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NEW AND CHARACTERISTIC SPECIES OF FOSSIL MOLLUSKS FROM THE OIL-BEARING TERTIARY FORMATIONS OF SANTA BARBARA COUNTY, CALIFORNIA

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INTRODUCTION

During an examination of the Santa Maria and Summerland oil districts, Santa Barbara County, California, by the writer, assisted by Robert Anderson and H. R. Johnson, in the summer of 1906, fossils were found representative of several geological horizons in the Tertiary. Many of these are well known or previously described species, but some of them are new forms. In the following paper several of the new forms are described and figured; while a few of those previously described are simply figured, and a brief note concerning their occurrence is inserted in the explanation accompanying each drawing. It has been deemed advisable to insert figures of the old species in this paper because the descriptions and illustrations of these forms are in publications inaccessible to most readers, and it is essential for the proper identification of the faunas that certain of the old species be known. The differentiation of the various geologic formations in the southern coast ranges of California depends almost entirely upon their paleontology, so that it has been the aim of the writer to give in this paper some of those species which will aid in the determination of the horizon of the various faunas found in that region. These fossils, together with some others, will be figured on plates IX to XVII, Bulletin 321, and plates XII to XXVI, Bulletin 322, U. S. Geological Survey.

The new Eocene forms, *Turritella (martinezensis)* Gabb, var. ?), *lompocensis*, and *Pecten yneziana*, are from the brownish sandstone of the Tejon formation which makes up a considerable portion of the Santa Ynez Range south of Lompoc and Santa Ynez. Within this formation in the territory mentioned are found the following fossils:

LIST OF EOCENE (TEJON FORMATION) FOSSILS FROM WESTERN END OF SANTA YNEZ RANGE

(Those marked "a" are found at locality No. 4507, just above the San Julian ranch house about 10 miles southeast of Lompoc, the type locality of *Pecten yneziana*; those marked "b" are found at locality No. 4509, a float boulder found in sharp turn in road in San Miguelito Canyon, 4½ miles southwest of Lompoc, the type locality of *Turritella (martinezensis)* Gabb, var. ?) *lompocensis*.)

- Cardium breweri* Gabb a.
- Codakia* (?) species a.
- Conus* cf. *hornii* Gabb.
- Crassatellites collina* Conrad a b.
- Dosinia elevata* Gabb a.
- Fusus occidentalis* Gabb a.
- Ficus mammillatus* Gabb a.
- Glycymeris* cf. *veatchii* Gabb, var. *major* Stanton a b.
- Maetra* cf. *uvasana* Conrad.
- Meretrix uvasana* Conrad a.
- Meretrix*, species.
- Neverita* ? species.
- Nucula truncata* Gabb.
- Ostrea idriensis* Gabb a.
- Pecten (Chlamys) yneziana*, new species a b.
- Phacoides cumulata* Gabb.
- Phacoides (Miltha?)*, species a.
- Tellina* (?), species.
- Turritella (martinezensis)* Gabb, var. ?) *lompocensis*, new variety a.
- Turritella uvasana* Conrad a.
- Venericardia planicosta* Lamarck a.

The lower Miocene or Vaqueros formation is stratigraphically above, but closely associated with, the Tejon, and consists largely of coarse conglomerate and sandstone, with some associated limestone near the top. The new species, *Purpura vaquerosensis*, *Pecten van-velecki*, and *Modiolus ynezianus*, are from the sandstone portion. Associated with the above forms in the Vaqueros formation, in the western end of the Santa Ynez Range, are the following species:

LIST OF LOWER MIOCENE (VAQUEROS FORMATION) FOSSILS FROM WESTERN END OF SANTA YNEZ RANGE

(Those marked "a" are from locality No. 4504, three-fourths of a mile up ridge northeast of San Julian ranch house, 10 miles southeast of Lompoc, the type locality of *Modiolus ynczianus*; those marked "b" are from locality No. 4478, 2 miles south of Santa Ynez, on knoll just east of mouth of Ballard Canyon, the type locality of *Pecten vanvlecki*.)

- Balanus* cf. *costellanus* Conrad.
Cardium aff. *quadrigenerium* Conrad ^a.
Chione cf. *mathewsonii* Gabb.
Conus, species.
Crassatellites, species.
Mcretrix (?) species.
Modiolus ynczianus, new species ^a.
Mytilus cf. *mathewsonii* Gabb.
Ostrea eldridgei Arnold ^{a b}.
Ostrea, new species, near *titan* Conrad ^a.
Pecten (*Pecten*) *vanvlecki*, new species ^b.
Pecten (*Lyropecten*) *bowersi* Arnold.
Pecten (*Lyropecten*) *crassicardo* Conrad.
Pecten (*Amusium*) *lompocensis* Arnold.
Pecten (*Lyropecten*) *magnolia* Conrad ^{a b}.
Pecten (*Chlamys*) *sespeensis*, var. *hydei* Arnold ^b.
Purpura vaquerosensis, new species.
Solen, species.
Terebratalia kennedyi Dall.
Turritella, species indeterminate.
Turritella ineziana Conrad.
Turritella variata Conrad (young).

The Fernando formation in the Santa Maria district is widespread, and consists largely of soft shale, sandstone, and more or less incoherent conglomerate, usually resting unconformably above the Monterey or middle Miocene shale. The most fossiliferous localities appear to represent a fauna of lower Pliocene age, although the formation as a whole is believed to extend down into the upper Miocene and upward into the Pleistocene.

The following new species and varieties are described from the Fernando formation in the Santa Maria district, all of the localities being north of the Santa Ynez River:

LIST OF NEW SPECIES AND VARIETIES OF FOSSILS FROM THE FERNANDO FORMATION (LARGELY LOWER PLIOCENE), SANTA MARIA DISTRICT

- Lymnaea alamosensis*, new species.
Drillia graciosa, new species.
Drillia waldorfensis, new species.
Bathytoma carpenteriana Gabb, var. *fernandoana*, new variety.

- Cancellaria cratfordiana* Dall, var. *fugleri*, new variety.
Nassa waldorfensis, new species.
Ocenebra micheli Ford, var. *waldorfensis*, new variety.
Leda orcutti, new species.
Phacoides nuttallii Conrad, var. *anteccdens*, new variety.
Spisula catilliformis Conrad, var. *alcatrazensis*, new variety.
Spisula sisquocensis, new species.

Associated with these at the various localities are the following (mostly previously described) species:

PARTIAL LIST OF FERNANDO (UPPER MIOCENE-PLIOCENE-PLEISTOCENE) FOSSILS
 FROM THE SANTA MARIA DISTRICT

- Actæon*, species.
Amphissa (?) species.
Angulus, species.
Arca, species a.
Arca, species indeterminate.
Arca trilincata Conrad.
Astyris richthofeni Gabb.
Balanus cf. *convexus* Bronn.
Bathytoma cf. *tryoniana* Gabb.
Bittium, new species a.
Bittium, new species c.
Cadulus fusiformis Sharp and Pilsbry.
Calliostoma, species indeterminate.
Callista subdiaphana Carpenter.
Cancellaria, species.
Cardium mceckianum Gabb.
Cardium, species indeterminate.
Chione, species.
Chlorostoma (?) species.
Chrysodomus, species.
Cliidiophora punctata Carpenter.
Crepidula princeps Conrad.
Crucibulum spinosum Sowerby.
Cryptomya ovalis Conrad.
Cumingia californica Conrad.
Dosinia ponderosa Gray.
Drillia johnsoni Arnold.
Echinarachnius ashleyi Merriam.
Echinarachnius cf. *excentricus* Eschscholtz, var. a.
Fusus, species a.
Fusus, species b.
Galerus inornatus Gabb.
Glycymeris cf. *barbarensis* Conrad.
Kennerlia (?) species.
Leda taphria Dall.
Lucapina cf. *crenulata* Sowerby.
Lunatia lewisii Gould.

- Macoma nasuta* Conrad.
Macoma, species.
Macoma cf. *secta* Conrad.
Mactra, species.
Mioplaciona oregonensis Dall.
Modiolus rectus Conrad.
Monia macroschisma Deshayes.
Muricidca, species.
Mya truncata Linné.
Mytilus, species indeterminate.
Nassa californiana Conrad.
Natica clausa Broderip and Sowerby.
Nezucrita reclusiana Petit.
Ocenebra lurida Middendorf.
Olivella biplicata Sowerby.
Olivella cf. *intorta* Carpenter.
Opalia anomala Stearns.
Opalia varicostata Stearns.
Ostrea veatchii Gabb.
Ostrea possibly *veatchii* Gabb.
Panomya cf. *ampla* Dall.
Panopea generosa Gould.
Pecten (*Plagiocentrum*) near *cerrosensis* Gabb.
Pecten (*Patinopecten*) *haleyi* Arnold.
Pecten (*Pecten*) *hemphilli* Dall.
Pecten (*Chlamys*) *lawsoni* Arnold.
Pecten (*Patinopecten*) *oweni* Arnold.
Pecten (*Pecten*) *stearnsii* Dall.
Pecten (*Chlamys*) *zattsi* Arnold.
Phacoides annulatus Reeve.
Phacoides intensus Dall.
Pholadidea ovoidca Conrad.
Pholadidea (?) species indeterminate.
Platyodon cancellatus Conrad, var. ^a.
Pleurotoma (*Borsonia*), species ^a.
Pleurotoma, species.
Priene oregonensis Redfield, var. *angelensis* Arnold (?)
Priene oregonensis Redfield (young).
Purpura crispata Chemnitz.
Saxidomus gracilis Gould.
Saxidomus (?) species ^a.
Scala, species ^a.
Sigaretus debilis Gould.
Siliqua cf. *cdentula* Gabb.
Solen cf. *sicarius* Gould.
Tapes cf. *lacinata* Carpenter.
Tapes staleyi Gabb.
Tapes tenerrima Carpenter.
Tellina, species.
Tellina aff. *bodcgensis* Hinds.
Terebratalia occidentalis Dall.

Thalotia coffea Gabb.
Thracia cf. *trapezoides* Conrad.
Thyasira aff. *gouldii* Philippi.
Tresus nuttallii Conrad.
Tritonium, species indeterminate.
Trochita radians Lamarck.
Trochita, species indeterminate.
Turritella cooperi Carpenter.
Venericardia californica Dall.

The Fernando formation in the vicinity of Santa Barbara consists of a series of conglomerate, sandstone, shale, and marl. The fossiliferous layers are largely sandstone and sandy marl (some of the latter made up almost entirely of bryozoan remains), and represent the Pliocene or possibly the lowest Pleistocene. The following new species and varieties are from the Fernando bryozoan marl at the bath-house beach, Santa Barbara:

Mitramorpha filosa Carpenter, var. *barbarensis*, new variety.
Puncturella delosi, new species.
Venericardia yatesi, new species.
Psephidia barbarensis, new species.

Associated with the above in the same locality are the following previously described or questionable species:

PARTIAL LIST OF FERNANDO (PLIOCENE OR LOWEST PLEISTOCENE) FOSSILS FROM
 BATH-HOUSE BEACH, SANTA BARBARA

Acmæa insessa Hinds.
Admete gracilior Carpenter.
Amphissa corrugata Reeve.
Balanus concavus Bronn.
Bela fidicula Gould.
Bittium barbarensis Bartsch.
Bittium catalincensis Bartsch.
Bryozoa, species.
Cardium corbis Martyn.
Calliostoma gemmulatum Carpenter.
Chrysodomus tabulatus Baird.
Clathurella conradiana Gabb.
Columbella (Astyris) gausapata Gould.
Columbella (Astyris) gausapata, var. *carinata* Hinds.
Columbella (Astyris) tuberosa Carpenter.
Crepidula adunca Sowerby.
Crepidula navicelloides Nuttall.
Crepidula princeps Conrad.
Cythara bramneri Arnold.
Diastoma, species.
Fusus robustus Trask.

