

NEW AND CHARACTERISTIC SPECIES OF FOSSIL MOLLUSKS FROM THE OIL-BEARING TERTIARY FORMATIONS OF SOUTHERN CALIFORNIA.

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INTRODUCTION.

Among the fossils commonly found in or characteristic of certain of the oil-bearing Tertiary formations of southern California are the species and varieties mentioned in the following pages. The new forms are described and figured: those previously described are simply figured, but 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 those species and only those 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 XXV to XLI, Bulletin No. 309, U. S. Geological Survey.

The following new species and varieties are found in the yellow sandstone of the lower Miocene at the head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California.

LIST OF LOWER MIOCENE FOSSILS FROM TOPANGA CANYON.

- Mytilus matheusonii* Gabb var. *expansus*, new variety.
- Cerithium topangensis*, new species.
- Chlorostoma dalli*, new species.
- Bathytoma keepi*, new species.
- Macron merriami*, new species.
- Ocenebra topangensis*, new species.
- Purpura edmondi*, new species.
- Sigaretus perrini*, new species.
- Turbo topangensis*, new species.

Associated with them at this locality are:

- Callista (Amiantis) diablocensis* Anderson.
Cardium, species (sharp ribs).
Cardium, species (square ribs).
Chione temblorcensis Anderson.
Dosinia ponderosa Gray.
Glycymeris, species (large).
Macoma cf. *nasuta* Conrad.
Ostrca titan Conrad.
Pecten bowersi Arnold.
Pecten cf. *miguelensis* Arnold.
Phacoides richthofeni Gabb.
Venus pertenuis Gabb.
Agasoma cf. *kernianum* Cooper.
Bittium, species.
Calliostoma, species.
Cancellaria cf. *condoni* Anderson.
Cylichna, species.
Drillia, species.
Fusus, species.
Neverita callosa Conrad.
Trochita costellata Conrad.
Trochita cf. *inornata* Gabb.
Trophon, species.
Turritella ocoyana Conrad.
Turritella variata Conrad.

The following new species and varieties are from the sandstone in the Pliocene (middle part of the Fernando formation) near the Pacific Coast Oil Company's wells in Elsmere Canyon, 2½ miles southeast of Newhall, Los Angeles County, California.

LIST OF LOWER PLIOCENE FOSSILS FROM ELSMERE CANYON.

- Cancellaria fernandoensis*, new species.
Cardium quadrigenarium Conrad var. *fernandoensis*, new variety.
Cypraea fernandoensis, new species.
Murex eldridgei, new species.
Pisania fortis Carpenter var. *angulata*, new variety.
Priene oregonensis Redfield var. *angelensis*, new variety.
Turritella cooperi Carpenter var. *fernandensis*, new variety.

Associated with these are:

- Amiantis callosa* Conrad.
Arca trilineata Conrad.
Bathytoma cf. *carpenteriana* Gabb.
Callista subdiaphana Carpenter.
Chione, new species (small).
Chrysolomus arnoldi Rivers?
Cryptomya californica Conrad.
Macoma indentata Carpenter.
Macoma, species.
Mactra cf. *hemphilli* Dall.
Modiolus rectus Conrad.

- Monio macroschisma* Deshayes.
- Mya truncata* Linnaeus.
- Neptunea humerosa* Gabb.
- Neverita reclusiana* Petit.
- Olivella intorta* Carpenter.
- Panopea generosa* Gould.
- Pecten* cf. *caurinus* Gould.
- Pecten estrellanus* Conrad var. *californæ* Arnold.
- Pecten healeyi* Arnold.
- Pecten* cf. *parmelœi* Dall.
- Phacoides annulatus* Reeve.
- Tapes tenerrima* Carpenter.
- Tellina* *ilæ* Dall.
- Tritonium*, species.
- Trochita filosa* Gabb.

Associated with the new forms *Nassa hamlini* and *Priené oregonensis* Redfield var. *angelensis* in the bluish-gray clayey shale of the lower Pliocene (middle Fernando formation) in the Third Street tunnel, Los Angeles, are the following:

LIST OF LOWER PLIOCENE FOSSILS FROM THIRD STREET TUNNEL.

- Arca multicosata* Sowerby.
- Astarte*, species.
- Carditoid*.
- Lima hamlini* Dall.
- Macoma*, species undetermined.
- Ostrea reatchii* Gabb.
- Pecten ashleyi* Arnold.
- Pecten latiauritus* Conrad.
- Pecten opuntia* Dall.
- Pecten pedroanus* Trask (abundant).
- Pecten stearnsii* Dall.
- Buccinum*, species undetermined.
- Fissuridea murina* Carpenter.
- Neverita reclusiana* Petit.
- Pleurotoma*, species undertermined, coral, bird bones.

The brachiopod, *Terebratalia occidentalis* Dall is associated with the following fauna, the equivalent of that of the San Diego formation, in the coarse sandstone and gravel immediately above the unconformity between the lower Pliocene (middle Fernando formation) and the Miocene shale near the mouth of Temescal Canyon, one-half mile north of Port Angeles, Los Angeles County:

LIST OF LOWER PLIOCENE FOSSILS FROM TEMESCAL CANYON.

- Terebratalia smithi* Arnold.
- Pecten ashleyi* Arnold.
- Pecten hastatus* Sowerby.
- Pecten healeyi* Arnold (abundant).
- Pecten stearnsii* Dall.
- Opalia varicostata* Stearns.

NEW MIOCENE SPECIES AND VARIETIES.

OSTREA ELDRIDGEI, new species.

Plate XLII, figs. 2 and 2a.

Description.—Shell about 150 mm. in length, inequivalve, the left very convex, the right flat or slightly concave. Left valve with incurved umbo; a prominent, falcate, evenly convex ridge extends from near the umbo to the margin of the left valve posteriorly; surface of this valve and ridge foliaceous and more or less inclined to be fluted. Left valve approximately flat, with foliaceous surface.

Dimensions.—Longitude, 147 mm.; latitude, 87 mm.; diameter (distance through both valves), 82 mm.

Notes.—This species is distinguished from the other Tertiary oysters of the California Tertiary by the prominent posterior ridge and incurved umbo of the left valve. The species has the external appearance of a *Gryphæa*. Named in honor of the late Mr. George Homans Eldridge, of the U. S. Geological Survey. The type was associated with *Turritella ineziana* Conrad at the Grimes Canyon locality.

Type.—Cat. No. 164966, U.S.N.M.

Locality.—Elkins ranch, east of Grimes Canyon, near Fillmore, Ventura County, California. (G. H. Eldridge.)

Horizon.—Lower Miocene, supposed equivalent of the Vaqueros formation.

MYTILUS MATHEWSONII Gabb var. EXPANSUS, new variety.

Plate XLIII, fig. 2.

Description.—Shell wedge-shaped, rounded behind, curved; posterior margin curved, semiangular in middle, anterior margin more nearly straight; beaks terminal, blunt; surface sculptured by irregular concentric lines and ridges of growth and by fine radiating striae.

Dimensions.—Longitude, 105 mm.; latitude, 50 mm.; diameter of both valves, 60 mm.

Notes.—This variety differs from the typical form in being somewhat smaller, relatively broader, and with straighter anterior margins. The fine radial striation is also said to be lacking in the typical form. It is associated at the type locality with *Scutella fairbanksi* Merriam, *Ostrea* near *titan* Conrad, and *Pecten sespeensis* var. *hydei* Arnold.

Type.—Cat. No. 164968, U.S.N.M.

Locality.—Near Torrey Canyon oil wells, southwest of Piru, Ventura County, California. (G. H. Eldridge.)

Horizon.—Lower Miocene, supposed equivalent of the Vaqueros formation.

PLEUROTOMA (BATHYTOMA) KEEPI, new species.

Plate XLVI, fig. 5.

Description.—Shell large for the genus *Pleurotoma*, fusiform; spire about as long as aperture; whorls six, angulated below the middle, sloping concavely above and about the same below. Surface ornamented by a rim of nodes (ten on the body whorl in the type) on the angle of the whorl and by numerous revolving raised lines or ribs. Aperture narrow, narrowing rapidly from top toward bottom; inner lip straight, outer lip reflecting angulation of whorls.

Dimensions.—Longitude (restored), 60 mm.; latitude, 30 mm.

Notes.—This species is closely allied to and is doubtless the precursor of *P. tryoniana* Gabb. It was first thought that the Miocene forms were the same species as the living, but a careful comparison of specimens shows *P. keepei* to be much more abbreviated and with a relatively more angulated body whorl than *P. tryoniana*. The nodes also are somewhat sharper and are more prominently developed on the body whorl in the former. Named in honor of Prof. Josiah Keep, of Mills College, California.

Type.—Cat. No. 164993, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

MACRON MERRIAMI, new species.

Plate XLI, figs. 4 and 4a.

Description.—Shell small, ovate, solid; spire elevated; apex acute; whorls five, evenly convex, nearly smooth, except for a prominent furrow which passes around the body whorl one-third the way up from its base; between this prominent furrow and the umbilicus are three other less prominent grooves. Suture narrow but canal-like; aperture narrow and elliptical. Columella slightly callous posteriorly; anterior portion produced and flexed; posterior part of lip bent. Canal a mere notch. Umbilicus subperforate.

Dimensions.—Longitude, 23 mm.; latitude, 13 mm.; body whorl, 19 mm.; aperture, 16 mm.; deflection, about 70°.

Notes.—This characteristic little species is closely allied to and probably is the precursor of *M. kelletii* A. Adams. It differs from the latter, however, in being relatively narrower, having a narrower shoulder at the suture and in having one more groove in the basal portion of the body whorl. Named in honor of Prof. John C. Merriam, of the University of California, Berkeley.

Type.—Cat. No. 164982, U.S.N.M.

Locality.—Head of Topanga Canyon 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

OCINEBRA TOPANGENSIS, new species.

Plate XLIII, fig. 4.

Description.—Shell large for one of this genus, fusiform; spire elevated, subacute; whorls five, strongly angulated above, giving a tabulate appearance to upper portion; whorls crossed by six or seven frills, some of which flex forward and rise to prominent points on the angle; anterior portion of whorls ornamented by about 12 rough, raised spiral lines, the alternate ones being relatively more prominent than those adjacent; posterior portion with six or seven similar lines; suture deeply appressed, undulating, distinct. Aperture subelliptical; inner lip slightly enameled; columella twisted, squamose, only slightly widened; umbilicus subperforate; canal of medium length, narrow.

Dimensions.—Altitude, 59 mm.; latitude, 30 mm.; body whorl, 46 mm.; aperture, 39 mm.

Notes.—The largest member of this genus known from the West Coast. Somewhat similar to *O. keepi* Arnold but much larger, with less prominently developed frills and much finer spiral sculpture. Named for the type locality, Topanga Canyon.

Type.—Cat. No. 164995, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

PUPURA EDMONDI, new species.

Plate XL, figs. 3 and 3a.

Description.—Shell fusiform, moderately thick; spire elevated; apex subacute; whorls four or five, angulated, the body whorl particularly so; nine or ten prominent nodes on the angle, each node gradually fading out above and below the angle; spiral sculpture consists of more or less obsolete ridges, of which there are about fourteen on the body whorl below the angle and three or four above it; suture appressed, distinct, somewhat wavy, the surface of the shell being corrugated near it. Aperture pyriform; outer lip slightly effuse, denticulated with seven or eight quite sharp and prominent teeth. Inner lip smooth. Umbilicus subperforate. Canal short, curved backward.

Dimensions.—Longitude, 19 mm.; latitude, 12.5 mm.; body whorl, 16.5 mm.; aperture, including canal, 14 mm.

Notes.—Unlike any other *Purpura* on the coast. Resembles *Cuma biphlicata* Gabb, but with angle higher up on whorl; umbilical region also more simple than in latter species. Named in honor of Prof. Geo. W. Edmond, of Santa Monica, California, who first discovered this species.

Type.—Cat. No. 164983, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

CERITHIUM TOPANGENSIS, new species.

Plate XL, figs. 7 and 8.

Description.—Shell turreted; apex acute; whorls nine or ten, slightly convex, with a faint suggestion of a shoulder at the posterior margin. Whorls ornamented by a varying number of spiral and longitudinal ridges of which there are eight of the former and twenty-one of the latter on the penultimate whorl of the type; the relative prominence of the two sets of ridges varies somewhat, but they are normally of about equal importance. Suture impressed; distinct. Aperture subquadrate; outer lip effuse, broadly rounded below and slightly produced in a columellar beak; inner lip straight above this beak.

Dimensions.—Longitude, 23.5 mm.; latitude, 7.5 mm.; body whorl, 10.5 mm.; aperture, 7 mm.

Notes.—Quite unlike any other West Coast Cerithium, being closest, possibly, to *C. gemmata* Hinds, from which it differs by having more numerous and more delicate longitudinal ridges and very much less pronounced nodose sculpture below the suture. Named after the type locality, Topanga Canyon.

