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IV

STRATIGRAPHIC AND FAUNAL RELATIONS OF THE
MARTINEZ TO THE CHICO AND TEJON OF
SOUTHERN CALIFORNIA*

BY CLARENCE A. WARING

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INTRODUCTION

General Statement.—The Chico and most of the Eocene material on which this paper is based, was collected by a Stanford geologic party, of which the writer was a member, during the summer of 1910. Much of the Tejon material was kindly furnished by Messrs. R. B. Moran and J. O. Lewis.

Since the original manuscript of this report was prepared the writer has had opportunity to visit more territory in the state where the Cretaceous and Eocene are represented. The report has been thoroughly revised and all late reports on the subject consulted and incorporated.

Acknowledgments.—Thanks are especially due to Dr. J. P. Smith under whose direction this paper was prepared, and to Harold Hannibal for assistance in determination of the faunas. Dr. Roy E. Dickerson has kindly assisted in the revision. Messrs. R. B. Moran and J. O. Lewis have made valuable contributions of fossils, without which the relations of the Martinez to the Tejon could not have been embodied in this report.

Historical Review.—Since the first attempt, made by Dr. T. W. Stanton,¹ to clear up the relations of the Cretaceous and Eocene on the Pacific Coast, much has been done towards differentiating them. The Chico-Tejon beds which were thought by early geologists to be a faunal and stratigraphic unit, have been shown by Dr. Roy E. Dickerson² to consist of three distinct units, separable both faunally and stratigraphically. The Martinez formation north of Mt. Diablo is separated from both the Chico and Tejon formations by unconformities, and the faunas show strikingly the interruption in sedimentation. Evidence confirms the belief, however, that this unconformity does not exist wherever these formations occur in California. In those parts of central California³ where Chico and Eocene strata occur, with the Martinez lacking, the Tejon rests unconformably on the Chico.

¹ Stanton, T. W., The Faunal Relations of the Eocene and Upper Cretaceous on the Pacific Coast, U. S. Geol. Surv. 17th Annual Rept., pt. 1, pp. 1005-1061, 1895-6.

² Dickerson, R. E., Stratigraphic and Faunal Relations of the Martinez to the Chico and Tejon North of Mount Diablo. Univ. Calif. Publ., Dept. Geol., vol. 6, pp. 171-7, June 28, 1911.

³ Arnold, R., and Anderson, R., Geology and Oil Resources of the Coalinga District, U. S. Geol. Surv. Bull. 398, pp. 62-86, 1910.

FORMATIONAL DISTRIBUTION IN CALIFORNIA

The Chico.—A review of the Cretaceous generally has been well presented by Messrs. Diller, Stanton, Anderson, Smith, Crandall, Packard, and others. The Cretaceous record of California has been kept exclusively by the Pacific, so naturally we may expect to find faunas from southern California closely related to faunal assemblages from northern California, Vancouver Island, Alaska, Japan and India. Comparing southern faunas with those from these regions, one is impressed with the large number of genera which occur elsewhere around the North Pacific. The Chico of California is confined primarily to the Coast Ranges, with smaller areas on the northeastern border of the Great Valley from which it was originally described. These deposits are not confined to the flanks of the Coast Ranges, but are often found as remnants resting unconformably on the older metamorphosed sediments. Most of our Eocene deposits are closely associated with the Chico and are often apparently conformable with it, although an unconformity usually exists. The area covered by the Chico rocks in California is not great, but its stratigraphic limits have been very difficult to determine, where it is associated directly with the Horsetown below or with the Martinez above. When either of these formations is absent a rather distinct unconformity is apparent. The Chico epoch, wherever its record has been observed in California, has been one of rapid sedimentation. Especially is this true in the lower Chico which is made up almost entirely of sandstones, and its fauna are those adapted to littoral conditions.

The Martinez.—North of Mt. Diablo, "the Martinez formation is represented areally by a strip averaging a quarter of a mile wide, which extends from lower Oil Creek westward for four miles. Its west end is terminated by a cross fault, while its eastern end is cut off by the Tejon conglomerate."⁴ The Martinez has been found in southern California only in the Calabasas sheet, east of Santa Ana⁵ and east of Los Angeles in the Rock Creek quadrangle. The formation in the Calabasas

⁴ Dickerson, R. E., Univ. of Calif. Publ. Bull. Dept. Geol., vol. 6, p. 175, 1910-11.

⁵ Martinez and Tejon are reported on the west flank of the Santa Ana mountains by the class in paleontology from the University of California in 1913.

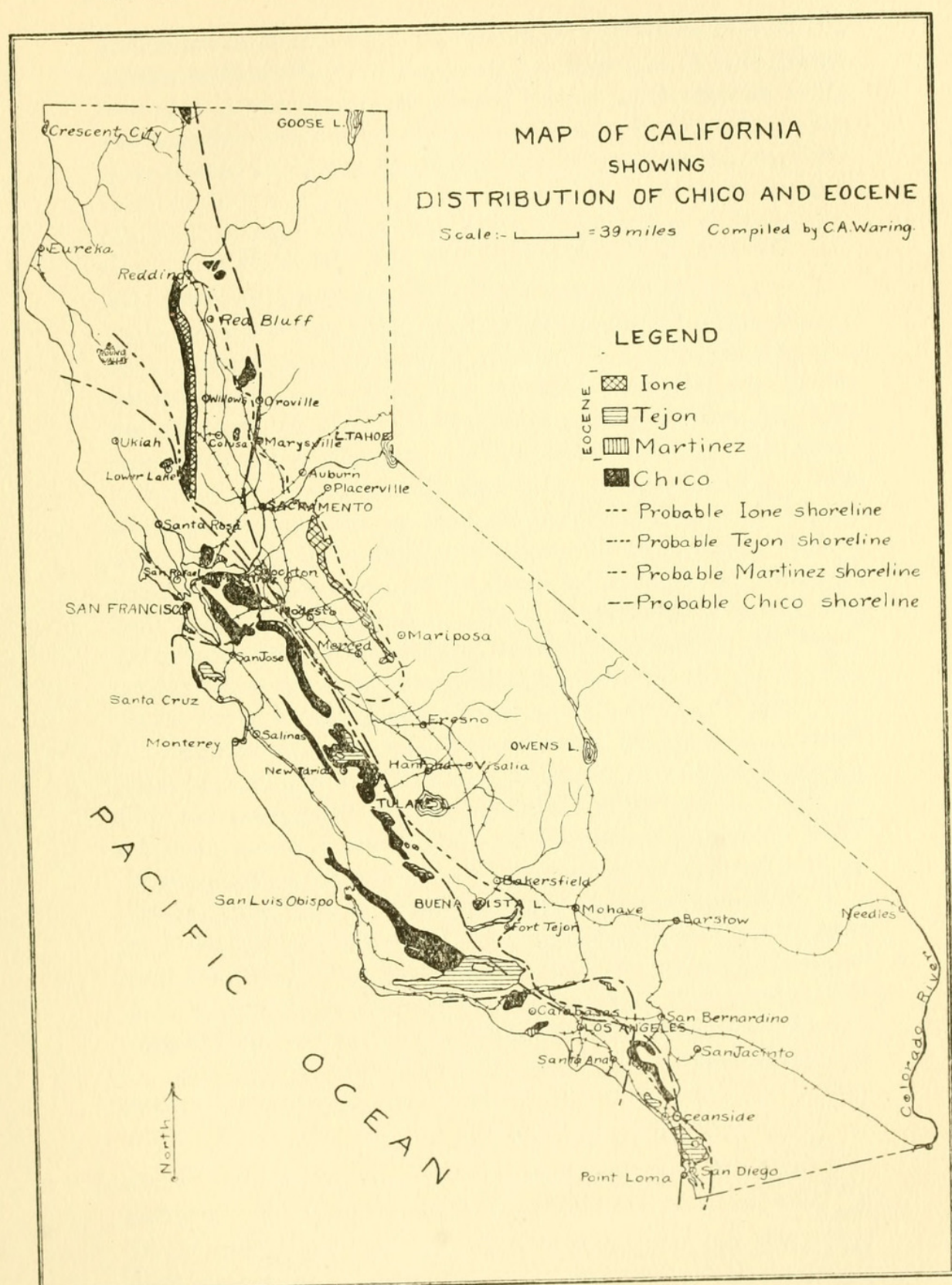


Fig. 1

quadrangle covers an area about two miles square, in the northwest corner of the sheet. A smaller area of about three square miles extends from Coal Canyon to Tuna Canyon near the coast. Only small areas occur west of Santa Ana. The species are such as flourish at a moderate depth, and show littoral conditions.

REVIEW OF THE MARTINEZ AT THE TYPE LOCALITY

It is desirable to review the Martinez of California and give a summary of the literature. W. M. Gabb⁶, in 1869, recognized a new horizon in his Chico Group near Martinez and on the northern flank of Mt. Diablo. He did not, however, keep the faunal horizons separate, and in 1895, Dr. T. W. Stanton⁷ revised the Chico and Tejon members and left the Martinez horizon still to be determined. In 1897 Dr. Merriam⁸ published lists of faunas with their stratigraphic positions, from a series of rich localities running across the strike of the beds, from the Chico to the Tejon. No unconformity was observed between the Chico and Martinez beds and the faunas alone distinguished them. *Dentalium cooperii* Gabb, was the only fossil found common to the two formations, and no overlapping of the faunas was found to occur. Merriam's locality No. 1 is distinctly Chico. Locality No. 2 is distinctly Martinez. Locality No. 3 furnished a fauna of the same type as No. 2, with the addition of *Tellina undulifera* Gabb, *Turritella infragranulata* (?) Gabb; *Brachysphingus liratus* Gabb, and *Modiolus ornatus* (Gabb), which is also characteristic of Tejon. From his locality No. 4 he states that about one-third of the fauna is composed of species known from the Tejon. However, when we consider that over one-half of his species from No. 4 are new, the Tejon species make up two-thirds of the species already described, while only about one-ninth of them are characteristic of the Martinez.

In 1904, C. E. Weaver⁹ described Dr. Merriam's Martinez fauna and attempted to draw the line between the Martinez

⁶ Gabb, W. M., Rept. Geol. Surv. of California, Paleontology, vol. 2, p. 13, preface, 1869.

⁷ Stanton, T. W., U. S. Geol. Surv. 17th Annual Rept., pt. 2, pp. 1011-1036, 1895-6.

⁸ Merriam, J. C., The Geological Relations of the Martinez Group of California at the Typical Locality. Jour. Geol. vol. 5, pp. 767-76, 1897.

⁹ Weaver, C. E., Contribution to the Palæontology of the Martinez Group, Univ. Calif. Publ. Dept. Geol., vol. 4, pp. 102-123, 1904-6.

and Tejon. In so doing he combined Merriam's locality No. 3, which was called upper Martinez, with locality No. 4, which was called near upper Martinez. The line should have been drawn below locality No. 4, and that fauna placed in the Tejon with species from locality No. 5. In his discussion, Dr. Merriam applied the name Martinez to that portion of Gabb's Martinez group which remained after the removal of the Chico-Cretaceous element. The following species listed by Weaver have been found only in the Tejon:

Venericardia planicosta hornii Gabb, *Megistostoma striata* Gabb, *Modiolus ornatus* (Gabb), *Galeodea tuberculata* (Gabb), *Tellina martinezensis* Weaver, *Tellina hornii* Gabb, *Thracia karquinezensis* Weaver, *Turritella conica* Weaver, *Turritella infragranulata* Gabb, *Nyctilochus eocenicus* (Weaver), and *Fusus æquilateralis* Weaver. Some of the other species are also questionably Martinez.

In 1910, R. E. Dickerson¹⁰ found a section north of Mt. Diablo, which showed an unconformity between the Martinez and Tejon and listed a characteristic Martinez fauna. Dr. Dickerson says: "The evidence of relationship of the Martinez to the Tejon formation is based (1) upon areal mapping of the beds containing characteristic faunas of these formations; (2) upon variation of strike at the contact of these formations; (3) upon variation in dip throughout the area studied; (4) upon the presence of a conglomerate which marks a very decided change in sedimentation at the base of the Tejon."

In bulletins issued from the Department of Geology, University of California, since this manuscript was originally prepared, Dr. Dickerson has revised the early work on the Martinez of California, and has described Martinez strata and their fauna from Lower Lake, Benicia, Martinez, Selby, north of Mt. Diablo, south of Mt. Diablo, San Pedro Point, San Mateo County, and at Rock Creek on the western border of the Mohave Desert region.

The Tejon.—Forty years ago Dr. Cooper¹¹ was trying to account for the non-deposition of Eocene sediments in California. Today we are trying to account for their erratic distribution in

¹⁰ Dickerson, R. E., Univ. Calif. Publ. Bull. Dept. Geol., vol. 6, pp. 171-7, 1911.

¹¹ Cooper, J. G., Cal. Acad. Sci., vol. 5, 1873, pp. 419-422.

California. "The Tejon is found most extensively developed in the vicinity of Fort Tejon and about Martinez. From the latter locality it forms an almost continuous belt in the Coast Ranges to Marsh's, 15 miles east of Mt. Diablo, where it sinks under the San Joaquin plain. It has also been found in the same range as far south as New Idria and as far north as near Round Valley, Mendocino County."¹²

The most southerly Tejon in California known today is found at Pt. Loma.¹³ Coming northward the next occurrence is in the Santa Ana Mountains and then at Fort Tejon,¹⁴ the type locality. The Lower Lake, New Idria and Mt. Diablo regions are well covered by Drs. Stanton¹³ and Dickerson¹⁵ and it hardly seems necessary to review them in this report.

The Tejon is very distinct from the Martinez and indicates, perhaps, a more tropical climate, with a fauna that flourished under littoral conditions.

Some of the later Eocene sediments have of recent years been included in the Tejon group. Among these are the Eocene at Marysville Buttes, Corral Hollow and some of that in the Mt. Diablo region. The late Eocene in the northern part of the State is later than the Tejon at the type locality and can be correlated with the Ione along the west face of the Sierras.¹⁶ The name Tejon could well be confined to the original formation of that name.

FORMATIONAL DISTRIBUTION IN THE AREA

In general the geology of the Calabasas quadrangle may be divided into three portions. A broad syncline of Monterey sandstone and shale covers the central part and is overlain by alluvium in the San Fernando Valley. Vaqueros sandstone underlies the Monterey sediments and is exposed both to the north and south of it. This large central area is abruptly faulted both north and south, and the older sediments of Eocene

¹² Gabb, W. M., *Pal. Cal.*, vol. 2, preface, p. xiii, 1869.

¹³ Stanton, T. W., *U. S. Geol. Surv.*, 17th Ann. Rept., pt. 1, p. 1028.

¹⁴ For description, see *Calif. Acad. Sci. Proc.*, 4th Series, vol. 5, No. 3, pp. 33-98, pls. 1-11, June 15, 1915.

¹⁵ Dickerson, R. E., *Fauna of the Martinez Eocene of California*, Univ. Calif. Publ. Bull. Dept. Geol., vol. 8, pp. 89-106, May 13, 1914.

¹⁶ Arnold, R., and Hannibal, H., *Dickerson on the Tejon Eocene of California*, Science, N. S., vol. 39, pp. 906-908, June 19, 1914. Waring, C. A., *Eocene Horizons of California*, *Jour. Geol.*, vol. 22, pp. 783-786, Nov.-Dec., 1914.

and Cretaceous age are brought into contact with the later Miocene sediments. To the north, the Simi fault has brought the Chico sandstone up against the Vaqueros. The Chico dips uniformly to the north, and over it lie the Martinez and Tejon in an apparently conformable series. To the south the Santa Monica fault has brought about relations similar to those in the north. Here metamorphics of probable Jurassic age are brought up below the Chico. This southern area has been a region of volcanic flows and intrusions, so that the relations are not so easily seen in the field as in the north.

