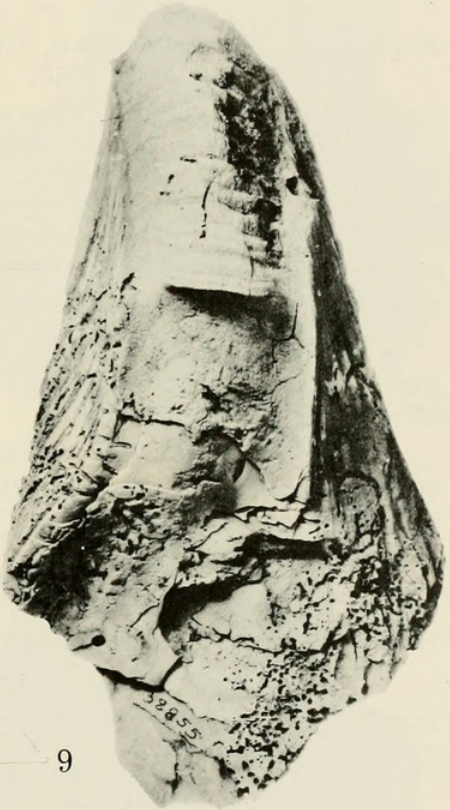
FIGURE 9. *Ostrea californica osunai* Hertlein, new subspecies. Paratype no. 12822 (CAS), from Locality 38855 (CAS), from Concepcion Peninsula, Concepcion Bay, Baja California; Pliocene. Length (incomplete), 238 mm. View of the interior of an upper valve.



7



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9

RANGE. Pliocene.

OCCURRENCE IN BAJA CALIFORNIA. Numerous localities in the Gulf of California region. Localities 39406, 39408, 39409a (CAS), Cerralvo Island; Locality 39413 (CAS), Rancho El Refugio. Also Tres Marias Islands.

COMMENTS. The radial ribs of this species are triangular to subtriangular in cross-section, especially in the early stage of growth. These are separated by narrow interspaces and the sides of the ribs and the interspaces are covered with a dense fringe of concentric lamellae.

This species is characteristic of strata of Pliocene age in the Gulf of California region and in the Tres Marias Islands.

***Chlamys (Argopecten) revillei* Durham.**

(Figure 10.)

Aequipecten revillei DURHAM, Geol. Soc. America, Mem. 43, pt. 2, pt. 63, pl. 9, figs. 3, 6, 9, August 10, 1950.

Chlamys revillei Durham, EMERSON AND HERTLEIN, Trans. San Diego Soc. Nat. Hist., vol. 13, no. 17, pp. 345, 346, 349, 1964. Isla San Jose; Isla Cerralvo. Pliocene.

FIGURE 10. *Chlamys (Argopecten) revillei* Durham. Hypotype no. 12819 (CAS), from Locality 39408 (CAS), Cerralvo Island, Baja California; Pliocene. Height 53.3 mm. View of the exterior of a right valve.

FIGURE 11. *Turritella marcosensis* Durham. Plastohypotype no. 12815 (CAS), from Locality 39405 (CAS), Rancho El Refugio, Baja California; Pliocene. Length 36 mm.

FIGURE 12. *Chlamys mediacostata grewinkii* Hertlein, new subspecies. Holotype no. 12812 (CAS), from Locality 39413 (CAS), Rancho El Refugio, Baja California; Pliocene. Height 39.6 mm. View of the exterior of a right valve.

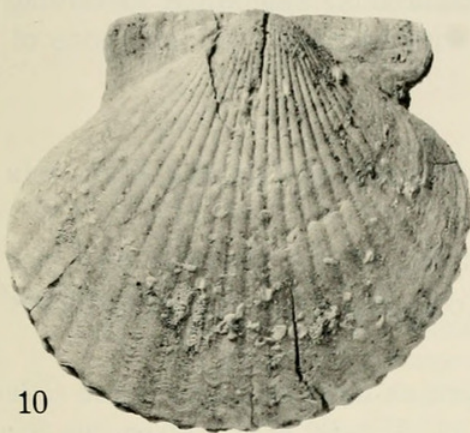
FIGURE 13. *Chlamys (Nodipecten) subnodosa* Sowerby. Hypotype no. 12824 (CAS), from Locality 39408 (CAS), Cerralvo Island, Baja California; Pliocene. Height 77 mm. View of the exterior of a right valve.