Type.—Cat. No. 164976, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

TURBO TOPANGENSIS, new species.

Plate XLI, figs. 6, 6a, and 6b.

Description.—Shell turbinated, solid; whorls somewhat convex and prominently tuberculated, one row of about nine sharp tubercles surmounting the whorl just below the suture, another band of less prominent ones in the middle of the whorl, and the base of the whorl ornamented by another spiral row, the tubercles of which are almost as prominent as the top row; in addition to this there is a secondary sculpture consisting of numerous faint ridges crossing the whorls diagonally from the base posteriorly toward the suture. Base ornamented by three prominent spiral ridges, the outer one tuberculated. Suture impressed, distinct. Aperture round, slightly produced and somewhat flaring in front.

Dimensions.—Altitude, 10.5 mm.; latitude, 18 mm.

Notes.—A unique species, somewhat resembling *Turbo squamigera* Reeve, but differing from the latter in having less tabulated and angulated whorls, a simpler sculpture of tubercles, and in having a

secondary transverse sculpture. Named after the type locality, Topanga Canyon.

Type.—Cat. No. 164980, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

TURRITELLA INEZIANA, Conrad var. **SESPEENSIS**, new variety.

Plate LI, fig. 6.

Description.—Shell turreted, with slender, tapering spire; number of whorls variable, eight or more; whorls slightly concave, with one very prominent revolving ridge at base, and two equal but less prominent ones above. There is also evidence in the type (a rather poorly preserved specimen) of minor spiral lines or riblets, especially one at the base of the major ridge; suture deeply impressed.

Dimensions.—Of broken and slightly distorted type; longitude, 34 mm.; latitude, 10 mm.

Notes.—This form is distinguishable from the typical *T. ineziana* (*T. hoffmanni* of most West Coast authors) by its small size and much more prominently developed spiral ridges. It is abundant but poorly preserved at the type locality. May possibly be of specific value, but if so is allied to *T. ineziana*. It is associated at the type locality with *Modiolus* sp., *Ostrea* cf. *idriensis* Gabb, and *Pecten sespeensis* Arnold. Named after the type locality, Sespe oil district, Ventura County, California.

Type.—Cat. No. 164970, U.S.N.M.

Locality.—Tar Creek, north of Fillmore, Ventura County, California. (G. H. Eldridge.)

Horizon.—Vaqueros formation (lower Miocene).

SIGARETUS PERRINI, new species.

Plate XLI, fig. 5.

Description.—Shell very much elongated for one of this genus; whorls, three or four (type decollete), slightly convex; apex subacute; whorls ornamented with numerous rough revolving lines, each alternate one being considerably more prominent than those adjacent; suture prominent, impressed; aperture pyriform, narrow posteriorly; lower portion of columellar lip slightly flaring.

Dimensions.—Altitude (restored), 21 mm.; latitude, 9.5 mm.; body whorl, 18.5 mm.; aperture, 14 mm.

Notes.—This unique species is entirely unlike anything else in the West Coast fauna, so far as known. It is certainly very much elongated for this genus. Named in honor of Prof. James Perrin Smith, of Leland Stanford Junior University, California.

Type.—Cat. No. 164979, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

CHLOROSTOMA (OMPHALIUS) DALLI, new species.

Plate XL, figs. 4, 4a and 4b.

Description.—Shell conoidal; spire somewhat elevated; apex obtuse; whorls four, slightly convex, angulated just above the suture; portion of whorl above angle crossed by (in the type twelve) transverse ridges or waves running obliquely backward from the angle and appressing against the antecedent whorls. Revolving ridge on angle, and, also on body whorl, on a second equally prominent angle, at the base of the whorl. Whole surface of shell, including base, ornamented by fine revolving lines (in the type there are four of these between the two angles on the body whorl). Five equivalent narrow revolving furrows also ornament the top of the body whorl. Suture distinct. Umbilicus deep and more or less effuse. Aperture circular; columellar lip slightly twisted around umbilicus. Outer lip unknown.

Dimensions.—Altitude, 10 mm.; latitude, 12.5 mm.

Notes.—This species differs from *Chlorostoma aureotinctum* Forbes, to which it is allied, by the lack of the prominent furrows in the base and the presence of the revolving furrows in the top of the whorl. *C. dalli* is a variable form, no two specimens being exactly similar. It grades into the two varieties next described. Named in honor of Dr. William Healy Dall, of the United States Geological Survey.

Type.—Cat. No. 164984, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

CHLOROSTOMA (OMPHALIUS) DALLI var. INORNATUS, new variety.

Plate XL, fig. 5.

Description.—Similar to *C. dalli* except that the transverse waves are obsolete and the revolving furrows on top of the whorls are more numerous and less prominent.

Dimensions.—Altitude, 10 mm.; latitude, 15 mm.

Notes.—The type of this variety is flatter than the typical form, but this is due to crushing.

Type.—Cat. No. 164986, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

CHLOROSTOMA (OMPHALIUS) DALLI var. SUBNODOSUS, new variety.

Plate XL, figs. 6 and 6a.

Description.—Similar to *C. dalli* except that the transverse waves are less pronounced and the spiral sculpture is somewhat coarser. A more or less prominent ridge revolves about the umbilicus.

Dimensions.—Altitude, 10 mm.; latitude, 13.5 mm.

Type.—Cat. No. 164985, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California.

Horizon.—Lower Miocene.

PLIOCENE SPECIES AND VARIETIES.

TEREBRATALIA OCCIDENTALIS Dall.

Plate XLIX, figs. 6, 7, 7a, 8, 8a, 9, and 9a.

Terebratalia occidentalis DALL, Proc. Cal. Acad. Sci., IV, 1871, p. 182, pl. I, fig. 7.

Description.—Shell from subcircular to subelliptical in outline, rather thin; pedicle (lower) valve with mesial flexure concave; on each side of this are usually two prominent ridges, and beyond these still a second pair; surface of valve sometimes nearly smooth, but more often with radiating ridges of varying prominence; lines of growth usually discernible, some being quite prominent; brachial (upper) valve strongly medially convex, with one and sometimes two ridges on either side; secondary sculpture similar to that of lower valve. Beak with a concave or flattened area on each side of the deltidium. Shell broader proportionately in the younger stages of growth.

Dimensions.—Longitude, 27 mm.; latitude, 29 mm.

Notes.—This variable species passes through the same mutations as *T. transversa* Sowerby, from which it differs by having the mesial flexure of the pedicle valve concave and of the brachial valve convex instead of vice versa as in *T. transversa*. Very abundant at Temescal Canyon locality; also found recent on the Pacific coast of North America.

Figured specimens.—Cat. No. 164996, U.S.N.M.

Locality.—Near the mouth of Temescal Canyon, 3 miles north of Santa Monica, Los Angeles County, California. (Ralph Arnold and J. J. Rivers).

Horizon.—Recent and lower Pliocene, probably equivalent of middle Fernando formation.

CARDIUM QUADRIGENARIUM Conrad var. FERNANDOENSIS,
new variety.

Plate XLVIII, figs. 2 and 2a.

Description.—Shell smaller than the typical form, oval, ventricose; umbones central, prominent, turned only slightly anteriorly; surface sculptured with about thirty-six prominent, subangular radiating ridges roughened over the anterior and posterior portions of the shell by prominent pointed tubercles on the posterior angle; those ridges near the posterior margin are less prominent, but are nodose for nearly their whole length.

Dimensions.—Altitude, 55 mm.; longitude, 58 mm.; diameter (both valves), 38 mm.

Notes.—This variety is more oblique, has narrower umbones, is relatively less in diameter, and has fewer and less prominently spinose ribs than the typical form. The typical form has over forty ribs, while var. *fernandoensis* has but thirty-six. Named after the Fernando formation of which it is supposed to be characteristic.

Type.—Cat. No. 164947, U.S.N.M.

Locality.—Elsmere Canyon, near Pacific Coast Oil Company's well, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (lower Pliocene).

CANCELLARIA FERNANDOENSIS, new species.

Plate I, fig. 4.

Description.—Shell about 20 to 24 mm. in altitude; broadly fusiform; spire elevated; whorls four or five, sharply angulated at about two-thirds height of whorl; flat or slightly convex both above and below the angle; whorls crossed by numerous (18 on body whorl) broad longitudinal varices which extend from suture to suture, being fainter above than below; surface also ornamented by equal equidistant raised spiral lines, about three or four below the angle, two or three above. Suture appressed, distinct. Lower portion of type broken.

Dimensions.—Altitude (restored), about 20 mm.; latitude, 13 mm.

Notes.—This species is closely allied to the tropical species *C. candida* Sowerby, but is distinguishable by its broader form, much broader varices, and more evenly spaced spiral lines. Named for the Fernando formation, of which it is supposed to be characteristic.

Type.—Cat. No. 164956, U.S.N.M.

Locality.—Elsmere Canyon, near Pacific Coast Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (lower Pliocene).

PISANIA FORTIS Carpenter var. ANGULATA, new variety.

Plate L, figs. 6 and 7.

Description.—Shell fusiform, short; spire elevated; apex subacute to subangular, whorls angular, about three-fourths of the whorl being below the angle; body whorl below the angle quite uniformly convex. The surface sculpture varies considerably in individual specimens; in the type the sculpture of the body whorl consists of ten equal subequidistant rounded subrugose spiral ridges, each interspace being ornamented by one less prominent but slightly more rugose revolving line on each side of which still finer lines may often be distinguished; above the angle are five revolving lines, less prominent than those on the lower part of the whorl, but alternating in relative size in the same manner as the latter. The penultimate and earlier whorls have about eleven longitudinal waves or low ribs which become most prominent on the angle of the whorls, forming more or less prominent nodes. A prominent sutural riblet is developed on the posterior portion of the whorl. Suture wavy, appressed, distinct. Aperture pyriform; outer lip unknown but probably denticulate. Umbilicus subperforate.

Dimensions.—Longitude (restored), about 55 mm.; latitude, 29 mm.; body whorl, 43 mm.; aperture, 30 mm.; deflection, about 62°.

Notes.—This variety differs from the typical *Pisania fortis* Carpenter, in being broader and in having prominently angulated whorls. The revolving lines in the former are also usually weaker than in the typical form.

Type.—Cat. No. 164959, U.S.N.M.

Locality.—Elsmere Canyon, near Union Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (lower Pliocene). Known only from the type locality where several specimens were found.

PRIENE OREGONENSIS Redfield var. ANGELENSIS, new variety.

Plate L, fig. 11.

Description.—Shell averaging between 80 mm. and 100 mm. in length, fusiform; spire elevated; apex blunt; whorls eight to ten, convex; sculpture of whorls consists of about twenty-four low and rather narrow longitudinal ridges and about seven less prominent, inequidistant spiral ridges, the whole giving the surface a somewhat subdued cancellated appearance; the spiral ridges are augmented by numerous fine spiral striae; suture deeply impressed, somewhat wavy; faint discontinuous, rounded varices in some specimens; aperture subovate; outer lip not thickened; canal long, narrow, recurved.

Dimensions.—Of imperfect and distorted type; longitude, 71 mm.; latitude, 40 mm.; body whorl, 5½ mm.

Notes.—This variety differs from the typical form by its longer, less recurved canal and much less pronounced sculpture. Named after the city of Los Angeles, the type locality.

Type.—Cat. No. 164975, U.S.N.M.

Locality.—Third Street tunnel, Los Angeles, California. (Homer Hamlin.)

Horizon.—Lower Pliocene, probably equivalent of middle Fernando formation.

MUREX ELDRIDGEI, new species.

Plate L, fig. 12.

Description.—Shell broadly fusiform; spire elevated; apex subacute; whorls four, exceedingly convex and ornamented by six prominent convex varices, which cross the whorl diagonally sloping forward up from the base of the whorl to the suture, and each being appressed against the analogous varix of the antecedent whorl in such a way as to give the connected varices a left-handed spiral arrangement, sloping backward down and across the whorls; varices extend full length of body whorl. Surface of whorls and varices ornamented with two or three (six on body whorl) raised lines, between which are finer, more or less beaded raised lines. Suture between the varices deeply impressed, forming pits. Aperture pyriform, narrowing into short, straight canal below; lips smooth.

Dimensions.—Altitude, 24 mm.; latitude, 15 mm.; body whorl, 20 mm.; aperture, 15 mm.

Notes.—This species is closely allied to *Murex incisus* Broderip, but is distinguishable from the latter by its broader form, narrow columella, and simple varices which do not have posteriorly reflexed serrate varices over the sutural pits. Named in honor of the late George Homans Eldridge, of the United States Geological Survey.

Type.—Cat. No. 164955, U.S.N.M.

Locality.—Elsmere Canyon, near Union Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (lower Pliocene).

NASSA HAMLINI, new species.

Plate L, fig. 9.