STRUCTURE OF THE REGION

The cross section, fig. 2, is taken along a NW.-SE. line, A-A', through the area. The interior portion of the area consists of a broad syncline of Vaqueros and Monterey which have

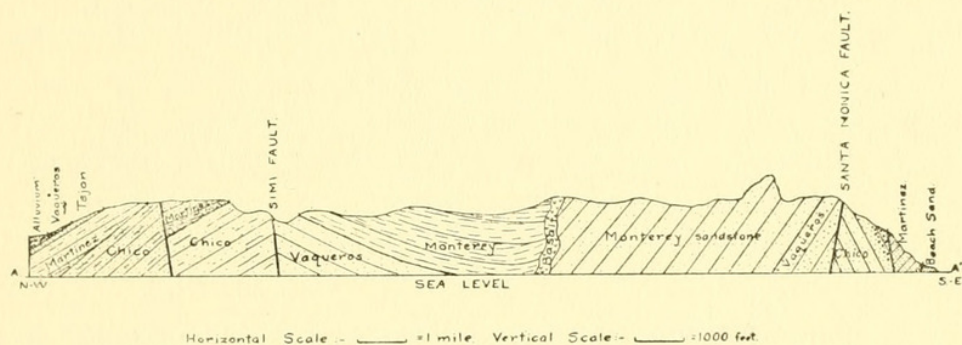


Fig. 2

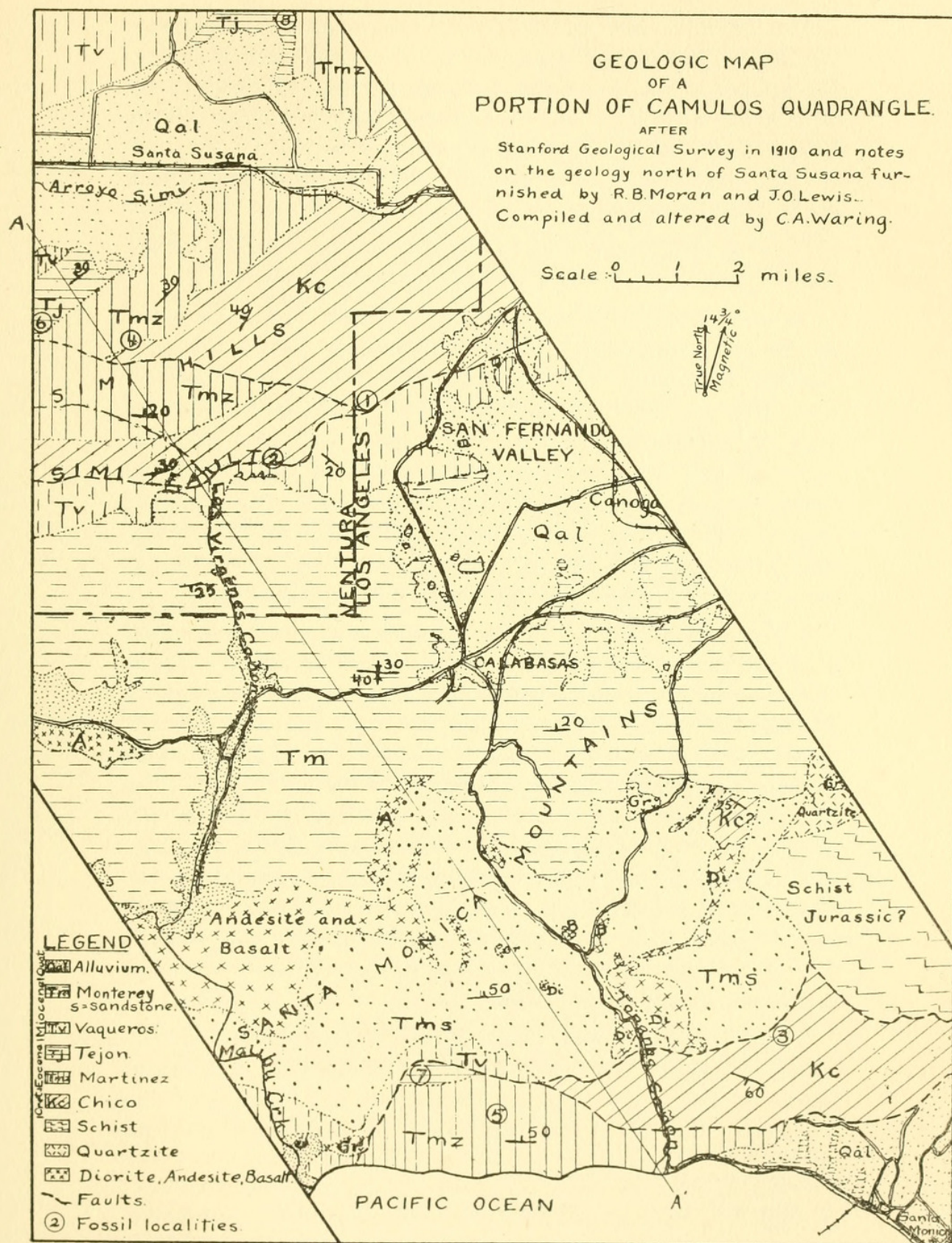
been faulted down against the Chico on either side. To the north the Chico and overlying Eocene have been faulted, such as to cause a repetition of the formations. The Eocene is overlain by Vaqueros which outcrops again north of Simi Valley. To the south, the Chico has been faulted and the Martinez brought down against it.

RELATIONS OF THE CRETACEOUS AND EOCENE

Chico.—The northwest corner of the Calabasas area is cut by two faults (see geologic map, fig. 3, p. 51). The smaller of these runs approximately east-west and runs into the main Simi fault about where it crosses the Los Angeles-Ventura county line. This faulting has brought up two small fossiliferous Cretaceous areas with their overlying sandstones and Eocene. The

secondary fault has evidently had its down-throw on the south side, carrying down a large area of the lower Eocene which was less exposed to erosion than that north of the fault, where the tops of the Simi Hills have been eroded down to the Chico sandstone. In this way the conglomerates of the lower Eocene are offset about two miles on the surface exposure. The beds dip at an angle of about 20 degrees and differ about 900 feet in present elevation. In order to produce such a horizontal difference, the vertical displacement must have been in the neighborhood of 3000 feet. The Chico exposed in Bell's canyon and to the north-east in Dayton's canyon contains upper Chico fossils and is overlain by about 8000 feet of heavy bedded gray granitic sandstone. This sandstone is medium to fine-grained and is interbedded in places with fine iron-stained sandy shales which carry considerable carbonaceous material. Conformably above these are about 200 feet of sandy shales. No fossils have been found in this series but lithologically and stratigraphically they resemble the uppermost Chico of northern California. By some geologists these sandstones (fig. 1, p. 125) have been considered Eocene, but the writer believes them to be uppermost Chico. They are unconformable with the Eocene conglomerates (fig. 2, p. 125) above and also, probably, with the Chico below.

The opening of the Eocene epoch is marked by the accumulation of about 200 feet of very coarse conglomerate of a light buff color. The cementing material is coarse granitic sand. The boulders, composed of polished quartzite and granite, average about six inches in diameter. This conglomerate is overlain by a white shaly rock about 50 feet thick. Above these are light buff sandstones with Martinez fossils. North of the Simi fault these fossiliferous sandstones are overlain by a series of about 2000 feet of drab shales with some interbedded dark gray fossiliferous sandstones in which *Turritella pachecoensis* is very abundant. From the upper sandstones of this series, *Glycimeris veatchi major*, *Turritella simiensis*, *Turritella pachecoensis*, *Turritella martinezensis*, *Amauropsis alveata*, *Cucullæa morani*, and *Polynices hornii*, have been taken. The top of these shales is apparently Tejon and probably the transition from Martinez takes place in this shale series, or at its base. The formations are apparently conformable.



The Tejon consists of 200 feet of heavy bedded conglomerate, 200 to 300 feet of shale, and 1700 to 1800 feet of shales, fine sands and conglomerates, towards the base of which is the oil bearing horizon. The fossils described were taken from 1000 to 1500 feet from the top of the upper beds.

From the Sespe-Eocene contact to 300 feet below the contact the following species were found at Locality 8:

Pinna lewisi, new species; *Dentalium cooperii* Gabb, *Natica hannibali* Dickerson, and *Turritella uvasana* Conrad.

Tejon.—The formation mapped as Tejon in the Camulos quadrangle consists of those sedimentary strata formerly mapped as Topa-Topa,¹⁷ and identical beds in Simi Valley. The lithologic descriptions, and lists of fossils have been carefully considered and they can be, in part, correlated with the Tejon of the type locality.¹⁸ Since the Topa-Topa sediments form a conformable series with a distinct fauna which is identical with part of the Tejon formation, it would be less confusing to future correlations if we drop Eldridge's local name. It has served its purpose as a preliminary horizon name.

Tejon in Simi Valley.—These sedimentaries are folded along a NE.-SW. axis. In Simi Valley they overlie the upper shales of the Martinez and dip to the NW. at an angle of about 35 degrees. They are exposed in the hills NE. and SW. of Santa Susana¹⁹ and consist of over 2000 feet of strata. This thickness consists of about 200 feet of conglomerate, 200 feet of oil bearing shales, and 1800 feet of shale, sandstone, and conglomerate. This upper shale member contains fossil plants and is probably a fresh water phase of sedimentation. The thickness of Tejon sediments in this entire region is very great as compared with the 1850-foot section in the San Joaquin Valley region where erosion took place through considerable of the Martinez and lower Tejon time.

Tejon north of Santa Clara River Valley.—North of Fillmore, Eldridge²⁰ lists fossils from beds exposed in Sespe Gorge, north of Tar Creek. He assigned these fossils to the Sespe (Eocene) and stated that they might be from beds below his

¹⁷ Bulletin U. S. Geol. Survey, No. 309, p. 5, 1907.

¹⁸ Geol. Survey California, Paleontology, vol. 2, preface, p. xiii, 1869.

¹⁹ See Bull. 69 Calif. State Mining Bureau, p. 383, 1914.

²⁰ Bull. U. S. Geol. Survey, No. 309, p. 11, 1907.

Sespe. However, he recognized the fauna as Eocene. These are all typical Tejon species and evidently came from Tejon strata underlying the Sespe, for it is known that Tejon is exposed in the immediate vicinity. Southwest of Sespe Gorge near the Silver Thread oil field the Tejon is exposed as a southerly overturned anticline with NE.-SW. axis. In no published reports has the name Topa-Topa been applied to strata older than Tejon, and it is improbable that the Martinez will be found exposed farther to the northwest in the region of less intense folding.

RELATIONS OF THE CRETACEOUS AND EOCENE FORMATIONS SOUTH OF THE SANTA MONICA MOUNTAINS

South of the Santa Monica Mountains, the structure is even more complicated. Two large faults cut across Topanga Canyon (see fig. 3, p. 51), and a large wedge-shaped block of Chico sediments is exposed. These consist of about 6000 feet of sediments, the lower 1500 feet being largely sandstone with dark micaceous shales interbedded. Above are about 4000 feet of well consolidated conglomerates with interbedded sandstones and shales, the pebbles of which vary from one inch to four or five inches in diameter. The upper division consists of 1200 feet of shale and light colored, fine-grained, medium bedded sandstone. The sandstones are characterized by an abundance of biotite. The lower sandstones are fossiliferous in places. The only fossil found in the upper shales was *Scutella* (?) species. Scattered over the surface of this Cretaceous area are remnants of the Martinez strata, in places bearing fossils. Some of the boulders bearing these Martinez fossils have found their way into the stream channels. The Martinez fossils found in this area at Locality 5 are the following:

Fasciolaria mucronata (Gabb), *Retipirula crassitesta* (Gabb), *Pseudoliva howardi* (Dickerson), *Polynices hornii* (Gabb), *Turritella martinezensis* Gabb, *Turritella pachecoensis* Stanton.

A strip a mile and a half wide to the southwest, bordering the coast, is brought into contact with the Chico by faulting. This formation is terminated by faulting east of Malibu Canyon. Faulting has complicated the structure to such an

extent that Cretaceous and Martinez fossils are found very close to those of Vaqueros age in a point on the coast. No attempt will here be made to differentiate them positively, but generally the formations are shown in their proper relation on the map, page 51, fig. 3.

EOCENE CORRELATION

Venericardia planicosta Lamarck and *V. planicosta regia*²¹ Conrad, range from lower Chickasawan, Lignitic or Wilcox, into the upper Chickasawan, Lignitic or Wilcox. This range is practically that of the Aquia formation. These species compare most closely with *V. planicosta hornii* (Gabb) of the lower Tejon of California.

V. planicosta var. 5 Harris²², *V. marylandica* Harris²³, *V. potapacoensis* Harris²⁴, and *V. planicosta* Harris²⁵ (not Lamarck?) range from upper Chickasawan into the Claiborne. This range is the range of Harris' Nanjemoy in Maryland and corresponds to that of *V. planicosta ionensis* Waring²⁶ of the Umpqua or Arago formation in Washington, and the Ione at Merced Falls, California.

V. planicosta venturensis of the upper Martinez of the Camulos quadrangle is of an entirely different horizon and represents sediments of Midway age and older. This species agrees more closely with *V. planicosta* Lamarck of Harris,²⁷ which seems deserving at least of subspecific rank.

V. planicosta Harris²⁸ seems to represent the typical *V. planicosta* of Lamarck of which the writer has access to several specimens from the Paris basin. It seems then that the typical *V. planicosta* is confined to a horizon which is to be correlated with the Lignitic of the Gulf States. The turritellas especially show the close relationship, and both the pelecypods and gastropods are very close to many Midway species.

It will be seen, then, that the Tejon is higher than Dall²⁹ placed it in 1896. It surely is to be correlated with the lower

²¹ Maryland Geol. Surv. Eocene, pls. 38, figs. 1, 1a; 39, figs. 1, 1a; 40, figs. 1. 2 and 3.

²² Bull. 9, Am. Pal., p. 54, pl. 16, fig. 5.

²³ Maryland Geol. Surv. Eocene, p. 179, pl. xl, figs. 7 and 7a.

²⁴ Maryland Geol. Surv. Eocene, p. 179, pl. xl, figs. 4-6.

²⁵ Bull. 9, Am. Pal., p. 54, pl. 16, figs. 1-4.

²⁶ Jour. of Geol., vol. 22, No. 8, p. 785, Nov.-Dec., 1914. Map folio accompanying Bull., 69, Cal. State Min. Bur., pl. 1, 1914.

²⁷ Bull. Am. Pal., No. 4, p. 58, pl. 4, fig. 13.

²⁸ Bull. Am. Pal., No. 9, p. 54, pl. 9, figs. 1-3.

²⁹ U. S. Geol. Surv., 18th Annual Report, pt. 2, p. 327.

OCCURRENCE OF EOCENE VENERICARDIAS

ATLANTIC	CALIFORNIA	WASHINGTON	MARYLAND	GULF STATES	EUROPE
				Jacksonian	
				Up. Claiborne L. Claiborne	
		----- Arago V. merriami Dick- erson	Nanjemoy Venericardia plan. var. σ Harris		
Up. Lignitic	Ione V. planicosta ionensis Waring		Venericardia mary- landica Harris V. potapacoensis Harris ----- Aquia	Up. Chickasawan V. planicosta La- marck Harris, Bull. 9, Am. Pal., p. 54, pl. 16, figs. 1-4	V. planicosta lati- cardo Wood
L. Lignitic	Tejon V. planicosta hornii Gb	Chehalis V. planicosta hornii Gb	V. planicosta var. regia Conrad -----	L. Chickasawan	
	Martinez V. planicosta ven- torensis Waring			Midway V. planicosta Harris Harris, Bull. Am. Pal., No. 4, p. 58, pl. 4, fig. 13	V. planicosta La- marck

C. A. W.

Chickasawan. The Ione formation is probably to be correlated with the upper Chickasawan, while the upper Arago probably runs as high as into the lower Claiborne.

The table, page 55, shows the various venericardias of the Eocene, and their horizons correlated with one another.

CONCLUSIONS

The Chico strata of the Calabasas sheet are lithologically like those of the northern Coast Ranges, and contain a similar fauna. They consist of a lower sandstone and an upper shale member, both of upper Chico age.

The Eocene lies unconformably on the Chico, and is represented by two distinct formations. The Martinez, or lower Eocene, is faunally very distinct from the Tejon, or middle Eocene, and apparently conformable with it. A slight unconformity may exist.

The Martinez is, in part at least, to be correlated with the Midway of the Gulf States, while the Tejon is more nearly to be correlated with the lower Chickasawan, or lower Lignitic, of the Gulf and Atlantic States.

LIST OF (UPPER) CHICO (CRETACEOUS) FOSSILS FROM THE CALABASAS QUADRANGLE, SOUTHERN CALIFORNIA

Ophiuroidea:	PAGES
*Amphiura lymani, new species 2.	58, 110
Echinoidea:	
†*Scutella? species 2.	58, 110
Pelecypoda:	
Acila truncata Gabb 2.	
Chione varians Gabb 3.	108
Crassatellites conradianus Gabb 3.	106
*Crassatellites triangulatus, new species 3.	59, 110
*Crassatellites tuscanus Gabb 2.	59, 108

* Species known only in the Upper Chico.

† Fauna from south of the Santa Monica Mountains. None of these fossils were found north of the Simi Fault.

