AN INVERTEBRATE FAUNA FROM THE "MODELO" OF DRY CANYON, LOS ANGELES COUNTY, CALIFORNIA

by

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ABSTRACT

The age of the Mint Canyon formation and it's stratigraphic relationships with the marine "Modelo" formation immediately overlying it have caused much discussion in recent years. Age determinations resulting from studies of vertebrate faunas collected from the Mint Canyon and invertebrate faunas collected from the "Modelo" differ considerably. The value of the equid genus Hipparion, as an index to the lower Pliocene, has been questioned.

An investigation, the results of which are embodies in this paper, included the collection of an invertebrate fauna from the "Modelo", the measurement of a detailed columnar section, and a comparison and evaluation of the fossils found. Three new species are described and 26 others are recorded.

A lower Neroly age (uppermost Miocene) is assigned to the "Modelo."

INTRODUCTION

For many years the attention of geologists investigating the sediments of Southern California has been provoked by an interesting sequence of non-marine Tertiary strata found in the easternmost portion of the Ventura Basin. Because these sediments occur in juxtaposition to a series of Tertiary marine beds found farther to the west, considerable effort has been expended in an attempt to accurately establish the stratigraphic relationships and correlative formations of the two areas.

As might be expected, the marine section to the west received the first and most thorough study. This section, through the years, has become fairly well established. Early workers made tentative correlations with the terrestrial sediments to the east which Kew (1924, p. 52) termed the Mint Canyon formation in 1924. A sparse vertebrate fauna from the Mint Canyon, reported by Kew and studied by Stock yielded the following forms:

- Parahippus ?
- Merychippus or Protohippus sp.
- Procamelus
- Mastodon remains, possibly belonging to Tetrabelodon
- Rabbit
- Very large tortoise

In his report to Kew, Stock (Kew, 1924, p. 54) says: "The fauna seems to be somewhat near the upper Miocene stage."

Later Maxson (1930) made a more extensive collection and study of the Mint Canyon vertebrates and recorded the following forms:

- Aelurodon sp.
- Hypolagus ? cf. apachensis
- Trilophodon sp.
- Oreodont cf. Merychyus
- Prosthennops ? sp.
- Merycodus near necatus
- Parahippus ? near mourningi

Merychippus intermontanus
Merychippus sumani
Merychippus sp.
Protohippus sp.
Hipparion ? near *mohavense*
Hipparion ? sp.

After comparing this fauna with other possibly correlative vertebrate assemblages, Maxson assigned an upper Miocene age to the Mint Canyon and substantiated Stock's tentative determination as reported by Kew.

In the vicinity of Dry and Haskell canyons, the top of the Mint Canyon formation is unconformably overlain by a six hundred foot thickness of brown sandstones, silts and shales of marine origin. In some places the strata are fossiliferous. Kew reported several species of invertebrates from these beds and listed the following determinations by B. L. Clark (Kew, 1924, pp.68-69):

Amphyssa n.sp.
Ostrea titan Conrad
Pecten crassicardo Conrad
Pecten raymondi Clark

Clark tentatively correlated the assemblage with the upper part of the San Pablo formation, again corroborating an upper Miocene age not only for the fossiliferous marine beds, but for the underlying Mint Canyon also.

On the basis of Stock's and Clark's determinations these beds were tentatively correlated with the Modelo by Kew, and he termed them Modelo (?). Further mention of these beds was made by Maxson (1930, pp.80-81) in supplementing his age determination of the Mint Canyon on the basis of vertebrates. He quoted Woodring (1930, p. 155), who, after studying an invertebrate fauna from the Modelo (?) stated: "Rather poorly preserved specimens of *Astrodapsis* from this locality closely resemble *A. tumidus* and these beds are regarded as the approximate equivalent of the Cierbo formation."

In a review of the stratigraphy of the easternmost Ventura basin, Jahns (1940, p. 166) called attention to the fact that the Modelo (?) of Kew, although equivalent to the upper part of the Modelo formation, did not correspond to the Modelo s.s. as restricted by Hudson and Craig (1929) at the type section in Modelo canyon. He further termed the beds "Modelo."

In 1933 R. A. Stirton (1933, pp. 569-576) reexamined the vertebrate material from which Maxson had made his original age determinations of the Mint Canyon. His identifications disagreed in part with those of Maxson, and he concluded that the Mint Canyon was of lower Pliocene age. The basis of his determination was largely the presence of the equid genus Hipparion which for many years has been considered as an index to the lower Pliocene.

Since the publication of Stirton's paper considerable controversy has arisen over the age of the Mint Canyon, and the consequent value of Hipparion as an indicator of the lower Pliocene. This was further complicated by the fact that a horse tooth referred to Hipparion mohavense Merriam had been described by Stock (1928) from the Puente shales, a formation "correlated with upper Miocene formations rather than with lower Pliocene deposits on the basis of independent stratigraphic evidence." (Stock, 1928, p. 53)

These discrepancies make it apparent that the relationships of the two formations must be reconciled, either by an adjustment of the boundary between the upper Miocene and the lower Pliocene, or through a reevaluation of the criteria, either vertebrate or invertebrate, by which the age determinations have been made.

ACKNOWLEDGEMENTS

The writer is indebted to Dr. J. Wyatt Durham who, in addition to critically reviewing the manuscript, supervised the project, and was, at all times, most generous of both his time and knowledge. Mr. R. C. White furnished a geologic map which covers a portion of the area in the vicinity of Haskell Canyon, and Mr. J. S. Martin furnished that portion of the map covering the Dry Canyon Reservoir area. Mr. Martin also collaborated in the field measurement of a columnar section which is included in this report. Mr. Toshio Asaeda very kindly prepared the photographic plates.

PURPOSE

The present investigation was undertaken to obtain additional collections of fossils in the hope of making an incontrovertible age determination, to further substantiate or refute the recorded age determinations of the "Modelo" and in so doing contribute additional information to the general problems related to the Miocene-Pliocene boundary in the Ventura basin.

To this end several days were spent in the field collecting from two separate localities within the "Modelo." Twenty-nine species of invertebrates, one vertebrate bone, and several specimens of a fossil plant were found. Another day was spent in measuring a columnar section in Haskell Canyon where the "Modelo" crops out in continuous exposure from the basal unconformity with the Mint Canyon to the unconformable contact with the Saugus above.

LOCATION

The fauna discussed in this paper was collected in the vicinity of Dry Canyon which lies in the easternmost portion of the Ventura basin, Los Angeles County, California. Dry Canyon is a tributary of Bouquet Canyon, and with Bouquet canyon drains into the Santa Clara River from the north at the approximate longitude of Saugus, a small town on the Southern Pacific Railroad. At a point almost five miles north of Saugus the Department of Water and Power, City of Los Angeles has constructed what is known as the Dry Canyon Reservoir. This reservoir functions in a storage capacity for the Owens Valley Aqueduct. The first of the two collections was made at a point about 300 yards due east of the southern portion of this reservoir. The second collection was made somewhat to the north from an exposure of well indurated sandstone lying athwart a small creek which drains into Haskell Canyon, another tributary of Bouquet Canyon which parallels Dry Canyon about a mile to the east. The collecting localities are indicated on the accompanying geologic map and described in detail on p.33 of this report. The general geographic locations are shown in Figs. 1 and 2 on the following page.

