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UPPER CRETACEOUS AND LOWER TERTIARY FORAMINIFERA FROM FRESNO COUNTY, CALIFORNIA

BY

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WIEN 1964

EIGENTÜMER, HERAUSGEBER UND VERLEGER: GEOLOGISCHE BUNDESANSTALT, WIEN III, RASUMOFSKYGASSE 23

ÖSTERREICHISCHE STAATSDRUCKEREI

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Abstract

Coniacian through Danian sediments more than 14,000 feet thick exposed along the six-mile length of Moreno Gulch, Panoche Hills, Fresno County, California, are represented by the upper part of the type Panoche group and the Moreno formation. The Panoche group in Moreno Gulch is subdivded into the Lower and Upper Marlife and Uhalde formations. Although these strata exhibit varied lithologic changes, they consist largely of sandy shales, sandstones, and organic shales. The geologic age for these sediments is based on Foraminifera.

The 167 foraminiferal species described and figured are assigned to 80 genera and 24 families. Twenty-nine species are considered to be new. These are: *Bathysiphon californicus*, *Psammosiphonella llanadoensis*, *Haplophragmoides impensus*, *Haplophragmoides incognatus*, *Bermudezina uvigerinaeformis*, *Eggerella obscura*, *Marginulina campbelli*, *Lenticulina almgreni*, *Lenticulina praeconvergens*, *Lenticulina rectovalis*, *Lenticulina schencki*, *Robulus pseudoligostegius*, *Planularia mirabilis*, *Praeglobotruncana caryi*, *Globotruncana churchi*, *Globotruncana fresnoensis*, *Globotruncana goudkoffi*, *Bulimina joaquinensis*, *Bolivinoides paynei*, *Rotalia bandyi*, *Rotalia minuta*, *Gyroidinoides grahami*, *Gavelinella turbinata*, *Globorotalites rosaceus*, *Valvulineria jarvisi*, *Anomalina becki*, *Anomalina occidentalis*, *Anomalina whitei*, and *Cibicidoides validus*.

Foraminiferal faunas described herein are composed largely of smaller benthonic forms with planktonic elements playing a minor but significant role. These assemblages, for the most part, are sparse and consist of relatively few species and specimens; however, well-developed and fairly rich assemblages also occur. A most striking feature is the predominance of arenaceous Foraminifera in the Lower Marlife and Uhalde formations of the Panoche group. Commonly occurring arenaceous genera are *Bathysiphon*, *Cribrostomoides*, *Gaudryina*, *Haplophragmoides*, and *Marssonella*. Calcareous foraminiferal faunas typify the Upper Marlife formation and some of the better represented genera are *Eponides*, *Stensioina*, *Gyroidina*, *Globotruncana*, *Reussella*, and *Lenticulina*. The lower portion of the Moreno formation is characterized by poorly preserved partially limonitized foraminiferal assemblages of which the principal constituent genera are *Bulimina*, *Gavelinella*, and *Siphogenerinoides*. *Globigerina* and *Valvulineria* are the most important of the genera in uppermost Moreno formation sediments.

Interpretation of depositional environments is based on consideration of paleoecological significance of the Foraminifera and other microfossils present. Composition, distribution, and inter-relationships of these and that of associated sediments suggest variable conditions of deposition for Moreno Gulch Upper Cretaceous strata. Indications are that deposition of the Lower and Upper Marlife formations probably took place in temperate, inner to outer neritic waters, respectively. Turbid waters may have been a contributing factor in the development of wholly arenaceous faunas in the greater part of the Uhalde formation. Faunal evidence points to a possible inner neritic environment for uppermost Uhalde sediments. A return to somewhat deeper neritic conditions during deposition of the Moren formoation is indicated by the microfauna.

Local correlations based on indigenous California foraminiferal species are consistent with current opinions. Significant California forms observed in this study are: *Planulina popenoei*, *Anomalina becki*, *Bermudezina uvigerinaeformis*, *Globotruncana churchi*, *Gyroidina quadrata*, *Nodosaria spinifera*, *Bulimina spinata*, *Bulimina prolixa*, *Siphogenerinoides whitei*, and *Valvulineria lillisi*. Stratigraphic distribution of these and associated species demonstrate that previously described Upper Cretaceous foraminiferal faunas from other California localities are correlative with those of Moreno Gulch. Foraminiferal faunal succession from Moreno Gulch also generally coincides with GOUDKOFF's California Upper Cretaceous substages.

A number of well-known species with regional stratigraphic significance occur in Moreno Gulch sediments. These provide a biostratigraphic sequence extending from the Coniacian through Danian. The more important of these species are: *Globorotalites subconicus*, *Stensioina exsculpta*, *Kyphopyxa christneri*, *Reussella szjanoche*, *Quadrimorphina allomorphinoides*, *Gaudryina pyramidata*, *Bolivina incrassata*, *Globigerinoides daubjergensis*, and *Globigerina pseudobulloides*.

Regional correlations based on a comparison of material from the Gulf Coast of the United States and Mexico, northern South America, and northwestern Europe further demonstrate that well-known and widely distributed Santonian and Campanian faunal elements are present in California. To a lesser degree, this also appears to be true of the Coniacian. California Maastrichtian microfaunas, in contrast, show few relationships to their Gulf Coast or European counterparts although they appear to be somewhat related to equivalent foraminiferal assemblages of northwestern South America.

Introduction

The primary objective of this study is to present the results of a detailed analysis of Upper Cretaceous foraminiferal assemblages from the type upper Panoche group and Moreno formation exposed along Moreno Gulch, Panoche Hills, Fresno County, California.

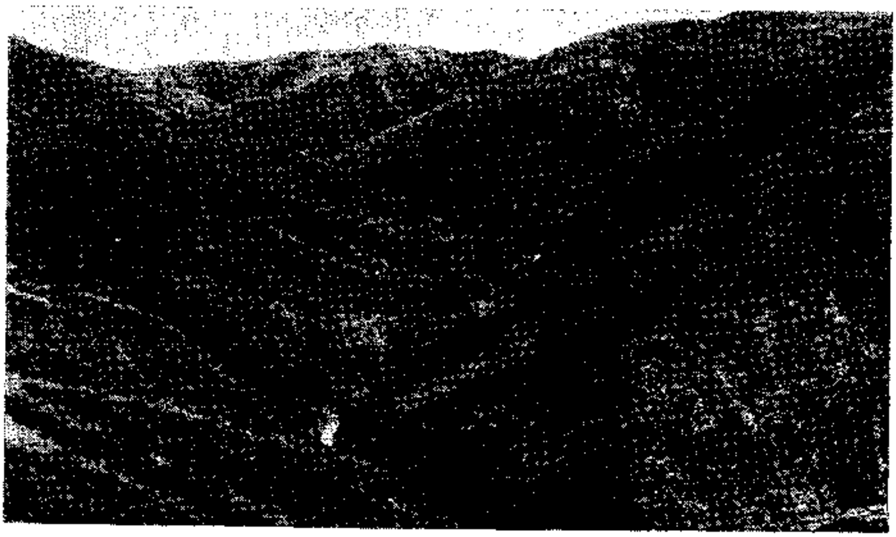
Comparatively little has been published regarding Upper Cretaceous Foraminifera of California. Aside from the works of CUSHMAN and CHURCH (1929), CUSHMAN and CAMPBELL (1935), CUSHMAN and GOUDKOFF (1944), BANDY (1951), and TRUJILLO (1960), and lesser but significant specific studies, no comprehensive taxonomic or illustrated faunal analysis has been presented.

In contrast, during the past few years workers in other parts of the world have focused attention on Upper Cretaceous Foraminifera. This readily affords an excellent opportunity to evaluate and analyze California Upper Cretaceous Foraminifera in light of recent developments elsewhere. Any extension of knowledge applicable to this neglected group is desirable, not only from a purely academic point of view, but also because of its potentiality as an aid to subsurface studies in petroleum geology. It is hoped that results of this investigation will attract and center attention on the many remaining problems involving faunal and stratigraphic relationships of Upper Cretaceous Foraminifera from the San Joaquin Valley.

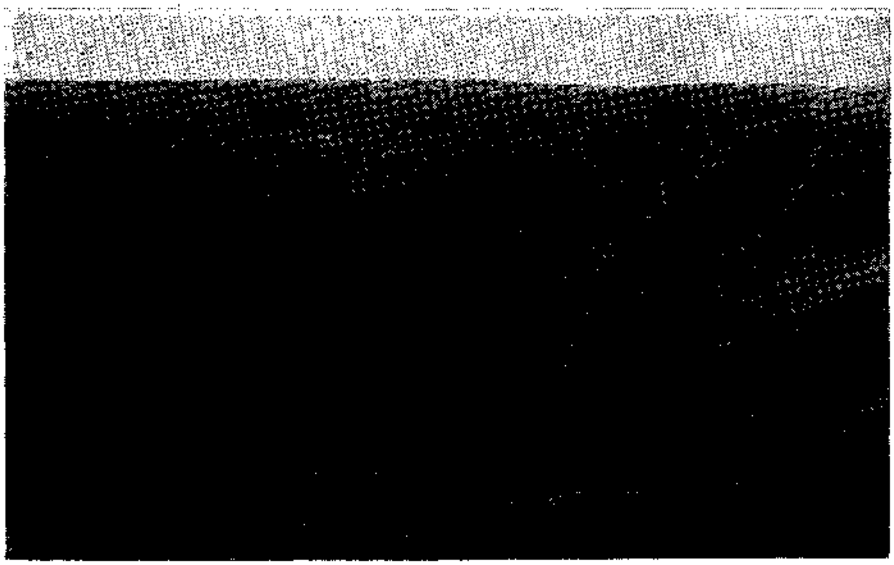
The area discussed herein is situated along the western side of the San Joaquin Valley in Fresno and Merced Counties, California. It forms the easternmost extension of the Diablo Range (Figures 1, 2). The Panoche Hills, designated by ANDERSON and PACK (1915, p. 38) as the type area of the Panoche and Moreno sediments, are situated mainly in T. 14 S., R. 11 E. and the northern half of T. 15 S., R. 11 E. This group of hills is separated from the Diablo Range by the Little Panoche and Panoche Valleys. They are characterized by a thick sequence of well-exposed, readily accessible, east northeastward-dipping Cretaceous and Tertiary marine strata (Figure 3).

Samples were obtained from two surface sections, namely Moreno Gulch and Laguna Seca Creek, located in the Panoche Hills and Laguna Seca Hills respectively (Figure 2). Moreno Gulch, easily identifiable because of its size and extent, is situated on the eastern flank of the Panoche Hills, approximately four miles southeast of Little Panoche Creek (Figure 2). It empties into the San Joaquin Valley in sec. 1, T. 14 S., R. 11 E. and can be followed for a distance of approximately six miles through secs. 11, 14, 15, 16, and 17, T. 14 S., R. 11 E. into the central part of the Panoche Hills.

Laguna Seca Creek is situated on the east flank of the Laguna Seca Hills about seven miles north of Little Panoche Creek and about 11 miles northeast of Moreno Gulch. It extends through secs. 8 and 18, T. 12 S.,



Text Figure A. Moreno Gulch as observed in NW 1/4 sec. 15, T. 14 S., R. 11 E., looking eastward from point near Television Peak.
Outcropping lower portion of Uhalde formation may be seen.



Text Figure B. Moreno Gulch as observed in NE 1/4 sec. 16, T. 14 S., R. 11 E., looking westward from point near Television Peak.
Upper and Lower Marlife formations (fore- and background respectively) are exposed.

R. 11 E., and secs. 13, 14, 23, and 22, T. 12 S., R. 10 E. for a distance of five miles. A selected stratigraphic interval from the Laguna Seca Creek is included in this study because of the occurrence of a foraminiferal assemblage entirely lacking in Moreno Gulch (Tables 3 and 4).

A total of 1242 samples representing a stratigraphic thickness of some 14,000 feet of upper Panoche and Moreno sediments in Moreno Gulch were analyzed. An additional 170 samples from a selected interval of uppermost Panoche sediments in Laguna Seca Creek were also examined. Not all samples from these sections were satisfactory for age determinations. In Moreno Gulch the vast majority of samples were either barren or contained weathered and generally indeterminate forms. Nevertheless, despite the fact that only eight per cent of the samples were used, it is believed that coverage is adequate inasmuch as samples containing identifiable material are stratigraphically well distributed throughout the section (Figure 4a). The Laguna Seca Creek section yielded similar results. Because of a high percentage of barren and near-barren samples, intervals between fossiliferous samples are highly irregular. Furthermore, the presence of coarse concretionary sandstones, some of which are several hundred feet thick, accentuates this irregularity (Figure 4 a, Appendices A and B).

This study was begun in the Fall of 1957 and was actively pursued during the following years. The writer is fortunate to have worked in Trinidad, B. W. I. and in Colombia, where he was able to personally observe and make faunal and specific comparisons upon which much of this work is based. Plates of Foraminifera were drawn by the author using a camera lucida.

Acknowledgments

The preparation and completion of this work was made possible by the assistance and cooperation of a number of individuals and organizations. It is with sincere gratitude that the writer acknowledges the aid and support of the following: Senor Augustin C. AYALA, National University of Mexico, who assisted in the specific identification of some forms of the genus *Globotruncana;* Dr. Orville L. BANDY, University of Southern California, who kindly loaned material from the Carlsbad area, San Diego, California; Dr. Paul BRÖNNIMANN, Esso Standard Libya Inc., helped to clarify several identifications of the genus *Globotruncana;* Dr. Benjamin H. BURMA, California Exploration Company, donated comparative Upper Cretaceous material from the Gulf Coast of the United States; Dr. Tatsuro MATSUMOTO, Kyushu University, Japan, made available use of data on ammonites from the Panoche Hills from an unpublished manuscript; Mr. Max B. PAYNE, Norris Oil Company, Bakersfield, California, generously gave of his time to accompany the writer into the field and point out stratigraphic features of the Panoche Hills; Miss Ruth TODD, United States Geological Survey, Washington, D. C., kindly checked identifications of several species sent to her.

Special thanks go to the managements of the Union Oil Company of California and The Superior Oil Company for releasing material from Moreno Gulch and Laguna Seca Creek sections. Messrs. Charles W. CARY and Alvin A. ALMGREN of the Union Oil Company and The Superior Oil Company, Bakersfield, respectively, are particularly thanked for their aid in the identification of species and for their discussions of various biostratigraphic aspects of Upper Cretaceous foraminiferal assemblages of central California.

The writer is also indebted to the following members of the Department of Geology, Stanford University: the late Dr. Hubert G. SCHENCK, who initially suggested the problem; Dr. Hans E. THALMANN, whose extensive library of Foraminifera facilitated various aspects of this study; and Dr. Joseph J. GRAHAM, who supervised this doctoral dissertation throughout and offered valuable suggestions and criticisms.

Lastly, the constant aid and encouragement of my wife, Lois Deicke MARTIN, is gratefully acknowledged.

Historical Review

1. Geology

The first published discussion of Cretaceous strata in the vicinity of Panoche Hills seems to be that of WHITNEY (1865, p. 9). He divided the Diablo Range into several geographic areas, one of which is the Panoche division between Pacheco Pass and Panoche Pass.

An account of the first known visit of a geological field party—one which took place shortly after the newly formed Geological Survey of California began its first field season—is described by WHITNEY (1865).

A limited survey was conducted as the party camped near Big Panoche Creek in July, 1861. The following quotation summarizes their observations:

> The sides of the Panoche Valley are distinctly terraced in many places, the plain once evident having been occupied by a lake. The ranges of the hills to the east of the Panoche Plain are in all probability of Tertiary sandstone; while the metamorphic rock on the west is presumed to be the continuation of Cretaceous which we have traced down from Monte Diablo (WHITNEY, 1865, p. 56).

Inasmuch as only a limited knowledge of the geography and geology of the Panoche area was known at that time, it is understandable that rocks now considered Franciscan were thought to be Cretaceous metamorphics, and sediments now known to be Cretaceous were regarded as Tertiary (Table 1).

Although it is likely that other investigators subsequently visited this area, no mention of the Panoche region appeared in the literature until ANDERSON (1905) published on the stratigraphy of the Mount Diablo Range. He briefly refers to the foothill strata north of Coalinga as follows:

> A fairly well marked band which extends along the foothills in a north and northwestwardly trend to Silver Creek and Panoche Valley (ANDERSON, 1905, p. 162).

The reports of ARNOLD and ANDERSON (1908, 1910) on the geology of the Coalinga area do not include any discussion of the Panoche Hills area. However, because of the geological similarities of the two areas, these reports are significant in the nomenclatural development of the Panoche group and the Moreno formation. The 1910 report (U. S. Geological Survey Bull. 398) is of especial importance, for in it the Cretaceous age of the Moreno or Purple shale, as it was then called, was established (Table 1). Prior to this time, the sedimentary rocks now known as Moreno were assigned to the Eocene. This opinion, based solely on the lithological character of the rocks, prevailed until paleontological evidence pointed to an Upper Cretaceous age for these sediments (ARNOLD and ANDERSON, 1910).

In 1915 ANDERSON and PACK published their now classic study of the west border of the San Joaquin Valley between Coalinga and Livermore Pass, and for the first time great thicknesses of Cretaceous strata were measured and mapped. The Panoche Hills were designated by them (1915, p. 38) as the type area of the Moreno and Panoche formations.

More than two decades were then to pass before detailed mapping was again attempted in Panoche Hills. PAYNE (1941, 1951) brought this period of apparent indifference to a close by mapping and dividing the Moreno formation into members, selecting Escarpado Canyon in the southeastern part of the Panoche Hills as the type locality.

SUTTON (1952) in an unpublished Master's thesis at Stanford University proposed a number of lithogenetic units as members of the Panoche formation in the type area. Since 1956 PAYNE has elaborated upon SUTTON's findings, elevating the Panoche to group rank (Dr. H. G. SCHENCK, personal communication). This revision provides for the subdivision of the Panoche group into lithogenetic units which will be assigned formational status. In Moreno Gulch only the Lower and Upper Marlife and Uhalde formations of the Panoche group are exposed (Table 1).

Historical development of the Laguna Seca Hills several miles northwest of the Panoche Hills is similar. The map by ANDERSON and PACK also shows this area as one in which the Cretaceous is subdivided into the Panoche and Moreno formations. Members from the type area of the Moreno have been traced by PAYNE (1951) into the Laguna Seca Hills. The most recent work in the area is that by BRIGGS (1953 a), who has described the geology of the nearby Ortigalita Quadrangle. The map of BRIGGS is also similar to that of ANDERSON and PACK in that it contains no subdivision of the Moreno formation.

On the basis of faunal studies and field investigations in the type area of the Panoche group and Moreno formation, the subdivisions of PAYNE (1951, 1962) and SUTTON (1952) are considered valid and are so used in this study (Table 1, Figure 3).

2. Micropaleontology

Although Upper Cretaceous Foraminifera from California were first recorded in the literature some 70 years ago, surprisingly little has been published in the way of detailed systematic and stratigraphic faunal analysis. The following paragraphs briefly outline some of the more interesting and significant developments in the study of Upper Cretaceous Foraminifera of California.

The year 1891 marks the earliest mention of Foraminifera from Upper Cretaceous strata in California. In a geological study of Mount Diablo, TURNER (1891, p. 395) cites the occurrence of Foraminifera associated with small fragments of fossil wood in beds of Chico age.

ANDERSON (1905, pl. 13, figures 9—29) published what probably are the first figures of California Cretaceous Foraminifera. These were from the Mount Diablo area, in shales then considered to be Eocene in age. Only generic determinations are given, but among those figured was *Sagrina*, a foraminifer which today is likely to be referred to as the genus *Siphogenerinoides*.

Abundant occurrences of Foraminifera from the Moreno shale of Moreno Gulch were reported by ANDERSON and PACK (1915, p. 47). They also mentioned the finding of diatoms and megafossils in this same region.

CUSHMAN and CHURCH (1929) described 44 species from the Chico shale from a well situated in the Alcalde Hills, west of Coalinga, Fresno County. The shale is now considered to be part of the upper Panoche group. When comparison of the California assemblage with that of the Gulf Coast of the United States was made, the relative absence of planktonic Foraminifera in the California microfauna was noted. Results attained in this study sustain this observation.

In 1935 CUSHMAN and CAMPBELL described a foraminiferal faunule of 20 species from near the town of Tracy, San Joaquin County. This faunule, originally thought to be representative of the Moreno formation, is now believed to belong to a higher stratigraphic horizon in the Panoche group.

As an aid to studies on Cretaceous Foraminifera, MARTIN (1936) compiled a checklist of 852 species based on papers from North and South

America, indexing the original names of the species as well as the publications from which the data were obtained.

Twenty-eight diagnostic and stratigraphically important species of Foraminifera were described and figured by CUSHMAN and GOUDKOFF in 1944 from various Upper Cretaceous localities throughout the Great Valley of California. Stratigraphic positions of the fossils were given with reference to the top of the Moreno formation as originally defined by ANDERSON and PACK (1915). Some of these species were described from surface sections and others from wells. In all cases these Foraminifera appear to be characteristic of the substages into which GOUDKOFF later (1945) subdivided the Upper Cretaceous of central California.

GOUDKOFF's study in 1945 contributed greatly to the overall understanding of foraminiferal assemblages of this region. The first attempted zonation of these strata based on Foraminifera had been presented by him in 1936 at a meeting of Pacific Section of the Society of Economic Paleontologists and Mineralogists. As this report was based on limited material these preliminary results were subsequently modified by additional data obtained from a number of surface sections along the western border of the San Joaquin and Sacramento Valleys, as well as from numerous wells located throughout the region. As a result of this study GOUDKOFF proposed 12 substages grouped into 7 stages. Microfaunal, lithologic, and paleogeographic relationships were also discussed at length by him.

An Upper Cretaceous foraminiferal fauna of 56 species was described and figured by BANDY in 1951 from shales in the Carlsbad area, San Diego County. This assemblage is correlated by BANDY with that of GOUDKOFF'S Tracian stage.

Recently TRUJILLO (1960) described and figured foraminiferal assemblages consisting of 90 species. These faunas range in age from Turonian to Santonian and were collected from near Redding, Shasta County, in northern California.

In addition to the published works mentioned above, biostratigraphic analyses of Upper Cretaceous Foraminifera from numerous surface sections along the western edge of the Great Valley have been carried out by various oil companies. Unfortunately and understandably, none of this work has been published. The present study is based upon material from two such sections collected by the Union Oil Company of California and The Superior Oil Company along Moreno Gulch and Laguna Seca Creek.

General Geology

Upper Cretaceous marine sedimentary rocks comprise the greater part of the eastern foothill belt of the Diablo Range. The Moreno Gulch section under investigation consists of a series of sandy shales and sandstones. Although a thickness of approximately 22,000 feet of Cretaceous strata are present in Panoche Hills, only the upper part or about 14,000 feet are dealt with in this study (Table 1). This includes the upper part of the Panoche group and all of the exposed Moreno formation.

In the Panoche Hills and adjacent areas (i. e. Laguna Seca Hills) Cretaceous and overlying Tertiary strata form a northeastward dipping homocline. At Moreno Gulch average dips for the Moreno formation are 35 to 40 degrees, whereas those of the Panoche group range from 40 to 55 degrees (Figures 4 a and 4 b). A gradual increase in dip is observed in proceeding from younger to older sediments, or going from east to west. These sediments dip beneath the San Joaquin Valley and probably extend throughout the greater part of the Great Valley of California. Field observations in the Laguna Seca Hills indicate that similar geological conditions exist there (Figure 5).

Siltstones, sandy shales, and concretionary and non-concretionary sandstones make up the chief lithologic types associated with the upper Panoche group. For the most part, sandstones range from a few inches to several hundred feet in thickness and are interbedded with siltstones and shales. Dark-brown "cannon-ball" concretions up to three feet in diameter easily identify the concretionary sandstones. These sandstones are generally massive and are reported to be uniform petrologically (Briggs, 1953 a, b).

Approximately 12,000 feet of the upper Panoche group are exposed in Moreno Gulch. This portion of the group is subdivided into three formations, of which the oldest is the Lower Marlife shale, some 5100 feet thick. The base of the Lower Marlife is not exposed in Moreno Gulch, and it is known to have a slightly greater thickness in other areas of the Panoche Hills. Brown shales and sandy shales are the predominant lithology of this unit. The Lower Marlife is separated from the Upper Marlife by the Llanada sandstone member, a concretionary unit of variable thickness. The overlying Upper Marlife shale is readily identifiable by its dark blue-gray to gray color. Minor thin sandstones and a 10 foot bentonite bed are associated with this shale. The Upper Marlife as exposed in Moreno Gulch is about 2700 feet thick. Conformably overlying this shale is the Television sandstone member, which marks the upper limit of the Upper Marlife. In the vicinity of Moreno Gulch this sandstone forms prominent ridges. The succeeding Uhalde formation is typified by a shale and sandstone complex accounting for a thickness of about 3800 feet. This highest lithogenetic unit of the Panoche group is made up of light gray-green shales and sandstones.

Conformably overlying the Uhalde formation is the Moreno formation, characterized by a dark-brown to maroon or lavender clayey to porcelaneous shale. Its thickness at Moreno Gulch is 2100 feet. The lowermost part of the Moreno formation in the type area consists of sandstones similar to those of the underlying Uhalde. This has caused some difficulty in determining the boundary between the two formations. Payne (1951, p. 7, fig. 3; p. 9) places the contact between the generally flaggy sandstone of the Moreno and that of the massive concretionary ridge-forming uppermost Uhalde sandstone. Stratigraphically this is identical to the contact of Anderson and Pack (1915). In Moreno Gulch this important contact is not well defined micropaleontologically, as the *Siphogenerinoides-Globotruncana-Rotalia* assemblage from the uppermost Uhalde sediments is followed by the barren overlying Dosados sandstone member of the Moreno formation. The upper limit of the Moreno formation in Moreno Gulch is placed at the uppermost occurrence of its Cima sand member and the disconformably overlying Laguna Seca formation (Figure 3).

Field observations of the strata discussed above indicate fairly abrupt lateral and vertical changes in lithology. These variations are characteristic of these sediments throughout the Diablo Range (BRIGGS, 1953 a, p. 417). Undoubtedly this factor has retarded efforts to define and correlate stratal units precisely. On the basis of detailed mapping, recent studies by PAYNE (1962) in the type area of the Panoche group and Moreno formation undoubtedly will clarify some of these problems.

Faunal Characteristics

Foraminiferal assemblages described herein consist largely of smaller benthonic forms with a minor planktonic element. Most of these microfaunas are sparse and include relatively few species and specimens. There are, of course, strata in which rich and well-developed microfaunas occur. Most notable of the latter are those of the Upper Marlife and Uhalde formations of the Panoche group as well as the Marca shale member of the Moreno formation.

One hundred and sixty-seven species constituting 80 genera and 24 families are recognized in the present study. Twenty-nine species are considered new. Among the typical and significant Upper Cretaceous genera present are *Bolivinoides*, *Globorotalites*, *Globotruncana*, *Heterohelix*, *Kyphopyxa*, *Neoflabellina*, *Praeglobotruncana*, *Rugoglobigerina*, *Siphogenerinoides*, and *Stensiöina*. A striking feature is the occurrence and predominance of wholly arenaceous faunas in portions of the Panoche group (Table 2). Most prevalent genera are as follows: *Bathysiphon*, *Bermudezina*, *Cribrostomoides*, *Gaudryina*, *Haplophragmoides*, and *Marssonella*. Siliceous genera associated with arenaceous forms are *Rzehakina* and *Silicosigmoilina*. Although this study is mainly concerned with Upper Cretaceous Foraminifera, in the Moreno Gulch section lower-most Tertiary Foraminifera were obtained from the Lower Dos Palos member of the Moreno formation. Some of the more commonly represented genera are *Globigerina*, *Globigerinoides*, and *Valvulineria*.

Many foraminiferal species were observed only after the most thorough examination of sample material. As previously stated, barren intervals in Moreno Gulch strata exist partially owing to weathering and in part to the rapid deposition of coarse sediments. As a result foraminiferal assemblages tend to occur in streaks, and only by collecting closely spaced samples can these fossiliferous intervals be detected. The occurrence and distribution of species as well as of whole faunas have been affected by this pattern of sedimentary deposition so typical of the California Cretaceous. The genus *Globotruncana* CUSHMAN may serve as an illustration. Although ten species are identified, only a few of these are represented by as many as 50 to 70 specimens in several samples. On the whole, relatively few specimens per samples were observed for this genus. The vertical or stratigraphic distribution of these identified *Globotruncana* has similarly been affected, for their most common occurrence coincides with the more marine or shaly portion of the Moreno Gulch section (i. e. Upper Marlife formation).

Although a number of Foraminifera are long-ranging in Moreno Gulch, many calcareous and arenaceous species have a limited stratigraphic range. The latter may eventually be useful as index markers once their absolute range has been established in the California area. Table 5 illustrates some of the more significant species believed to have local and regional stratigraphic importance. For the present, any stratigraphic significance attached to these forms is limited by a lack of well-documented observations and the aforementioned environmental factors.

Comparison of Foraminifera from the upper Panoche group with those of the Gulf Coast of the United States and northwestern Europe reveals faunal affinities common to all three. These relationships and occurrences are treated in detail in the discussion on correlation and to a lesser degree in the systematic descriptions. In marked difference, foraminiferal assemblages of the Moreno formation show little if any resemblance to their Gulf Coast or European counterparts. However, surprisingly enough, these faunas show striking generic affinities with late Upper Cretaceous assemblages from Peru (FRIZZELL, 1943), and Colombia (BURGL and TOBON, 1954; PETTERS, 1955). Arenaceous species from Moreno Gulch are apparently related to described arenaceous forms from the Gulf Coast and northern South America. Generic resemblances to Upper Cretaceous faunas from western Canada are also noted. However, close examination of species from both areas reveals few specific relationships (NAUSS, 1947; WICKENDEN, 1932). This also appears to be true of Upper Cretaceous arenaceous faunas from the interior of the United States (BOLIN, 1956).

Depositional Environments

In attempting to reconstruct past depositional and environmental conditions that have affected successively varying foraminiferal assemblages distributed throughout sediments of the Moreno Gulch section, one must consider the composition, association, and distribution of the microfaunal and lithological elements.

The majority of Upper Cretaceous Foraminifera dealt with herein are extinct forms; hence their ecologic relationships to living forms cannot be precisely ascertained. Interpretation of criteria indicative of ancient environments must necessarily be made with caution. However, when dealing with large and varied populations, one can establish trends suggesting the general nature of past controlling environmental factors. Foraminifera are generally well suited to this as they tend to occur in large numbers. The presence of other micro- and mega-fossils may supply additional data.

Some concept of past environments may be gained through faunal analyses in which conditions of deposition may be inferred by the presence of one or more dominant bionomic groups. These groups may then be compared with their Recent counterparts on a generic or family basis. Table 6 presents analyses of selected samples from Moreno Gulch. These were chosen because of their faunal content and are representative of the better developed and varied assemblages studied. Based on relative abundance counts of 350 specimens per sample, resulting data in Table 6 points out significant faunal characteristics at selected stratigraphic levels (see Table 2 for stratigraphic allocation of these samples). Although only few samples are so treated they serve to demonstrate prevailing trends throughout parts of the Moreno Gulch section.

Analytical treatment of assemblages from the Lower Marlife formation and the Tierra Loma and Marca members of the Moreno formation is not attempted. Lower Marlife microfaunas are sparse and those of the Moreno poorly preserved. In both cases statistical analysis would be devoid of validity and interpretation.

Results of data from Table 6 clearly show that the Rotaliidae and the Nodosariidae are the two most common groups in predominantly calcareous faunas. Planktonic forms are in all cases a distinct minority. Arenaceous forms make a notable but minor group except for a few wholly arenaceous faunas.

A more comprehensive analysis of the occurrence and distribution of micro- and mega-fossils in Moreno Gulch is shown in Table 7. Whereas Table 6 emphasizes a few selected samples divided into bionomic groups and arranged according to family classification, Table 7 shows not only the bionomic grouping of Foraminifera but all other micro- and mega-fossils observed in the section. Occurrence, distribution, and inter-relationships have been determined by using relative abundance counts. Dominant lithologic types are also shown and serve to illustrate the association of sediments and fossils. The resulting chart, although established on a broad basis of classification, clearly illustrates the development of depositional environments throughout time. The trend outlined in Table 7 is considered chronologically in the discussion that follows.

Panoche Group

Lower Marlife Formation

The Lower Marlife formation is characterized by sparse foraminiferal assemblages consisting of poorly-developed, small arenaceous species, mostly of the genera *Bathysiphon*, *Bermudezina*, *Haplophragmoides*, *Hyperammina*, *Marssonella*, and *Psammosphaera*. *Silicosigmoilina*, a siliceous form, is observed only in the upper part of the formation. A gradual increase in the number of calcareous Foraminifera takes place in the upper portion of the Lower Marlife (Tables 2, 7). These calcareous forms are limited in number of species and specimens. Generic forms present are as follows: *Eponides*, *Globorotalites*, *Globotruncana*, *Lenticulina*, *Planularia*, *Planulina*, *Pleurostomella*, and *Stensiöina*. The majority of these calcareous forms range upwards into the overlying Upper Marlife formation. Those of the Lower Marlife are distinguished from the latter by their reduced size and erratic occurrence. Size reduction, as Myers (1948, p. 488) and Glaessner (1945, p. 191) have suggested, may possibly be attributed to conditions of low salinity. The drastic reduction in numbers of species, benthonic as well as planktonic, may also be related to this factor.

Macerated plant material is common to abundant in the Lower Marlife. It sporadically occurs in flood quantities and completely obscures the microfauna. The origin and source of this plant material is not known.

Thus it appears that a depositional environment similar to that postulated by Lowman (1949, p. 1957), in which he reports occurrences of *Bathysiphon, Cyclammina, Haplophragmoides*, and *Trochammina* in marine deposits containing mineral and plant components (suggesting low oxygen content) may be applicable to the Lower Marlife formation. The paleoecology, as indicated by sparse, small arenaceous faunas and more or less abundant plant material in a series of silty shales, is probably that of an abnormal marine deposit lacking normal salinities and well-oxygenated conditions. The near lack of calcareous foraminifers lends support to this hypothesis. Deposition of the Lower Marlife apparently took place near shore waters of low salinity where turbid conditions may possibly have been a factor in restricting the development of calcareous forms. Evidence for the latter, however, is not readily apparent. An amelioration of depositional conditions followed during the deposition of the later Lower and Upper Marlife sediments until a normal neritic environment was established.

Upper Marlife Formation

Foraminiferal assemblages of the Upper Marlife formation form the best developed and richest microfaunas in the Moreno Gulch section. Calcareous benthonic forms predominate, with planktonic species a minor element. Arenaceous foraminifers, although notable, also form a subordinate portion of the fauna.

Analyses of two selected representative samples from the Upper Marlife, samples 574 and 727, are shown in Table 6. It is at once evident that both of these samples contain a number of well-represented families among which the more significant are the Rotaliidae and Nodosariidae in the calcareous group, and the Lituolidae in the arenaceous. In the Upper Marlife, planktonic Foraminifera are first noticeable in quantity. The predominance of calcareous benthonic foraminifers represents the peak of development of these forms, which began in the upper half of the Lower Marlife formation.

Upper Marlife foraminifers are beautifully preserved and are of normal size for the respective genera they represent. Some of the more common calcareous benthonic genera are: *Anomalina, Eponides, Gyroidina, Lenticulina, Marginulina, Osangularia, Planularia, Reussella, Robulus, Stensiöina*, and *Valvulineria*. Planktonic forms, although forming a small minority, are well represented by the following: *Heterohelix, Globotruncana, Planomalina*, and *Praeglobotruncana*. The arenaceous fraction is made up of a more varied group than that of the Lower Marlife formation. Genera present include *Bathysiphon, Bermudezina, Cribrostomoides, Eggerella, Gaudryina, Haplophragmoides, Marssonella*, and *Verneuilina*. *Rzehakina* and *Silicosigmoilina*, both siliceous forms, occur throughout the formation. Radiolaria are abundantly represented and occur in flood proportions in several samples (Table 7). *Inoceramus* prisms are also locally common. Plant material, so common in the Lower Marlife, is lacking.

Comparison of percentages of Rotaliidae (26% in sample 727; 23% in sample 574) and the Nodosariidae (21% in sample 727; 12% in sample 574) from the Upper Marlife with the distribution of Recent Foraminifera from the East Coast of the United States (PARKER, 1948, fig. 2) and the Gulf of Mexico (LOWMAN, 1949, fig. 13) suggests a mid-neritic environment for these forms. The relatively small percentage of planktonic species (14% for sample 727; 17% for sample 574) is not unreasonable, for LOWMAN (1949, fig. 13) shows that in the Gulf of Mexico planktonic forms vary from 10 to 15% at depths of about 1200 to 1400 feet. He also shows that in waters less than 125 feet deep, planktonic forms constitute 5% or less of the fauna. Similar results were obtained from the East Coast of the United States by PARKER (1948), who found that in waters less than 150 feet in depth planktonic forms have a negligible occurrence. Conversely, from the 150 foot depth outward, a rapid increase in the relative percentage of planktonic forms present takes place (PARKER, 1948, p. 235).

The presence of abundant Radiolaria indicates a marine environment, since these forms are never found in brackish waters (CAMPBELL, 1952, p. 40). While the Radiolaria themselves are not conclusively suggestive of any especial depth, the presence of large numbers of these planktonic forms corroborates the assumption of a neritic depositional environment indicated by the Foraminifera.

In view of the evidence presented above, depositional environment of the Upper Marlife formation, characterized by blue-gray silts, shales and thin sandstones, and a rich and varied microfauna, was probably that of an open-sea, temperate, middle to outer neritic zone.

Uhalde Formation

Three distinct microfaunas are contained in sediments of the Uhalde formation. In general these correspond respectively to the lower half, middle, and uppermost portions of the formation (Tables 2, 6). The lowermost assemblage is somewhat similar to those of the Upper Marlife. It is by no means as rich or varied as Upper Marlife faunas, however, and contains new specific elements not observed previously. Analysis of a representative assemblage, sample 463, shows the Rotaliidae to make up 36% of the fauna, followed by the Anomalinidae which comprise 15%. Planktonic species again form a minority. Generic representatives of these groups are similar to those of the Upper Marlife with the exception of the genus *Anomalina*, which occurs in greater numbers. Arenaceous genera are also similar in composition and occurrence of species. Radiolaria are rare in the lower part of the Uhalde and abundant plant material, similar to that of the Lower Marlife, is once again observed. In the Uhalde formation, however, it occurs abundantly only in a few samples (nos. 408 and 333).

Succeeding this predominantly calcareous assemblage is a series of generally sparse wholly arenaceous microfaunas. In several samples these assemblages are extremely rich, assuming flood proportions. These faunas are characterized by having relatively few species represented by innumerable specimens (see Tables 2, 7; samples 262, 247, and 238). As a typical assemblage, sample 247 was analyzed (see Table 6). This sample was obtained from a coarse sandstone from the upper part of the Uhalde formation. A preponderance of *Bathysiphon* and *Haplophragmoides* easily obscures other arenaceous genera present in this sample. Minor occurring but distinctive foraminiferal genera are *Gaudryina*, *Glomospira*, *Involutina*, *Trochamminoides*, and *Spiroplectammina*. *Silicosigmoilina* is also prevalent.