FIGURE 14. *Turritella marcosensis* Durham. Plastohypotype no. 12816 (CAS), from Locality 39405 (CAS), Rancho El Refugio, Baja California; Pliocene. Length 21 mm.

FIGURE 15. *Chlamys (Argopecten) abietis* E. K. Jordan and Hertlein. Hypotype no. 12813 (CAS), from Locality 39406 (CAS), Cerralvo Island, Baja California; Pliocene. Height 60.3 mm. View of the exterior of a right valve.

FIGURE 16. *Pecten (Euvola) refugioensis* Hertlein. Hypotype no. 12768 (CAS), from Locality 39413 (CAS), Rancho El Refugio, Baja California; Pliocene. Height 55.3 mm. View of the exterior of a left valve.

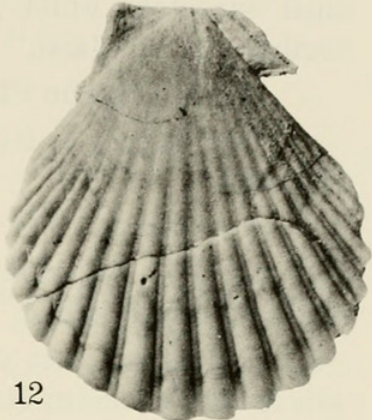
FIGURE 17. *Pecten (Euvola) refugioensis* Hertlein. Hypotype no. 12772 (CAS), from Locality 39412 (CAS), Rancho El Refugio, Baja California; Pliocene. Height 32 mm. View of the exterior of a right valve.



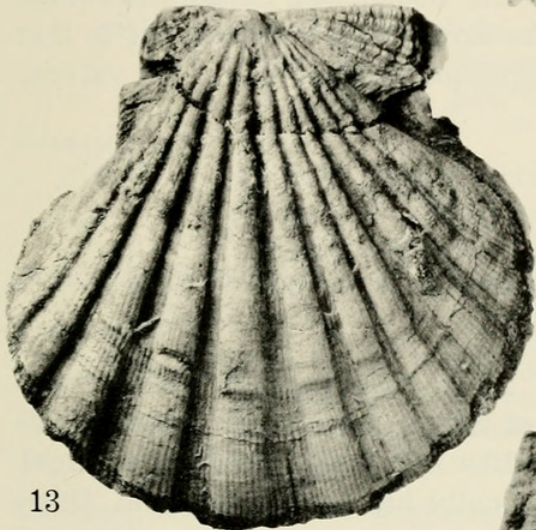
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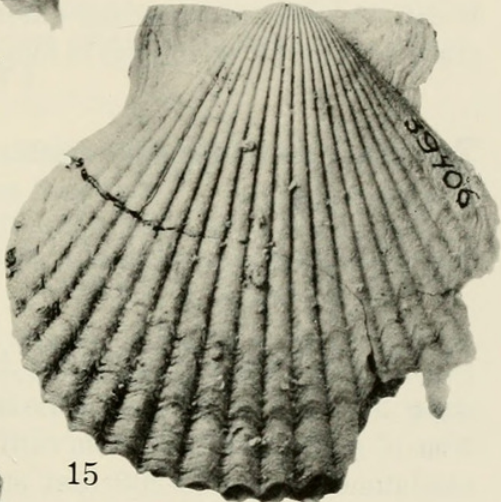
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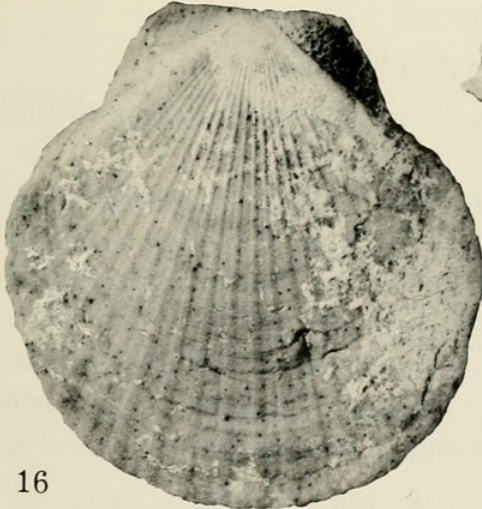
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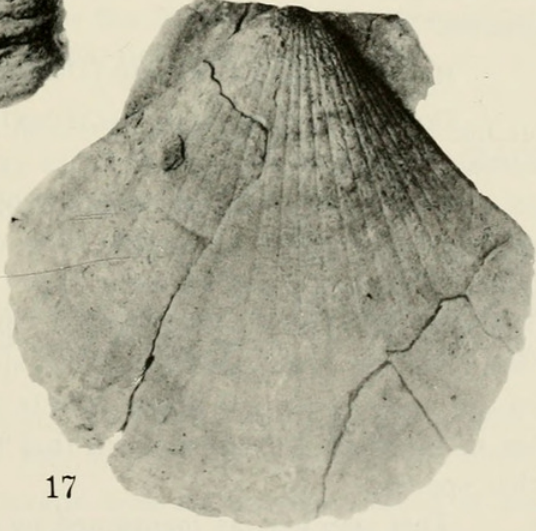
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TYPE LOCALITY. Locality A3566 (Univ. Calif.), "Middle Pliocene, Monserrate Island. From pecten bed in calcareous 'sandstone' overlying algal sandstone which is in fault contact with breccia. On east side of southern tip of island."