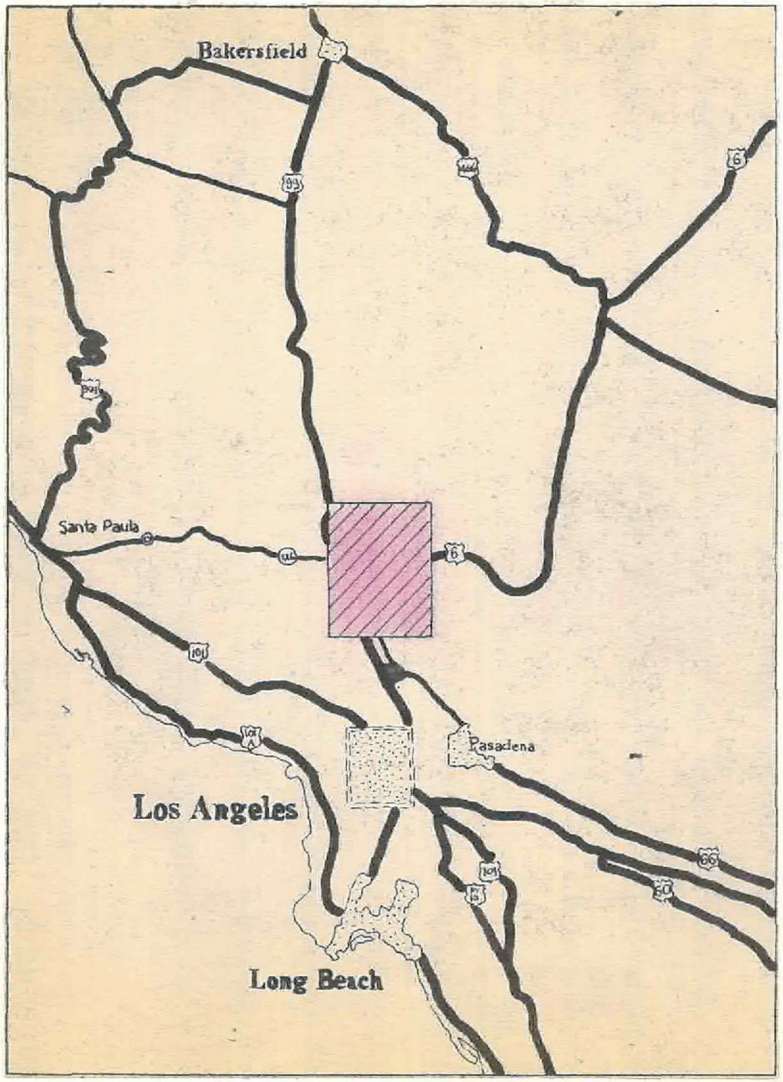


Fig. 1 Colored area in center of map is shown in detail in Fig. 2 on this page.

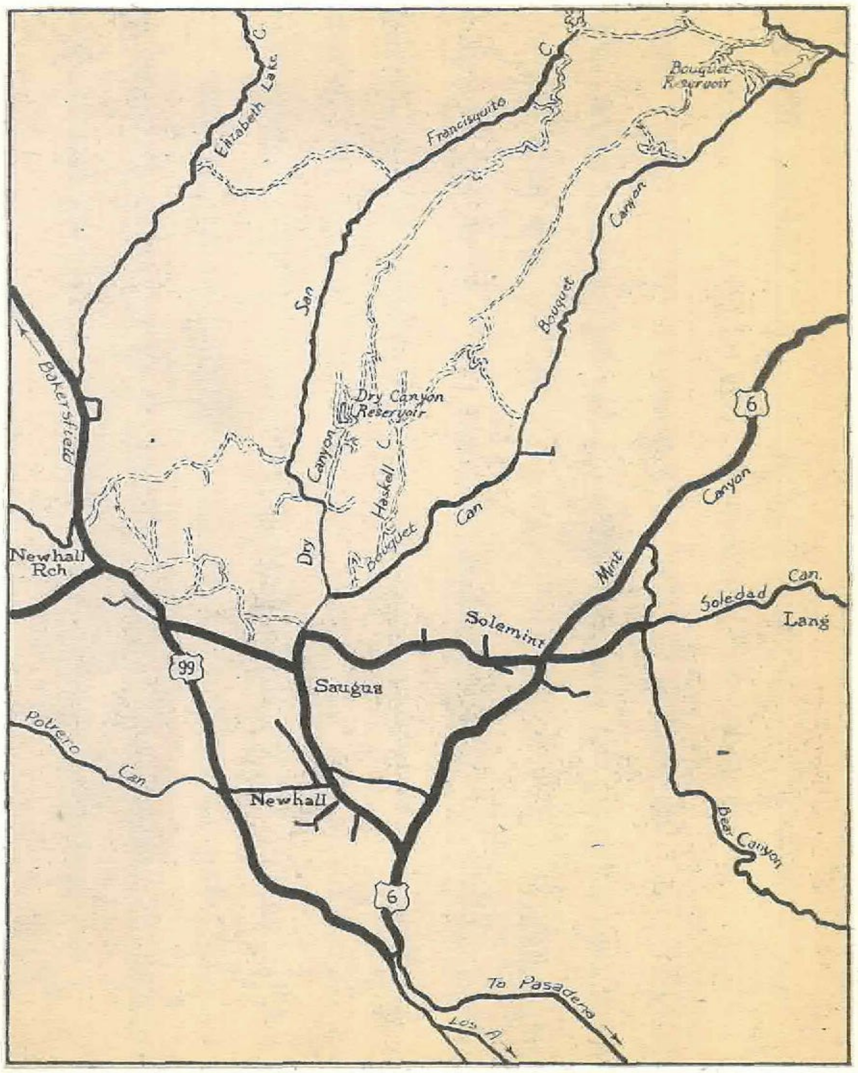


Fig. 2 Generalized map of the Dry Canyon-Haskell Canyon area.

STRATIGRAPHY

Basement Complex

Basement rocks in the easternmost Ventura basin are reported by Jahns (1940, p.153) to consist largely of metamorphic rocks associated with later igneous intrusives. The dominant metamorphic rock is a fine-grained blue gray schist which takes it's name from the Sierra Pelona Range to the north. The igneous intrusions include miscellaneous syenites, granodiorites, porphyroblastic gneisses and, in somewhat larger quantities, the "spotted diorites" such as the so-called Parker Mountain quartz-diorite with it's characteristic "plum-pudding" texture.

Little can be said of the age of these rocks except that they are, at present, believed to be pre-Cretaceous. This belief is founded on a supposition that they are intruded by Sierran plutonics.

Vasquez Series

Approximately 9,000 feet of coarse light colored sandstones and conglomerates are found in fault contact with the basement rocks in Vasquez Canyon, a more northerly tributary of Bouquet Canyon. Farther to the east they have depositional relationships with the underlying crystallines. Inasmuch as no fossils have been found or reported from these sediments their age is moot. A doubtful Oligocene age by Jahns (1940, p. 153) followed a tentative reference of the beds to the Sespe (?) by Kew (1924, p.38). An additional series of intercalated basic flows and concordant intrusions adds another 4,000 feet of thickness to this section. The name Vasquez was given to the series in 1935 by Sharp (1935, p. 336).

Tick Canyon Formation

As originally discussed by Hershey (1902, p. 356) and Kew (1924, p. 52) the Mint Canyon formation also included some 600 feet of basal beds which Jahns has been able to establish as a separate formation which he has termed the Tick Canyon (Jahns, 1940, p. 152). These basal beds are largely red clays, siltstones, sandstones and conglomerates, and have yielded a mammalian fauna permitting an independent age determination of late lower Miocene or early middle Miocene. The equivalent in the marine section is close to the lower Temblor.

<u>Mint Canyon Formation</u>

The lithology of the Mint Canyon formation is variable throughout its very considerable areal extent, ranging from vari-colored conglomerates, sandstones and clays to light gray or white gravels interbedded with greenish clays or light sands. In the vicinity of Dry and Haskell Canyons the section is predominantly interbedded sandstones and conglomerates. Grays and brownish-red colors are most frequent. Light gray to white tuff beds provide excellent markers where they can be traced.

In his detailed section of the formation Jahns (1940, p. 162) reports a total maximum thickness of 4,044 feet. The Mint Canyon overlies the Tick Canyon wherever the latter crops out, and, as far as is known, lies with depositional contact on the basement to the north. It rests unconformably on the Vasquez.

<u>"Modelo"</u>

The "Modelo" formation in the vicinity of Dry and Haskell Canyons consists of approximately 600 feet of brownish sandstones, silts and shales. The section measured in Haskell Canyon (see Fig. 3 on p. 12) includes, in addition, a tuff bed 18 feet thick which could be traced along the entire face of the exposure. Fossils have been found in at least three different places in the area of "Modelo" indicated on the accompanying geologic map. In addition to C.I.T. localities 1670 and 1671, which are discussed in this paper, invertebrates are also found on the face of the Haskell Canyon anticlinal exposure where the columnar section was measured. This fauna, at present, is under study by R. C. White of the California Institute of Technology.

An unsuccessful attempt to trace the beds from which the fossils of localities 1670 and 1671 were secured testifies to the deep weathering and lateral facies variations to which the "Modelo" is subject in this area. Accordingly, estimations based on the general structure of the area must serve for marking the approximate positions of the fossil beds in the section.

From the geologic map it is seen that C.I.T. locality 1670 lies on the north flank of a small syncline. The columnar section (outline of traverse indicated on map) was taken approximately on the axis of an anticline just to the south. A rough projection of the fossil bed makes a guess that it is correlative with the top 100 feet of the measured section reasonably safe.

With the strata arching over another small anticline to the north, the occurence of locality 1671 can also be placed close to the top of the section. This placement is further suggested by the fact that the fossiliferous stratum is overlain by a thick massive sandstone member, possibly correlative with the sandstones in the upper 125 feet of the measured section and underlain by a light gray punky shale very suggestive of the tuff beds.

In Haskell Canyon the "Modelo" overlies the Mint Canyon with distinct unconformity. The "Modelo" is the only known marine formation in the easternmost Ventura basin north of the Santa Clara River.