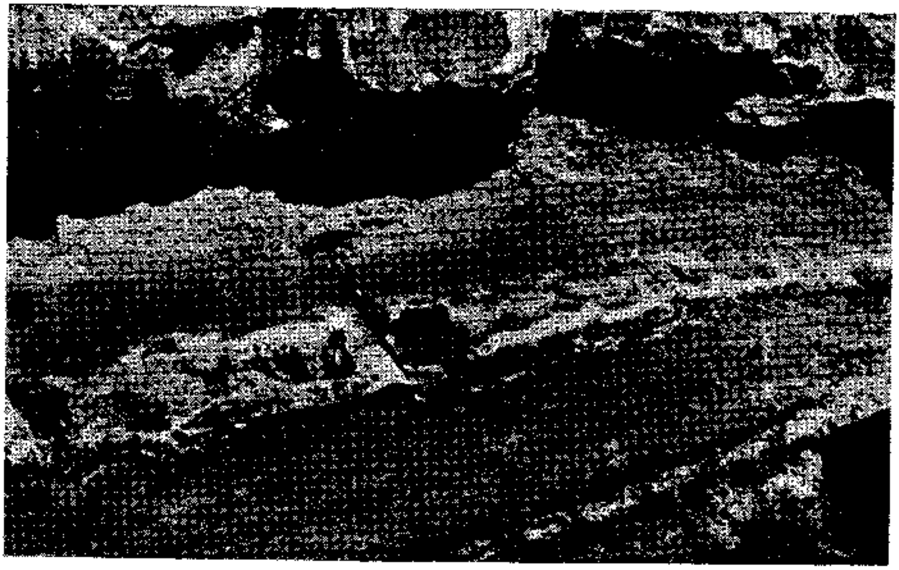
Arenaceous faunas of the Uhalde formation differ in composition from those already described from the Lower Marlife, although several species are common to both. Other points of difference are that the Uhalde faunas are much richer, are associated with Radiolaria, have no calcareous elements present, and consist of robust, medium to coarse textured forms. Lower Marlife arenaceous assemblages, it will be recalled, are sparse and consist of small delicate looking, generally smoothly textured forms.

Similar differences have been reported in Recent foraminiferal assemblages. Faunas consisting of small and delicate arenaceous species restricted to brackish and low saline waters have been reported from many coastal areas, whereas well-developed, robust arenaceous forms are found to flourish in normal marine environments ranging from neritic to abyssal depths (Stainforth, 1948).

Hada (1957) studied Recent arenaceous Foraminifera from waters off the coast of Japan and made some interesting deductions regarding these forms. He finds that depth apparently affects their texture. Shallow water forms usually tend to be coarsely textured, whereas the deep water variety, for the most part, is smooth. This textural variation apparently occurs in the same species collected from various depths as well as in different species.

According to Hada (1957, p. 35) arenaceous Foraminifera show a decided preference for sandy and muddy deposits regardless of depth. Temperature also appears to be a decisive factor in the depth and geographic distribution of these forms. Undoubtedly other factors are involved, but these have not been studied in detail.

Some of Hada's conclusions may also be applicable to arenaceous faunas from the Uhalde formation which are generally medium to coarse textured and are associated with the numerous sandstones typical for this portion of the Uhalde. Obviously these species lived in an environment that allowed them to flourish while it restricted calcareous species. A solution to this problem may be a new concept advanced by Renz (1942) and Stainforth (1948, 1952) regarding the ecology of arenaceous assemblages. They suggest that depth, salinity, and temperature are not solely responsible for the development of these faunas, but that turbidity is also a major contributing factor. Facies studies in Trinidad, B. W. I., substantiate this hypothesis, for they reveal that arenaceous assemblages are usually confined to sediments produced by rapid sedimentation caused by either: 1) active erosion of a land mass, 2) colloidal clays interbedded in deltaic sediments, or 3) clays representing deep water deposition of submarine mud extrusions (Stainforth, 1952, p. 43). Although examples of similar fossil arenaceous associations from various locations in the world are given by Stainforth, unfortunately to date no Recent arenaceous



Text Figure C. Flow structures in Moreno Gulch near base of Uhalde formation in SW 1/4 NW 1/4 T. 14 S., R. 11 E.
Pick handle one foot long.

Text Figure D. Flow structures in Moreno Gulch about 60 feet stratigraphically above base of Uhalde formation.
Locality: SW 1/4 NW 1/4 T. 14 S., R. 11 E.

fauna has been described where turbidity may possibly be interpreted as the chief controlling factor.

Turbidity may well have been a factor in the case of Uhalde arenaceous faunas. Slump and flow structures in conglomerates and sandstones from uppermost Panoche strata (Uhalde equivalent) of the Laguna Seca Hills have been reported by Briggs (1953 b). Field observations by the writer confirm the fact that similar structures occur in Moreno Gulch (Figures C and D). Slump bedding was found in a siltstone interbedded with sandstones approximately 60 feet above the Television sandstone member in Moreno Gulch. This phenomenon coupled with the rapid deposition believed to have taken place for the coarse sandstones of the Uhalde, could conceivably account for turbid water conditions. If such were the case, suspended matter would act as a restricting factor in the productivity of calcareous foraminifers while providing an environment suitable for arenaceous forms.

In more recent papers Tappan (1960) and Trujillo (1960) consider turbid water environments as a most likely factor in accounting for dominantly arenaceous assemblages from northern Alaska and northern California, respectively.

The uppermost foraminiferal assemblages of the Uhalde formation consist largely of calcareous foraminifers. Among the better represented calcareous benthonic genera are *Anomalina*, *Bulimina*, and *Rotalia*. *Siphogenerinoides* occurs in lesser numbers. Planktonic forms, although again forming a minority, are well represented by *Heterohelix*, *Globotruncana*, *Planomalina*, and *Rugoglobigerina*. Only a few arenaceous specimens of *Involutina* and *Marssonella* are present. Of interest is the presence of several ostracods and bryozoan fragments. Analysis of sample 200 shown in Table 6 illustrates the statistical composition of the above-mentioned forms. A shallow, possibly warm water environment is postulated because of these faunal elements present.

General depositional environments for the Uhalde formation indicate a gradual shallowing. The lowermost microfauna suggests a continuation of open sea conditions prevalent during the deposition of the underlying Upper Marlife formation. A change in environment is evidenced by the succeeding development of wholly arenaceous foraminiferal assemblages and by a series of the massive sandstones that typify the greater portion of the Uhalde formation. The presence of robust arenaceous foraminifera associated with flow and slump structures indicates that a turbid water environment probably existed during the deposition of the Uhalde sandstones. Because of the occurrence of coarsely textured arenaceous species and plant material as well as the general coarseness of the sediments, and the nature of the uppermost fauna of the Uhalde, which consists largely of *Rotalia* and bryozoan fragments, shallowing is believed to have taken place during deposition of the middle and upper parts of the Uhalde formation. It should be noted that in the uppermost levels of the Uhalde, arenaceous and calcareous faunal components never occur together in the same sample but appear to alternate irregularly from sample to sample (Tables 2, 7). Arenaceous species of the uppermost Uhalde sediments consist of coarsely textured *Ammobaculites*, *Reophax*, and *Bathysiphon*. Similar forms are observed in uppermost sediments of the Uhalde equivalent in Laguna Seca Creek.

Moreno Formation

Dosados, Tierra Loma, and Marca Members

The Tierra Loma and Marca members of the Moreno formation are considered together because the foraminiferal assemblages from these two members, except for minor variations in species distribution, appear to be the same. The lowermost part of the Moreno (Dosados member) is barren in Moreno Gulch. The lower portion of the Tierra Loma member has a sparse fauna in which the dominant form is *Bulimina prolixa*. Other forms are present but because of poor preservation they are not identified specifically. Occasionally *Bathysiphon* and *Haplophragmoides* also occur. A notable increase in microfaunal content is observed in the upper half of the Tierra Loma member. This increase reaches a climax in the overlying Marca member, which appears to have the richest assemblage of the Moreno formation. Since the bulk of material collected from Moreno Gulch consists of limonitized foraminiferal tests, topotype material was collected from the type locality of *Siphogenerinoides whitei* Church (see Appendix C) for purposes of analysis and identification. This locality is situated in the Marca shale member about six miles south-east of Moreno Gulch. In this material the Buliminidae make up the major portion of the assemblage, being represented by *Bulimina prolixa* Cushman and Parker and *Siphogenerinoides whitei* Church. After the Buliminidae, the Rotaliidae are most numerous in the assemblage. These are best represented by the genus *Gavelinella*. No planktonic or arenaceous elements were observed.

The large number of specimens representative of very few species is often associated with abnormal environmental factors such as might occur in a restricted basin. Under such conditions species which cannot tolerate abnormal conditions are reduced in number or exterminated. Adaptable form, in contrast, may have a richer development.

Abnormal depositional environments can best develop in restricted areas or embayments coexistent with environmental conditions peculiar to the area. Some evidence for abnormal environmental conditions existing during the deposition of the Moreno formation is indicated by the presence of siliceous shale in the Marca member. The *Bulimina-Siphogenerinoides* assemblage of the Moreno formation apparently reached its optimum development in these silica-rich waters. The occurrence of diatoms in the Marca member reported by Hanna (1927, 1934) substantiates this theory. The source of silica has been attributed to minor contemporaneous submarine volcanism believed to have taken place during the Upper Cretaceous (Taliaferro, 1943, p. 128). Further evidence is provided by Goudkoff's (1945, p. 1004) paleogeographic study of Moreno sediments in the Coalinga-Panoche Hills areas, which strongly suggests that deposition of the Moreno (C substage) took place in a restricted area.

A situation involving similar faunal characteristics and environmental conditions has been reported by Petters (1955) in Colombia. In the upper Magdalena-Bogotá area he found a *Bulimina-Siphogenerinoides* fauna associated with cherts and other siliceous rocks. Development of this microfauna is thought to be related to the excess silica present at the time of deposition. In Colombia the source of silica is attributed to volcanic action in the south of the country (Petters, 1955, p. 220). It may be of interest to note that *Bulimina prolixa* CUSHMAN and PARKER and *Siphogenerinoides clarki* CUSHMAN and CAMPBELL, both well known California Upper Cretaceous species, occur in the upper Magdalena Valley area of Colombia. In that region, however, they seem to have a longer range, as they have been recorded from rocks of Maastrichtian and Campanian ages (BÜRGL and TOBON, 1954, pl. 2). In California, in so far as the writer knows, they are only known from the Maastrichtian.

Examination of the lithologic properties of the Dosados, Tierra Loma, and Marca members of the Moreno formation indicates that with the exception of the basal Dosados sandstone, deposition of these members is markedly different from the clastic deposits of the Panoche group. The predominant shale deposition of the Moreno formation probably took place in waters of moderate depths within a restricted embayment. Studies by DAVID on fish remains found in the Moreno formation of the Panoche Hills are in agreement with this view. A coastal sea environment is postulated for the Moreno shale, based on fish skeletal fragments and fish scales (DAVID, 1946, p. 107).

Lower Dos Palos Member

The lower Dos Palos member of the Moreno formation as exposed in Moreno Gulch is characterized by a varied rich limonitized microfauna of which only a small portion is identified in the present study. Analysis of sample 11 A, as shown in Table 5, distinctly shows that about one half of the fauna consists of rotaliids and nodosariids. Also very well represented are the planktonic forms consisting of *Globigerina* and *Globigerinoides*. This is the only sample in the material from Moreno Gulch with a relatively high rate of planktonics (39%) and serves to illustrate the complete faunal change, not only in planktonic forms but in benthonic species as well, between Upper Cretaceous and Lower Tertiary foraminiferal assemblages. This statement bears further qualification because there is no doubt that better preserved material would alter percentages given in this study. However, the fact remains that, in spite of the poor results attained in foraminiferal recovery, faunal differences between the Lower Dos Palos and the Marca members of the Moreno formation are so pronounced that there can be little doubt that this constitutes a major biostratigraphic break.

Because of poor preservation a relatively low number of specific identifications can be made. Paleoecological assumptions are therefore considered tentative. Nevertheless, the presence of a high percentage of rotaliids and globigerinids suggests a middle to outer neritic, normal, marine environment. It further indicates that this fauna heralded the Lower Tertiary transgression that followed in the San Joaquin Valley (MALLORY, 1959, p. 99).

Laguna Seca Creek Section

A selected section of the uppermost 1500 feet of the Panoche group (Uhalde equivalent) exposed at Laguna Seca Creek was studied. The entire sequence is of shallow marine origin as witnessed by the presence of shallow water Foraminifera, bryozoan fragments, and floods of *Inoceramus* prisms.

Two distinct microfaunas were noted. The upper assemblage is identical to that occurring in the uppermost Uhalde sediments of the Moreno Gulch. *Rotalia*, *Anomalina*, and *Bulimina* are the most common benthonic genera. Some planktonic species were also found; these include *Heterohelix*, *Globotruncana*, and *Planomalina*. The lower fauna, which occurs in the lower 200 feet of the Laguna Seca Section, is made up largely of *Bulimina*, *Robulus*, and *Bolivina*. Arenaceous species are represented by *Bathysiphon* and *Haplophragmoides*. These forms occur sparingly with calcareous species, but in certain levels they constitute an overwhelming majority of the fauna. At the base of the section studied, wholly arenaceous faunas predominate (Table 3). With the exception of the lower calcareous fauna (samples 22 to 50), which is not present in Moreno Gulch, the faunal sequence of Laguna Seca Creek is similar to that of Moreno Gulch (see Table 4).

Biostratigraphy

Stratigraphic ranges of foraminiferal species described in this report are not fully known in California. Common and characteristic species which appear to have local and, in certain instances, regional significance are listed below under the respective formation or member in which they occur.

Occurrence, stratigraphic distribution, and interrelationships of foraminiferal populations from Moreno Gulch, as well as those from Laguna Seca Creek, are given in Tables 2, 3, 4, and 5.

Panoche Group

As previously discussed, only the upper half of the Panoche group is considered in this study (Table 1). The stratigraphic thickness of this portion of the group as exposed in Moreno Group is approximately 12,000 feet. Only the three upper formations of the group are studied. In ascending order these are: the Lower Marlife, Upper Marlife, and Uhalde formations.

Lower Marlife Formation

This formation is about 5100 feet thick in Moreno Gulch. It overlies the Carnerada conglomerate lentil and is succeeded by the Llanado sandstone. The base is not exposed, however, in Moreno Gulch, as the lower portion is capped by non-marine Miocene terrace deposits (Figure 3). The Lower Marlife consists largely of a series of brown, sandy to silty shales, with minor sandstones, occurring near the upper part of the formation. Foraminifera are rare in the lower part but become more frequent in the upper portion of the formation. On the whole, assemblages may be described as impoverished and sparse. Arenaceous forms prevail throughout the formation but are most common in the lower part. In the upper half of the formation a gradual increase in calcareous Foraminifera takes place. This reaches a maximum development in the overlying Upper Marlife formation. Abundant plant material is also characteristic of the Lower Marlife.

Significant and diagnostic foraminifers of the Lower Marlife formation are as follows:

Anomalina becki MARTIN, Pl. 16, fig. 2
Bathysiphon sp., Pl. 1, fig. 1
Eponides bandyi TRUJILLO, Pl. 13, fig. 7
Globorotalites subconicus (MORROW), Pl. 14, fig. 6
Globotruncana linneiana (d'ORBIGNY), Pl. 10, fig. 3
Gyroidina florealis WHITE, Pl. 13, fig. 6
Haplophragmoides impensus MARTIN, Pl. 2, figs. 3, 4
Hyperammina elongata BRADY, Pl. 1, fig. 7
Planularia umbonata LOETTERLE, Pl. 7, fig. 6
Psammosphaera laevigata WHITE, Pl. 1, fig. 6
Stensiöina exsculpta (REUSS), Pl. 14, fig. 8.

Most of these forms, with the exception of *Anomalina becki* MARTIN, *Planularia umbonata* LOETTERLE, *Stensiöina exsculpta* (REUSS), and *Psammosphaera laevigata* WHITE, range upward into the Upper Marlife formation. Foraminiferal species from the Lower Marlife with representatives in the Upper Marlife can be distinguished by their constantly smaller size. This phenomenon is attributed to unfavorable environmental factors previously discussed.

MATSUMOTO (personal communication) reports the following ammonites and inocerami from the Lower Marlife (LSJU 3315, 3316).

Baculites schencki MATSUMOTO
Inoceramus cf. *I. uwajimemsis* YEHARA.

The localities from which these megafossils were found are not situated in Moreno Gulch itself. In all cases, however, occurrences mentioned in this study are from the adjacent areas within the Panoche Hills (Appendix C).

On the basis of Foraminifera and megafossils present, a Coniacian to lowermost Santonian age is assigned to this unit. Of the foraminiferal species listed above *Anomalina becki* MARTIN, *Eponides bandyi* TRUJILLO, and *Gyroidina florealis* WHITE appear to have local stratigraphic significance and may be of value once their range is established. *Planularia umbonata* LOETTERLE and *Globorotalites subconicus* (MORROW) are known from the Niobrara formation which is generally considered to be of Coniacian-Santonian age (COBBAN and REESIDE, 1952). *Globorotalites subconicus* (MORROW) and *Stensiöina exsculpta* (REUSS) are indicative of the Coniacian of Europe although not restricted to it. Accordingly, the Coniacian-Santonian boundary in Moreno Gulch is tentatively placed at sample 872 when these species first appear (Table 2).

Upper Marlife Formation

Approximately 2700 feet of dark marine shales interbedded with minor thin sandstones and a ten foot bentonite bed comprise the Upper Marlife formation (Figures 4 a, 4 b). This formation overlies the Llanada sandstone member and in turn is overlain by the Television sandstone member.

The Upper Marlife contains what may be considered the most abundant, varied, and best preserved microfauna obtained from Moreno Gulch samples. *Inoceramus* prisms and particularly Radiolaria also have a common to abundant occurrence throughout. Characteristic Foraminifera of the Upper Marlife formation are:

Bermudezina uvigerinaeformis MARTIN, Pl. 3, fig. 6
Buliminella carseyae PLUMMER, Pl. 11, fig. 11
Cribrostomoides cretacea CUSHMAN and GOUDKOFF, Pl. 2, fig. 11
Globotruncana fresnoensis MARTIN, Pl. 9, fig. 8
Gublerina ornatissima (CUSHMAN and CHURCH), Pl. 11, fig. 3
Gyroidina florealis WHITE, Pl. 13, fig. 6
Heterohelix pulchra (BROTZEN), Pl. 11, fig. 2
Kyphopyxa christneri (CARSEY), Pl. 7, fig. 12
Lingulina californiensis TRUJILLO, Pl. 5, fig. 1
Praeglobotruncana caryi MARTIN, Pl. 9, fig. 3
Reussella szjanoche (GRZYBOWSKI), Pl. 12, fig. 4.

The majority of these species appear to be restricted to Upper Marlife sediments in Moreno Gulch. However, further study may extend the known stratigraphic ranges of these forms.

Radiolaria present are made up largely of *Dictyomitra multicostata* ZITTEL. These forms are often very well preserved, although crushed specimens occur in a number of samples. In the Moreno Gulch section Radiolaria have their most common and abundant occurrence in the Upper Marlife formation. Several samples (Nos. 516, 573) consist of countless numbers of these organisms.

Recent work by MATSUMOTO (personal communication) in nearby areas of Moreno Gulch has resulted in the discovery of the following megafossils from locality LSJU 3320:

Baculites capensis WOODS
Anagaudryceras politissima KOSSMAT
Inoceramus naumanni
Inoceramus cf. *I. ezoensis* YOKOYAMA

At locality LSJU 3323 the following megafossils are found to occur:

Baculites cf. *B. inornatus* MEEK
Pachydiscus buckhami USHER

Ammonites also have been reported from Upper Marlife strata by ANDERSON (1958, p. 48) from the south branch of Moreno Gulch. The following species were obtained from this locality:

Parapachydiscus panochensis ANDERSON
Phylloceras gargantum ANDERSON

All of the fossil data listed above indicates a Santonian age for the greater part of the Upper Marlife. The top of the Santonian is placed at sample 529 where new specific elements suggestive of the Campanian first appear.

Uhalde Formation

The Uhalde formation of the Panoche group consists of about 3800 feet of massive concretionary and nonconcretionary sandstones interbedded with dark silty to sandy shales. The Uhalde formation overlies the Television sandstone member, and is overlain by the Dosados member of the Moreno formation.

Generally sparse calcareous faunas are typical of the lower part of the Uhalde. Some of the Foraminifera noted in this lower assemblage first occur in the upper part of the Upper Marlife formation. These gradually give way to rich, well developed arenaceous assemblages associated with Radiolaria. The uppermost Uhalde sediments contain a calcareous fauna totally different from that of the lower part. Diagnostic Foraminifera from these three assemblages are listed below in ascending order.

Lower Fauna (Samples 346—484)

Anomalina whitei MARTIN, Pl. 16, fig. 4
Eponides spinea CUSHMAN, Pl. 13, fig. 8
Globotruncana churchi MARTIN, Pl. 9, fig. 5
Gyroidina goudkoffi TRUJILLO, Pl. 13, fig. 3
Gyroidina quadrata CUSHMAN and CHURCH, Pl. 13, fig. 5
Marginulina curvisepta CUSHMAN and GOUDKOFF, Pl. 5, fig. 12
Osangularia cordieriana (d'ORBIGNY), Pl. 15, fig. 2.

Middle Fauna (Samples 229—334)

Bathysiphon californicus MARTIN, Pl. 1, fig. 2
Bathysiphon dubia (WHITE), Pl. 1, fig. 1
Cribrostomoides cretacea CUSHMAN and GOUDKOFF, Pl. 2, fig. 11
Eggerella obscura MARTIN, Pl. 3, fig. 10, 11
Haplophragmoides excavatus CUSHMAN and WATERS, Pl. 2, figs. 6 7
Haplophragmoides impensus MARTIN, Pl. 2, figs. 3, 4
Haplophragmoides kirki WICKENDEN, Pl. 2, fig. 9
Gaudryina pyramidata CUSHMAN, Pl. 3, fig. 3
Rzehakina epigona lata CUSHMAN and RENZ, Pl. 4, fig. 2.

Upper Fauna (Samples 198—216)

Anomalina occidentalis MARTIN, Pl. 16, fig. 3
Bulimina joaquinensis, Pl. 11, figs. 5, 6
Globotruncana arca (CUSHMAN), Pl. 9, fig. 4
Planomalina aspera (EHRENBERG), Pl. 10, fig. 7
Rotalia bandyi MARTIN, Pl. 12, fig. 10
Rotalia minuta MARTIN, Pl. 12, fig. 11
Rugoglobigerina rugosa (PLUMMER), Pl. 10, fig. 6
Siphogenerinoides clarki CUSHMAN and CAMPBELL, Pl. 12, figs. 5, 6.

Megafossils reported from the upper part of the Uhalde formation from locality LSJU 3326 by MATSUMOTO include the following:

Baculites rex ANDERSON
Baculites lomaensis ANDERSON
Pachydiscus ganesa FORBES
Halymanites sp.

Paleontological evidence presented above indicates a Campanian age for most of the Uhalde formation. The uppermost portion of the formation is considered Maastrichtian in age because of the presence of *Rugoglobigerina rugosa* (PLUMMER) in association with *Globotruncana arca* (CUSHMAN) and *Siphogenerinoides clarki* CUSHMAN and CAMPBELL. *Baculites rex* ANDERSON, a Maastrichtian index fossil in California, also occurs in uppermost Uhalde sediments.

The Campanian-Maastrichtian boundary is difficult to define in Moreno Gulch owing to the lack of guide fossils. The arenaceous microfaunas which characterize the greater part of the Uhalde consist of long ranging species whose stratigraphic significance is unknown. To arrive at a satisfactory solution, samples from the uppermost 1500 feet of Uhalde sediments from Laguna Seca Creek were examined. The faunal sequence is similar to that of Moreno Gulch with the exception of a foraminiferal assemblage occurring 1300 feet below the top of the Uhalde formation (Tables 3, 4). Important species from this selected Laguna Seca Creek section are given below in ascending order.

Lower Fauna (Samples 22—50)

Bolivina incrassata REUSS, Pl. 11, fig. 14
Bulimina spinata CUSHMAN and CAMPBELL, Pl. 11, fig. 10
Globulina lacrima subsphaerica (BERTHELEIN), Pl. 7, fig. 13
Neoflabellina pilulifera CUSHMAN and CAMPBELL, Pl. 7, fig. 8
Nodosaria spinifera CUSHMAN and CAMPBELL, Pl. 4, fig. 6
Nodosaria velascoensis CUSHMAN, Pl. 4, figs. 7, 8.

Upper Fauna (Samples 102—130)

Anomalina occidentalis MARTIN, Pl. 16, fig. 3
Bulimina joaquinensis MARTIN, Pl. 11, figs. 5, 6
Globotruncana arca (CUSHMAN), Pl. 9, fig. 4
Planomalina aspera (EHREHBERG), Pl. 10, fig. 7
Rotalia bandyi MARTIN, Pl. 12, fig. 10
Rotalia minuta MARTIN, Pl. 12, fig. 11
Rugoglobigerina rugosa (PLUMMER), Pl. 10, fig. 6
Siphogenerinoides clarki CUSHMAN and CAMPBELL, Pl. 12, figs. 5, 6.

The presence of *Bolivina incrassata* REUSS, *Globulina lacrima subsphaerica* (BERTHELEIN), *Nodosaria velascoensis* CUSHMAN strongly suggests an upper Campanian or Maastrichtian age for this assemblage. The first two of the aforementioned species have been widely reported from upper Campanian and Maastrichtian strata in northwestern Europe. *Nodosaria velascoensis* CUSHMAN is known to occur in uppermost Cretaceous sediments of Mexico and Trinidad, B. W. I. It is therefore not unreasonable to assume that in

California the Campanian-Maastrichtian boundary may lie at the lowermost occurrence or possibly within the lower range of these species as they occur in Laguna Seca Creek. In this study the Campanian-Maastrichtian boundary is provisionally placed at the last occurrence of these forms (Table 3).

Examination of Table 4 shows that in Moreno Gulch this boundary falls at or near sample 270 approximately 1500 feet below the top of the Uhalde formation. Table 4 also clearly illustrates the difficulties of correlating strata exhibiting lateral and vertical variations over short distances which have affected faunal occurrence and distribution. This factor is to be considered in establishing biostratigraphic relationships of California Cretaceous foraminiferal assemblages.

Other species of the lower Laguna Seca Creek fauna which appear to have local stratigraphic value are *Bulimina spinata* CUSHMAN and CAMPBELL, *Neoflabellina pilulifera* CUSHMAN and CAMPBELL, and *Nodosaria spinifera* CUSHMAN and CAMPBELL. These species described by CUSHMAN and CAMPBELL (1935) were originally considered representative of the Moreno Formation. It is now thought that they occur in upper Panoche strata.

Moreno Formation

The Moreno formation in Moreno Gulch has a thickness of about 2100 feet. Near the base and immediately overlying the uppermost concretionary sandstone of the Uhalde formation, the basal Dosados sandstone is interbedded with the dark brown shales so typical of the Moreno. In ascending order the Moreno formation is subdivided into the following members: Dosados sandstone, and shale, Tierra Loma shale, Marca shale, Lower Dos Palos shale, and the Cima sand. The Upper Dos Palos shale is not present in the Moreno Gulch section. In the area around Moreno Gulch the Moreno formation is disconformably overlain by the Laguna Seca formation (PAYNE, 1951).

In this report the microfaunas of the Tierra Loma and Marca members are considered the same. The assemblage obtained from the upper part of the Lower Dos Palos member is completely different and is treated accordingly.

Results obtained from samples of the Moreno formation generally are not so satisfactory as those of the Panoche group. Due to extreme weathering, calcareous foraminifers have been leached out throughout most of the exposed sequence. A number of samples is noted to contain very rich faunas consisting solely of limonitized foraminiferal tests. Fortunately a few samples contained sufficiently well preserved material useful for specific identification. Field examination of the lavender to white Marca shale member in Moreno Gulch reveals the impressions of countless foraminiferal tests, among which the more common are those of *Bulimina prolixa* CUSHMAN and PARKER and *Siphogenerinoides whitei* CHURCH. Results from washed residues do not indicate this profusion of tests noted in the field. Nevertheless, the actual richness of this fauna was verified when excellent results were obtained from material from the type locality of *Siphogenerinoides whitei* (see Appendix C). In view of the foregoing, faunal and biostratigraphic analysis of Moreno formation foraminiferal assemblages presented herein is probably incomplete. However it is believed that the principal characteristic and diagnostic Foraminifera have been identified. Diagnostic foraminifers from the Tierra Loma, and Marca members of the Moreno formation are as follows:

Bulimina prolixa CUSHMAN and PARKER, Pl. 11, figs. 5, 6
Gavelinella orolomamensis (CUSHMAN and GOUDKOFF), Pl. 14, fig. 1
Gavelinella turbinata MARTIN, Pl. 14, figs. 2, 3
Hoglundina supracretacea (TEN DAM), Pl. 15, fig. 7
Siphogenerinoides whitei CHURCH, Pl. 13, figs. 2, 3

MATSUMOTO records the following megafossils from the Moreno formation (LSJU 3329):

Baculites lomaensis ANDERSON
Baculites rex ANDERSON
Neophylloceras hetonaiensis MATSUMOTO
Neophylloceras hetonaiensis var. *tuberculata* MATSUMOTO

Foraminiferal evidence for a Maastrichtian age is not clear-cut for the Moreno formation. Consideration of the generic entities present, however, may be interpreted as indicative of the age. The genus *Siphogenerinoides* CUSHMAN has its most common occurrence in the Maastrichtian of many parts of the world. It is not, however, restricted to that stage, for it has been reported in Campanian strata from Colombia (PETTERS, 1955; BURGL and TOBON, 1954). In Moreno Gulch a Maastrichtian age is favored for the greater portion of the Moreno formation because of the common occurrence of *Siphogenerinoides* in association with *Baculites rex* ANDERSON, considered a reliable index fossil for the Maastrichtian of California (MATSUMOTO, personal communication). Further supporting evidence is provided by the occurrence of elasmosaurs in nearby areas of the Moreno formation. These are believed to be representative of a Maastrichtian age (WELLES, 1952, p. 124).

A most curious fact is that, in so far as the writer knows, no species of *Globotruncana* has ever been definitely found in the Tierra Loma or Marca members of the Morreno formation. This may possibly be due to the restrictive environmental factors previously discussed or perhaps to the extreme weathering so characteristic of the Moreno formation. In the future a more detailed systematic study of Moreno microfaunas may reveal the presence of this highly significant genus.

A complete faunal change takes place between the upper limit of the *Bulimina-Siphogenerinoides* assemblage of the Marca shale member and the overlying Lower Dos Palos shale member of the Moreno formation. The Lower Dos Palos member is characterized by a fauna in which planktonic elements are made up of *Globigerina* and *Globigerinoides*, generally considered indicative of a Tertiary age. Immediately above the Marca shale a barren zone exists in the Lower Dos Palos shale. The uppermost 30 feet however, yielded positive results. In the Lower Dos Palos, as in the rest of the Moreno formation, weathering is a restrictive factor in the collecting of suitable foraminiferal samples. Although very few Foraminifera were identified, the faunal change is so complete that there can be no mistaking it for anything other than a major faunal boundary. Significant Foraminifera of the Lower Dos Palos member are as follows:

Globigerina pseudobulloides PLUMMER, Pl. 9, fig. 2
Globigerina triloculinoides (PLUMMER), Pl. 8, fig. 10
Globigerinoides daubjergensis (BRONNIMANN), Pl. 9, fig. 1
Spiroplectammina perplexa ISRAELSKY, Pl. 2, fig. 14
Valvulineria lillisi CUSHMAN and GOUDKOFF, Pl. 15, fig. 6

These Foraminifera are indicative of a Paleocene (Danian) age for the Lower Dos Palos member of the Moreno formation, an age determination in agreement with that of GOUDKOFF (1945, p. 970), who, in discussing the difficulties of assigning an age to his Cheneyan stage (A zone), favored a Paleocene age rather than Cretaceous because of the presence of the coral *Flabellum*, known only from Tertiary deposits. GOUDKOFF also reported the occurrence of *Valvulineria lillisi* CUSHMAN and GOUDKOFF from the horizon in Jergin's Chaney Ranch well no. 1 which he selected as the type section of the Cheneyan stage (GOUDKOFF, 1945, p. 967). This well is situated some nine miles southeast of Moreno Gulch. LOEBLICH (1958, p. 2261) studied material from GOUDKOFF's type section of the Cheneyan stage and found a planktonic foraminiferal assemblage similar to that reported in this study from the Lower Dos Palos member of the Moreno formation in Moreno Gulch.

The planktonic Foraminifera listed above are typical of the Paleocene (Danian) and have been reported from many areas of the world. For example, *Globigerinoides daubjergensis* (BRÖNNIMANN) was originally described from Danian sediments of Denmark. It has since been reported from the Paleocene (Danian) of the Atlantic and Gulf coastal plains of the United States, Trinidad, and various parts of Europe (LOEBLICH and TAPPAN, 1957).

The Danian, as interpreted in this study, is representative of the lowermost Tertiary strata found in California. It is significant to note that MALLORY (1959, p. 74) suggests that the base of his Ynezian stage (Paleocene) does not represent the lowermost Tertiary in California. He further suggests that Danian strata might be present in the Laguna Seca formation in the southeastern portion of the Panoche Hills.

Results of this study of the Moreno Gulch section establishes the Cretaceous-Tertiary boundary on foraminiferal evidence within the Lower Dos Palos member of the Moreno formation 110 feet below the base of the Cima sand. Because the lower portion of the Lower Dos Palos seems to be barren, one cannot state with certainty that it is also of Paleocene age. However, because of uniformity of the lithology throughout the Lower Dos Palos, the Cretaceous-Tertiary boundary is placed at the base of this member (Table 2).

Foraminiferal evidence presented in this study indicates that an Upper Cretaceous-Lower Tertiary planktonic succession similar to that found in other areas occurs in the California province. It has been demonstrated herein that Upper Cretaceous planktonic species of *Globotruncana* and *Rugoglobigerina* are present in the highest levels of the Uhalde formation considered to be Maastrichtian in age. The next pelagic suite observed is the Danian *Globigerina-Globigerinoides* assemblage of the Lower Dos Palos member of the Moreno formation. Between these assemblages the previously discussed *Bulimina-Siphogenerinoides* fauna, also of Maastrichtian age, occurs in the greater part of the Moreno formation. The faunal succession in Moreno Gulch differs from that of other areas, for at many places the *Globotruncana-Rugoglobigerina* fauna is immediately succeeded by the *Globigerina-Globigerinoides* group. In the San Joaquin Valley this variation in faunal sequence may have been the result of the restrictive depositional conditions postulated for the Moreno formation.

The presence of keeled *Globorotalia* together with *Globigerina* in Lower Tertiary strata of the San Joaquin Valley has been known for many years. MARTIN (1943) described and figured several forms of *Globigerina* and keeled *Globorotalia* from the type locality of the Lodo formation, which overlies the Moreno formation and is believed to be of Paleocene and Lower Eocene age.

There is little doubt that future studies will result in the establishment of a planktonic foraminiferal succession of Maastrichtian *Globotruncana-Rugoglobigerina* forms followed by a Danian *Globigerina-Globigerinoides* group, which in turn is succeeded by a keeled *Globorotalia-Globigerina* assemblage indicative of the Landenian. This planktonic foraminiferal sequence has been reported from various parts of the world by a number of workers (BOLLI, 1957; BRÖNNIMANN, 1952 a, 1952 b; LOEBLICH and TAPPAN, 1957; OLSSON, 1960; REISS, 1955; and WEISS, 1955).

Correlation

1. Local Correlation

In establishing correlations the methods employed have been comparison of assemblages, matching of occurrences of individual species, preferably those considered index fossils, and a study of stratigraphic sequence of faunas. Local California correlations based on the use of these methods do not appear to be inconsistent with prevailing opinions. However, the application of these methods in regional correlation may be suspect due to the following restrictive factors: 1. presence of species indigenous to California or to the area being compared, 2. effects of varying depositional environments on the ranges of California species which as yet are not well known, 3. general sparseness of species considered good index markers elsewhere [i. e. *Globotruncana rosetta* (CARSEY)], 4. variation in reported stratigraphic ranges of species, and 5. the present state of confusion existing in the taxonomy of certain groups, which renders the identification of species difficult. These factors have been taken into account in attempting to differentiate between successive foraminiferal assemblages from Moreno Gulch that are indicative of various Cretaceous stages.

European standard stage terminology is used in this paper because it is well known and widely employed. However, in California the Upper Cretaceous stages of GOUDKOFF, particularly his letter and number classification, have been generally adopted by oil company paleontologists and therefore merit some consideration and discussion here.

Stratigraphic succession of foraminiferal assemblages from Moreno Gulch generally coincide with the stage and sub-stages proposed by GOUDKOFF (1945). Some differences arise because of the presence of species which, while not new, have not been previously reported from California. Some of these are well documented in the literature and have been recorded from various localities throughout the world.

Foraminifera from Moreno Gulch serve to identify several of GOUDKOFF's substages. The lower Cheneyan (A-2), lower Ciervian (C), upper Ingramian (D-1), and Cachenian (G) are fairly easy to recognize by their faunal contents. The upper Ciervian (B), Tracian (E), Weldonian (F), and Delevanian (H) are difficult to identify and evaluate. Faunal evidence for the upper Ciervian (B) and lower Ingramian (D-2) is completely lacking in Moreno Gulch. The Trancian (E) and Weldonian (F) are not recognizable because of the occurrence of arenaceous assemblages lacking index markers typical of these substages. The presence of the Delevanian (H) in Moreno Gulch is not satisfactorily proved. GOUDKOFF (1945, p. 994) defines this stage as follows:

a meager fauna of poorly preserved and indeterminate species of Foraminifera, here and there associated with limonitized radiolarian tests.

Examination of samples from the lower part (12,000 to 14,000 foot interval) of the Moreno Gulch section reveals the rare occurrence of well-preserved calcareous and arenaceous foraminifers similar to those from the lower Cachenian (G-2). No doubt the close spacing of samples facilitated detection of these species. Accordingly in this study the lower Cachenian (G-2) is extended to include all of the lowermost exposed section in Moreno Gulch.

Correlations with previously described Upper Cretaceous foraminiferal assemblages from northern, central, and southern California are shown in Tables 8—12. Table 8 illustrates the correlation of previously described microfaunas from California with those of Moreno Gulch as interpreted in this study. It also shows their relationship to the European standard stages. Tables 9—12 show the number of species having common occurrences in Moreno Gulch and the area being compared.