Description.—Shell about 15 mm. in length, bluntly conical; spire elevated; apex blunt; whorls five or six, quite convex and crossed by several (on the body whorl 12) rather sharp narrow ridges between which are wide interspaces; spiral sculpture consists of four equal,

subequidistant raised lines, of much less prominence than the longitudinal ridges. Suture appressed, distinct, and only slightly wavy. Aperture ovate; outer lip thickened; columellar lip incrustated. Columella slightly twisted, faintly spirally sculptured, and with groove next to body whorl. Canal short.

Dimensions.—Longitude, 15 mm.; latitude, 9 mm.

Notes.—This species is unlike any other West Coast form, being characterized by its blunt apical whorls, convex whorls, deep suture and sharp narrow longitudinal ridges. The type has a glossy surface. Named in honor of Mr. Homer Hamlin, city engineer of Los Angeles, California, to whom we are indebted for preserving the valuable paleontological material taken out of the Third Street tunnel, Los Angeles.

Type.—Cat. No. 164946, U.S.N.M.

Locality.—Third Street tunnel, Los Angeles, California. (Homer Hamlin.)

Horizon.—Lower Pliocene, probably middle Fernando formation.

CYPRÆA FERNANDOENSIS, new species.

Plate L, figs. 8 and 8^a.

Description.—Shell about 40 mm. in length, pyriform, ventricose, convolute; spire concealed; surface covered with brown enamel, some of which is retained; aperture long and narrow, with a canal at each end, the anterior canal being the longer; outer lip inflected and crenulated with about seventeen teeth; inner lip similarly crenulated.

Dimensions.—Longitude, 40 mm.; latitude, 24 mm.

Notes.—This species, which is doubtless the precursor of *C. spadicea* Gray, is relatively broader, has a relatively broader and less protruding anterior portion to the outer lip, has a relatively broader and more nearly straight aperture, fewer teeth, and has these teeth, especially those on the anterior portion of the inner lip, more evenly spaced, than in *C. spadicea*. Named for the Fernando formation, of which it is supposed to be characteristic.

Type.—Cat. No. 164961, U.S.N.M.

Locality.—Elsmere Canyon, near the Pacific Coast Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (Lower Pliocene).

TURRITELLA COOPERI Carpenter var. FERNANDOENSIS new variety.

Plate LI, fig. 13.

Description.—Shell strong, acute-conic, when perfect probably of twelve or more whorls; early whorls unknown; later whorls angulated both above and below near the suture; surface between the

angles flat or slightly concave and ornamented by four (including those at the angles) prominent spiral ridges; both above the upper angle and below the lower one is a similar ridge; suture quite deeply impressed; base practically flat, faintly spirally sculptured; aperture subquadrate.

Dimensions.—Of the type, an imperfect specimen, altitude, 31 mm.; latitude, 12 mm.; altitude of body whorl, 13 mm.

Notes.—The spiral ribs in this variety are all of about equal prominence while in the typical Pleistocene forms the rib on each angle is much more prominent than those between, the latter being little more than raised lines; the surface of the whorl between the angles is also less concave and the general shape of the shell less slender in var. *fernandoensis* than in typical *cooperi*.

Type.—Cat. No. 164957, U. S. N. M.

Locality.—Elsmere Canyon, near the Pacific Coast Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (Lower Pliocene).

EXPLANATION OF PLATES.

All figures are natural size unless otherwise indicated. Unless otherwise indicated all specimens figured are from California.

PLATE XXXVIII.

Fig. 1. *Venericardia planicosta* Lamarek. Cat. No. 164973, U.S.N.M. Left valve; longitude, 84 mm. Eocene, Little Falls, Washington. This is the most widespread and characteristic Eocene species in the world. Found in the Sespe and Silver Thread districts, Ventura County.

1a. View of anterior end of both valves of same.

1b. View from above of both valves of same.

2. *Cardium cooperii* Gabb. Cat. No. 164998, U.S.N.M. A decorticated right valve; longitude, 35 mm. Eocene, Rose Canyon, San Diego County. A common species in the Eocene of the West Coast.

2a. View of both valves of same specimen from above.

3. *Meretrix hornii* Gabb. Left valve; longitude, 36 mm. Pal. Cal., II, pl. xxx, fig. 78. A common species in the Eocene of the west coast.

4. *Modiolus ornatus* Gabb. Right valve; longitude, 38 mm. Pal. Cal., I, pl. xxiv, fig. 166. Another species found in most Eocene faunas of the West Coast.

PLATE XXXIX.

Figures 3, 3a, 3b, 5, and 7 are copied from Pal. Cal., I and II.

Fig. 1. *Pecten (Chlamys) calkinsi* Arnold. Collection Univ. California. An imperfect left valve; altitude 45 mm. Eocene, Sisar Creek, Ventura County.

2. Same species as fig. 1. Imperfect right valve; altitude, 29 mm. Same locality and collection as fig. 1.

3. *Pecten (Propeamusium) interradiatus* Gabb. Left valve; altitude, 25 mm. Eocene shales at New Idria, San Benito County, and in Silver Thread district, Ventura County.

- Fig. 3a. Interior of left valve of same specimen.
- 3b. Outline of ears of right valve of same species.
4. *Glycymeris reatchii* Gabb var. *major* Stanton. Cat. No. 165003, U.S.N.M. Imperfect left valve; longitude, 30 mm. Eocene, Rock Creek, Los Angeles County. Found in the lower Eocene (Martinez formation) in California.
5. *Cardium breuerii* Gabb. Right valve; longitude, 51 mm. Common in the Eocene (Tejon formation and equivalents).
6. *Teredo* sp. Cat. No. 164972, U.S.N.M. Imperfect section of tube, lateral view; diameter, 11 mm. Eocene, Sisar Creek, Ventura County.
- 6a. Same species as fig. 6. Cat. No. 164972, U.S.N.M. Cross section of a crushed specimen; maximum diameter, 15 mm. Same locality as fig. 6.
7. *Fusus remondii* Gabb. Front view; altitude, 41 mm. Common in Eocene (Tejon formation and equivalents) on West Coast.
- 7a. Magnified view of surface of original of fig. 7.
8. *Amatropsis alveatus* Conrad. Cat. No. 165000, U.S.N.M. Front view of partially decorticated specimen; altitude 32 mm. Eocene, Rose Canyon, San Diego County. A characteristic Eocene gasteropod in California.
9. *Morio (Sconsia) tuberculatus* Gabb. Cat. No. 164999, U.S.N.M. Front view of an imperfect and decorticated specimen; altitude 27 mm. Eocene, Rose Canyon, San Diego County. Perfect specimens have an anteriorly plicate plate over the inner lip; outer lip crenulate; revolving lines on surface.
10. *Cylichna costata* Gabb. Cat. No. 165001, U.S.N.M. Front view of slightly imperfect specimen; altitude 18 mm.; twice natural size. Eocene, Rose Canyon, San Diego County. Common in the Eocene (Martinez and Tejon formations and equivalents) in California.

PLATE XL.

- Fig. 1. *Pecten (Lyropecten) bowersi* Arnold. Collection Univ. California. Holotype. Right valve; altitude 150 mm.; about two-thirds natural size. Lower Miocene, Santa Inez Mountains, Santa Barbara County. Also abundant at same horizon in Santa Monica Mountains and elsewhere. The left valve of this species is more convex than the right, but otherwise is very similar.
2. *Ostrea titan* Conrad. Cat. No. 164987, U.S.N.M. Side view of both valves; altitude of large valve 131 mm.; two-thirds natural size. Lower Miocene, 3 miles south of Calabasas, Los Angeles County. This species is found in both the upper and lower Miocene, and often grows to a length of 20 inches (500 mm.). (See Plate XLV, fig. 2.)
3. *Purpura edmondi*, new species. Cat. No. 164983, U.S.N.M. Holotype. Aperture view; altitude 19 mm.; about $1\frac{1}{2}$ times natural size. Lower Miocene, 3 miles south of Calabasas, Los Angeles County.
- 3a. Reverse view of same specimen as fig. 3; same enlargement.
4. *Chlorostoma (Omphalius) dalli*, new species. Cat. No. 164984, U.S.N.M. Holotype. Aperture view; latitude 12.5 mm.; $1\frac{1}{2}$ times natural size. Lower Miocene, 3 miles south of Calabasas, Los Angeles County. A common species in this horizon.
- 4a. Top view of same specimen.
- 4b. Base view of same specimen.
5. *Chlorostoma (Omphalius) dalli* var. *inornatus*, new variety. Cat. No. 164986, U.S.N.M. Holotype. Top view; latitude 13.5 mm.; $1\frac{1}{2}$ times natural size. Same locality as fig. 4.
6. *Chlorostoma (Omphalius) dalli* var. *subnodosus*, new variety. Cat. No. 164985, U.S.N.M. Holotype. Top view; latitude 13 mm.; $1\frac{1}{2}$ times natural size. Same locality as fig. 4.
- 6a. Base view of same specimen as fig. 6.

- Fig. 7. *Cerithium topangensis*, new species. Cat. No. 164976, U.S.N.M. Holotype. Aperture view of imperfect specimen; longitude 23 mm.; $1\frac{1}{2}$ times natural size. Lower Miocene, 3 miles south of Calabasas, at head of Topanga Canyon, Los Angeles County. A common species at the type locality.
8. *Cerithium topangensis*, new species. Cat. No. 164976, U.S.N.M. Cotype. Aperture view of imperfect specimen; longitude 13 mm.; $1\frac{1}{3}$ times natural size. Same locality as fig. 7.
9. *Cancellaria* cf. *condoni* Anderson. Cat. No. 164981, U.S.N.M. Back view of imperfect specimen; altitude 21 mm.; $1\frac{1}{3}$ times natural size. Lower Miocene, 3 miles south of Calabasas, Los Angeles County. This species appears to range from the San Joaquin Valley to the Santa Monica Mountains in the lower Miocene.

PLATE XLI.

- Fig. 1. *Pecten (Lyropecten) magnolia* Conrad. Collection Univ. California. Imperfect right valve; altitude 14.5 mm.; about two-thirds natural size. Lower Miocene, Vaqueros formation, Ojai Valley, Ventura County. Characteristic of the lower Miocene throughout central and southern California. The left valve has narrow, more rounded ribs.
2. *Pecten (Lyropecten) estrellanus* Conrad. Cat. No. 164851, U.S.N.M. Left valve; altitude 97 mm.; about two-thirds natural size. Upper Miocene, Wildhorse Canyon, Monterey County. This species is usually abundant in both the lower and upper Miocene faunas of central and portions of southern California. Ribs of right valve broader and anterior ear notched; otherwise similar to left.
3. *Drillia* sp. Cat. No. 164977, U.S.N.M. Back view; longitude 13.5 mm.; about $1\frac{1}{2}$ times natural size. Lower Miocene, head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County.
4. *Macron merriami*, new species. Cat. No. 164982, U.S.N.M. Holotype. Aperture view; longitude 23 mm.; about $1\frac{1}{3}$ times natural size. Lower Miocene, same locality as fig. 3. This species appears to range over central and southern California in the lower Miocene.
- 4a. Back view of same specimen.
5. *Sigaretus perrini*, new species. Cat. No. 164979, U.S.N.M. Holotype. Aperture view of partially decorticated and imperfect specimen; altitude 18.5 mm.; about $1\frac{1}{3}$ times natural size. Lower Miocene, same locality as fig. 3.
6. *Turbo topangensis*, new species. Cat. No. 164980, U.S.N.M. Holotype. Aperture view; altitude 18.5 mm.; about $1\frac{1}{3}$ times natural size. Lower Miocene, same locality as fig. 3.
- 6a. Top view of same specimen.
- 6b. Base view of same specimen.

PLATE XLII.

- Fig. 1. *Pecten (Amusium) lompopensis* Arnold. Cat. No. 164852, U.S.N.M. Paratype. Interior view, showing internal liræ; altitude 90 mm.; about two-thirds natural size. Lower Miocene, Ojai Valley, Ventura County. This form, so far as known, is confined to the lower Miocene of Santa Barbara and Ventura counties.
2. *Ostrea eldridgei*, new species. Cat. No. 164986, U.S.N.M. Holotype. View of exterior of larger valve; altitude 14.7 mm.; two-thirds natural size. Lower Miocene, supposed equivalent of Vaqueros formation, Elkins ranch, east of Grimes Canyon, south of Fillmore, Ventura County.
- 2a. Lateral view of same specimen.

Fig. 3. *Scutella fairbanksi* Merriam. Cat. No. 164963, U.S.N.M. View of top, showing details; maximum diameter 36 mm.; $1\frac{1}{3}$ times natural size. Lower Miocene, supposed equivalent of Vaqueros formation, near Torrey Canyon wells, southwest of Piru, Ventura County; abundant. This species is also found near the base of the Vaqueros formation in the Sespe district. Supposed to be characteristic of the lower Miocene.

PLATE XLIII.