- Galeus mammilaris* Broderip.
Glottidia albida Hinds.
Lacuna compacta Carpenter.
Laqueus jeffreysi (?) Dall.
Leptothyra bacula Carpenter.
Leptothyra paucicostata Dall.
Macoma, species.
Mangilia angulata Carpenter.
Mangilia interfossa, var. *pedroana* Arnold.
Mangilia tabulata Carpenter.
Margarita pupilla Gould.
Mercenaria perlaminosa Conrad.
Modiolus fornicatus Carpenter.
Nassa mendica Gould.
Nassa perpinguis Hinds.
Natica clausa Broderip and Sowerby.
Ocenebra barbarensis Gabb.
Ocenebra lurida Middendorf.
Ocenebra lurida, var. *aspera* Baird.
Ocenebra perita Hinds.
Odostomia nuciformis, var. *avellana* Carpenter.
Odostomia gouldii Carpenter.
Olivella biplicata Sowerby.
Panopea generosa Gould.
Pecten (*Pecten*) *bellus* Conrad.
Pecten (*Patinopecten*) *caurinus* Gould.
Pecten (*Chlamys*) *hastatus* Sowerby.
Pecten (*Chlamys*) *hastatus* Sowerby, var. *strategus* Dall.
Pecten (*Chlamys*) *jordani* Arnold.
Pecten (*Chlamys*) *opuntia* Dall.
Phacoides annulatus Reeve.
Phacoides californica Conrad.
Pododesmus macroschisma Deshayes.
Protocardia centiflosa Carpenter.
Puncturella cuculata Gould.
Semele pulchra Sowerby, var. *montereyi* Arnold.
Strongylocentrotus purpuratus Stimson.
Terebratalia hemphilli Dall.
Tornatina culcitella Gould.
Trophon (*Boreotrophon*) *gracilis* Perry.
Trophon (*Boreotrophon*) *orpheus*, var. *præcursor* Arnold.
Trophon (*Boreotrophon*) *stuarti* Smith.
Turbonilla tridentata Carpenter.
Venericardia monilicosta Gabb.

NEW EOCENE (TEJON FORMATION) SPECIES AND VARIETIES
TURRITELLA (MARTINEZENSIS Gabb, var. ?) LOMPOCENSIS,
 new variety

Pl. LI, figs. 5*a*, 5*b*, and 8.

DESCRIPTION.—Shell averaging about 80 millimeters in altitude, turreted, slender; apex acute. Whorls 10 or more, angulated near base, upper portion flat or slightly convex, lower concave. Suture appressed, not very distinct. Sculpture consists of a prominent raised revolving line on angle, another equally as important at the anterior margin and 3 others of varying degrees of importance above the angle; between these 5 principal lines there are sometimes intercalaries, the type showing a persistent one between the angle and the next line above; fine sharp incremental lines, some more important than others, cross the whorls, bowing convexly backward, this system of sculpture associated with the spiral lines, often giving the surface a cancellate appearance; the interspaces between the major spiral lines are of approximately the same width except in the case of the ones between the second and third lines above the angle, and between the third line above the angle and the suture, both of which are about two-thirds the width of the major interspaces.

DIMENSIONS.—Altitude of type, from which four or five upper whorls are gone, 68 mm.; latitude, 20 mm.

NOTES.—This variety is much slenderer than the typical form, and has the angle relatively nearer the base. Named for the town of Lompoc, near the type locality.

TYPE.—Cat. No. 165,316, U. S. N. M.

LOCALITY.—Float boulder, sharp turn in road in San Miguelito Canyon, 4½ miles southwest of Lompoc, Santa Barbara County, Cal.; locality No. 4509.

HORIZON.—Tejon formation, Eocene

PECTEN (CHLAMYS ?) YNEZIANA, new species

Pl. I, fig. 4, and Pl. LI, figs. 6*a* and 6*b*

DESCRIPTION.—Shell averaging 60 to 70 millimeters in altitude; slightly higher than long, moderately convex, practically equivalve and equilateral, rather thin; base regularly rounded; dorsal margins concave; margins somewhat serrate. Surface of disk ornamented by from 30 to 45 irregular, inequidistant rounded, more or less imbricated ribs; in some instances the ribs occur quite regularly, every alternate one being prominent, with lesser ones (appearing as inter-

calaries) between; in others the ribs are irregularly disposed, although there is a tendency for the alternate ones to be larger and sometimes dichotomous. Ears radially striate in addition to incremental imbricating sculpture; anterior ear of right valve with deep byssal notch and well isolated byssal area.

DIMENSIONS.—Latitude (restored) 75 mm.

NOTES.—The imperfect fragments which furnish the characters described above represent a species apparently allied to *P. perrini* Arnold, although it is smaller and has more numerous and less imbricate ribs than the latter. *P. yneziana* is the only species of this group found in the Eocene. It has been recognized in the Tejon formation throughout the whole length of the Santa Ynez Range, and as far east as the Ojai Valley, Ventura County.

TYPE.—Cat. No. 165,313, U. S. N. M. Paratype, same number.

LOCALITY.—San Julian ranch, 10 miles southeast of Lompoc, Santa Barbara County, California; locality No. 4507.

HORIZON.—Tejon formation, Eocene.

NEW LOWER MIOCENE (VAQUEROS FORMATION) SPECIES

PURPURA VAQUEROSENSIS, new species

Pl. LII, figs. 1a and 1b

DESCRIPTION.—Shell averaging about 100 millimeters in altitude, very broadly spindle-shaped, spire elevated, conical; apex subacute. Whorls 4 or 5, sharply angulated anteriorly immediately adjacent to suture, portion posterior to angle flat except for a slight concavity just in front of suture caused by bending back of posterior margin where it appresses against antecedent whorl. Suture appressed, wavy, distinct, sometimes encroaching on angle of posterior whorl. Sculpture of the penultimate and preceding whorls confined to fine backward-sloping incremental lines and sometimes a faint suggestion of nodes on the angle; body whorl biangulate, the posterior angle being the more prominent owing to a row of prominent nodes (10 in type), some of which are quite regular, some more or less spirally elongate, and others approaching the importance of spines, anterior angle consisting of a rounded spiral ridge and below this four other similar revolving ridges, separated by impressed lines; area between the two angles flat or slightly convex and carrying four obsolete spiral ridges; whole surface of whorl crossed by sharp imbricating lamellæ, which slope backward on posterior portion of whorl and rise to the importance of imbricating spines on the second and fourth ridges in front of anterior angle and occasionally on the other ridges.

Columella twisted and recurved, the lower portion overlapping a narrow canal; columella strongly sculptured by incremental lines. Aperture ovate; outer lip simple.

DIMENSIONS.—Altitude, 100 mm.; latitude, 68 mm.; altitude of body whorl, 92 mm.; longitude of aperture, including canal, 80 mm.

NOTES.—In all of the specimens of this species examined the aperture and the greater part of the columella are unfortunately concealed. It appears, however, from external characteristics to belong to the genus *Purpura*, and to that group of the genus represented by *P. tricerialis* Blainville and *P. triangularis* Blainville, although *P. vaquerosensis* is very much larger than either of the latter. This magnificent species is known in the lower Miocene from Monterey County south to Santa Barbara County, and is, so far as the writer is aware, confined to this one horizon of the Miocene. It is one of the prominent members of the very characteristic fauna of which *Pecten magnolia* Conrad, *Turritella ineziana* Conrad, and *Cardium*, new species near *quadrigenarium*, are a part. Named for the Vaqueros formation (lower Miocene), of which it is believed to be characteristic.

TYPE.—Collection of Delos Arnold, Pasadena, California.

LOCALITY.—Lynch Mountain, Monterey County, California.

HORIZON.—Vaqueros formation, lower Miocene.

PECTEN (PECTEN) VANVLECKI, new species

Pl. LIII, figs. 1 and 2

DESCRIPTION.—Shell averaging about 70 millimeters in altitude, length and height about equal, outline circular; both valves convex, the right slightly more so than the left, equilateral, thin; base regularly rounded; sides only very slightly concave above; margins smooth. Right valve somewhat convex, the region of greatest convexity being just below the beak; surface ornamented with 13 or 14 rather prominent ribs, these being quite rounded in the younger stages of growth, but gradually becoming flatter and lower toward the periphery; interspaces rounded near umbos, but shallower and flatter below; equal, fine, sharp, raised incremental lines, separated by interspaces as wide as the lines, cover the surface of the disk and ears; hinge line longer than half length of disk; ears subequal, anterior with shallow byssal notch; posterior rectangularly truncated. Left valve slightly less convex than right, flat to concave immediately below umbo; ribs regularly rounded throughout entire length, becoming flatter and sometimes almost obsolete toward the

periphery; minute sculpture as in right valve; ears flat, the anterior one showing two or three faint radial riblets. Interior of both valves reflecting the external ribbing very prominently.

DIMENSIONS.—Longitude, 70 mm.; altitude, 64 mm.; diameter (approximate), 12 mm.

NOTES.—This species appears to be most closely related to *P. sanctacruzensis* Arnold, which occurs in the Oligocene and lowest Miocene of the Santa Cruz Mountains. It is distinguishable from the latter by its larger size, flatter disks, less elevated ribs, and by the prominent reflection of the external ribbing on the interior of the disk. This last is one of the most prominent, unique, and interesting characteristics of *P. vanvlecki*. Named in honor of Mr. Robert Van Vleck Anderson, of the United States Geological Survey.

TYPE.—Cat. No. 165,305, U. S. N. M. (right valve).

PARATYPE.—Cat. No. 165,306, U. S. N. M. (left valve).

LOCALITY.—Mouth of Ballard Canyon, 2 miles south of Santa Ynez, Santa Barbara County, California; locality No. 4478.

HORIZON.—Vaqueros formation, lower Miocene.

MODIOLUS YNEZIANUS, new species

Pl. LII, fig. 2

DESCRIPTION.—Shell averaging about 60 millimeters in altitude, elongate-ovate in outline, convex, equivalve; beaks nearly terminal, protruding forward and slightly beyond margin; base not regularly rounded, curving sharper anteriorly; anterior margin curving sharply around attenuate extremity just in front of beak, and then straight for nearly entire length of shell, with the exception of a slight contraction near middle caused by a sulcation extending obliquely backward from beaks; posterior dorsal margin straight, bending around a moderately angular extremity into the slightly arcuate ventral margin; the shell bulges in the middle in such a way as to suggest a broad, rounded ridge bowing over obliquely backward from the anterior part of the base to the beak; surface sculpture consists of fine incremental lines.

DIMENSIONS.—Of type, a small specimen; altitude, 31 mm.; latitude, 18 mm.; diameter, 11 mm.

NOTES.—This species is allied to *M. fornicatus* Carpenter, from which it differs by being much larger, more angular posteriorly, not as ventricose nor with the bulging part as overturned posteriorly. It is quite abundant at the type locality and at other places where the Vaqueros formation is fossiliferous. Named for the Santa Ynez Mountains.

TYPE.—Cat. No. 165,324, U. S. N. M.

LOCALITY.—San Julian ranch, 10 miles southeast of Lompoc, Santa Barbara County, California; locality No. 4504.

HORIZON.—Vaqueros formation, lower Miocene.