COLUMNAR SECTION

MEASURED AT HASKELL CANYON

SCALE 1:1200

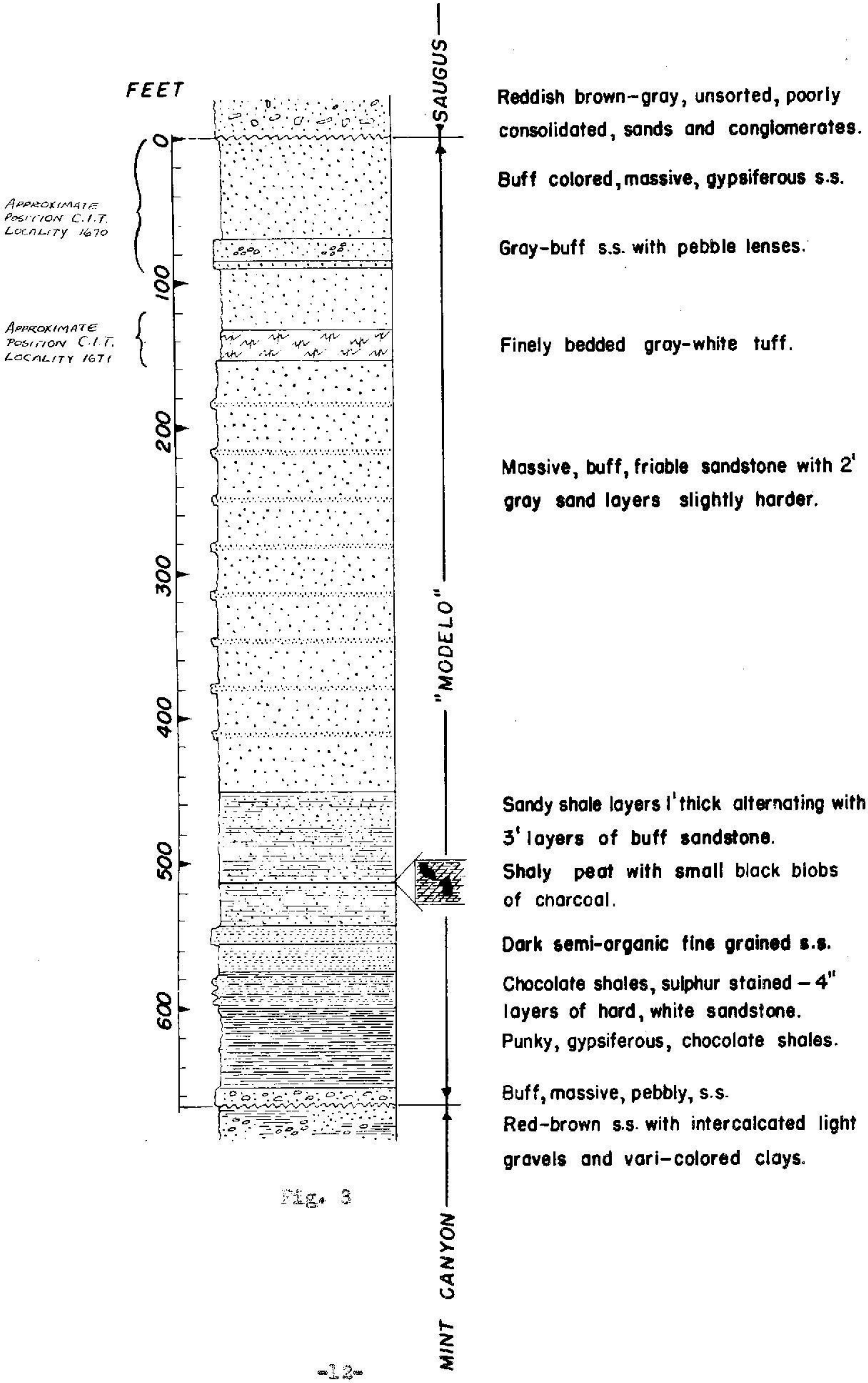


Fig. 3

Saugus Formation

Unconformably resting on the "Modelo" are the light gray to reddish brown terrestrial sediments of the Saugus formation. The beds are poorly consolidated and only barely stratified. According to Jahns (1940, pp.167-168) they represent "extensive deposition on a broad westward dipping flood plain or alluvial fan series" ... and ... "reflect the nature of the terranes from which they were derived." To the west, marine facies of the non-fossiliferous terrestrial sediments yield a fauna indicating an upper Pliocene to lower Pleistocene age.

Quaternary Deposits

Throughout the area of Dry and Haskell Canyons thin Pleistocene terraces are common. With flat-lying attitudes and a characteristic reddish brown color they are easily distinguished from the surrounding formations. They comprise coarse unsorted accumulations of gravels replete with fragments of the basement complex.

The stream valleys are almost without exception filled with recent alluvium which is currently being incised by intermittent streams.

FAUNAL LIST

California Institute of Technology Locality 1670

BRACHIOPODA

Terebratalia occidentalis Dall
Terebratalia smithi Arnold

GASTROPODA

Astraea (Pomalaux) gradata Grant & Gale
Cancellaria ? sp.
Clavus (Cymatosyrinx) hemphilli Stearns
Forreria durhami Buffington n. sp.
Olivella sp.
Polynices (Neverita) reclusiana (Deshayes)
Trophosycon cf. ocoyana (Conrad)
Turris aff. elsmerensis English

PELECYPODA

Aequipecten sp. ?
Aequipecten sp. ?
Chione diabloensis Clark
Chlamys cf. hastatus Sowerby
Lyropecten crassicardo Conrad
Lyropecten crassicardo ? Conrad
Mytilus (Mytiloconcha) coalingensis Arnold
Nemocardium centifilosum (Carpenter)
Ostrea titan Conrad var.
Pododesmus macroschismus (Deshayes)
Spisula (?) sp.

VERTEBRATA

Pliauchenia (?) sp.
Indeterminate fragment of mammal bone

FAUNAL LIST

California Institute of Technology Locality 1671

ECHINOIDEA

Astrodapsis aff. fernandoensis Pack

GASTROPODA

Lunatia cf. draconis (Dall)
Searlesia secoensis Buffington n. sp.

PELECYPODA

Anadara (Anadara) haskellensis White n. sp.
Clams ?
Macoma nootis (Deshayes) var. acolasta Dall
Ostrea titan Conrad var.
Periploma haskellensis Buffington n. sp.
Petricola sp.

AGE OF THE "MODELO"

The preponderance of evidence seems to point to an uppermost Miocene age for the "Modelo." Of the invertebrates the following forms are considered critical:

1. Primary importance

   A. From C.I.T. Locality 1670

      a. *Lyropecten crassicardo* Conrad
      b. *Ostrea titan* Conrad var.

   B. Not listed with fauna from C.I.T. Localities 1670 and 1671, but known to exist in the "Modelo" of this area.

      a. *Astrodapsis* of *tumidus* clan
      b. *Astrodapsis* of *whitneyi* clan

2. Secondary importance

   A. From C.I.T. Locality 1670

      a. *Trophosycon* cf. *ocoyana* (Conrad)
      b. *Chione diabloensis* Clark

   B. From C.I.T. Locality 1671

      a. *Astrodapsis* aff. *fernandoensis* Pack

Of *Ostrea titan* Eaton, Grant and Allen (1941, p. 247) write: "For many years any large oyster found in the Miocene of California from the Vaqueros upward through Neroly time, was recorded as *Ostrea titan*, whereas the typical variety of this species seems to be confined to the Neroly (late upper Miocene) substage." The uppermost Miocene age of *O. titan* is recorded by Clark (1915, p. 426) who further stated (p. 447) that he "had not seen a specimen of *O. titan* Conrad from the lower San Pablo group or the upper part of the Monterey group."

Throughout much of the literature the form *Astrodapsis tumidus* is mentioned as an index to the uppermost Miocene (Clark, 1915)(Woodring, 1930) (Kew, 1915). Eaton, Grant and Allen (1941, p. 240, fig. 12) further restrict _A. tumidus_ and _A. whitneyi_ to the lower Neroly. Regarding two specimens collected in an exposure of the "Modelo" at Haskell Canyon, but not included in the faunal list accompanying this report in that they were not collected by the author, J. E. Eaton,[1] senior of the above mentioned authors, writes:

> "The genus _Astrodapsis_ has numerous species and varieties, determinable if large collections of well preserved specimens are available. These fall into seven or eight more or less distinct clans into which the many different forms may be grouped. The small, thin, nearly whole specimen from Haskell Canyon that you showed me, though it differs from _A. tumidus_ s.s. in having a thinner test, and petals which widen to the ambitus instead of becoming parallel-sided toward the latter, rather clearly belongs to the clan of that name. The large high petalled, highly ventricose cast from a good mold exhibits a combination of dorsal attributes thus far known only in the _A. whitneyi_ clan. Both of these clans, on the basis of existing collections, are confined to the Neroly, the late upper Miocene of California as commonly classified."