Fig. 1. *Venus (Chione) temblorensis* Anderson. Cat. No. 164989, U.S.N.M. Exterior of imperfect right valve; longitude 80 mm. Lower Miocene, head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County. Usually abundant in the lower Miocene; a nearly related, possibly identical, form found in the upper Miocene.

1a. Top view of same specimen.

2. *Mytilus mathewsonii* Gabb var. *expansus*, new variety. Cat. No. 164968, U.S.N.M. Holotype. Right valve; altitude 10.5 mm. Lower Miocene, supposed equivalent of the Vaqueros formation, near Torrey Canyon wells, southwest of Piru, Ventura County. This species is usually found in the faunas of the lower Miocene through central and southern California.

3. *Scutella fairbanksi* Merriam. Cat. No. 164963, U.S.N.M. Same locality as fig. 2, but possibly at a somewhat lower horizon.

4. *Ocenebra topangensis*, new species. Cat. No. 164995, U.S.N.M. Holotype. Back view; altitude 59 mm. Lower Miocene, Topanga Canyon, 3 miles south of Calabasas, Los Angeles County. So far known only from this horizon.

PLATE XLIV.

Fig. 1. *Pecten (Lyropecten) crassicardo* Conrad. Cat. No. 164967, U.S.N.M. Exterior of valve, showing characteristic sculpture; altitude 90 mm. Lower Miocene, Ojai Valley, Ventura County. This species ranges through the lower and upper Miocene, being commoner in the former in southern California, in the latter in central California. It is sometimes more convex than the figured specimen, and often shows concentric undulations of the disk.

2. *Pecten (Chlamys) sespeensis* var. *hydei* Arnold. Collection of Delos Arnold. Type. Right valve, ear missing; altitude 46 mm. Lower Miocene, Lynchs Mountain, San Luis Obispo County. Found also in the Vaqueros formation, Little Sespe Creek, and, with *Mytilus mathewsonii* Gabb, in supposed equivalents of the Vaqueros formation near the Torrey Canyon wells, Ventura County.

3. *Pecten (Pseudanusium) peckhami* Gabb. Cat. No. 164839, U.S.N.M. Right and left valves in matrix; altitude of largest 17 mm. Monterey shale (middle Miocene), southeast of Pinole, Contra Costa County. The type of this species came from the Ojai Valley, Ventura County. It is the commonest form in the shales of the middle Miocene (Monterey, Modelo, and equivalent formations) and is also known from the Oligocene in the Santa Cruz Mountains.

4. *Nererita callosa* Gabb. Cat. No. 164992, U.S.N.M. View from above, specimen slightly tilted; maximum latitude 44 mm. Lower Miocene, head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County. Ranges through the Miocene. Common in the lower Miocene of southern San Joaquin Valley and the Santa Monica Mountains.

4a. View of base and aperture of same specimen, showing characteristic shape of callous.

PLATE XLV.

- Fig. 1. *Pecten (Hinnites) giganteus* Gray. Cat. No. 164965, U.S.N.M. Exterior of right valve; altitude 90 mm. Lower Miocene, supposed equivalent of Vaqueros formation, gulch east of Wiley Canyon, southwest of Piru, Ventura County. A very variable species, ranging from the lower Miocene to the Recent fauna.
2. *Ostrea titan* Conrad. Cat. No. 164987, U.S.N.M. View of exterior of larger valve; altitude 131 mm. Lower Miocene, 3 miles south of Calabasas, Los Angeles County. A common form in the upper and lower Miocene; often grows to a length of 20 inches (500 mm.) or more. (See Plate XL, fig. 2.)
3. *Trochita costellata* Conrad. Cat. No. 164994, U.S.N.M. View from above; maximum diameter 38 mm. Same locality as fig. 2. Common in the Miocene.
4. *Phacoides richthofeni* Gabb. Cat. No. 164978, U.S.N.M. Right valve; altitude 17.5 mm. Same locality as fig. 2.
5. *Balanus concavus* Brown. Cat. No. 164971, U.S.N.M. Type. Lateral view; maximum latitude 26 mm. Lower Miocene, Little Sespe Creek, Ventura County. A very common species in this horizon.
- 5a. Top view of same species.

PLATE XLVI.

- Fig. 1. *Pecten (Chlamys) sespeensis* Arnold. California State Mining Bureau. Cotype. Portion of mold of interior of right valve; altitude 50 mm. Lower Miocene, Vaqueros formation, Sespe Canyon, Ventura County. A common species at the type locality; also found elsewhere in central and southern California in the lower Miocene.
- 1a. Mold of interior of left valve of same specimen.
2. *Pecten (Chlamys) sespeensis* Arnold. California State Mining Bureau. Platype. Cast of exterior of slightly imperfect left valve (young); altitude 18 mm. Same locality as fig. 1.
3. *Pecten (Lyropecten) rughani* Arnold. Collection of Delos Arnold. Type. Right valve; altitude 37 mm. Lower Miocene, supposed equivalent of Vaqueros formation, Ojai Valley, Ventura County.
- 3a. View of left valve of same specimen.
4. *Dosinia ponderosa* Gray. Cat. No. 164988, U.S.N.M. Imperfect right valve; altitude 80 mm. Lower Miocene, 3 miles south of Calabasas, Los Angeles County. A common species from the lower Miocene to the Recent southern fauna of the west coast.
5. *Pleurotoma (Bathytoma) keipi*, new species. Cat. No. 164993, U.S.N.M. Holotype. Back view of imperfect specimen. Same locality as fig. 4. Found also in this horizon at several localities in southern San Joaquin Valley.

PLATE XLVII.

- Fig. 1. *Arca camulocensis* Osmont. California State Mining Bureau. Holotype. Right valve; altitude 89 mm. Fernando formation, lower Pliocene or upper Miocene, 1 mile north of Camulos, Ventura County. So far as known this species is characteristic of the lower horizon of the Fernando formation. Also reported from the Puente Hills.
- 1a. End view of same specimen as fig. 1.
- 1b. Portion of surface of same specimen as fig. 1, enlarged, showing nodose ribs.

PLATE XLVIII.

- Fig. 1. *Arca multicosata* Sowerby. Cat. No. 12574, U.S.N.M. Right valve; longitude 101 mm. Recent, San Diego. Found in the lower Pliocene (Fernando formation) in the Puente Hills, Orange County, and in the vicinity of Los Angeles.
2. *Cardium quadrigenarium* Conrad, var. *fernandocensis*, new variety. Cat. No. 164947, U.S.N.M. Holotype. Imperfect left valve; longitude 58 mm. Lower Pliocene (Fernando formation), Elsmere Canyon, near Newhall, Los Angeles County. A common variety in the lower Pliocene. The typical form with 44 ribs and less obliquity is found in the Recent.
- 2a. View of umbos of same specimen from above.
3. *Arca trilineata* Conrad. Cat. No. 164948, U.S.N.M. Right valve of medium-sized specimen; longitude 40 mm. Same locality as fig. 2. A common species in the Pliocene of California. Also appears to extend down as far as the middle Miocene (Monterey).
- 3a. Umbos and hinge area of same specimen viewed from above.
4. *Arca trilineata* Conrad. Cat. No. 164948, U.S.N.M. Portion of an adult left valve, showing the more complex sculpture of the ribs in the later stages of growth; altitude 60 mm. Same locality as fig. 2.
5. *Leda taphria* Dall. Cat. No. 164952, U.S.N.M. Right valve; longitude 36 mm.; twice natural size. Same locality as fig. 2. This species is common from the Pliocene to the Recent fauna in the California province.
- 5a. View of umbos of same specimen from above.
6. *Neverita reclusiana* Petit. Cat. No. 164960, U.S.N.M. Back view; latitude 25 mm. Same locality as fig. 2. A common species from the Pliocene to the Recent fauna; also probably occurs in the Miocene.

PLATE XLIX.

- Fig. 1. *Ostrea reatchii* Gabb. Cat. No. 153827, U.S.N.M. Exterior of valve; altitude 90 mm. Lower Pliocene, San Diego. An abundant and characteristic species in many of the Pliocene localities from southern California to Cerros Island, off Lower California.
2. *Callista (Amiantis) callosa* Conrad. Cat. No. 164953, U.S.N.M. Imperfect left valve; altitude 50 mm. Lower Pliocene (Fernando formation), Elsmere Canyon, near Newhall, Los Angeles County. Base evenly rounded in perfect specimens. Common from Pliocene to Recent.
3. *Callista subdiaphana* Carpenter. Cat. No. 164951, U.S.N.M. Imperfect right valve; longitude 41 mm. Same locality as fig. 2. Abundant in the Pliocene and also found in the Recent.
4. *Terebratalia smithi* Arnold. Cat. No. 164977, U.S.N.M. Pedicle valve; longitude 42 mm. Pliocene, Temescal Canyon, 3 miles north of Santa Monica, Los Angeles County. Known only from the Pliocene. A somewhat variable species.
- 4a. View of brachial valve of same specimen.
5. *Terebratalia smithi* Arnold. Cat. No. 164977, U.S.N.M. Pedicle valve; longitude 29 mm. Same locality as fig. 4. More prominent ribbing than specimen shown in fig. 4.
- 5a. View of brachial valve of same specimen.
6. *Terebratalia occidentalis* Dall. Cat. No. 164996, U.S.N.M. Brachial valve; longitude 40 mm. Same locality as fig. 4. This species is most variable, as is evidenced by this and the following figures, which show a series collected at one locality. Found in the lower Pliocene (and possibly upper Miocene).

Fig. 7. Same species and locality as fig. 6. Pedicle valve; longitude 29 mm.

7a. View of brachial valve of same specimen.

8. Same species and locality as fig. 6. Pedicle valve; longitude 22 mm.

8a. View of brachial valve of same specimen.

9. Same species and locality as fig. 6. Pedicle valve of a less rugose variety; longitude 21 mm.

9a. View of brachial valve of same specimen.

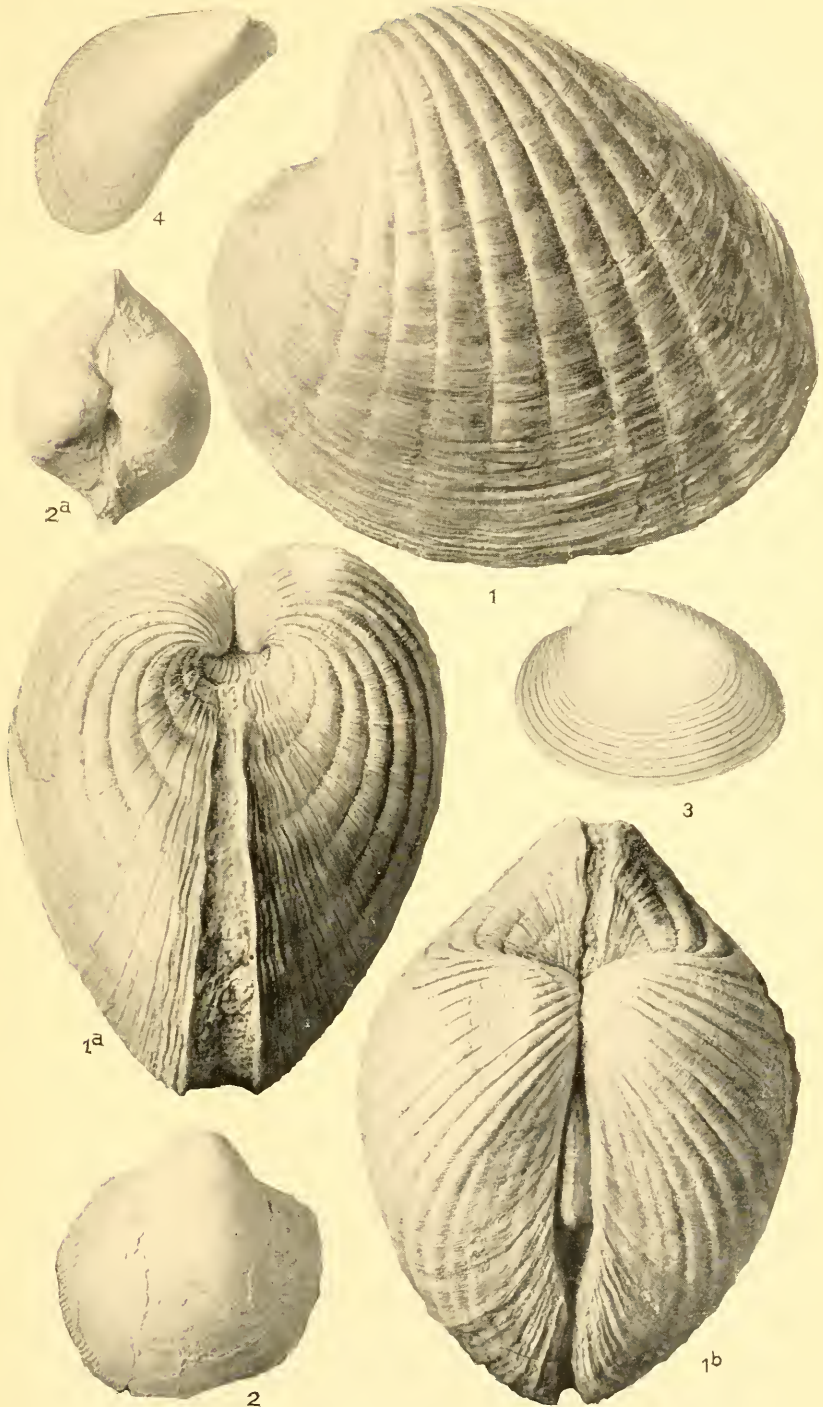
PLATE L.