The numbers following specific names refer to the following localities marked on the map, fig. 3, p. 51:

- 1 Chico area north of the Simi fault, near Ventura-Los Angeles county line.
- 2 Chico area in Bell's Canyon, north of Simi fault.
- 3 Chico area south of the Santa Monica mountains.

	PAGES
<i>Crassatellites uvasana</i> Gabb	108
<i>Cucullæa youngi</i> , new species 2.	59, 108
<i>Dosinia milthoidea</i> , new species 2.	60, 108
<i>Glycimeris veatchii</i> Gabb 1, 2 and 3.	61, 108
* <i>Inoceramus pembertoni</i> , new species 3.	61, 106
<i>Inoceramus whitneyi</i> Gabb 3.	62, 108
<i>Isocardia chicoensis</i> , new species 2.	62, 108
* <i>Lysis suciensis</i> Whiteaves 2.	62
* <i>Macrocallista cordata</i> , new species 2.	62, 108
* <i>Mactra gabbiana</i> Anderson 3.	63, 108
<i>Nemodon</i> (<i>Arca</i>) <i>breweriana</i> (Gabb) 2.	106
* <i>Pecten cowperi</i> , new species 2.	63, 106
* <i>Pholadomya subelongata</i> Meek 3.	64
†* <i>Pinna calamitoides</i> Shumard 3.	64, 110
<i>Trigonia evansana</i> Meek 2.	65, 108
† <i>Venus pertenuis</i> Gabb 3.	60

Gastropoda :

* <i>Anchura</i> , (?) species 1.	65
* <i>Amauropsis oviformis</i> Gabb 2.	65, 110
* <i>Cancellaria crassa</i> , new species 2.	66, 110
<i>Cinulia obliqua</i> Gabb 2.	66, 110
* <i>Gyrodes canadensis</i> Whiteaves 1.	66, 110
* <i>Gyrodes compressus</i> , new species 1.	67, 110
* <i>Perissolax brevirostris</i> Gabb 1.	67
†* <i>Pugnellus rotundus</i> , new species 3.	67, 110
† <i>Rostellites gabbi</i> White 1.	68, 110
* <i>Solariaxis templetoni</i> , new species 2.	68, 110
* <i>Turris plicata</i> , new species 2.	68, 110
<i>Turritella chicoensis</i> Gabb 2.	69, 110

Cephalopoda :

<i>Baculites chicoensis</i> Trask 1.	69, 110
* <i>Hauericeras transitionale</i> , new species 2.	69, 110
†* <i>Placenticeras californicum</i> Anderson 3.	70, 110
†* <i>Placenticeras pacificum</i> Smith 3.	70, 110
†* <i>Placenticeras sanctæmonicæ</i> , new species 3.	70, 110

* Known only in the Upper Chico.

† Fauna from south of the Santa Monica Mountains. None of these fossils were found north of the Simi Fault.

The numbers following specific names refer to the following localities marked on the map, fig 3, p. 51:

- 1 Chico area north of the Simi fault, near Ventura-Los Angeles county line.
- 2 Chico area in Bell's Canyon, north of Simi fault.
- 3 Chico area south of the Santa Monica mountains.

DESCRIPTIONS OF SPECIES

CHICO (UPPER CRETACEOUS)

All types and figured specimens are in the Leland Stanford Jr. University Paleontological Collection.

Cotypes of new species are in the museum of the California Academy of Sciences.

Locality 1—Chico area north of the Simi fault (near Ventura-Los Angeles county line.

Locality 2—Chico area in Bell's Canyon north of Simi fault.

Locality 3—Chico area south of the Santa Monica Mountains.

None of these Chico species is known to occur in the Eocene.

OPHIUROIDEA

Amphiura lymani, new species.

Pl. 9, Fig. 13

A rather detailed impression of this brittle star was obtained from the uppermost transitional shales of the Chico formation, Locality 2, L. S. J. U. Pal. Coll. Disc small, diameter 4 mm., pentagonal in outline. Arms short, slightly tapering. Arm spines sharp, and slightly longer than the breadth of the brachial plates.

This species differs from *Amphiura sanctæcrucis* Arnold,³⁰ in its smaller size, relatively shorter and less tapering arms, and in the slenderness of the arm spines. The genus to which the species belongs was kindly determined by Mr. Herbert Lyman Clark of Cambridge, Massachusetts, in whose honor the species is named.

ECHINOIDEA

***Scutella* (?) species.**

Pl. 9, Fig. 14

A single fragment of a *Scutella* (?) was obtained from the upper transitional shales of the Chico formation. The dorsal section figured shows the plates and relative proportions.

³⁰ Description of a new brittle star from the upper miocene of the Santa Cruz Mountains, Calif. Proc. U. S. Nat. Mus., vol. 34, pp. 403-406, 1908.

PELECYPODA

Crassatellites triangulatus, new species.

Pl. 9, Fig. 1

Shell thick, robust, triangular, convex; beaks broad, incurved, somewhat depressed; cardinal margin convex and sloping to the posterior end which is subangular; anterior end rounded below and deeply excavated above; basal margin broadly convex; umbonal ridges rather square; surface marked by concentric lines of growth.

This species somewhat resembles Gabb's *Crassatella uvasana*,³¹ but the umbonal angle of the new species is smaller, the umbonal ridges are more square, the ribbing covers the entire shell, and the posterior extremity is more truncated. Locality 3, L. S. J. U. Pal. Coll.

Crassatellites tuscanus Gabb.

Pl. 8, Fig. 4

Astarte tuscana Gabb, Pal. Cal., Vol. 1, p. 179, pl. 30, fig. 257.

Astarte tuscana Gabb, Geol. Surv. Canada, vol. 1, pt. 2, p. 160, pl. 18, fig. 6.

Shell moderate in size, elongate; umbone inconspicuous and anterior; cardinal margin slightly convex and sloping gradually towards the posterior, which is broadly rounded; anterior margin truncated and rounded and basal margin broadly convex; surface ornamented by irregular fine to coarse lines of growth, and where worn, by fine radial lines; beaks excavated both posteriorly and anteriorly. Locality 2, L. S. J. U. Pal. Coll.

Cucullæa youngi, new species

Pl. 8, Fig. 12

Shell large, thick, ventricose; strongly convex, so that the maximum umbonal breadth across both valves about equals

³¹ Geol. Surv. of Cal. Pal., vol. 1, p. 214, pl. 32, fig. 284.

the height, older individuals of this species tending to have the height considerably greater than the length, thus differing from *Cucullæa ponderosa* Whiteaves.³² Umbone broad, curved slightly anteriorly, and deeply excavated both anteriorly and posteriorly; anterior margin broadly rounded, basal margin nearly straight, posterior truncated; posterior umbonal angle sharp; anterior umbonal angle broadly rounded; hinge area broad and long, extending about two-thirds length of shell; exterior of shell ornamented by fine radial lines and fine irregular lines of growth, the lines of growth obscuring the fine radial lines in older individuals.

The species is probably closely related to *Cucullæa mathewsonii* Gabb, of the Martinez. It differs in having much finer ribs and broader umbone. Locality 2, L. S. J. U. Pal. Coll. Named for Mr. H. W. Young of Stanford University.

***Dosinia milthoidea*, new species**

Pl. 8, Fig. 5

Shell of medium thickness, circular and inflated; beak small, excavated anteriorly; cardinal margin convex, sloping into the circular posterior margin; anterior and basal margins rounded; surface ornamented by fine concentric lines of growth and three or four irregularly spaced major concentric lines. Locality 2, L. S. J. U. Pal. Col.

***Venus pertenuis* Gabb**

Dosinia pertenuis Gabb, Pal. Cal., vol. 1, p. 167, pl. 30, fig. 253.

Our specimens of this species are about the size of the one Gabb figured. The shell is thin and subcircular; the anterior and basal margins form a regular curve, while the cardinal margin is slightly arched and joins the posterior margin with a small angle; an inward truncation of the cardinal border runs from the beaks to the posterior angle; surface marked by fine concentric lines of growth. Locality 3, L. S. J. U. Pal. Coll.

³² Whiteaves, Geol. Surv. Canada, vol. 1, pt. 4, p. 294, pl. 38, figs. 1 and 1a.

Glycimeris veatchii Gabb

Pl. 8, Figs. 2, 7 and 8

Axinæa veatchii Gabb, Pal. Cal., vol. 1, p. 197, pl. 25, figs. 183-183a.

Pectunculus veatchii Gabb, 17th An. Rept. U. S. G. S., p. 1039, pl. 64, fig. 1.

Gabb's original description is as follows: "Shell thick, subglobose, equivalve and nearly equilateral; beaks large, incurved, central, approximate, with sides sloping downward, anterior and basal margins regularly rounded; posterior end rounded, or subtruncate, surface marked by 36 to 40 radiating ribs, very regular in size, a little the smallest anteriorly and obsolete behind; a faint depression usually exists on the posterior side of the umbones, which passes down and strikes the middle of the posterior margin. Internal margin coarsely crenulated. Hinge robust; teeth arranged radiately, the lateral teeth largest and most widely separated. Area very short and narrow."

The radiating ribs in the young are usually narrower than the interspaces, while in the adult they are broader. The height of the shell is slightly greater than the length. Localities 1, 2 and 3. L. S. J. U. Pal. Coll.

Inoceramus pembertoni, new species

Pl. 7, Figs. 7 and 8

This enormous *Inoceramus* has a length of 22 cm. and a breadth of 15 cm.; thickness of both valves about 10 cm. Some of the prismatic layer of the shell is still present on the buff sandstone cast which shows the valves to have been oval in shape with straight cardinal margin posteriorly; beaks prominent, approximate, and turn posteriorly; anterior margin robust and rounding, and grading into the slightly convex basal margin; posterior margin presenting a jagged outline due to a single large wrinkle which is concave in the right valve and convex in the left; surface ornamented by about 20 coarse, rounded concentric ribs. From locality 3, L. S. J. U. Pal. Coll.

Named in honor of Mr. J. R. Pemberton, who directed the work of the Stanford geological party during the summer of 1910.

Inoceramus whitneyi Gabb

Pl. 8, Fig. 9

Inoceramus whitneyi Gabb, Geol. Surv. of Cal., Pal., vol. 2, p. 193, pl. 32, fig. 91.

The shell figured is medium in size, and subelliptical; beak broken, but is anterior and was, no doubt, prominent; cardinal margin straight and makes a sharp curve with the broadly rounded posterior margin, which is continuous with the basal and anterior margins; surface marked by prominent, smooth, concentric ribs which are more widely spaced towards the margins; shell pearly. Found at locality 3, L. S. J. U. Pal. Coll.

Isocardia chicoensis, new species

Pl. 8, Fig. 3

Shell thick, robust, equivalve; margins circular in outline; beaks prominent, approximate, and turned forwards; hinge-line smooth; surface marked by coarse concentric lines of growth, covering minute radial ribs which are seen on worn parts of the shell. Locality 2, L. S. J. U. Pal. Coll.

Lysis suciensis Whiteaves

L. suciensis Whiteaves, Geol. Surv. Canada, vol. 1. pt. 5, p. 367, pl. 45, fig. 3.

The single specimen found is partially a cast, so any external sculpture has been lost. In form, spire, smooth surface, and inner lip, the specimen is very close to Whiteaves's species. The specimen is too poor to figure. Locality 2, L. S. J. U. Pal. Coll.

Macrocallista cordata, new species

Pl. 8, Fig. 1

Shell cordate, thick, flattened, much longer than high; anterior margin broadly rounded, about same as posterior car-

dinal margin, with which it makes a sharp smooth curve; umbone small and depressed; surface ornamented by large concentric lines of growth. Locality 2, L. S. J. U. Pal. Coll.

***Mactra gabbiana* Anderson**

Pl. 8, Fig. 11

M. gabbiana Anderson, Proc. Cal. Acad., 3rd Series, vol. 2, No. 1, p. 74, pl. 7, fig. 156, 1902.

Shell thick, deeply sculptured by evenly spaced concentric lines. Posterior cardinal margin straight; anterior cardinal margin excavated; basal margin broadly curved; extremities sharply curved. Beaks depressed and turned forward. Locality 3, L. S. J. U. Pal. Coll.

***Pecten (Propeamusium) cowperi*, new species**

Pl. 7, Figs. 1 and 2

This species is easily recognized as being closely allied to Gabb's *Pecten interradiatus* of the Eocene. The shell is small, subcircular, equivalve, equilateral, compressed, thin; upper valve, ears equal, moderately large; lower (right) valve, right ear long, deeply and narrowly emarginate; right valve with about nine large internal ribs, equally spaced, which are rounded and extend from the umbone nearly to the margin where they are abruptly truncated; external surface ornamented with many fine equally spaced concentric lines; upper valve with four to eight rather large rounded internal riblets which extend from the umbone nearly to margins; external surface marked by many fine radial ribs which are nearly obsolete near the anterior and posterior of the shell. Locality 2, L. S. J. U. Pal. Col.

This species has also been found by the writer in the Chico shales of the Tesla sheet. Probably the unnamed *Pecten** allied to *P. interradiatus* from "Road cutting below Prof. Richer's house at mouth of Strawberry Canyon, Berkeley.

* U. S. Geol. Surv. Prof. Paper No. 47, p. 54.

Cutting now walled up. A. C. L. Cretaceous shale," belongs to this species.

Named in honor of Dr. Andrew Cowper Lawson of the University of California.

Pholadomya subelongata Meek

P. subelongata Meek, 1857; Tr. Alb. Inst., vol. 4, p. 42.

P. brewerii Gabb, 1864; Pal. Cal., vol. 1, p. 152, pl. 22, fig. 123.

P. royana Whiteaves, 1879; Geol. Surv. Canada, vol. 1, pt. 2, p. 140.

Shell ovate or subquadrate, compressed; beaks anterior, moderate in size; posterior extremity rounded, sub-truncate; posterior cardinal border nearly straight and gently sloping; basal margin slightly convex. The anterior margin of the left valve found is missing so the exact number of ribs can not be told; 16 ribs can be counted, however, and there were probably at least 25 which radiated from the beak and are crossed by fine lines of growth. The ribs are obsolete near the posterior cardinal margin. Locality 3, L. S. J. U. Pal. Coll.

Since Whiteaves has shown the wide variation in the number of ribs on *P. royana* and believes it to be the same as *P. subelongata*, there seems no reason for retaining Gabb's name, *P. brewerii*, as a different species.

Pinna calamitoides Shumard

Pl. 9, Fig. 4

P. calamitoides Shumard, Trans. Ac. Sc. St. Louis, vol. 1, p. 124, 1858. (From Vancouver Island.)

P. calamitoides Shumard, Geol. Surv. Canada, vol. 1, pt. 2, p. 167, pl. 20, figs. 1, 1a, and 1b, 1879. (From Sucia Island.)

P. brewerii Gabb, Pal. Cal., vol. 2, p. 195, pl. 32, fig. 93, 1869. (From the Chico of California.)

Shell elongated, triangular, compressed, slightly curved; angle of divergence of sides about 30°; a strongly marked rib near middle of valve, on one side of which are eleven

slender, rounded, longitudinal, radiating ribs; on the other side are three of these radial ribs, and starting from the margin are other ribs which make an angle of about 30 degrees with the margin and curve inwards towards the midrib. Locality 3. There seem to be no characteristic differences between Shumard's and Gabb's species, so they are placed under the earlier species name.

Trigonia evansana Meek

Pl. 8, Fig. 6

T. evansi Meek, Pal. Cal., vol. 1, p. 189, pl. 25, fig. 177.

"Shell trigonal, produced behind; beaks anterior, subterminal, very prominent, strongly incurved; anterior end convexly truncated, very broad laterally; basal margin prominently rounded in the middle. Sloping upwards posteriorly straight to the posterior end, which is narrow and round; cardinal margin concave, nearly straight behind. Corslet bordered by a rounded double rib crossed by small transverse lines, and marked on its surface by about eighteen small oblique ribs; remainder of the surface marked by about twenty large prominent ribs, slightly radiating, but nearly parallel posteriorly."

The posterior end of the figured specimen is broken off, as is part of the corslet. Locality 2. L. S. J. U. Pal. Coll.

GASTROPODA

Anchura, species?

This species resembles *A. transversa* Gabb,³³ in the following characteristics: Shell large, fusiform, spire elevated; whorls rounded, suture deep; surface of whorls strongly cancellated by longitudinal and transverse ribs; canal long and straight. Locality 1. L. S. J. U. Pal. Coll.