Lyropecten crassicardo Conrad is generally considered an index to the upper Miocene though it does not appear to be as completely diagnostic as the other three mentioned forms. According to Clark (1915, p.426) _P. crassicardo_ Conrad has not been found in beds younger than the San Pablo group.

Further substantiation of the upper Miocene age determination by Clark (Kew, 1924, pp. 68-69) and Woodring (1930, p. 155) was given by an invertebrate collection made by Maxson. In addition to the forms involved in Clark's and Woodring's determinations, Maxson's fauna, as identified by U.S. Grant IV (Maxson, 1938, pp. 1716-1717), includes:

Terebratalia occidentalis
Terebratalia occidentalis obsoleta
Anadara osmonti
Anadara obispoana
Aequipecten discus
Lyropecten crassicardo
Lyropecten cf. _estrellanus_
Astrea aff.? _brangulata_
Polinices sp.
Tegula sp.

1. Letter to Prof. J. Wyatt Durham, dated Feb. 14, 1947.

Chione diabloensis Clark has not been found in any beds higher than the upper division of the san Pablo (Clark, 1915, pp. 425-426).

Trophosycon cf. *ocoyana* (Conrad) is of interest in that both it and *Astrodapsis* aff. *fernandoensis* Pack are common forms in the so-called lower Pliocene of Elsmere Canyon. This suggests a correlation which is strongly disparaged by the presence of the other discussed forms which are limited to the upper Miocene.

The only record of foraminiferal evidence from the "Modelo" originates with Hughes (Kleinpell, 1938, p. 71) who says: "Foraminifera collected from this area, supposedly close to one of the mammalian localities under discussion, are represented by very meagre assemblages. They are believed to include *Uvigerina hootsi* and are a great deal like those of the uppermost Miocene of the Los Angeles basin.

DISCUSSION OF THE FAUNA

Of the specimen listed as Pliauchenia (?) sp. Stock[1] writes:

> " Fragment is the distal end of a left humerus which has suffered somewhat from wear in the process of preservation. It is slightly smaller than the comparable part in the modern bactrian camel (Camelops), and distinctly smaller than that in the Pleistocene Camelops from Rancho La Brea. I cannot always be certain that a striking difference in structure, as for example the absence of the tuberosity at the upper outer side of the trochlea in the fossil is due to greater wear in the latter specimen, but I suspect this is the case. The depressed area on the anterior surface of the shaft, above the distal articulation is broader and deeper in the fossil. When viewed from the rear the differences seen in the region adjacent to the olecranon fossa are due to breakage.
>
> The specimen is not rhino as shown definitely by the form of the distal trochlea. It comes closest to camel, although there is nothing in the Pleistocene forms available to me that is like it in size. Without materials available for comparison, my notion is that it is like later Tertiary types as for example Pliauchenia. Later Tertiary camels, of which there is a great variety, are undergoing revisional study by Mr. Frick."

Although this specimen is of no assistance in age determination, it is interesting for ecological reasons. (See page 21.)

The specimen listed as Anadara obispoana (p. 17) by Maxson is practically identical with Anadara (Anadara) haskellensis White n. sp. Inasmuch as forms of this clan have a very short vertical range, interesting speculations arising from it's occurence may be noted with regard to the age of the Elsmere Canyon fauna (commonly considered lower Pliocene). Although it would be unwise to make any definite statement at the present time, a series of relationships suggests that the Pliocene-Miocene boundary in this general region may eventually have to be shifted one way or another.

A research project currently conducted by L. A. Wright of the California Institute of Technology in the "Modelo" west of Sand Canyon, some miles to the south and east of Dry Canyon, reveals a fauna, which, in it's

1. Personal note to Prof. J. Wyatt Durham.

present stage of study, has definite affinities with the fauna of Elsmere Canyon. Dr. J. Wyatt Durham has indicated to the writer that, stratigraphically, the Sand Canyon faunal localities appear to be on the same level as those discussed in this paper. In addition the Anadara obispoana of Maxson, correlative with A. haskellensis of Dry and Haskell Canyons, occurs higher in the section than Wright's localities. This latter fact has been established by field investigations conducted by Durham.[1]

If these relationships can be irrevocably established, a situation would develop which would favor moving some of the so-called type lower Pliocene as noted in Elsmere Canyon to the upper Miocene or vice versa.

Moreover, the occurence of Astrodapsis aff. fernandoensis Pack, an echinoid commonly believed an index of the lower Pliocene, in a dominantly Miocene assemblage, again raises the question of the exact position of the Miocene-Pliocene boundary.

1. Personal communication from Dr. J. Wyatt Durham.

ECOLOGY

The fauna is believed to be a near shore assemblage for the following reasons:

1. The presence of the knuckly bone of a land dwelling form (Pliauchenia ?) suggests that the animal died close to an old beach. It is unlikely that the remains would have been carried any great distances seaward.

2. The presence of the oyster, Ostrea titan. Oysters are noted shallow water inhabitors. (Woodring, 1938, Pl. 3)

3. The presence of several specimens of fossil leaves. Admitting the possibility that strong currents could carry a leaf long distances before it was buried, it is still unlikely that many of them would be carried out and all deposited in close juxtaposition.

4. The existence of a peaty layer in the section indicates conditions favoring a brackish swamp or bog just inland from the beach.

CONCLUSIONS

On the basis of the fauna collected by the writer, and other fossil collections made in the environs, an age equivalent to the lower portion of the Neroly substage of the upper Miocene, as established in the standard Pacific Coast time scale, is hereby assigned to the "Modelo" formation. This age is equivalent to the uppermost of the three divisions Hudson and Craig made of the type Modelo section in Modelo Canyon and for which they proposed the name Santa Margarita. This division they believed to equal the Santa Margarita of the type area which Clark (1915, pp. 425 and 435) closely correlated with the upper San Pablo.

It should be emphasized that the formations upon which the standard Pacific Coast marine section is established are not, in the large majority of cases, correlable with formations of the European Tertiary section. Weaver (1944, p. 571) says: "There is general agreement with respect to the stages in the Eocene, but very wide divergences with respect to the position of the European stages of the Oligocene and Miocene epochs." Accordingly, until some equivalency can be established close to the Miocene-Pliocene boundary, it would be difficult to predict, with regard to a possible adjustment, whether the "Modelo" and Mint Canyon formations should be included in the lower Pliocene as Stirton favors, or the so-called lower Pliocene formations be called uppermost Miocene.

DESCRIPTION OF SPECIES

ECHINOIDEA

Astrodapsis aff. fernandoensis Pack

Pl. 3, Figs. 1a, 1b

Astrodapsis fernandoensis Pack, Univ. Calif. Publ. Bull. Dept. Geol., Vol. 5, p. 279, Pl. 24, Figs. 3 and 4, 1908.

Astrodapsis fernandoensis Pack, English, Univ. Calif. Publ. Dept. Geol., Vol. 8, p. 209, Pl. 23, Fig. 5, 1914.

Astrodapsis fernandoensis Pack, Grant-Hertlein, Publ. Univ. Calif. Los Angeles Math. and Physical Sci., Vol. 2, pp. 72-73, Pl. 25, Figs. 4,5, 1938.

Occurence: C.I.T. Locality 1671

BRACHIOPODA

Terebratalia occidentalis Dall

Pl. 3, Figs. 6a, 6b, 6c, 6d

Terebratalia occidentalis Dall, Proc. Calif. Acad. Sci., Vol. 4, p. 182, Pl. 1, Fig. 7, 1871.

Terebratalia occidentalis Dall, Hertlein-Grant, Publ. Univ. Calif. Los Angeles Math. and Physical Sci., Vol. 3, pp. 127-131, Pl. 10, Fig. 3; Pl. 17, Figs. 2,5,8,11,12; text figure 27, 1944.

Occurence: C.I.T. Locality 1670

Terebratalia smithi Arnold

Pl. 3, Figs. 2a, 2b, 2c, 2d

Terebratalia smithi Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 93, Pl. 17, Fig. 9, 1903.

Terebratalia smithi Arnold, Hertlein-Grant, Publ. Univ. Calif. Los Angeles Math. and Physical Sci., Vol. 3, pp. 133-134, Pl. 10, Figs. 4,6-8, 1944.

Occurence: C.I.T. Locality 1670

PELECYPODA

<u>Anadara</u> (<u>Anadara</u>) <u>haskellensis</u> White n. sp.