- Fig. 1. *Mya truncata* Linnaeus. Cat. No. 164950, U.S.N.M. Left valve; longitude 46 mm. Pliocene (Fernando formation), Elsmere Canyon, near Newhall, Los Angeles County. Found also in the Recent fauna of the Arctic regions.
2. *Trochita filosa* Gabb. Cat. No. 164949, U.S.N.M. Slightly imperfect specimen viewed from above; maximum diameter 20 mm.; twice natural size. Same locality as fig. 1. Also found in the upper Miocene.
- 2a. Same specimen. View from the side.
3. *Pissuridea murina* Carpenter. Cat. No. 164945, U.S.N.M. Specimen viewed from above; longitude 14.5 mm.; twice natural size. Lower Pliocene, Third street tunnel, Los Angeles. Also found in the Pleistocene and Recent fauna of the coast.
- 3a. Same specimen; view from the side.
4. *Cancellaria fernandoensis*, new species. Cat. No. 164956, U.S.N.M. Holotype. Back view of imperfect specimen; altitude 17 mm.; twice natural size. Same locality as fig. 1. A similar or identical form was found in the Pliocene of the San Diego well.
5. *Tritonium* sp. Cat. No. 164954, U.S.N.M. Back view of imperfect specimen; altitude 20 mm.; twice natural size. Same locality as fig. 1.
6. *Pisania fortis* Carpenter var. *angulata*, new variety. Cat. No. 164959, U.S.N.M. Paratype. Aperture view of imperfect young; altitude 30 mm. Same locality as fig. 1. A rather common species in the Pleistocene and Pliocene of central and southern California.
7. *Pisania fortis* Carpenter var. *angulata*, new variety. Cat. No. 164958, U.S.N.M. Holotype. Aperture view of imperfect adult; altitude 49 mm. Same locality as fig. 1.
8. *Cyprina fernandoensis*, new species. Cat. No. 164961, U.S.N.M. Holotype. View from back; longitude 40 mm. So far known only from same locality as fig. 1.
- 8a. Aperture view of same specimen.
9. *Nassa hantlini*, new species. Cat. No. 164946, U.S.N.M. Holotype. Aperture view of imperfect specimen; longitude 15 mm. Same locality as fig. 3.
10. *Chrysolonax* cf. *arnoldi* Rivers. Cat. No. 164962 U.S.N.M. Back view of imperfect specimen. Same locality as fig. 1. Known also from the Pleistocene of San Pedro, Los Angeles County.
11. *Priene oregonensis* Redfield var. *angelensis*, new variety. Cat. No. 164975, U.S.N.M. Holotype. Back view of imperfect and slightly contorted specimen; longitude 71 mm. Same locality as fig. 3. Common in the lower Pliocene of the Pacific coast. It is the precursor of the recent *Priene oregonensis* Redfield.
12. *Murex eldridgei*, new species. Cat. No. 164955, U.S.N.M. Holotype. Back view; longitude 24 mm.; twice natural size. Known only from the same locality as fig. 1. Near the Recent *M. incisus* Broderip.
13. *Pecten* (*Chlamys*) *hastatus* Sowerby var. *strategus* Dall. Collection of Delos Arnold. Left valve; altitude 36 mm. Pliocene, Santa Barbara. Also found in the Pliocene of southern California.

Fig. 14. *Pecten (Chlamys) bellilamellatus* Arnold. Collection of Delos Arnold. Holotype. Right valve; altitude 18 mm. Pliocene, Pacific Beach, San Diego. Known only from this horizon at this locality.

PLATE LI.

- Fig. 1. *Turritella pachecoensis* Stanton. Cat. No. 165002, U.S.N.M. Back view of imperfect specimen; altitude 59 mm. Eocene, Rock Creek, Los Angeles County. This species is supposed to be characteristic of the Martinez formation (lower Eocene).
2. *Turritella urasana* Conrad. Cat. No. 164974, U.S.N.M. Wax cast, back view; altitude 41 mm. Sespe Canyon, Ventura County. Supposed to be characteristic of the Tejon formation (middle Eocene).
3. *Turritella urasana* Conrad. Cat. No. 165004, U.S.N.M. Back view of imperfect specimen; altitude 44 mm. Eocene, Rose Canyon, San Diego County.
4. *Turritella ineziana* Conrad (+ *T. hoffmanni* Gabb). Cat. No. 164964, U.S.N.M. Lower Miocene, supposed equivalent of the Vaqueros formation, Chaffee Canyon, southwest of Piru, Ventura County. Supposed to be characteristic of the lower Miocene; found from San Mateo to San Diego counties.
5. *Turritella ineziana* Conrad. Cat. No. 164969, U.S.N.M. Back view of imperfect specimen; altitude 36 mm. Tar Creek, north of Fillmore, Ventura County. Common in the Vaqueros formation, but good specimens are hard to obtain.
6. *Turritella ineziana* Conrad var. *sespensis*, new variety. Cat. No. 164970, U.S.N.M. Holotype. Aperture view of imperfect specimen; altitude 34 mm. Same locality as fig. 5.
7. *Turritella ocoyana* Conrad. Cat. No. 164990, U.S.N.M. Back view of imperfect large specimen; altitude 60 mm. Topanga Canyon, 3 miles south of Calabasas, Los Angeles County. Supposed to be characteristic of the lower Miocene. Common in central and southern California.
8. Same species and locality; altitude 58 mm.
9. Same species and locality; altitude 32 mm.; upper whorls.
10. *Turritella variata* Conrad. Cat. No. 164991, U.S.N.M. Back view of imperfect specimen; altitude 34 mm. Same locality as fig. 7. Supposed to be characteristic of the lower Miocene; so far known only in Fresno County and south.
11. Same species and locality; slender variety; altitude 59 mm.
12. Same species and locality; broad variety; altitude 43 mm.
13. *Turritella cooperi* Carpenter (var.) *fernandoensis*, new variety. Cat. No. 164957, U.S.N.M. Type. Aperture view of imperfect specimen; altitude 31 mm. Lower Pliocene, Fernando formation, Elsmere Canyon, near Newhall, Los Angeles County. A common form in the lower Pliocene of southern California.
14. *Turritella cooperi* Carpenter. Collection of Delos Arnold. Aperture view of typical form. Lower Pleistocene, lower San Pedro formation, Deadman Island, San Pedro, Los Angeles County. Common in the Pliocene and lower Pleistocene from Ventura County southward.
15. *Turritella jewetti* Carpenter. Collection of Delos Arnold. Typical form, aperture view; altitude 70 mm. Same locality and horizon as fig. 14; geologic and geographic range also about the same.



EOCENE PELECYPODA.

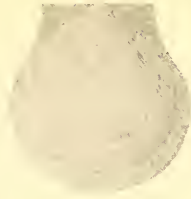
FOR EXPLANATION OF PLATE SEE PAGE 539.