RANGE. Middle Pliocene.

OCCURRENCE IN BAJA CALIFORNIA. Isla Monserrate; Isla San José; Isla Cerralvo.

COMMENTS. One well preserved specimen of this species, 58.2 mm. long and 53.3 mm. high, is present in the collection from Locality 39408 (CAS), Cerralvo Island.

This species is very similar to the species described as *Pecten (Plagioctenium) subdulus* Hertlein (1925, p. 20, pl. 5, figs. 2, 4, 7) from the San Diego formation of Pliocene age, at Pacific Beach, San Diego, California. It differs from that species chiefly in the more circular outline and in that the hinge line (41 mm. long) is longer in proportion to the length of the valves.

***Turritella marcosensis* Durham.**

(Figures 11, 14.)

Turritella marcosensis DURHAM, Geol. Soc. America, Mem. 43, pt. II, p. 122, pl. 28, fig. 3, August 10, 1950.

TYPE LOCALITY. Locality A 3576. "Lower Pliocene, San Marcos formation San Marcos Island. On east side of island in northeast corner of outcrop of gypsum beds. From cliff in mesalike hill. In grey calcareous algal sandstone some 150-200 feet stratigraphically higher than gypsum. Overlies conglomerate and is overlain by a conglomerate containing pebbles of granite."

RANGE. Early Pliocene (Durham); middle Pliocene.

OCCURRENCE IN BAJA CALIFORNIA. San Marcos Island; Locality 39405 (CAS), Rancho El Refugio.

COMMENTS. Two impressions of a *Turritella*, 21 mm. and 36 mm. long respectively, agree in general characters with those on a cast of the holotype of *Turritella marcosensis* in the collections of the California Academy of Sciences. One of these fossils represents an earlier portion of the shell than does the type specimen of that species. The position of the two carinas on the anterior portion of the whorls and the fine spiral ribbing are so similar to those of *T. marcosensis* that the present specimens are assigned to that species.

This species, as mentioned by Durham, bears a resemblance to a specimen of *Turritella vanvlecki teglandae* Merriam (see Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 26, no. 1, p. 126, pl. 37, fig. 4, 1941), from strata of

Pliocene age near Newhall, California. The apical angle of the present specimens is decidedly less than that of the fossil from California.

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