Pl. 2, Figs. 2a, 2b, 2c, 2d

<u>Anadara</u> (<u>Anadara</u>) <u>haskellensis</u> White, Unpublished manuscript for Masters Thesis, California Institute of Technology, June 1947.

Occurence: C.I.T. Locality 1671

<u>Ostrea titan</u> Conrad var.

Pl. 1, Figs. 1a, 1b

<u>Ostrea titan</u> Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 6, p. 199, 1853

<u>Ostrea titan</u> Conrad, Pacific R.R. Reports, Vol. 6, Part 2, No. 2, p. 72, Pl. 4, Fig. 17; Pl. 5, Fig. 17a, 1857.

<u>Ostrea titan</u> Conrad, Arnold, U.S. Geol. Surv. Bull. 396, p. 116, Pl. 5, Fig. 1, 1910.

<u>Ostrea titan</u> Conrad, Clark, Univ. Calif. Publ. Bull. Dept. Geol., Vol. 8, Pl. 44, Fig. 1, 1915.

Occurences: C.I.T. Locality 1670
C.I.T. Locality 1671

<u>Chlamys</u> cf. <u>hastatus</u> Sowerby

<u>Pecten hastatus</u> Sowerby, Thes. Conch., Vol. 1, p. 72, Pl. 20, fig. 236, 1843

<u>Pecten</u> (<u>Chlamys</u>) <u>hastatus</u> Sowerby, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 109, Pl. 11, Figs. 4, 4a, 1903.

<u>Pecten (Pecten) hastatus</u> Sowerby, Grant and Gale, Mem. San Diego Soc. Nat. Hist., Vol. 1, pp. 166-168, Pl. 11, Figs. 6a, 6b, 1931.

Occurence: C.I.T. Locality 1670

<u>Lyropecten crassicardo</u> Conrad

Pl. 1, Figs. 3a, 3b

<u>Pallium crassicardo</u> Conrad, Proc. Acad. Nat. Sci. Phila., p. 313, 1856.

<u>Lyropecten crassicardo</u> Conrad, Am. Jour. Conch., Vol. 3, 1867, p. 6

<u>Pecten</u> (<u>Lyropecten</u>) <u>crassicardo</u> Conrad, Arnold, U.S. Geol. Surv. Prof.

Paper 47, pp. 71-73, Pl. XVI, Figs. 1 and 1a; Pl. XVII, Figs. 1, 1a and 1b; Pl. XVIII, Figs. 1, 2, and 2a. 1906.

Occurence: C.I.T. Locality 1670

Aequipecten sp. ?

Occurence: C.I.T. Locality 1670

Aequipecten sp. ?

Occurence: C.I.T. Locality 1670

Pododesmus macroschismus (Deshayes)

Anomia macroschisma Deshayes, Rev. Zool. Soc. Couverienne, p. 359, 1839; Guerin's Mag. Zool., Pl. 34, 1841; Middendorf, Beitr. Mal. Rossica, Vol. 3, p. 6, 1849; Philippi, Abbild. Beschreib., Vol. 3, *Anomia*, p. 132, Pl. 1, Fig. 4, 1850.

Pododesmus macroschisma (Deshayes), Grant and Gale, Mem. San Diego Soc. Nat. Hist., Vol. 1, pp. 241-242, Pl. 12, Figs. 3, 4a, 4b, 1931.

Occurence: C.I.T. Locality 1670

Mytilus (*Mytiloconcha*) *coalingensis* Arnold

Pl. 1, Fig. 4

Mytilus (*Mytiloconcha*) *coalingensis* Arnold, U. S. Geol. Surv. Bull. 396, pp. 73-75, Pl. XIX, Fig. 5; Pl. XXII, Fig. 6, 1909.

Occurence: C.I.T. Locality 1670

Order	ANOMALODESMACEA
Superfamily	LATERNULACEA = (ENSIPHONIA Dall)
Family	Periplomatidae
Genus	*Periploma* Schumacher, 1817

Periploma Schumacher, Ess. Nouv. Syst. Habit. Vers Test., pp. 115, 116, Pl. 5, Fig. 1, 1817.

Type (by monotypy), *Periploma inaequivalvis* Schumacher, op. cit., p. 116, Pl. 5, Fig. 1, 1817.

"Shell oval or rounded; surface smooth or with faint growth lines; lithodesma present." (Grant and Gale)

Periploma haskellensis Buffington n. sp.

Pl. 1, Fig. 5

Holotype California Institute of Technology Paleontological Collection, No. , C.I.T. Locality 1671.

Description Shell semi-ovate, thin, with incremental striae. The right valve perceptibly more ventricose than the left; beak slightly to the posterior of the vertical median line when viewed in profile; small projection posterior to the beak. Posterior dorsal margin slopes about 10° away from the beak and sharply rounds at an angle of about 100° to the posterior margin which continues almost vertically for a short distance until it gently rounds into the ventral margin. The anterior dorsal margin slopes about 5° away from the beak, rounds gently at an angle of 140° into the foremost portion of the anterior margin; at this point the profile breaks at an angle of approximately 105° and gently rounds into the ventral margin.

Dimensions

Length.............27 mm
Height.............21 mm
Convexity......... 9 mm

Comparisons and Affinities This form is somewhat similar to *Periploma planiuscula* Sowerby as described and figured by Grant and Gale, Mem. San Diego Soc. Nat. Hist., Vol. 1, p. 255, Pl. 13, Figs. 1a, 1b. The main distinctions lie in the position of the beak which is considerably more posterior in *P. haskellensis*, and in the small posterior projection mentioned in the description above.

Number of Specimens Only one complete specimen was found, but several external molds and fragments of actual shell material give supplementary information.

Preservation and Matrix The holotype specimen is a natural cast of an external mold, and none of the original shell material is present. The occurence is in a compact, dense, well indurated, calcareous sandstone.

Collector E. C. Buffington

Type Locality C.I.T. Locality 1671 as described in this paper.

Repositories of the Type Material California Institute of Technology, Geology Department, Paleontological Collections.

Glans ? sp.

Occurence: C.I.T. Locality 1671

Nemocardium centifilosum (Carpenter)

Cardium var. *centifilosum* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 642, 1864.

Laevicardium (*Nemocardium*) *centifilosum* (Carpenter), Grant and Gale, Mem. San Diego Soc. Nat. Hist., Vol. 1, p. 311, Pl. 19, Figs. 9, 10, 1931.

Occurence: C.I.T. Locality 1670

Chione diabloensis Clark

Pl. 1, Fig. 7

Chione diabloensis Clark, Univ. Calif. Publ. Bull. Dept. Geol., Vol. 8, No. 22, pp. 468-469, Pl. 58, Fig. 4, 1915.

Occurence: C.I.T. Locality 1670

Petricola sp.

Pl. 3, Fig. 5

Occurence: C.I.T. Locality 1671

Macoma moetis (Deshayes) var. *acolasta* Dall

Pl. 2, Figs. 1a, 1b

Macoma acolasta Dall, West American Scientist, Vol. 19, No. 3, p. 21, June 15, 1921; Proc. U.S. Nat. Mus., Vol. 66, Art. 17, p. 19, Pl. 8, Figs. 2, 3, 1925; Jordon, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Macoma moetis (Deshayes) var. *acolasta* Dall, Grant and Gale, Mem. San Diego Soc. Nat. Hist., Vol. 1, p. 371, Pl. 14, Fig. 7; Pl. 20, Figs. 4a, 4b, 10. 1931

Occurence: C.I.T. Locality 1671

Spisula (?) sp.

Occurence: C.I.T. Locality 1670

Turris aff. elsmerensis English

Turris elsmerensis English, Univ. Calif. Publ. Bull. Dept. Geol., Vol. 8, No. 8, pp. 216-217, Pl. 23, Figs. 4a, 4b, 1914.

Occurence: C.I.T. Locality 1670

Clavus (Cymatosyrinx) hemphilli (Stearns)

Pl. 3, Fig. 4

Pleurotoma (Drillia) hemphilli Stearns, Conchological Memoranda, No. 7, p. 2, separately printed, Journal & Argus Print, Petaluma, Calif., Aug. 28, 1871; Proc. Calif. Acad. Sci., Vol. 5, p. 80, Pl. 1, Fig. 3, 1873.

Clavus (Cymatosyrinx) hemphilli (Stearns), Grant and Gale, Mem. San Diego Soc. Nat. Hist., Vol. 1, pp. 577-578, Pl. 26, Fig. 8, 1931.

Occurence: C.I.T. Locality 1670

Cancellaria ? sp.

Occurence : C.I.T. Locality 1670

Olivella sp.