NEW PLIOCENE (FERNANDO FORMATION) SPECIES AND VARIETIES

LYMNÆA ALAMOSENSIS, new species

Pl. LIV, figs. 6 and 7

DESCRIPTION.—Adult shell averaging about 6 or 7 millimeters in altitude, broadly spindle-shaped, spire elevated, apex rounded. Whorls four, bulging, more convex posteriorly than anteriorly; outline of body whorl regularly arcuate; a faint ridge crowns the posterior margin of each whorl where it appresses against the antecedent whorl. Suture appressed, slightly sinuous, distinct; sculpture consisting of numerous microscopic incremental lines, which are somewhat better developed on the posterior portion of the whorl, and occasional faint spiral striæ; a hard, glossy epidermis is preserved on some of the specimens. Aperture sub-oval, narrowing posteriorly; outer lip protruding anteriorly, thickened into overhanging flange internally, and flaring from posterior extremity as far around as umbilical region; a minute umbilical chink is visible in most specimens.

DIMENSIONS.—Altitude, 6 mm.; latitude, 3 mm.; altitude of body whorl, 4.9 mm.; longitude of aperture, 3 mm.; latitude of aperture, 1.5 mm.

NOTES.—This unique little fossil occurs in a peculiar fine-grained gray clay in the upper portion of the Fernando formation, where, at the type locality, near Los Alamos, it is quite abundant. No other fresh-water species were found associated with it.

TYPE.—Cat. No. 165,426, U. S. N. M.

LOCALITY.—Fresh-water beds one mile southeast of bench-mark 425, Los Alamos Valley, Santa Barbara County, California; locality No. 4483.

HORIZON.—Fernando formation, fresh-water portion at top, which probably corresponds with the Paso Robles formation of the San Luis quadrangle described by Fairbanks in the San Luis folio.

DRILLIA GRACIOSANA, new species

Pl. LIV, fig. 18

DESCRIPTION.—Shell averaging about 14 or 15 millimeters in altitude, spindle-shaped; the sharper portion of the spindle being above;

apex subacute. Whorls 5, somewhat angulated medially, convex anteriorly, concave to flat posteriorly, sculpture consisting of not very prominent rounded axial ribs (17 on penultimate whorl), obsolete above angle, and 2 spiral ridges of about equal importance to the axial ribs, also below the angle, these two systems giving a characteristic cancellated appearance to the surface; the upper margin of each whorl is appressed against the anterior portion of the one preceding and bent back into a little, more or less nodose revolving ridge next to suture; the area between this revolving ridge and the angle of the whorl is ornamented only by lines of growth which bow convexly posteriorly; the axial ridges become almost obsolete or are replaced by irregular lines of growth on the body whorl, while the spiral ridges (of which there are 7) become quite prominent, and are separated by channeled interspaces equal in width to the ridges. Suture appressed, wavy, and not very distinct. Columella curved, short and broad, faintly biangularly plicated and with a faint indication of an umbilical chink between it and the incrustated inner lip. Aperture subpyriform; notch rather prominent, though quite shallow; canal short and curved.

DIMENSIONS.—Altitude, 14 mm.; latitude, 6 mm.; altitude of body whorl, 8.8 mm.; longitude of aperture, 4.5 mm.; latitude of aperture, 2 mm.; canal, 1.7 mm.

NOTES.—This stubby little species is more closely related to *D. cancellata* Carpenter than to any other West Coast form, but is easily distinguishable from the latter by its broader outline, heavier shell, broader columella, fewer and stronger ribs and ridges. A species similar if not identical to *D. graciosa* is found in the San Diego formation at Pacific Beach, San Diego County. Named for Graciosa Ridge, the type locality.

TYPE.—Cat. No. 165,309, U. S. N. M.

LOCALITY.—Graciosa Ridge, near Folsom well No. 5, Orcutt, Santa Barbara County, California; locality No. 4476.

HORIZON.—Fernando formation, Pliocene portion.

DRILLIA WALDORFENSIS, new species

Pl. LIV, fig. 12

DESCRIPTION.—Shell averaging about 18 to 20 millimeters in altitude, slender, spindle-shaped; apex subacute when perfect. Whorls 8 or 9, convex, prominently angulated slightly anterior to middle; portion of whorl posterior to angle has a decidedly concave aspect, which is heightened by a tendency of the posterior margin of the whorl (which is appressed against the preceding whorl) to bend out-

ward, sculpture consisting of obliquely forward sloping, broad, rounded axial ribs (10 on the penultimate whorl of the type), which are elevated into nodes on the angle, but become obsolete toward the sutures, especially posteriorly, where the whorl is almost free from axial ornamentation; spiral sculpture almost obsolete, although faint traces of spiral lines are sometimes visible between the ribs and on the anterior portion of the body whorl; faint lines of growth, still more oblique than the ribs, are visible, especially on the body whorl. Suture distinct, appressed, occasionally slightly undulating. Columella twisted at base and biangularly plicated. Aperture subpyriform; canal relatively long for this genus, slender, and strongly recurved; notch of medium prominence; inner lip straight, incrustated, with a decided callus at posterior end of aperture.

DIMENSIONS.—Altitude, 18.5 mm.; latitude, 6 mm.; altitude of body whorl, 10 mm.; longitude of aperture, 4 mm.; latitude of aperture, 2.1 mm; canal, 3.4.

NOTES.—This beautiful little *Drillia* appears to be more closely related to *D. empyrosia* Dall than to any other West Coast form, although its nodose whorls suggest *D. torosa* Carpenter at first sight. It is distinguishable from *D. empyrosia* by its smaller size, slenderer form, more recurved canal, and obsolete spiral sculpture (*D. empyrosia* being quite prominently spirally sculptured, especially on the body whorl). The recurved canal, oblique ribs, and slenderer form of *D. waldorfensis* separate it at once from *D. torosa*. *D. waldorfensis* reminds one of *D. (Cymotosyrinx) apynota*, var. *acila* Dall, from the Shell Creek, Florida, Pliocene, but is slenderer and has fewer and more rounded ribs. Named for the type locality, Waldorf asphalt mine.

TYPE.—Cat. No. 165,270, U. S. N. M.

LOCALTY.—Waldorf asphalt mine, 3 miles southeast of Guadalupe, Santa Barbara County, California; locality No. 4473.

HORIZON.—Fernando formation, lower Pliocene portion.

BATHYTOMA CARPENTERIANA Gabb, var. **FERNANDOANA**,
new variety

Pl. LVI, fig. 7

DESCRIPTION.—Shell averaging about 25 millimeters in altitude, broadly spindle-shaped; apex in type is imperfect, but from other specimens is known to be subacute. Whorls 4 or 5, more or less angulated, concave in front and convex behind, the anterior margin of each whorl appressed against the lower convex portion of the preceding one; body whorl similar to others except that it is protracted

anteriorly, sculpture consisting of moderately sharp raised spiral lines, the penultimate whorl in the type carrying 9, 5 anterior to the angle and 4 posterior, the latter being slightly less prominent than those in front; the raised lines become more prominent on the anterior portion of the body, where they are wider spaced and the alternate ones are relatively more important; faint lines of growth, convex posteriorly on the angle and concave posteriorly on the posterior portion of the whorl, record a very wide, shallow notch as having been present in the lip. Suture slightly undulating, often prominent, owing to appressed portion of whorl being elevated slightly into a faint ridge just anterior to suture. Aperture narrow pyriform; canal very short and broad and only very slightly curved. Inner lip straight and smooth except for a single faint spiral ridge.

DIMENSIONS.—Altitude, 24 mm.; latitude, 12.3 mm.; altitude of body whorl, 20 mm.; longitude of aperture and canal combined, 16 mm.; latitude of aperture, 5 mm.

NOTES.—This variety is closely allied to the typical *B. carpenteriana*, but in the series of specimens examined is constantly smaller, relatively much shorter, and has the whorls more angulated than in the typical form. Named for the Fernando formation, of which it appears to be characteristic.

TYPE.—Cat. No. 165,303, U. S. N. M.

LOCALITY.—Graciosa Ridge, near Folsom well No. 5, Orcutt, Santa Barbara County, California; locality No. 4476.

HORIZON.—Fernando formation, Pliocene portion.

CANCELLARIA CRAWFORDIANA Dall, var. FUGLERI, new variety

Pl. LIV, fig. 9

DESCRIPTION.—Shell averaging between 20 and 25 millimeters in altitude, quite narrowly oval in outline. Spire elevated, and usually consisting of 5 or 6 whorls in addition to the body whorl. Whorls evenly convex and prominently angulated above, the portion of the whorl posterior to the angle forming a narrow revolving table. The surface of the whorls is cancellate, the sculpture consisting of narrow, rounded, raised revolving ridges (9 on the penultimate whorl, 18 on the body whorl in the type) and longitudinal ribs of the same character (23 on the penultimate whorl of the type) and prominence as the revolving ridges. Suture deeply appressed and distinct. Aperture ovate, canalculated in front (the canal is broken off in the type). Columella with two prominent oblique plications.

DIMENSIONS.—Altitude of imperfect specimen (type), 22 mm.;

latitude, 11.5 mm.; longitude of aperture without canal, 10 mm.; latitude of aperture, 5 mm.

NOTES.—This variety differs from the recent typical form in that the former has an average of many more (23 instead of 15) longitudinal ribs, more (9 instead of 7) spiral ridges, and a relatively narrower revolving table above the angle.

TYPE.—Cat. No. 165,322, U. S. N. M.

LOCALITY.—Fugler Point asphalt mine, 1 mile north of Gary, Santa Barbara County, California (U. S. G. S. locality No. 4475).

HORIZON.—Fernando formation (lower Pliocene).

NASSA WALDORFENSIS, new species

Pl. LIV, fig. 17

DESCRIPTION.—Shell averaging about 13 to 15 millimeters in altitude, sharply conical in outline, apex subacute. Whorls 6, convex, angulated near posterior margin. Suture appressed, distinct, wavy, sculpture consisting of sharp axial ribs (13 on penultimate whorl), extending with almost equal prominence from suture to suture, and prominent squarish revolving ridges (5 on penultimate whorl) separated by channeled interspaces, the whole presenting a most characteristic cancellate appearance; fine lines of growth are visible under a lens. Columella short, twisted and slightly curved; separated from body whorl by a distinct canal; sculptured much less prominently than whorls and by spiral lines only. Aperture broadly elliptical; canal short and sharply recurved; inner lip incrustated; outer lip slightly dentate.

DIMENSIONS.—Altitude, 13 mm.; latitude, 6.5 mm.; altitude of body whorl, 8 mm.; longitude of aperture, 4.8 mm.; latitude of aperture, 2.8 mm.; canal, 1.2 mm.

NOTES.—This species is slenderer and has coarser axial sculpture than *N. perpinguis* Hinds, and is somewhat smaller, relatively broader, and has much sharper ribs than *N. mendica* Gould; it is more closely related to the latter than to any other of the West Coast species. Found abundantly in the Pliocene throughout southern California. Named for the type locality, Waldorf asphalt mine.

TYPE.—Cat. No. 165,272, U. S. N. M.

LOCALITY.—Waldorf asphalt mine, 3 miles southeast of Guadalupe, Santa Barbara County, California; locality No. 4473.

HORIZON.—Fernando formation, lower Pliocene portion.

OCINEBRA MICHELI Ford, var. **WALDORFENSIS**, new variety

Pl. LIV, fig. 10

DESCRIPTION.—Shell averaging about 11 or 12 millimeters in altitude, rather slender, spindle-shaped; apex acute. Whorls 5, prominently angulated in the middle; anterior portion convex, posterior flat or concave, with a slight curving back of the posterior margin where it appresses against the preceding whorl. Sculpture consists of axial varices and spiral lines; axial varices (8 on penultimate whorl) are broad and rounded anterior to angle, narrower and sharper behind; the spiral lines are prominent only below the angle of each whorl; they are equal, rounded, ornamented by imbricating plates of growth, and are separated by distinct impressed interspaces; anterior portion of whorl sculptured by fine lines of growth. Suture appressed and not very distinct. Columella rather long, narrow, and recurved; spirally ribbed like body whorl. Aperture broadly pyriform; canal long, narrow, and recurved.