Table 9 shows that the microfauna described from the Alcalde Hills near Coalinga by CUSHMAN and CHURCH (1929) is probably equivalent to the lower Uhalde and possibly the uppermost part of the Upper Marlife formations. The following foraminifers are common to both areas: *Bulimina aspera* CUSHMAN and PARKER *(Bulimina obtusa)*, *Globotruncana churchi* MARTIN *(Globotruncana arca)*, *Gublerina ornatissima* (CUSHMAN and CHURCH) *(Ventilabrella ornatissima)*, *Gyroidina quadrata* CUSHMAN and CHURCH, *Hoglundina supracretacea* (TEN DAM) *(Epistomina caracolla)*, *Lagena paucicosta* FRANKE *(Lagena* sp.*)*, *Marginulina bullata* REUSS, *Marginulina curvisepta* CUSHMAN and GOUDKOFF *(Marginulina jonesi)*, *Marssonella oxycona* (REUSS) *(Gaudryina oxycona)*, *Pseudonodosaria larva* (CARSEY) *(Glandulina manifesta)*, *Silicosigmoilina californica* CUSHMAN and CHURCH, *Spiroplectammina chicoana* LALICKER *(Spiroplectammina anceps)*, and *Valvulineria lenticula* REUSS *(Gyroidina depressa)*. This assemblage may be considered correlative to that interval of the Moreno Gulch represented by samples 346 to 529 (Table 2).

It should be pointed out that names in parenthesis are those used by CUSHMAN and CHURCH in their 1929 paper. This publication appeared over 30 years ago and pioneered in the description of Upper Cretaceous Foraminifera from California. Hence it is understandable that since that time taxonomic changes and the description of new species have altered the nomenclatural pattern then in use.

Table 9. Stratigraphic occurrences of Moreno Gulch Foraminifera recorded from the Alcalde Hills (CUSHMAN and CHURCH, 1929)

Foraminifera	Moreno fm.	Uhalde fm.	Upper Marlife fm.	Lower Marlife fm.
Hoglundina supracretacea	×	×		
Pseudonodosaria larva	×		×	
Silicosigmoilina californica	×	×	×	×
Lagena paucicosta		×		
Marginulina curvisepta		×		
Globotruncana churchi		×	×	
Gublerina ornatissima		×	×	
Gyroidina quadrata		×	×	
Marginulina bullata		×	×	
Pullenia jarvisi		×	×	
Spiroplectammina chicoana		×	×	
Valvulineria lenticula		×	×	
Marssonella oxycona		×	×	×

In 1935 CUSHMAN and CAMPBELL described and figured some Foraminifera from a well near Tracy in central California. This assemblage, although not present in Moreno Gulch, is well developed in Laguna Seca Creek about 1300 feet below the top of the Uhalde formation of the Panoche group (samples 22 to 50). Foraminifera having a common occurrence in both areas are as follows: *Bolivina incrassata* REUSS, *Bulimina spinata* CUSHMAN and CAMPBELL, *Bulimina aspera* CUSHMAN and PARKER *(Bulimina obtusa* of CUSHMAN and CAMPBELL*)*, *Dentalina megalopolitana* REUSS, *Marginulina campbelli* MARTIN *(Marginulina* cf. *M. Bronni* of CUSHMAN and CAMPBELL*)*, *Neoflabellina pilulifera* (CUSHMAN and CAMPBELL), *Nodosaria monile* v. HAGENOW, *Nodosaria velascoensis* CUSHMAN, and *Nodosaria* sp.

This fauna in Laguna Seca Creek is correlated with the upper part of the Uhalde formation in Moreno Gulch (samples 262 through 270). The Moreno Gulch assemblages are characteristically arenaceous (Table 4) throughout this interval.

The foraminiferal fauna described and figured by BANDY (1951) from the Carlsbad area in San Diego County is tentatively correlated with that from the middle portion of the Uhalde formation in Moreno Gulch. Foraminifera common to both areas include the following: *Dentalina megalopolitana* REUSS, *Dorothia bulletta* (CARSEY), *Globotruncana arca* (CUSHMAN), *Globotruncana rosetta* (CARSEY), *Heterohelix striata* (EHRENBERG), *Hoglundina supracretacea* (TEN DAM), *Lagena brevipostica* BANDY, *Lagena proboscidialis* BANDY, *Marginulina bullata* REUSS, *Marssonella oxycona* (REUSS), *Planomalina aspera* (EHRENBERG), *Palmula primitiva* CUSHMAN, and *Robulus modestus* BANDY.

The distribution of these species in Moreno Gulch renders recognition of GOUDKOFF'S E zone difficult. Many of the above listed forms are long ranging while others have a sparse occurrence. The presence of a predominantly arenaceous fauna in the middle portion of the Uhalde formation further restricts proper identification of this zone. Table 10 illustrates the distribution of Moreno Gulch foraminifers recorded from the Carlsbad area.

Table 10. Stratigraphic occurrence of Moreno Gulch Foraminifera recorded from the Carlsbad area (BANDY, 1951)

Foraminifera	Moreno fm.	Uhalde fm.	Upper Marlife fm.	Lower Marlife fm.
Dentalina megalopolitana	×	×		
Höglundina supracretacca	×	×		
Gyroidina orbicella	×		×	
Heterohelix striata		×		
Globotruncana arca		×		
Globotruncana rosetta		×		
Lagena brevipostica		×		
Lagena proboscidialis		×		
Planomalina aspera		×		
Dentalina basiplanata		×	×	
Marginulina bullata		×	×	
Marssonella oxycona		×	×	×
Dentalina aculeata			×	
Dorothia bulletta			×	
Frondicularia archiaciana			×	
Palmula primitiva			×	
Robulus modestus			×	

GRAHAM and CHURCH (written communication) have in preparation a paper dealing with Upper Cretaceous foraminifers from a locality on the Stanford University campus. They consider this assemblage to be of Campanian age (GRAHAM and CHURCH, 1959, p. 1610). Table 11 shows the stratigraphic occurrences of Foraminifera common to both Moreno Gulch and the Stanford University locality. It is at once evident that the Stanford fauna is correlative with those from the Uhalde and Upper Marlife formations of the Panoche Hills area.

Of the many species common to both areas, the following appear to be more significant: *Bolivinitella eleyi* (CUSHMAN), *Bolivinoides decoratus latticeus* (CARSEY), *Eponides spinea* CUSHMAN, *Globotruncana paraventricosa* (HOFKER), *Gublerina ornatissima* (CUSHMAN and CHURCH), *Gyroidina quadrata* CUSHMAN and CHURCH, *Lingulina californiensis* TRUJILLO, *Marginulina curvisepta* CUSHMAN and GOUDKOFF, *Reussella szajnoche* (GRZYBOWSKI), *Spiroplectammina chicoana* LALICKER, and *Quadrimorphina allomorphinoides* (REUSS).

Because absolute stratigraphic ranges of these species are not as yet established, only a provisional correlation between the Stanford locality and Moreno Gulch is attempted. As shown in Table 8 the Stanford foraminiferal assemblage is interpreted as including elements that in Moreno Gulch range in the lower half of the Uhalde and the uppermost part of the Upper Marlife formations.

Table 11. Stratigraphic occurrences of Moreno Gulch Foraminifera recorded from the Stanford University Campus locality (GRAHAM and CHURCH, in preparation)

Foraminifera	Moreno fm.	Uhalde fm.	Upper Marlife fm.	Lower Marlife fm.
Höglundina supracretacea	×	×		
Dentalina basiplanata		×		
Heterohelix striata		×		
Marginulina curvisepta		×		
Gyroidina quadrata		×		
Astacolus jarvisi		×	×	
Buliminella carseyae		×	×	
Dorothia bulletta		×	×	
Eponides bandyi		×	×	
Eponides spinea		×	×	
Globotruncana paraventricosa		×	×	
Gublerina ornatissima		×	×	
Heterohelix globulosa		×	×	
Marginulina bullata		×	×	
Planomalina aspera		×	×	
Spiroplectammina chicoana		×	×	
Quadrimorphina allomorphinoides		×	×	
Haplophragmoides impensus		×	×	×
Marssonella oxycona		×	×	×
Silicosigmoilina californica		×	×	×
Bolivinitella eleyi			×	
Bolivinoides latticeus			×	
Lingulina californiensis			×	
Reussella szajnoche			×	

More recently TRUJILLO (1960) described and figured lower Senonian Foraminifera from near Redding in northern California. On the basis of Foraminifera common to both the Redding and Panoche Hills areas it is evident that the former section stratigraphically overlaps the lower half of the Moreno Gulch section represented by the Lower and Upper Marlife formations. Significant foraminiferal species common to both areas are as follows: *Psammosphaera laevigata* WHITE, *Marssonella oxycona* (REUSS), *Quadrimorphina allomorphinoides* (REUSS), *Lingulina californiensis* TRUJILLO, *Astacolus jarvisi* (CUSHMAN), *Globotruncana linneiana* (d'ORBIGNY), *Gyroidina florealis* WHITE, *Eponides bandyi* TRUJILLO, *Gyroidina goudkoffi* TRUJILLO, *Planulina popenoei* TRUJILLO, *Planularia umbonatus* LOETTERLE, and *Pleurostomella greatvalleyensis* TRUJILLO.

Some of these species range upward into sediments of the Uhalde formation in Moreno Gulch. In most cases, however, they have their most common occurrence in the Upper and Lower Marlife formations. In this study these latter lithogenetic units have been assigned Santonian and Coniacian ages respectively. Table 12 demonstrates the distribution of Redding foraminifers occurring in Moreno Gulch. The largest number of occurrences are in the lower portion of the section. It is significant that several stratigraphically important species observed in Moreno Gulch are apparently not present in the Redding area. These are *Globorotalites subconicus* (MORROW), *Stensiöina exsculpta* (REUSS), and *Anomalina becki* MARTIN.

Table 12 shows also that the Lower Marlife formation has only nine species in common with the Redding fauna, whereas the Uhalde formation has 11. On the basis of numerical analysis it would seem to follow that the Uhalde is correlative with Cretaceous strata of the Redding area. However, the danger of correlating solely on the basis of statistical results is well illustrated here, for closer examination of the nine species common to the Lower Marlife formation and the Redding area discloses that seven of them extend no higher than the Upper Marlife formation. Furthermore, all seven of these species have their most common occurrences in the lower half of the Upper Marlife and upper half of the Lower Marlife formations. The small number of species in common between the stratigraphically equivalent Lower Malife formation of the Panoche Hills and Unit IV of the Redding area can be accounted for by the unfavorable environment existing during deposition of the former.

Table 12. Stratigraphic occurrences of Moreno Gulch Foraminifera recorded from near Redding (TRUJILLO, 1960)

Foraminifera	Moreno fm.	Uhalde fm.	Upper Marlife fm.	Lower Marlife fm.
Dentalina megalopolitana	×	×		
Höglundina supracretacea	×	×		
Haplophragmoides excavata		×		
Cribrostomoides cretacea		×	×	
Gaudryina pyramidata		×	×	
Gyroidina goudkoffi		×	×	
Heterohelix globulosa		×	×	
Spiroplectammina chicoana		×	×	
Quadrimorphina allomorphinoides		×	×	
Haplophragmoides impensus		×	×	×
Marssonella oxycona		×	×	×
Astacolus jarvisi			×	
Kyphopyxa christneri			×	
Lingulina californiensis			×	
Robulus modestus			×	
Eponides bandyi			×	×
Globotruncana linneiana			×	×
Gyroidina florealis			×	×
Planulina popenoei			×	×
Pleurostomella greatvalleyensis			×	×
Planularia umbonata				×
Psammosphaera laevigata				×

2. Regional Correlation

Identification of Upper Cretaceous Foraminifera from Moreno Gulch and Laguna Seca Creek was facilitated by a comparison of these foraminifers with those from areas outside of California. These comparisons in conjunction with an extensive literature survey, it is believed, establish plausible correlations. Although a number of species relationships were noted, no attempt has been made to draw concrete conclusions regarding the correlation of stratal units from foreign areas with California equivalents. Moreno Gulch foraminiferal assemblages, however, are interpreted in terms of European standard stages (Table 8). The present state of knowledge of California Cretaceous Foraminifera, in addition to the restrictive factors already mentioned preclude efforts to arrive at any finer correlations than those attempted in this paper. Future studies of this group will undoubtedly clarify and establish specific and faunal associations that will result in detailed valid regional correlations.

In the course of this study it was found that a number of species observed in Moreno Gulch also occur in the Tampico embayment area of Mexico (Cushman, 1926; White, 1928, 1929). Some of these forms are as follows: *Bathysiphon dubia* (White), *Glomospira charoides* (Jones and Parker), *Nodellum velascoensis* (Cushman), *Gaudryina pyramidata* Cushman, *Clavulina trilaterus* (Cushman), *Dorothia bulletta* (Carsey), *Nodosaria velascoensis* Cushman, *Astacolus jarvisi* (Cushman), *Lenticulina velascoensis* White, *Globotruncana arca* (Cushman), *Globotruncana rosetta* (Carsey), *Bolivina incrassata* Reuss *(Bolivina primatumida* of White*)*, *Reussella szajnoche* (Grzybowski) *(Bulimina limbata* of White*)*, *Gyroidina florealis* White, *Gyroidina subangulata* (Plummer), *Eponides spinea* Cushman, *Stensiöina excolata* (Cushman), and *Anomalina whitei* Martin *(Rotalia beccariiformis* var. of White*)*.

White (1928, 1929) tabulates the stratigraphic ranges of these forms, and, although the majority of them occur in the Mendez shale, many range upward into the overlying Velasco shale. According to White's charts, foraminiferal species occurring in the Mendez shale and apparently restricted to the Cretaceous include the following: *Globotruncana arca* (Cushman), *Globotruncana rosetta* (Carsey), *Stensiöina excolata* (Cushman), *Heterohelix globulosa* (Ehrenberg), *Eponides spinea* Cushman, and *Reussella szajnoche* (Grzybowski). All of these species occur in the Moreno Gulch section (Table 2).

Recently Olvera (1959) described and figured the more important Foraminifera from the Mendez shale in the Tampico-Tuxpan basin. Among the species described by her which also occur in Moreno Gulch, the following are of significance: *Gaudryina pyramidata* Cushman, *Clavulinoides trilaterus* (Cushman), *Globotruncana linneiana* (d'Orbigny), *Globotruncana linneiana tricarinata* (Quereau), *Globotruncana riojae* Olvera, *Globotruncana rosetta* (Carsey), *Reussella szajnoche* (Grzybowski), and *Quadrimorphina allomorphinoides* (Reuss).

Most of these forms occur in the Uhalde formation, although some range down into the underlying Upper Marlife sediments. Little else can be said about correlations between the Tampico area and California because of the general lack of information concerning both Californian and Mexican foraminiferal assemblages. As pointed out by Bonet (1956) there is a definite need for a comprehensive biostratigraphic analysis of Senonian and Maastrichtian foraminifers of Mexico.

Upper Cretaceous Foraminifera reported from Colombia and noted in Moreno Gulch samples include: *Haplophragmoides excavata* Cushman and WATERS, *Dorothia bulletta* (CARSEY), *Dentalina basiplanata* CUSHMAN, *Marginulina curvisepta* CUSHMAN and GOUDKOFF, *Palmula primitiva* CUSHMAN, *Globotruncana arca* (CUSHMAN), *Bulimina aspera* CUSHMAN and PARKER, *Bulimina reussi* MORROW, *Buliminella carseyae* PLUMMER, *Buliminella colonensis* CUSHMAN and HEDBERG, *Valvulineria lenticula* (REUSS), and *Höglundina supracretacea* (TEN DAM).

A number of these forms were recorded by CUSHMAN and HEDBERG (1941) from the Colon and Mito Juan formations in northeastern Colombia. Although exact stratigraphic correlations based on the ranges of these species cannot be made, their distribution in Colombia suggests a Campanian to Maastrichtian age for those sediments. In terms of the Gulf Coast area of the United States these would be equivalent to the Taylor and Navarro formations (CUSHMAN and HEDBERG, 1941, p. 80). In the Panoche Hills most of these foraminifers occur in the Upper Marlife and Uhalde formations.

GANDOLFI (1955) reviews stratigraphic and taxonomic data of species of *Globotruncana* from northeastern Colombia. He reports *Globotruncana rosetta* (CARSEY) from Campanian strata of that country and *Globotruncana arca* (CUSHMAN) and *Rugoglobigerina rugosa* (PLUMMER) from the Campanian and Maastrichtian. In Moreno Gulch these forms occur in the upper portion of the Uhalde formation.

A *Bulimina-Siphogenerinoides* assemblage somewhat similar to that of the Marca shale member of the Moreno formation has been described from Campanian and Maastrichtian strata from surface sections near the town of Girardot in Colombia by BURGL and TOBON (1954, pl. 1). California species reported from the Girardot sections are *Siphogenerinoides clarki* CUSHMAN and CAMPBELL and *Bulimina prolixa* CUSHMAN and PARKER. It is noteworthy that in Colombia these species occur together and range throughout the Campanian and Maastrichtian. In Moreno Gulch *Bulimina prolixa* CUSHMAN and PARKER is restricted to the Moreno formation where it is associated with *Siphogenerinoides whitei* CHURCH. *Siphogenerinoides clarki* CUSHMAN and CAMPBELL occurs only in the uppermost Uhalde sediments. Another difference between *Bulimina-Siphogenerinoides* faunas from Colombia and California is that Colombian assemblages are more varied, for they have a greater number of species of *Siphogenerinoides* and *Bulimina*. The California fauna is dominated by specimens of *Siphogenerinoides whitei* CHURCH and *Bulimina prolixa* CUSHMAN and PARKER.

Published accounts (CUSHMAN and RENZ, 1946, 1947; BOLLI, 1951, 1957) as well as examination of material from the Naparima Hill and Guayguayare formations of Trinidad, B. W. I., demonstrate existing specific similarities between that area and California. Foraminifera common to both areas are as follows: *Bathysiphon dubia* (WHITE), *Pelosina complanata* FRANKE, *Hyperammina elongata* H. B. BRADY, *Saccorhiza ramosa* H. B. BRADY, *Involutina glabratus* (CUSHMAN and JARVIS), *Glomospira charoides* (JONES and PARKER), *Nodellum velascoensis* (CUSHMAN), *Gaudryina pyramidata* CUSHMAN, *Marssonella indentata* (CUSHMAN and JARVIS), *Rzehakina epigona lata* CUSHMAN and JARVIS, *Rzehakina epigona minima* CUSHMAN and RENZ, *Nodosaria velascoensis* CUSHMAN, *Astacolus jarvisi* (CUSHMAN), *Pullenia jarvisi* CUSHMAN, *Globotruncana arca* (CUSHMAN), *Globotruncana rosetta* (CARSEY), *Globotruncana linneiana tricarinata* (QUE-

REAU), *Rugoglobigerina rugosa* (PLUMMER), *Buliminella colonensis* CUSHMAN and HEDBERG, and *Bolivinitella eleyi* (CUSHMAN).

Most of the species listed above have been reported from outcrops representative of the upper part of the Naparima Hill formation formerly known as the Tarouba formation. CUSHMAN and RENZ (1947), in discussing the fauna of the Naparima Hill formation, arrive at the conclusion that it is equivalent in age to the Taylor stage of the Gulf Coast of the United States. Almost all of these species in Moreno Gulch are known to occur in the Upper Marlife and Uhalde formations.

BOLLI (1957) on the basis of *Globotruncana* species assigns a Campanian age to the upper part of the Naparima Hill formation and a late Campanian to Maastrichtian age to the Guayaguayare. This author also shows (1957, p. 53, fig. 10) that in Trinidad *Globotruncana arca* (CUSHMAN) ranges from the Campanian to the lower Maastrichtian. In Moreno Gulch the stratigraphic distribution of this species is similar, for it occurs in the Uhalde formation considered to be Campanian to lower Maastrichtian in age. The only other species of *Globotruncana* reported from Trinidad by BOLLI —which also occurs in Moreno Gulch—is *Globotruncana linneiana tricarinata* (QUEREAU). This form does not have the same stratigraphic ranges in the two areas, for in Trinidad its reported range is from the upper Campanian to Maastrichtian, whereas in Moreno Gulch it is observed only in sediments of Santonian age.

Since a great number of California Cretaceous species are found to be conspecific with forms from the Gulf Coast of the United States, they have been listed in Appendix D. Stratigraphic ranges are based primarily on the works of CUSHMAN (1946) and FRIZZELL (1954). The stratigraphic distribution of many of the Gulf Coast species does not coincide with that of California, for in the majority of cases, the Gulf Coast forms seem to have longer ranges. A few Gulf Coast species, however, do indicate that they are not only conspecific with California forms but that their stratigraphic distribution is comparable to that of their west coast counterparts. Some of the more important of these and their reported Gulf Coast ranges are:

Rugoglobigerina rugosa, Navarro
Globulina lacrima subsphaerica, Navarro-Upper Taylor
Bulimina prolixa, Navarro-Upper Taylor
Globotruncana arca, Navarro-Upper Taylor
Hoglundina supracretacea, Navarro-Upper Taylor
Bolivina incrassata, Lower Navarro-Taylor
Palmula primitiva, Upper Taylor
Gaudryina laevigata, Upper Taylor
Bolivinoides decoratus latticeus, Taylor
Rzehakina epigona lata, Taylor
Bolivinitella eleyi, Taylor-Upper Austin
Globotruncana paraventricosa, Taylor-Austin
Heterohelix pulchra, Taylor-Austin
Kyphopyxa christneri, Taylor-Austin
Globorotalites michelianus, Taylor-Austin
Globorotalites subconicus, Lower Taylor-Austin

In Moreno Gulch the majority of these forms occur in the Uhalde and Upper Marlife formations, and thus demonstrate existing faunal and stratigraphic similarities between the California and Gulf Coast provinces. This is not true of Moreno formation assemblages, which show little if any relationships to Gulf Coast foraminiferal assemblages. In terms of Gulf Coast terminology this means that the uppermost Uhalde and Moreno formation foraminiferal faunas, considered Maastrichtian in age, have very little in common with Navarro microfaunas. The lower Uhalde and Upper Marlife assemblages can be readily recognized as Taylor and Austin equivalents respectively. The arenaceous faunas from the middle portion of the Uhalde cannot be easily identified because of the lack of index foraminifers. However, this fauna and those from other stratigraphic horizons of the Uhalde suggest an age equivalency to those from the Taylor formation of the Gulf Coast.

A similar analytical treatment is given to those foraminiferal species from California known to occur in northwestern Europe (see Appendix E). A considerable number of publications were consulted to arrive at what may be considered adequate stratigraphic ranges for these species. Although some disagreement exists regarding stratigraphic distribution of Cretaceous foraminifers in Europe, examination of the compiled data in Appendix E shows that a few species can be of assistance in determining the age of equivalent California Cretaceous strata. The more important and characteristic of these and their reported stratigraphic range in northwestern Europe are listed below.

Bolivina incrassata, Maastrichtian-upper Campanian
Globotruncana arca, Maastrichtian-Campanian
Bulimina prolixa, Maastrichtian-Campanian
Globulina lacrima subsphaerica, Maastrichtian-Campanian
Globotruncana rosetta, Maastrichtian-Campanian
Nodosaria monile, Maastrichtian-Campanian
Gublerina ornatissima, Maastrichtian-Campanian
Osangularia cordieriana, Campanian
Dentalina basiplanata, Campanian
Globotruncana mariai, Campanian
Aptiopterina cylindroides, Campanian
Lagena paucicosta, Campanian
Bolivinitella eleyi, Campanian-Santonian
Globotruncana linneiana tricarinata, Campanian to Coniacian
Globotruncana linneiana, Campanian-Coniacian
Reussella szajnoche, Campanian-Santonian
Globorotalites michelinianus, Lower Campanian-Santonian
Stensiöina exsculpta, Lower Campanian to Coniacian
Globorotalites subconicus, Santonian-Coniacian
Robulus lepidulus, Santonian-Coniacian

Comparison of Moreno Gulch foraminifers with those of northwestern Europe shows that specific similarities may be observed between the two areas. This is true of microfaunas of the Upper Marlife and Uhalde formations, considered Santonian and Campanian respectively. It is also true, to a much lesser degree, of the Lower Marlife formation of Coniacian age.

The Maastrichtian Moreno formation microfaunas do not show any affinities with their European equivalents. For instance, the genus *Siphogenerinoides*, so prevalent in California, has not, to the writer's knowledge, been reported from northwestern Europe.

Moreno Gulch equivalents of the European standard stages can be fairly well recognized, although definitions of stage boundaries are not wholly satisfactory. In Europe there is also some disagreement concerning stage boundaries, and it is evident that considerable work is still required before establishing interregional correlations on a firm basis.

It may be argued that in the series of analyses presented, foraminifers listed from each of the areas discussed represent an extremely small fraction of the fauna. It may further be argued that apparently only selected or chosen species have been used. For example, CUSHMAN (1946) described and figured some 600 Upper Cretaceous foraminiferal species from the Gulf Coast and adjacent areas of the United States. Of these 52 species are considered to have been satisfactorily identified for use as correlative units. This number is further reduced when only those species whose stratigraphic distribution approximates that of their California counterparts are considered. This pattern is true for all areas compared. It is believed that in spite of the many limiting factors that have to be taken into account, essentially the same species and their recorded stratigraphic ranges from various areas provide a basic stratigraphic sequence which is also applicable to the California province. These observations have led to the recognition of two groups of diagnostic foraminifers. One group consists of forms indigenous to California that have local stratigraphic significance. Members of this group and their occurrence in terms of GOUDKOFF's California substages and European standard stages are as follows:

	California Substages	European Standard
Valvulineria lillisi	A-2	Danian
Siphogenerinoides whitei	C	Maastrichtian
Gavelinella orolomaensis	C	Maastrichtian
Gavelinella turbinata	C	Maastrichtian
Rotalia bandyi	D-1	Maastrichtian
Anomalina occidentalis	D-1	Maastrichtian
Bulimina spinata	D-2	Maastrichtian
Nodosaria spinifera	D-2	Maastrichtian
Cribrostomoides cretacea	F	Campanian
Gyroidina quadrata	F	Campanian
Globotruncana churchi	F	Campanian
Globotruncana fresnoensis	F, G-1	Campanian-Santonian
Bermudezina uvigerinaeformis	G-1, G-2	Santonian-Coniacian
Anomalina becki	G-1, G-2	Santonian-Coniacian
Planulina popenoei	G-1, G-2	Santonian-Coniacian
Pleurostomella greatvalleyensis	G-2	Coniacian

The second group consists of Foraminifera with wide geographic distribution and fairly well established stratigraphic ranges. The more prominent of these are as follows:

	California Substages	European Standard
Globigerina pseudobulloides	A-2	Danian
Globigerina triloculinoides	A-2	Danian
Globigerinoides daubjergensis	A-2	Danian
Bulimina prolixa	C	Maastrichtian
Rugoglobigerina rugosa	D-1	Maastrichtian
Siphogenerinoides clarki	D-1	Maastrichtian
Gublerina ornatissima	D-1, G-1	Maastrichtian-Santonian
Bolivina incrassata	D-2	Maastrichtian
Globulina lacrima subsphaerica	D-2	Maastrichtian
Gaudryina pyramidata	E	Campanian
Globotruncana rosetta	E	Campanian
Quadrimorphina allomorphinoides	F, G-1	Campanian-Santonian
Reussella szajnoche	F, G-1	Campanian-Santonian
Bolivinitella eleyi	F, G-1	Campanian-Santonian
Globotruncana linneiana tricarinata	G-1	Santonian
Kyphopyxa christneri	G-1, G-2	Santonian-Coniacian
Globotruncana linneiana	G-1, G-2	Santonian-Coniacian
Globorotalites subconicus	G-1, G-2	Santonian-Coniacian
Stensiöina exsculpta	G-1, G-2	Santonian-Coniacian

These two groups provide an interlocking series which serves to check age determinations based on provincial forms by comparing them with age determinations based on widely distributed species. In California these two groups seem to complement each other very well. One should point out, however, that future work will undoubtedly modify some of the stratigraphic ranges of species described in this study.

Stratigraphic distribution of some of these provincial and cosmopolitan Foraminifera as they occur in Moreno Gulch and Laguna Seca Creek is shown in Table 5. Other occurrences and stratigraphic significance of species are given in the systematic descriptions. These include occurrences from areas other than those discussed in the text. The foregoing examples show that as California Cretaceous foraminifers become better known, finer and more conclusive interpretations and correlations can be expected.

Systematic Descriptions

In this study synonymies consist of the following: (1) original reference, (2) synonyms, (3) generic changes, and (4) references containing fairly complete published synonymies.

All figured specimens are catalogued and deposited in the micropaleontological collection of Stanford University, Stanford, California.

Phylum PROTOZOA
Class SARCODINA Butschli, 1882
Order FORAMINIFERA d'Orbigny, 1826
Family RHIZAMMINIDAE Cushman, 1927
Genus *BATHYSIPHON* Sars, 1872
Bathysiphon dubia (White)

Plate 1, figs. 1 a, b

1928 *Kalamopsis dubia* White, Journ. Pal., vol. 2, no. 3, p. 185, pl. 27, fig. 3; Upper Cretaceous, Mexico.

Description: Test elongate, small, smooth exterior, tube generally collapsed, occasional constriction present; wall thick, consisting of amorphous siliceous material, sponge spicules rare; chamber opening relatively small. Length, 0.45 *mm.*; diameter, 0.25 *mm.*

Remarks: This small form matches well the description given by WHITE. California specimens sent to the U. S. National Museum compare favorably with the type.

Hypotype: SU no. 9331, Locality no. MG 239.

Bathysiphon californicus MARTIN, n. sp.

Plate 1, figs. 2 a, b

Description: Test elongate, cylindrical, medium sized for genus; wall fairly thin, rough exterior, composed of fine amorphous material, sand grains, and rare sponge spicules; chamber opening comparatively large. Length, up to 1.00 *mm.*; diameter, 0.40 *mm.*; diameter of chamber, 0.20 *mm.*

Remarks: Characterized by its relatively rough exterior and thin wall, this foraminifer may be readily distinguished from *Bathysiphon alexanderi* CUSHMAN and *Bathysiphon taurinensis* SACCO. It differs from the former by its rough exterior and larger cavity and from the latter by its smaller size.

Holotype: SU no. 9331 a, Locality no. MG 247.

Bathysiphon sp.

Plate 1, figs. 3 a, b

Description: Test elongate, subcylindrical, large; wall thin, smooth, consisting of siliceous material, rarely of sponge spicules; chamber opening large. Length, up to 0.75 *mm.*

Remarks: Only small broken fragments representative of this species were observed. Better preserved material is required for identification.

Depository: SU no. 9332, Locality no. MG 247.

Genus *PSAMMOSIPHONELLA* AVNIMELECH, 1952

Psammosiphonella llanadoensis MARTIN, n. sp.

Plate 1, figs. 4 a, b

Description: Test tubular, sides parallel, elliptical in cross section due to being deformed, no constrictions noted; wall coarsely arenaceous; chamber large. Length, up to 1.75 *mm.*; breadth, 0.60 *mm.*; thickness, 0.35 *mm.*

Remarks: Tubular agglutinated forms are assigned to the genus *Psammosiphonella* in accordance with AVNIMELECH'S (1952) revision of the Monothalamia. Although only fragments are present in Moreno Gulch material, examination of numerous specimens failed to demonstrate the presence of a closed end or of sponge spicules.

Holotype: SU no. 9333, Locality no. MG 574.

Family SACCAMMINIDAE Brady, 1884

Genus *PSAMMOSPHAERA* Schulze, 1875

Psammosphaera laevigata White

Plate 1, figs. 5 a—c

1928 *Psammosphaera laevigata* White, Journ. Pal., vol. 2, no. 3, p. 183, pl. 27, fig. 1; Upper Cretaceous, Mexico.
1960 *Psammosphaera laevigata*. Trujillo, Journ. Pal., vol. 34, no. 2, p. 302, pl. 43, figs. 1 a, b; Upper Cretaceous, northern California.

Description: Test subspherical, unilocular, lenticular in cross section due to being deformed; wall moderately coarse but smoothly finished, arenaceous; aperture simple, round. Diameter, 0.90 *mm*.

Remarks: The few specimens in Moreno Gulch seem to be conspecific with White's species.

Hypotype: SU no. 9334, Locality no. MG 1126.

Genus *PELOSINA* Brady, 1879

Pelosina complanata Franke

Plate 1, figs. 6 a, b

1911 *Pelosina complanata* Franke, K. preuss. geol. Landesanstalt Jahrb., vol. 32, pt. 2, p. 107, pl. 3, figs. 1 a, b; Upper Cretaceous, Germany.
1946 *Pelosina complanata*. Cushman, U. S. Geol. Survey Prof. Paper 206, p. 15, pl. 1, figs. 9—11; Upper Cretaceous, U. S. Gulf Coast (Contains prior synonomy).

Description: Test unilocular, distorted to lenticular shape, subcircular in outline; wall finely arenaceous, apparently partially replaced by amorphous silica; aperture simple, round, located at end of short tube. Diameter, 0.42 *mm*.

Hypotype: SU no. 9335, Locality no. MG 574.

Family HYPERAMMINIDAE Cushman, 1910

Genus *HYPERAMMINA* Brady, 1878

Hyperammina elongata H. B. Brady

Plate 1, figs. 7 a, b

1878 *Hyperammina elongata* Brady, Ann. Mag. Nat. Hist., ser 5, vol. 1, p. 433, pl. 20, fig. 2; Recent, Arctic Sea.
1932 *Hyperammina elongata*. Cushman and Jarvis, U. S. Nat. Mus. Proc., vol. 80, art. 14, p. 6, pl. 1, figs. 7, 8; Upper Cretaceous, Trinidad, B. W. I.
1951 *Hyperammina* cf. *H. elongata*. Noth, Jb. Geol. Bundesanst. Wien, Sonderband 3, p. 24, pl. 6, fig. 6; Upper Senonian, Austria.

Description: Test elongate, cylindrical, sides parallel except for swollen proloculus; wall finely arenaceous, with varying amounts of cement; aperture simple, formed by open end of test. Length, 0.65 *mm*.; diameter, 0.20 *mm*.

Hypotype: SU no. 9336, Locality no. MG 962.

Genus *SACCORHIZA* EIMER and FICKERT, 1899

Saccorhiza ramosa (H. B. BRADY)

Plate 1, figs. 8 a, b; 9

1879 *Hyperammina ramosa* H. B. BRADY, Quart. Journ. Micr. Sci., n. ser., vol. 19, p. 33 pl. 3, figs. 14, 15; Recent, north Atlantic.
1899 *Saccorhiza ramosa.* EIMER and FICKERT, Zeitschr. Wiss. Zoologie, vol. 65, p. 670.
1932 *Saccorhiza ramosa.* CUSHMAN and JARVIS, U. S. Nat. Mus. Proc., vol. 80, art. 14, p. 6, pl. 1, figs. 10—12; Upper Cretaceous, Trinidad, B. W. I.

Description: Test short, tubular, branching, circular in cross section but usually crushed or deformed; wall finely arenaceous, rarely with spicules; apertures at open ends of test. Length, 0.90 *mm.*; diameter, 0.18 *mm.*

Hypotype: SU no. 9337, Locality no. MG 546.

Family TOLYPAMMINIDAE CUSHMAN, 1929

Genus *INVOLUTINA* TERQUEM, 1862

Involutina glabratus (CUSHMAN and JARVIS)

Plate 1, figs. 10 a, b; 11

1928 *Ammodiscus glabratus* CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res.; Paleocene, Upper Cretaceous, Trinidad.

Description: Test planispiral, compressed, biconcave, circular in outline, most specimens deformed; periphery smooth, edge broadly rounded; chamber consisting of proloculus and simple tube, test including about 7 to 8 appressed whorls, increasing gradually in size as added; sutures distinct, depressed; wall thin, finely arenaceous, with much cement, smooth, polished; aperture lunate, located at end of tube. Diameter, 0.60 *mm.*; thickness, 0.10 *mm.*

Hypotype: SU no. 9338, Locality no. MG 578.

Involutina irregularis (REUSS)

Plate 1, figs. 12 a, b; 13 a, b

1863 *Cornuspira cretacea* (REUSS) var. *irregularis* REUSS, K. Akad. Wiss. Wien, Math. Naturw. Cl., Sitzber., Wien, vol. 46, p. 34, fig. 11 (not 12); Middle Cretaceous, Germany.

Description: Test planispiral, except for initial stage which is irregularly coiled in various planes, whorls about 5 to 6 in planispiral portion of test; periphery smooth, edge rounded; chamber consisting of proloculus and simple tube; suture depressed; wall finely arenaceous, smooth but not polished; aperture lunate, at end of tube. Diameter, 0.35 *mm.*; thickness, 0.07 *mm.*

Remarks: REUSS considered *Cornuspira cretacea* var. *irregularis* different from *Cornuspira cretacea* in the arrangement of the initial coils and in its lack of the radial chamber constrictions. California forms appear to be similar to the one figured by REUSS. This species may be distinguished from *Ammodiscoides turbinatus* CUSHMAN by its irregularly coiled initial end and by absence of the early high conical spire so typical of the latter.

Hapotype: SU no. 9339, Locality no. MG 300.

Genus *GLOMOSPIRA* RZEHAK, 1888

Glomospira charoides (JONES and PARKER)

Plate 1, figs. 14 a, b

1860 *Trochammina squamata charoides* JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, p. 304; Recent.
1925 *Glomospira charoides.* CUSHMAN, Smithsonian Misc., Coll. vol. 77, no. 4, p. 25, pl. 2, fig. 12; Recent.
1931 *Glomospira charoides.* GALLOWAY and MORREY, Journ. Pal., vol. 5, no. 4, p. 331, pl. 37, figs. 1, 2; Lower Tertiary, Mexico.

Description: Test tubular, regularly coiled in a spire, resulting in a spheroidal form; chamber tubular; suture distinct, slightly depressed; wall finely arenaceous, with much cement, smooth; aperture a simple opening at end of tube. Diameter, 0.35 *mm.*

Hapotype: SU no. 9340, Locality no. MG 300.

Glomospira charoides var. *corona* CUSHMAN and JARVIS

Plate 1, figs. 15 a, b

1928 *Glomospira charoides* var. *corona* CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res., vol. 4, pt. 4, p. 89, pl. 12, figs. 9—11; Upper Cretaceous, Trinidad, B. W. I.

Description: Test tubular, regularly coiled in a spire for the greater part of the test, later portion irregularly coiled, forming crown at end of test; chamber tubular; suture distinct, slightly depressed; wall finely arenaceous, with much cement, smooth; aperture simple, round, at open end of tube. Diameter, 0.30 *mm.*

Hypotype: SU no. 9341, Locality no. MG 343.

Glomospira gordialis (JONES and PARKER)

Plate 1, figs. 16 a, b

1860 *Trochammina squamata* var. *gordialis* JONES and PARKER, Quart. Journ. Geol. soc., vol. 16, p. 304; Recent.
1918 *Glomospira gordialis.* CUSHMAN, U. S. Nat. Mus. Bull. 104, pt. 1, p. 99, pl. 36, figs. 7—9; Recent.
1946 *Glomospira gordialis.* CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 18, pl. 1, figs. 38—40; Upper Cretaceous, Texas, Mexico, Trinidad, B. W. I.