Occurence: C.I.T. Locality 1670

Order Ctenobranchiata

Family Neptuneidae

Genus Searlesia Harmer, 1914

Searlesia F. W. Harmer, Mon. Palaeo. Soc., Vol. 67, Plio. Moll. Gt. Brit., Vol. 1, p. 135, Pl. 13, Fig. 1, 1914; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 215, 1918.

Type (by original designation), Trophon costifer S. V. Wood, figured by Harmer, op. cit., Pl. 13, Fig. 1.

"Shell solid, fusiform; apex blunt but not bulbous; ornamented by spiral lines or ribs and by strong longitudinal costae; canal usually short, open, straight or bending slightly to the left." (S. V. Wood)

Amplification of the above generic description by Dall is hereby quoted.

"Nucleus smooth, of two laxly coiled smooth whorls changing abruptly into the adult sculpture of few strong axial ribs crossed by numerous spiral threads. The shell-structure subtranslucent, dark colored; the shell short-fusiform, periostracum inconspicuous; aperture shorter than the spire, the outer lip thickened and internally lirate; the body callous, with a narrow chink between the reflected enamel and the strong siphonal fasciole; canal short, open, slightly recurved. Radular formula 1/2 ; 1/3 : 1/2, the medium rachidian cusp longer than the others."

<u>Searlesia secoensis</u> Buffington n. sp.

Pl. 1, Figs. 6a, 6b, 6c

<u>Syntypes</u> California Institute of Technology Paleontological Collection, Nos.   , C.I.T. Locality 1671.

<u>Description</u> Shell of moderate size, sub-fusiform; eight ventricose whorls; spiral sculpture on body whorl of 16-25 evenly spaced spiral cords which are perceptible but barely rise above the surface of the shell; interspaces at least twice the width of the cords; approximately 10-12 irregularly spaced faint axial ribs best seen on the body whorl; ovate aperture with smooth outer lip; anterior canal quite short and apparently uncurved; thin shell.

<u>Dimensions</u> Length....................45 mm
Maximum width..............19 mm

<u>Comparisons and Affinities</u> This new species approaches, in some ways, the characteristics of <u>S. dira</u> (Reeve), but differs that it's axial rib sculpture becomes more pronounced on the body whorl while that of <u>S. dira</u> (Reeve) becomes obsolete. In addition <u>S. dira</u> (Reeve) has many less ribs. Small nodes are evident on <u>S. dira</u> (Reeve) where the axial ribs intersect the most protuberant portions of the whorls.

<u>Number of Specimens</u> Approximately 35 specimens of this species were collected.

<u>Preservation and Matrix</u> The occurence of this form is in a compact, dense well indurated calcareous sandstone. The shells are found in varying degree of preservation. Frequently the shell of the animal is completely leached away leaving nothing but an interior mold and an exterior

mold. Latex rubber casts made from the latter reveal in excellent detail the fine sculpture of the exterior. About one-half of the specimens retain their original shell material in lesser or greater degree.

Type Locality C.I.T. Locality 1671 as described in this paper.

Collector E. C. Buffington

Repositories of the Type Material California Institute of Technology Geology Department, Paleontological Collections.

Order CTENOBRANCHIATA

Family Muricidae

Genus Forreria Jousseaume, 1880

Forreria Jousseaume, Le Naturaliste, 2nd year, No. 42, p. 335, Dec. 15, 1880.

"Chorus Gray" of various authors, not of Gray, Proc. Zool. Soc. London for 1847, type by original designation, Monoceros giganteus Lesson.

Type of Forreria - Forreria belcheri (Hinds) Quoting Grant and Gale's description of this type (Mem. San Diego Soc. Nat. Hist., Vol. 1, p. 727, 1931:

> "Forreria belcheri (Hinds) is a rather large shell with quadrate whorls handsomely coronated with hollow, trough-like spines. The body whorl is rather abruptly constricted anteriorly, a slight sulcus being reflected at the aperture by a projecting tooth on the outer lip, as in Pseudoliva. In general aspect the shell recalls Forreria catalinensis (I. S. Oldroyd), but the thin, expanded varices of the latter are in belcheri closely welded to the sides of the whorl and the shell of Hind's species is heavier, more quadrate in shape, and has a relatively shorter and more bent anterior canal and a more open umbilicus. The genus Forreria may be related to Trophon through such species, that is, via Austrotrophon."

Forreria durhami Buffington n. sp.

Pl. 3, Fig. 3

Holotype California Institute of Technology Paleontological Collections, No. , C.I.T. Locality 1670.

Description   This form is of medium size, and is strongly characterized by an obliquity in it's general configuration as viewed in profile. It has four whorls, the external extremities of which are decorated by spines. Each whorl has eight spines. The apical angle is roughly 80° giving moderate slopes to the spire. The surface is marked by strong spiral growth lines. In the holotype these were absent from all but the body whorl on which a minimum of eleven were counted. Their width is approximately one-half the width of the interspaces which separate them. Ribs, prominences on which the spines form, are seen to merge at the umbilicus following an oblique path from right to left as the specimen is oriented with a line from the apex through the umbilicus situated vertically.

Dimensions   Maximum width.......29 mm
Measured height.....28 mm

Comparisons and Affinities   This form resembles Trophon carisaensis Anderson (Clark, 1915, Pl. 66, Figs. 1,2) to a slight degree. It's pronounced obliquity and unique rib pattern are the diagnostic characteristics.

Number of Specimens   Only one specimen, the holotype, was secured.

Preservation and Matrix   The specimen was secured in a fairly well preserved state from deeply weathered shales and sands which mark C.I.T. Locality 1670. A large percentage of the original shell is present, though some of the more prominent protuberances and spines have been worn off.

Type Locality   C.I.T. Locality 1670 as described in this paper.

Collector   E. C. Buffington

Repositories of type material   California Institute of Technology, Geology Department, Paleontological Collections.

Note: This species is named for Dr. J. Wyatt Durham, Associate Professor of Invertebrate Paleontology at the California Institute.

Trophosycon cf. ocoyana (Conrad)

Pl. 2, Figs. 4a, 4b

Sycotypus ocoyanus Conrad, U. S. House of Representatives, Doc. No. 129, p. 19, 1855, reprinted by Dall, Prof. Paper, 59, U.S. Geol. Survey, p. 170, 1909; Reports of U.S. Pacific Railroad Explorations and Surveys, Vol. 5, Pt. 2, appendix, p. 329, Pl. 7, Figs. 72, 72a, Washington, 1856, reprinted by W. P. Blake, New York, 1858; Cooper, Bull. No. 4, Calif. St. Mining Bureau, p. 54, 1894.

Trophosycon ocoyana (Conrad), Grant and Gale, Mem. San Diego Soc. Nat. Hist. Vol. 1, pp. 743-746, Pl. 30, Figs. 3,7,8a,8b,11, 1931

Occurence; C.I.T. Locality 1670

Polynices (Neverita) reclusiana (Deshayes)

Natica reclusiana Deshayes, Rev. Zool. Soc. Cuv., p. 361, 1839; Guerin's Mag. de Zool., Mollusca, Pl. 37, 1841; Reeve, Conch. Icon., Vol. 9, Natica, Pl. 1, Fig. 3, 1855; Sowerby, Thes. Conch., Vol. 5, p. 76, Pl. 1, Fig. 6, 1883.

Polynices (Neverita) reclusiana (Deshayes), Grant and Gale, Mem. San Diego Soc. Nat. Hist., Vol. 1, pp. 800-801, text Figures 13a,13b,13c, 1931.

Occurence: C.I.T. Locality 1670

Lunatia cf. draconis (Dall)

Pl. 2, Figs. 5a,5b,5c,5d

Proceedings of the Biological Society of Washington 16:174. Bulletin 112, United States National Museum, Pl. 14, Figs. 4,6.

Polinices draconis Dall, 1903, Oldroyd, The Marine Shells of the West Coast of North America, Vol. II, Part III, pp. 128-129, Plate 99, Figs. 3, 6, 1927.

Occurence: C.I.T. Locality 1671

Astraea (Pomalaux) gradata Grant and Gale

Astraea (Pomalaux) gradata Grant and Gale, Mem. San Diego Soc. Nat. Hist., Vol. 1, pp. 818-819, Pl. 31, Figs. 1a,1b, 3a, 3b, 5, 8, 9, 1931.

Occurence: C.I.T. Locality 1670

DESCRIPTION OF FOSSIL LOCALITIES

C.I.T. Locality 1670 lies almost directly east of the Dry Canyon reservoir in the SW $\frac{1}{4}$ of the SE$\frac{1}{4}$ of the SE$\frac{1}{4}$ of section 26, T. 5 N., R. 16 W on the U.S.G.S. topographic map of the Saugus quadrangle. (Ed. of 1933, reprinted 1939, Scale 1:24,000) It is approximately 1,000 feet on a line bearing N 69 W from the point where sections 25, 26, 35, and 36 meet. Fossils are found primarily on a small ridge running up about 100 feet from the valley floor, and in several small gullies directly to the west. The ridge appears to be a dip slope. Accordingly the fossils found up and down it's length are assumed to be stratigraphically very close.