DIMENSIONS.—Altitude, 11 mm.; latitude, 5 mm.; altitude of body whorl, 8.4 mm.; longitude of aperture, 3.4 mm.; latitude of aperture, 1.3 mm.; canal, 3 mm.

NOTES.—This slender little *Ocinebra* differs from the typical *O. micheli* in the following respects: It is slenderer, has less angular whorls, and the imbricate sculpture on the posterior portion of the whorl is less prominently developed; the axial ribs are more prominent posterior to the angle, the spiral lines are equal, not alternate, the aperture is narrower, and the canal more recurved. Named for the type locality, Waldorf asphalt mine.

TYPE.—Cat. No. 165,261.

LOCALITY.—Waldorf asphalt mine, 3 miles southeast of Guadalupe, Santa Barbara, California; locality No. 4473.

HORIZON.—Fernando formation, lower Pliocene portion.

LEDA ORCUTTI, new species

Pl. LV, fig. 9

DESCRIPTION.—Shell averaging about 7 millimeters in longitude, solid, equivalve; beaks slightly anterior; anterior end rounded, shorter; posterior end rostrate, subacute; base arcuate; lunule long and very narrow, separated from shell by deeply impressed line; escutcheon much broader than lunule, its surface prominently concave and its carina well developed, especially toward the posterior end, sculpture consisting of several (7 in type) prominent wide

spaced, narrow concentric riblets, this sculpture confined to the main portion of shell; lunule, escutcheon, and carinæ ornamented only by fine concentric incremental lines; incremental lines also visible between the concentric riblets. Hinge and interior similar in a general way to *L. minuta* Fabr.

DIMENSIONS.—Longitude, 7 mm.; altitude, 4.2 mm.; diameter, 3 mm.

NOTES.—This beautiful little *Leda* is allied to *L. minuta* Fabr., but differs from it in being less attenuate posteriorly, having coarser and wider spaced concentric riblets, and in having simple rather than biangular carinæ. A rather abundant species in the finer fossiliferous sands and shales of the lower Pliocene. Named in honor of Mr. W. W. Orcutt, of Los Angeles, California.

TYPE.—Cat. No. 165,271, U. S. N. M.

LOCALITY.—Waldorf asphalt mine, 3 miles southeast of Guadalupe, Santa Barbara County, California; locality No. 4473.

HORIZON.—Fernando formation, lower Pliocene portion.

PHACOIDES NUTTALLII Conrad, var. **ANTECEDENS**, new variety

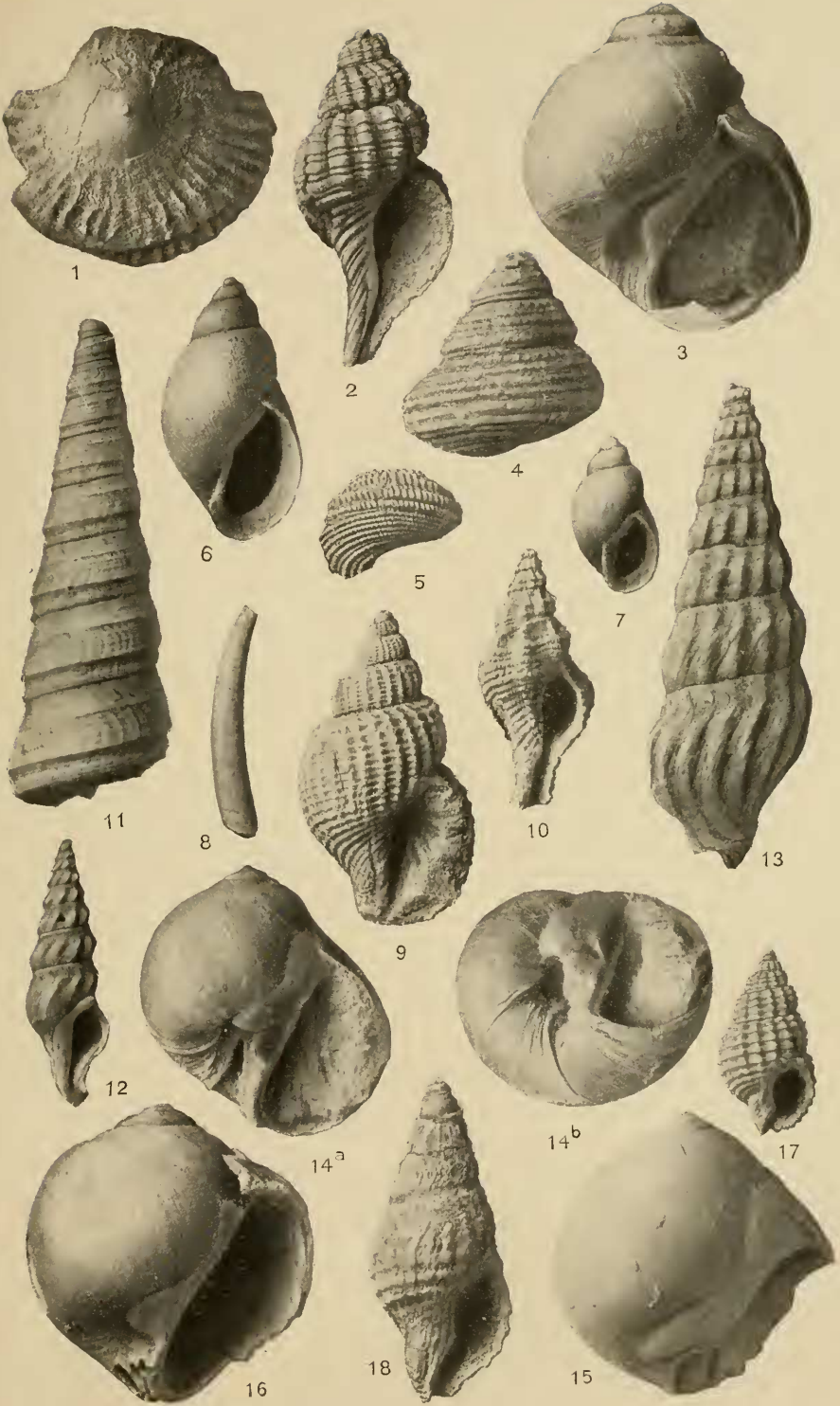
Pl. LV, fig. 6

DESCRIPTION.—Shell averaging about 25 millimeters in longitude, very broadly elliptical in outline, longer than high, ventricose, and equivalve; beaks only moderately prominent, placed slightly anterior to middle of shell; base arcuate; anterior margin sloping more rapidly from beaks than posterior, the latter being nearly straight for about 6 or 8 millimeters from the beaks; both extremities quite regularly rounded, the posterior being possibly slightly more attenuate, sculpture consisting of numerous close-set subequal rounded radiating ridges and concentric ribs which are narrower than the radials, and spaced about twice the distance between two of the latter; the concentric ribs tend to become obsolete toward the periphery in adult specimens; the general appearance of the surface is decidedly cancellate. Lunule deep, small, and inconspicuous. Interior and hinge as in *P. nuttallii*.

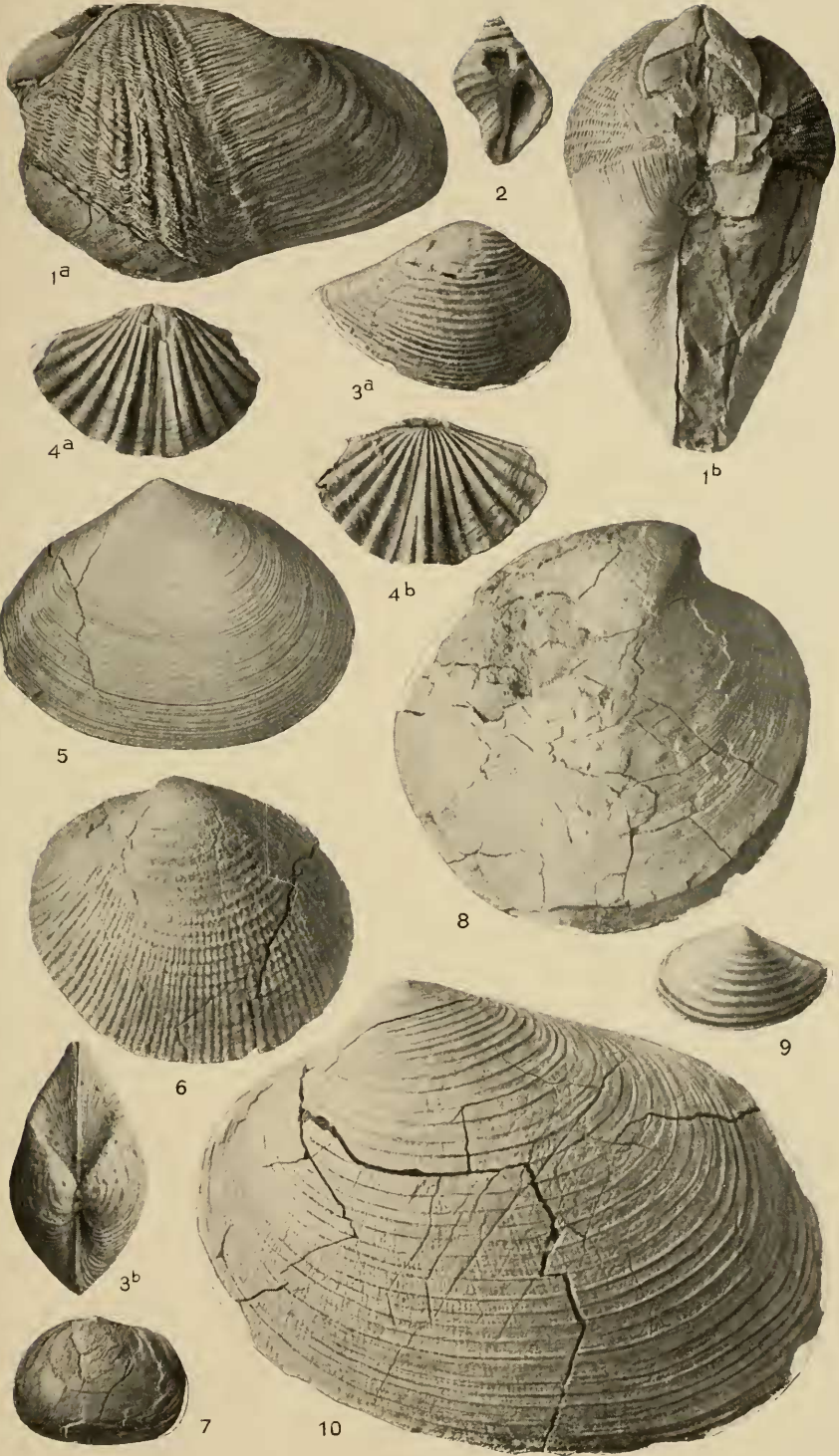
DIMENSIONS.—Longitude, 23 mm.; altitude, 19 mm.; diameter, 12 mm.

NOTES.—This variety is more ventricose, less angulated posteriorly, and has its concentric ribs much wider spaced than the typical *P. nuttallii*.