Description: Test tubular, in early portion regularly planispiral, later irregularly planispirally coiled, resulting in a ovate form; chamber tubular, increasing in size as added; suture distinct, depressed; wall finely arenaceous, smooth, with much cement; aperture broadly crescentic, at end of tube. Length, 0.52 *mm.*; breadth, 0.44 *mm.*; thickness, 0.11 *mm.*

Hypotype: SU no. 9342, Locality no. MG 557.

Family REOPHACIDAE CUSHMAN, 1927

Genus *REOPHAX* MONFORT, 1808

Reophax sp.

Plate 1, figs. 17 a, b

Description: Test elongate, tapering towards initial end, uniserial; chambers globular, slightly appressed, only 2 to 3 chambers, increasing in size as added; sutures indistinct, apparently normal to axis of test, depressed; wall coarsely arenaceous; aperture simple, round, terminal. Length, 0.85 *mm.*; diameter, 0.55 *mm.*

Remarks: Several specimens of the form were obtained from the uppermost samples of the Uhalde formation. More material is required in order to make a specific determination.

Depository: SU no. 9343, Locality no. MG 187.

Genus *NODELLUM* Rhumbler, 1913

Nodellum velascoensis (Cushman)

Plate 1, figs. 18 a, b

1926 *Nodosinella velascoensis* Cushman, Amer. Assoc. Petrol. Geol. Bull., vol. 10, no. 6, p. 583, pl. 20, fig. 9; Velasco, Mexico.
1932 *Nodellum velascoensis.* Cushman and Jarvis, U. S. Nat. Mus. Proc., vol. 80, art. 14, p. 8, pl. 1, figs. 15—17; Upper Cretaceous, Trinidad, B. W. I.
1951 *Nodellum velascoensis.* Noth, Jb. Geol. Bundesanst. Wien, Sonderband 3, p. 26, pl. 6, figs. 15 a—c; Upper Senonian, Austria.

Description: Test elongate, uniserial, gently tapering towards initial end; chambers 3 to 4, inflated; wall smooth, chitinous, semitransparent; sutures distinct, depressed, apparently oblique due to test being deformed; aperture terminal, round, simple. Length, 0.75 *mm.*; diameter, 0.30 *mm.*

Remarks: Only broken specimens of this species were found in Moreno Gulch samples. Comparison of these fragments with whole specimens from the Velasco shale strongly indicates they are conspecific.

Hypotype: SU no. 9344, Locality no. MG 300.

Family LITUOLIDAE Reuss, 1861

Genus *TROCHAMMINOIDES* Cushman, 1910

Trochamminoides proteus (Karrer)

Plate 2, figs. 1 a, b

1865 *Trochammina proteus* Karrer, Sitzb. Kais. Akad. Wien, vol. 52, pt. 1, p. 494, pl. 1, fig. 8 (not 1—7); Upper Cretaceous, Austria.
1910 *Trochamminoides proteus.* Cushman, U. S. Nat. Mus. Bull. 71, pt. 1, p. 98, figs. 142 to 144; Recent.

Description: Test tubular, initial stage glomerate, later planispirally coiled, with regularly spaced constrictions forming about 12 chambers in last whorl; wall finely arenaceous; constrictions depressed, radial; aperture simple, round, at end of tube. Diameter, 0.55 *mm.*; thickness, 0.17 *mm.*

Hypotype: SU no. 9345, Locality no. MG 550.

Genus *HAPLOPHRAGMOIDES* Cushman, 1910

Haplophragmoides calcula Cushman and Waters

Plate 2, figs. 2 a, b

1927 *Haplophragmoides calcula* Cushman and Waters, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 4, p. 83, pl. 10, figs. 5 a, b; Navarro, Texas.
1946 *Haplophragmoides calcula.* Cushman, U. S. Geol. Survey Prof. Paper 206, p. 19, pl. 2, figs. 11, 12; Upper Cretaceous, U. S. Gulf Coast.

Description: Test planispiral, closely coiled, strongly compressed; periphery irregularly lobulate, edge bluntly rounded; chambers indistinct, 4 to 5 per coil; wall coarsely arenaceous, roughly finished; sutures indistinct; aperture generally indistinct but in some specimens a low opening at base of last chamber. Diameter, 0.95 *mm.*; thickness, 0.20 *mm.*

Hypotype: SU no. 9346, Locality no. MG 557.

Haplophragmoides excavata CUSHMAN and WATERS

Plate 2, figs. 8 a, b

1927 *Haplophragmoides excavata* CUSHMAN and WATERS, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 4, p. 82, pl. 10, figs. 3 a, b; Upper Cretaceous, Texas.

1946 *Haplophragmoides excavata.* CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 21, pl. 2, figs. 13—15; Upper Cretaceous, U. S. Gulf Coast.

1960 *Haplophragmoides excavata.* TRUJILLO, Journ. Pal., vol. 34, no. 2, p. 305, pl. 43, figs. 5 a, b; Upper Cretaceous, northern California.

Description: Test large, planispiral, partially involute, slightly biumbilicate, compressed; periphery gently lobulate, edge subacute; 9 to 11 chambers in last whorl, simple; sutures generally indistinct but appearing to be flush, radial; wall finely arenaceous; aperture a narrow slit at base of last-formed chamber. Diameter, 1.10 *mm.*; thickness, 0.30 *mm.*

Hypotype: SU no. 9347, Locality no. MG 238.

Haplophragmoides glabra CUSHMAN and WATERS

Plate 2, figs. 5 a, b

1927 *Haplophragmoides glabra* CUSHMAN and WATERS, Contr. Cushman Lab. Foram Res., vol 2, pt. 4, p. 83, pl. 10, figs. 6 a, b; Upper Cretaceous, Texas.

Description: Test planispiral, of medium size for genus, partially involute, biumbilicate, usually deformed; periphery gently lobulate, edge bluntly rounded or subacute; chambers indistinct, about 8 to 9 in last formed coil, distinct only when test is wet, simple; initial sutures indistinct, later ones gently curved and depressed; wall finely arenaceous, smoothly finished; aperture a low slit at base of last septal face. Diameter, 0.50 *mm.*; breadth, 0.40 *mm.*; thickness, 0.20 *mm.*

Hypotype: SU no. 9348, Locality no. MG 982.

Haplophragmoides impensus MARTIN n. sp.

Plate 2, figs. 3 a, b; 4 a, b

Description: Test planispiral, slightly biumbilicate, subcircular in outline; chambers slightly inflated, simple, 5 or 6 in last formed coil; sutures indistinct, but appearing to be flush, radial; wall finely arenaceous but not smoothly finished; aperture a low slit at base of last chamber. Diameter, 0.55 *mm.*; thickness, 0.40 *mm.*

Remarks: This long ranging species is distinguished from *Haplophragmoides glabra* CUSHMAN and WATERS by having fewer chambers per coil, slightly inflated chambers, and a broadly rounded edge. It is nearly always deformed, and well-formed specimens such as that of figure 3 a and 3 b are very rare.

Holotype: SU no. 9349, Locality no. MG 961.

Haplophragmoides incognatus MARTIN, n. sp.

Plate 2, figs. 6 a, b; 7 a, b

1960 *Haplophragmoides* cf. *H. glabra* CUSHMAN and WATERS. TRUJILLO, Journ. Pal., vol. 34, no. 2, p. 305, pl. 43, figs. 9 a—c; Upper Cretaceous, northern California.

Description: Test planispiral, subcircular in outline, distinctly biumbilicate, closely coiled; peripery slightly lobulate, edge broadly rounded; chambers about 8 or 9 in last coil; sutures straight, radial; wall finely arenaceous, not smoothly finished; aperture a low slit near base of last septal face. Diameter, 0.55 *mm.*; thickness, 0.35 *mm.*

Remarks: The deeper unbilical area and greater number of chambers per coil serve to distinguish this species from *Haplophragmoides impensus* MARTIN. It occurs in the Moreno Gulch and Laguna Seca Creek areas.

Holotype: SU no. 9350, Locality no. MG 210.

Haplophragmoides kirki WICKENDEN

Plate 2, figs. 9 a, b

1932 *Haplophragmoides kirki* WICKENDEN, Royal Soc. Canada Trans., 3rd Ser., sec. 4, p. 85, pl. 1, figs. 1 a—c; Upper Cretaceous, Canada.

Description: Test planispiral, small, closely coiled, biumbilicate; periphery lobulate, edge broadly rounded; chambers 4 to 5 in last-formed coil, involute; sutures distinct, depressed, straight; wall finely arenaceous, smooth; aperture a low slit at base of last-formed septal face. Diameter, 0.35 *mm.*; thickness, 0.20 *mm.*

Hypotype: SU no. 9351, Locality no. MG 248.

Haplophragmoides trifolium (EGGER)

Plate 2, figs. 10 a—c

1899 *Haplophragmium trifolium* EGGER, Abh. Bayer. Akad. Wiss. München, vol. 21, p. 137, pl. 1, figs. 10, 32, 53; Upper Cretaceous, Germany.

1928 *Trochammina trifolium.* FRANKE, Abh. Preuss, Geol. Landes. n. ser., vol. 3, p. 174, pl. 15, fig. 5; Senonian, Germany.

Description: Test planispiral, chambers inflated, compressed; periphery broadly lobulate, edge sharply to bluntly rounded; chambers 3 to 4 per coil, simple; wall moderately coarse, smoothly finished; sutures distinct, depressed, very gently curved; aperture a low narrow slit at base of last chamber. Diameter, 0.57 *mm.*; thickness, 0.15 *mm.*

Remarks: Comparison of specimens with the original figures of EGGER strongly indicates that the two forms are conspecific. Only a few specimens were noted in the Upper Marlife formation of the Panoche group.

Hypotype: SU no. 9352, Locality no. MG 550.

Genus *CRIBROSTOMOIDES* CUSHMAN, 1910

Cribrostomoides cretacea CUSHMAN and GOUDKOFF

Plate 2, figs. 11 a—c

1944 *Cribrostomoides cretacea* CUSHMAN and GOUDKOFF, Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 54, pl. 9, fig. 4; Upper Cretaceous, central California.

Description: Test planispiral, bilaterally symmetrical, subglobular, closely coiled, biumbilicate; chambers 8 to 10 in the final coil, gradually increasing in size as added, very slightly inflated; sutures distinct, radial; wall finely arenaceous, smoothly finished; aperture with 5 to 6 pores. Diameter, 0.38 *mm.*; thickness, 0.35 *mm.*

Remarks: Although this species has a fairly common occurrence in the Upper Marlife and lower portion of the Uhalde formations, only a few well preserved specimens were obtained. These allow the examination of apertural characteristics which generally are difficult to view.

The upper range of this species is suspect due to poor preservation. Possibly it is restricted to the lower half of the Uhalde and Upper Marlife formations (Table 2).

Several median sections were made in order to clarify the generic status of this form. FRIZZELL and SCHWARTZ (1950) placed *Cribrostomoides cretacea* CUSHMAN and GOUDKOFF in their genus *Barkerina* on the basis of external characters of the test. MAYNC (1952), in his nomenclatural revision of the Lituolidae, separates *Cribrostomoides* from *Barkerina* on the basis of internal structure and complexity of the test, *Cribrostomoides* being characterized by simple undivided chambers and *Barkerina* by partitioned ones. Although MAYNC did not have specimens of *Cribrostomoides cretacea*, he temporarily assigned it to the genus *Cribrostomoides* rather than to *Barkerina*. The section shown in Plate 2, figure 11 c, serves to illustrate the simple internal structure of this genus and to settle the generic position of the species.

Hypotype: SU no. 9353, Locality no. MG 544.

Genus *AMMOBACULITES* CUSHMAN, 1910

Ammobaculites sp.

Plate 2, figs. 12 a, b

Description: Test large, initial portion planispiral, later portion uncoiled and uniserial, subcircular in cross section; chambers about 7 with 4 initially one; early sutures indistinct, later ones distinct and depressed, normal to long axis of test; wall coarsely arenaceous; aperture simple, round, terminal at end of slight protuberance. Length, 1.70 *mm.*; breadth 0.85 *mm.*; width, 0.80 *mm.*

Remarks: Characterized by its large size and coarsely arenaceous test, this species most resembles *Ammobaculites jarvisi* CUSHMAN and RENZ (1946) recorded from the Lizard Springs formation of Trinidad, B. W. I. As only one complete specimen was obtained from Moreno Gulch material, no attempt to assign a specific name is made. The occurrence of this species appears to be limited to uppermost sediments of the Uhalde formation of the Panoche group.

Depository: SU no. 9354, Locality no. MG 187.

Family TEXTULARIIDAE d'ORBIGNY, 1846

Genus *SPIROPLECTAMMINA* CUSHMAN, 1927

Spiroplectammina chicoana LALICKER

Plate 2, figs. 13 a, b

1929 *Spiroplectammina anceps.* CUSHMAN and CHURCH (not REUSS), Proc. Calif. Acad. Sci., 4th Ser., vol. 18, p. 500, pl. 36, figs. 1, 2; Upper Cretaceous, central California.

1935 *Spiroplectammina chicoana* LALICKER, Contr. Cushman Lab. Foram. Res., vol. 11, pt. 1, p. 7, pl. 1, figs. 8, 9; Upper Cretaceous, central California.

1960 *Spiroplectammina chicoana.* TRUJILLO, Journ. Pal., vol. 34, no. 2, p. 310, pl. 44, figs. 6 a, b; Upper Cretaceous, northern California.

Description: Test elongate, compressed, tapering towards initial end, planispiral in initial stage, biserial in later stage; peripery irregular, edge angular; chambers numerous, distinct, closely appressed, low and broad; wall coarsely arenaceous, smoothly finished; sutures distinct, limbate, gently curved; aperture a low arched opening at base of inner margin of last-formed chamber. Length, 0.63 *mm.*; width, 0.25 *mm.*; thickness, 0.10 *mm.*

Hypotype: SU no. 9355, Locality no. MG 550.

Spiroplectammina perplexa ISRAELSKY

Plate 2, figs. 14 a, b

1928 *Spiroplectoides clotho.* CUSHMAN and JARVIS (GRZYBOWSKI), Contr. Cushman Lab. Foram. Res., vol. 4, pt. 4, p. 10, pl. 14, fig. 13 (not 14); Upper Cretaceous, Trinidad.

1946 *Spiroplectammina grzybowski.* CUSHMAN and RENZ (not FRIZZELL), Cushman Lab. Foram. Res., Spec. Publ. no. 18, p. 20, pl. 5, figs. 34, 37, 38 (not 35, 36); Upper Cretaceous, Paleocene, Trinidad, B. W. I.

1951 *Spiroplectammina perplexa* ISRAELSKY, U. S. Geol. Survey Prof. Paper 240-A, p. 12, pl. 3, figs. 9—14; Paleocene, central California.

Description: Test elongate, compressed, initial stage planispiral with umbo at center, later biserial, sides parallel; periphery irregular in outline view, edge subacute; chambers numerous, distinct, closely appressed; sutures distinct, flush, with tendency to become limbate and glassy, forming a 45 degree angle with long axis of test; wall apparently finely granular, with much siliceous cement; aperture a low opening in notch at base of last chamber. Length, 0.43 *mm.*; width, 0.24 *mm.*; thickness, 0.09 *mm.*

Hypotype: SU no. 9356, Locality no. MG 11, 11 a.

Family VERNEUILINIDAE CUSHMAN, 1911

Genus *VERNEUILINA* d'ORBIGNY, 1840

Verneuilina münsteri REUSS

Plate 3, figs. 1 a, b

1845 *Textularia triquetra* REUSS (not MÜNSTER), Verstein. Böhm. Kreide, pt. 1, p. 39, pl. 13, fig. 77; Upper Cretaceous, Bohemia.

1854 *Verneuilina münsteri* REUSS, Denkschr. Akad. Wiss. Wien, vol. 7, p. 71, pl. 26, fig. 5; Upper Cretaceous, Bohemia.

1937 *Verneuilina münsteri.* CUSHMAN, Cushman Lab. Foram. Res. Spec. Publ. no. 7, p. 9, pl. 1, figs. 9—13; Upper Cretaceous, Germany.

Description: Test high-spired, triserial, pyramidal, initial end acute, sides with tendency towards concavity, greatest width at last three chambers, angles acute; chambers in initial portion indistinct, later ones fairly distinct, closely appressed; wall finely arenaceous, smoothly finished; sutures indistinct in initial portion, distinct in later stage, gently curved; aperture a low arched slit at base of last-formed chamber. Length, 0.75 *mm.*; width, 0.50 *mm.*

Remarks: Originally described by REUSS from the Upper Cretaceous of Bohemia, this species is known from various European localities. Our specimens show affinities with REUSS' original figure. CUSHMAN (1937) reproduced figures based on REUSS' co-type from the Harvard University collection which strongly resembles the California specimens.

Hypotype: SU no. 9357, Locality no. MG 730.

Genus *GAUDRYINA* d'ORBIGNY, 1839

Gaudryina laevigata FRANKE

Plate 3, figs. 2 a—c

1914 *Gaudryina laevigata* FRANKE, Deutsche geol. Gesell. Zeitschr., vol. 66, p. 431, pl. 27, figs. 1, 2; Upper Cretaceous, Germany.

1946 *Gaudryina laevigata.* CUSHMAN, U. S. Geol. Survey Prof. 206, p. 33, pl. 8, fig. 4; Upper Cretaceous, U. S. Gulf Coast.

Description: Test about twice as long as broad, tapering, with widest part towards apertural end, initial stage triserial and triangular in cross section, angles subacute, later stages biserial, apertural view broadly rounded; chambers in triserial portion appressed, later biserial series rapidly increasing in size as added, inflated; sutures distinct, initially slightly depressed, those of later stage depressed; wall finely arenaceous, smoothly finished; aperture a low elongate slit at base of septal face. Length, 0.80 *mm.*; breadth, 0.50 *mm.*

Hypotype: SU no. 9358, Locality no. MG 581.

Gaudryina pyramidata CUSHMAN

Plate 3, figs. 3 a, b

1926 *Gaudryina laevigata* FRANKE var. *pyramidata* CUSHMAN, Bull. Amer. Assoc. Petrol. Geol., vol. 10, p. 587, pl. 16, fig. 8; Upper Cretaceous, Mexico.

1944 *Gaudryina pyramidata.* CUSHMAN and GOUDKOFF, Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 56, pl. 9, figs. 7, 8; Upper Cretaceous, California.

1959 *Gaudryina pyramidata.* OLVERA, Assoc. Mex. Geol. Petr., vol. 11, nos. 3, 4, p. 65, pl. 1, figs. 1, 2; Campanian-Maastrichtian, Mexico.

Description: Test about twice as long as broad, tapering toward initial end, greatest width at apertural end, initial stage triserial and triangular in cross section, later stage biserial; chambers distinct, early ones appressed, later biserial ones inflated, one series of chambers with a truncate periphery, opposite series pointed; sutures distinct, slightly depressed; wall coarsely arenaceous but smoothly finished; aperture a distinct reentrant at inner margin of last-formed chamber. Length, 0.80 *mm.*; width, 0.50 *mm.*

Hypotype: SU no. 9359, Locality no. MG 262.

Gaudryina rudita Sandidge

Plate 3, figs. 4 a, b

1932 *Gaudryina rudita* Sandidge, Amer. Midland Nat., vol. 13, p. 342, pl. 31, figs. 19, 20; Upper Cretaceous, Tennessee.

1946 *Gaudryina rudita*. Cushman, U. S. Geol. Survey Prof. Paper 206, p. 34, pl. 7, figs. 23, 24; Upper Cretaceous, U. S. Gulf Coast.

Description: Test elongate, about 3 times as long as broad, initial end bluntly pointed, greatest width at last chambers, small triserial portion, biserial portion longer; chambers numerous, rapidly increasing in size in initial stage, gradually in later stage, the later ones somewhat inflated; wall arenaceous, rough surface; sutures in early stage indistinct, later ones distinct, depressed; aperture a low arched opening at base of last septal face. Length, 0.70 *mm.*; width, 0.25 *mm.*; thickness 0.18, *mm.*

Hypotype: SU no. 9360, Locality no. MG 553.

Gaudryina rudita Sandidge subsp. *diversa* Cushman and Goudkoff

Plate 3, figs. 5 a, b

944 *Gaudryina rudita* Sandidge var. *diversa* Cushman and Goudkoff, Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 55, pl. 9, fig. 6; Upper Cretaceous, central California.

Description: Test elongate, large, early chambers triserial, later one biserial, gently tapering except for strongly tapered initial end; chambers gently overlapping, gradually increasing in height as added, later ones slightly inflated; wall smoothly arenaceous; sutures slightly depressed, forming an angle of about 35 degrees with the horizontal; aperture a low slit in a distinct reentrant at base of last-formed chamber. Length, 1.10 *mm.*; width, 0.50 *mm.*; thickness, 0.40 *mm.*

Hypotype: SU no. 9361, Locality no. MG 544.

Genus *BERMUDEZINA* Cushman, 1937

Bermudezina uvigerinaeformis Martin, n. sp.

Plate 3, figs. 6 a—c

Description: Test triserial, uvigerine in form, circular in apertural view, greatest width at last whorl; periphery broadly lobate; chambers distinct, later area ones inflated with the last three comprising about two, thirds of test; wall finely arenaceous, smoothly finished; sutures distinct, increasingly depressed, in later portion of test; aperture simple, round-at end of short tubular protuberance. Length, 0.60 *mm.*; diameter, 0.40 *mm.*

Remarks: This easily recognizable uvigerine-shaped form differs from *Bermudezina extans* Bandy (1951) from the Upper Cretaceous of southern California, in its smaller size, greater width and tapering of the test.

Holotype: SU no. 9362, Locality no. MG 720.

Genus *PSEUDOGAUDRYINELLA* Cushman, 1936

Pseudogaudryinella capitosa (Cushman)

Plate 3, figs. 7 a, b

1933 *Gaudryinella capitosa* Cushman, Contr. Cushman Lab. Foram. Res., vol. 9, pt. 3, p. 52, pl. 5, figs. 8 a—c; Upper Cretaceous, Mississippi.
1937 *Pseudogaudryinella capitosa.* (Cushman), Cushman Lab. Foram. Res. Spec. Publ. no. 7, p. 139, pl. 19, fig. 12; Upper Cretaceous, U. S. Gulf Coast.

Description: Test elongate, early stage triserial, triangular in cross section, later stage biserial; chambers in early stages indistinct, later ones distinct and inflated, chambers in 2 series, one truncate, the other with subacute angle, final chambers with tendency to become uniserial; early sutures indistinct, later ones well defined and depressed; wall coarsely arenaceous, smoothly finished; aperture simple round, terminal. Length, 0.80 *mm.*; breadth, 0.30 *mm.*; diameter, of last chamber 0.25 *mm.*

Hypotype: SU no. 9363, Locality no. MG 553.

Genus *CLAVULINOIDES* Cushman, 1936

Clavulinoides trilaterus (Cushman)

Plate 3, figs. 8 a, b

1926 *Clavulina trilatera* Cushman, Bull. Amer. Assoc. Petrol. Geol., vol. 10, no. 6, p. 588, pl. 17, fig. 2; Upper Cretaceous, Mexico.
1937 *Clavulinoides trilatera* (Cushman). Cushman Lab. Foram. Res. Spec. Publ. no. 7, p. 121, pl. 16, figs. 12—18; Upper Cretaceous, U. S. Gulf Coast.
1959 *Clavulinoides trilatera.* Olvera, Asoc. Mex. Geol. Petr., vol. 11, nos. 3, 4; p. 66, pl. 1, figs. 3, 4; Campanian, Maastrichtian, Paleocene, Mexico.

Description: Test elongate, gently tapering, triangular in cross section, angles distinct, subacute; chambers in initial portion triserial, uniserial in later stage, closely appressed, 4 to 5, increasing in size gradually and uniformly, final ones with tendency to become inflated; wall finely arenaceous, smoothly finished; sutures indistinct in early part of test, later ones well defined and slightly depressed; aperture round, terminal. Length, 0.70 *mm.*; breadth, 0.25 *mm.*

Hypotype: SU no. 9364, Locality no. MG 581.

Clavulinoides sp.

Plate 3, figs. 9 a, b

Description: Test elongate, sides almost parallel, early stage triserial, triangular in cross section, later portion uniserial, circular in cross section; early chambers appressed, later ones inflated, wall coarsely arenaceous but smoothly finished; sutures indistinct in early portion, well defined and depressed in later part; aperture terminal, round. Length, 0.75 *mm.*; diameter, 0.26 *mm.*

Remarks: Only one poorly preserved specimen was found; hence no specific identification is attempted.

Depository: SU no. 9365, Locality no. MG 262.

Family VALVULINIDAE CUSHMAN, 1927

Genus *EGGERELLA* CUSHMAN, 1933

Eggerella obscura MARTIN, n. sp.

Plate 3, figs. 10 a, b; 11

Deposition: Test elongate, spire high trochoid with tapering initial end, later portion with parallel sides, gently lobulate in outline view, circular in cross section; chambers numerous, closely appressed, 5 to a whorl in initial stage, 4 in later stage, and finally 3 in adult stage; wall finely arenaceous; sutures distinct only when test is wet, gently depressed; aperture a narrow slit in a depression at juncture of last three chambers. Length, 0.65 *mm.*; diameter, 0.23 *mm.*

Remarks: This small form occurs in a few samples from the lower part of the Upper Marlife formation. Its rare occurrence and the obscure nature of its test characteristics suggested the specific name.

Holotype: SU no. 9366, Locality no. MG 581.

Genus *DOROTHIA* PLUMMER, 1931

Dorothia bulletta (CARSEY)

Plate 3, figs. 12 a—c

1926 *Gaudryina bulletta* CARSEY, Univ. Texas Bull. 2612, p. 28, p. 4, fig. 4; Upper Creta ceous, Texas.
1931 *Dorothia bulletta.* PLUMMER, Univ. Texas Bull. 3101, p. 132, pl. 8, figs. 13—17; Upper Cretaceous, Texas.
1946 *Dorothia bulletta.* CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 46, pl. 12, fig. 21—26; Upper Cretaceous, U. S. Gulf Coast.
1959 *Dorothia bulletta.* OLVERA, Asoc. Mex. Geol. Petro., vol. 11, nos. 3, 4, p. 67, pl. 1, figs. 6, 7; Campanian, Maastrichtian, Mexico.

Description: Test elongate, about twice as long as broad, circular in cross section, initial end broadly rounded and tapering, later sides almost parallel; early chambers 4 or 5 to a whorl, later triserial, and in adult stage biserial, later chambers distinct, increasing gradually in size as added, moderately inflated; wall arenaceous, smoothly finished; sutures distinct, depressed in adult stage; aperture a low broad arch at base of septal face. Length, 0.96 *mm.*; diameter, 0.50 *mm.*

Hypotype: SU np. 9367, Locality no. MG 581.

Genus *MARSSONELLA* CUSHMAN, 1933

Marssonella indentata (CUSHMAN and JARVIS)

Plate 3, figs. 13 a, b

1928 *Gaudryina indentata* CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res., vol. 4, pt. 4, p. 92, pl. 13, fig. 7; Upper Cretaceous, Trinidad, B. W. I.
1937 *Marssonella indentata.* CUSHMAN, Cushman Lab. Foram. Res. Spec. Publ. 8, p. 39, pl. 6, figs. 21, 22; Upper Cretaceous, Trinidad, B. W. I., Mexico.

Description: Test elongate, twice as long as broad, conical, rounded in cross section, tapering towards acute initial end, with greatest width at apertural end; chambers fairly distinct, in early stages 4 to 5 per whorl, later ones triserial, biserial in adult stage, slightly indented in late stage;

wall arenaceous, smooth, sutures fairly distinct, raised; aperture a low small semicircular opening at base of last chamber. Length, 0.80 *mm.*; diameter, 0.40 *mm.*

Hypotype: SU no. 9368, Locality no. MG 514.

Marssonella oxycona (REUSS)

Plate 3, figs. 14 a, b

1860 *Gaudryina oxycona* REUSS, Akad. Wiss. Wien. Math.-Naturw. Cl., Sitzungsber., vol. 40, p. 229, pl. 12, fig. 3; Upper Cretaceous, Germany.
1933 *Marssonella oxycona.* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 9, pt. 2, p. 36, pl. 4, figs. 13 a, b; Upper Cretaceous.
1951 *Marssonella oxycona.* BANDY, Journ. Pal., vol. 25, no. 4, p. 492, pl. 72, figs. 8 a, b; Upper Cretaceous, southern California.
1960 *Dorothia oxycona.* TRUJILLO, Journ. Pal., vol. 34, no. 2, p. 309, pl. 44, figs. 5 a, b; Upper Cretaceous, northern California.

Description: Test conical, circular in cross section, tapering toward initial end; chambers fairly distinct, initial stage with 4 or 5 chambers per whorl, reduced to 3 and then 2 in adult stage; wall finely arenaceous, smoothly finished; sutures distinct, flush; aperture a low opening at inner margin of last chamber. Length, 0.60 *mm.*; diameter, 0.30 *mm.*

Hypotype: SU no. 9369, Locality no. MG 574.

Family TROCHAMMINIDAE SCHWAGER, 1877

Genus *TROCHAMMINA* PARKER and JONES, 1859

Trochammina ribstonensis WICKENDEN

Plate 4, figs. 1 a, b

1932 *Trochammina ribstonensis* WICKENDEN, Royal Soc. Canada Trans., 3rd ser., vol. 26, sec 4, p. 90, pl. 1, figs. 12 a—c; Upper Cretaceous, Canada.

Description: Test small, spire with low trochoid, 2 or 3 dorsal whorls, last-formed as seen ventrally slightly biconvex, umbilical area open; periphery slightly lobulate, edge rounded; chambers numerous, about 9 in last-formed whorl, somewhat appressed, wall finely arenaceous, smoothly finished; sutures distinct, depressed, gently curved dorsally and ventrally; aperture a low curved slit at base of last chamber on ventral side between periphery and umbilical area. Diameter, 0.40 *mm.*; thickness, 0.15 *mm.*

Hypotype: SU no. 9370, Locality no. MG 238.

Family RZEHAKINIDAE CUSHMAN, 1933

Genus *RZEHAKINA* CUSHMAN, 1927

Rzehakina epigona (RZEHAK) subsp. *lata* CUSHMAN and JARVIS

Plate 4, figs. 2 a—c

1928 *Rzehakina epigona* (RZEHAK) var. *lata* CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res., vol. 4, pt. 4, p. 93, pl. 13, figs. 11 a, b; Upper Cretaceous, Trinidad, B. W. I.
1946 *Rzehakina epigona* (RZEHAK) var. *lata* CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 47, pl. 14, figs. 1—3; Upper Cretaceous, Texas.

Description: Test compressed, biumbilicate, planispiral, involute, elliptical and side view, only last-formed whorl discernable; periphery smooth, broadly rounded, edge with rounded carina; chamber simple, best observed in reflected light, tubular, planispiral, each whorl constricted at opposite ends; wall siliceous; aperture U-shaped, terminal. Length, 0.60 *mm.*; width, 0.40 *mm.*; thickness, 0.15 *mm.*

Hypotype: SU no. 9371, Locality no. MG 238.

Rzehakina epigona (Rzehak) subsp. *minima* Cushman and Renz

Plate 4, figs. 3 a—c

1946 *Rzehakina epigona* (Rzehak) var. *minima* Cushman and Renz, Cushman Lab. Foram. Res. Spec. Publ. no. 18, p. 24, pl. 3, fig. 5; Upper Cretaceous, Trinidad, B. W. I.

Description: Test small, strongly compressed, biumbilicate, planispiral, involute, elliptical in side view; periphery smooth, broadly rounded, edge sharply rounded; chamber single, best seen in reflected light, planispiral, about 6 to 7 whorls, each whorl with tendency to narrow or become constricted at opposite ends; wall siliceous; aperture U-shaped, terminal. Length, 0.45 *mm.*; width, 0.25 *mm.*; thickness, 0.09 *mm.*

Remarks: Although this species appears to be a smaller variation of *Rzehakina epigona* subsp. *lata* Cushman and Renz, examination under reflected light reveals a marked difference in the number of whorls present. Specimens from Moreno Gulch have been compared with those from the Lizard Springs formation, Trinidad, B. W. I., and were found to be identical.

Hypotype: SU no. 9372, Locality no. MG 247.

Genus *SILICOSIGMOILINA* Cushman and Church, 1929

Silicosigmoilina californica Cushman and Church

Plate 4, figs. 4 a—d

1929 *Silicosigmoilina californica* Cushman and Church, Calif. Acad. Sci. Proc., 4th Ser., vol. 18, no. 16, p. 502, pl. 36, figs. 10—12; Upper Cretaceous, central California.
1951 *Silicosigmoilina californica.* Israelsky, U. S. Geol. Survey Prof. Paper 240-A, p. 10, pl. 2, figs. 19—21; pl. 10, fig. 20; Paleocene, central California.
1959 *Silicosigmoilina californica.* Mallory, Lower Tertiary Biostratigraphy of the California Coast Ranges, p. 129, pl. 5, figs. 10, 11; Paleocene, California.

Description: Test compressed, oval to elliptical in outline view, sigmoid in end view; periphery broadly rounded, edge subround to subacute; chambers planispiral in early stage, sigmoid in adult stage; wall finely arenaceous, with much siliceous cement, smoothly finished; sutures generally indistinct except for those of last-formed chamber, slightly depressed; aperture simple, terminal, oval. Length, 0.83 *mm.*; width, 0.55 *mm.*; thickness, 0.32 *mm.*

Hypotype: SU no. 9373, Locality no. MG 237.

Family NODOSARIIDAE SCHULTZE, 1854

Genus *NODOSARIA* LAMARCK, 1812

Nodosaria monile v. HAGENOW

Plate 4, figs. 5 a, b

1842 *Nodosaria monile* v. HAGENOW, Neues Jahrb., p. 568; Upper Cretaceous, Germany.
1845 *Nodosaria monile*. REUSS, Verstein. Böhm. Kreide., pt.1, p. 27, pl. 8, fig. 7; Upper Cretaceous, Bohemia.
1935 *Nodosaria monile*. CUSHMAN and CAMPBELL, Contr. Cushman Lab. Foram. Res., vol. 11, pt. 3, p. 71, pl. 10, fig. 5; Upper Cretaceous, central California.

Description: Test elongate, straight, circular in cross section; chambers 6 or 7, distinct, slightly inflated, wall calcareous, smooth, finely perforate; sutures depressed, distinct, normal to long axis of test; aperture terminal, radiate, central. Length, 1.00 *mm.*; diameter, 0.25 *mm.*

Hypotype: SU no. 9374, Locality no. LS 609.

Nodosaria spinifera CUSHMAN and CAMPBELL

Plate 4, figs. 6 a, b

1935 *Nodosaria spinifera* CUSHMAN and CAMPBELL, Contr. Cushman Lab. Foram. Res., vol. 11, pt. 3, p. 71, pl. 10, figs. 9, 10; Upper Cretaceous, central California.

Description: Test elongate, slender, circular in cross section, initial chamber globular with greater diameter than later chambers; chambers about 5 times as long as wide, fragments with 2 or 3 chambers noted; wall thick, smooth, ornamented with spines pointing towards, initial end; aperture not observed. Length, 0.87 *mm.*; chamber diameter, 0.25 *mm.*; diameter of tube, 0.12 *mm.*

Hypotype: SU no. 9375, Locality no. LS 609.

Nodosaria velascoensis CUSHMAN and JARVIS

Plate 4, figs. 7 a, b; 8

1926 *Nodosaria fontannesi* BERTHELEIN subsp. *velascoensis* CUSHMAN, Bull., Amer. Assoc. Petrol. Geol. vol., 10, no. 6, p. 504, pl. 18, fig. 12; Upper Cretaceous, Mexico.
1928 *Nodosaria velascoensis*. CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res., vol. 4, pt. 4, p. 97, pl. 13, figs. 15, 16; Upper Cretaceous, Trinidad, B. W. I.
1935 *Nodosaria velascoensis*. CUSHMAN and CAMPBELL, Contr. Cushman Lab. Foram. Res., vol. 11, pt. 3, p. 72, pl. 11, fig. 3; Upper Cretaceous, central California.

Description: Test elongate, straight, circular in cross section, gently tapering toward initial end, greatest width at last chamber; 6 to 8 chambers, increasing in height gradually as added; wall calcareous, finely perforate, ornamented by fine longitudinal costae continuous in early chambers but restricted in later chambers to the suture area; sutures distinct only in later portion of test, those of initial end obscured by ornamentation; aperture terminal, radiate. Length of fragment in Plate 4, figure 7 a, 1.20 *mm.*; diameter, 0.26 *mm.*

Remarks: Just a few fragments of this species were found in samples from Laguna Seca Creek. Comparison with material from the Lizard Springs formation, Trinidad, B. W. I., indicates that the two forms are conspecific.

Hypotype: SU no. 9376, Locality no. LS 599.

Nodosaria sp.

Plate 4, figs. 9 a, b

1935 *Nodosaria* sp. CUSHMAN and CAMPBELL, Contr. Cushman Lab. Foram. Res., vol. 11, pt. 3, p. 72, pl. 11, fig. 2; Upper Cretaceous, central California.

Description: Test elongate, circular in cross section, only fragments of 1 or 2 chambers observed; chambers globular with area in between strongly constricted, each one with 14 to 15 well-developed costae, which are continuous in some fragments but not in others; wall calcareous, finely perforate; sutures indistinct, apparently normal to long axis of test; aperture not observed. Length of figured fragment, 1.10 *mm.*; diameter 0.45 *mm.*

Remarks: Specimens from Moreno Gulch are similar to those described by CUSHMAN and CAMPBELL. Unfortunately no complete specimens were found, and specific identification must be deferred until better material is available.

Hypotype: SU no. 9377, Locality no. MG 216.

Genus *GLANDULINA* d'ORGIGNY, 1839

Glandulina parallela MARRSON

Plate 4, figs. 10 a, b

1878 *Glandulina parallela* MARSSON, Naturw. Ver. Neu-Vorpommern u. Rugen Mitt., Jahrb. 10, vol. 10, p. 124, pl. 1, figs. 4 a, b; Upper Cretaceous, Germany.

1932 *Pseudoglandulina parallela.* CUSHMAN and JARVIS, U. S. Nat. Mus. Proc., vol. 80, art. 14, p. 36, pl. 11, fig. 9; Upper Cretaceous, Trinidad, B. W. I.

Description: Test small, broadly elliptical in outline, circular in cross section, initial end rounded, apertural end bluntly pointed; chambers few wall calcareous, finely perforate; sutures distinct, normal to long axis of test; aperture terminal, radiate. Length, 0.45 *mm.*; diameter, 0.32 *mm.*

Hypotype: SU no. 9378, Locality no. MG 574.

Genus *PSEUDONODOSARIA* BOOMGAART, 1949

Pseudonodosaria larva (CARSEY)

Plate 4, figs. 11 a, b

1926 *Nodosaria larva* CARSEY, Univ. Texas Bull. 2612, p. 31, pl. 2, fig. 2; Upper Cretaceous, Texas.

1931 *Nodosaria radicula.* PLUMMER (not LINNÉ, 1758), Univ. Texas Bull. 3101, p. 155, pl. 11, fig. 2; Upper Cretaceous, Texas.