C.I.T. Locality 1671 is found in the bottom of a small canyon forming the westernmost branch of the trifurcation of Haskell Canyon. It may be located in the SE$\frac{1}{4}$ of the SE$\frac{1}{4}$ of the NE$\frac{1}{4}$ of the SE$\frac{1}{4}$ of section 26, T. 5 N., R. 16 W on the U.S.G.S. topographic map of the Saugus quadrangle. (Ed. of 1933, reprinted 1939, Scale 1:24,000). It is approximately 1260 feet on a line bearing N 5 W from a point where sections 25, 26, 35 and 36 meet just east of the Dry Canyon Reservoir. Here the fossils occur in a medium brown, compact, fairly dense, well indurated, calcareous sandstone. The fossiliferous bed crosses the creek at the bottom of the canyon forming a small six-foot cliff in the stream bed. Most of the fossils were found in the upper foot of this small cliff.

Fig. 4 C.I.T. Locality 1670, with the Dry Canyon Reservoir showing in the background.

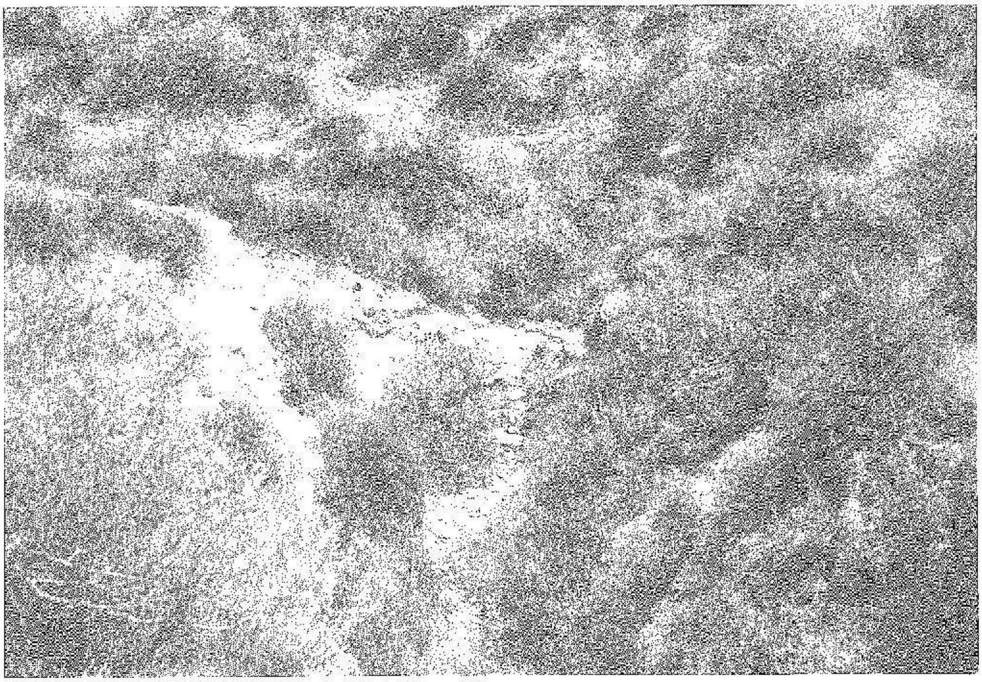


Fig. 5 C.I.T. Locality 1671

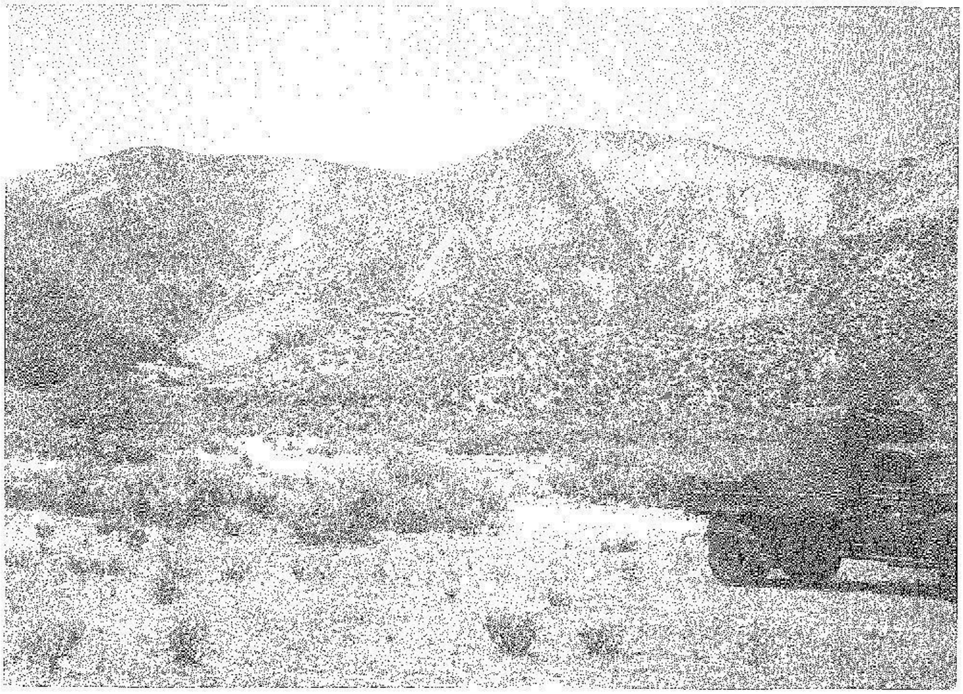
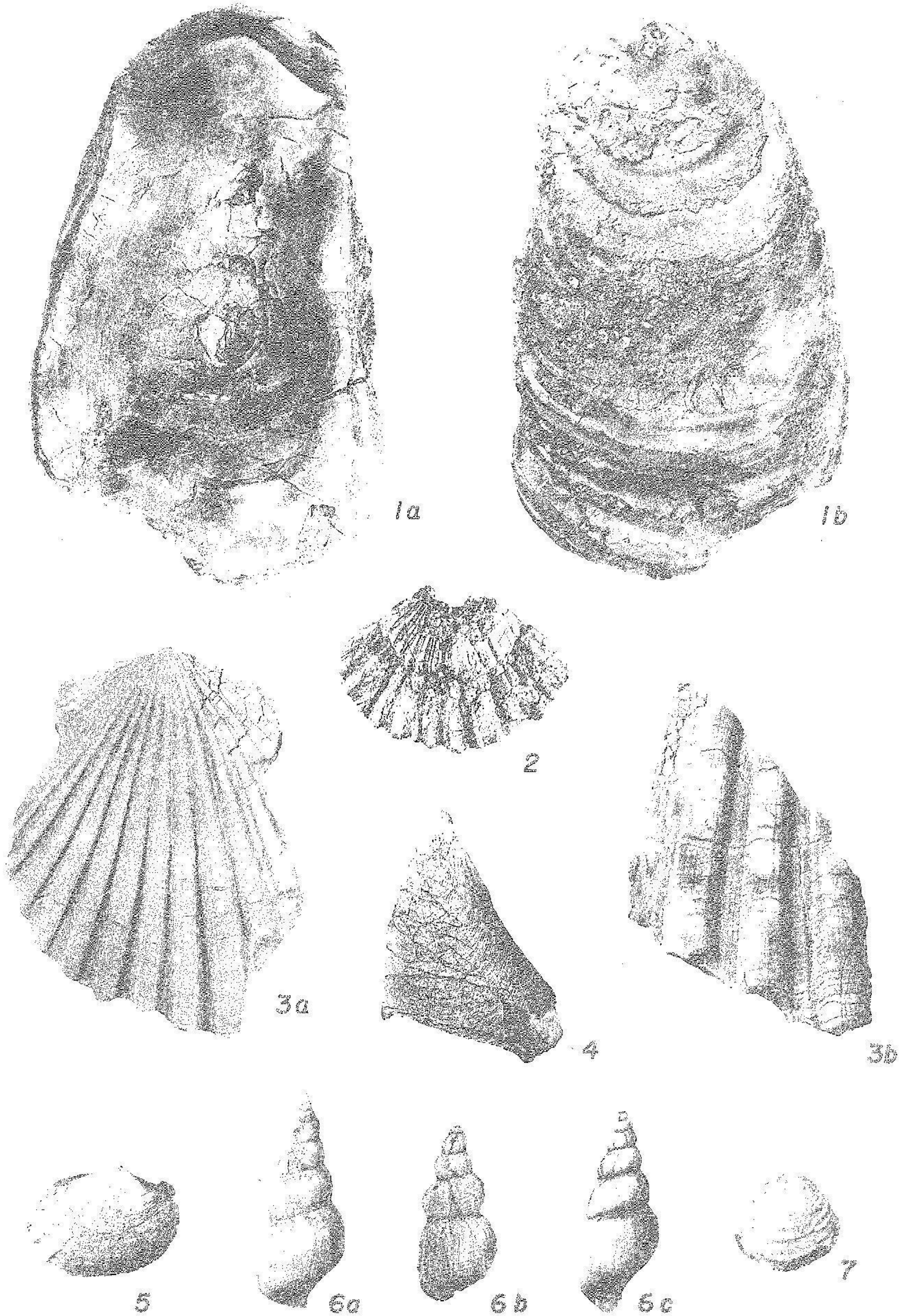


Fig. 6 Anticlinal exposure of the "Modelo" on the west side of Haskell Canyon where the columnar section was measured.