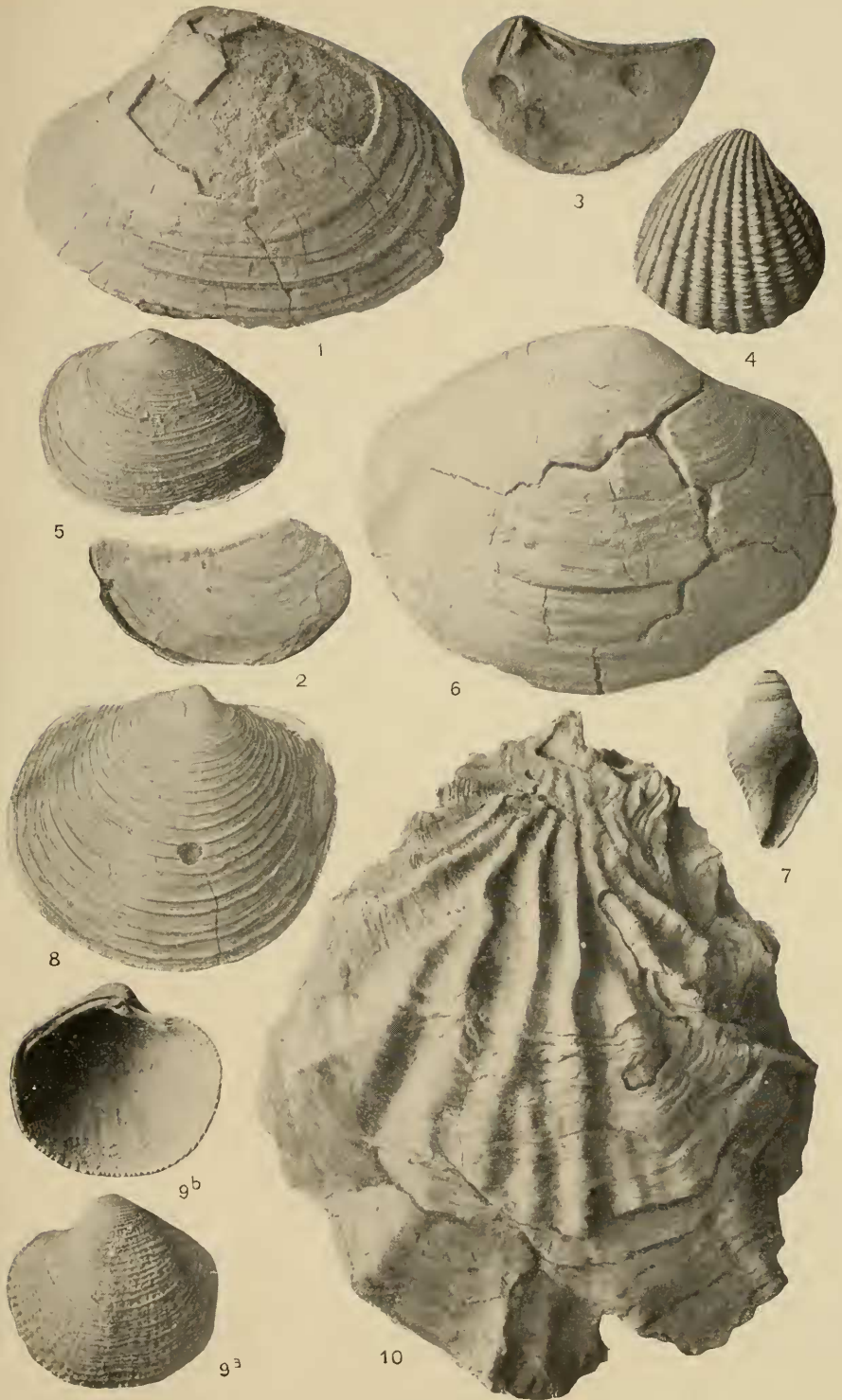
TYPE.—Cat. No. 165,290, U. S. N. M.



FERNANDO (PLIOCENE) GASTEROPODA



FERNANDO (PLIOCENE) FOSSILS



FERNANDO (PLIOCENE) FOSSILS



1



2



3



4



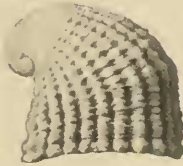
5^b



6



7



5^a



8



12



9



10



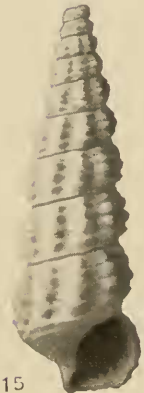
11



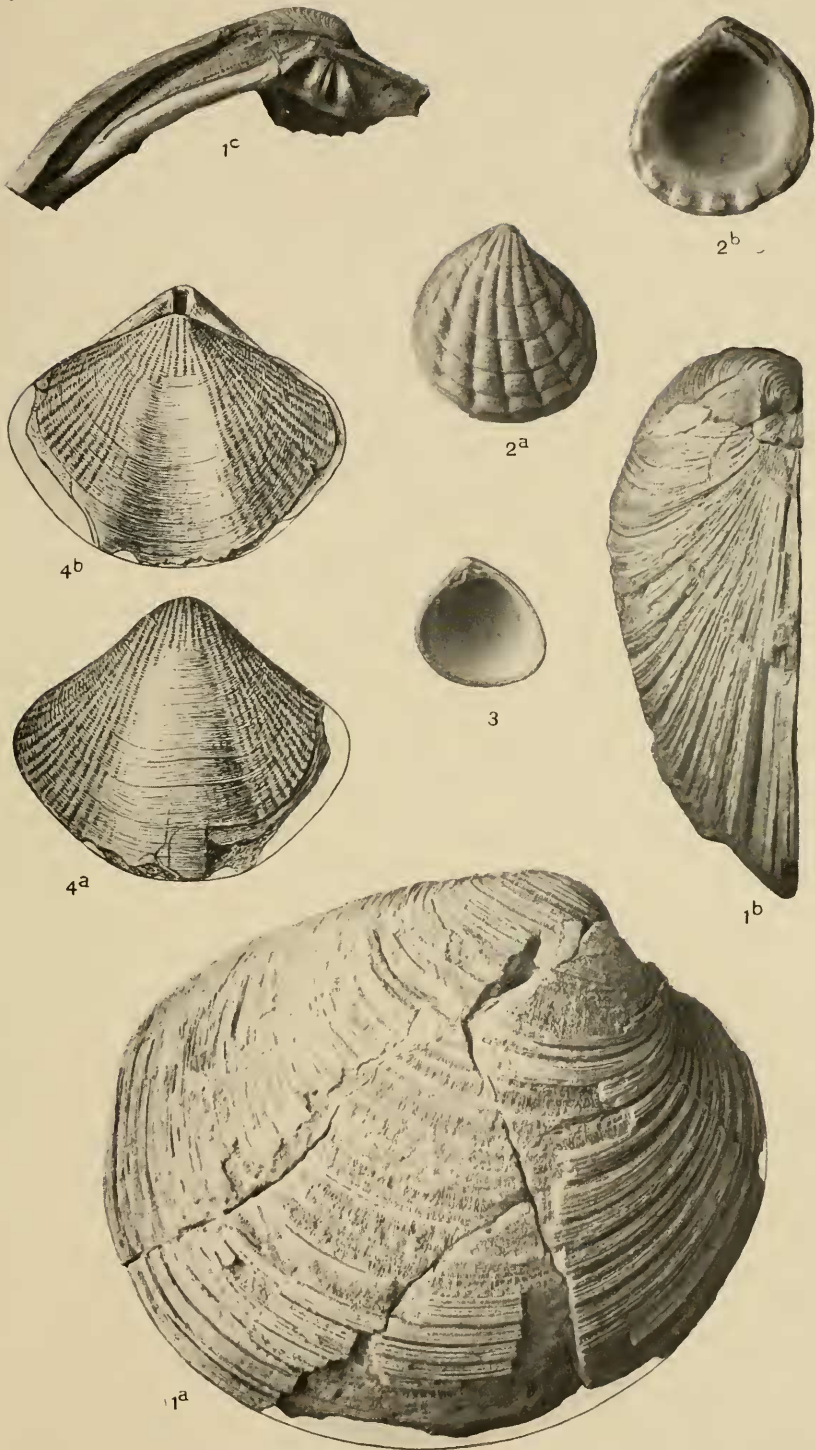
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14



15



FERNANDO (PLIOCENE) PELECYPODA AND BRACHIOPODA

LOCALITY.—Alcatraz asphalt mine, near Sisquoc, Santa Barbara County, California; locality No. 4471.

HORIZON.—Fernando formation, lower Pliocene portion.

SPISULA CATILLIFORMIS Conrad, var. **ALCATRAZENSIS**, new variety

Pl. LVI, fig. 6

DESCRIPTION.—Shell averaging about 130 millimeters in longitude, oval in outline, slightly narrower in front than behind, equi-valve, inequilateral, ventricose, extremities slightly gaping; base regularly arcuate; posterior portion of dorsal margin nearly straight at umbo, gradually becoming more and more arcuate as it passes around the broadly rounded extremity; anterior dorsal margin only slightly depressed in front of umbo, but carrying a slight bump only a short distance from the latter; anterior extremity more truncate and narrower than posterior; beaks slightly anterior, bent forward, but not exceptionally prominent. Surface consists of numerous more or less irregular lines of growth. Hinge and interior quite similar to typical form.

DIMENSIONS.—Longitude, 128 mm.; altitude, 98 mm.; diameter, 57 mm.

NOTES.—This variety is more ventricose, more excavated and attenuate in front, more regularly rounded below, and has the beaks more central than the typical *S. catilliformis*. Named for type locality, Alcatraz asphalt mine.

TYPE.—Cat. No. 165,291, U. S. N. M.

LOCALITY.—Alcatraz asphalt mine, near Sisquoc, Santa Barbara County, California; locality No. 4471.

HORIZON.—Fernando formation, lower Pliocene portion.

SPISULA SISQUOCENSIS, new species

Pl. LVI, fig. 1

DESCRIPTION.—Shell averaging about 120 millimeters in longitude, subtrigonal in outline, equi-valve, inequilateral, ventricose; base regularly arcuate; beaks anterior, prominent, bent forward, protruding beyond periphery or shell; anterior end shorter and narrower than posterior, which is evenly rounded; area in front of beaks depressed concavely as a whole, but slightly elevated at margin, this condition, when the two valves are together, suggesting a large lunule with a slightly raised ridge running down the middle; posterior margin becomes more and more arcuate as extremity is

approached, sculpture consisting of numerous fine incremental lines, some of which are more prominent than the great majority, these more prominent ones giving a slightly irregular surface to the shell. Hinge and interior unknown, but probably quite similar to *S. hemphilli*.

DIMENSIONS.—Longitude, 120 mm.; altitude, 85 mm.; diameter, 59 mm.

NOTES.—This species is near *S. hemphilli* Dall, but is constantly and decidedly narrower. Named for Sisquoc, near the type locality.

TYPE.—Cat. No. 165,292, U. S. N. M.

LOCALITY.—Alcatraz asphalt mine, near Sisquoc, Santa Barbara County, California; locality No. 4471.

HORIZON.—Fernando formation, lower Pliocene portion.

MITRAMORPHA FILOSA Carpenter, var. **BARBARENSIS**, new variety

Pl. LVII, fig. 1

DESCRIPTION.—Shell averaging between 6 and 7 millimeters in length, mitraform; apex quite acute. Whorls six, slightly ventricose, angulated above at suture; two nuclear whorls, smooth and somewhat irregular, the second being eccentric with relation to the axis of the spire; other whorls ornamented by four rounded, raised, revolving ridges and (16 on the penultimate whorl of the type) rounded longitudinal ribs. The longitudinal sculpture is relatively of greater prominence on the upper whorls and fades away below the middle of the body whorl. In the type the body whorl is sculptured by 16 revolving lines, those toward the base being faint. Suture appressed, distinct. Aperture narrow and elliptical; canal short. Outer lip smooth, inner lip slightly reflexed toward base, columella showing faint indications of two plications, lower part of columella showing trace of axial sculpture.