Amauropsis oviformis Gabb

Pl. 9, Fig. 9

A. oviformis Gabb, Pal. Cal., vol. 1, p. 109, pl. 19, fig. 63.

Shell ovoid; spire rather elevated; six rounded whorls; suture slightly channelled; aperture moderate, acute pos-

³³ *A. transversa* Gabb, Pal. Cal., vol. 2, p. 165, pl. 27, fig. 45.

teriorly, expanded in advance; columella faintly incrustated; umbilicus imperforate; surface marked by irregular lines of growth. Locality 2. L. S. J. U. Pal. Coll.

Cancellaria crassa, new species

Pl. 9, Fig. 5

Shell thick, robust, broadly fusiform; spire low, a little more than half as high as the aperture; whorls six, angulated; sides flattened, upper surface sloping; suture distinct, impressed; surface ornamented by longitudinal folds, 11 on the last whorl, which slant towards the back and are crossed by spiral lines; aperture moderate in size; outer lip simple; inner lip incrustated and bears two distinct folds. Locality 2. L. S. J. U. Pal. Coll.

Cinulia obliqua Gabb

Pl. 9, Fig. 2

C. obliqua Gabb, Pal. Cal., vol. 1, p. 111, pl. 19, figs. 64 and 64a, b, c.

"Shell subglobose, obliquely truncated below; whorls four, rounded; suture distinct. Surface ornamented by numerous fine revolving ribs, with deep interspaces, which are divided into minute, square compartments by cross-bars, which do not rise to the level of the ribs. Outer lip heavy, smooth and sinuous. Columella coated by a heavy callus which unites at both ends with the lip, and bears a large fold anteriorly." The specimen figured is a large one of the species. Locality 2. L. S. J. U. Pal. Coll.

Gyrodes canadensis Whiteaves

Pl. 9, Fig. 7

Gyrodes excavatus Whiteaves, Geol. Surv. Canada, vol. 1, pt. 2, pl. 16, figs. 2 and 2a.

G. canadensis Whiteaves, Geol. Surv. Can., vol. 1, pt. 5. p. 365.

Shell small, moderately thin, depressed, subglobose, about as wide as high; spire short; whorls four, the outer two truncated horizontally near the suture and concavely constricted

immediately below the angle, which is subacute, and swells out widely near, or a little below it; base obliquely and somewhat concavely truncated, on the inner side; umbilicus widely and deeply funnel-shaped, with a distinctly carinated margin; aperture longer than wide, outer lip simple; inner lip nearly straight; surface marked by fine lines of growth. Locality 1. L. S. J. U. Pal. Coll.

***Gyrodes compressus*, new species**

Pl. 9, Fig. 6

Shell medium size, thick, subglobose, about as wide as high; spire depressed nearly to the level of third whorl and narrow; whorls four, the outer two sharply rounded near the suture and concavely constricted immediately below the rounded part; aperture subcircular, but angulated at the top; umbilicus small; surface marked by coarse lines of growth. Locality 1. L. S. J. U. Pal. Coll.

***Perissolax brevirostris* Gabb**

P. brevirostris Gabb, Pal. Cal., vol. 1, p. 91, pl. 18, fig. 43.

"Shell short, robust, thick; spire of moderate height; whorls five, enveloped, such that only the upper part of the inner whorls are visible. Suture distinct, bordered below by a carina, or swelling of the upper part of the whorl. Apical angle variable, usually obtuse." Surface marked by short longitudinal folds on the body-whorl, crossed by distinct raised spiral ribs which are biggest at the base of the body-whorl. Two or three blunt tubercles on each fold are connected by low rounded ribs. Mouth wide above and narrows suddenly into a long slender canal. Columella incrustated and somewhat undulated in the middle.

A single fragmentary specimen of this species was found in the Chico sandstone. Locality 1. L. S. J. U. Pal. Coll.

***Pugnellus rotundus*, new species**

Pl. 9, Fig. 10

Shell robust, spire moderately high; whorls five, rounded, ornamented by fine spiral lines on the upper whorls; body-whorl ornamented by a row of small tubercles just above the

center and by fine wavy spiral lines and fine lines of growth. Locality 3. L. S. J. U. Pal. Coll.

The specimen found is a young one. The adult form probably develops an incrustation which covers part of the body-whorl. The species differs mainly from Gabb's species³⁴ in that the whorls of his species are angulated.

Rostellites gabbi White (fide Whiteaves)

Pl. 9, Fig. 8

Rostellites gabbi White, Whiteaves, Geol. Surv. of Canada, vol. 1, pt. 5, p. 356.

Shell large, fusiform, thick, tapering nearly equally from the middle towards both extremities. Spire rather short and conical; the three or four nuclear whorls smooth; body-whorl marked by spirally arranged nodules on longitudinal folds; aperture long and moderately broad, terminating in a well defined canal; columella marked by about three oblique folds. Locality 1. L. S. J. U. Pal. Coll.

Since Dr. Dall³⁵ has based specific differences on the nucleus of the volutoid series, the nomenclature of this species, formerly called *Volutoderma*, has been changed to conform with his classification.

Solariaxis templetoni, new species

Pl. 9, Fig. 22

Shell small, globular, thin, pearly; spire short; umbilicus scalar, the umbilical wall with a rib between the umbilical carina (basal margin of the umbilicus) and the suture above; umbilical carina annulate; surface ornamented by spiral lines. Aperture ovate. Locality 2. L. S. J. U. Pal. Coll.

Named for Mr. Eugene Templeton of Palo Alto.

Turris plicata, new species

Pl. 9, Fig. 3

Shell thick, elongate, fusiform, spire high, whorls seven, suture indistinct. Whorls marked by rounded folds, as large as the interspaces, which run slightly diagonally backward,

³⁴ *P. hamulus* Gabb. Pal. Cal., vol. 1, p. 124, pl. 18, fig. 48, and pl. 20, fig. 81.

³⁵ Tran. Wag. Free Inst., vol. 50, p. 69, etc.

and are crossed by distinct spiral ribs which also cover the canal. Aperture elongated, widest above and tapering down to the canal. Locality 2. L. S. J. U. Pal. Coll.

***Turritella chicoensis* Gabb**

Pl. 9, Fig. 12

Shell variable in size, elongate; number of whorls variable with age, usually about nine; whorls rounded and sometimes flattened on upper half; ornamented by six or seven spiral ribs; between which are minute spiral lines; suture deep; under surface of body whorl slightly convex and usually marked by fine revolving lines. Locality 2. L. S. J. U. Pal. Coll.

CEPHALOPODA

***Baculites chicoensis* Trask**

Pl. 9, Fig. 11

Baculites chicoensis Trask, Proc. Cal. Acad. Nat. Sci., vol. 1, pt. 2, p. 93, pl. 2, fig. 2, 1856, Chico Creek, Cal.

Shell elongated, slightly tapering, section ovoid, dorsal side narrowest; sides ornamented by curved ribs with convexity downwards and longest limb on the dorsal side; under surface marked by septæ which may be seen in the figure. The mouth and lower part of the specimen are missing. Locality 2. L. S. J. U. Pal. Coll.

***Hauericeras transitionale*, new species**

Pl. 9, Fig. 15

Shell compressed, nearly circular; whorls six, abruptly depressed at the umbilical margin; venter keeled; surface smooth with five broad transverse grooves to a revolution; these grooves turning slightly forward at the umbilical margin and backward on the back. Locality 2. L. S. J. U. Pal. Coll.

This species seems very close to *Ammonites gardeni* Stoliczka³⁶. *H. gardeni* Baily³⁷ differs by having closely spaced sickle-shaped lines of growth.

H. transitionale is confined to the upper shales of the Chico formation.

³⁶ *Ammonites gardeni* Stoliczka, 1865, Cret. Cephal. S. India, p. 61, pl. 33, fig. 4.

³⁷ Quat. Jour. Geol. Soc. Lon., vol. 11, p. 156, pl. 11, fig. 3.

Placenticerias californicum Anderson

Pl. 9, Figs. 16 and 17

P. californicum Anderson, Proc. Cal. Acad. Sci., Third Series Geology, vol. 2, no. 1, p. 78, pl. 8, figs. 173-7, 1902.

Shell discoidal, compressed, narrowing regularly from umbilical margin outwards; marked by coarse ribs which tend to develop a row of tubercles near the umbilical region, and two rows near the outer margin which are elongate and narrow; ribs turning forward on leaving the umbilicus and then backward about center of side of coil, then gently forward near the peripheral angle, only about every other one of these ribs extending whole way across shell, the other half arising about halfway between the others from middle of side and extending to peripheral angle as do the others; space between tubercles at periphery flattened, its width equal to about one-third thickness of shell. Locality 3. L. S. J. U. Pal. Coll.

Placenticerias pacificum Smith

Pl. 9, Figs. 18 and 19

P. pacificum Smith, Proc. Cal. Acad. Sci., Third Series, Geol., vol. 1, pp. 207-210, pls. 25-28, 1900.

Shell discoidal, involute, compressed, and moderately smooth; under surface ornamented with sickle-shaped ribs; peripheral angle sharp and back slightly concave, giving it a double-keeled appearance. Figured specimen from locality 3, in L. S. J. U. Pal. Coll. Found at locality 3. Also near Henley, Cal.; in the Santa Ana Mountains, and in Arroyo del Valle, Cal. This species differs from *P. californicum* in its ornamentation; it may be the same as *Placenticerias subtilis-trialum* Jimbo.³⁸

Placenticerias sanctæmonicæ, new species

Pl. 9, Figs. 20 and 21

This species is intermediate between *P. californicum* Anderson and *P. pacificum* Smith. The external surface is ornamented by strong sickle-shaped ribs, which are separated by

³⁸ Palæontologische Abhandlungen, 1894; Kotora Jimbo; p. 25, pl. 1, figs. 1 and 1a.

deeply channeled interspaces; ends of ribs abruptly terminated at outer edge and forming a chain of elongated tubercles on either edge of the squared back, as keels; thus differing from *Placenticerias pacificum*, which has only faint keels, and only slightly channeled interspaces between the ribs. None of these tubercles is developed on the sides as in *Placenticerias californicum*. The young of the three species show the differences more pronounced. The young of *Placenticerias sanctæmonicæ* has fine ribs with deeply impressed interspaces, and *Placenticerias californicum* has very coarse ribs which are knotted near the inner margin and tuberculated near the outer margin. Locality 8. L. S. J. U. Pal. Coll.

LIST OF MARTINEZ FOSSILS FROM THE CALABASAS
QUADRANGLE, SOUTHERN CALIFORNIA

None of these Martinez species occurs in the Chico.

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<i>Kingenia simiensis</i> , new species, 4.	73, 116
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* <i>Cardium cooperii</i> Gabb, 4.....	74, 118
<i>Crassatellites branneri</i> Waring, 4.....	74, 120
<i>Crassatellites grandis</i> Gabb, 4.....	74, 116
<i>Cucullæa mathewsonii</i> Gabb, 5.....	75, 116
<i>Glycimeris veatchi major</i> Stanton.	75, 112
<i>Leda alæformis</i> Gabb, 4.	76, 116
* <i>Leda gabbi</i> Conrad, 4.	76, 118
<i>Lima perrini</i> , new species, 4.	76, 112
<i>Macrocallista stantoni</i> , new species, 4.	77, 120
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<i>Ostrea idriænsis</i> Gabb, 5.	78, 118
<i>Periploma undulifera</i> Gabb, 5.....	79

* Species found also in the Tejon.

The numbers following specific names refer to the following localities marked on the map, fig. 3, p. 51:

- Loc. 4 Martinez area in the Simi Hills, Ventura County.
- Loc. 5 Martinez area, south of the Santa Monica Mountains, Los Angeles County.
- Loc. 6 Tejon north of secondary fault in the Simi Hills, Ventura County.
- Loc. 7 Tejon from south of the Santa Monica Mountains, Los Angeles County.
- Loc. 8 Tejon from the McCray wells, Ventura County.

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Turritella reversa, new species, 4.	88, 116
Turritella simiensis, new species, 4 and 6.	88, 120
Cephalopoda:	
Nautilus hallidayi Waring, 4.	89, 118
Pisces:	
Lamna clavata Agassiz, 4.	89, 116

* Species found also in the Tejon.

The numbers following specific names refer to the following localities marked on the map, fig. 3, p. 51:

Loc. 4 Martinez area in the Simi Hills, Ventura County.

Loc. 5 Martinez area, south of the Santa Monica Mountains, Los Angeles County.

Loc. 6 Tejon north of secondary fault in the Simi Hills, Ventura County.

Loc. 7 Tejon from south of the Santa Monica Mountains, Los Angeles County.

Loc. 8 Tejon from the McCray wells, Ventura County.

MARTINEZ (LOWER EOCENE) FOSSILS

All types and original specimens are in the Leland Stanford Jr. University Paleontological collection.

Cotypes of the new species are in the museum of the California Academy of Sciences.

Locality 4, Martinez area in the Simi Hills, Ventura County.

Locality 5, Martinez area south of the Santa Monica Mountains, Los Angeles County.

ANTHOZOA

Flabellum remondianum Gabb

Pl. 13, Fig. 5

F. remondianum Gabb, Pal. Cal., vol. 1, p. 207, pl. 26, fig. 199.

F. remondianum Gabb, U. S. G. S. 17th An. Rept., pt. 1, p. 1036, pl. 63, figs. 1 and 2.

Gabb's description is as follows: "Polypidom triangular, convex on all sides, acute and straight on the lateral margins; sides marked by eight or nine prominent radiating ribs, with regularly concave interspaces." There are usually two or three smaller costæ, or ribs, between the larger ones which are welded along the longer transverse axis. Locality 4, L. S. J. U. Pal. Coll.

Trochocyathus zitteli Vaughan

Pl. 12, Fig. 1

A single horn-shaped specimen preserved in yellow sandstone shows the circular cross section. The septa are stout; columella papillous and trabecular, and surrounded by several cycles of pali. Locality 5, L. S. J. U. Pal. Coll.

BRACHIOPODA

Kingena simiensis, new species

Pl. 12, Fig. 11

This species resembles somewhat *Kingena occidentalis* Whiteaves³⁹ but the lower margin of the shell is rounded and not

³⁹ Geol. Surv. of Canada, vol. 1, pt. 5, p. 404, pl. 51, figs. 7 and 7a, 1903.

truncated as is *K. occidentalis*. Ventral valve slightly more convex than the dorsal, and the umbone short and incurved; beaks of both valves divided longitudinally by a median septum that extends about halfway to the front margin. Locality 4, L. S. J. U. Pal. Coll.

PELECYPODA

***Cardium cooperii* Gabb**

Pl. 13, Fig. 3

C. cooperii Gabb, Pal. Cal. Sci., vol. 1, p. 172, pl. 24, fig. 154a.

Shell broad, cordate, equilateral; beaks small, central, prominent; cardinal margins sloping and rounded on both sides; base regularly convex; surface marked by many minute, rounded radiating ribs, which are larger on posterior third of shell. Locality 4. This species occurs also in the Tejon. L. S. J. U. Pal. Coll.

***Crassatellites branneri* Waring**

Pl. 14, Fig. 17

Crassatellites branneri Waring, Jour. Geol., vol. 22, no. 8, pp. 782-6, Nov.-Dec., 1914.

Shell very large, trigonal, slightly longer than high; beaks subcentral, prominent, deeply excavated front and back, incurved, with sides sloping equally and rapidly, most abrupt in advance, slightly convex behind; lunule cordate; anterior end broadly rounded; posterior truncated and flattened from the umbonal ridge to the cardinal and posterior margins; surface marked by lines of growth and fine radiating lines which are especially apparent on worn specimens. Locality 4, L. S. J. U. Pal. Coll.

Named in honor of Dr. J. C. Branner of Stanford University.

***Crassatellites grandis* Gabb**

Pl. 12, Fig. 16

C. grandis Gabb, Pal. Cal., vol. 1, p. 181, pl. 24, fig. 163.

Shell large, longer than high; beaks prominent; excavated both anteriorly and posteriorly; anterior cardinal margin slop-

ing steeply; anterior margin rounded; posterior cardinal margin sloping gradually; posterior margin truncated; basal margin slightly convex; umbonal ridge faint; exterior marked by fine lines of growth, with obscured radial ribs; hinge with two large teeth anteriorly. Locality 4, L. S. J. U. Pal. Coll.

***Cucullæa mathewsonii* Gabb**

Pl. 12, Figs. 14, 18 and 19

C. mathewsonii Gabb, Pal. Cal., vol. 1, p. 195, pl. 31, fig. 266.

C. mathewsonii Gabb, 17 An. Rept. U. S. G. S., pt. 1, p. 1039, pl. 64, figs. 4 and 5.

Shell large, thick, gibbous, subquadrate, rounded in front and on the base; truncated posteriorly; beaks large, subcentral and incurved; area long and wide; hinge line nearly as long as greatest length of shell; surface marked by many small rounded ribs, sometimes grooved longitudinally; ribs very fine, posterior of umbonal angle; fine lines of growth cross radial ribs; basal margin of large specimens figured are truncated and marked by coarse lines of growth, probably due to age. Locality 5, L. S. J. U. Pal. Coll.