1946 *Pseudoglandulina manifesta.* CUSHMAN (not REUSS, 1851), U. S. Geol. Survey Prof. Paper 206, p. 76, pl. 27, figs. 21—26; Upper Cretaceous, U. S. Gulf Coast.

1955 *Pseudonodosaria larva.* LOEBLICH and TAPPAN, Smithsonian Misc. Coll., vol. 126, no. 3, p. 6, pl. 1, figs. 7—11; Upper Cretaceous, Texas.

Description: Test elongate, tapering toward initial end, circular in cross section, initial end bluntly rounded; early chambers appressed, later ones slightly inflated, about 6 to 7 to the adult form; wall calcareous, smooth, finely perforate; sutures distinct, normal to long axis of test, flush in early stage, depressed in later; aperture terminal, at end of slight protuberance, radiate. Length, 0.45 *mm.*; diameter, 0.21 *mm.*

Remarks: As pointed out by LOEBLICH and TAPPAN (1955) *Pseudonodosaria larva* (CARSEY) may be differentiated from *Nodosaria radicula* LINNÉ by its more rounded initial end. It differs from *Glandulina manifesta* REUSS by having a rounded initial end, a less flaring test, and deeper depressed sutures.

Hypotype: SU no. 9379, Locality no. MG 610.

Genus *DENTALINA* d'ORBIGNY, 1839

Dentalina aculeata d'ORBIGNY

Plate 4, figs. 12 a, b

1840 *Nodosaria (Dentalina) aculeata* d'ORBIGNY, Soc. géol. France Mem., 1st Ser., vol. 4, p. 13, pl. 1, figs. 2, 3; Senonian, Paris Basin.
1946 *Dentalina aculeata.* CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 67, pl. 26, figs. 17, 18; Upper Cretaceous, Texas.
1951 *Dentalina aculeata.* BANDY, Journ. Pal., vol. 25, no. 4, p. 499, pl. 73, fig. 4; Upper Cretaceous, southern California.

Description: Several incomplete specimens referable to this species were noted in Moreno Gulch material. They consist of a single pyriform chamber with attenuated ends. The walls are calcareous and ornamented with fine papillae. Length of figured fragment, 0.76 *mm.*; diameter, 0.46 *mm.*

Hypotype: SU no. 9380, Locality no. MG 574.

Dentalina basiplanata CUSHMAN

Plate 4, figs. 13 a, b

1931 *Dentalina annulata.* CUSHMAN (not REUSS), Tennessee Geol. Survey Bull. 41, p. 28, pl. 3, fig. 3; Upper Cretaceous, Tennessee.
1938 *Dentalina basiplanata* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, pt. 2, p. 38,pl. 6, figs. 6—8; Upper Cretaceous, Texas.
1951 *Dentalina basiplanata.* BANDY, Journ. Pal., vol. 25, no. 4, p. 299, pl. 73, figs. 6 a—c; Upper Cretaceous, southern California.

Description: Test elongate, slightly curved, gently tapering toward rounded initial end, which is circular in cross section; 7 or 8 chambers, early ones shorter than broad, appressed, later ones longer than broad, slightly inflated; wall calcareous, smooth, finely perforate; sutures slightly oblique and flush in early portion of test, gently depressed and normal to long axis of test in later portion; aperture rudiate, placed toward concave side. Length, 1.77 *mm.*; diameter, 0.30 *mm.*

Hypotype: SU no. 9381, Locality no. MG 346.

Dentalina megalopolitana REUSS

Plate 4, figs. 14 a, b

1855 *Dentalina megalopolitana* REUSS, Deutsche geol. Gesell. Zeitschr., vol. 7, p. 267, pl. 8, fig. 10; Turonian, Germany.
1946 *Dentalina megalopolitana.* CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 67, pl. 23, figs. 24—26; Upper Cretaceous, U. S. Gulf Coast.
1951 *Dentalina megalopolitana.* BANDY, Journ. Pal., vol. 25,no. 4, p.500, pl. 73, figs. 7a—c; Upper Cretaceous, southern California.
1960 *Dentalina* cf. *D. megalopolitana.* TRUJILLO, Journ. Pal. vol. 34, no. 2, p. 327, pl. 47, figs. 5 a—b; Upper Cretaceous, northern California.

Description: Test elongate, slightly arcuate, gently tapering toward initial end, circular in cross section; chambers about 9 or 10, gradually increasing in height as added; wall finely perforate, smooth; sutures distinct, flush, limbate, normal to long axis of test; aperture terminal, radiate, at inner edge of last chamber. Length, 1.15 *mm.*; diameter, 0.16 *mm.*

Hypotype: SU no. 9382, Locality no. MG 346.

Genus *LINGULINA* d'ORBIGNY, 1826

Lingulina californiensis TRUJILLO

Plate 5, figs. 1 a—c

1960 *Lingulina californiensis* TRUJILLO, Journ. Pal., vol. 34, no. 2, p. 314, pl. 45, figs. 8 a, b; Upper Cretaceous, northern California.

Description: Test small, compressed, ovate in side view, elliptical in edge view, twice as long broad; edge acute with small projecting keel at base of each chamber; chambers about 6 to 7 in number, inflated, closely appressed and overlapping, gradually increasing in height as added; wall calcareous, smooth, finely perforate; sutures distinct, depressed, curved in central portion with tendency to straighten out laterally; aperture terminal, central, slitlike. Length, 0.45 *mm.*; breadth, 0.23 *mm.*; thickness, 0.10 *mm.*

Remarks: This species occurs in few numbers but its characters appear to be constant. Its larger size, overlapping and arched chambers, and greater relative width serve to distinguish it from *Lingulina tayloriana* CUSHMAN.

Hypotype: SU no. 9383, Locality no. MG 550.

Genus *LAGENA* WALKER and BOYS, 1784

Lagena acuticosta REUSS

Plate 5, figs. 2 a, b

1862 *Lagena acuticosta* REUSS, Akad. Wiss. Wien, Math.-Naturw. Cl., Sitzber., Wien, vol. 44, p. 305, pl. 1, fig. 4; Maastrichtian, Holland.

1946 *Lagena acuticosta*. CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 94, pl. 39, figs. 14, 15; Upper Cretaceous, U. S. Gulf Coast.

Description: Test small, unilocular, globular, greatest width at center; base broadly rounded, apertural end with small attenuated neck; wall calcareous, finely perforate, with 14 or 15 well-developed costae extending from base to near apertural neck; aperture terminal, simple, round. Length, 0.20 *mm.*; diameter, 0.18 *mm.*

Hypotype: SU no. 9384, Locality no. MG 581.

Lagena acuticosta REUSS subsp. *brevipostica* BANDY

Plate 5, figs. 3 a, b

1951 *Lagena acuticosta* REUSS var. *brevipostica* BANDY, Journ. Pal., vol. 25, no. 4, p. 502, pl. 73, figs. 19 a, b; Upper Cretaceous, southern California.

Description: Test small, unilocular, ovate in side view, circular in cross section; base broadly rounded, apertural end with short tubular neck; wall calcareous, finely perforate, with 7 to 9 costae extending from near apertural end to base; aperture terminal, simple, round. Length, 0.22 *mm.*; diameter, 0.14 *mm.*

Hypotype: SU no. 9385, Locality no. MG 200.

Lagena acuticosta Reuss subsp. *proboscidialis* Bandy

Plate 5, figs. 4 a, b

1951 *Lagena acuticosta* Reuss var. *proboscidialis* Bandy, Journ. Pal., vol. 25, no. 4, p. 503, pl. 73, figs. 16 a, b; Upper Cretaceous, southern California.

Description: Test small, unilocular, ovate in side view, circular in cross section; base broadly rounded; apertural end with short tubular neck; wall calcareous, finely perforate, with 17 to 19 costae extending from near apertural neck to base; aperture at end of short neck, simple, round. Length, 0.30 *mm.*; diameter, 0.19 *mm.*

Hypotype: SU no. 9386, Locality no. MG 200.

Lagena amorpha Reuss subsp. *paucicosta* Franke

Plate 5, figs. 5 a, b

1928 *Lagena amorpha* Reuss var. *paucicosta* Franke, Preuss. geol. Landesanstalt Abh., n. ser., vol. 111, p. 87, pl. 7, fig. 38; Upper Cretaceous, Germany.
1929 *Lagena* sp. Cushman and Church, California Acad. Sci. Proc., 4th ser., vol. 18, p. 512, pl. 39, fig. 11; Upper Cretaceous, central California.
1946 *Lagena amorpha* Reuss var. *paucicosta*. Cushman, U. S. Geol. Survey Prof. Paper 206, p. 94, pl. 40, figs. 4, 5; Upper Cretaceous, U. S. Gulf Coast.

Description: Test small, unilocular, pyriform, circular in cross section; base broadly rounded, apertural end with short tubular neck; wall calcareous, finely perforate, with 7 or 8 costae extending from neck to base; aperture at end of short neck, simple, round. Length, 0.32 *mm.*; diameter, 0.16 *mm.*

Hypotype: SU no. 9387, Locality no. MG 544.

Lagena apiculata Reuss

Plate 5, figs. 6 a, b

1850 *Oolina apiculata* Reuss, Haidinger's Naturwiss. Abh., vol. 4, pt. 1, p. 22, pl. 1 fig. 1; Upper Cretaceous, Europe.
1862 *Lagena apiculata*. Reuss, Akad. Wiss. Wien, Math.-Naturw., Cl. Sitzber., vol. 46, p. 318, pl. 1, figs. 4—8, 10, 11; Upper Cretaceous, Germany.
1954 *Lagena apiculata*. Frizzell, Univ. Texas Rept. Investigations no. 22, p. 102, pl. 14, figs. 5, 6; Lower and Upper Cretaceous, Texas.

Description: Test pyriform, unilocular, round in cross section; wall calcareous, finely perforate, smooth, with basal spine; aperture simple, round, at end of small neck. Length, 0.33 *mm.*; diameter, 0.23 *mm.*

Hypotype: SU no. 9388, Locality no. MG 581.

Lagena hispida Reuss

Plate 5, figs. 7 a, b

1858 *Lagena hispida* Reuss, Deutsche geol. Gesell., Zeitschr., vol. 10, p. 434; Oligocene, Germany.
1863 *Lagena hispida.* Reuss, Akad. Wiss. Wien, Kl. Sitzber., vol. 46, p. 335, pl. 6, figs. 77—79; Upper Cretaceous, Germany.
1931 *Lagena hispida.* Plummer, Univ. Texas Bull. no. 3101, p. 159, pl. 10, fig. 12; Upper Cretaceous, Texas.

Description: Test globular, unilocular, delicately spinose throughout globular portion of test; aperture simple, round, at end of moderately long tube. Length, 0.65 *mm.*; diameter, 0.40 *mm.*

Hypotype: SU no. 9389, Locality no. MG 574.

Oolina (?) *simplex* Reuss

Plate 5, figs. 8 a, b

1850 *Oolina simplex* Reuss, Haidinger's Naturwiss. Abh., vol. 4, pt. 1, p. 22, pl. 2, figs. a, b; Upper Cretaceous, Europe.
1928 *Oolina simplex.* White, Journ. Pal., vol. 2, no. 3, p. 210, pl. 29, fig. 8; Upper Cretaceous, Mexico.

Description: Test unilocular, broadly ovate in side view, circular in cross section; wall calcareous, smooth, finely perforate; aperture terminal, radiate. Length, 0.55 *mm.*; diameter, 0.45 *mm.*

Remarks: This form appears to identical to that figured by Reuss, Its identification on a generic level is questioned, as more material is required before making a definite decision.

Hypotype: SU no. 9390, Locality no. MG 574.

Genus *FISSURINA* Reuss, 1850

Fissurina orbignyana Seguenza

Plate 5, figs. 9 a, b

1862 *Fissurina orbignyana* Seguenza, Foram. Monotal. miocene Messina, p. 66, pl. 2, figs. 25, 26.
1931 *Lagena orbignyana.* Cushman, Tenn. Div. Geol. Bull. 41, p. 39, pl. 6, figs. 2 a, b (not 1 a, b); Upper Cretaceous, Tennessee.

Description: Test unilocular, oval to almost round in side view, elliptical in end view, greatest width about the middle; wall calcareous, finely perforate, with pronounced lateral keel extending around entire test and coalescing at apertural end, additional keel on each side of the median keep forming a definite raised border; aperture fissurine, parallel with median keel. Length, 0.55 *mm.*; width, 0.42 *mm.*; thickness, 0.27 *mm.*

Hypotype: SU no. 9391, Locality no. MG 574.

Genus *MARGINULINA* d'Orbigny, 1826

Marginulina bullata Reuss

Plate 5, figs. 10 a, b

1845 *Marginulina bullata* Reuss, Verstein. Böhm. Kreide, pt. 1, p. 29, pl. 13, figs. 34—38; Upper Cretaceous, Bohemia.

1936 *Marginulina bullata.* BROTZEN, Sveriges geol. undersokning, Ser. C, no. 396, Ars. 30, p. 62, pl. 4, figs. 1 a—c; text fig. 19; Lower Senonian, Sweden.
1946 *Marginulina bullata.* CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 62, pl. 21, figs. 32—37; Upper Cretaceous, U. S. Gulf Coast.
1951 *Marginulina bullata.* BANDY, Journ. Pal., vol. 25, no. 4, p. 498, pl. 72, figs. 13 a, b; Upper Cretaceous, southern California.

Description: Test elongate, coiled in early stage, later stage uncoiled, circular in cross section; 5 or 6 chambers, slightly inflated in early portion, more so at apertural end; wall calcareous, finely perforate, smooth; sutures distinct, flush in early stage, later depressed, nearly transverse to oblique; radiate aperture terminal, at outer margin of last chamber. Length, 0.65 *mm.*; diameter, 0.30 *mm.*

Hypotype: SU no. 9392, Locality no. MG 581.

Marginulina campbelli MARTIN, n. sp.

Plate 5, figs. 11 a—b

1935 *Marginulina* cf. *M. bronni.* CUSHMAN and CAMPBELL (not ROEMER), Contr. Cushman Lab. Foram. Res., vol. 11, pt. 3, p. 67, pl. 10, figs. 6 a, b; Upper Cretaceous, central California.

Description: Test elongate, initial portion planispiral, later gently curved to straight, broadly oval in cross section, keeled in initial stage; chambers 8 to 9, closely appressed, increasing gradually in height as added; wall calcareous, finely perforate; sutures curved and tangential in early stanges, oblique in later portion of test, flush; aperture radiate, at outer margin of last chamber. Length, 0.56 *mm.*; width, 0.30 *mm.*; thickness, 0.16 *mm.*

Remarks: This form, of which several specimens were found in Laguna Seca Creek, is identical to that figured by CUSHMAN and CAMPBELL as *Marginulina bronni* (ROEMER). The California species differs in being more compressed in the initial stage, as well as in the later portion, in having less inflated chambers, and in being less curved in side view. It is named in honor of Prof. A. S. CAMPBELL in recognition of his contribution to the micropaleontology of California.

Holotype: SU no. 9393, Locality no. LS 612.

Marginulina curvisepta CUSHMAN and GOUDKOFF

Plate 5, figs. 12 a—c

1944 *Marginulina curvisepta* CUSHMAN and GOUDKEFF, Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 57, pl. 19, figs. 12, 13 a, b; Upper Cretaceous, central California.

Description: Test elongate, curved, planispiral in initial stage, adult portion nearly straight, compressed in early portion, almost circular in cross section in later chambers; early chambers indistinct, closely appressed, later ones distinct, loosely appressed; wall calcareous, finely perforate, with well-developed longitudinal costae that are curved in early portion of test; sutures distinct and depressed in later portion of test, early ones indistinct; aperture terminal, radiate, slightly projecting, at outer margin of last chamber. Length, 0.75 *mm.*; diameter, 0.33 *mm.*

Remarks: Only 3 specimens were found in material from Moreno Gulch. These resemble the one figured by CUSHMAN and GOUDKOFF (1944, pl. 19, fig. 12). The latter, however, like the Moreno Gulch specimens, appears to be an immature representative of the species.

Hypotype: SU no. 9394, Locality no. MG 346.

Genus *ASTACOLUS* MONFORT, 1808

Astacolus jarvisi (CUSHMAN)

Plate 5, figs. 13 a, b

1926 *Cristellaria grata*. CUSHMAN (not REUSS), Bull., Amer. Assoc. Petrol. Geol., vol. 10, no. 6, p. 598, pl. 19, figs. 1 a, b; Upper Cretaceous, Mexico.

1938 *Marginulina jarvisi* CUSHMAN, Contr. Cushman, Lab. Foram. Res., vol. 14, pt. 2, p. 35, pl. 15, figs. 17, 18; Upper Cretaceous, Trinidad, B. W. I.

1946 *Marginulina jarvisi*. CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 63, pl. 22, figs. 18—20; Upper Cretaceous, Texas, Mexico, Trinidad, B. W. I.

1960 *Astacolus jarvisi*. TRUJILLO (not BROTZEN), Journ. Pal., vol. 34, no. 2, p. 317, pl. 46, figs. 2 a, b; Upper Cretaceous, northern California.

Description: Test elongate, slightly compressed, broadly oval in cross section, early portion of test coiled, later uncoiled and nearly straight; periphery rounded; chambers about 8 or 9, first 4 or 5 coiled, appressed, increasing gradually in height along outer margin as added; wall calcareous, smooth, finely perforate; sutures distinct, slightly limbata, flush, gently curved; aperture terminal, radiate, at outer margin of last chamber. Length, 0.93 *mm.*; breadth, 0.42 *mm.*; thickness, 0.30 *mm.*

Hypotype: SU no. 9395, Locality no. MG 463.

Genus *LENTICULINA* LAMARCK, 1804

Lenticulina almgreni MARTIN, n. sp.

Plate 6, figs. 1 a, b

Description: Test lenticular, planispiral, involute, biumbonate, subcircular in outline; periphery smooth, edge sharply acute, with narrow keel; last-formed whorl with 7 chambers, increasing gradually in size as added; wall calcareous, smooth, finely perforate; sutures distinct, flush, limbate, slightly curved and tangential; aperture radiate, at outer margin of last chamber. Diameter, 0.41 *mm.*; thickness, 0.20 *mm.*

Remarks: Numerous specimens were noted in the Laguna Seca Creek section, but none was observed in the Moreno Gulch section. This species is characterized by its relatively large umbo and small triangular apertural face. It is named in honor of A. A. ALMGREN, micropaleontologist for the Superior Oil Company.

Holotype: SU no. 9396, Locality no. LS 609.

Lenticulina nuda (REUSS)

Plate 6, figs. 2 a, b

1861 *Cristellaria nuda* REUSS, Akad. Wiss. Wien, Math.-Naturw. Cl., Sitzungsber. vol. 44, pt. 1, p. 328, pl. 6, figs. 1—3; Upper Cretaceous, Germany.

1928 *Lenticulina nuda*. CUSHMAN and JARVIS, Contr. Cushman, Lab. Foram. Res., vol. 4, pt. 4, p. 96, pl. 14, fig. 2; Upper Cretaceous, Trinidad, B. W. I.

Description: Test lenticular, planispiral, involute; periphery smooth, edge subacute but not carinate; chambers, about 7 to 8 appressed, embracing umbilical area; wall calcareous, smooth, finely perforate; sutures flush, curved; aperture radiate, at outer edge of last chamber. Length, 0.93 *mm.*; width, 0.65 *mm.*; thickness, 0.40 *mm.*

Remarks: REUSS' original figures show that considerable variation is characteristic of this species. The few specimens found in Moreno Gulch agree rather well with REUSS' figure 2.

Hypotype: SU no. 9397, Locality no. MG 581.

Lenticulina praeconvergens MARTIN, n. sp.

Plate 6, figs. 3 a, b

1936 *Robulus convergens*. JENNINGS (not BORNEMANN), Bull., Amer. Pal., vol. 23, no. 78, p. 16, pl. 1, fig. 16; Upper Cretaceous, New Jersey.

Description: Test lenticular, planispiral, involute, biumbonate; periphery smooth, edge acute or with narrow keel; 8 chambers, increasing gradually in size as added, the spetal face of the final one forming a convex surface; wall calcareous, smooth, finely perforate; sutures gently curved, slightly tangential, flush; aperture radiate, at outer edge of last chamber. Length, 0.55 *mm.*; breadth, 0.45 *mm.*; thickness, 0.21 *mm.*

Remarks: Although exhibiting features similar to *Cristellaria convergens* BORNEMANN from the Oligocene of Germany our form has a consistently greater number of chambers per whorl and a more beak-like last chamber. JENNINGS (1936) records a form from the Mt. Laurel Upper Cretaceous beds of New Jersey that appears to be identical with the Moreno Gulch Species.

Holotype: SU no. 9398, Locality no. MG 734.

Lenticulina rectovalis MARTIN, n. sp.

Plate 6, figs. 4 a, b

Description: Test planispiral, broadly lenticular; periphery smooth, edge rounded; chambers 5 to 6, initial one globular, forming broadly rounded base, septal face of last-formed chamber smoothly concave; wall calcareous, smooth, finely perforate; sutures flush, tangential, straight; aperture radiate, located at outer margin of last chamber. Length, 0.75 *mm.*; width, 0.55 *mm.*; thickness, 0.35 *mm.*

Remarks: This relatively rare form closely resembles *Cristellaria ovalis* REUSS. However, it may be distinguished by its straight and tangential sutures and by the absence of a keel.

Holotype: SU no. 9399, Locality no. MG 603.

Lenticulina rotulata (LAMARCK)

Plate 6, figs. 5 a, b

1804 *Lenticulites rotulata* LAMARCK, Ann. Mus. Paris, vol. 5, p. 188; vol. 8, pl. 62, fig. 11; Upper Cretaceous, France.
1927 *Lenticulina rotulata* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 3, p. 142, pl. 28, figs. 7 a, b; Upper Cretaceous, France.
1946 *Lenticulina rotulata.* CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 56, pl. 19, fig. 7 (not 1—6); Upper Cretaceous, Texas.

Description: Test lenticular, planispiral, closely-coiled, biumbonate; periphery smooth, edge keeled; 8 chambers in last-formed whorl, increasing gradually in size as added; wall calcareous, smooth, finely perforate; sutures flush, limbate, curved, radial to slightly tangential; aperture radiate, on outer margin of last septal face, apertural face triangular, with thickened sides. Length, 0.87 *mm.*; breadth, 0.75 *mm.*; thickness, 0.40 *mm.*

Hypotype: SU no. 9400, Locality no. MG 727.

Lenticulina schencki MARTIN, n. sp.

Plate 6, figs. 6 a, b

Description: Test lenticular, planispiral, almost circular in outline, involute, biumbonate with large umbo of clear shell material, thickest across the umbo; periphery denticulate due to broken keel, edge with narrow keel; 11 or 12 chambers, curved, increasing gradually in size as added; wall calcareous, smooth, finely perforate; sutures distinct, limbate, curved; aperture radiate, at peripheral margin of last chamber, apertural face convex. Diameter, 0.60 *mm.*; thickness, 0.32 *mm.*

Remarks: This form differs from *Lenticulina velascoensis* WHITE in having more chambers per whorl, in being relatively thicker, and in the convex apertural face. It may be distinguished from *Lenticulina* sp. A., by having chambers of shorter height, greater curved sutures, and a greater number of chambers per whorl. This species is named in honor of the late Dr. H. G. SCHENCK in recognition of his work in the field of micropaleontology.

Holotype: SU no. 9401, Locality no. MG 727.

Lenticulina velascoensis WHITE

Plate 6, figs. 7 a, b

1928 *Lenticulina velascoensis* WHITE, Journ. Pal., vol. 2, no. 3, p. 199, pl. 28, fig. 8; Paleocene, Upper Cretaceous, Mexico.

Description: Test lenticular, planispiral, subcircular in outline, involute, with depressed umbo of clear material through which earlier whorls can be seen; periphery irregular due to broken keel, edge carinate; 8 or 10 chambers in last whorl, increasing gradually in size as added; wall calcareous, finely perforate; sutures distinct, flush, slightly curved; aperture radiate, at outer margin of last chamber. Diameter, 0.56 *mm.*; thickness, 0.20 *mm.*

Hypotype: SU no. 9402, Locality no. MG 574.

Lenticulina sp. A.

Plate 6, figs. 8 a, b

Description: Test lenticular, planispiral, subcircular in outline, biumbonate; periphery smooth, edge acute; chambers, about 8 to 9, curved, increasing gradually in size as added; wall calcareous, smooth, finely perforate; sutures distinct, flush, curved, tangential, fusing into umbo; apertural face slightly depressed with 2 marginal ridges; aperture radiate, on outer peripheral margin. Diameter, 0.60 *mm.*; thickness, 0.27 *mm.*

Remarks: Only two specimens were found in Moreno Gulch samples. More material is required prior to making a specific determination.

Depository: SU no. 9403, Locality no. MG 727.

Lenticulina sp. B.

Plate 6, figs. 9 a, b

Description: Test lenticular, planispiral, subcircular in outline, biumbonate; periphery smooth, edge subacute; chambers few, 5 to 6 in last whorl, broadly triangular; wall calcareous, smooth, finely perforate; sutures distinct, limbate, flush, tangential, fusing into umbo of clear shell material; apertural face slightly depressed, with marginal ridges; aperture radiate, at outer margin of last chamber. Diameter, 0.60 *mm.*; thickness, 0.30 *mm.*

Remarks: This form has a very rare occurrence in Moreno Gulch. More specimens are needed to be examined before assigning a specific name.

Depository: SU no. 9404, Locality no. MG 576.

Genus *ROBULUS* MONFORT, 1808

Robulus lepidulus (REUSS)

Plate 6, figs. 10 a, b

1874 *Cristellaria lepidula* REUSS, Paleontographica, vol. 20, pt. 2, p. 106, pl. 23, figs. 4 a, b; Turonian, Germany.

1936 *Robulus lepidulus*. BROTZEN, Sveriges geol. undersokning, Ser. C, no. 396, Ars. 30, p. 48, pl. 2, figs. 2 a, b; Lower Senonian, Sweden.

Description: Test lenticular, planispiral, biumbonate; periphery smooth, edge sharply acute in early portion of test, with tendency to become acute in later portion; chambers numerous, about 10 to 11 in last-formed whorl, increasing gradually in size as added, those of later stages embracing umbilical area and with tendency to become evolute; wall calcareous, smooth, finely perforate; sutures distinct, flush, gently curved; aperture radiate with elongate median slit, at outer edge of last chamber. Length, 0.98 *mm.*; width, 0.80 *mm.*; thickness, 0.42 *mm.*

Remarks: The few specimens from Moreno Gulch agree with the original figure of REUSS as well as with that of BROTZEN.

Hypotype: SU no. 9405, Locality no. MG 928.

Robulus modestus BANDY

Plate 6, figs. 11 a, b

1951 *Robulus modestus* BANDY, Journ. Pal., vol. 25, no. 4, p. 493, pl. 72, figs. 9 a, b; Upper Cretaceous, southern California.
1960 *Lenticulina modesta*. TRUJILLO, Journ. Pal., vol. 34, no. 2, p. 313, pl. 45, figs. 3 a, b; Upper Cretaceous, northern California.

Description: Test lenticular, planispiral, biumbonate, closely coiled; periphery smooth, edge acute, chambers about 7 to 9 in last whorl, increasing gradually in size as added; wall calcareous, smooth, finely perforate; sutures slightly curved, flush, tangential; aperture radiate with narrow slit, at outer margin of last chamber. Diameter, 0.65 *mm.*; thickness, 0.24 *mm.*

Remarks: Comparison of Moreno Gulch specimens with those of BANDY proves these forms to be conspecific.

Hypotype: SU no. 9406, Locality no. MG 544.

Robulus pseudoligostegius MARTIN, n. sp.

Plate 6, figs. 12 a—c

1946 *Robulus oligostegius*. CUSHMAN (not REUSS), U. S. Geol. Survey Prof. Paper 206, p. 54, pl. 17, figs. 16, 17; Upper Cretaceous, Trinidad, B. W. I.

Description: Test planispiral, broadly lenticular, with tendency to uncoil; periphery smooth, edge bluntly rounded; chambers about 5 to 6, increasing rapidly in size as added, last one tending to uncoil; wall calcareous, smooth, finely perforate; sutures distinct, flush, curved; apertural face broadly oval with slight depression, aperture radiate with elongate slit, near outer margin of last chamber on a slight protuberance. Length, 0.56 *mm.*; width, 0.41 *mm.*; thickness, 0.30 *mm.*

Remarks: California specimens differ from *Cristellaria oligostegius* REUSS in being more evolute and elongate. CUSHMAN (1946) figures a form from the Upper Cretaceous of Trinidad that agrees with Moreno Gulch specimens rather than with REUSS' species.

Holotype: SU no. 9407, Locality no. MG 557.

Robulus sp. A.

Plate 7, figs. 1 a, b

Description: Test broadly lenticular, planispiral, biumbonate, early portion of test closely coiled, later portion to a lesser degree; periphery smooth, edge subacute; chambers about 9 to 10 in last whorl, increasing gradually in height as added; wall calcareous, smooth, finely perforate; sutures distinct, flush, gently curved, tangential at umbo; apertural face gently concave; aperture radiate with median slit, at outer peripheral margin. Length, 0.90 *mm.*; breadth, 0.63 *mm.*; thickness, 0.30 *mm.*

Remarks: Specimens from Moreno Gulch show some affinities with *Robulus discrepans* CUSHMAN and JARVIS (not REUSS) described from Trinidad, B. W. I. This form differs from *Robulina discrepans* REUSS in having a slightly concave apertural face and the last few chambers which are not inflated. Unfortunately since it has a very rare occurrence in Moreno Gulch, additional specimens are necessary to properly define its specific characteristics.

Depository: SU no. 9408, Locality no. MG 692.

Robulus sp. B.

Plate 7, figs. 2 a, b

Description: Test large, lenticular, planispiral, biumbonate; periphery smooth, edge; chambers about 8, wall calcareous, smooth, finely perforate; sutures distinct, gently curved, slightly tangential, flush, fusing into umbonal area; aperture radiate with median slit, at outer peripheral angle of last septal face. Length, 1.10 *mm.*; breadth, 0.91 *mm.*; thickness, 0.55 *mm.*

Remarks: A number of authors have referred similar forms to *Robulus macrodiscus* (Reuss). However, that species has distinctly curved sutures, whereas most other forms referred to it are characterized by slightly curved, tangential sutures. For examples of these see Cushman (1946) and Loetterle (1937). As only very few specimens of this form were observed in Moreno Gulch samples, it is deemed best to differ judgment regarding its specific identification until more specimens are available.

Depository: SU no. 9409, Locality no. MG 610.

Genus *SARACENARIA* Defrance, 1824

Saracenaria acutauricularis (Fichtel and Moll)

Plate 7, figs. 3 a, b

7 98 *Nautilus acutauricularis* Fichtel and Moll, Test. Micr., p. 102, pl. 18, figs. g—i.
9 28 *Saracenaria acutauricularis.* White, Journ. Pal., vol. 2, no. 3, p. 200, pl. 28, fig. 10; Upper Cretaceous, Mexico.

Description: Test planispiral, initial portion coiled, later portion with tendency to uncoil, triangular in cross section; periphery smooth, edge subacute; chambers 6 to 7, tending to become evolute; septal face of last one broad and angled; wall calcareous, smooth, finely perforate; sutures distinct, flush, curved; aperture radiate, at outer margin of triangular septal face. Length, 0.61 *mm.*; breadth, 0.45 *mm.*; thickness, 0.37 *mm.*

Hypotype: SU no. 9410, Locality no. MG 727.

Saracenaria pseudonavicula Marie

Plate 7, figs. 4 a, b

1937 *Robulus navicula.* Marie (not d'Orbigny), Bull. Soc. Géol. France, ser. 5, vol. 7, p. 232; Upper Cretaceous, France.
1941 *Saracenaria pseudonavicula* Marie, Mém. Mus. Hist. Nat., n. ser., vol. 12, p. 110, pl. 12, fig. 113 a, b, 114; Campanian, Paris Basin.

Description: Test planispiral, evolute, with small coiled initial portion, tending later to uncoil, triangular in cross section; periphery smooth, edge subacute; 7 chambers, increasing in height as added; wall calcareous, smooth, finely perforate; sutures distinct, curved, flush; aperture radiate, at outer edge of last septal face. Length, 0.58 *mm.*; breadth, 0.35 *mm.*; thickness, 0.36 *mm.*

Remarks: This form agrees rather well with MARIE's species and differs from *Saracenaria triangularis* d'ORBIGNY by being less evolute in the later portion of the test and in having curved instead of sinuate sutures. It may be distinguished from *Saracenaria navicula* (d'ORBIGNY) by its greater relative width.

Hypotype: SU no. 9411, Locality no. MG 587.

Genus *PLANULARIA* DEFRANCE, 1824

Planularia mirabilis MARTIN, n. sp.

Plate 7, figs. 5 a—c

Description: Test small, compressed, sides parallel, suboval in outline view, initial end coiled, later evolute; periphery smooth, edge bluntly rounded; chambers about 11 to 12, much wider than high, increasing gradually in height as added; wall calcareous, finely perforate; sutures distinct, raised, limbate, curved; those of the initial end beaded, later ones plain and strongly curved at outer margin where they fuse into the periphery; aperture terminal, radiate. Length, 0.35 *mm.*; breadth, 0.20 *mm.*; thickness, 0.07 *mm.*

Remarks: The smooth bluntly rounded outer periphery, the greater number of chambers, and the early beaded sutures serves to distinguish this California form from *Planularia tricarinella* (REUSS).

Holotype: SU no. 9412, Locality no. MG 611.

Planularia umbonata LOETTERLE

Plate 7, figs. 6 a—c

1937 *Planularia umbonata* LOETTERLE, Nebraska Geol. Survey, Bull. 12, ser. 2, p. 23, pl. 2, figs. 2 a, b; Upper Cretaceous, Nebraska.

1960 *Astacolus umbonata*, TRUJILLO, Journ. Pal., vol. 34, no. 2, p. 318, pl. 45, figs. 13 a, b; Upper Cretaceous, northern California.

Description: Test elongate, compressed, initial end tightly coiled and umbonate, tending later to uncoil, almost parallel in edge view; periphery broadly rounded, edge with narrow keel developed in initial portion of test, in later stages rounded; chambers about 9 to 10, closely appressed, much wider than high, gradually increasing in height as added; wall calcareous, smooth, finely perforate; sutures raised, limbate, oblique in later portion, irregularly thickened at peripheral area; aperture terminal, radiate, at outer edge of last chamber. Length, 0.50 *mm.*; breadth, 0.23 *mm.*; thickness, 0.10 *mm.*

Hypotype: SU no. 9413, Locality no. MG 905.

Genus *PALMULA* LEA, 1833

Palmula primitiva CUSHMAN

Plate 7, figs. 7 a, b

1938 *Palmula simplex.* CUSHMAN (not REUSS), Contr. Cushman Lab. Foram. Res., vol. 14, pt. 2, p. 36, pl. 6, fig. 1; Upper Cretaceous, Texas.
1939 *Palmula primitiva* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 15, pt. 4, p. 91, pl. 16, figs. 4, 5; Upper Cretaceous, Texas.
1951 *Palmula primitiva.* BANDY, Journ. Pal., vol. 25, no. 4, p. 495, pl. 72, figs. 14 a, b; Upper Cretaceous, southern California.

Description: Test elongate, strongly compressed, edge subacute, initial stage planispiral, later stage uncoiled consisting of rectilinear chevron-shaped chambers; sides in later stage parallel; chambers about 9 in number, gradually increasing in height; wall calcareous, smooth, finely perforate; sutures distinct, slightly limbate, with tendency to develop delicate longitudinal striae; aperture terminal, radiate, at end of slight protuberance. Length, 0.77 *mm.*; breadth, 0.22 *mm.*; thickness, 0.09 *mm.*

Hypotype: SU no. 9414, Locality no. MG 581.

Genus *NEOFLABELLINA* BARSTEIN, 1948

Neoflabellina pilulifera (CUSHMAN and CAMPBELL)

Plate 7, figs. 8 a—c

1935 *Flabellina pilulifera* CUSHMAN and CAMPBELL, Contr. Cushman Lab. Foram. Res., vol. 11, pt. 3, p. 67, pl. 10, figs. 6 a, b; Upper Cretaceous, central California.

Description: Test compressed, initial stage planispiral, with thick mass giving test greatest thick at this point, oval-shaped in outline view; periphery smooth, edge bluntly truncated; chambers numerous, early ones exhibiting distinct coiling, later ones forming inverted V-shaped chambers; wall calcareous, finely perforate; sutures distinct, forming thin raised carina, beaded in early stage, smooth in later portion of test; aperture terminal, central, round, slightly produced. Length, 0.75 *mm.*; breadth, 0.50 *mm.*; thickness, 0.10 *mm.*

Hypotype: SU no. 9415, Locality no. LS 609.

Neoflabellina rugosa (d'ORBIGNY)

Plate 7, figs. 9 a, b

1840 *Flabellina rugosa* d'ORBIGNY, Soc. géol. France Mém., 1st. ser., vol. 4, p. 23, pl. 2, figs. 4, 5, 7; Upper Cretaceous, Paris Basin.
1963 *Flabellina rugosa.* BROTZEN, Sveriges geol. undersokning Ser. C, no. 396, Anb. 30, p. 107, text-figure 35 a, b; Lower Senonian, Sweden.
1946 *Palmula rugosa.* CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 83, pl. 31, figs. 9—17; Upper Cretaceous, U. S. Gulf Coast.

Description: Test compressed, rhomboid to elliptical in outline, early portion planispiral, later part of test consisting of rectilinear chevron-shaped chambers; periphery smooth, edge flat, truncated; chambers about 10 to 12, narrow and uniformly broad; wall calcareous, finely perforate, papillae in area between sutures; sutures strongly raised, acute; aperture terminal, round. Length, 0.55 *mm.*; breadth, 0.35 *mm.*; thickness, 0.10 *mm.*

Hypotype: SU no. 9416, Locality no. MG 727.

Genus *FRONDICULARIA* Defrance, 1826

Frondicularia archiaciana d'Orbigny

Plate 7, figs. 10 a—c

1840 *Frondicularia archiaciana* d'Orbigny, Soc. géol. France Mém., 1st ser., vol. 4, p. 20, pl. 1, figs. 34—36; Upper Cretaceous, Paris Basin.
1946 *Frondicularia archiaciana*. Cushman, U. S. Geol. Survey Prof. Paper 206, p. 91, pl. 37, figs. 8—20; Upper Cretaceous, U. S. Gulf Coast.
1951 *Frondicularia archiaciana*. Bandy, Journ. Pal., vol. 25, no. 4, p. 496, pl. 72, figs. 7 a, b; Upper Cretaceous, southern California.

Description: Test elongate, gently tapering, sides flattened, compressed, greatest width towards apertural end; periphery lobulate, edge flat; chambers varying from about 2 to 8, increasing in height as added, forming rectilinear V-shaped series; wall calcareous, finely perforate, with 2 or 3 costae and small apical spine; sutures distinct, raised, limbate; aperture terminal, round. Length, 1.75 *mm.*; breadth, 0.41 *mm.*; thickness, 0.14 *mm.*

Hypotype: SU no. 9417, Locality no. MG 727.