DIMENSIONS.—Altitude, 6.5 mm.; latitude, 2.6 mm.; altitude of aperture and canal, together, 3 mm.; latitude of aperture, 1 mm.

NOTES.—In this variety the whorls are more convex, the longitudinal sculpture much more pronounced, the suture more distinct, and the canal relatively narrower than in the type. It lies between *M. filosa* and *M. intermedia* Arnold, having more numerous and less prominent longitudinal ribs than the latter. Recent specimens of a variety of *M. filosa* very closely resembling var. *barbarensis* are in the National Museum labeled from Monterey. It is the opinion of the writer that the prominently longitudinally sculptured forms are northern types inhabiting somewhat colder water than the typical *filosa*.

TYPE.—Cat. No. 165,245, U. S. N. M.

LOCALITY.—Bath-house Beach, Santa Barbara, California. (Delos and Ralph Arnold.)

HORIZON.—Fernando formation (Pliocene or lower Pleistocene).

PUNCTURELLA DELOSI, new species

Pl. LVII, fig. 5a and 5b

DESCRIPTION.—Shell minute for one of this genus; body of shell roughly cylindrical, the cross-section of base being broadly elliptical, tapering off above into a coiled apex, the coil being right-handed and of about $1\frac{1}{2}$ turns; a narrow slit about 0.7 mm. long perforates the shell in front of the apex and truncates one of the radiating ribs. The axis of the slit is parallel with the longer axis of the elliptical base. The sculpture consists of (in the type 23) prominent equal, equidistant, rounded, raised ridges, which radiate from the apex toward the periphery or base; near the apex these ridges are quite sharp. The interspaces are slightly narrower than the ribs and are crossed by numerous sharp raised lamellæ of growth which flex forward and give the surface a cancellated appearance. These lamellæ also cross the radiating ribs, giving them an imbricated or nodose surface. The lamellæ are more numerous on the anterior or cylindrical part of the shell. The interior of the shell is smooth. A raised border or septum associated internally with the slit divides the shell near the apex, crossing parallel with the narrow axis of the base.

DIMENSIONS.—Altitude, 1.8 mm.; longer diameter of base, 1.8 mm.; shorter diameter, 1.6 mm.

NOTES.—This species of *Puncturella* is very much smaller than any other from the West Coast. Its shape is also quite distinctive and its ribs equal in size rather than alternating or subequal, as in the previously described forms. Two specimens only were found at the type locality. Named in honor of Delos Arnold, of Pasadena, California.

TYPE.—Cat. No. 165,234, U. S. N. M.

LOCALITY.—Bath-house Beach, Santa Barbara, California. (Delos Arnold.)

HORIZON.—Fernando formation (Pliocene or lower Pleistocene).

VENERICARDIA YATESI, new species

Pl. LVIII, figs. 2a and 2b

DESCRIPTION.—Shell averaging between 4 and 5 millimeters in altitude, subcircular in outline, moderately convex. Beaks slightly

posterior, turned slightly forward, and somewhat prominent. Anterior margin slightly depressed in front of beaks, but convex below this; anterior angle somewhat more sharply rounded than posterior, giving the valve an obliquely protruding appearance anteriorly. Posterior margin and base regularly rounded. The sculpture consists of 8 or 9 broad falcate ribs separated by narrow incised interspaces and several (8 in the type) very prominent concentric imbrications of growth; in addition to the latter are numerous fine incremental lines. Hinge relatively narrow for one of this genus.

DIMENSIONS.—Altitude, 4 mm.; latitude, 4 mm.; diameter of single valve, 1 mm.

NOTES.—This species is more closely related to *V. incisa* Dall than to any of the other West Coast forms, but is easily distinguishable from the latter by the fewer number (8 in type of *yatesi*, 19 in type of *incisa*) and greater breadth of its ribs, relatively smaller size and shorter and more angulated outline anteriorly. Named in honor of Dr. Lorenzo G. Yates, Santa Barbara, California.

TYPE.—Cat. No. 165,248, U. S. N. M.

LOCALITY.—Bath-house Beach, Santa Barbara, California. (Delos and Ralph Arnold.)

HORIZON.—Fernando formation (Pliocene or lower Pleistocene).

PSEPHIDIA BARBARENSIS, new species

Pl. LVIII, fig. 3

DESCRIPTION.—Shell averaging about 4 millimeters in altitude; subtrigonal in outline, ventricose. Beaks slightly anterior of the center, bowed slightly forward, but not prominent. Anterior margin nearly straight; anterior angle broadly rounded; base not prominently rounded; posterior angle much sharper than anterior; posterior margin regularly bowed and much more rounded than anterior. Surface smooth except for very fine lines of growth. Muscle scars prominent; pallial sinus oblique and extending nearly to middle of valve. The hinge consists of three prominent teeth—the middle one heavy, triangular, and slightly sulcated, the anterior and posterior ones short.

DIMENSIONS.—Altitude, 4 mm.; longitude, 4.1 mm.; diameter of single valve, 1 mm.

NOTES.—This species is higher and more trigonal in outline, has a straighter anterior margin, and a less conspicuous anterior tooth than *P. lordii* Baird, which it resembles. Named for the type locality, Santa Barbara.

TYPE.—Cat. No. 165,238, U. S. N. M.

LOCALITY.—Bath-house Beach, Santa Barbara, California. (Delos and Ralph Arnold.)

HORIZON.—Fernando formation (Pliocene or lower Pleistocene).

EXPLANATION OF PLATES

All figures are natural size unless otherwise indicated. Unless otherwise indicated, all specimens figured are from Santa Barbara County, California.

PLATE L

Tejon (Eocene) Fossils

- FIG. 1. *Cardium brewerii* Gabb. Type. View of exterior of right valve; altitude, 61 mm. Pal. Cal. I, pl. xxiv, fig. 155. A common species in the Eocene of the Santa Ynez Mountains.
- 2a. *Crassatellites collina* Conrad. Cat. No. 165,312, U. S. N. M. View of exterior of left valve; longitude, 87 mm. San Julian ranch; locality No. 4507. A characteristic species of the Tejon in the Santa Ynez Range.
- 2b. View of anterior end of same specimen.
3. *Crassatellites collina* Conrad. Cat. No. 165,312, U. S. N. M. View of hinge. Same locality as fig. 2a.
4. *Pecten (Chlamys?) yneziana*, new species. Cat. No. 165,313, U. S. N. M. Paratype. View of exterior; altitude, 52 mm. San Julian ranch; locality No. 4507. A characteristic species of the Tejon in the Santa Ynez Range.
- 5a. *Ficus mamillatus* Gabb. Cat. No. 165,319, U. S. N. M. View of back; altitude, 31 mm.; 3 miles north of Sudden; locality No. 4518. Quite rare, but nevertheless found at most Tejon localities in the southern Coast Ranges.
- 5b. View of same specimen from above.
6. *Turritella uvasana* Conrad. Cat. No. 165,327, U. S. N. M. Aperture view of imperfect specimen; altitude, 25 mm.; 3 miles north of Sudden; locality No. 4518. Characteristic of the Tejon on the West Coast.

PLATE LI

Knoxville (Cretaceous) and Tejon (Eocene) Fossils

- FIG. 1. *Aucella piochii* Gabb. Cat. No. 30,831, U. S. N. M. View of exterior of right valve; altitude, 25 mm. Knoxville (Lower Cretaceous) formation, East Fork Tepusquet Creek; locality No. 4173. Characteristic of the Knoxville throughout the Coast Ranges.
2. *Aucella piochii* Gabb. Cat. No. 30,831, U. S. N. M. View of exterior of left valve, $\times 2$. Same locality and horizon as fig. 1.
- 3a. *Aucella piochii* Gabb. View of exterior of left valve; altitude, 27 mm. Bull. U. S. Geol. Survey, No. 133, 1895, pl. iv, fig. 6.
- 3b. Exterior of right valve of same specimen. *Op. cit.*, pl. iv, fig. 7.

4. *Venericardia planicosta* Lamarck. Cat. No. 164,973, U. S. N. M. Exterior view of left valve; longitude, 84 mm. Eocene, Little Falls, Washington. This is the most widespread and characteristic Eocene species in the world.
- 5a. *Turritella (martinezensis* Gabb, var. ?) *lompocensis*, new variety. Cat. No. 165,316, U. S. N. M. Paratype. Back view of basal fragment; altitude, 30 mm. Southwest of Lompoc, in San Miguelite Canyon; locality No. 4509.
- 5b. Basal view of same specimen.
- 6a. *Pecten (Chlamys ?) yneziana*, new species. Cat. No. 165,313. Type. View of exterior of imperfect disk; altitude, 64 mm. San Julian ranch, 10 miles southeast of Lompoc; locality No. 4507.
- 6b. View of hinge of right valve of same species; length, 25 mm.
7. *Turritella wasana* Conrad. Cat. No. 165,326, U. S. N. M. Aperture view of imperfect specimen; altitude, 68 mm. San Julian ranch, southeast of Lompoc; locality No. 4507. Characteristic of the Tejon of the Pacific Coast.
8. *Turritella (martinezensis* Gabb, var. ?) *lompocensis*, new variety. Cat. No. 165,316, U. S. N. M. Type. View of back; altitude, 68 mm. Same locality as fig. 5a.

PLATE LII

Vaqueros (Lower Miocene) Fossils

- FIG. 1a. *Purpura vaquerosensis*, new species. Collection of Delos Arnold. Type. Aperture view; altitude, 100 mm. Lynch Mountain, Monterey County.
- 1b. Back view of same specimen.
2. *Modiolus ynezianus*, new species. Cat. No. 165,324, U. S. N. M. Type. View of exterior of right valve, $\times 2$. San Julian ranch, southeast of Lompoc; locality No. 4504.

PLATE LIII

Vaqueros (Lower Miocene) Fossils

- FIG. 1. *Pecten (Pecten) vanvlecki*, new species. Cat. No. 165,305, U. S. N. M. Type. View of exterior of right valve; altitude, 64 mm. Mouth of Ballard Canyon, 2 miles south of Santa Ynez; locality No. 4478.
2. *Pecten (Pecten) vanvlecki*, new species. Cat. No. 165,306, U. S. N. M. Paratype. View of exterior of left valve; altitude, 72 mm. Same locality as fig. 1.
3. *Pecten (Chlamys) sespeensis*, var. *hydei* Arnold. Cat. No. 165,308, U. S. N. M. View of exterior of left valve; altitude, 60 mm. Mouth of Ballard Canyon, south of Santa Ynez; locality No. 4478. This species is apparently characteristic of the Vaqueros.
- 4a. *Terebratalia kennedyi* Dall. Cat. No. 165,325, U. S. N. M. View of exterior of ventral valve; altitude, 26 mm. Lime quarry 5 miles southwest of Lompoc; locality No. 4521. The specimens from this quarry are indistinguishable from the type of *T. kennedyi*, which came from Cerros Island, Lower California.

- 4b. View of exterior of imperfect dorsal valve of same species; altitude, 18 mm.
- 4c. View of exterior of dorsal valve of same species; altitude, 19 mm.
- 4d. View of exterior of ventral valve of same species; altitude, 28 mm.