***Glycimeris veatchi major* Stanton**

Pl. 10, Figs. 3 and 4

G. veatchi var. *major* Stanton, 17 An. Rept. U. S. G. S., pt. 1, p. 1040, pl. 64, figs. 2 and 3.

The specimens of this subspecies are much smaller than those of the Chico species, *Glycimeris veatchii* Gabb, of the southern area. The shells of the specimens are thinner than in the Chico species and are nearly equivalve. Cardinal margins sloping steeply; posterior slope somewhat truncated; very faint depressions in posterior sides of umbones pass down and strike middle of posterior margin. In the Chico form these depressions are very marked. Hinge robust and teeth arranged radially; area short and narrow; surface ornamented with rounded radial ribs wider than interspaces. Locality 4, L. S. J. U. Pal. Coll.

Leda alæformis (Gabb)

Pl. 12, Fig. 12

Corbula alæformis Gabb, Pal. Cal., vol. 2, p. 177, pl. 29, fig. 63.

The shell is small and thin, rounded anteriorly and narrowed posteriorly; beak forward of the middle, posterior cardinal margin slightly concave, bordered by a broad groove extending from the beaks to the posterior end; basal margin broadly rounded; surface ornamented by fine prominent concentric ribbing. Locality 4, L. S. J. U. Pal. Coll.

Leda gabbi Conrad

Pl. 13, Fig. 6

L. gabbi Conrad, Pal. Cal., vol. 2, p. 197; vol. 1, p. 199, pl. 26, fig. 185.

This species is much more slender than *L. alæformis* Gabb, and the posterior cardinal margin is usually produced to a point where it joins the broadly convex basal margin; surface marked by many concentric lines, much finer than in *L. alæformis*. Locality 4. This species occurs also in the Tejon. L. S. J. U. Pal. Coll.

Lima perrini Waring

Pl. 10, Figs. 1, 1a, and 2

Lima perrini Waring, Jour. of Geol., vol. 22, No. 8, Nov.-Dec., 1914, p. 782.

This giant circular Lima has a thick shell with nacreous, and outer prismatic layer; umbones small; cardinal margin sloping gradually to posterior where it becomes rounded and grades into the circular margin below; beaks slightly excavated in front, the margin sloping at a 35-degree angle into the round anterior margin; hinge very thick, with a deep wedge-shaped ligament pit sloping from interior edge of shell to exterior edge at anterior end of hinge line; a single large sub-posterior muscle impression marking interior of shell; surface ornamented by many fine radiating lines, the prismatic shell layer giving the surface a silken appearance. It belongs to the subgenus *Acesta*. Locality 4, L. S. J. U. Pal. Coll.

Named in honor of Dr. J. Perrin Smith of Stanford University.

Since this manuscript was prepared, *Lima haseltinei* Dickerson, has been described,⁴⁰ from the Martinez in the Mount Diablo quadrangle, with the statement that it is the same species as a Lima found by the Stanford Geol. Survey in the Martinez just north of the Calabasas quadrangle. The writer does not believe that the two species are the same. In comparing them, conclusions must necessarily be drawn from a comparison of the two specimens themselves and from the figures and descriptions of them. The figure of *Lima haseltinei* Dickerson (plate 8, fig. 2), is not even similar to *Lima perrini* Waring, and one can judge little better by comparison of the specimens themselves. The small specimen (pl. 9, fig. 11) included by Dickerson in his description of *L. haseltinei* could not possibly be *L. perrini*, and the writer has doubts as to its belonging even to the same genus. In his description, however, Dr. Dickerson has combined the characteristics of his two specimens in a description of his type, the larger specimen, although he apparently questions the identity of the two specimens himself. In his description, *Lima haseltinei* is described as having square ribs. *Lima perrini* has distinctly fine linear ribs, is proportionately higher than long, and one-third larger, besides having a very different hinge-line. Since the type specimen of *Lima perrini* is a right valve and the type specimen of *Lima haseltinei* a left valve, no positive determination can be made at this time. When more specimens are found at both localities, it will either prove or disprove the identity of the two; but until then it is best to consider them as distinct species.

Macrocallista stantoni, new species

Pl. 14, Figs. 1 and 6

Shell ovate-trigonal, porcellanous; umbones prominent, incurved, and excavated anteriorly; anterior margin broadly curved; basal margin broadly convex; posterior sharply curved and slightly produced at the base of the umbonal ridge which is prominent and near the posterior cardinal margin; surface

⁴⁰ Univ. Cal. Bul. Dept. Geol., vol. 8, no. 6, p. 126, pl. 8, fig. 2, 1914.

ornamented by regularly and closely spaced concentric ribs. Locality 4, L. S. J. U. Pal. Coll.

Named in honor of Dr. T. W. Stanton of the U. S. Geological Survey.

Miltha parsonsi, new species

Pl. 12, Fig. 13

Shell sub-circular, convex, rather thick; beak small, pointed, depressed and turned forward; anterior cardinal margin straight and sloping, making a sharp angle with the broadly rounded anterior margin; posterior cardinal margin convex and sloping into broadly rounded posterior margin; surface marked by six major concentric lines of growth and fine concentric ribs. Locality 4, L. S. J. U. Pal. Coll.

Named in honor of Mr. B. F. Parsons of Taft.

Opis virginalis, new species

Pl. 14, Fig. 4

Shell small, oblique, cordate in profile, triangular; valves equal, higher than long; beaks submedian, prominent, incurved, and approximate; surface divided by a sharply angular umbonal ridge into two areas, the posterior of which is flattened and narrow, while the anterior is broadly convex and about twice as wide as the posterior area; anterior margin broadly rounded; base of margin broadly curved and extending to end of umbonal ridge where it makes an angle of about 80 degrees with the truncated and deflected posterior end; surface marked by flattened, equally spaced concentric ribs, which are separated by fine interspaces. Locality 4, L. S. J. U. Pal. Coll.

This species is very similar to *O. triangulatus* (Cooper),⁴¹ of the Chico, but is broader at the base, more full anteriorly, has a longer beak, and is less angulated.

Ostrea idriænsis Gabb

Pl. 13, Fig. 10

O. idriænsis Gabb, Pal. Cal., vol. 2, p. 203, pl. 33, fig. 103b, c, and d., pl. 34, fig. 103, 103a.

⁴¹ Proc. Cal. Acad. Sci., Second Series, vol. 6, p. 332, pl. 47, fig. 7, 1896.

Shell medium size, thick, oblique, curved; ventral valve larger and more convex than the upper; surface rough and somewhat squamose. Loc. 5. This species occurs also in the Tejon formation. L. S. J. U. Pal. Coll.

***Periploma undulifera* (Gabb)**

Tellina undulifera Gabb, Pal. Cal., vol. 2, p. 183, pl. 30, fig. 74.

Shell medium size, thin, convex, inequilateral, broadly rounded in advance, tapering behind; beaks about two-fifths of length from anterior end and rather sharp; anterior cardinal margin sloping rapidly, posterior cardinal margin sloping, with slight convexity, gradually to posterior sharply curved end; basal margin broadly rounded and sloping upwards with slight convexity, to posterior end; surface marked by broad rounded concentric ribs which are somewhat undulate. Loc. 5. L. S. J. U. Pal. Coll.

***Septifer elegans*, new species**

Pl. 14, Fig. 2

Shell small, oblique, subquadrate; cardinal margin straight, anterior and posterior submargins subparallel, base irregularly convex; anterior side abruptly truncated, at an acute angle, to rest of surface; surface marked, posterior to this angle, by many fine radiating ribs. This species differs from *S. dichotomus* Gabb⁴² in having fine radial sculpture.

Mytilus dichotomus Cooper⁴³ is probably of this species.

Loc. 8. This species occurs also in the Martinez. L. S. J. U. Pal. Coll.

***Solen stantoni* Weaver**

S. stantoni Weaver, Bull. Dept. Geol. Univ. Cal., vol. 4, p. 116, pl. 12, fig. 1.

Shell thin, elongated, moderately convex; cardinal margin straight and nearly parallel to the slightly convex basal margin; posterior margin rounded and gaping; anterior margin crumpled and basal margin tapered to it; beak anterior, a

⁴² Pal. Cal., vol. 1, p. 186, pl. 30, fig. 261.

⁴³ Cal. State Min. Bureau, Bull. no. 4, p. 49, pl. 5, fig. 64.

sharp constriction running from it nearly perpendicular to the basal margin; surface marked by fine concentric lines of growth. Loc. 4.

The anterior end of the shell is slightly more produced than Weaver's figure shows.

***Spisula æquilateralis*, new species**

Pl. 14, Fig. 8

Shell small, convex, equilateral, trigonal; beaks adjacent, sharp, with sides sloping equally either way; ligament sagitate; basal margin broadly curved; surface marked by fine lines of growth; umbonal ridges sharp. Martinez formation at Loc. 4, L. S. J. U. Pal. Coll.

***Venericardia planicosta venturensis*, new subspecies**

Pl. 11, Figs. 6-9

Shell large, thick, cordate, deeply convex, altitude greater than the length; beaks large, turned forward, nearly touching; lunule small; anterior cardinal margin deeply excavated in front of beaks, short and convex, joining the broadly convex anterior margin at a slight angle; posterior cardinal margin deeply grooved and broadly convex; posterior margin convexly truncated; surface ornamented by 25-30 large, square shouldered ribs, which are strong clear to the margins, with deep squared interspaces; posterior ribs narrow and indistinct; entire surface marked by wrinkled lines of growth. Locality 4, L. S. J. U. Pal. Coll.

This subspecies exhibits characteristics different from any of this genus previously found on the Pacific Coast. It is probably characteristic of the Martinez, or lower Eocene. It resembles very closely *V. planicosta* Harris⁴⁴ from the Midway of Alabama and Georgia.

Its chief distinguishing features are the prominent truncation of the submargins, narrowness and squareness of ribs compared with the later forms, and a nearly constant relation between the altitude and length, the former being slightly greater. It is

⁴⁴ Bull. Am. Pal. no. 4, 1896, p. 58, pl. 4, fig. 13.

readily distinguished from that in the Tejon, or upper Eocene. A typical specimen of *V. planicosta venturensis* measures 73 mm. in height and 67 mm. in length, while a similarly perfect specimen of *V. planicosta hornii* measures 82 mm. in height and 100 mm. in length.

SCAPHOPODA

Dentalium cooperii Gabb

D. cooperii Gabb, Pal. Cal., vol. 1, p. 139, pl. 31, fig. 100.

Shell tubular, symmetrically tapering, slightly curved; aperture circular or elliptical; open at both ends; surface smooth and polished, and large specimens sometimes show longitudinal impressed lines. The thickness of the shell varies individually, but is usually thick. Locality 4, L. S. J. U. Pal. Coll.

This species occurs also in the Tejon formation.

GASTEROPODA

Actæon merriami, new species

Pl. 14, Fig. 11

Shell very small, subovate, spire rather high; whorls five, regularly rounded; suture channeled; surface of whorls marked by narrow revolving ribs; outer lip simple; inner lip marked by revolving ribs; aperture elongate, anterior round and wide, posterior angular. Locality 4, L. S. J. U. Pal. Coll.

This species is smaller, and higher in proportion to the diameter than *A. lawsoni* Weaver.⁴⁵ Named in honor of Dr. J. C. Merriam of the University of California.

Bathytoma boundeyi, new species

Shell small, broadly fusiform, spire elevated; whorls six, angulated in the middle, sloping and slightly concave above, slightly convex below; numerous fine revolving linear ribs above the angle, and below are four, subacute revolving ribs with broad concave interspaces; fine ribs also cover the base of the canal; aperture broad above, narrowing into the slender

⁴⁵ Bull. Dept. Geol. U. C., vol. 4, pl. 13, fig. 10.

canal, the end of which is broken; inner lip slightly incrustated; surface covered, besides the revolving ribs, by fine lines of growth. Locality 4, L. S. J. U. Pal. Coll.

This species resembles very much Gabb's *Helicaulax costata*⁴⁶ of the Martinez formation, but shows no sign of a posterior canal, and the ornamentation is finer.

Named for Mr. E. J. Boundey of San Jose, California.

Brachysphingus sinuatus Gabb

Pl. 13, Figs. 7 and 8

B. sinuatus Gabb, Pal. Cal., vol. 2, p. 156, pl. 26, fig. 35.

Shell short, thick, subovate; spire low; whorls five, nearly hidden by outer whorl; suture variable, in some specimens linear and in others deep and bordered by a thickening of the succeeding whorl; body-whorl swollen in the middle, and marked by sinuous longitudinal lines of growth which slant slightly from the top towards the back; minute revolving lines cover the anterior of the body-whorl; aperture broad in the middle, acute behind, and narrowed in front where it is notched; a fold revolves backward from the notch around the anterior portion of the shell, occupying the former position of the notch at the successive stages of growth; outer lip simple, inner lip heavily incrustated. Locality 4, L. S. J. U. Pal. Coll.

This species differs from *B. liratus* Gabb, in not having longitudinal ribs which slant from the top of the body-whorl forward, and in having a more callous, notched, inner lip.

Cylichna costata Gabb

Pl. 15, Fig. 5

C. costata Gabb, Pal. Cal., vol. 1, p. 143, pl. 21, fig. 107.

Shell elongated, subcylindrical, widest anteriorly; spire hidden by outer whorl; whorls three to four; surface marked by numerous flattened revolving ribs, with narrow interspaces, and by lines of growth; aperture long and narrow, widest below; small fold in advance on columella; inner lip incrustated. Locality 4, L. S. J. U. Pal. Coll.

This species occurs also in the Tejon formation.

⁴⁶ Pal. Cal., vol. 2, p. 167, pl. 28, fig. 48.

Fasciolaria mucronata (Gabb)

Pl. 12, Fig. 5

Neptunea mucronata Gabb, Pal. Cal., vol. 2, p. 147, pl. 26, fig. 25.

"Shell moderate in size, thin, rounded, fusiform; spire elevated, acute; whorls seven, rounded; suture sharply defined, linear; body whorl regularly convex, swollen in the middle, excavated in advance. Aperture large, acute behind, continued into a canal in advance; outer lip simple, thin; inner lip slightly incrustated; canal moderately produced and a little deflected. Surface marked by a few faint striæ of growth, and by regular, small, revolving, impressed lines." Locality 5, L. S. J. U. Pal. Coll.

Ficus plectatus, new species

Pl. 12, Fig. 8

Shell thick, pyriform; body-whorls rounded below and squared above, slightly flattened on the sides; whorls five, rapidly increasing in size; spire low, suture indistinct; aperture narrow; canal moderate and slightly curved, outer lip simple, columellar lip sinuous; body-whorl ornamented by 15 very prominent transverse ribs which are abruptly truncated at the shoulders; surface marked by fine spiral lines which run across the ribs. Locality 4, L. S. J. U. Pal. Coll.

Retipirula crassitesta (Gabb)

Pl. 13, Figs. 1 and 2

Turbinella crassitesta Gabb, Pal. Cal., vol. 2, p. 157, pl. 26, fig. 37.

Shell moderate in size, subfusiform, thick, spire low; whorls four to four and one-half, suture distinct; surface marked by four or five large revolving ribs on the middle and upper part of the whorl, and smaller ones anteriorly; the larger of these crossed by about 15 longitudinal folds, each point of intersection being marked by an enlargement and formation of a tubercle; aperture broad in the middle and narrowed and straight in advance; outer lip acute and undulated on the margin and possessed of an interior partition which makes the aperture small;

inner lip thickened, flattened, and bearing two distinct oblique folds in the middle; canal straight and slightly produced on the columella. Localities 4 and 5, L. S. J. U. Pal. Coll.

Gyrodes robustus, new species

Pl. 13, Figs. 11 and 12

Shell large, compressed, subglobose; spire low, whorls five, rounded, robust, truncated above; suture linear; aperture elongated, terminating about equally at its upper and lower extremity; lips simple; umbilicus patulous. In older individuals, as fig. 11, the body-whorl becomes sinuous and tends to coil higher and almost cover the inner whorls; the suture then becomes deep and carinate; surface marked by sinuous lines of growth. Locality 4, L. S. J. U. Pal. Coll.

This species is about one-half larger than *G. expansus* Gabb⁴⁷ of the Chico formation, and the whorls are not depressed on the sides.