3^a



3^b



3



7^a



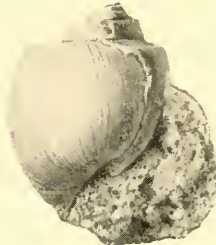
7



9



6



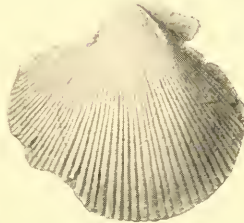
8



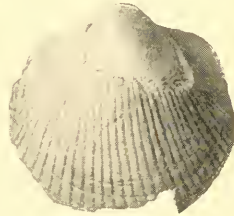
10



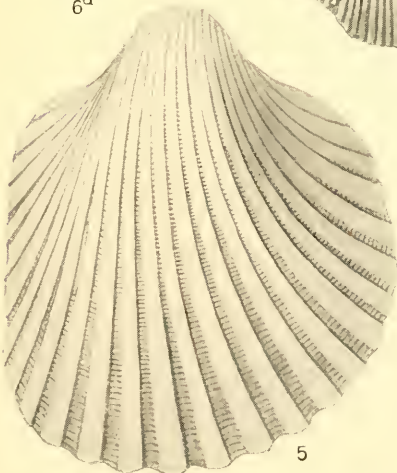
6^a



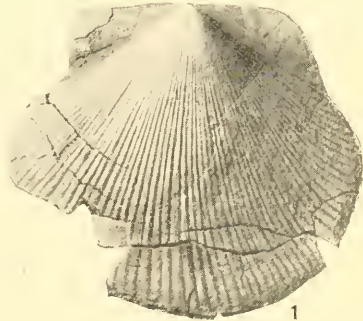
2



4



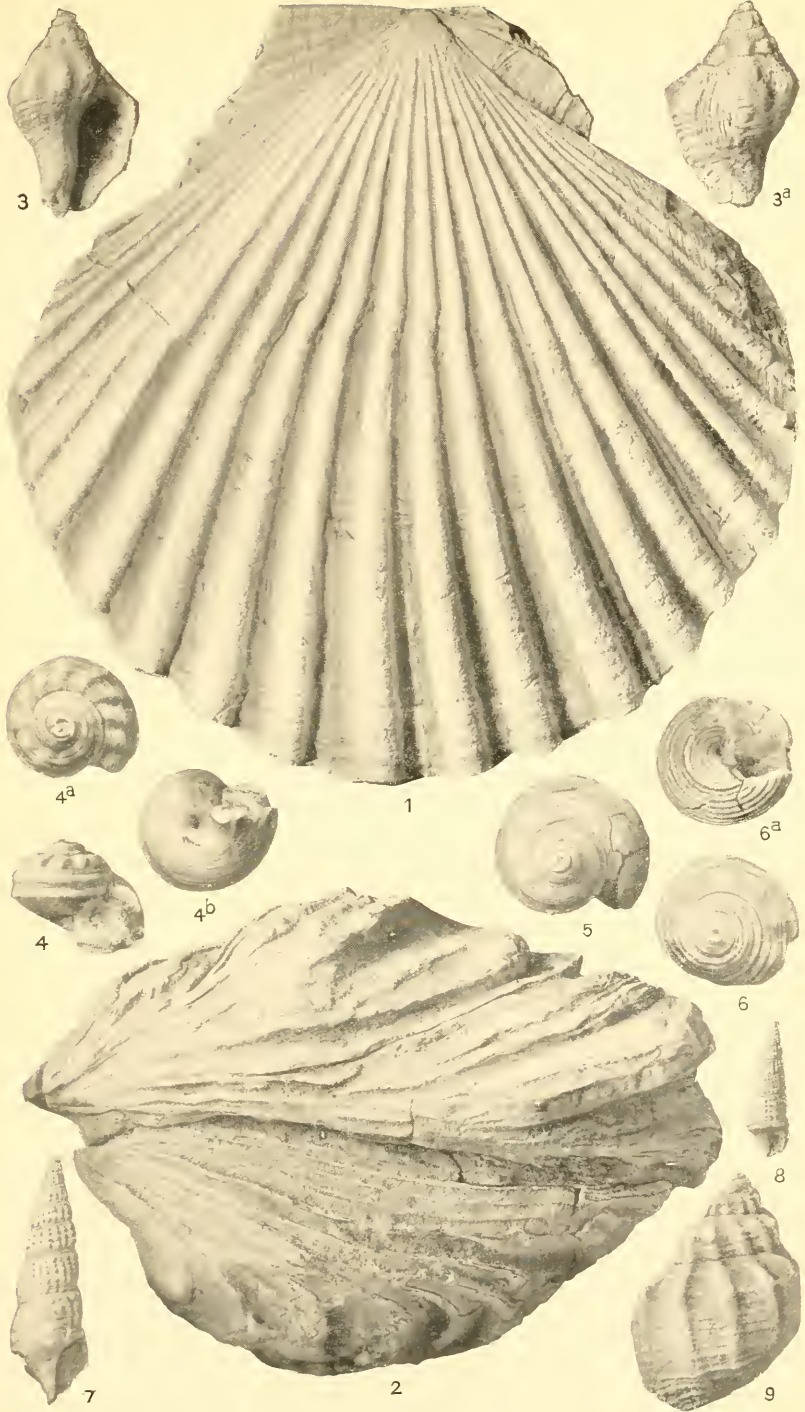
5



1

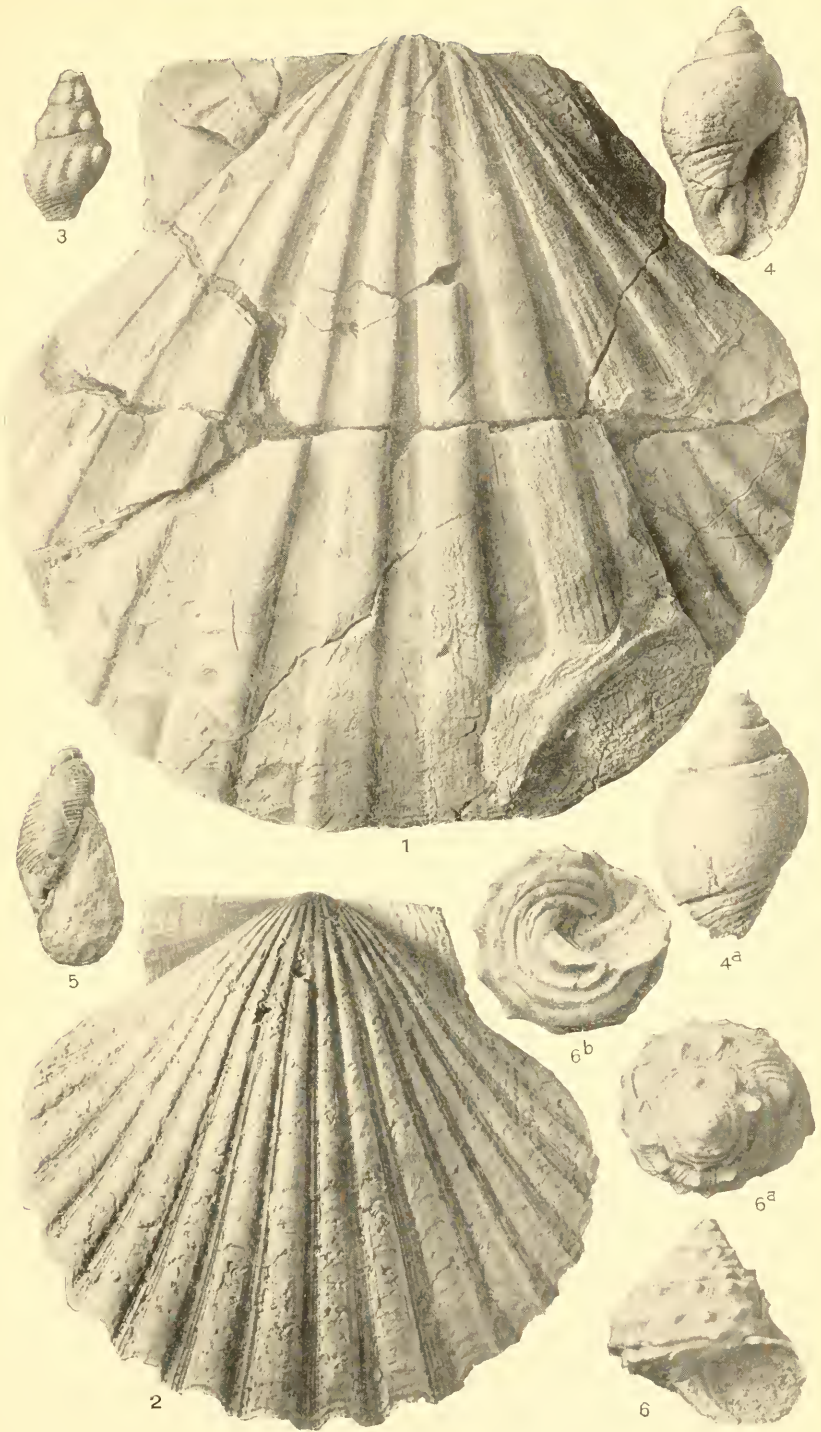
Eocene PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGES 539, 540.



MIocene PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGES 540, 541.



MIocene PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGE 541.



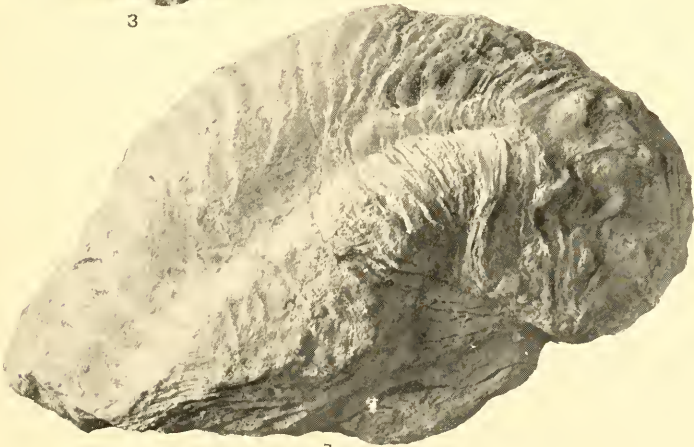
1



2



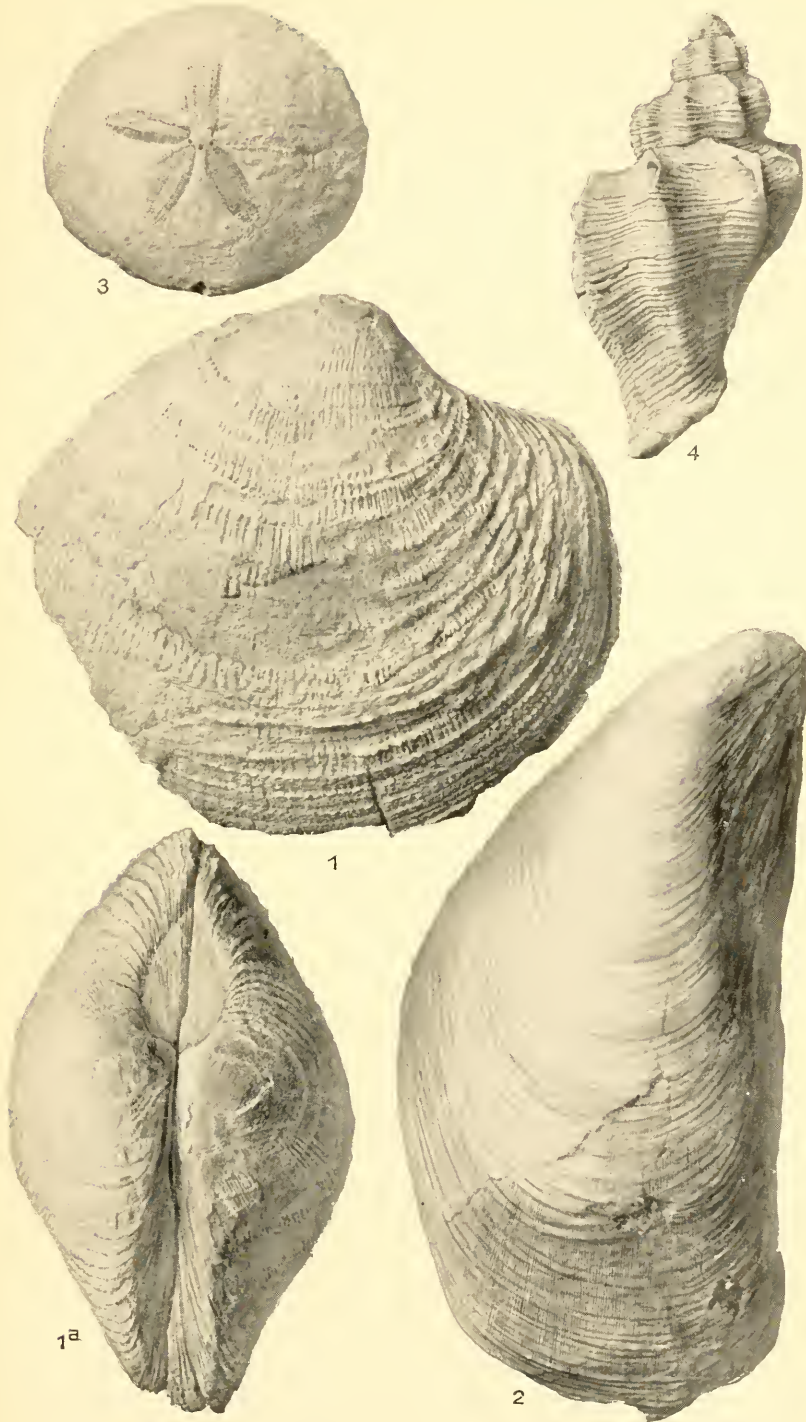
3



2^a

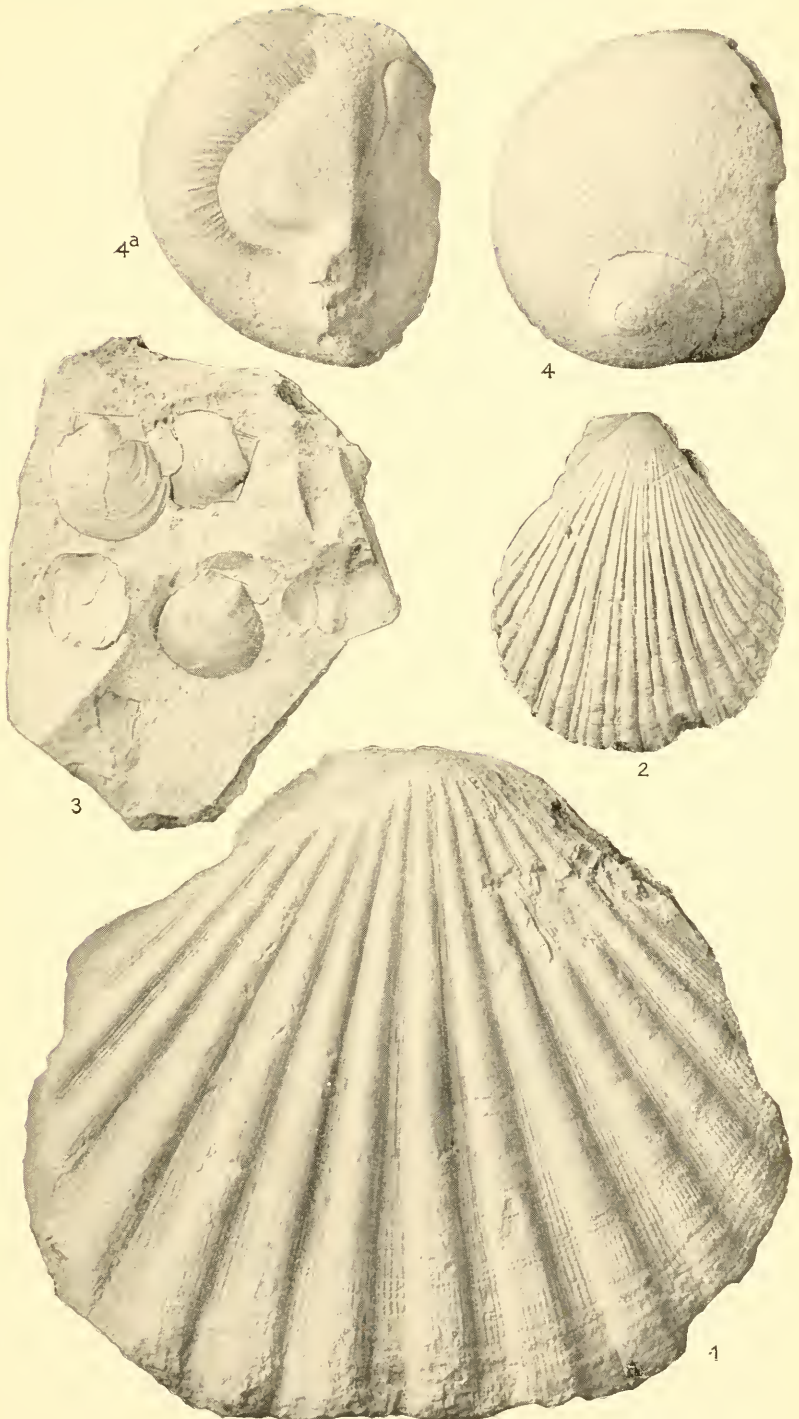
MIOCENE ECHINOIDEA AND PELECYPODA.

FOR EXPLANATION OF PLATE SEE PAGES 541, 542.