PLATE LIV

Fernando (Pliocene) Gasteropoda

- FIG. 1. *Trochita radians* Lamarck. Cat. No. 165,310, U. S. N. M. View of top of imperfect specimen; maximum diameter, 20 mm., $\times 2$. Fugler Point asphalt mine, near Gary; locality No. 4475. Characteristic of the upper Miocene and lower Pliocene in this region.
2. *Priene oregonensis* Redfield. Cat. No. 165,262, U. S. N. M. Aperture view of young specimen; altitude, 46 mm. Waldorf asphalt mine; locality No. 4473. This species is also found recent.
3. *Lumatia leavisii* Gould. Cat. No. 165,264, U. S. N. M. Aperture view of young specimen; altitude, 23 mm., $\times 2$. Waldorf asphalt mine; locality No. 4473; also known recent.
4. *Thalotia coffea* Gabb. Cat. No. 165,298, U. S. N. M. Back view; altitude, 29 mm. Fugler Point asphalt mine, near Gary; locality No. 4475; also known recent.
5. *Thalotia coffea* Gabb. Cat. No. 165,297, U. S. N. M. View of side of fragment, slightly tilted up; altitude, 21 mm.; same locality as fig. 4.
6. *Lymnaea alamosensis*, new species. Cat. No. 165,426, U. S. N. M. Type. Aperture view; altitude, 6 mm., $\times 6$. Fresh-water beds 1 mile southeast of bench-mark 425, Los Alamos Valley; locality No. 4483.
7. *Lymnaea alamosensis*, new species. Cat. No. 165,426, U. S. N. M. Aperture view of young specimen; altitude, 3.5 mm., $\times 6$. Same locality as fig. 6.
8. *Cadulus fusiformis* Sharp and Pilsbry. Cat. No. 165,267, U. S. N. M. Side view; longitude, 10 mm., $\times 3$. Waldorf asphalt mine; locality No. 4473; also known recent.
9. *Cancellaria crawfordiana* Dall, var. *fugleri*, new variety. Cat. No. 165,322, U. S. N. M. Type. Aperture view; altitude, 22.5 mm., $\times 2$. Fugler Point asphalt mine, near Gary; locality No. 4475.
10. *Ocenebra micheli* Ford, var. *waldorfensis*, new variety. Cat. No. 165,261, U. S. N. M. Type. Altitude, 11 mm.; aperture view, $\times 3$. Waldorf asphalt mine; locality No. 4473.
11. *Turritella cooperi* Carpenter. Cat. No. 165,273, U. S. N. M. Altitude, 34 mm.; aperture view, $\times 2$. Waldorf asphalt mine; locality No. 4473. Common in the Pliocene and Pleistocene.
12. *Drillia waldorfensis*, new species. Cat. No. 165,270, U. S. N. M. Type. Aperture view of imperfect specimen; altitude, 18.5 mm., $\times 2$. Waldorf asphalt mine; locality No. 4473.
13. *Drillia johnsoni* Arnold. Cat. No. 165,263, U. S. N. M. Altitude, 34 mm.; back view, $\times 2$. Waldorf asphalt mine; locality No. 4473; also found fossil at San Pedro.

- 14a. *Neverita reclusiana* Petit. Cat. No. 165,323, U. S. N. M. Altitude, 35 mm.; aperture view. Fugler Point asphalt mine, near Gary; locality No. 4475; also known recent.
- 14b. View of base of same specimen.
15. *Neverita reclusiana* Petit. Cat. No. 165,299, U. S. N. M. Altitude, 20 mm.; aperture view, $\times 2$. Fugler Point asphalt mine, near Gary; locality No. 4475.
16. *Natica clausa* Broderip and Sowerby. Cat. No. 165,269, U. S. N. M. Altitude, 21 mm.; aperture view, $\times 2$. Waldorf asphalt mine; locality No. 4473; also known recent.
17. *Nassa waldorfensis*, new species. Cat. No. 165,272, U. S. N. M. Type. Altitude, 13 mm.; aperture view, $\times 2$. Waldorf asphalt mine; locality No. 4473.
18. *Drillia graciosana*, new species. Cat. No. 165,309, U. S. N. M. Type. Altitude, 14 mm.; aperture view, $\times 2$. Graciosa Ridge, near Orcutt; locality No. 4476.

PLATE LV

Fernando (Pliocene) Fossils

- FIG. 1a. *Pholadidea ovoidca* Gould. Cat. No. 165,277, U. S. N. M. Longitude, 58 mm.; view of valve. Waldorf asphalt mine; locality No. 4473; also known recent.
- 1b. View of both valves of same specimen from above.
2. *Purpura crispata* Chemnitz. Cat. No. 165,278, U. S. N. M. Altitude, 20 mm.; aperture view. One mile north of Schumann; locality No. 4474; also known recent.
- 3a. *Leda taphia* Dall. Cat. No. 165,296, U. S. N. M. View of exterior of valve; longitude, 10.5 mm., $\times 3$. Fugler Point asphalt mine, near Gary; locality No. 4475; also known recent.
- 3b. View of both valves of same specimen from above.
- 4a. *Terebratalia occidentalis* Dall. Cat. No. 165,300, U. S. N. M. View of exterior of ventral valve; latitude, 30 mm. Fugler Point asphalt mine, near Gary; locality No. 4475. A variable species extending from the upper Miocene to Recent faunas.
- 4b. View of dorsal valve of same specimen.
5. *Macoma nasuta* Conrad. Cat. No. 165,276, U. S. N. M. Longitude, 47 mm.; view of right valve. Waldorf asphalt mine; locality No. 4473. Extends from the Miocene to the Recent fauna.
6. *Phacoides nuttallii* Conrad, var. *antecedens*, new variety. Cat. No. 165,290, U. S. N. M. Type. View of exterior of left valve; longitude, 23 mm., $\times 2$. Alcatraz asphalt mine, near Sisquoc; locality No. 4471.
7. *Cryptomya ovalis* Conrad. Cat. No. 165,289, U. S. N. M. Left valve; longitude, 23 mm. Alcatraz asphalt mine, near Sisquoc; locality No. 4471. Apparently characteristic of the lower Pliocene.
8. *Dosinia ponderosa* Gray. Cat. No. 165,295, U. S. N. M. View of exterior of right valve; altitude, 105 mm., $\times \frac{1}{2}$. Alcatraz asphalt mine, near Sisquoc; locality No. 4471; also known recent farther south.

9. *Leda orcutti*, new species. Cat. No. 165,271, U. S. N. M. Type. View of exterior; longitude, 7 mm., $\times 3$. Waldorf asphalt mine; locality No. 4473.
10. *Tapes tenerrima* Carpenter. Cat. No. 165,293, U. S. N. M. View of exterior of left valve; longitude, 83 mm. Alcatraz asphalt mine, near Sisquoc; locality No. 4471. Common in the Pliocene; also known recent farther north.

PLATE LVI

Fernando (Pliocene) Fossils

- FIG. 1. *Spisula sisquocensis*, new species. Cat. No. 165,292, U. S. N. M. Type. View of exterior of left valve; longitude, 120 mm., $\times \frac{1}{2}$. Alcatraz asphalt mine, near Sisquoc; locality No. 4471.
2. *Clidiophora punctata* Carpenter. Cat. No. 165,302, U. S. N. M. View of exterior of right valve; longitude, 36 mm. Graciosa Ridge, near Orcutt; locality No. 4476; also known recent.
3. *Clidiophora punctata* Carpenter. Cat. No. 165,283, U. S. N. M. View of interior of left valve; longitude, 35 mm. Graciosa Ridge, near Orcutt; locality No. 4476.
4. *Venericardia californica* Dall. Cat. No. 165,274, U. S. N. M. Altitude, 29 mm.; aperture view. Waldorf asphalt mine; locality No. 4473. A magnificent species common in and characteristic of the lower Pliocene.
5. *Cuningia californica* Conrad. Cat. No. 165,311, U. S. N. M. View of exterior of left valve; longitude, 17 mm., $\times 2$. Fugler Point asphalt mine, near Gary; locality No. 4475; also known recent.
6. *Spisula callilliformis* Conrad, var. *alcatrazensis*, new variety. Cat. No. 165,291, U. S. N. M. Type. View of exterior of right valve; longitude, 128 mm., $\times \frac{1}{2}$. Alcatraz asphalt mine, near Sisquoc; locality No. 4471.
7. *Bathytoma carpenteriana* Gabb, var. *fernandoana*, new variety. Cat. No. 165,303, U. S. N. M. Type. Altitude, 24 mm.; aperture view. Graciosa Ridge, near Orcutt; locality No. 4476.
8. *Phacoides annulatus* Reeve. Cat. No. 165,286, U. S. N. M. View of exterior of right valve; longitude, 45 mm. One mile north of Schumann; locality No. 4474. Common in the Fernando, and also found recent in southern waters.
- 9a. *Phacoides intensus* Dall. Cat. No. 165,260, U. S. N. M. View of exterior of left valve; altitude, 6.5 mm., $\times 4$. Waldorf asphalt mine; locality No. 4473. Found in lower Pliocene as far south as San Diego.
- 9b. View of interior of same specimen, $\times 4$.
10. *Ostrea veatchii* Gabb. Cat. No. 165,282, U. S. N. M. View of exterior of left valve; altitude, 96 mm. One mile north of Schumann; locality No. 4474. Found in same horizon as far south as San Diego.

PLATE LVII

Fernando (Pliocene) Gasteropoda

(All specimens are from Fernando formation, Bath-house Beach, Santa Barbara.)

- FIG. 1. *Mitramorpha filosa* Carpenter, var. *barbarensis*, new variety. Cat. No. 165,245, U. S. N. M. Type. Altitude, 6.5 mm.; aperture view, $\times 4$. Characteristic of this horizon.
2. *Lacuna compacta* Carpenter. Cat. No. 165,235, U. S. N. M. Altitude, 6.5 mm.; aperture view, $\times 4$; also known recent.
3. *Leptothyra bacula* Carpenter. Cat. No. 165,236, U. S. N. M. Diameter, 3 mm.; aperture view, $\times 6$; also known recent.
4. *Mangilia tabulata* Carpenter. Cat. No. 165,240, U. S. N. M. Altitude, 4 mm.; aperture view, $\times 4$; also known recent.
- 5a. *Puncturella delosi*, new species. Cat. No. 165,234, U. S. N. M. Type. Altitude, 1.9 mm.; view of side, $\times 10$. Characteristic of this horizon.
- 5b. Rear view of same specimen, $\times 10$.
6. *Tornatina culcitella* Gould. Cat. No. 165,239, U. S. N. M. Altitude, 5 mm.; aperture view, $\times 4$; also known recent.
7. *Amphissa corrugata* Reeve. Cat. No. 165,243, U. S. N. M. Altitude, 11 mm.; aperture view, $\times 3$; also known recent.
8. *Nassa perpinguis* Hinds. Cat. No. 165,237, U. S. N. M. Altitude, 10 mm.; aperture view, $\times 2$; also known recent.
9. *Clathurella conradiana* Gabb. Cat. No. 165,247, U. S. N. M. Altitude, 11 mm.; aperture view, $\times 3$; also reported as recent, but the recent form is probably another species or variety.
10. *Columbella (Astyris) tuberosa* Carpenter. Cat. No. 165,242, U. S. N. M. Altitude, 9 mm.; aperture view, $\times 3$; also known recent.
11. *Ocenebra lurida* Middendorf. Cat. No. 165,233, U. S. N. M. Altitude, 12 mm.; aperture view, $\times 2$; also known recent.
12. *Trophon (Boreotrophon) stuarti* Smith. Cat. No. 165,244, U. S. N. M. Altitude, 20 mm.; aperture view, $\times 2$; also known recent.
13. *Bittium catalinensis* Bartsch. Cat. No. 165,232, U. S. N. M. Type. Altitude, 7 mm.; aperture view, $\times 6$.
14. *Galerus mammillaris* Broderip. Cat. No. 165,251, U. S. N. M. Maximum diameter, 17 mm.; view of top, $\times 2$; also known recent.
15. *Bittium barbarensis* Bartsch. Cat. No. 165,231, U. S. N. M. Type. Altitude, 8.5 mm.; aperture view, $\times 6$.