Heterotermia trochoidea Gabb

H. trochoidea Gabb, Pal. Cal., vol. 2, p. 151, pl. 26, figs. 30 and 30a.

"Shell depressed, fusiform, spire low, whorls five and one-half, concave above, body-whorl bicarinate, each carina being a row of large rounded tubercles; suture linear, undulated, the upper margin of each whorl being attached to the upper row of tubercles on the proceeding volution; between the two carinae on the body-whorl, the surface is obliquely concave; anteriorly it is deeply excavated and produced in a long, straight canal. Aperture broad above; narrow and straight below; outer lip simple, broadly emarginate on the upper surface, inner lip incrustated. Surface ornamented, besides the tubercles, by minute revolving lines, smaller above than below, and showing a tendency in advance, to alternation in size." Locality 5, L. S. J. U. Pal. Coll.

Lyria hannibali, new species

Pl. 12, Figs. 2 and 3

Shell subfusiform, six whorled; nucleus broken, so indeterminate; fine spiral sculpture covering entire shell except the

⁴⁷ Pal. Cal. vol. 1, p. 108, pl. 19, fig. 62, a, b, c.

protoconch; transverse sculpture of 12 or more rounded, very prominent elevated ribs or folds; suture oppressed, the whorl in front prominently constricted with tendency towards tubercles; aperture narrow, outer lip simple, strongly ribbed, not varicose; four strong, and two or three accessory plaits on inner lip, which has a wash of callus its entire length. Locality 4, L. S. J. U. Pal. Coll.

This species is similar to the specimen figured as *Cancellaria irelaniana* (C) by Arnold,⁴⁸ but differs in the shape and sculpture of the shoulders.

Named for Mr. Harold Hannibal.

Olivella spissa, new species

Pl. 12, Fig. 7

Small, fusiform, spire low; smooth and conical; whorls four or five, suture linear and not impressed; surface smooth; aperture acute behind, broad in front and deeply notched; inner lip callous and with seven fine hairlike plications; a spiral suture-like line at the upper edge of a wash of callous runs from the base of the outer lip around the back of the shell and on to the inner lip. Locality 4, L. S. J. U. Pal. Coll.

Perissolax blakei Conrad

Pl. 13, Fig. 9

Shell elongate; spire moderately elevated; whorls six; body-whorl ornamented by three prominent revolving carinæ. The upper two form prominent nodose angles between which is a concave surface; on the inner whorls, only the upper carina can be seen; a third slightly nodose carina close below the lower large carina; aperture elongated, narrowed into the slender, slightly curved canal; aperture and canal about two and one-half times as long as the height of the spire; surface covered by fine spiral ribs. Locality 4, L. S. J. U. Pal. Coll.

P. tricarinatus Weaver⁴⁹ is probably of this species. This species occurs also in the Tejon formation.

⁴⁸ Bull. 396, U. S. Geol. Surv., p. 52, pl. 4, fig. 22.

⁴⁹ *P. tricarinatus* Weaver, Bull. U. of C., vol. 4, p. 121, pl. 13, fig. 9.

Polynices hornii (Gabb)

Pl. 13, Fig. 4

Lunatia hornii Gabb, Pal. Cal., vol. 1, p. 106, pl. 29, fig. 217.

Shell moderate in size, subglobose; spire small, acute, not prominent; whorls five, almost entirely enveloped; aperture semilunar, rounded below; outer lip acute; columellar lip with a moderately large callus, thickened above, smaller and flat below, containing as a thickened lip almost to the anterior end of the mouth. Umbilicus small and partially covered. Surface marked by irregular lines of growth. Locality 4, L. S. J. U. Pal. Coll.

This species occurs also in the Tejon formation.

Pseudoliva howardi (Dickerson)

Pl. 12, Figs. 4 and 9

P. reticulata Waring, Jour. Geol., vol. 22, no. 8, p. 783, Nov.-Dec., 1914.

Molopophorus (?) *howardi* Dickerson, Bull. Dept. Geol. Univ. of Calif., vol. 8, no. 15, p. 301, pl. 29, figs. 3a and 3b, Dec., 1914.

Shell subconical; whorls four, spire low, suture linear; inner whorls almost covered by body whorl, which is concave; aperture wide, posterior angular; anterior produced slightly into a canal; outer lip simple, inner lip incrustated and marked by a fold revolving from end of canal around to inner lip, representing former positions of end of canal; surface ornamented by longitudinal folds and spiral ribs; where these intersect, small tubercles develop; middle of body-whorl impressed by a single revolving line which forms a tooth where it is truncated on the outer lip. Locality 4, L. S. J. U. Pal. Coll.

Sinum dickersoni, new species

Pl. 14, Fig. 10

Shell thin, depressed, auriform; spire small; whorls five, rapidly increasing in size; suture deep; upper part of the whorls

flattened; body-whorl oblique, ornamented by numerous band-like, revolving ribs, with linear interspaces; surface also marked by sinuous lines of growth which give the revolving ribs a wavy appearance; umbilicus imperforate; umbilical margin acutely rounded; aperture distended, subelliptical; outer lip acute, inner lip slightly thickened. Locality 4, L. S. J. U. Pal. Coll.

This species differs from *Natica lineata* Dickerson⁵⁰ by having an imperforate umbilicus.

Named for Dr. Roy E. Dickerson, Curator of Paleontology, Cal. Acad. Sci.

Trachytriton titan, new species

Pl. 14, Fig. 18

Shell very large, fusiform, thick; spire elevated, whorls five, subangulated, nodose; aperture broad, anterior end narrowing into the canal; posterior rounded; whorls slightly convex above, concave below; body whorl below ornamented by coarse spiral ribs; about 15 tubercles ornament the angle of the body-whorl. Locality 4, L. S. J. U. Pal. Coll.

This species is very similar to *T. tejonensis* Gabb,⁵¹ but is larger, has thickened shell, more numerous tubercles, and the whorls are more angular.

Turritella maccreadyi Waring

Pl. 12, Fig. 10

T. maccreadyi Waring, Jour. Geol., vol. 22, no. 8, p. 783, Nov.-Dec., 1914.

Shell robust, apical angle broad; whorls 11, rounded, with six or seven strong, nearly equally spaced, spiral ribs; first five or six whorls angulated as in *T. martinezensis* Gabb;⁵² surface below body-whorl also ornamented by spiral lines, and whole surface marked by lines of growth; aperture broad, outer lip

⁵⁰ Bull. Dept. of Geol. Univ. Calif., vol. 8, no. 6, p. 141, pl. 13, fig. 3a.

⁵¹ Pal. Cal., vol. 2, p. 154, pl. 26, fig. 34.

⁵² Pal. Cal., vol. 2, p. 169, pl. 28, fig. 51.

slightly sinuous; inner lip sinuous, flattened and twisted. Characteristic of lower Martinez. Locality 4, L. S. J. U. Pal. Coll.

Named for Mr. Geo. McCready of Guanoco, Venezuela.

***Turritella pachecoensis* Stanton**

Pl. 12, Fig. 20

T. saffordi Gabb, Pal. Cal., vol. 1, p. 135, pl. 2, fig. 93.

T. pachecoensis Stanton, U. S. Geol. Surv. 17th An. Rept., pt. 1, p. 1043, pl. 66, figs. 1 and 2.

Adult with 15 whorls that are flattened on the sides and more or less angulated above and below, near the channeled suture; surface of early whorls marked by fine spiral lines which are usually obsolete in the older, more sinuous whorls. In very old individuals, obscure tubercles are sometimes formed on the angles of the whorls. Localities 4, 5, and 8, L. S. J. U. Pal. Coll.

This species is found also in the Tejon.

***Turritella reversa*, new species**

Pl. 12, Fig. 15

Adult with about 15 whorls that are nearly vertical on the sides and slightly rounded above, near the suture; base of the whorls slightly concave; whorls ornamented with fine revolving lines. Locality 4, L. S. J. U. Pal. Coll.

This species resembles *T. humerosa* Conrad.⁵³ The apical angle is about the same as that of the Maryland species.

***Turritella simiensis*, new species**

Pl. 14, Fig. 15

Adult with about 15 whorls, that are convex above, flattened on the sides, and marked by a heavy rib or enlargement of the lower angle; whorls ornamented by about nine spiral lines, the third from the top of which is larger; apical angle greater than that of *T. pachecoensis*. The older whorls tend to develop, ir-

⁵³ Maryland Geol. Surv., Eocene, 1901, p. 148, pl. 27, figs. 1 and 1a.

regularly, tubercles on the lower angle. Localities 4 and 6. Common in the upper Martinez and lower Tejon. L. S. J. U. Pal. Coll.

This species is probably the same as that figured as *T. infragranulata* Gabb.⁵⁴ The true *Turritella infragranulata* has a small apical angle, and is found in the upper Tejon.

CEPHALOPODA

Nautilus hallidayi Waring

Pl. 13, Fig. 13

N. hallidayi Waring, Jour. Geol., vol. 22, no. 8, p. 783-4, Nov.-Dec., 1914.

Shell large; inner whorls completely enveloped, while last whorl is more evolute; dorsum rounded; aperture elliptical, concave below, where it envelops the early coils. The outer volution has a width slightly less than remaining diameter of shell; sutures slightly inflected; shell pearly. The greatest diameter of the figured specimen is 36 mm. It is probably one of the oldest species of true *Nautilus* known. Locality 4, L. S. J. U. Pal. Coll.

Named in honor of Mr. T. W. Halliday of Spokane, Washington, the discoverer of this species.

PISCES.

Lamna (?) clavata Agassiz

Pl. 12, Fig. 6

L. clavata Agassiz, Bull. Dept. Geol. U. of C., vol. 5, p. 106, fig. 8.

Unfortunately the base of the specimen is lost so it can not be assigned positively to this genus. The tooth is narrow, flexuous and smooth; inner surface rounded; outer surface slightly convex; edges of enamel sharp. Locality 4, L. S. J. U. Pal. Coll.

This species differs from *Odontaspis elegans* Agassiz in not having the inner face striated.

⁵⁴ U. S. Geol. Surv., 17th An. Rept., pt. 1, p. 1044, pl. 66, fig. 3.

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* Species occurring also in the Martinez.

The numbers following specific names refer to the following localities marked on the map, fig. 3, p. 51:

Loc. 4 Martinez area in Simi Hills, Ventura County.

Loc. 5 Martinez area south of the Santa Monica Mountains, Los Angeles County.

Loc. 6 Tejon north of the secondary fault in the Simi Hills, Ventura County.

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TEJON (UPPER EOCENE) FOSSILS⁵⁵

All types and original specimens are in the Leland Stanford Jr. Univ. Paleontological Collection.

Cotypes of new species are in the museum of the California Academy of Sciences.

Loc. 6: Tejon north of the secondary fault in the Simi Hills, Ventura County.

Loc. 7: Tejon from south of the Santa Monica Mountains, Los Angeles County.

Loc. 8: Tejon from the McCray wells, Ventura County, Cal.

PELECYPODA

Cardita superioris, new species

Shell small, very convex; beaks large, incurved; anterior end deeply excavated under the beaks; margin broadly rounded; basal margin broadly curved; posterior obliquely and convexly truncated; cardinal margin sloping and slightly convex; shell slightly concave near the cardinal margin and flared; surface ornamented by about 23 broad, slightly rounded ribs which are broader than the interspaces. A few casts of this species were obtained from the upper beds. Locality 8, L. S. J. U. Pal. Coll.

⁵⁵ The author is greatly indebted to Messrs. R. B. Moran and J. O. Lewis, who kindly donated many of these fossils to the Stanford paleontological collection.

Cardium brewerii Gabb

Pl. 14, Fig. 9

C. brewerii Gabb, Pal. Cal., vol. 1, p. 173, pl. 24, fig. 155.

Shell moderate in size, subequilateral, altitude about equal to the length; beaks central, strongly incurved, hinge line straight. Anterior margin forms regular curve with base; posterior submargin rounded and forming angle with posterior cardinal margin above; umbonal ridges high and convex, posterior slightly concave; surface ornamented by about 24 uniform, subflattened ribs with flat interspaces; interspaces crossed by numerous squamose lines which are less prominent on the ribs. Locality 7, L. S. J. U. Pal. Coll.

Corbula dilatata, new species

Pl. 15, Fig. 2

C. parilis Arnold, U. S. G. S. Bull. 398, pl. 24, fig. 2.

"Shell small, thick, very convex, equivalve, somewhat inequilateral; beaks prominent, broad, strongly incurved and inclined forward. Anterior end sloping downwards; abruptly and regularly rounded below; posterior obliquely truncated and biangular; a distinct umbonal ridge passes from the beaks to the posterior angle in both valves. Basal margin of right valve regularly and broadly convex, straight on the left." Surface marked by prominent concentric band-like ribs, the upper edges of which are angulated. Locality 8, L. S. J. U. Pal. Coll.

This species differs from *C. parilis* Gabb⁵⁶ by not having any radiating sculpture. There is a big contrast also in the general outline and convexity of the shell.

Cucullæa morani Waring

Pl. 14, Figs. 12 and 13

C. morani Waring, Jour. Geol., vol. 22, no. 8, p. 784, Nov.-Dec., 1914.

Shell thick, oblique, very convex; beaks large, broad, prominent and about one-third the distance from the anterior, incurved and somewhat remote; area oval in shape and about two-thirds the length of the shell; anterior margin broadly

⁵⁶ Pal. Cal., vol. 1, p. 150, pl. 29, figs. 239-239a.

rounded and more prominent above; base nearly straight; posterior produced and sharply rounded; umbonal ridge prominent and running to posterior margin; cardinal margin sloping at an angle of about 45 degrees; surface marked by alternating single and double radiating ribs which are crossed by fine to coarse lines of growth. From one and one-half miles east of McCray wells. L. S. J. U. Pal. Coll. Named in honor of Mr. R. B. Moran of Los Angeles.

***Glycimeris maccrayi*, new species**

Pl. 15, Fig. 1

Shell small, of medium thickness and moderate convexity; umbone prominent, central, incurved; cardinal margin slightly convex and flared; anterior margin slightly produced above, broadly rounded below; basal margin broadly convex; posterior slightly produced above, broadly rounded below; surface marked by medium-size rounded, radiating ribs, which are crossed by lines of growth. Locality 8, L. S. J. U. Pal. Coll. This species has its closest resemblance in *Glycimeris veatchii* Gabb, of the Chico, but is less convex, and more symmetrical.

***Isocardia tejonensis* Waring**

Pl. 15, Fig. 14

I. tejonensis Waring, Jour. of Geol., vol. 22, no. 8, pp. 784-5, Nov.-Dec., 1914.

Shell of medium size, thin; valves equal, inflated, rotund, completely closed, margins plain, beaks prosogyrous; surface marked by concentric band-like ribs, which become fine and nearly obsolete on the beaks. Locality 8, L. S. J. U. Pal. Coll. No other species of *Isocardia* has so far been described from the Eocene of California.

***Marcia conradiana* (Gabb)**

Pl. 14, Fig. 3, Pl. 15, Fig. 7

Tapes conradiana Gabb, Pal. Cal., vol. 1, p. 169, pl. 32, fig. 282.

"Shell long, narrow, very inequilateral, oblique; beaks prominent and placed about a third the distance from the anterior

end; cardinal margin sloping nearly straight to the posterior extremity, which is narrowly and regularly rounded." Anterior cardinal margin slightly concave and sloping into the broadly convex anterior margin. "Surface ornamented by regular concentric ribs, nearly uniform throughout." Some worn specimens lose these ribs entirely. Found at Locality 6, the figured specimen from the Tejon at Ft. Tejon. L. S. J. U. Pal. Coll.

***Meretrix hornii* Gabb**

Pl. 15, Figs. 9 and 19

M. hornii Gabb, Pal. Cal., vol. 1, p. 164; vol. 2, pl. 23, fig. 144.

"Shell subtrigonal, cuneate; beaks anterior, with the cardinal margin sloping convexly to the posterior end, which is narrow; anterior end prominent above, and curving inwards rapidly below towards the base; lunule small, very narrow, acute below and impressed." Surface marked by prominent, large, band-like concentric ribs with linear interspaces. Locality 6, L. S. J. U. Pal. Coll.

***Pinna lewisi* Waring**

Pl. 15, Fig. 24

Shell thin, pearly, mytiliform, equivalve, truncate and wholly open behind; hinge line long; valves triangular, the apical angle being about 45 degrees; convex along the center line and flaring at the margins; base of shell notched in the middle and convex on either side; surface marked by five indistinct radiating ribs and concentric lines of growth. Locality 8, L. S. J. U. Pal. Coll.

Named in honor of Mr. J. O. Lewis. Differs from *Pinna barrowsi* Dickerson of the Martinez formation by having a wider apical angle and fewer radiating ribs.