Genus *KYPHOPYXA* Cushman, 1929

Kyphopyxa christneri (Carsey)

Plate 7, figs. 12 a, b

1926 *Frondicularia christneri* Carsey, Univ. Texas Bull. no. 2612, p. 41, pl. 6, fig. 7; Upper Cretaceous, Texas.
1929 *Kyphopyxa christneri*. Cushman, Contr. Cushman Lab. Foram. Res., vol. 5, pt. 1, p. 1, pl. 1, figs. 1—7; Upper Cretaceous, Texas.
1960 *Kyphopyxa christneri*. Trujillo, Journ. Pal., vol. 34, no. 2, p. 323, pl. 46, figs. 9 a, b; Upper Cretaceous, northern California.

Description: Test compressed, leek-shaped in outline, apertural end produced, widest and thickest toward initial end; periphery smooth, edge truncated; chambers distinct, initially planispiral, later biserial, adult ones reported to be frondicularian in type, but not observed in Moreno Gulch material; wall calcareous, finely perforate; sutures distinct, limbate, in early stage strongly raised, later ones reduced; aperture terminal, radiate. Length, 0.60 *mm.*; breadth, 0.36 *mm.*; thickness, 0.12 *mm.*

Remarks: Very few specimens of this form were obtained from Moreno Gulch samples. Comparison of the California form with those of the Taylor marl of Texas indicates that the two are identical.

Hypotype: SU no. 9418, Locality no. MG 692.

Family POLYMORPHINIDAE d'Orbigny

Genus *GLOBULINA* d'Orbigny

Globulina lacrima Reuss subsp. *subsphaerica* (Berthelein)

Plate 7, figs. 13 a—c; Plate 8, figs. 1 a—e

1880 *Polymorphina subsphaerica* Berthelein, Soc. géol. France Mém., ser. 3, vol. 1, p. 58, pl. 4, figs. 18 a, b.
1930 *Globulina lacrima* Reuss var. *subsphaerica* (Berthelein). Cushman and Ozawa, U. S. Nat. Mus. Proc., vol. 77, art. 6, p. 78, pl. 19, figs. 5—7.
1944 *Globulina lacrima* var. *subsphaerica*. Cushman and Goudkoff, Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 57, pl. 9, fig. 14; Upper Cretaceous, central California.

Description: Test subglobular, slightly compressed, oval in cross section; chambers few, extending almost to the base, quinqueloculine but apearing triserial owing to overlapping; wall calcareous, smooth, finely perforate; sutures indistinct, observed only when test is wet, slightly depressed near the basal part of test, flush in later portion; aperture terminal, radiate or an elongate slit. Length of specimen on plate 8, 0.44 *mm.*; breadth, 0.35 *mm.*; thickness, 0.25 *mm.*

Hypotype: SU no. 9419, Locality no. LS 609.

Genus *APIOPTERINA* ZBOREWSKI, 1834

Apiopterina cylindroides (ROEMER)

Plate 7, figs. 11 a, b

1838 *Polymorphina cylindroides* ROEMER, Neuss Jahrb., p. 385, pl. 3, fig. 26.
1930 *Pyrulina cylindroides.* CUSHMAN and OZAWA, U. S. Nat. Mus. Proc., vol. 77, art. 6, p. 56, pl. 14, figs. 1—5.
1946 *Pyrulina cylindroides.* CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 97, pl. 40, figs. 18, 19; Upper Cretaceous, U. S. Gulf Coast.

Description: Test elongate, fusiform, subcircular in cross section, almost 3 times as long as broad, subacute at both ends; chambers triserial in early stage, becoming biserial in later portion of test, elongate, gently embracing; wall calcareous, smooth, finely perforate; sutures distinct only when test is wet, flush; aperture terminal, radiate. Length, 0.50 *mm.*; breadth, 0.18 *mm.*; thickness, 0.15 *mm.*

Hypotype: SU no. 9420, Locality no. MG 576.

Family PLEUROSTOMELLIDAE REUSS, 1860

Genus *PLEUROSTOMELLA* REUSS, 1860

Pleurostomella greatvalleyensis TRUJILLO

Plate 8, figs. 2 a—c

1960 *Pleurostomella greatvalleyensis* TRUJILLO, Journ. Pal., vol. 34, no. 2, p. 345, pl. 50, figs. 5 a—c, 6 a—b; Upper Cretaceous, northern California.

Description: Test elongate, tapering toward initial end, later portion with nearly parallel sides, greatest width along last few chambers, circular in cross section; chambers relatively few, slightly inflated, early triserial ones becoming biserial, later ones uniserial, last-formed one with tendency to become elongate; wall calcareous, smooth, finely perforate; sutures distinct, early ones flush, later ones depressed, oblique; aperture subterminal, in hooded depression, crescentic with median slit. Length, 0.60 *mm.*; diameter, 0.14 *mm.*

Hypotype: SU no. 9421, Locality no. MG 603.

Pleurostomella sp.

Plate 8, figs. 3 a—d

Description: Test elongate, cylindrical, triserial in early stage, later biserial, gently tapering towards rounded initial end; chambers about 7, slightly inflated; wall calcareous, smooth, finely perforate; sutures distinct, set at angles of 45 degrees to long axis of test, gently depressed; aperture and arched opening with median slit situated in depression in last chamber. Length, 0.70 *mm.*; diameter, 0.20 *mm.*

Remarks: Unfortunately only one complete specimen of this species was obtained. The arrangement of the last chamber is similar to that of *Pleurostomella barroisi* BERTHELEIN from the Albian of France. The early chamber arrangement of the California form, however, is not uniserial as is that of *P. barroisi*. Until more material can be studied a specific assignment must be deferred.

Depository: SU no. 9422, Locality no. MG 928.

Genus *NODOSARELLA* RZEHAK, 1895

Nodosarella gracillima CUSHMAN

Plate 8, figs. 6 a—c

1933 *Nodosarella gracillima* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 9, pt. 3, p. 64, pl. 7, figs. 14 a, b; Upper Cretaceous, U. S. Gulf Coast.

Description: Test elongate, uniserital slightly tapering toward initial end, circular in cross section; greatest width toward apertural end; chambers distinct, early ones slightly staggered, later regularly arranged, increasing in height as added; wall calcareous, smooth, finely perforate; sutures distinct, gently depressed, normal to long axis of test; aperture crescentic, terminal, with arched hood-like structure. Length, 0.80 *mm.*; diameter, 0.16 *mm.*

Hypotype: SU no. 9423, Locality no. MG 581.

Nodosarella texana CUSHMAN

Plate 8, figs. 7 a—c

1938 *Nodosarella texana* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, pt. 2, p. 46, pl. 8, fig. 1; Upper Cretaceous, Texas.

Description: Test elongate, slender, uniserial, gently curved, with tlight taper toward initial end, circular in cross section; chambers about 6 so 7, increasing in height as added, final one about 3 times as long as wide, gently inflated; wall calcareous, smooth, finely perforate; sutures distinct, gently depressed particularly those of last chambers; aperture subterminal, with arched hood-like structure. Length, 0.80 *mm.*; diameter, 0.12 *mm.*

Hypotype: SU no. 9424, Locality no. MG 574.

Genus *ELLIPSONODOSARIA* SILVESTRI, 1900

Ellipsonodosaria subnodosa (GUPPY)

Plate 8, figs. 5 a—c

1894 *Ellipsoidina subnodosa* GUPPY, Zool. Soc. London Proc., p. 650, pl. 41, fig. 12.
1928 *Ellipsonodosaria subnodosa*. CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 4, pt. 4, p. 102, pl. 14, figs. 15, 16; Upper Cretaceous, Trinidad, B. W. I.

Description: Test elongate, uniserial, tapering toward initial end, greatest width toward apertural end, round in cross section; chambers 5 to 6, increasing fairly rapidly in height and width as added; wall calcareous, smooth, finely perforate; sutures distinct, depressed, normal to long axis of test; apertue a low narrow crescentic slit, terminal. Length, 0.82 *mm*. diameter, 0.28 *mm*.

Hypotype: SU no. 9425, Locality no. MG 587.

Genus *ELLIPSOGLANDULINA* Silvestri, 1900

Ellipsoglandulina velascoensis Cushman

Plate 8, figs. 4 a—c

1926 *Ellipsoglandulina velascoensis* Cushman, Bull., Amer. Assoc. Petrol. Geol., vol. 10, no. 6, p. 590, pl. 16, figs. 7 a, b; Upper Cretaceous, Mexico.

Description: Test small, broadly fusiform, greatest width about the middle, nearly twice as long as broad, circular in cross section, initial and apertural end bluntly rounded; only 3 chambers observed, greatly embracing; wall calcareous, smooth, finely perforate; sutures indistinct, visible only when wetted, slightly depressed; aperture a low narrow curved slit subterminally placed in last chamber. Length, 0.45 *mm*.; diameter, 0.34 *mm*.

Hypotype: SU no. 9426, Locality no. MG 576.

Family CHILOSTOMELLIDAE Brady, 1884

Genus *PULLENIA* Parker and Jones, 1862

Pullenia jarvisi Cushman

Plate 8, figs. 8 a, b

1932 *Pullenia quinqueloba*. Cushman and Jarvis (not Reuss), U. S. Nat. Mus. Proc., vol. 80, art. 14, p. 49, pl. 15, fig. 4; Upper Cretaceous, Trinidad, B. W. I.
1936 *Pullenia jarvisi* Cushman, Contr. Cushman Lab. Foram. Res., vol. 12, pt. 4, p. 77, pl. 13, fig. 6; Upper Cretaceous, Trinidad, B. W. I.

Description: Test planispiral, involute, compressed, biumbilicate, subcircular in outline; periphery lobulate, edge broadly rounded; chambers about 5 to 6, inflated, increasing fairly rapidly in size as added; wall calcareous, smoothly polished, finely perforate; sutures distinct, depressed, gently curved; aperture a long slit at base of last septal face, extending from one umbilical area to the other. Length, 0.35 *mm*.; breadth, 0.30 *mm*.; thickness, 0.20 *mm*.

Hypotype: SU no. 9427, Locality no. MG 727.

Family GLOBIGERINIDAE Carpenter, Parker, and Jones, 1862

Genus *GLOBIGERINA* d'Orbigny, 1826

Globigerina sp.

Plate 8, figs. 9 a, b

Description: Test with low trochoid spire, subcircular in outline, periphery lobulate; chambers 5 or 6 in final whorl, globular, increasing rapidly in size as added; wall coarsely perforate, finely hispid; sutures depressed, radial; aperture an arched opening facing large umbilical area, with distinct lip. Diameter, 0.30 *mm.*; thickness, 0.15 *mm.*

Remarks: This form and similar ones like it were considered to be identical to *Globigerina cretacea* d'ORBIGNY until recently. BANNER and BLOW (1960) studied the type species of *Globigerina cretacea* d'ORBIGNY and recognize it to be a species of *Globotruncana* CUSHMAN having two faintly developed carinae. Examination of the rare form obtained from Moreno Gulch samples shows that it does not have carinae. Until such time when more material is available a specific determination must be deferred.

Depository: SU no. 9428, Locality no. MG 200.

Globigerina pseudobulloides PLUMMER

Plate 9, figs. 2 a—c

1926 *Globigerina pseudobulloides* PLUMMER, Univ. Texas Bull. 2644, pp. 133—134, pl. 8, figs. 9a—c;

1951 *Globigerina pseudobulloides.* CUSHMAN, U. S. Geol. Survey Prof. Paper 232, p. 60, pl. 17, figs. 7, 8; Paleocene, U. S. Gulf Coast.

1957 *Globorotalia pseudobulloides.* LOEBLICH and TAPPAN, U. S. Nat. Mus. 215, p. 192, pls. 40, figs. 3 a—c; 41, figs. 1 a—c; 42, figs. 3 a—c; 43, figs. 3 a—4 c; 44, figs. 4—6 c; 45, figs. 1 a—2 c; 46, figs. 6 a—c; Paleocene, U. S. Atlantic and Gulf Coasts.

1958 *Globorotalia pseudobulloides.* LOEBLICH, Bull., Amer. Assoc. Petrol. Geol., vol. 42, no. 9, p. 2261 List; Paleocene (Danian), central California.

Description: Test small, consisting of 2 to 2—½ whorls, low trochoid spire, subcircular in outline, distinct umbilical area on ventral side; chambers about 5 to a whorl, inflated, increasing rapidly in size as added, 12 to 14 on spiral side; wall calcareous, finely reticulate and perforate; sutures depressed, curved in initial stage on spiral side, later ones less curved, ventral or umbilical sutures radial and depressed; aperture extraumbilical-umbilical, interiomarginal, a rounded arch on last chamber extending from near outer margin to umbilical area, a thin flaring lip often present. Diameter, 0.25 *mm.*; thickness, 0.13 *mm.*

Hypotype: SU no. 9429, Sample no. MG 11, 11 A.

Globigerina triloculinoides PLUMMER

Plate 8, figs. 10 a—c

1926 *Globigerina triloculinoides* PLUMMER, Univ. Texas Bull. 2644, pp. 134—135, pl. 8 figs. 10 a—c; Paleocene, Texas.

1951 *Globigerina triloculinoides.* CUSHMAN, U. S. Geol. Survey Prof. Paper 232, p. 60, pl. 17, figs. 10, 11; Paleocene, U. S. Gulf Coast.

1957 *Globigerina triloculinoides.* LOEBLICH and TAPPAN, U. S. Nat. Mus. Bull. 215, p. 183, pls. 40, figs. 4 a—c; 41, figs. 2 a—c; 42, figs. 2 a—c; 43, figs. 5 a—c; 8 a—c; 45, figs. 3 a—c; 46, figs. 1 a—c; 47, figs. 2 a—c; 52, figs. 3—7; 56, figs. 8 a—c; 62, figs. 3 a—4 c; Paleocene, U. S. Atlantic and Gulf Coasts.

Description: Test with low trochoid spire consisting of about 2 whorls, spiral or dorsal side slightly convex, ventral or umbilical side with shallow umbilical area; chambers about 3—½ to last whorl, distinct, subglobular, increasing rapidly as added; wall calcareous, distinctly reticulate, finely perforate; sutures distinct, depressed; aperture interiomarginal, with a distinct lip. Diameter, 0.20 *mm.*; thickness, 0.18 *mm.*

Remarks: Specimens from Moreno Gulch agree very well with PLUMMER's original description and figure. It is also similar to all of the form described and figured by LOEBLICH and TAPPAN from various localities of the Gulf Coast.

Hypotype: SU no. 9430, Locality no. MG 11 A.

Genus *GLOBIGERINOIDES* CUSHMAN, 1927

Globigerinoides daubjergensis (BRÖNNIMANN)

Plate 9, figs. 1 a—c

1953 *Globigerina daubjergensis* BRÖNNIMANN, Eclogae Geol. Helvetiae, vol. 45, no. 2, p. 340, text-figure 1; Danian, Denmark.

1957 *Globigerinoides daubjergensis*. LOEBLICH and TAPPAN, U. S. Nat. Mus. Bull. 215, p. 184, pls. 40, figs. 1 a—c, 8 a—c; 41, figs. 9 a—c; 42, figs. 6 a—7 c; 43, figs. 1 a—c; 44, figs. 7—8 c; Danian, Denmark; U. S. Atlantic and Gulf Coasts.

1958 *Globigerinoides daubjergensis*. LOEBLICH, Bull., Amer. Assoc. Petrol. Geol., vol. 42, no. 9, p. 2261 (list); Paleocene (Danian), central California.

Description: Test small for genus, trochospiral, highspired; chambers 4 per whorl, forming small umbilical area on ventral side, increasing rapidly in size as added; wall calcareous, finely perforate, with fine spines; sutures distinct, depressed; aperture an arched opening facing umbilical area, accessory apertures small and situated along sutures on spiral side. Diameter, 0.25 *mm.*; thickness, 0.15 *mm.*

Hypotype: SU no. 9431, Locality no. MG 11 A.

Family GLOBOROTALIIDAE CUSHMAN, 1927

Genus *PRAEGLOBOTRUNCANA* BERMUDEZ, 1952

Praeglobotruncana caryi MARTIN, n. sp.

Plate 9, figs. 3 a—c

Description: Test rotaloid, gently trochoid, about 2 to 2—½ whorls seen on spiral side, only last-formed whorl observed ventrally, spiral side flattened, ventral side slightly convex, subcircular in outline; periphery lobulate, edge broadly rounded; chambers 6 to a whorl, increasing gradually in size as added, slightly compressed; wall calcareous, smooth, finely but distinctly perforate; sutures distinct, depressed, radial, slightly limbate in the last chambers; aperture interiomarginal, a small arched slit extending into the umbilical area with a valvular lip; successive lips of earlier chambers noted in umbilical area. Diameter, 0.30 *mm.*; thickness, 0.14 *mm.*

Remarks: At first glance this species appears to be similar to *Globorotalia compressa* (PLUMMER). However, the California form may be distinguished from the latter by its lower trochoid spire, and radial sutures, by consistently having 6 chambers in the last whorl, and by the presence of relict apertural lips in the umbilical area. It is named in honor of C. W. CARY, paleontologist for the Union Oil company of California.

Holotype: SU no. 9432, Locality no. MG 578.

Family GLOBOTRUNCANIDAE Brotzen, 1942

Genus *GLOBOTRUNCANA* Cushman, 1927

Globotruncana arca (Cushman)

Plate 9, figs. 4 a—c

1926 *Pulvinulina arca* Cushman, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, p. 23, pl. 3, figs. 1 a—c; Upper Cretaceous, Mexico.
1927 *Globotruncana arca*. Cushman, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 1, p. 91, pl. 19, fig. 11; Upper Cretaceous, Mexico.
1946 *Globotruncana arca*. Cushman, U. S. Geol. Survey Prof. Paper 206, p. 150, pl. 62, fig. 4 (not fig. 5); Upper Cretaceous, Texas, Mexico.
1951 *Globotruncana arca*. Bandy, Journ. Pal., vol. 25, no. 4, p. 509, pl. 75, figs. 1 a—c; Upper Cretaceous, southern California.

Description: Test rotaloid, trochospiral, biconvex, subcircular in outline, with low regular dorsal spire, ventral or umbilical side convex with deep umbilical depression; periphery lobulate, edge truncate with 2 keels; chambers about 6 to 7 in last whorl, slightly inflated, increasing gradually in size as added; wall calcareous, finely perforate; sutures on spiral side curved and oblique, limbate, raised, ventral ones strongly curved, raised and beaded; aperture interiomarginal, a high arched opening facing the umbilical area. Diameter, 0.45 *mm.*; thickness, 0.20 *mm.*

Remarks: Because of recalcification Moreno Gulch specimens do not lend themselves to detailed morphological description. Details such as the presence of accessory apertures and beading of dorsal sutures cannot be confirmed. California forms have been compared with specimens from the Mendez shale of Mexico and seem to be identical.

Hypotype: SU no. 9433, Locality no. MG 346.

Globotruncana churchi Martin, n. sp.

Plate 9, figs. 5 a—c

1929 *Globotruncana arca*. Cushman and Church (not Cushman), Proc. California Acad. Sci., 4th Ser., vol. 18, no. 16, p. 518, pl. 41, figs. 1—3; Upper Cretaceous, central California.

Description: Test rotaloid, subcircular in outline, highly trochoid on spiral side, ventral side convex with large umbilical area; periphery lobulate, edge truncate obliquely with 2 well-developed keels; chambers 7 or 8 to a whorl, slightly inflated on dorsal side, more so on ventral side, gradually increasing in size as added; wall calcareous, smooth, finely perforate; sutures on dorsal side raised, limbate, and curved, ventral sutures strongly curved, raised, beaded, forming horse-shoe design; aperture interiomarginal, a high arched opening facing the umbilicus, relict apertures of successive chambers noted along umbilical margin. Diameter, 0.55 *mm.*; thickness, 0.30 *mm.*

Remarks: This distinctive representative of the genus *Globotruncana* Cushman is characterized by its high trochoid spire and the raised ridge formed by the spiral suture. It is named in honor of C. C. Church in recognition of his work with the Cretaceous of California.

Holotype: SU no. 9434, Locality no. MG 544.

Globotruncana goudkoffi MARTIN, n. sp.

Plate 10, figs. 1 a—c

Description: Test rotaloid, subcircular in outline, dorsal or spiral side more convex than ventral, ventral side with small umbilical area; periphery lobulate, edge subacute with one keel at chamber margin and second less well-developed keel located in middle area of chamber on ventral side; chambers about 6 or 7 in last-formed whorl, increasing gradually in size as added; wall calcareous, finely perforate; sutures on dorsal side curved, raised, and beaded, those of ventral side curved, limbate, oblique, forming overlapping horse-shoe shaped design; aperture interiomarginal, a high arched opening facing the umbilicus, umbilical margin of each successive chamber with relict apertural lip. Diameter, 0.45 *mm.*; thickness, 0.22 *mm.*

Remarks: This new species differs from *Globotruncana rosetta* (CARSEY) in its consistently smaller size, in having a relatively higher trochoid spire, in possessing a second weakly developed ventral keel, and in showing a greater overlap of ventral sutures. It is named in honor of the late Dr. P. P. GOUDKOFF in recognition of his work on the biostratigraphy of Upper Cretaceous strata in the Great Valley of California.

Holotype: SU no. 9435, Locality no. MG 576.

Globotruncana fresnoensis MARTIN, n. sp.

Plate 9, figs. 8 a—d

Description: Test rotaloid, biconvex, median trochoid spire, subcircular in outline, moderately large umbilical area; periphery lobulate, edge truncate, inclined toward ventral side, bicarinate; chambers 6 to 7 in last whorl, inflated on spiral or dorsal side, ventral ones overlapping and inflated; wall calcareous, smooth, finely perforate; sutures raised, curved, beaded on spiral side; ventral ones horseshoe-shaped and overlapping; aperture interiomarginal, a low arched opening facing the umbilical area, relict apertural lip of previvious chambers observed in some specimens. Diameter, 0.48 *mm.*; thickness, 0.22 *mm.*

Remarks: This species may be distinguished from other forms of *Globotruncana* by its biconvexity, arched dorsal side, strongly arched chambers, and moderately developed trochoid spire. It appears to resemble the cross section of *Globotruncana lapparenti lapparenti* BROTZEN figured by BOLLI (1945, pl. 9, fig. 11, not text-figure 1, nos. 15, 16). Although probably BOLLI included more than one species in his figures of *Globotruncana lapparenti lapparenti* BROTZEN, his description of that species definitely states that it includes those forms in which dorsal and ventral sides are flat and parallel and the peripheral edge more or less perpendicular to the sides (BOLLI, 1945, p. 230).

Globotruncana fresnoensis MARTIN differs from *Globotruncana paraventricosa* (HOFKER) in having less inflated chambers and a smaller umbilical area. The chambers of the latter species when observed in edge view form a slightly oblique arrangement.

Holotype: SU no. 9436, Locality no. MG 574.

Globotruncana linneiana tricarinata (QUEREAU)

Plate 10, figs. 2 a—c

1893 *Pulvinulina tricarinata* QUEREAU, Beitr. geol. Karte der Schweiz, no. 33, pl. 5, fig. 3 a.
1918 *Rosalina linne,* type 2. DE LAPPARENT, Mém. Carte Géol. France, p. 7, p. 4, text-figure 1 b, d—f; p. 5, text-figure 2 d, n; Upper Cretaceous, France.
1944 *Globotruncana lapparenti tricarinata.* BOLLI, Eclogae Geol. Helv., vol. 37, no. 2, pp. 232—233, text-figure 1 (19, 20); pl. 9, fig. 13; Upper Cretaceous, Switzerland.
1959 *Globotruncana lapparenti tricarinata.* OLVERA, Bol. Asoc. Mex. Geol. Petr., vol. 11, nos. 3, 4, p. 114, pl. 6, figs. 9, 10, 11; Campanian, Maastrichtian, Mexico.

Description: Test rotaloid, slightly biconvex, almost circular in outline, spire low trochoid, umbilical area fairly wide; periphery slightly lobulate, edge truncated with 2 strongly developed keels; chambers about 6 or 7 in last whorl, slightly inflated on dorsal side, flat on ventral side; wall calcareous, smooth, finely perforate; spiral sutures raised, beaded, curved, ventral sutures strongly raised inner portion, forming third keel, curved, slightly sigmoidal; aperture interiomarginal, umbilical, those of earlier chambers forming a serrated border along umbilical margin, this inner central opening being much smaller than that of the umbilical area. Diameter, 0.55 *mm.*; thickness, 0.30 *mm.*

Remarks: This subspecies of *Globotruncana linneiana* is distinguished by a third keel on the ventral side formed by the inner portion of the ventral sutures.

Hypotype: SU no. 9437, Locality no. MG 730.

Globotruncana linneiana (d'ORBIGNY)

Plate 10, figs. 3 a—c

1839 *Rosalina linneiana* d'ORBIGNY, in Ramon de la Sagra, Hist. physique, politique, et naturelle de l'île de Cuba: A. Bertrand, editor, Paris, vol. 8, p. 101, pl. 5, figs. 10—12; Reworked Upper Cretaceous, Cuba.
1955 *Globotruncana linneiana.* BRÖNNIMANN and BROWN, Eclogae geol. Helv., vol. 48, p. 540, pls. 20, figs. 13—17; 21, figs. 16—18; Reworked Upper Cretaceous, Cuba.

Description: Test rotaloid, subcircular in outline, umbilical area of medium size; periphery loculate in outline, edge flat, bicarinate with keels well separated; chambers about 5 to 6 in last whorl, inflated in initial stage, later much flattened on dorsal and ventral sides, some overlapping, wall calcareous, smooth, finely perforate; sutures distinct, curved, slightly raised and finely beaded, ventral ones overlapping; aperture interiomarginal, an arched opening facing the umbilical area, apertures of earlier chambers not observed. Diameter, 0.45 *mm.*; thickness, 0.25 *mm.*

Remarks: Dr. Paul BRÖNNIMANN was kind enough to examine California specimens of this species. In his opinion it is conspecific with the neotype from Cuba.

Hypotype: SU no. 9438, Locality no. MG 928.

Globotruncana paraventricosa (HOFKER)

Plate 10, figs. 4 a—c

1956 *Marginotruncana paraventricosa* HOFKER, Neues Jahrb. Geol. Pal. Abh., vol. 103, no. 3, p. 328, text-figs. 17—18.

1961 *Globotruncana* aff. *G. paraventricosa* GRAHAM and CLARK, Contr. Cushman Found. Foram. Res., vol. 12, pt. 3, p. 112, pl. 5, figs. 7 a—c; Upper Cretaceous, Central California.

Description: Test rotaloid, low trochoid spire, circular in outline, biconvex, small ventral umbilical area; periphery lobulate, edge with 2 marginal keels separated by narrow marginal band; chambers about 6 to 7 in last whorl, oblique, inflated on dorsal and ventral sides; wall calcareous, smooth, finely perforate; sutures on dorsal side curved, depressed, ventral sutures strongly curved horseshoe-shaped; aperture interiomarginal, a low arch at base of last chamber facing the umbilical area, those of earlier chambers not defined due to poor preservation. Diameter, 0.50 *mm.*; thickness, 0.25 *mm.*

Hypotype: SU no. 9439, Locality no. MG 574.

Globotruncana mariai GANDOLFI

Plate 9, figs. 7 a—c

1941 *Rosalinella globigerinoides* f. typica MARIE, Mém. Mus. Nat. Hist., vol. 12, fasc. 1, p. 239, pl. 36, figs. 338 a—c; Upper Cretaceous, Paris Basin.
1955 *Globotruncana mariai.* GANDOLFI, Bull. Amer. Paleo., vol. 36, no. 155, p. 33.

Description: Test rotaloid, spire low trochoid, slightly convex dorsally, slightly concave ventrally with broad umbilical area; periphery strongly lobulate, edge rounded with 2 weakly developed oblique and diverging keels; chambers globular, loosely appressed; typically 5 chambers in last whorl; wall calcareous, smooth, finely perforate; sutures distinct, depressed, radial; aperture a high arched opening at base of last chamber, those of earlier chambers only partially observed. Diameter, 0.43 *mm.*; thickness, 0.20 *mm.*

Remarks: This small globular form superficially resembles *Globotruncana globigerinoides* BROTZEN. It is readily distinguishable from the latter by its obliquely set and diverging keels as well as by its greater dorsal convexity.

MARIE (1941) designated this form as a new species of his new genus and named it *Rosalinella globigerinoides*. However, since *Rosalinella* MARIE, 1941, is a junior synonym of *Globotruncana* CUSHMAN, 1927, his specific name is preoccupied by *Globotruncana globigerinoides* BROTZEN. GANDOLFI (1955) noting this fact as well as specific differences between the 2 species, proposed the name *Globotruncana mariai* for MARIE'S species.

Hypotype: SU no. 9440, Locality no. MG 574.

Globotruncana riojae OLVERA

Plate 9, figs. 6 a—c

1959 *Globotruncana riojae* OLVERA, Bol. Mex. Asoc. Geol. Petr., vol. 11, nos. 3, 4, pl. 7, figs. 3, 4, 5; Campanian Maastrichtian, Mexico.

Description: Test rotaloid, low trochoid spire, subcircular in outline, biconvex, more so dorsally than ventrally, small umbilical area; periphery lobulate, edge bicarinate, carinal band narrow, inclined; chambers 5 in last whorl, slightly inflated on dorsal side, ventral ones overlapping with tendency to become concave as added; wall calcareous, smooth, finely perforate; sutures oblique, curved, raised, beaded on dorsal side, ventral ones horseshoe-shaped, overlapping; aperture interiomarginal, those of last 3 chambers overlapping and facing umbilicus, that of final chamber a low arched slit. Diameter, 0.40 *mm.*; thickness 0.20 *mm.*

Hypotype: SU no. 9441, Locality bo. 550.

Globotruncana rosetta (CARSEY)

Plate 10, figs. 5 a—c

1926 *Globigerina rosetta* CARSEY, Univ. Texas Bull. 2612, p. 44, pl. 5, figs. 3 a—c; Upper Cretaceous, Texas.
1928 *Globotruncana rosetta.* WHITE, Journ. Pal., vol. 2, no. 4, p. 286, pl. 39, fig. 1; Upper Cretaceous, Mexico.
1951 *Globotruncana rosetta.* BANDY, Journ. Pal., vol. 25, no. 4, p. 509, pl. 75, figs. 4 a—c; Upper Cretaceous, southern California.
1959 *Globotruncana rosetta.* OLVERA, Bol. Asoc. Mex. Geol. Petr., vol. 11, nos. 3, 4, p. 117, pl. 7, figs. 6, 7, 8; Campanian, Maastrichtian, Mexico.

Description: Test rotaloid, subcircular in outline, relatively low trochoid spire, biconvex, ventral side more convex than dorsal, well-developed large umbilical area on ventral side; periphery lobulate with tendency to become more so as chambers are added, edge acute with single keel; chambers 6 to 7 in last whorl, gradually increasing in size, slightly appressed; wall calcareous, smooth, finely perforate; sutures on dorsal side limbate, curved and beaded, ventral ones radial, strongly curved, partially overlapping, beaded in part; aperture interiomarginal, a high rounded opening at base of last chamber facing the umbilical area, apertures of earlier chambers not seen due to poor preservation of umbilical area. Diameter, 0.60 *mm.*; thickness, 0.30 *mm.*

Hypotype: SU no. 9442, Locality no. MG 463.

Genus *RUGOGLOBIGERINA* BRÖNNIMANN, 1952

Rugoglobigerina rugosa (PLUMMER)

Plate 10, figs. 6 a—c

1926 *Globigerina rugosa* PLUMMER, Univ. Texas Bull. 2644, pp. 38—39, pl. 2, figs. 10 a—d; Navarro, Texas.
1952 *Rugoglobigerina rugosa.* BRÖNNIMANN, Bull. Amer. Pal., vol. 34, no. 140, p. 28, text-figures 11, 12, 13; Upper Cretaceous, Trinidad, B. W. I.
1957 *Rugoglobigerina rugosa.* BOLLI, LOEBLICH, and TAPPAN, U. S. Nat. Mus. Bull. 215, p. 43, pl. 11, figs. 2 a—5 c; Upper Cretaceous, Texas.

Description: Test trochoid in early stage tending toward planispiral in later stage, subcircular in outline, slightly biconvex, moderately large umbilical area on ventral side; periphery broadly lobulate; chambers globular, 5 or 6 in last whorl; wall calcareous, finely perforate, ornamented with rugose ridges radiating outward from chamber midpoint, less distinct on early chambers; sutures distinct, depressed, radian on dorsal and ventral sides; aperture interiomarginal, a high arched opening facing the umbilical area, umbilical area with cover plate or tegilla. Diameter, 0.25 *mm.*; thickness, 0.13 *mm.*

Hypotype: SU no. 9443, Locality no. MG 200.

Family HANTKENINIDAE Cushman, 1927

Genus *PLANOMALINA* Loeblich and Tappan, 1946

Planomalina aspera (Ehrenberg)

Plate 10, figs. 7 a—c

1854 *Rotalia aspera* Ehrenberg, Mikrogeologie, Leipzig, pl. 27, figs. 57—58; pl. 28, figs. 42, 42 a; Cretaceous and Eocene, Europe.
1929 *Globigerinella aspera.* Carman, Journ. Pal., vol. 25, no. 3, p. 315, pl. 34, fig. 6; Upper Cretaceous, Wyoming.
1951 *Globigerinella aspera.* Bandy, Journ. Pal., vol. 25, no. 4, p. 508, pl. 75, figs. 3 a—c; Upper Cretaceous, southern California.

Description: Test small, planispiral, biumbilicate, lastformed whorl enclosing large portion of previous one, subcircular in outline; periphery broadly lobulate; chambers globular, 5 or 6 in last whorl, loosely appressed, increasing rapidly in size as added; wall calcareous, coarsely perforate, finely spinose; sutures radial, deeply depressed; aperture a lunate opening at base of last chamber with distinct well-developed upper lip, relict apertural structures of previous chambers not observed. Diameter, 0.22 *mm.*; thickness, 0.12 *mm.*

Hypotype: SU no. 9444, Locality no. MG 200.

Planomalina alvarezi Olvera

Plate 10, figs. 8 a—c, 9

1959 *Planomalina alvarezi* Olvera, Bol. Asoc. Mex. Geol. Petr., vol. 11, nos. 3, 4; p. 91, pl. 4, figs. 5, 6, 7; Campanian, Maastrichtian, Mexico.

Description: Test small, planispiral, biumbilicate, subcircular, in outline, periphery lobulate; chambers about 7 to 8 in last whorl, increasing gradually in size as added, slightly appressed, wall calcareous, smooth, finely perforate; sutures radial, gently curved, depressed; aperture a distinct arched lunate opening at base of last septal face with a narrow lip; umbilical marginal area in some specimens with an overlapping series of relict apertural lips. Diameter, 0.30 *mm.*; thickness, 0.13 *mm.*

Hypotype: SU no. 9445, Locality no. MG 581.

Family HETEROHELICIDAE Cushman, 1927

Genus *HETEROHELIX* Ehrenberg, 1841

Heterohelix globulosa (Ehrenberg)

Plate 10, figs. 10 a, b

1834 *Textularia globulosa* Ehrenberg, K. Akad. Wiss. Berlin, Abh., p. 135, pl. 4, fig. 4 b; Upper Cretaceous, Europe.
1899 *Gümbelina globulosa.* Egger, K. Bayer. Akad. Wiss., Math.-naturw. Abt., Abh., Kl. 2, vol. 21, pt. 1, p. 32, pl. 14, fig. 34; Upper Cretaceous, Germany.
1946 *Gümbelina globulosa.* Cushman, U. S. Geol. Survey Prof. Paper 206, p. 105, pl. 45, figs. 9—15; Upper Cretaceous, Texas.
1957 *Heterohelix globulosa.* Gallitelli, U. S. Nat. Mus. Bull. 215, pp. 137—138, pl. 31, figs. 12—15; Upper Cretaceous, Texas, Arkansas.
1960 *Heterohelix globulosa.* Trujillo, Journ. Pal., vol. 34, no. 2, p. 344, pl. 50, figs. 10 a, b; Upper Cretaceous, northern California.

Description: Test small, tapering toward initial end, greatest width towards apertural end, 6 or 7 pairs of biserially arranged chambers; periphery lobulate; chambers globular, loosely appressed, increasing rapidly in size as added; wall calcareous, smooth, finely perforate; sutures distinct, depressed, straight; aperture a low lunate opening with slight upper lip, at base of last chamber. Length, 0.25 *mm.*; breadth, 0.16 *mm.*; thickness, 0.11 *mm.*

Hypotype: SU no. 9446, Locality no. MG 200.

Heterohelix striata (Ehrenberg)

Plate 11, figs. 1 a, b

1838 *Textularia striata* Ehrenberg, K. preuss. Akad. Wiss. Abh., p. 135, pl. 4, figs. 1, 2, 3; Upper Cretaceous, Europe.
1899 *Gümbelina striata.* Egger, K. Bayer. Akad. Wiss., Math.-naturh. Abt. Abh., Kl. 2, vol. 21, p. 33, pl. 14, figs. 5—7, 10, 11, 32, 38, 39; Upper Cretaceous, Germany.
1951 *Gümbelina striata.* Bandy, Journ. Pal., vol. 25, no. 4, p. 510, pl. 75, figs. 8 a, b, 9 a, b; Southern California.
1959 *Heterohelix striata.* Olvera, Bol. Asoc. Mex. Geol. Petro., vol. 11, nos. 3, 4, p. 71, pl. 2, figs. 4, 8; Campanian, Maastrichtian, Mexico.

Description: Test small, tapering toward initial end, greatest width toward apertural end, biserial; periphery lobulate; chambers subspherical, inflated, 6 to 7 pairs; wall calcareous, finely perforate, with fine striations only observable when test is wet; sutures distinct, depressed; aperture a low arched lunate opening with a slight upper lip at base of last-formed chamber. Length, 0.29 *mm.*; breadth, 0.20 *mm.*; thickness, 0.12 *mm.*

Hypotype: SU no. 9447, Locality no. MG 200.

Heterohelix pulchra (Brotzen)

Plate 11, figs. 2 a, b

1932 *Gümbelina tessera.* Cushman (not Ehrenberg), Journ. Pal., vol. 6, no. 4, p. 358, pl. 51, figs. 4, 5; Upper Cretaceous, Texas.
1936 *Gümbelina pulchra* Brotzen, Sveriges geol. undersokning, Ser. C, no. 396, p. 121, pl. 9, figs. 2 a, b, 3 a, b; Lower Senonian, Sweden.
1937 *Gümbelina tessera.* Loetterle, Nebraska Geol. Survey Bull. 12, ser. 2, p. 34, pl. 5, fig. 4; Upper Cretaceous, Nebraska.
1938 *Gümbelina pseudotessera.* Cushman, Contr. Cushman Lab. Foram. Res., vol. 14, pt. 1, p. 14, pl. 2, figs. 19—21; Upper Cretaceous, Texas.
1957 *Heterohelix pulchra.* Gallitelli, U. S. Nat. Mus. Bull. 215, p. 137, pl. 31, fig. 20; Upper Cretaceous, Texas.