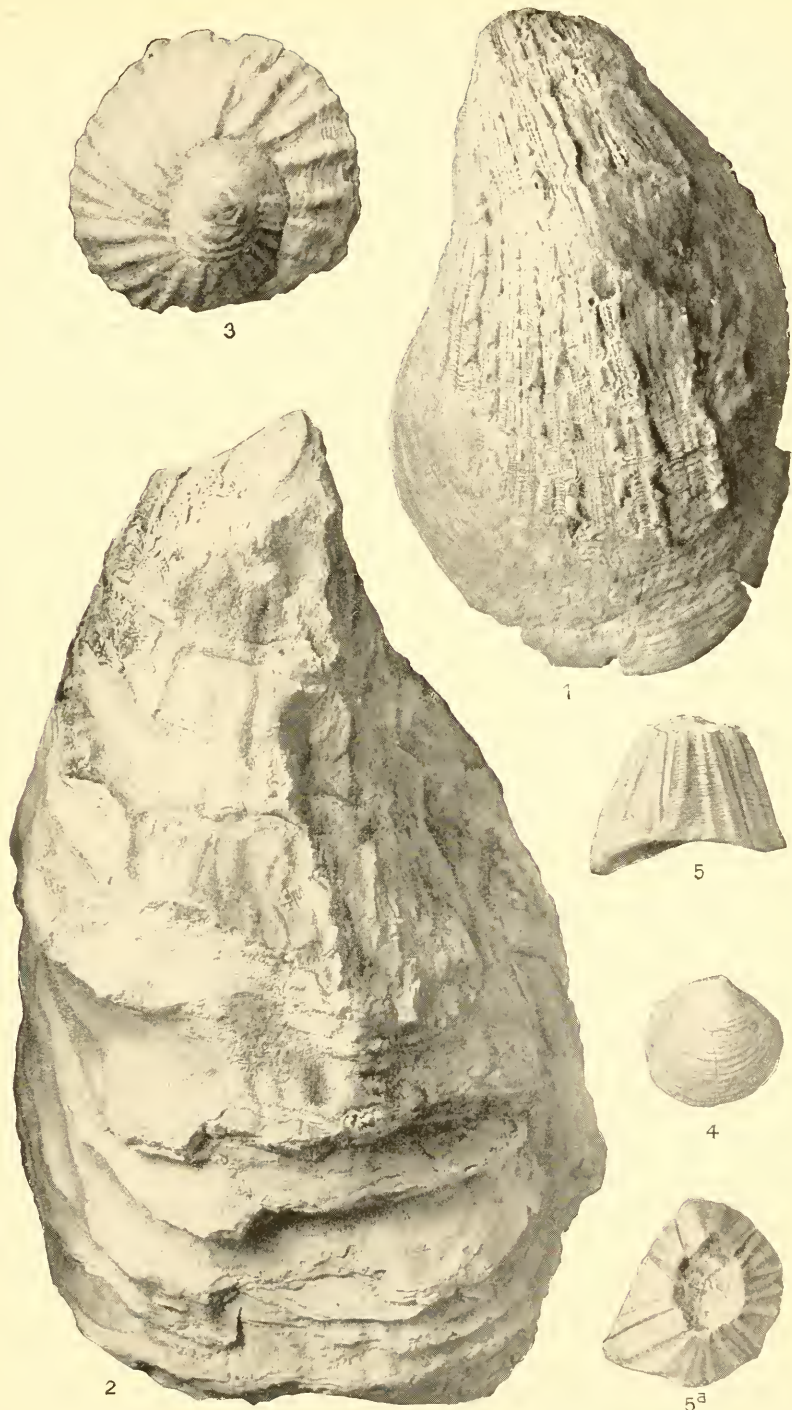
MIOCENE ECHINOIDEA, PELECYPODA, AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGE 542.



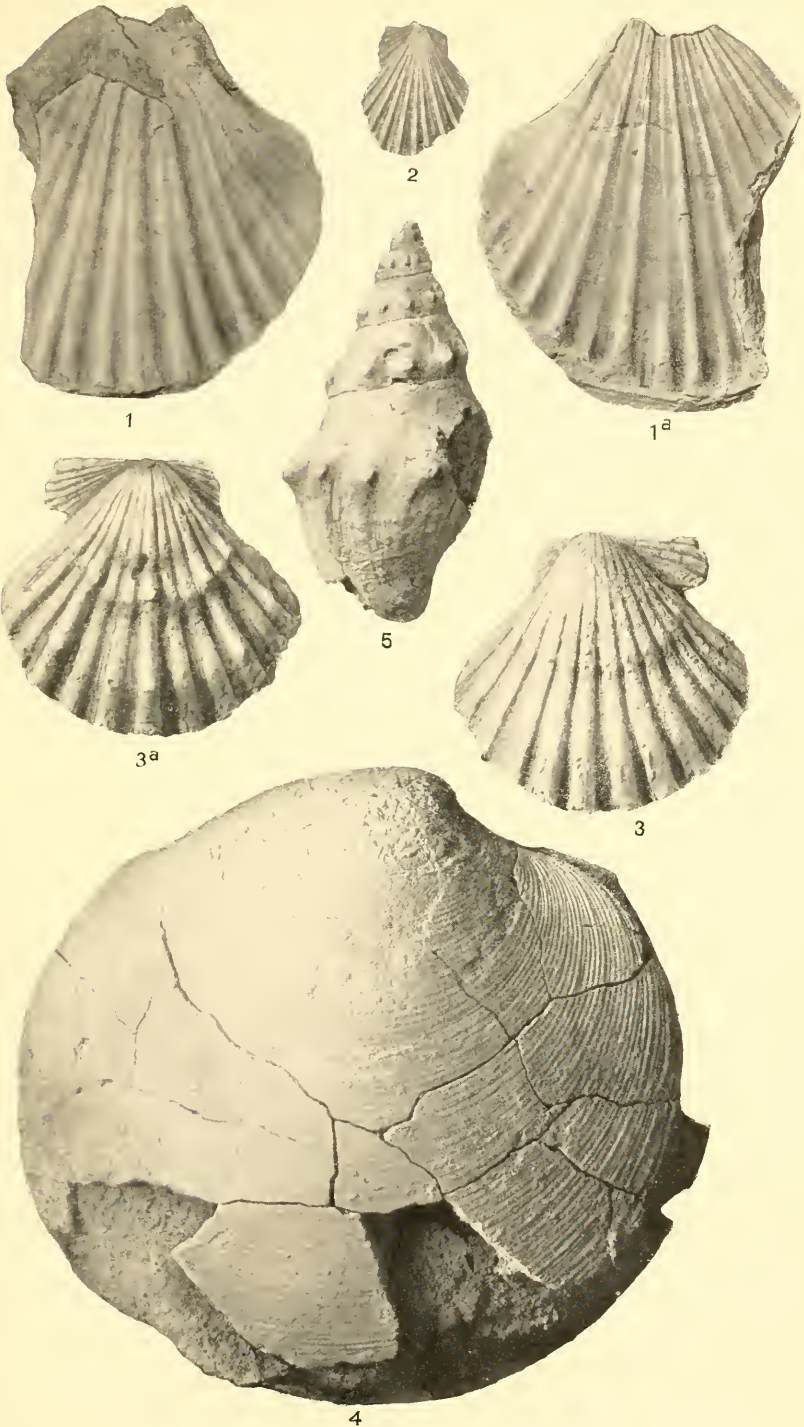
MIOCENE PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGE 542.



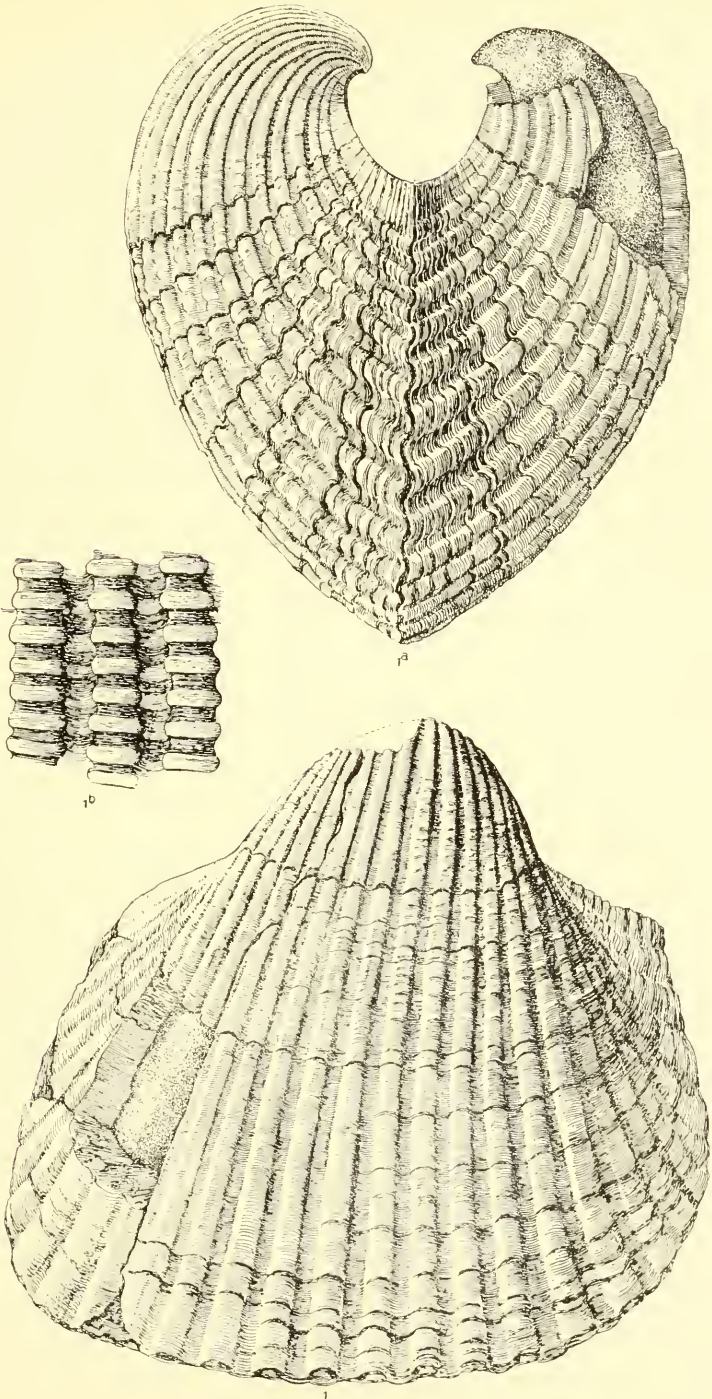
MIOCENE PELECYPODA, GASTEROPODA, AND CRUSTACEA.

FOR EXPLANATION OF PLATE SEE PAGE 543.



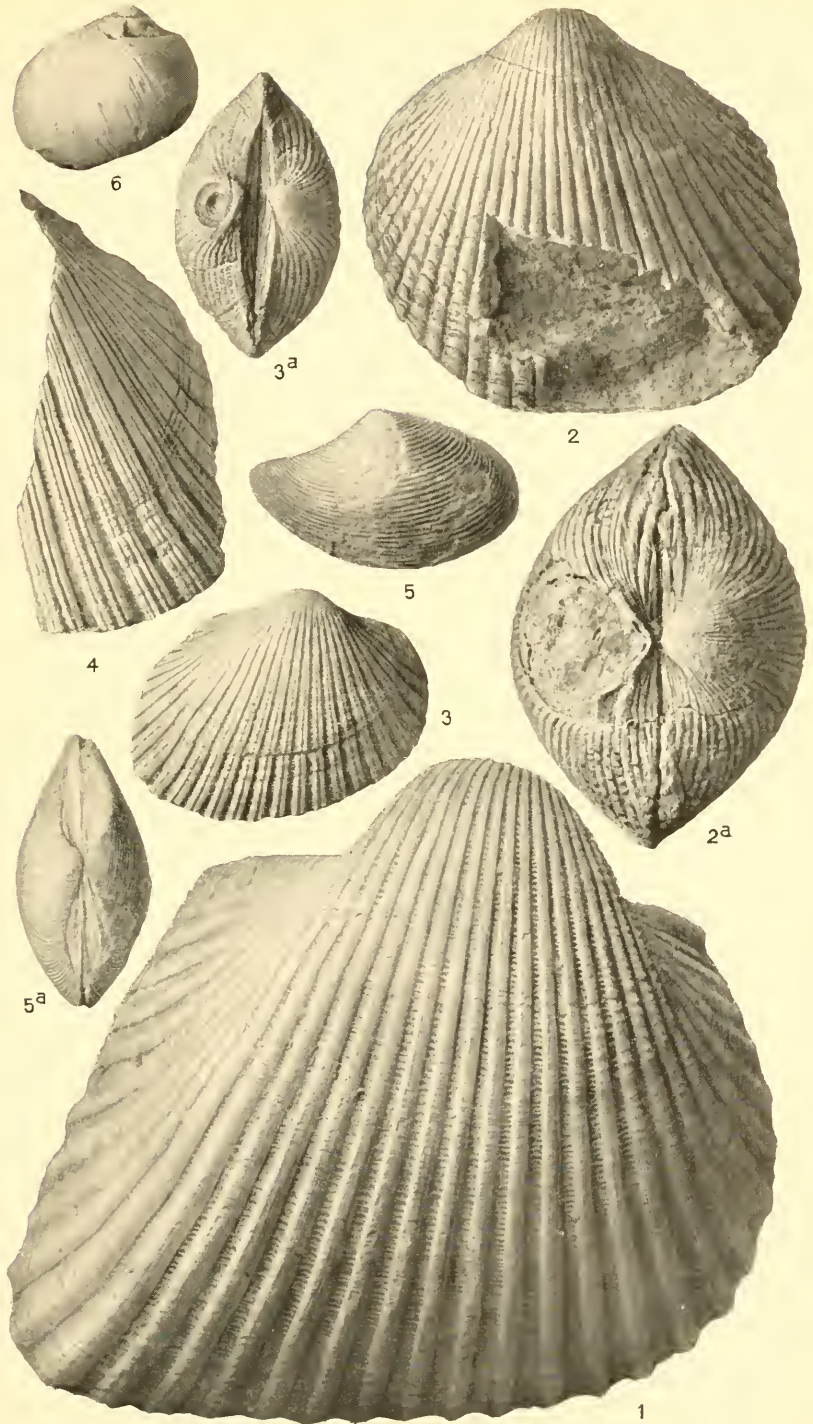
MIocene PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGE 543.