***Solen parallelus* Gabb**

S. parallelus Gabb, Pal. Cal., vol. 1, p. 146, pl. 22, fig. 117.

"Shell elongated, slender, thin; sides parallel, ends rounded; anterior end somewhat more abruptly truncated than the pos-

terior, and slightly deflected. Surface marked by a few irregular lines of growth." Parts of a few large specimens of this species were found. Locality 7.

***Venericardia planicosta hornii* (Gabb)**

Pl. 11, Figs. 3, 4, and 5

Cardita hornii Gabb, Pal. Cal., vol. 1, p. 174, pl. 24, fig. 157, 1864.

V. planicosta Arnold & Anderson, U. S. G. S. Bull. 322, pl. 13, fig. 4.

V. planicosta Arnold, U. S. G. S. Bull. 321, pl. 9, fig. 3.

V. planicosta Arnold & Eldridge, U. S. G. S. Bull. 309, pl. 25, figs. 1, 1a, and 1b.

V. planicosta Arnold & Anderson, U. S. G. S. Bull. 398, pl. 24, fig. 1.

Shell large, thick, cordate, deeply convex; length greater than the altitude; beaks large, turned forward, nearly touching; lunule large; anterior cardinal margin deeply excavated in front of the beaks, slightly convex and about twice as long as in *V. planicosta venturensis*; anterior margin convex and flared; posterior margin convexly truncated; surface ornamented with about 22 broad, rounded ribs which become very broad, and almost obsolete near the margins in the adult; interspaces shallow, linear; surface marked by wrinkled lines of growth. Locality 8, L. S. J. U. Pal. Coll. Only sandstone casts of this species were found.

This subspecies, for so long called *V. planicosta* Lam. by Pacific Coast geologists, certainly deserves at least subspecific rank. In our California Eocene there are, no doubt, three distinct forms of *Venericardia*. The young, pl. 11, fig. 5, shows the characteristic knotted ribs of the young stages of *V. planicosta hornii*. The ribs are fine, hair-like, with deep interspaces; they are mounted by rows of tubercles until they attain a height of about 14 mm., after which they are abruptly rounded.

This subspecies is distinguished chiefly by the flaring margins, broad, flat ribs, linear interspaces, and by the greater length as compared with the height. It grows to be much

larger than any specimens of *V. planicosta venturensis* that have been found. It has been found only in the Tejon formation of the Pacific Coast and is a characteristic horizon marker.

Introduced here for comparison are figures of *V. planicosta ionensis*,⁵⁷ pl. 11, figs. 1 and 2. This species is from the Umpqua beds, a higher horizon than that of *V. planicosta hornii*, and represents a later development in the evolutionary series. The young form exhibits the same type of ribs as *V. planicosta hornii* and at a height of about 10 mm. the ribs are abruptly of a rounded type, while at an elevation of 25 mm. the ribs are obsolete.

Specimens, probably of this same horizon, have been collected by J. E. Mills from the left bank of Merced River near Merced Falls, Cal., from the upper Tejon.

Comparing these with eastern species it will be seen that *V. planicosta hornii* corresponds very well with *V. planicosta regia* Conrad, of the Aquia and Lower Chickasawan. *V. planicosta ionensis* and the *Venericardia* from Merced Falls correspond to a horizon similar to *V. planicosta* Lam.⁵⁸ and *V. planicosta* var. δ from Wood's Bluff,⁵⁹ Alabama, of the Nanjemoy, Upper Chickasawan and Lower Claibornian; also to *V. marylandica* and *V. potapacoensis* of Harris⁶⁰; also *V. planicosta latiscardo*⁶¹ of England.

Since this manuscript was prepared, this subspecies has been described by the writer.⁶² The figured specimen with the ribs showing on the umbone is characteristic of the Ione formation. The form described by Mr. Dickerson from the Roseburg Quadrangle, Oregon⁶³ as *V. planicosta merriami* has not been found in the Ione of California. It is possible that the beds at the Oregon locality range a little higher than the Ione of California, which accounts for the presence of specimens with totally obsolete ribs. When *V. planicosta* reaches this extreme stage in its evolution, it may be well to consider it a new species.

⁵⁷ These specimens were collected by Mr. Harold Hannibal in the Eocene of Washington.

⁵⁸ Harris, Bull. 9, Am. Pal., p. 54, pl. 16, figs. 1-4.

⁵⁹ Harris, Bull. 9, Am. Pal., p. 54, pl. 16, fig. 5.

⁶⁰ Mary. Geol. Surv., Eocene, pp. 178-9, pl. 11, figs. 4-7.

⁶¹ Dall, Florida Tertiary, vol. 6, pp. 1420-1422.

⁶² Jour. Geol., vol. 22, No. 8, Nov.-Dec. 12, 1914, p. 785.

⁶³ Cal. Acad. Sci., vol. 4, p. 118, pl. 11, fig. 1a. Dec. 30, 1914.

GASTEROPODA

Surcula (?) species

Pl. 15, Fig. 16

Cf. *Surcula davisiana* Cooper, Bull. Univ. of Cal., vol. 7, p. 279, pl. 12, figs. 6a and 6b, 1913.

Nuclear whorls and canal broken off. Spire of medium height; center of whorls sharply angulated, concave above and marked by fine spiral lines; body whorl concave immediately below to a wide rounded rib, which is covered by the succeeding whorls; lower part of body whorl slightly concave and tapering into the canal; aperture broad and angulated above, narrow below. Locality 8, L. S. J. U. Pal. Coll.

Fasciolaria chatsworthensis, new species

Pl. 14, Fig. 16

Shell large, solid, seven whorls; nucleus small; whorls all broadly convex, smooth, or covered with minute, almost megascopic spiral lines, and by lines of growth; suture linear, faintly impressed; canal rather short, with a strong siphonal fasciole; aperture elongated, acute behind; outer lip simple; pillar twisted. From one and one-half miles east of McCray Wells, Ventura County. L. S. J. U. Pal. Coll.

Lyria andersoni, new species

Pl. 15, Fig. 12

Shell subfusiform, eight-whorled; first whorls nuclear; spiral sculpture covering entire shell save protoconch; transverse sculpture of eight prominent, transverse folds extending entire height of whorls; abruptly truncated above and gradually impressed below; aperture long and narrow, outer lip slightly in advance of a transverse fold; inner lip with wash of callous and three or four plaits; canal slightly turned backward and notched; a spiral fold on the canal represents the former positions of the notch. This species does not develop tubercles on the whorls as does *Cancellaria irelaniana* Cooper. Locality 8, L. S. J. U. Pal. Coll.

Probably Arnold's⁶⁴ *Cancellaria irelaniana* belongs to this genus.

Arnold's species is neither *C. irelaniana* Cooper, Cal. State Min. Bur. Bull. no. 4, p. 42, pl. 1, fig. 5, nor *C. irelaniana* Cooper, Bull. Dept. of Geol. Univ. of Cal., vol. 7, p. 282, pl. 12, fig. 8.

This new species is named in honor of Mr. Robert Anderson, formerly with the U. S. Geol. Survey.

Rimella canalifera (Gabb)

Pl. 15, Fig. 10

Rostellaria (*Rimella*) *canalifera* Gabb, Pal. Cal., vol. 1, p. 123, pl. 29, fig. 228, 1864.

Shell small, somewhat fusiform; spire elevated, longer than the mouth; suture deep; whorls convex, and marked by from 15 to 20 transverse folds, which become more prominent and projecting on the large whorls; entire surface also ornamented by revolving rounded band-like ribs with linear interspaces; aperture long, rather narrow, oblique, acute behind and broadly and obliquely emarginate in front; posterior angle of aperture continued in a deep narrow callous canal, slightly curved along the spire to the apex; anterior canal broad and strongly curved upwards; outer lip thick; inner lip callous. Locality 8, L. S. J. U. Pal. Coll.

Stellaxis cognata (Conrad)

Solarium cognatum Conrad.

Architectonica cognata Gabb, Pal. Cal., vol. 1, p. 117, pl. 20, fig. 72, 1864.

"Shell low, conical; whorls five, flat or slightly convex and sloping above, acutely carinate on the margin. Mouth quadrangular, oblique. Surface marked by oblique lines of growth and faint revolving lines, sometimes obsolete. Near the margin on the upper surface, is a prominent isolated rib." Locality 8, L. S. J. U. Pal. Coll.

⁶⁴ *Cancellaria irelaniana* (Cooper), Arnold; Bull. 398, U. S. Geol. Surv., p. 286, pl. 26, fig. 22.

Sinum obliquum (Gabb)

Naticina obliqua Gabb, Pal. Cal., vol. 1, p. 109, pl. 21, fig. 112, 1864.

Shell medium-size, auriform; spire slightly prominent, whorls four, rapidly increasing in size; suture faintly canaliculate; surface marked by numerous compound revolving lines, minutely waved laterally and showing a tendency to an alternation of larger and smaller ones; these are crossed by irregular lines of growth, which completely encircle the whorls, and are most distinct and crowded in the umbilicus; aperture patulous, acute behind; inner lip slightly thickened, and forming a small incrustation on the preceding whorl; umbilicus moderate in size. Locality 8, L. S. J. U. Pal. Coll.

Tornatina evoluta, new species

Pl. 15, Fig. 8

Form cylindrical, whorls four, rapidly increasing in height; spire low, suture excavated; aperture narrow, widening and produced below; lips simple; shell thin and marked by fine lines of growth. Locality 8, L. S. J. U. Pal. Coll.

Turritella andersoni, Dickerson

Pl. 15, Fig. 18

T. andersoni Dickerson, Bull. Dept. Geol. Univ. Cal., vol. 9, p. 501, pl. 42, 1916.

Shell turreted, apical angle small; whorls slightly concave, straight or slightly convex above, somewhat angulated and obliquely truncated below; suture linear; surface marked by fine spiral linear ribs. Locality 8, L. S. J. U. Pal. Coll.

Turritella infragranulata Gabb

Pl. 15, Fig. 20

T. infragranulata Gabb, Pal. Cal., vol. 1, p. 212, pl. 32, fig. 279, 1864.

Not *T. infragranulata* (Gabb) Stanton, U. S. G. S., 17th An. Rept., pt. 1, p. 1044, pl. 66, fig. 3.

"Shell elongated, tapering, scaliform; whorls numerous, sloping, straight, or somewhat concavely outwards above, angulated and obliquely truncated below"; suture impressed and carinated by a small tubercular spiral rib. "Surface marked by numerous fine, revolving thread-like lines, sometimes alternating in size, and on the angle near the lower margin of the whorl, by coarse granulations. Aperture subquadrate." Locality 8, L. S. J. U. Pal. Coll.

The apical angle of this species is much smaller than that figured by Stanton as *T. infragranulata*. His specimen was probably of the species *T. simiensis*, new species.

***Turritella martinezensis* Gabb**

Pl. 14, Fig. 5

T. martinezensis Gabb, Pal. Cal., vol. 2, p. 169, pl. 28, fig. 51.

Shell robust, apical angle broad; whorls 11, angulated, flat above and below the angle; body whorl with two angles, the lower less prominent and covered, during growth, by outer whorl; surface marked by three strong lines on the upper face, one between the revolving angles, and three below; besides there are fine revolving lines, and faint striae of growth covering them all; aperture broad, outer lip slightly sinuous; inner lip flattened and somewhat twisted. Localities 6, 7, and 8, L. S. J. U. Pal. Coll.

This species also occurs in the Martinez horizon at Martinez.

***Turritella uvasana* Conrad**

Pl. 15, Fig. 13

T. uvasana Conrad, Pac. R. R. Rept., vol. 5, p. 321, pl. 2, fig. 12; Gabb, Pal. Cal., vol. 1, p. 134, pl. 21, fig. 92; Arnold, U. S. G. S. Bull. 398, p. 285, pl. 26, fig. 11.

"Shell moderate in size, turreted, apical angle small; whorls numerous and gradually increase in size, convex and ornamented by from 6 to 10 revolving, rounded ribs, with sometimes finer ones interpolated. Suture impressed. Aperture circular. Locality 8, L. S. J. U. Pal. Coll.

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PLATE 7.

CHICO (UPPER CRETACEOUS) FOSSILS.

(Unless otherwise stated, all figures are natural size.)

- | | |
|---|------------|
| <i>Pecten (Propeamusium) cowperi</i> , new species. | PAGE
63 |
| Fig. 1. Mould of interior of left valve; alt. 19 mm. | |
| Fig. 2. Mould of interior of right valve; long. 24 mm. | |
| This species is characteristic of the upper transitional zone of the Chico. Loc. 2, L. S. J. U. Pal. Coll. | |
| | |
| <i>Crassatellites conradianus</i> (Gabb). | 56 |
| Fig. 3. Exterior of left valve $\times \frac{2}{3}$; long. 40 mm., alt. 29 mm. | |
| Fig. 4. Exterior of right valve $\times \frac{2}{3}$; long. 36 mm., alt. 29 mm. Loc. 3, L. S. J. U. Pal. Coll. | |
| | |
| <i>Nemodon (Arca) breweriana</i> (Gabb). | 57 |
| Fig. 5. Cast of exterior mould of right valve $\times \frac{2}{3}$ that has been somewhat crushed; long. 32 mm., alt. 14 mm. Uppermost Chico. | |
| Fig. 6. Exterior of left valve $\times \frac{2}{3}$; long. 24 mm., alt. 17 mm. Loc. 2, L. S. J. U. Pal. Coll. | |
| | |
| <i>Inoceramus pembertoni</i> , new species. | 61 |
| Fig. 7. Exterior of right valve $\times \frac{1}{2}$; alt. 217 mm., width 160 mm. | |
| Fig. 8. Exterior of left valve $\times \frac{1}{2}$. Same dimensions as Fig. 7. Loc. 3, L. S. J. U. Pal. Coll. | |



PLATE 8.

CHICO (UPPER CRETACEOUS) FOSSILS.

(Unless otherwise stated, all figures are natural size.)

	PAGE
<i>Macrocallista cordata</i> , new species.	62
Fig. 1. Exterior of left valve; long. 39 mm., alt. 31 mm. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Glycimeris veatchii</i> Gabb.	61
Fig. 2. Small left valve; long. 25 mm., alt. 25 mm. Loc. 3.	
Fig. 7. Large right valve; long. 76 mm., alt. 76 mm. Loc. 3.	
Fig. 8. Large left valve; long. 65 mm., alt. 68 mm. Loc. 3, L. S. J. U. Pal. Coll.	
<i>Isocardia chicoensis</i> , new species.	62
Fig. 3. Left valve; long. 32 mm., alt. 38 mm. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Crassatellites tuscanus</i> Gabb.	59
Fig. 4. Left valve; long. 43 mm., alt. 29 mm. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Dosinia milthoidea</i> , new species.	60
Fig. 5. Left valve; long. 29 mm., alt. 30 mm. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Trigonia evansana</i> Meek.	65
Fig. 6. Right valve; width 40 mm. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Inoceramus whitneyi</i> Gabb.	62
Fig. 9. Left valve; length 45 mm., width 35 mm. Loc. 3, L. S. J. U. Pal. Coll.	
<i>Crassatellites uvasana</i> Gabb.	57
Fig. 10. Right valve, small specimen, $\times \frac{2}{3}$; length 25 mm. Loc. 3, L. S. J. U. Pal. Coll.	
<i>Macra gabbiana</i> Anderson.	63
Fig. 11. Left valve; long. 27 mm. Loc. 3, L. S. J. U. Pal. Coll.	
<i>Cucullæa youngi</i> , new species.	59
Fig. 12. Large right valve, $\times \frac{2}{3}$; long. 80 mm., alt. 75 mm. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Chione varians</i> Gabb.	56
Fig. 13. Right valve; long. 40 mm., alt. 32 mm. Loc. 3, L. S. J. U. Pal. Coll.	