Description: Test small, slightly compressed, twice as long as wide, tapering toward subacute initial end, greatest breadth toward apertural end; chambers inflated, biserial, 7 or 8 pairs, wider than high, loosely appressed, slightly curved; wall calcareous, smooth, finely perforate; sutures distinct, depressed, gently curved in later stages; aperture a high arched opening with an upper lip, at base of septal face. Length, 0.40 *mm.*; breadth, 0.23 *mm.*; thickness, 0.10 *mm.*

Hypotype: SU no. 9448, Locality no. MG 578.

Genus *GUBLERINA* KIKOINE, 1948

Gublerina ornatissima (CUSHMAN and CHURCH)

Plate 11, figs. 3 a—c

1929 *Ventilabrella ornatissima* CUSHMAN and CHURCH, California Acad. Sci. Proc., 4th Ser., vol. 18, no. 16, p. 512, pl. 39, figs. 12—15; Upper Cretaceous, central California.

1948 *Gublerina cuvillieri* KIKOINE, Soc. Geol. France, Bull., Ser. 5, vol. 18, fasc. 1—3, p. 26; Upper Cretaceous, France.

1957 *Gublerina ornatissima*. GALLITELLI, U. S. Nat. Mus. Bull. 215, p. 140, pl. 32, figs. 1—9; Upper Cretaceous, California, France.

Description: Test compressed, sides tapering toward initial end, rapidly increasing in width toward apertural end, roughly triangular in outline, initial coiled stage observed only in one specimen, later biserial stage followed by irregular chamber arrangement; periphery rounded; chambers distinct, subglobular; wall calcareous, finely perforate, early ones with longitudinal costae, often beaded; suture distinct, limbate, depressed or occasionally projecting; apertures at sides of adult chamber. Length, 0.62 *mm.*; breadth, 0.50 *mm.*; thickness, 0.20 *mm.*

Remarks: Until recently the occurrence of this species was thought to be restricted to California. However, KIKOINE (1948) decribed a form from southern France which he named *Gublerina cuvillieri*. GALLITELLI (1957), in her revision of the Heterohelicidae, examined holotypes of both *Ventilabrella ornatissima* CUSHMAN and CHURCH and *Gublerina cuvillieri* KIKOINE, and found them to be identical. The genus *Ventilabrella* is invalidated as it is a junior subjective-objective synonym of *Planoglobulina* CUSHMAN (see GALLOWAY, 1933, p. 346; GALLITELLI, 1957, p. 142).

The reported range of this form in Europe is Campanian to Maastrichtian. It appears to have a longer range in California for careful examination of Moreno Gulch material shows it to range throughout most of the Upper Marlife formation (samples 692 to 529). It was also observed in sample 200 in uppermost Uhalde sediments. As interpreted in this study this represents a range from the Santonian to lower Maastrichtian for this form in Moreno Gulch.

Hypotype: SU no. 9449, Locality no. MG 574.

Family BULIMINIDAE JONES, 1876

Genus *BULIMINA* d'ORBIGNY, 1826

Bulimina aspera CUSHMAN and PARKER

Plate 11, figs. 4 a, b

1929 *Bulimina obtusa*. CUSHMAN and CHURCH (not d'ORBIGNY), California Acad. Sci. Proc., 4th ser., vol. 18, p. 513, pl. 39, figs. 17—19; Upper Cretaceous, central California.

1940 *Bulimina aspera* CUSHMAN and PARKER, Contr. Cushman Lab. Foram. Res., vol. 16, pt. 2, p. 44, pl. 8, figs. 18, 19; Upper Cretaceous, Texas.

1951 *Bulimina aspera*. BANDY, Journ. Pal., vol. 25, no. 4, p. 511, pl. 75, figs. 10 a, b; Upper Cretaceous, southern California.

Description: Test elongate, gently tapering toward initial end, twice as long as wide, circular in cross section, about 4 to 5 whorls to test; chambers triserial, slightly inflated in early stage, later ones more so; wall calcareous, smooth except for initial end which may be roughened; sutures distinct, slightly depressed; aperture elongate, comma-shaped, with small plate-like tooth. Length, 0.40 *mm.*; diameter, 0.20 *mm.*

Hypotype: SU no. 9450, Locality no. LS 609.

Bulimina joaquinensis MARTIN, n. sp.

Plate 11, figs. 5 a, b; 6 a, b

1944 *Bulimina petroleana.* CUSHMAN and GOUDKOFF (not CUSHMAN and HEDBERG), Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 59, pl. 10, fig. 2; Upper Cretaceous, central California.

Description: Test elongate, strongly tapering to subacute initial end, triserial throughout, greatest diameter above the middle portion of last-formed whorl, roughly circular in cross section; chambers distinct, slightly inflated, increasing rapidly in size as added, those of last whorl accounting for almost half of the test; wall calcareous, smooth, except for fine spines at base of chambers and initial end; sutures distinct, those of later stages depressed; aperture loop or comma-shaped at base of last chamber. Length, 0.36 *mm.*; diameter, 0.24 *mm.*

Remarks: This form is well represented in both the Laguna Seca Creek and Moreno Gulch section. It has been compared with specimens of *Bulimina petroleana* CUSHMAN and HEDBERG and is found to differ in having an unornamented last whorl, in being ornamented with fine spines rather than fine costae, and in having a greater marginal chamber undercut in the microspheric form.

Holotype: SU no. 9451, Locality no. MG 194.

Bulimina prolixa CUSHMAN and PARKER

Plate 11, figs. 7 a, b; 8 a, b

1931 *Bulimina puschi.* CUSHMAN (not REUSS), Tennessee Div. Geol. Bull. 41, p. 47, figs. 19 a, b; Upper Cretaceous, Tennessee.

1935 *Bulimina prolixa* CUSHMAN and PARKER, Contr. Cushman Lab. Foram. Res., vol. 11, pt. 4, p. 98, pl. 15, figs. 5 a, b; Upper Cretaceous, U. S. Gulf Coast.

1944 *Bulimina prolixa.* CUSHMAN and GOUDKOFF, Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 58, pl. 10, fig. 1; Upper Cretaceous, central California.

Description: Test elongate, about twice as long as wide, triserial throughout, 6 or 7 whorls, gently tapering toward initial end, broadly rounded at apertural end, triangular in cross section, some specimens exhibiting a twisting of the test toward the initial end; chambers numerous, distinct, inflated, those of each whorl placed directly above each other forming a zig-zag suture pattern; wall calcareous, moderately coarsely perforate; sutures distinct, depressed; aperture comma-shaped, on last septal face removed from juncture of third preceding chamber. Lenght, 0.47 *mm.*; diameter, 0.24 *mm.*

Hypotype: SU no. 9452, Locality no. MG 41.

Bulimina reussi Morrow

Plate 11, figs. 9 a, b

1845 *Bulimina ovulum*. Reuss (not *ovula* d'Orbigny), Verstein. Böhm. Kreide, pt. 1, p. 37, pl. 8, fig. 57; pl. 13, fig. 73; Upper Cretaceous, Bohemia.
1934 *Bulimina reussi* Morrow, Journ. Pal. vol. 8, no. 2, p. 195, pl. 29, fig. 12; Upper Cretaceous, Kansas.
1947 *Bulimina reussi*. Cushman and Parker, U. S. Geol. Survey Prof. Paper 210-D, p. 84, pl. 20, fig. 6; Upper Cretaceous, U. S. Gulf Coast.

Description: Test small, triserial throughout, ovate in outline, almost twice as long as wide, strongly tapering toward subacute initial end, subcircular in cross section, greatest diameter formed by last whorl above middle of test; chambers fairly distinct, enlarging rapidly in size as added; wall calcareous, smooth, finely perforate; sutures distinct, slightly depressed; aperture comma-shaped, at juncture of two last-formed chambers. Length, 0.27 *mm.*; diameter, 0.15 *mm.*

Hypotype: SU no. 9453, Locality no. MG 574.

Bulimina spinata Cushman and Campbell

Plate 11, figs. 10 a, b

1935 *Bulimina spinata* Cushman and Campbell, Contr. Cushman Lab. Foram. Res., vol. 11, pt. 3, p. 72, pl. 11, fig. 1; Upper Cretaceous, central California.

Description: Test small, slightly longer than broad, initial end acute, greatest width above the middle of test at last whorl, apertural end rounded, subcircular in cross section, about 4 whorls to test; chambers distinct, those of last whorl inflated, enlarging rapidly as added, typically undercut, early chambers with distinct spines extending along chambers as costae, last-formed whorl lacking ornamentation; wall calcareous, smooth, except for previously mentioned ornamentation; sutures distinct, depressed; aperture loop-shaped with tooth, at base of last chamber. Length, 0.56 *mm.*; diameter, 0.36 *mm.*

Hypotype: SU no. 9454, Locality no. LS 609.

Genus *BULIMINELLA* Cushman, 1911

Buliminella carseyae Plummer

Plate 11, figs. 11 a, b

1926 *Bulimina compressa*. Carsey (not Bailey), Univ. Texas Bull. 2612, p. 29, pl. 4, fig. 14; Upper Cretaceous, Texas.
1931 *Buliminella carseyae* Plummer, Univ. Texas Bull. 3101, pl. 8, fig. 7; Upper Cretaceous, Texas.
1947 *Buliminella carseyae*. Cushman and Parker, U. S. Geol. Survey Prof. Paper 210-D, p. 58, pl. 15, fig. 8; Upper Cretaceous, U. S. Gulf Coast.

Description: Test elongate, ovate in outline, about twice as long as wide, greatest width slightly above the middle, initial end bluntly pointed, about 3—½ whorls per test; chambers distinct, slightly inflated, 4 to a whorl, increasing rapidly in size as added; wall calcareous, smooth, finely perforate; sutures distinct, depressed, curved, inclined to longitudinal axis of test;

aperture comma-shaped, in well-defined depression at base of last-formed chamber, containing a narrow flap extending along septal face. Length, 0.40 *mm.*; diameter, 0.20 *mm.*

Hypotype: SU no. 9455, Locality no. MG 692.

Buliminella colonensis CUSHMAN and HEDBERG

Plate 11, figs. 12 a, b

1930 *Buliminella colonensis* CUSHMAN and HEDBERG, Contr. Cushman Lab. Foram. Res., vol. 6, pt. 3, p. 65, pl. 9, figs. 6, 7; Upper Cretaceous, Venezuela.

1947 *Buliminella colonensis.* CUSHMAN and PARKER, U. S. Geol. Survey Prof. Paper 210-D, p. 59, pl. 15, figs. 14, 15; Upper Cretaceous, Venezuela, Mexico.

Description: Test small, broadly ovular in outline, nearly as wide as long, circular in cross section, initial end acute, apertural end broadly rounded; chambers distinct, rapidly increasing in height as added, slightly inflated; wall calcareous, smooth, finely perforate; sutures distinct, slightly depressed; aperture comma-shaped in slight depression at base of last chamber. Length, 0.40 *mm.*; diameter, 0.33 *mm.*

Remarks: Specimens from Moreno Gulch agree well with the figured Venezuelan form. California specimens have been compared with material from the Colon shale of Colombia and are found to be identical.

Hypotype: SU no. 9456, Locality no. MG 587.

Buliminella cushmani SANDIDGE

Plate 11, figs. 13 a, b

1932 *Buliminella cushmani* SANDIDGE, Journ. Pal., vol. 6, no. 3, p. 280, pl. 42, figs. 18, 19; Upper Cretaceous, Alabama.

1947 *Buliminella cushmani.* CUSHMAN and PARKER, U. S. Geol. Survey Prof. Paper 210-D, p. 58, pl. 15, figs. 10, 11; Upper Cretaceous, U. S. Gulf Coast.

Description: Test medium-sized, strongly tapering toward initial end, greatest width slightly above middle of test, formed by last-formed whorl, circular in cross section, initial end bluntly acute, apertural end rounded; chambers distinct, 4 to a whorl, gently inflated in first three whorls, not evident in last whorl, increasing in height rapidly as added; wall calcareous, smooth, finely perforate; sutures fairly distinct, in initial portion only seen when test is wet, spiral suture slightly depressed; aperture comma-shaped, at base of last-formed chamber. Length, 0.40 *mm.*; diameter, 0.24 *mm.*

Remarks: Although similar to *Buliminella carseyae* PLUMMER this species may be distinguished by its smaller size, more compact form, and less inflated chambers. As pointed out by CUSHMAN and PARKER (1947, p. 51), *Buliminella cushmani* SANDIDGE is similar to *Buliminella laevis* (BEISSEL) from the Upper Cretaceous of Germany; however, the former is smaller and has a broader apertural face.

Hypotype: SU no. 9457, Locality no. MG 550.

Genus *BOLIVINA* d'ORBIGNY, 1834

Bolivina incrassata REUSS

Plate 11, figs. 14 a, b

1851 *Bolivina incrassata* REUSS, Haidinger's Naturwiss. Abh., vol. 4, p. 29, pl. 4, fig. 13; Upper Cretaceous, Poland.
1935 *Bolivina incrassata*. CUSHMAN and CAMPBELL, Contr. Cushman Lab. Foram. Res., vol. pt. 3, p. 73, pl. 11, fig. 10; Upper Cretaceous, central California.
1946 *Bolivina incrassata*. CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 127, pl. 53, figs. 8—11; Upper Cretaceous, U. S. Gulf Coast, Mexico.
1951 *Bolivina incrassata*. BANDY, Journ. Pal., vol. 25, no. 4, p. 510, pl. 75, figs. 5 a, b; Upper Cretaceous, southern California.
1959 *Bolivina incrassata*. OLVERA, Bol. Asoc. Mex. Geol. Petro., vol. 11, nos. 3, 4, p. 79, pl. 2, p. 79, pl. 2, figs. 17, 18; Campanian, Maastrichtian, Mexico.

Description: Test elongate, compressed, 3 times as long as wide, greatest width toward apertural end, gently tapering toward rounded initial end; periphery rounded; chambers about 6 to 7 pairs in adult form, distinct, increasing slightly in height as added; wall calcareous, smooth, finely perforate; sutures flush, slightly curved, limbate; aperture an elongate oval without lip. Length, 0.60 *mm.*; breadth, 0.18 *mm.*; thickness, 0.10 *mm.*

Remarks: This well-known species has been recorded from Europe, the Gulf Coast of the United States, California, and many other places. It is found only in Laguna Seca Creek material. Our specimens agree well with REUSS' original figures.

Hypotype: SU no. 9458, Locality no. LS 618.

Genus *BOLIVINOIDES* CUSHMAN, 1927

Bolivinoides paynei MARTIN, n. sp.

Plate 12, figs. 1 a—c

Description: Test small, rhomboid in outline, thickening toward apertural end; chambers biserial, low and broad, closely appressed, gradually increasing in height as added, about 9 pairs to the test; wall calcareous, finely perforate; sutures distinct, curved, raised, slightly limbate, irregularly crenulated; aperture a low slit with a lip at base of last chamber. Length, 0.30 *mm.*; thickness, 0.20 *mm.*

Remarks: Although this form is similar to *Bolivinoides trinitatensis* CUSHMAN and JARVIS and *Bolivinoides velascoensis* CUSHMAN, the California species can be distinguished by its greater relative width, lack of ornamentation, and consistently smaller size. It has been compared with the two previously mentioned species and can be readily identified. It is named in honor of Max B. PAYNE in recognition of his work on California stratigraphy.

Holotype: SU no. 9459, Locality no. MG 581.

Bolivinoides decoratus CUSHMAN subsp. *latticeus* (CARSEY)

Plate 12, figs. 2 a, b

1926 *Bolivina decorata*. CUSHMAN (not JONES), Bull., Amer. Assoc. Petrol. Geol., vol. 10, no. 6, p. 582, pl. 15, fig. 11; Upper Cretaceous, Mexico.
1926 *Bolivina latticea* CARSEY, Univ. Texas Bull. no. 2612, p. 27, pl. 4, fig. 9; Upper Cretaceous, Texas.

1954 *Bolivinoides decoratus* var. *latticeus*. FRIZZELL, Bureau Econ. Geol., Rept. Investigations no. 22, p. 112, pl. 16, figs. 18, 19; Upper Cretaceous, Texas.

Description: Test elongate, compressed, about 2—½ times as long as wide, tapering toward initial end, widest at apertural end; chamber biserial about 6 to 7 pairs, closely appressed; wall calcareous, finely perforate, ornamented with raised lobes restricted to each chamber; sutures indistinct, obscured by lobes, aperture an elongate slit at base of last chamber. Length, 0.36 *mm.*; breadth, 0.25 *mm.*; thickness, 0.10 *mm.*

Hypotype: SU no. 9460, Locality no. MG 574.

Genus *BOLIVINITELLA* MARIE, 1941

Bolivinitella eleyi (CUSHMAN)

Plate 12, figs. 3 a—c

1859 *Textularia obsoleta*. ELEY (not REUSS), Geology in the Garden, p. 195, pl. 2, fig. 11, p. 202, pl. 8, fig. 11 c; Upper Cretaceous, England.
1927 *Bolivinita eleyi* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 4, p. 91, pl. 12, figs. 11 a, b; Upper Cretaceous, Arkansas.
1941 *Bolivinitella eleyi*. MARIE, Mem. Mus. Nat. Hist., n. ser. vol. 12, p. 190, pl. 29, figs. 282 a—c; Upper Cretaceous, Paris Basin.

Description: Test small, biserial, compressed, quadrangular in cross section, biconcave, gently tapering toward initial end greatest width toward apertural end; periphery keeled, truncated; chambers numerous, about 7 to 8 pairs, increasing fairly rapidly in height as added; wall calcareous, smooth, finely perforate; sutures distinct, strongly curved, limbate; aperture terminal an elongate slit on the last septal face. Length, 0.40 *mm.*; breadth, 0.13 *mm.*; thickness, 0.08 *mm.*

Remarks: In the original description of this species CUSHMAN 1927, p. 91 did not give any details concerning the aperture. His figure does show a large and broad opening extending along the edge of the last chamber. In a subsequent publication CUSHMAN (1946, p. 114) failed to mention the apertural characteristics of this species. MARIE (1941, p. 190) erected a new genus *Bolivinitella* designating *Bolivinita eleyi* CUSHMAN as genoholotype. *Bolivinitella*, according to MARIE, is compressed, has lateral keels, and has the aperture placed terminally.

Hypotype: SU no. 9461, Locality no. MG 557.

Genus *REUSSELLA* GALLOWAY, 1933

Reussella szajnoche (GRZYBOWSKI)

Plate 12, figs. 4 a—c

1896 *Verneuilina szajnoche* GRZYBOWSKI, Rozr. Ak. Um. Krakow, Bd. 30 (Ser. 2, Bd. 10), p. 287, pl. 9, figs. 19 a, b; Upper Cretaceous, Europe.
1929 *Bulimina limbata* WHITE, Journ. Pal., vol. 3, no. 1, p. 48, pl. 5, figs. 9 a, b; Upper Cretaceous, Mexico.

1944 *Reussella californica* CUSHMAN and GOUDKOFF, Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 59, pl. 10, figs. 3—5; Upper Cretaceous, central California.

1951 *Reussella szajnoche* californica. NOTH, Jb. Geol. Bundesanst. Wien, Sonderband 3, p. 65, pl. 7, fig. 6; Upper Senonian, Austria.

1954 *Reussella szajnoche*. DE KLASZ and KNIPSCHEER, Geol. Jb., Bd. 69, p. 609, pl. 45, figs. 11—13; Upper Cretaceous, Europe.

1959 *Reussella szajnoche* californica. OLVERA, Bol. Asoc. Mex. Geol. Petr., vol. 11, nos. 3, 4; p. 83, pl. 3, figs. 1, 2; Campanian, Maastrichtian, Mexico.

Description: Test triangular in cross section, pyramidal in shape, with concave sides and strongly projecting keels and spines, greatest width toward apertural end at base of last-formed chamber; chambers numerous, closely appressed, deeply excavated; wall calcareous, smooth, finely perforate; sutures forming prominent raised ridges; aperture semilunar with raised lip, at base of last chamber. Length, 0.60 *mm.*; breadth, 0.45 *mm.*

Remarks: This distinctive species evidently has a wide geographic distribution as it has been reported from both America and Europe. Some doubt has existed as to the relationship of *Bulimina limbata* WHITE and *Reussella californica* CUSHMAN and GOUDKOFF to *Reussella szajnoche* (GRZYBOWSKI). This appears to have been clarified by the study of de KLASZ and KNIPSCHEER (1954). These authors compared material from Mexico and California containing *Bulimina limbata* and *Reussella californica*, respectively. In both cases the American forms are conspecific with *Reussella sazjnoche*.

The following excerpt has been translated from de KLASZ and KNIPSCHEER (1954, p. 606):

The other form, *Reussella californica* CUSHMAN and GOUDKOFF, was described from the Chico series of California (CUSHMAN and GOUDKOFF, 1944, p. 59, pl. 10, figs. 3 a, b, 4, 5; in this study pl. 45, figs. 10—12). NOTH (1951, p. 65) considers *Reussella californica* as a subspecies of *Reussella szajnoche* from the Upper Cretaceous (Senonian) of Nussbach, Austria; he considers it impossible for *Reussella californica* CUSHMAN and GOUDKOFF to be a synonym of *Reussella szjanoche* var. *elongata* (LIEBUS and SCHUCHERT). Mr. P. P. GOUDKOFF has been kind enough to put at our disposal two topotypes of *Reussella californica*. One of these specimens is figured in plate 45, figure 13. According to our observations these specimens are identical with the Upper Campanian form of *Reussella szajnoche*. It would be interesting to ascertain whether the age of the strata from which these topotypes originate correlate with the Upper Campanian in which *Reussella szajnoche* is found.

It has to be proved if in the Upper Cretaceous of California a similar evolution of this form occurs (that is similar to what we have observed in the European material).

NOTH (1951) considered *Reussella california* CUSHMAN and GOUDKOFF (1944, figs. 4, 5 only) a synonym of *Reussella szajnoche* (GRZYBOWSKI). The specimen of *Reussella californica* designated by CUSHMAN and GOUDKOFF as the holotype is figure 3 of the same 1944 publication. This last specimen NOTH believed to be a subspecies of *Reussella szajnoche*. This division is artificial as the differences between figures 3, 4 and 5 of CUSHMAN and GOUDKOFF are due solely to preservation. A. A. ALMGREN, of The Superior Oil Company, kindly showed the writer topotypes of *Reussella californica* from the Solano County locality. It was observed that a number of specimens have the keel projections worn down giving them a slightly different appearance. As this was the only difference noted, NOTH'S subspecies should be considered conspecific with *Reussella szajnoche*. For the most part, Moreno Gulch specimens are well preserved and show all the characteristics attributed to *Reussella szajnoche*.

Hypotype: SU no. 9462, Locality no. MG 574.

Genus *SIPHOGENERINOIDES* CUSHMAN, 1927

Siphogenerinoides clarki CUSHMAN and CAMPBELL

Plate 12, figs. 5 a, b; 6 a, b

1936 *Siphogenerinoides clarki* CUSHMAN and CAMPBELL, Contr. Cushman Lab. Foram. Res., vol. 12, p. 91, pl. 13, figs. 9—12; Upper Cretaceous, central California.

1943 *Siphogenerinoides clarki*. FRIZZELL, Journ. Pal. vol. 17, no. 4, p. 349, pl. 56, fig. 30; Upper Cretaceous, Peru.

Description: Test elongate, circular in cross section, slightly tapering toward initial end in megalospheric form, more so in microspheric form, widest diameter at apertural end; initial chambers triserial in microspheric form, biserial in megalospheric, uniserial in later stage, initial end rounded in megalospheric form, bluntly pointed in microspheric; chambers fairly distinct, slightly inflated, slightly appressed, increasing gradually in height as added; wall calcareous, conspicuously but not coarsely perforate, no evidence of longitudinal striations as in original description; sutures distinct, slightly depressed; aperture terminal, central, with lip, one side convex, the other concave, usually with two inwardly projecting tooth-like plates. Length, 0.60 *mm.*; diameter, 0.23 *mm.*

Remarks: Only a few specimens were obtained from Moreno Gulch samples and more material is required in order to have a better figured specimen.

Hypotype: SU no. 9463, Locality no. MG 200.

Siphogenerinoides whitei CHURCH

Plate 12, figs. 7 a, b; 8 a, b; 9 a, b

1943 *Siphogenerinoides whitei* CHURCH, Calif. Div. Mines Bull. 118, p. 182, pl. 67, fig. 37; Upper Cretaceous, central California.

1944 *Siphogenerinoides whitei*. CUSHMAN and GOUDKOFF, Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 58, pl. 9, figs. 17, 18; Upper Cretaceous, central California.

Description: Test elongate, large, circular in cross section, slightly tapering toward initial end in megalospheric forms, more so in microspheric, greatest diameter toward apertural end at last or next to last chamber, microspheric form with pointed initial end, megalospheric form with rounded initial end; early chambers triserial in microspheric form, biserial in megalospheric, uniserial in later stage; chambers distinct, increasing gradually in height as added, slightly inflated, slightly overlapping; wall calcareous, finely perforate, smooth; sutures distinct, indented, giving sinuate appearance; aperture terminal, central, one side convex, the other concave, with two inwardly projecting tooth-like plate. Length, 2.0 *mm.*; diameter, 0.60 *mm.*

Remarks: Because specimens from Moreno Gulch were badly preserved, topotype material was collected from the Marca shale locality of WHITE. In plate 12 of this study figures 7 a, b; and 8 a, b, are based on topotype material. Figures 9 a, b, are typical of the poorly preserved and fragmental specimens obtained from Moreno Gulch.

Hypotypes: SU no. 9464 a—b, Locality no. MG 41. Figs. 9 a, b; Figs. 7 a, b; 8 a, b. Sec. 7, T. 15 S. R. 12 E. Panoche Hills.

Family ROTALIIDAE REUSS, 1860

Genus *ROTALIA* LAMARCK, 1804

Rotalia bandyi MARTIN, n. sp.

Plate 12, figs. 10 a—c

Description: Test rotaloid, trochoid, subcircular in outline, almost equally biconvex but with greater convexity on ventral side, prominent ventral umbo, periphery lobulate, edge acute but not keeled; chambers distinct, about 7 to 8 in last whorl slightly inflated on ventral side; wall calcareous, finely perforate; sutures slightly raised, curved, limbate, oblique on dorsal side, in some specimens with tendency to become beaded, ventral ones depressed and radial; aperture a low arched opening at base of last chamber, midway between the periphery and umbo. Diameter, 0.30 *mm.*; thickness, 0.20 *mm.*

Remarks: This species differs from *Rotalia primitiva* BERMUDEZ in being consistently smaller, having greater ventral convexity, and lacking dorsal papillae. It is named in honor of Dr. Orville L. BANDY who introduced the writer to the field of micropaleontology.

Holotype: SU no. 9465, Locality no. MG 200.

Rotalia minuta MARTIN, n. sp.

Plate 12, figs. 11 a—c

Description: Test small, rotaloid, subcircular in outline, conical in edge view, dorsally convex, ventrally slightly convex to flattened, umbilical area covered by plug; periphery gently lobulate to smooth, edge subacute; chambers distinct, about 7 in final whorl, increasing gradually in size as added, in some specimens inner ventral margin adjacent to umbilical plug with knobs of shell material; wall calcareous, finely perforate; sutures distinct, curved, dorsal ones slightly raised on last whorl, earlier ones flush, gently curved and depressed on ventral side; aperture a small round to slightly elongate slit on ventral face of last chamber, midway between the periphery and umbilicus. Diameter, 0.30 *mm.*; thickness, 0.12 *mm.*

Remarks: This small but distinctive species has been compared with specimens of *Rotalia hemispherica* REUSS from the Maastrichtian of Holland. Our specimens are smaller and broadly conical in edge view whereas REUSS' species is dorsally broadly rounded and has strongly curved dorsal sutures.

Holotype: SU no. 9466, Locality no. MG 200.

Genus *GYROIDINOIDES* BROTZEN, 1942

Gyroidinoides grahami MARTIN, n. sp.

Plate 13, figs. 1 a—c

Description: Test rotaloid, trochoid, subcircular in outline, dorsal side slightly convex, ventral side strongly so with small open umbilicus; periphery smooth, edge, broadly rounded; chambers about 6 to 7 in last whorl, increasing rapidly in depth as added, particularly those of the last whorl; wall calcareous, smooth, finely perforate; sutures distinct, flush, curved and tangential on dorsal side, radial on ventral side, spiral suture depressed only along last 3 or 4 chambers; aperture a low elongate slit with a lip extending along inner margin of last chamber from near the periphery to the umbilical area. Diameter, 0.45 *mm.*; thickness, 0.36 *mm.*

Remarks: This form differs from *Gyroidinoides nitida* (REUSS) in having dorsally curved and tangential sutures and non-inflated chambers. It is named in honor of Dr. Joseph J. GRAHAM, Stanford University, in appreciation of his help and guidance in the preparation of this study.

Holotype: SU no. 9467, Locality no. MG 584.

Genus *GYROIDINA* d'ORBIGNY, 1826

Gyroidina globosa (HAGENOW)

Plate 12, figs. 12 a—c

1842 *Nonionina globosa* HAGENOW, Neues Jahrb., p. 574.
1861 *Rotalia globosa.* REUSS, Akad. Wiss. Wien, Math.-Naturwiss. Cl., Sitzungsber, vol. 44, pt. 1, p. 330, pl. 7, figs. 2 a, b; Upper Cretaceous, Germany.
1931 *Gyroidina globosa.* CUSHMAN, Journ. Pal., vol. 5, no. 4, p. 310, pl. 35, figs. 19 a—c; Upper Cretaceous, Arkansas.

Description: Test rotaloid, small, low-spired, circular in dorsal view, spheroid in edge view, ventral side with slight depression; periphery smooth, edge broadly rounded; chambers, 6 to 7, increasing gradually in size as added; wall calcareous, smooth, finely perforate; sutures radial, flush, later ones gently curved; aperture a low slit extending from slightly above the middle of test to near the umbilical area. Diameter, 0.15 *mm.*; thickness, 0.10 *mm.*

Remarks: Comparison of specimens from Moreno Gulch with the original figure given by REUSS shows the two forms to be similar in many respects.

Hypotype: SU no. 9468, Locality no. MG 574.

Gyroidina globosa (HAGENOW) subsp. *orbicella* BANDY

Plate 13, figs. 2 a—c

1944 *Gyroidina globosa.* CUSHMAN and GOUDKOFF (not HAGENOW), Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 61, pl. 10, fig. 6; Upper Cretaceous, central California.
1951 *Gyroidina globosa* (HAGENOW) var. *orbicella* BANDY, Journ. Pal., vol. 25, no. 4, p. 505, pl. 74, figs. 2 a—c; Upper Cretaceous, southern California.

Description: Test rotaloid, low-spired, almost circular in outline, dorsal side slightly convex, ventral side convex with a slight depression in central portion; periphery broadly lobulate, edge rounded; chambers 6 to 8 in last whorl, increasing gradually in size as added; wall calcareous, smooth, finely perforate; sutures gently curved on dorsal side, radial on ventral side; aperture a long narrow slit with lip, at base of last chamber and extending from periphery to umbilical area. Diameter, 0.32 *mm.*; thickness, 0.20 *mm.*

Remarks: As pointed out by BANDY (1951), *Gyroidina globosa* subsp. *orbicella* differs from HAGENOW'S species in not being as thick and in having a relatively higher but not broader apertural face. The aperture of *Gyroidina globosa* (HAGENOW) appears not to be as long as that of BANDY'S form which extends from the periphery to the umbilical area.

Hypotype: SU no. 9469, Locality no. MG 730.

Gyroidina florealis WHITE

Plate 13, figs. 6 a—c

1928 *Gyroidina florealis* WHITE, Journ. Pal., vol. 2, no. 4, p. 293, pl. 40, figs. 3 a—c; Upper Cretaceous, Mexico.

1946 *Pulvinulinella florealis.* CUSHMAN, U. S. Geol. Survey Prof. Paper 206, p. 144, pl. 59, figs. 11, 12; Upper Cretaceous, Mexico. Trinidad, B. W. I.

1960 *Gyroidina florealis.* TRUJILLO, Journ. Pal., vol. 34, no. 2, p. 331, pl. 48, figs. 1 a—c; Upper Cretaceous, northern California.

Description: Test rotaloid, trochoid, planoconvex, subcircular in outline, ventral side with umbilical area, dorsal side slightly concave except for central area which is raised; periphery strongly keeled; chambers distinct, 6 to 8 in last whorl, gently inflated on ventral side; wall calcareous, smooth, finely perforate; sutures on dorsal side curved, limbate, oblique, ventral ones slightly sigmoid and depressed; aperture an elongate slit nearly parallel to direction of coiling. Diameter, 0.45 *mm.*; thickness, 0.25 *mm.*

Hypotype: SU no. 9470, Locality no. MG 544.

Gyroidina goudkoffi (TRUJILLO)

Plate 13, figs. 3 a—c

1960 *Eponides goudkoffi* TRUJILLO, Journ. Pal. vol. 34, no. 2, p. 333, pl. 48, figs. 6 a—c; Upper Cretaceous, northern California.

Description: Test rotaloid, subcircular in outline, dorsal side convex, ventral side greatly so with slight umbilical development; periphery gently lobulate, edge sharply rounded; chambers distinct, 6 to 7 in last whorl, increasing gradually in size as added; wall calcareous, smooth, finely perforate; sutures on dorsal side curved, limbate, flush, spiral suture raised and limbate, ventral sutures sigmoid and limbate, especially toward the umbilical area; aperture a low opening beginning at about the midway point between the periphery and umbilical area and extending to the umbilical area, at base of last chamber; apertural face shaped in sigmoid form. Diameter, 0.57 *mm.*; thickness, 0.45 *mm.*

Hypotype: SU no. 9471, Locality no. MG 550.

Gyroidina subangulata (PLUMMER)

Plate 13, figs. 4 a—c

1927 *Rotalia soldani* (d'ORBIGNY) var. *subangulata* PLUMMER, Univ. Texas Bull. 2644, p. 154, pl. 12, fig. 1; Paleocene, Texas.
1928 *Gyroidina subangulata*. WHITE, Journ. Pal. vol. 2, no. 4, p. 291, pl. 39, fig. 6; Upper Cretaceous, Mexico.

Description: Test rotaloid, circular in outline, slightly convex on dorsal side, strongly so on ventral side with shallow umbilical area; periphery gently lobulate, edge sharply rounded; chambers about 7 to last-formed whorl, increasing gradually in size as added, final one with broad flat septal face; wall calcareous, smooth, finely perforate; sutures on dorsal side tangential, slightly curved, flush in early part but depressed in last few chambers, ventral ones radial to slightly curved; aperture an elongate slit in the middle of the base of the last chamber. Diameter, 0.42 *mm.*; thickness, 0.32 *mm.*

Hypotype: SU no. 9472, Locality no. MG 587.

Gyroidina quadrata CUSHMAN and CHURCH

Plate 13, figs. 5 a—c

1929 *Gyroidina quadrata* CUSHMAN and CHURCH, California Acad. Sci. Proc., 4th Ser., vol. 18, no. 16, p. 516, pl. 41, figs. 7—9; Upper Cretaceous, central California.

Description: Test rotaloid, small, subcircular in outline, dorsal side concave, strongly convex on ventral side with slight depression in umbilical area; periphery lobulate, edge view quadrate; chambers about 6 in last whorl, increasing gradually in size as added, gently inflated on ventral side; wall calcareous, smooth, finely perforate; sutures distinct, depressed on dorsal side, curved and limbate, ventral ones depressed and radial; aperture a narrow slit with lip on face of last-formed septal face midway between periphery and umbilical area. Diameter, 0.25 *mm.*; thickness, 0.18 *mm.*

Hypotype: SU no. 9473, Locality no. MG 550.

Genus *EPONIDES* MONFORT, 1808

Eponides bandyi TRUJILLO

Plate 13, figs. 7 a—c

1960 *Eponides bandyi* TRUJILLO, Journ. Pal., vol. 34, no. 2, p. 332, pl. 43, figs. 3 a—c; Upper Cretaceous, northern California.

Description: Test rotaloid, trochoid, biconvex, more so on ventral side than on dorsal, umbilicial area sometimes slightly depressed, subcircular in outline; periphery gently lobulate, edge sharply rounded; chambers about 7 in last-formed whorl, increasing gradually in size as added; wall calcareous, smooth, finely perforate; sutures on dorsal side curved, limbate, flush in early part, gently raised in later chambers, ventral ones slightly depressed and sigmoid, becoming limbate toward the central area; aperture a low arched opening extending from the periphery to the umbilical area. Diameter, 0.45 *mm.*; thickness, 0.27 *mm.*

Remarks: The above decribed species may be distinguished from *Eponides beisseli* SCHIJFSMA in having sigmoid ventral sutures and a convex ventral side.

Hypotype: SU no. 9474, Locality no. MG 730.

Eponides spinea CUSHMAN

Plate 13, figs. 8 a—c

1926 *Truncatulina spinea* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, p. 22, pl. 2, figs. 10 a—c; Upper Cretaceous, Mexico.
1927 *Eponides spinea.* CUSHMAN, Journ. Pal., vol. 1, no. 2, p. 165, pl. 27, figs. 1 a—c; Upper Cretaceous, Mexico.

Description: Test small, planoconvex, dorsal side concave to convex, ventral side highly convex, slightly umbilicate; periphery gently lobulate, edge acute with keel and spines; chambers in majority of specimens indistinct (except when test is wet), about 6 to 7 in last whorl, increasing gradually in size as added, later ones having greater length than width; wall calcareous, smooth, finely perforate; sutures on dorsal side curved, limbate, flush, those of ventral side slightly depressed and radial; aperture a ventral elongate slit, located, extending from umbilicus to near the periphery. Diameter, 0.40 *mm.*; thickness, 0.20 *mm.*

Remarks: The original figures of this species lack details necessary for proper identification. However, the written description and general dimensions agree closely with the California specimens. Material from Moreno Gulch contains some specimens which are poorly preserved and look like that of CUSHMAN's original figure.

Hypotype: SU no. 9475, Locality no. MG 554.

Genus *GAVELINELLA* BROTZEN, 1942

Gavelinella orolomaensis (CUSHMAN and GOUDKOFF)

Plate 14, figs. 1 a—c

1944 *Valvulineria orolomaensis* CUSHMAN and GOUDKOFF, Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 60, pl. 10, figs. 7 a—c; Upper Cretaceous, central California.

Description: Test slightly trochoid, nearly planispiral, subcircular in outline, unequally biconvex, ventral side more convex than dorsal and with open but depressed umbilical area; periphery slightly lobulate, edge sharply rounded; chambers about 8 to 10 in last whorl, gradually increasing in size as added; wall calcareous, smooth, finely perforate; sutures limbate, strongly curved, flush; aperture a narrow opening extending from near the periphery to the umbilical area on ventral side, relict apertural lips which form keel-like edge noted along inner margin of umbilicus. Diameter, 0.40 *mm.*; thickness, 0.18 *mm.*

Hypotype: SU no. 9476, Locality no. MG 41.