EXPLANATION OF PLATE 1

Figs. 1a, 1b	*Ostrea titan* Conrad var., Fig. 1a interior view, Fig. 1b dorsal view. x 2/3
Fig. 2	*Lyropecten crassicardo* ? Conrad x 1
Figs. 3a, 3b	*Lyropecten crassicardo* Conrad, Fig. 3a x 2/3, Fig. 3b a fragment of another specimen. x 1
Fig. 4	*Mytilus* (*Mytiloconcha*) *coalingensis* Arnold x 1
Fig. 5	*Periploma haskellensis* Buffington n. sp., Holotype, natural cast from an external mold. x 1
Figs. 6a, 6b, 6c	*Searlesia secoensis* Buffington n. sp., Fig. 6b is a latex rubber cast from an external mold. x 1
Fig. 7	*Chione diabloensis* Clark x 2

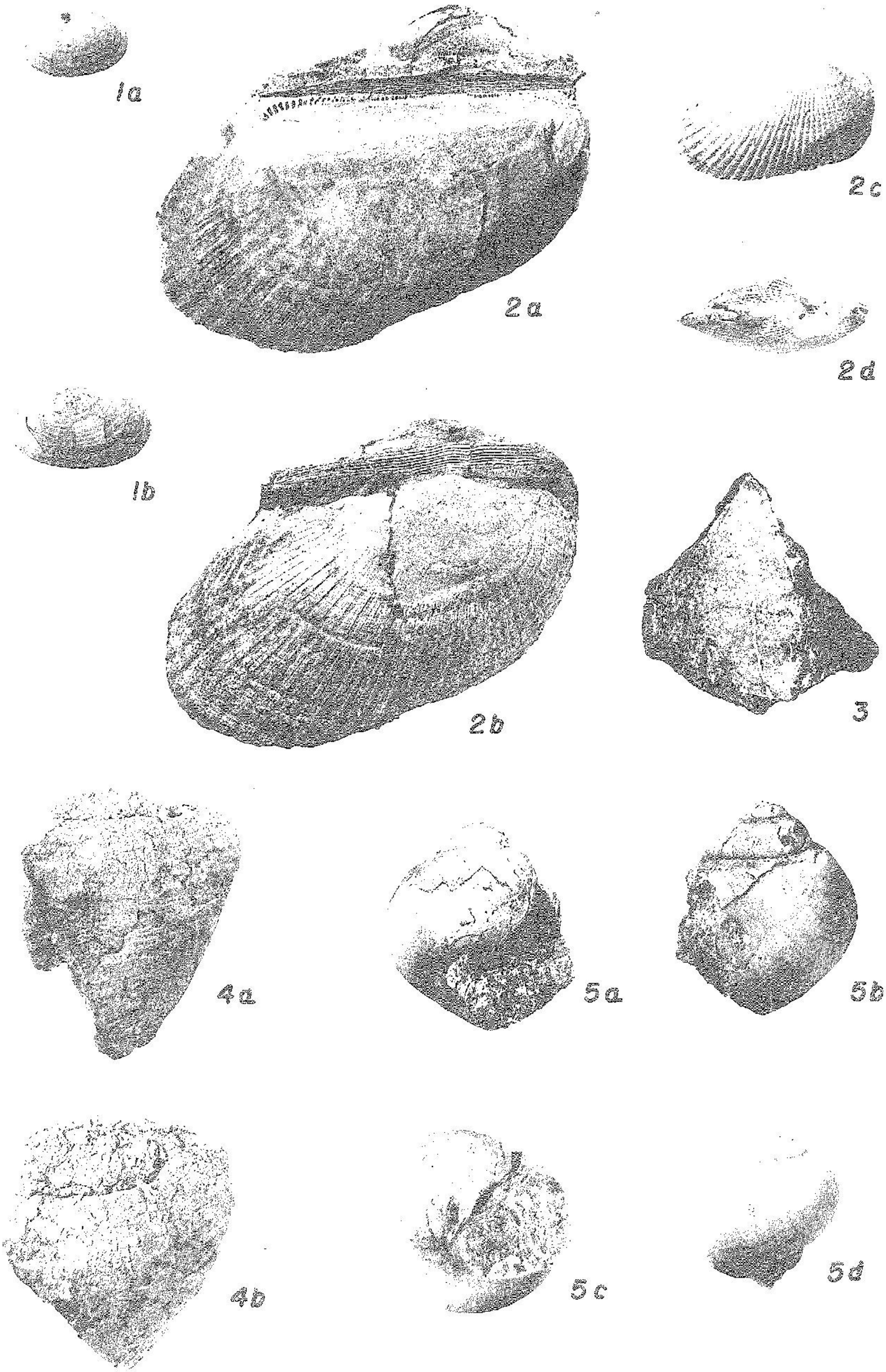
PLATE I



EXPLANATION OF PLATE 2

Figs. 1a, 1b	Macoma moetis (Deshayes) var. acolasta (Dall) x 2
Figs. 2a, 2b, 2c, 2d	Anadara (Anadara) haskellensis White n. sp., Fig. 2a is a natural cast from an external mold. The upper portions of the right valve have been removed to expose the teeth and hinge lines of the left valve which has been displaced dorsally in the process of preservation. Fig. 2b is a latex rubber cast of the external mold in which the specimen figured in 2a was found. Rib detail is much more pronounced in this. Fig. 2c is the right valve of a smaller specimen found close by, and Fig. 2d is a dorsal view of the same. Figs. 2a and 2b x 1, Figs. 2c and 2d x 2.
Fig. 3	Fossil leaf x 1
Figs. 4a, 4b	Trophosycon cf. ocoyana (Conrad), Fig. 4b is an oblique view. x 2/3
Figs. 5a, 5b, 5c, 5d	Lunatia cf. draconis (Dall), Fig. 5a apertural view, Fig. 5b back view, Fig. 5c umbilical view. Fig. 5d is a different specimen than Figs. 5a, 5b, and 5c. Figs. 5a, 5b, 5c x 1, Fig. 5 d x 2.

PLATE 2



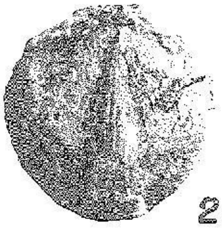
EXPLANATION OF PLATE 3

Figs. 1a, 1b	*Astrodapsis* aff. *fernandoensis* Pack, Fig. 1a is a clay cast of an external mold. Fig. 1b is a latex rubber cast from the external mold of a different specimen. x 1
Figs. 2a, 2b, 2c, 2d	*Terebratalia smithi* Arnold, Fig. 2a dorsal view, Fig. 2b ventral view, Fig. 2c anterior end view, Fig. 2d posterior end view. x 1
Fig. 3	*Forreria durhami* Buffington, n. sp. x 1
Fig. 4	*Clavus* (*Cymatosyrinx*) hemphilli Stearns x 2
Fig. 5	*Petricola sp.* x 2
Figs. 6a, 6b, 6c, 6d	*Terebratalia occidentalis* Dall, Fig. 6a dorsal view, Fig. 6b ventral view, Fig. 6c anterior end view, Fig. 6d posterior end view. x 1

PLATE 3

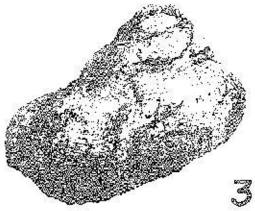
1a

1b



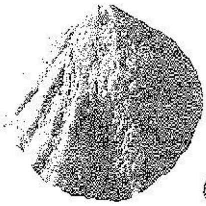
2a

6a



3

2b

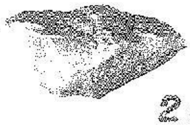


6b

4

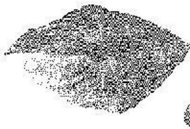
2c

6c



2d

5



6d

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