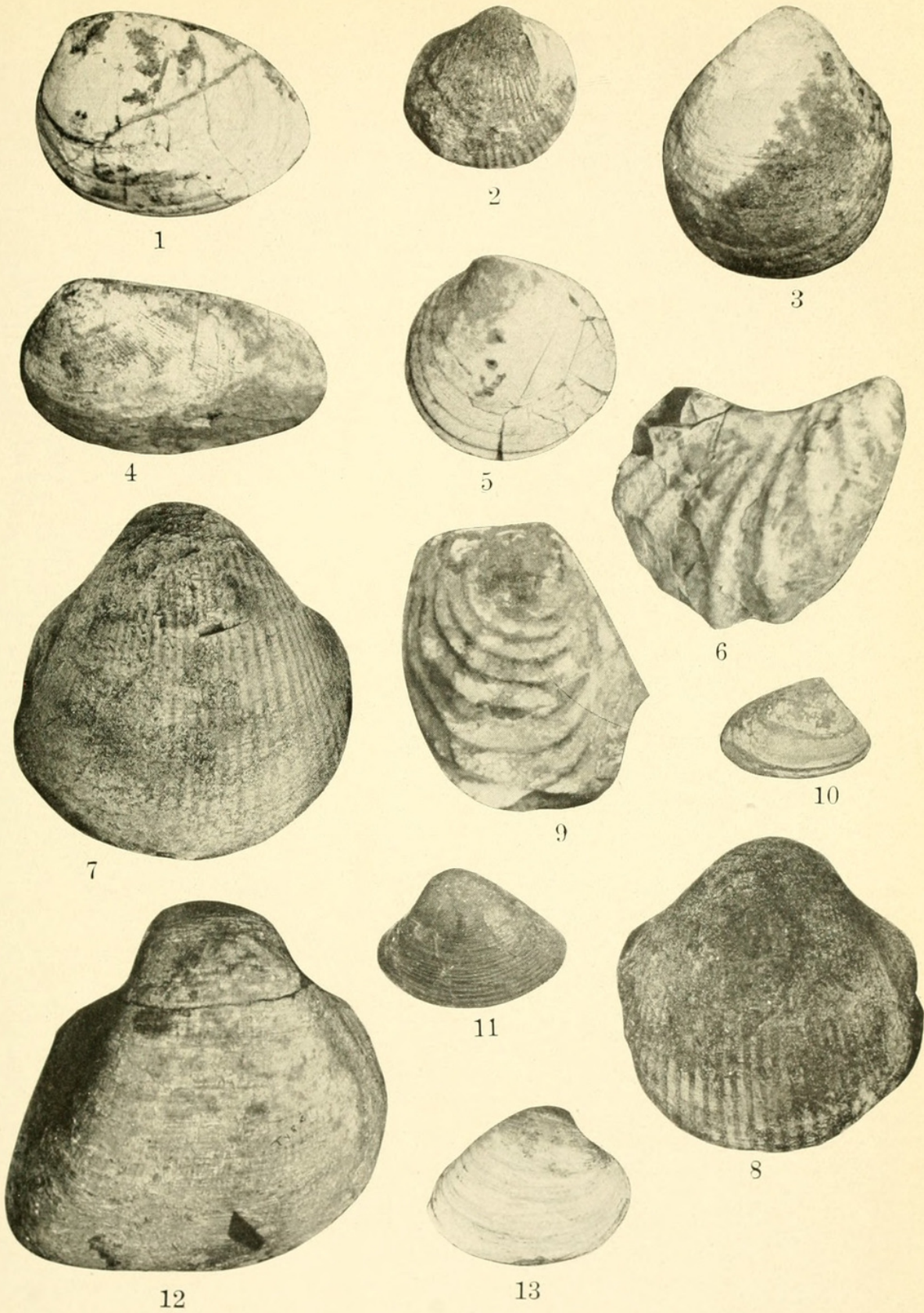


PLATE 9.

CHICO (UPPER CRETACEOUS) FOSSILS.

(Unless otherwise stated, all figures are natural size.)

	PAGE
<i>Crassatellites triangulatus</i> , new species.	59
Fig. 1. Large right valve; long. 40 mm., alt. 32 mm. Loc. 3, L. S. J. U. Pal. Coll.	
<i>Cinulia obliqua</i> Gabb.	66
Fig. 2. Back and top of average size specimen. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Turris plicata</i> , new species.	68
Fig. 3. Back of imperfect specimen. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Pinna calamitoides</i> Shumard.	64
Fig. 4. Inside cast showing cross ribbing. Loc. 3, L. S. J. U. Pal. Coll.	
<i>Cancellaria crassa</i> , new species.	66
Fig. 5. Back view; alt. 22 mm. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Gyrodes compressus</i> , new species.	67
Fig. 6. Back and top of average size specimen; alt. 17 mm., greatest diameter 18 mm. Loc. 1, L. S. J. U. Pal. Coll.	
<i>Gyrodes canadensis</i> Whiteaves.	66
Fig. 7. Top and part of side; greatest diameter 17 mm. Loc. 1, L. S. J. U. Pal. Coll.	
<i>Rostellites gabbi</i> White.	68
Fig. 8. Front of imperfect specimen. Loc. 1, L. S. J. U. Pal. Coll.	
<i>Amauropsis oviformis</i> Gabb.	65
Fig. 9. Back view. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Pugnellus rotundus</i> , new species.	67
Fig. 10. Inside cast of imperfect specimen. Loc. 3, L. S. J. U. Pal. Coll.	
<i>Baculites chicoensis</i> Trask.	69
Fig. 11. Side of imperfect specimen showing septæ. Loc. 1, L. S. J. U. Pal. Coll.	
<i>Turritella chicoensis</i> Gabb.	69
Fig. 12. Three whorls of a large specimen. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Amphiura lymani</i> , new species.	58
Fig. 13. Impression in hard shale. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Scutella</i> (?), species.	58
Fig. 14. Top of imperfect specimen. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Hauericeras transitionale</i> , new species.	69
Fig. 15. Side of broken specimen. Loc. 2, L. S. J. U. Pal. Coll.	
<i>Placenticerus californicum</i> Anderson.	70
Fig. 16. Adult specimen, $\times \frac{2}{3}$. Loc. 3, L. S. J. U. Pal. Coll.	
Fig. 17. Young specimen, $\times \frac{2}{3}$. Loc. 3, L. S. J. U. Pal. Coll.	
<i>Placenticerus pacificum</i> Smith.	70
Fig. 18. Adult specimen, $\times \frac{2}{3}$. Loc. 3, L. S. J. U. Pal. Coll.	
Fig. 19. Young specimen, $\times \frac{2}{3}$. Loc. 3, L. S. J. U. Pal. Coll.	
<i>Placenticerus sanctæmonicæ</i> , new species.	70
Fig. 20. Adult specimen, $\times \frac{2}{3}$. Loc. 3, L. S. J. U. Pal. Coll.	
Fig. 21. Young specimen, $\times \frac{2}{3}$. Loc. 3, L. S. J. U. Pal. Coll.	
This species is intermediate between <i>P. pacificum</i> and <i>P. californicum</i> .	
<i>Solariaxis templetoni</i> , new species.	68
Fig. 22. Front of specimen. Loc. 2, L. S. J. U. Pal. Coll.	

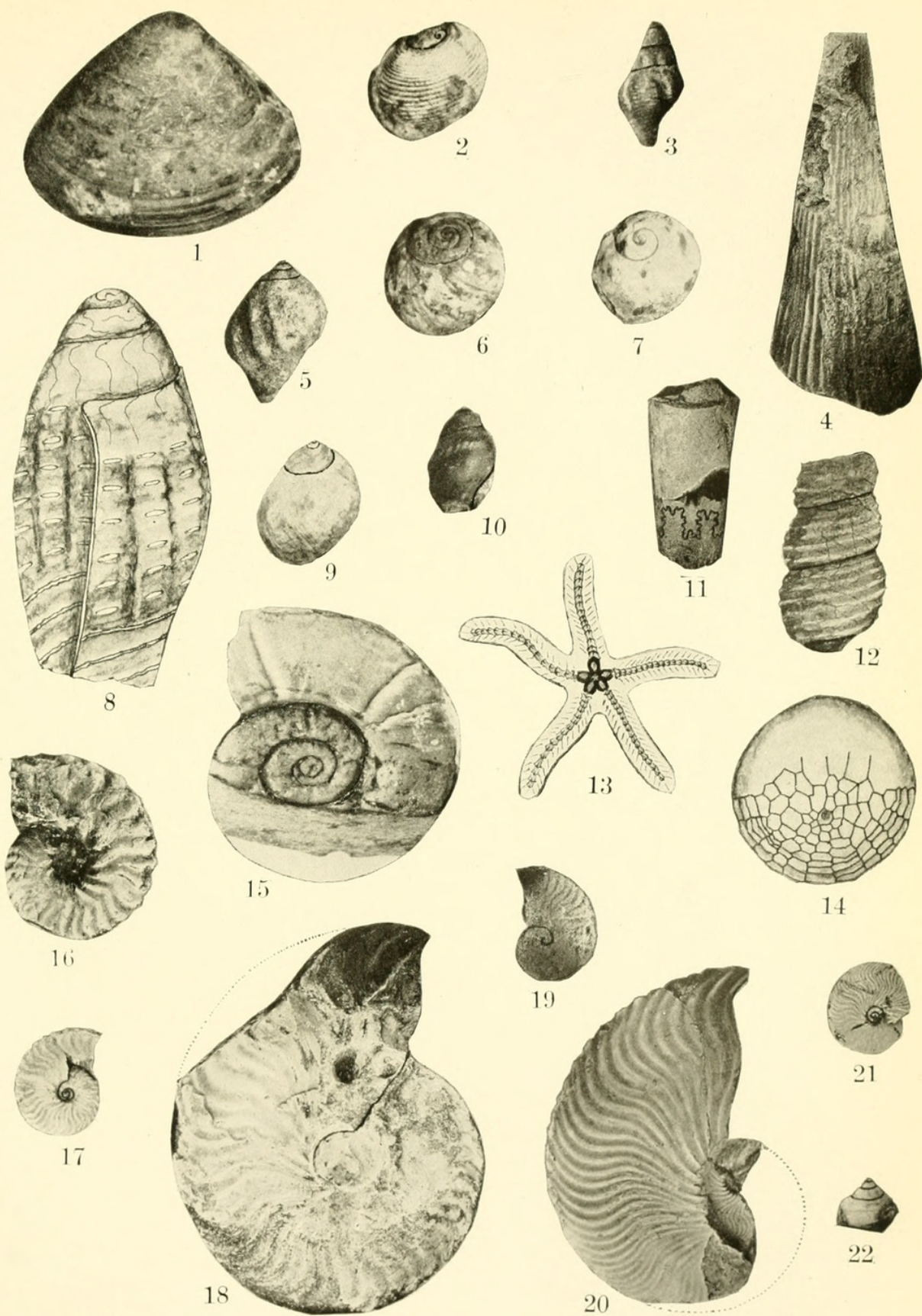


PLATE 10.

MARTINEZ (LOWER EOCENE) FOSSILS.

(Unless otherwise stated, all figures are natural size.)

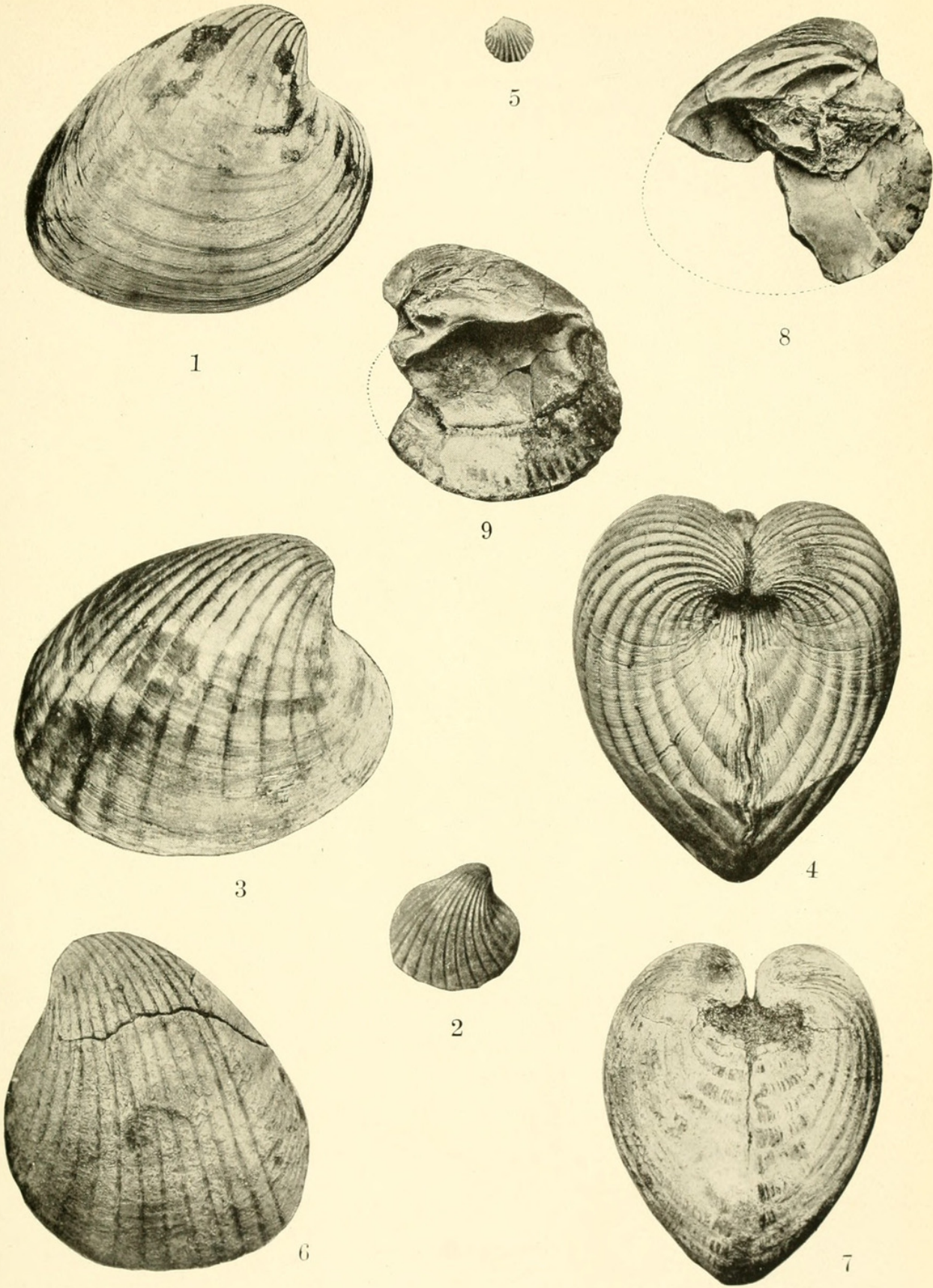
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|--|------|
| <i>Lima perrini</i> Waring. | 76 |
| Fig. 1. Right valve, $\times \frac{2}{3}$; alt. 170 mm., long. 160 mm. Loc. 4, L. S. J. U. Pal. Coll. | |
| Fig. 1A. Cross section of shell, $\times 2$, showing arrangement of nacreous and outer prismatic layers. Loc. 4, L. S. J. U. Pal. Coll. | |
| Fig. 2. Inside cast of left valve, $\times \frac{2}{3}$. Loc. 4, L. S. J. U. Pal. Coll. | |
| <i>Glycimeris veatchi major</i> Stanton. | 75 |
| Fig. 3. Right valve of small specimen, $\times \frac{2}{3}$. Loc. 4, L. S. J. U. Pal. Coll. | |
| Fig. 4. Left valve of small specimen, $\times \frac{2}{3}$. Loc. 4, L. S. J. U. Pal. Coll. | |



PLATE 11.

(Unless otherwise stated, all figures are natural size.)

- | | |
|--|------|
| | PAGE |
| <i>Venericardia planicosta ionensis</i> Waring. | 96 |
| Fig. 1. Right valve, $\times \frac{1}{2}$. From Umpqua formation (Upper Tejon), Umpqua Valley, Oregon. This same variety is found in the lone at Merced Falls, California. L. S. J. U. Pal. Coll. | |
| Fig. 2. Young specimen showing change in ribbing. Same locality. L. S. J. U. Pal. Coll. | |
| <i>Venericardia planicosta hornii</i> Gabb. | 95 |
| Fig. 3. Exterior of right valve, $\times \frac{1}{2}$. | |
| Fig. 4. Anterior view of both valves, $\times \frac{1}{2}$, from Olequa formation, Little Falls, Washington. Lower margin of valves water-worn. | |
| Fig. 5. Young specimen. | |
| This species is introduced here for comparison. It is characteristic of the Chehalis and Olequa formations (Tejon Group), Washington, and of the Tejon of California. | |
| <i>Venericardia planicosta venturensis</i> , new subspecies. | 80 |
| Fig. 6. Exterior of left valve, $\times \frac{1}{2}$. | |
| Fig. 7. Anterior view of both valves, $\times \frac{1}{2}$. | |
| Fig. 8. Inside of left valve, $\times \frac{1}{2}$, showing hinge. | |
| Fig. 9. Inside of right valve, $\times \frac{1}{2}$, showing hinge and muscle impressions. | |
| This species is characteristic of the Martinez formation. All four specimens are from Loc. 4, L. S. J. U. Pal. Coll. | |





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