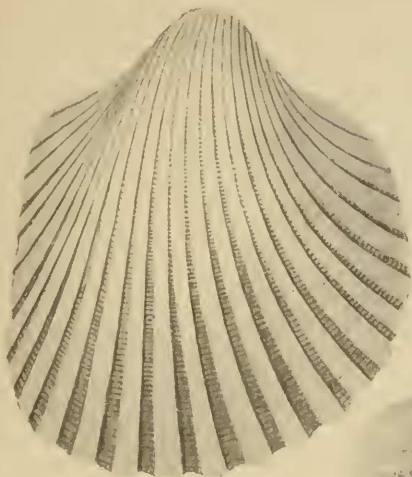
PLATE LVIII

Fernando (Pliocene) Pelecypoda and Brachiopoda

(Unless otherwise stated, all specimens are from Fernando formation, Bath-house Beach, Santa Barbara.)

- FIG. 1a. *Mercenaria perlaminosa* Conrad. Cat. No. 165,252, U. S. N. M. Right valve; longitude, 87 mm.; view of exterior. Characteristic of this horizon.
- 1b. View of the same specimen from front.

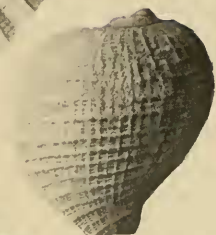
- 1c. *Mercenaria perlaminosa* Gabb. Cat. No. 165,288, U. S. N. M. Longitude of fragment, showing hinge of left valve, 56 mm. Characteristic of this horizon.
- 2a. *Venericardia yatesi*, new species. Cat. No. 165,248, U. S. N. M. Type. Right valve; latitude, 4 mm.; view of exterior, $\times 6$. Characteristic of this horizon.
- 2b. View of interior of same specimen.
3. *Psephidia barborensis*, new species. Cat. No. 165,238, U. S. N. M. Type. Altitude, 4 mm.; view of interior, $\times 4$. Characteristic of this horizon.
- 4a. *Terebratalia hemphilli* Dall. Cat. No. 108,495, U. S. N. M. Holotype. Proc. U. S. Nat. Mus., xxiv, 1902, pl. xl, fig. 10. Ventral valve; longitude, 35 mm.; view of exterior, slightly enlarged. Arroyo Burro, west of Santa Barbara.
- 4b. Exterior of view of dorsal valve of same specimen. *Op. cit.*, pl. xl, fig. 8.



1



2^b



5^a



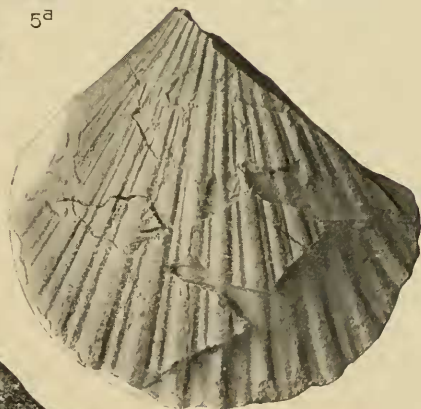
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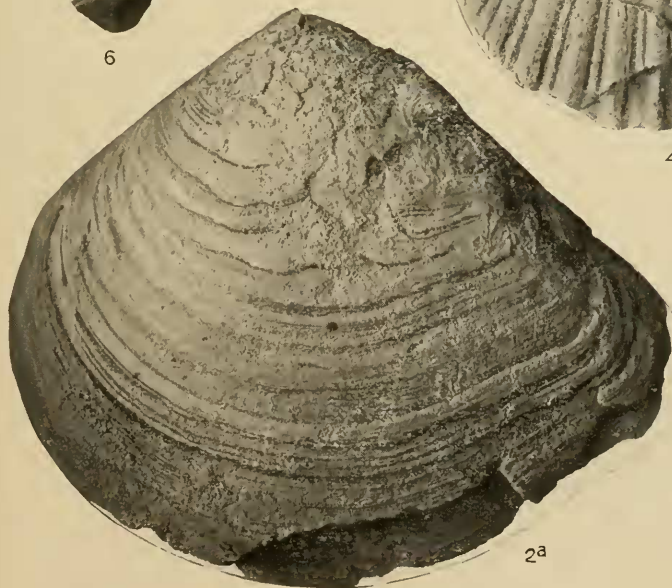
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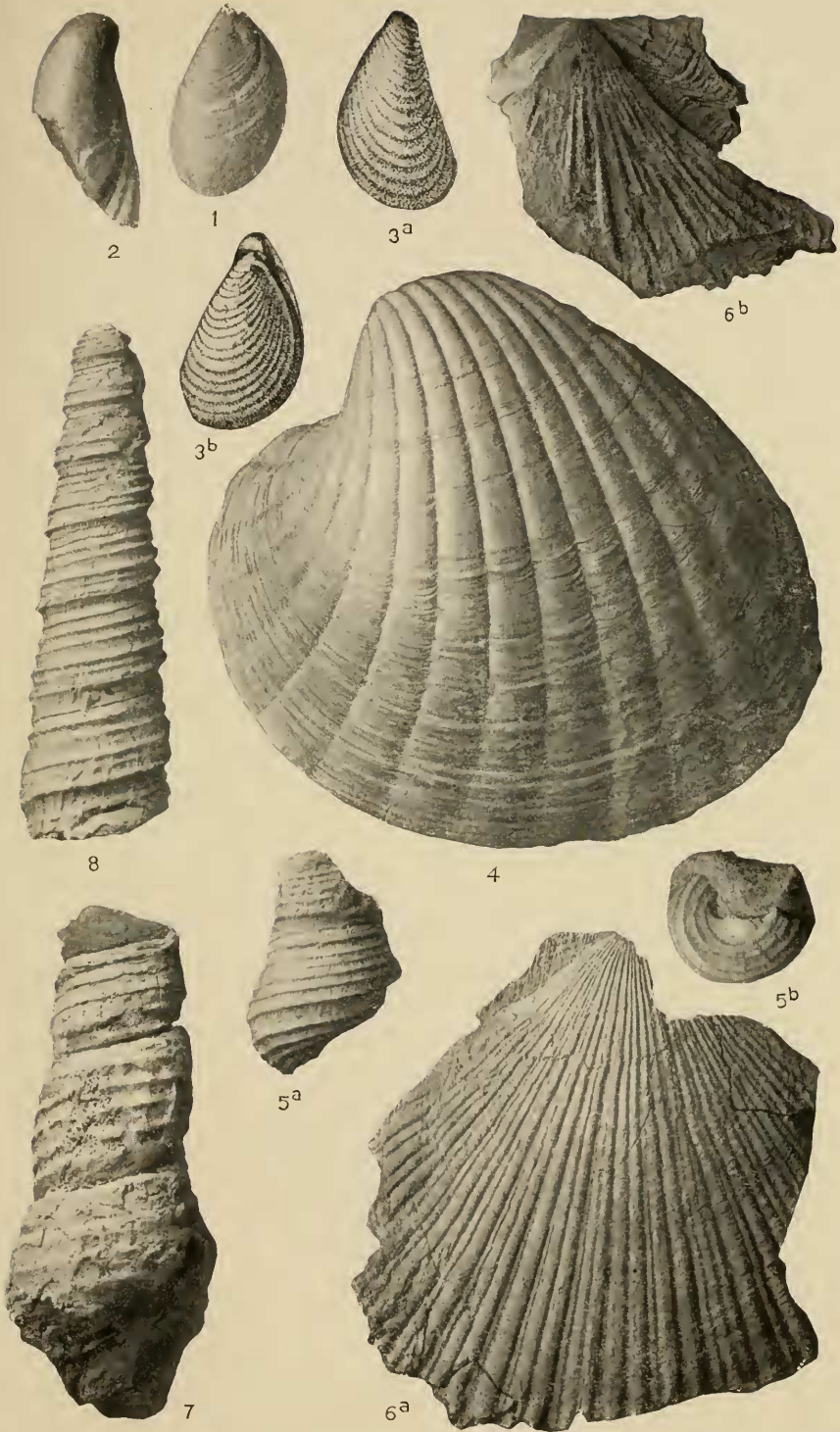
5^b



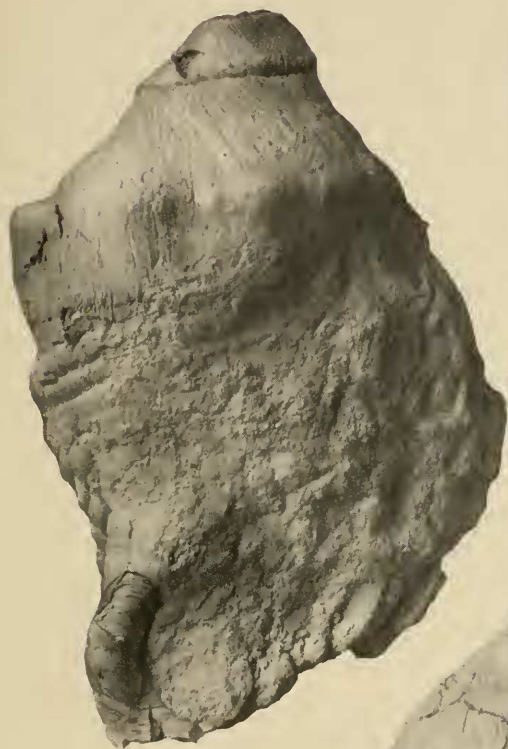
4



2^a



KNOXVILLE (CRETACEOUS) AND TEJON (EOCENE) FOSSILS



1a



2



1b



2



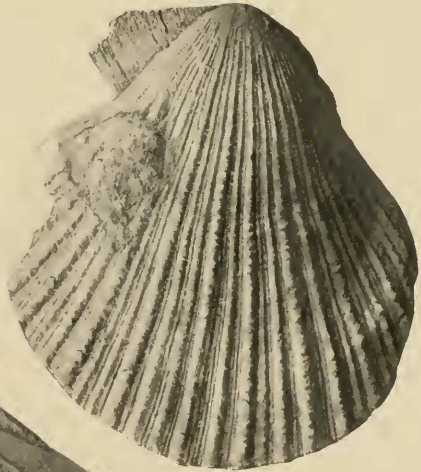
4^a



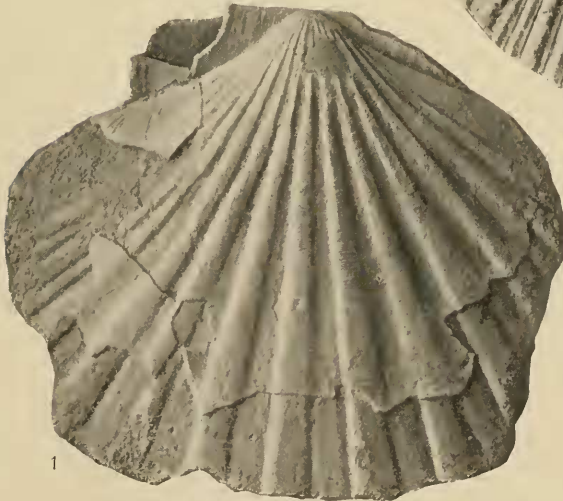
4^c



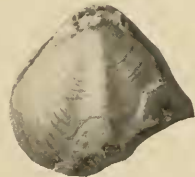
4^d



3



1



4^b