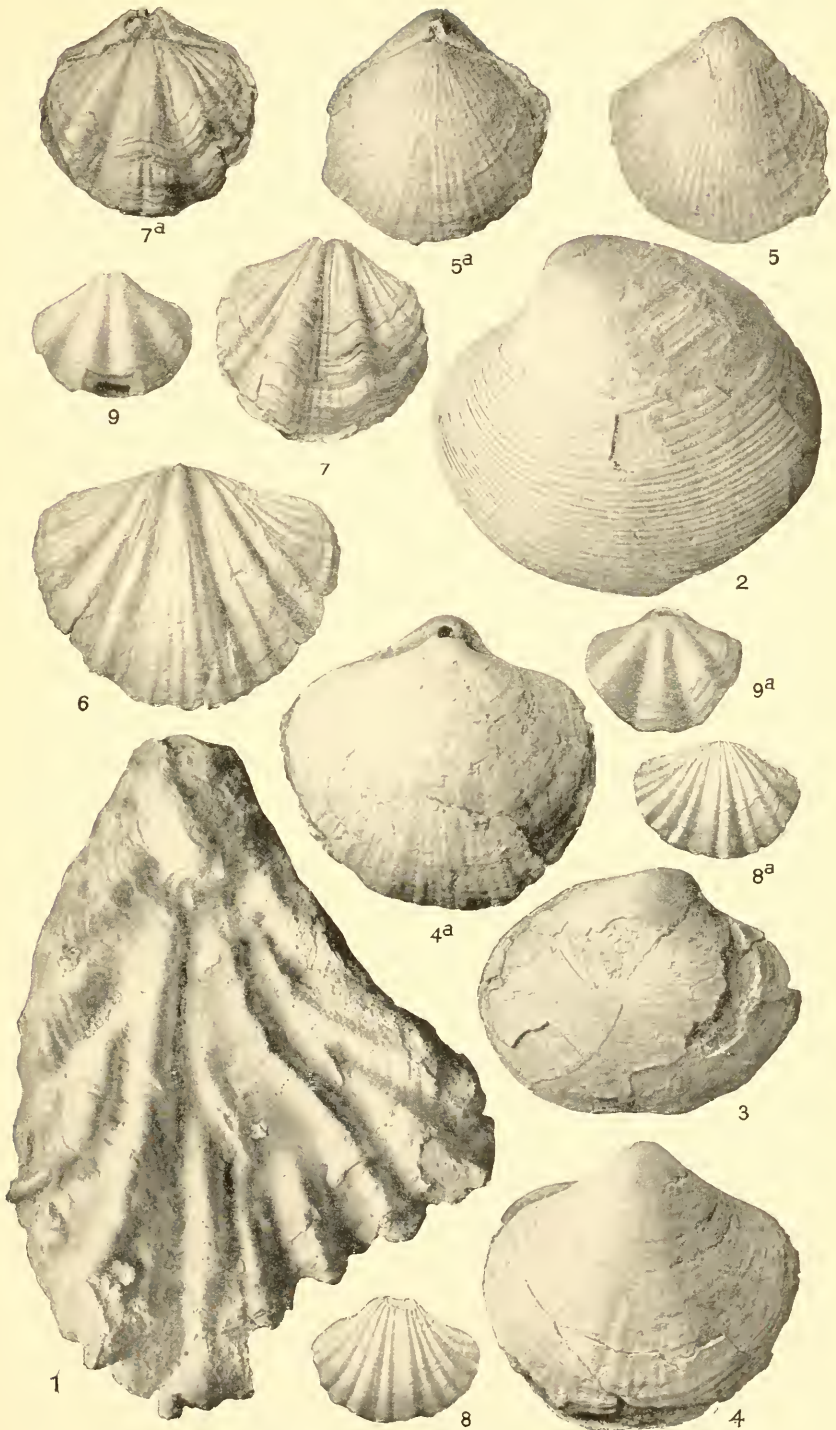
PLIOCENE ARCAS.

FOR EXPLANATION OF PLATE SEE PAGE 543.



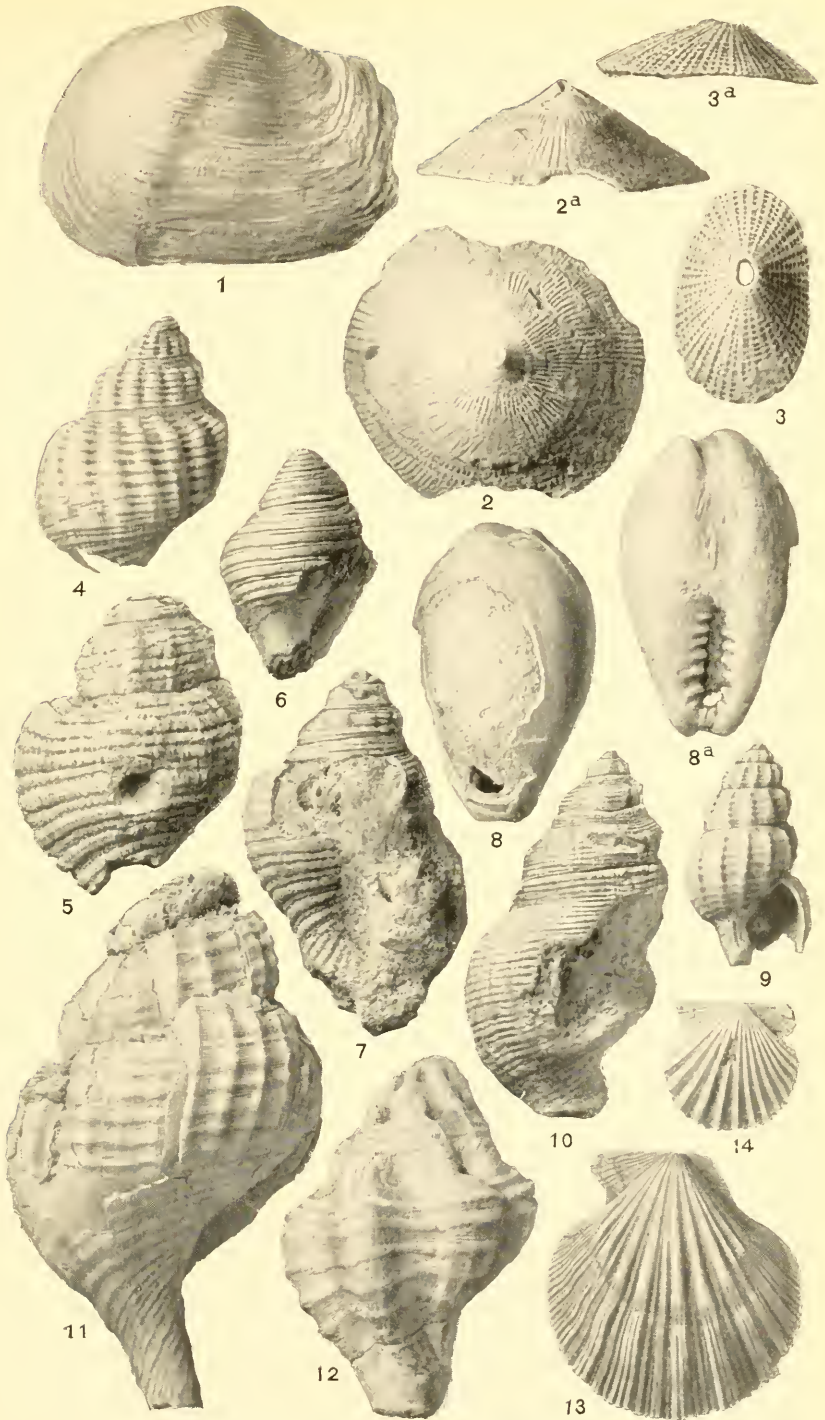
PLIOCENE PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGE 544.



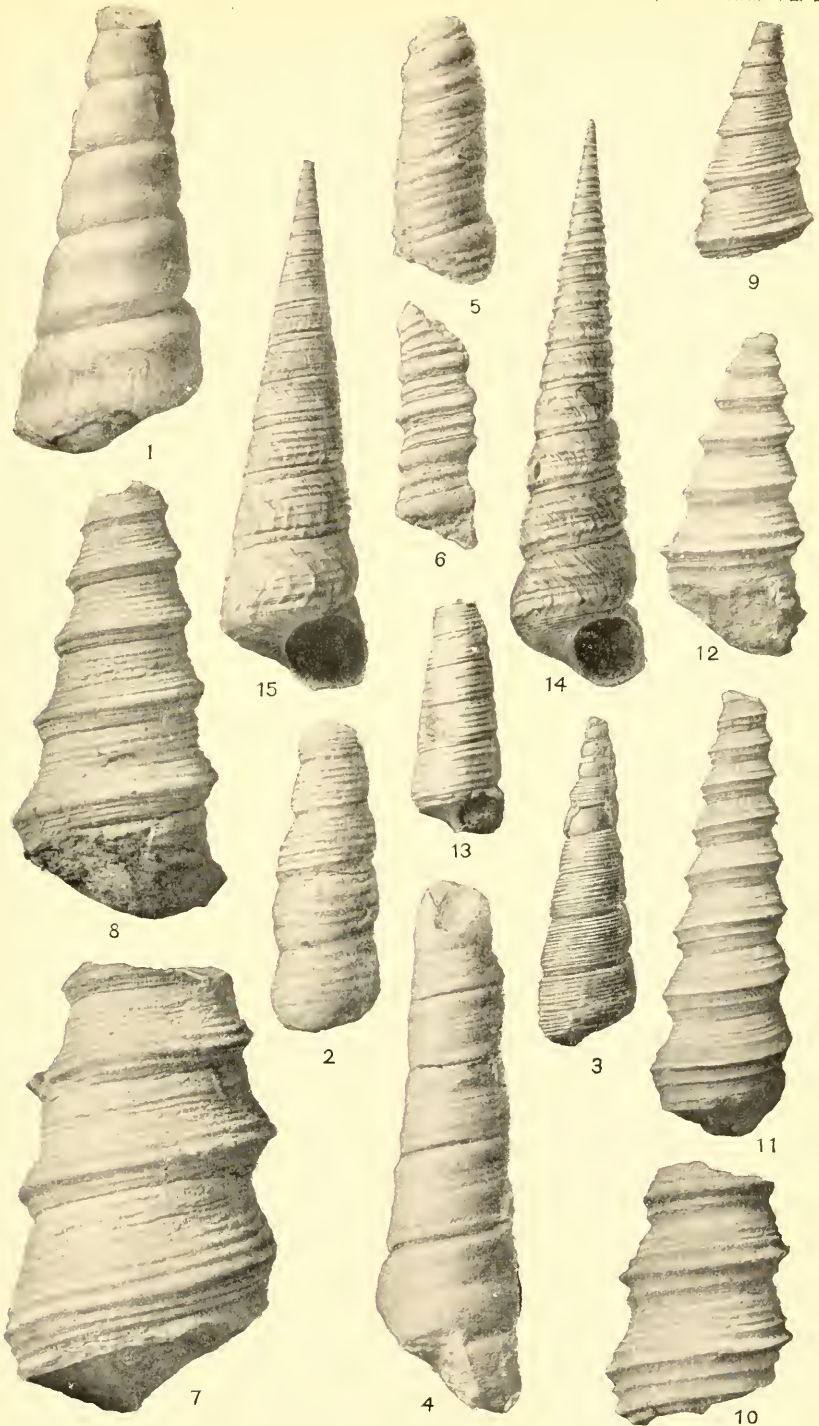
PLIOCENE BRACHIOPODA AND PELECYPODA.

FOR EXPLANATION OF PLATE SEE PAGES 544, 545.



PLIOCENE PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGES 545, 546.



TERTIARY TURRITELLAS.

FOR EXPLANATION OF PLATE SEE PAGE 546.