Gavelinella turbinata MARTIN, n. sp.

Plate 14, figs. 2 a—c; 3 a—c

Description: Test trochoid, biconvex, more so on dorsal side, subcircular to circular in outline, ventral side with well-developed open and deep umbilicus; periphery smooth to gently lobulate, edge rounded; chambers about 8 to 9 in last whorl, gradually increasing in size as added; wall calcareous, smooth, finely perforate; sutures on dorsal side limbate, curved, flush in early stage, later slightly depressed in last 3 or 4 chambers which are gently depressed; aperture a low narrow opening extending from the periphery to the umbilical area, and further extending along the inner margin of the umbilicus, relict apertural lips noted in some specimens forming an irregular serrated edge along inner margin of umbilicus. Diameter, 0.68 *mm.*; thickness, 0.30 *mm.*

Remarks: This California species differs from *Gavelinella pertusa* (MARSSON) in having fewer chambers per whorl and a greater dorsal convexity as well as a smaller umbilical area.

Holotype: SU no. 9477 a—b, Locality no. MG 87 Figs. 2 a, b; Figs. 3 a, b, Sec. 6, T. 15 S., R. 12 E., Panoche Hills.

Genus *GLOBOROTALITES* BROTZEN, 1942

Globorotalites michelinianus (d'ORBIGNY)

Plate 14, figs. 4 a—c

1840 *Rotalina micheliniana* d'ORBIGNY, Mem. Soc. Geol. France, ser. 1, vol. 4, pp. 31—32, pl. 3, figs. 1—3; Upper Cretaceous, Paris Basin.

1948 *Globorotalites micheliniana.* TEN DAM and MAGNE, Revue. Inst. Française du Pétrole et Ann. des Combustible liquides, vol. 3, no. 8, p. 223, text-figures 8 a—c; Campanian-Santonian, Europe.

Description: Test trochoid, subcircular in outline, dorsal side flat to slightly convex, ventral side conical with a small umbilical area; periphery smooth to gently lobulate, edge acute but not keeled; chambers about 6 to 7 in last whorl, curved, increasing in height fairly rapidly as added; wall calcareous, smooth, finely perforate; sutures on dorsal side curved, flush, ventral sutures slightly depressed and curved; aperture a low elongate slit at base of last chamber, extending from periphery to the umbilicus. Diameter, 0.30 *mm.*; thickness, 0.18 *mm.*

Hypotype: SU no. 9478, Locality no. MG 905.

Globorotalites rosaceus MARTIN, n. sp.

Plate 14, figs. 5 a—c

Description: Test small, low trochoid, biconvex, ventral side with greater degree of convexity, depressed umbilical area on ventral side, subcircular in outline; periphery lobulate, edge acute with a slight keel; chambers 6 to last-formed whorl, increasing rapidly in height as added; wall calcareous, smooth, finely perforate; sutures on dorsal side curved, slightly tangential, flush in early portion, depressed in later chambers, spiral suture forming a raised border, ventral sutures curved, depressed; aperture a low elongate opening extending from the periphery to the umbilicus with a distinct lip. Diameter, 0.27 *mm.*; thickness, 0.14 *mm.*

Remarks: This form may be distinguished from *Globorotalites multisepta* BROTZEN in having less tangential and limbate sutures and in having fewer chambers per whorl. It may be distinguished from *Globorotalites umbilicata* LOETTERLE by slightly flaring ventral margin and by its greater biconvexity.

Holotype: SU no. 9479, Locality no. MG 578.

Globorotalites subconicus (MORROW)

Plate 14, figs. 6 a—c

1934 *Globorotalia subconica* MORROW, Journ. Pal., vol. 8, no. 2, p. 200, pl. 30, figs. 11 a—c; Upper Cretaceous, Kansas.

1937 *Globorotalia subconica.* LOETTERLE, Nebraska Geol. Survey, Bull. 12, ser. 2, p. 43, pl. 4, figs. 10 a—c; Upper Cretaceous, Nebraska.

1948 *Globorotalites subconica.* TEN DAM and MAGNE, Revue Inst. Française Pétrole et Ann. Combustibles liquides, vol. 3, no. 8, p. 225, text-figures 4 a—c; 5 a—c; Campanian-Santonian, Europe.

Description: Test small, planoconvex, trochoid, ventral side conical, dorsal side flat to slightly convex, small umbilical area on ventral side; periphery smooth, edge sharply rounded; chambers indistinct, about 6 to 7 in last whorl, test must be wet to observe, gradually increasing in height as added; wall calcareous, smooth, finely perforate; sutures indistinct, slightly curved, radial; aperture an elongate slit extending along base of last chamber from the periphery to the umbilicus. Diameter, 0.33 *mm.*; thickness, 0.20 *mm.*

Hypotype: SU no. 9480, Locality no. MG 880.

Genus *STENSIÖINA* BROTZEN, 1936

Stensiöina excolata (CUSHMAN)

Plate 14, figs. 7 a—c

1926 *Truncatulina excolata* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, p. 22, pl. 3, figs. 2 a, b; Upper Cretaceous, Mexico.

1940 *Stensiöina excolata.* CUSHMAN and DORSEY, Contr. Cushman Lab. Foram. Res., vol. 16, pt. 1, p. 4, pl. 1, fig. 6; Upper Cretaceous, Mexico.

1959 *Stensiöina excolata.* OLVERA, Bol. Asoc. Mex. Geol. Petr.; vol. 11, nos. 3, 4, p. 87, pl. 3, figs. 10, 12, 13; Upper Cretaceous, Mexico.

Description: Test rotaloid, almost subcircular in outline, dorsal side flat, ventral side convex with umbilical area; periphery lobulate, edge subacute; chambers distinct, about 8 or 9 in last-formed whorl, increasing rapidly in size as added; wall calcareous, smooth ventrally, dorsally roughened between sutures, coarsely perforate on ventral side, finely perforate dorsally; sutures dorsally curved, raised, those of later chambers distinct, earlier ones irregular, ventral sutures slightly curved, limbate, slightly depressed; aperture a low narrow slit at base of last chamber, nearer to umbilicus than periphery. Diameter, 0.45 *mm.*; thickness, 0.21 *mm.*

Hypotype: SU no. 9481, Locality no. MG 594.

Stensiöina exsculpta (REUSS)

Plate 14, figs. 8 a—c

1860 *Rotalia exsculpta* REUSS, Sitz. Akad. Wiss. Wien, vol. 40, p. 222, pl. 11, figs. 4 a—c; Upper Cretaceous, Germany.

1936 *Stensiöina exsculpta*. BROTZEN, Sveriges geol. undersokning, Ser. C., no. 396, p. 165, pl. 11, figs. 8 a—c; Lower Senonian, Sweden.

Description: Test rotaloid, almost circular in outline, slightly convex on dorsal side, strongly so on ventral side, small umbilicus present on ventral side; periphery gently lobulate, edge acute; chambers distinct, about 11 in last-formed whorl, increasing gradually in size as added; wall calcareous, smooth and conspicuously perforate ventrally, on dorsal side area between sutures papillate; sutures on dorsal side distinct, strongly raised, curved, joining at periphery to form continuous raised ridge, ventral ones curved and raised, aperture an elongate slit with a slight lip, at base of last chamber nearer periphery than umbilicus. Diameter, 0.35 *mm.*; thickness, 0.20 *mm.*

Remarks: This small and distinctive foraminifer is noted only in the Lower Marlife formation of the Panoche group. Its stratigraphic relationship to *Stensiöina excolata* is most interesting, as it appears—at least in the Moreno Gulch section—that these two forms have a similar stratigraphic distribution to that reported for them in Europe by BROTZEN (1936, p. 166). According to BROTZEN, *Stensiöina excolata* CUSHMAN ranges through the Senonian and *Stensiöina exsculpta* (REUSS) is found not only in the Senonian but also in the Coniacian and Turonian. It is too early to say definitely if this relationship in California is a valid one. Future work on other California section should confirm or disprove this relationship.

Hypotype: SU no. 9482, Locality no. MG 905.

Stensiöina sp.

Plate 15, figs. 1 a—c

Description: Test rotaloid, subcircular in outline, dorsal side slightly convex, ventral side strongly so, with depressed umbilical area, almost hemispheric in edge view; periphery smooth to very gently lobulate, edge acute; chambers about 7 or 8 in last-formed whorl, gradually increasing in size as added; wall calcareous, smooth, conspicuously perforate on dorsal side, chamber area between sutures finely roughened; sutures distinct, dorsal ones curved, raised, joining at periphery to form continuous raised ridge, spiral suture forming a low trochoid spire leading to fused central mass of irregular ridges; ventral sutures radial, limbate, flush to slightly depressed; aperture not clearly observed due to poor preservation but appears to be at base of last chamber near umbilical area. Diameter, 0.42 *mm.*; thickness, 0.21 *mm.*

Remarks: Although this form of *Stensiöina* appears to differ from all other described species of this genus, it seems best to defer naming it specifically until more and better preserved material is available. Only two specimens were obtained from Moreno Gulch samples.

Depository: SU no. 9483, Locality no. MG 574.

Genus *OSANGULARIA* Brotzen, 1940

Osangularia cordieriana (d'Orbigny)

Plate 15, figs. 2 a—c

1840 *Rotalina cordieriana* d'Orbigny, Mém. Soc. Geol. France, vol. 4, p. 33, pl. 3, figs. 9—11; Upper Cretaceous, Paris Basin.

1941 *Pulvinulinella cordieriana*. Marie, Mém. Mus. Hist. Nat. Paris, vol. 12, p. 228; pl. 35, figs. 329 a—c, 330; Senonian, Paris Basin.

Description: Test rotaloid, biconvex, almost circular in outline, broadly lenticular in edge view, slightly umbilicate, closely coiled; periphery lobulate, edge acute with fine but well-developed keel; chambers about 9 to 10 in last whorl, those of last whorl distinct, earlier ones less distinct toward center portion of test, increasing gradually in size as added; wall calcareous, smooth, finely perforate; sutures distinct on dorsal side, curved and gently raised, joining at periphery to form a continuous lateral keel, spiral suture raised and fusing at the center into mass of shell material, ventral sutures indistinct (best observed when test is wet), slightly curved and depressed at outer margins, joining at center of test to form flush umbilical mass; ventral aperture with 2 elongate slits, one extending near and parallel to the base of the last chamber, the other forming an angle to the first, both midway between the periphery and umbilical area. Diameter, 0.47 *mm.*; thickness, 0.24 *mm.*

Remarks: Unfortunately d'Orbigny's original figures do not lend themeselves for specific determination and were it not for the figures and detailed description given by Marie (1941), it would not have been possible to arrive at a satisfactory identification. Our specimens seem to match well those described from the Paris Basin.

Hypotype: SU no. 9484, Locality no. MG 550.

Genus *QUADRIMORPHINA* Finlay, 1939

Quadrimorphina allomorphinoides (Reuss)

Plate 15, figs. 3 a—c

1860 *Valvulina allomorphinoides* Reuss, Akad. Wiss. Wien, Math.-Naturwiss. Cl., Sitzungsber., vol. 40, p. 223, pl. 11, figs. 6 a—c; Upper Cretaceous, Germany.

1926 *Discorbis allomorphinoides*. Cushman, Bull., Amer. Assoc. Petrol. Geol., vol. 10, no. 6, p. 606, pl. 20, figs. 18, 19; Upper Cretaceous, Mexico.

1936 *Valvulineria allomorphinoides*. Brotzen, Sveriges geol. undersokning, Ser. C., no. 396, p. 153, pl. 11, figs. 1 a—c; Lower Senonian, Sweden.

1960 *Quadrimorphina allomorphinoides*. Trujillo, Journ. Pal. vol. 34, no. 2, p. 330, pl. 47, figs. 15 a—c; Upper Cretaceous, northern California.

Description: Test rotaloid, biconvex, slightly longer than wide, umbilicate; periphery lobulate, edge broadly rounded; chambers distinct, 4 in last-formed whorl, ventral ones inflated, increasing rapidly in size as added; wall calcareous, smooth, finely perforate; sutures distinct, dorsal ones slightly depressed; curved, ventral sutures more depressed than those of dorsal side, gently curved; aperture a low opening in umbilical area beneath plate-like lip of last chamber. Diameter, 0.50 *mm.*; breadth, 0.43 *mm.*; thickness, 0.24 *mm.*

Remarks: Specimens from Moreno Gulch agree very well with the original figure of REUSS.

Hypotype: SU no. 9485, Locality no. MG 576.

Genus *VALVULINERIA* CUSHMAN, 1926

Valvulineria jarvisi MARTIN, n. sp.

Plate 15, figs. 4 a—c

1932 *Valvulineria allomorphinoides.* CUSHMAN and JARVIS (not REUSS), U. S. Nat. Mus. Proc., vol. 80, art. 14, p. 46, pl. 13, figs. 17 a—c; Upper Cretaceous, Trinidad, B. W. I.

1939 *Rotamorphina cushmani* FINLAY, Trans. Roy. soc. New Zealand, vol. 69, p. 325, pl. 28, figs. 130—133; Upper Cretaceous, New Zealand.

Description: Test rotaloid, trochoid, biconvex, more so on ventral side, subcircular to circular in outline; periphery gently lobulate to lobulate, edge broadly rounded; chambers distinct, about 6 to 7 in last-formed whorl, increasing fairly rapidly in size as added; wall calcareous, smooth, finely perforate; sutures distinct, those of dorsal side tangential, slightly curved and depressed, ventral ones slightly depressed, radial; aperture a low opening on ventrally side, extending along umbilical area beneath plate-like lip of last chamber. Diameter, 0.55 *mm.*; thickness, 0.28 *mm.*

Remarks: This form has been previously recorded as a variant of *Quadrimorphina allomorphinoides* (REUSS) by CUSHMAN and JARVIS as well as other authors. It may be distinguished from the latter in having a greater number of chambers per whorl and in having tangential dorsal sutures. In the Moreno Gulch section this form as well as *Quadrimorphina allomorphinoides* (REUSS) are observed to a similar stratigraphic occurrence and distribution. Future studies in California should determine if the larger form *(Valvulineria jarvisi)* ranges into younger strata as it does in Trinidad, B. W. I.

This species is named in honor of the late Mr. P. W. JARVIS, who with Dr. Joseph A. CUSHMAN were the first to record it.

Holotype: SU no. 9486, Locality no. MG 346.

Valvulineria lenticula (REUSS)

Plate 15, figs. 5 a—c

1845 *Rotalina lenticula* REUSS, Verstein. Böhm. Kreide, pt. 1, p. 35, pl. 12, figs. 17 a—c; Upper Cretaceous, Bohemia.

1929 *Gyroidina depressa.* CUSHMAN and CHURCH, California Acad. Sci. Proc., 4th ser., vol. 18, no. 16, p. 515, pl. 41, figs. 4, 5, 6; Upper Cretaceous, central California.

1951 *Valvulineria cretacea.* BANDY, Journ. Pal., vol. 25, no. 4, p. 504, pl. 74, figs. 1 a—c; Upper Cretaceous, southern California.

1956 *Valvulineria lenticula.* HARRIS and MCNULTY, Journ. Pal., vol. 30, no. 4, p. 866, pl. 97, figs. 1—5; Upper Cretaceous, U. S. Gulf Coast.

Description: Test rotaloid, trochoid, subcircular in outline, gently compressed, slightly convex on dorsal side, less so on ventral side; periphery slightly lobulate, edge subacute to rounded; chambers 9 to 11 in last-formed whorl, gradually increasing in size as added, those of later portion of test slightly inflated, last one with ventral umbilical flap; wall calcareous, smooth, finely perforate; sutures on dorsal side moderately curved, flush, those of ventral side curved, flush, and limbate; aperture a low narrow slit extending along base of last chamber from near the periphery to the umbilical flap. Diameter, 0.40 *mm.*; thickness, 0.21 *mm.*

Remarks: This species has been the object of a study by HARRIS and McNULTY (1956). They noted a wide variation in chamber inflation, compression of the test, and peripheral taper. Specimens from Moreno Gulch exhibit some of these variations.

Hypotype: SU no. 9487, Locality no. MG 574.

Valvulineria lillisi CUSHMAN and GOUDKOFF

Plate 15, figs. 6 a—c

1944 *Valvulineria lillisi* CUSHMAN and GOUDKOFF, Contr. Cushman Lab. Foram. Res., vol. 20, pt. 3, p. 61, pl. 10, figs. 8 a—c.

Description: Test rotaloid, trochoid, subcircular in outline, slightly convex on dorsal side, strongly convex on ventral side; periphery gently lobulate, edge sharply rounded; with well-developed ventral umbilical area; chambers 7 or 8 in last-formed whorl, increasing rapidly in size as added, slightly inflated dorsally, inflated on ventral side; wall calcareous, smooth, conspicuously but not coarsely perforate; sutures distinct, curved, limbate, slightly depressed on dorsal side, curved and strongly depressed on ventral side; aperture a narrow elongate slit with a slight lip, extending from near the periphery to umbilical area on ventral side. Diameter, 0.40 *mm.*; thickness, 0.22 *mm.*

Hypotype: SU no. 9488, Locality no. MG 11, 11 A.

Family CERATOBULIMINIDAE GLAESSNER, 1945

Genus *HÖGLUNDINA* BROTZEN, 1948

Höglundina supracretacea (TEN DAM)

Plate 15, figs. 7 a—c

1925 *Epistomina caracolla*. FRANKE (not ROEMER), Geol. Pal., Inst. Univ. Greifswald Abh., vol. 6, p. 88, pl. 8, figs. 10; Senonian, Germany.
1929 *Epistomina caracolla*. CUSHMAN and CHURCH, California Acad. Sci Proc., 4th Ser., vol. 18, p. 517, pl. 40, figs. 11—13; Upper Cretaceous, central California.
1948 *Epistomina supracretacea* TEN DAM, Revue Inst. Française Pétrole et Ann. Combustibles liquides, vol. 3, no. 6, p. 163, pl. 1, fig. 8; Upper Cretaceous, Texas.
1951 *Höglundina supracretacea*. BANDY, Journ. Pal. vol. 25, no. 4, p. 507, pl. 74, figs. 3a—c; Upper Cretaceous, southern California.
1960 *Höglundina supracretacea*. TRUJILLO, Journ. Pal., vol. 34, no. 2, p. 338, pl. 49, figs. 3 a—c; Upper Cretaceous, northern California.

Description: Test rotaloid, almost circular in outline, biconvex, periphery slightly lobulate, edge acute; chambers 7 or 8 in the last-formed whorl, gradually increasing in size as added; wall calcareous, smooth, finely perforate; sutures strongly limbate, flush, oblique and gently curved on dorsal side, on ventral side nearly straight and joining at central umbo; aperture a low narrow slit at base of last chamber near the periphery, accessory apertures parallel and near ventral peripheral margins of chambers. Diameter, 0.60 *mm.*; thickness, 0.39 *mm.*

Hypotype: SU no. 9489, Locality no. MG 41.

Family ANOMALINIDAE CUSHMAN, 1927

Genus *ANOMALINA* d'ORBIGNY, 1826

Anomalina sp.

Plate 16, figs. 1 a—c

Description: Test planoconcave, early stage trochoid, later stage planispiral, biumbilicate, that of dorsal side wider and shallower than ventral umbilicus; periphery lobulate, edge rounded; chambers about 7 to 9 in last whorl, enlarging gradually as added; wall calcareous, smooth, coarsely perforate; sutures distinct, dorsal ones curved, limbate, depressed, ventral ones slightly curved, limbate, and depressed; aperture a narrow arched slit extending from dorsal to ventral umbilical areas. Diameter, 0.35 *mm.*; thickness, 0.20 *mm.*

Remarks: A few specimens of this form were obtained from Moreno Gulch samples. It resembles *Anomalina ammonoides* (REUSS) but is not as compressed and has less limbate sutures. Until detailed studies based on more material are carried out, specific determination of this form must be deferred.

Depository: SU no. 9490, Locality no. MG 574.

Anomalina becki MARTIN, n. sp.

Plate 16, figs. 2 a—c

Description: Test planispiral, subcircular in outline, biconvex, dorsal side with central plug, ventral side with distinct but less developed umbilical plug or boss; periphery smooth to slightly lobulate, edge sharply rounded; chambers numerous, about 11 to 12 in last whorl, increasing gradually in size as added; wall calcareous, smooth, conspicuously but not coarsely perforate; sutures curved, slightly raised and limbate in early stages, slightly depressed in later stages; aperture a low arched slit located at base of last chamber and extending along umbilical margin of last 2 or 3 chambers. Diameter, 0.41 *mm.*; thickness, 0.23 *mm.*

Remarks: This species differs from *Cibicides stephensoni* CUSHMAN in being almost biconvex, in having less limbate early sutures, and in being consistently smaller. It is named in honor of R. S. BECK in recognition of his work in zoning Upper Cretaceous strata of central California.

Holotype: SU no. 9491, Locality no. MG 1136.

Anomalina occidentalis MARTIN, n. sp.

Plate 16, figs. 3 a—c

Description: Test small, planispiral in adult stage, subcircular in outline, dorsal side slightly convex, ventrally more so, dorsal side with small central plug; periphery gently lobulate, edge sharply rounded; chambers numerous, about 9 to 11 in last-formed whorl, closely appressed, gradually increasing in size as added; wall calcareous, smooth, dorsal side conspicuously but not coarsely perforate, ventral side finely perforate; sutures curved, limbate, flush in early stages, slightly depressed in last few chambers; aperture a low slit located at base of last chamber and extending from periphery to umbilical area. Diameter, 0.25 *mm.*; thickness, 0.10 *mm.*

Remarks: The form here described differs from *Anomalina complanata* Reuss in having less chambers per whorl and in being less compressed. It may be distinguished from *Anomalina semicomplanata* Cushman by its smaller size, less numbers per whorl, and rounded edge.

Holotype: SU no. 9492, Locality no. MG 200.

Anomalina whitei Martin, n. sp.

Plate 16, figs. 4 a—c

1928 *Rotalia beccariiformis* var. White, Journ. Pal., vol. 2, no. 4, p. 287, pl. 39, fig. 4; Upper Cretaceous, Mexico.

Description: Test planoconvex, subcircular in outline, dorsal side slightly convex, ventral side with umbilical area; periphery smooth in early stages, lobulate in later portion, edge broadly rounded; chambers 8 or 9 in last-formed whorl, gradually increasing in size as added, last one with large and broadly rounded septal face, wall calcareous, smooth except for minute irregular lines and depressions near ventral umbilical area and extending outward for a short distance, finely perforate; sutures flush, slightly curved on dorsal side, generally indistinct on ventral side (seen only when test is wet), radial; aperture a low narrow slit at base of last chamber and extending from periphery to umbilical area. Diameter, 0.42 *mm.*; thickness, 0.20 *mm.*

Remarks: This distinctive form was first described from the Velasco and Mendez formations of Mexico. The California specimens appear to have the same characteristic thread-like lines and small depressions in the ventral umbilical area. It is named in honor of Dr. M. P. White who first recorded it.

Holotype: SU no. 9493, Locality no. MG 544.

Genus *PLANULINA* d'Orbigny, 1826

Planulina popenoei (Trujillo)

Plate 16, figs. 6 a—c

1960 *Anomalina popenoei* Trujillo, Journ. Pal., vol. 34, no. 2, p. 335, pl. 48, figs. 9 a—c; Upper Cretaceous, northern California.

Description: Test low trochoid, generally biconvex, ventral side with concave umbilical area, circular in outline, lenticular in edge view; periphery lobulate, edge with narrow keel; chambers numerous, 10 to 11 in last-formed whorl, gradually increasing in size as added, curved, tangentially arranged, gently inflated, on ventral side with thickening adjacent to location of relict aperture; wall calcareous, smooth, finely perforate; sutures curved, raised, and limbate on dorsal side, depressed, curved, and limbate on ventral side; aperture a low slit at base of last chamber and extending from near the periphery on the ventral side to the umbilical area. Diameter, 0.42 *mm.*; thickness, 0.13 *mm.*

Remarks: This form is closely related to *Planulina spissocostata* CUSHMAN described from the Gulf Coast of the United States. The California species may be differentiated by the presence of a narrow keel, fewer chambers per whorl, and greater involution of the ventral side.

Hypotype: SU no. 9494, Locality no. MG 730.

Planulina mascula BANDY

Plate 16, figs. 7 a—c

1951 *Planulina mascula* BANDY, Journ. Pal., vol. 25, no. 4, p. 506, pl. 74, figs. 8 a—c; Upper Cretaceous, southern California.

Description: Test planispiral, subcircular in outline, dorsally slightly umbilicate, spire visible on both sides; periphery gently lobulate, particularly in later chambers, smooth in early portion, edge broadly rounded; chambers about 10 to 11 in last-formed whorl, gradually increasing in size as added; wall calcareous, smooth, coarsely perforate; sutures slightly curved, gently depressed in later stage, flush in earlier portion of test; aperture a low slit at base of last chamber and extending dorsally along umbilical margin of last few chambers. Diameter, 0.35 *mm.*; thickness, 0.14 *mm.*

Remarks: This form differs from *Planulina nacatochensis* CUSHMAN, described from the Gulf Coast of the United States, in its much thicker test, curved sutures, and more distinct perforations.

Hypotype: SU no. 9495, Locality no. LS 609.

Genus *CIBICIDOIDES* BROTZEN, 1936

Cibicidoides validus MARTIN, n. sp.

Plate 16, figs. 5 a—c

Description: Test rotaloid, biconvex, subcircular in outline, lenticular in edge view, nearly involute on dorsal and ventral sides, dorsal side with centrally raised boss, ventral side with central flush umbo; periphery smooth, edge sharply rounded; chambers numerous, 14 to 15 in last-formed whorl, gradually increasing in size as added, closely appressed; wall calcareous, coarsely perforate; sutures raised, curved, limbate, coalescing on ventral side to form flush umbo, on dorsal side forming raised boss; aperture an arched slit at base or peripheral margin of last chamber and extending dorsally along the inner borders of the last 3 or 4 chambers. Diameter, 0.38 *mm.*; thickness, 0.15 *mm.*

Remarks: This distinctive form may be distinguished from *Cibicides constrictus* (REUSS) in having raised sutures and compressed chambers, in lacking an acute edge, and in being biconvex.

Holotype: SU no. 9496, Locality no. MG 346.

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Appendix A

List of samples from Moreno Gulch surface section, Panoche Hills, Fresno County, California

Sample Number	Stratigraphic Allocation (Ft.)	Sample Interval (Ft.)
5	50	50
10	100	50
11—11 A	110	10
30	290	180
31	300	10
41	400	100
59	580	180
61	600	20
62	610	10
65	640	30
71	700	60
72	720	20
74	740	20
87	900	160
92	1040	140
113	1220	180
126	1340	120
153	1595	255
165	1730	135
178	1870	140
187	1990	120
190	2020	30
194	2060	40
198	2239	179
200	2269	30
201	2284	15
204	2314	30
210	2374	60
216	2434	60
219	2464	30
220	2480	16
225	2530	50
229	2680	150
237	2760	80
238	2770	10
239	2780	10
247	2920	120
249	2930	10
260	3160	250
262	3180	20
269	3260	80
278	3640	380
291	4170	530

Appendix A Cont'd.

Sample Number	Stratigraphic Allocation (Ft.)	Sample Interval (Ft.)
295	4210	40
300	4260	50
307	4370	110
310	4395	25
317	4470	75
320	4500	30
333	4655	155
337	4695	40
346	4810	115
355	4905	95
370	5040	135
374	5100	60
391	5260	160
408	5445	185
410	5465	20
425	5610	145
443	5780	170
452	5870	90
458	5930	60
463	5980	50
484	6335	355
501	6515	180
508	6590	75
513	6640	50
516	6670	30
525	6760	90
529	6800	40
544	6950	150
546	6970	20
550	7010	40
553	7040	30
557	7080	40
568	7190	110
573	7240	50
574	7250	10
581	7320	70
587	7380	60
594	7450	70
603	7540	90
610	7610	70
618	7690	80
636	7870	180
654	8050	180
670	8210	160
681	8320	110

Appendix A Cont'd.

Sample Number	Stratigraphic Allocation (Ft.)	Sample Interval (Ft.)
692	8430	110
710	8600	170
727	8760	160
729	8780	20
730	8790	10
751	9005	215
765	9140	135
770	9190	50
794	9430	240
800	9490	60
806	9550	60
812	9610	60
813	9620	10
833	9820	200
847	9970	150
849	9990	20
872	10220	230
874	10240	20
875	10275	35
880	10325	50
887	10395	70
894	10455	60
905	10560	105
920	10710	150
923	10750	40
934	10840	50
937	10870	30
951	11010	140
959	11090	80
961	11110	20
966	11160	50
970	11200	40
982	11320	120
1004	11545	225
1008	11585	40
1012	11625	40
1029	11795	170
1031	11810	15
1037	11870	60
1052	12035	165
1061	12125	90
1066	12175	50
1083	12345	170
1088	12395	50
1098	12495	100

Appendix A Cont'd.

Sample Number	Stratigraphic Allocation (Ft.)	Sample Interval (Ft.)
1107	12585	90
1119	12705	120
1136	12875	170
1147	12985	110
1158	13205	220
1179	13405	200
1180	13415	10
1190	13515	100
1199	13605	90
1207	13695	90
1209	13715	20
1220	13825	110
1225	13875	50
1236	13985	110
1237	13995	10
1242	14080	90

Appendix B

List of samples from Laguna Seca Creek surface section, Laguna Seca Hills, Merced County, California.

Sample Number	Stratigraphic Allocation (Ft.)	Sample Interval (Ft.)
170	0	0
166	35	35
165	40	5
158	75	35
154	95	20
147	130	35
135	230	100
133	240	10
131	250	10
130	255	5
128	265	10
127	270	5
126	275	5
125	425	150
121	435	20
120	447	12
118	481	34
116	505	24
115	517	12
114	525	8
113	537	12
112	548	11
110	570	22
108	590	20
107	598	8
103	625	27
102	631	6
89	708	77
87	718	10
85	728	10
84	735	5
80	753	20
78	763	10
75	783	20
66	832	49
63	851	19
58	880	29
50	1105	225
44	1147	42
43	1154	7
41	1188	34
38	1213	25

Appendix B Cont'd.

Sample Number	Stratigraphic Allocation (Ft.)	Sample Interval (Ft.)
35	1253	40
32	1274	21
27	1309	35
24	1313	12
22	1321	8
18	1337	16
17	1341	4
16	1347	6
12	1361	14
9	1373	12
6	1385	12
3	1400	15
1	1410	10

Appendix C

Fossil Locality Register

Microfossils

1. *Siphogenerinoides whitei* Type locality — near center sec. 6, T. 15 S., R. 12 E., M. D., Panoche Hills, Fresno County, California.

Megafossils

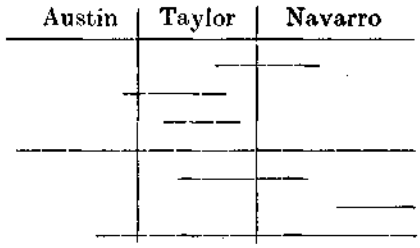
1. LSJU 3329 sec. 7, T. 15 S., R. 12 E. M. D., Marca shale member, Moreno formation, Panoche Hills, Fresno County, California.
2. LSJU 3326 sec. 12, T. 15 S., R. 11 E., M. D., upper Uhalde formation, Panoche group, Panoche Hills, Fresno County, California.
3. LSJU 3323 sec. 15, T. 14 S., R. 11 E., M. D., Upper Marlife formation, Panoche group, Panoche Hills, Fresno County, California.
4. CAS 28542 near center sec. 15, T. 14 S., R. 11 E., M. D., Upper Marlife formation, Panoche group, Panoche Hills, Fresno County, California.
5. LSJU 3320 sec. 9, T. 14 S., R. 11 E., M. D., Upper Marlife formation (lower part), Panoche group, Panoche Hills, Fresno County, California.
6. LSJU 3316 sec. 17, T. 14 S., R. 11 E., M. D., Lower Marlife formation, Panoche group, Panoche Hills, Fresno County, California.
7. LSJU 3315 sec. 28, T. 14 S., R. 11 E., M. D., Lower Marlife formation, Panoche group, Panoche Hills, Fresno County, California.

LSJU = Leland Stanford Junior University localities.
CAS = California Academy Science locality.

Appendix D

Stratigraphic ranges of Gulf Coast Upper Cretaceous Foraminifera occurring in central California (After CUSHMAN, 1946; FRIZZELL, 1954).

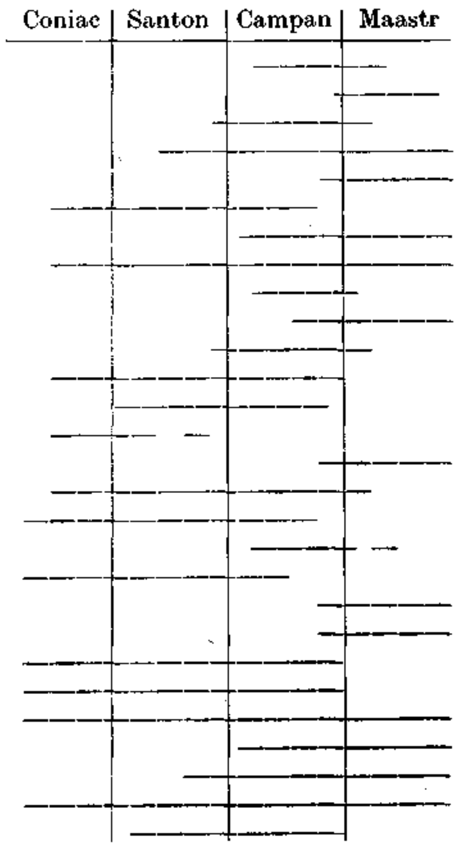
	Austin	Taylor	Navarro
Apiopterina cylindroides			—
Astacolus jarvisi			—
Bolivina incrassata			—
Bolivinitella eleyi	—	—	
Bolivinoides latticeus		—	—
Bulimina aspera		—	—
Bulimina prolixa		—	—
Bulimina reussi	—	—	—
Buliminella carseyae	—	—	—
Buliminella cushmani	—	—	—
Clavulinoides trilaterus		—	—
Dentalina aculeata	—	—	
Dentalina basiplanata		—	—
Dentalina megalopolitana		—	—
Dorothia bulletta		—	—
Frondicularia archiaciana		—	—
Gaudryina laevigata		—	—
Gaudryina rudita	—	—	—
Globorotalites michelinianus	—	—	
Globorotalites subconicus	—	—	
Globotruncana arca		—	—
Globotruncana paraventricosa	—	—	
Globotruncana rosetta		—	—
Globulina lacrima subsphaerica		—	—
Glomospira gordialis	—	—	—
Gyroidina globosa	—	—	—
Haplophragmoides calcula	—	—	—
Haplophragmoides excavata		—	—
Haplophragmoides glabra			—
Heterohelix globulosa		—	—
Heterohelix pulchra	—	—	
Heterohelix striata	—	—	—
Höglundina supracretacea		—	—
Involutina glabratus	—	—	—
Kyphopyxa christneri	—	—	—
Lagena acuticosta	—	—	—
Lagena apiculata		—	—
Lagena paucicosta		—	—
Lenticulina rotulata	—	—	—
Marssonella oxycona	—	—	—
Marginulina bullata		—	—
Neoflabellina rugosa	—	—	—
Nodosarella gracillima	—	—	
Nodosarella texana	—	—	—



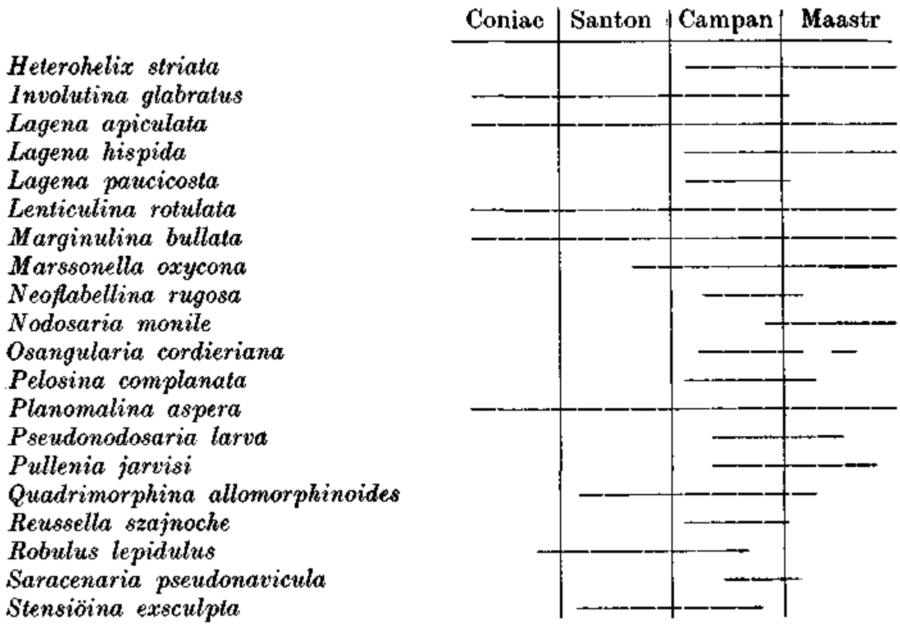
Palmula primitiva
Pelosina complanata
Pseudogaudryinella capitosa
Pseudonodosaria larva
Rzehakina epigona lata
Rugoglobigerina rugosa
Valvulineria lenticula

Appendix E

Stratigraphic ranges of northwestern European Upper Cretaceous Foraminifera occurring in central California (After HILTERMANN, 1956; HOFKER, 1957; MARIE, 1941; SCHIJSMA, 1946; TEN DAM and MAGNE, 1948; and WICHER and BETTENSTAEDT, 1957).



Apiopterina cylindroides
Bolivina incrassata
Bolivinitella eleyi
Bulimina aspera
Bulimina prolixa
Bulimina reussi
Buliminella carseyae
Dentalina aculeata
Dentalina basiplanata
Dorothia bulletta
Frondicularia archiaciana
Gaudryina laevigata
Globorotalites michelinianus
Globorotalites subconicus
Globotruncana arca
Globotruncana linneiana tricarinata
Globotruncana linneiana
Globotruncana mariai
Globotruncana paraventricosa
Globotruncana rosetta
Globulina lacrima subsphaerica
Glomospira charoides
Glomospira charoides corona
Glomospira gordialis
Gublerina ornatissima
Gyroidina globosa
Heterohelix globulosa
Heterohelix pulchra


Coniac
Santon
Campan
Maastr
Heterohelix striata
Involutina glabratus
Lagena apiculata
Lagena hispida
Lagena paucicosta
Lenticulina rotulata
Marginulina bullata
Marssonella oxycona
Neoflabellina rugosa
Nodosaria monile
Osangularia cordieriana
Pelosina complanata
Planomalina aspera
Pseudonodosaria larva
Pullenia jarvisi
Quadrimorphina allomorphinoides
Reussella szajnoche
Robulus lepidulus
Saracenaria pseudonavicula
Stensiöina exsculpta

Explanation of Plate 1

Figure | Page

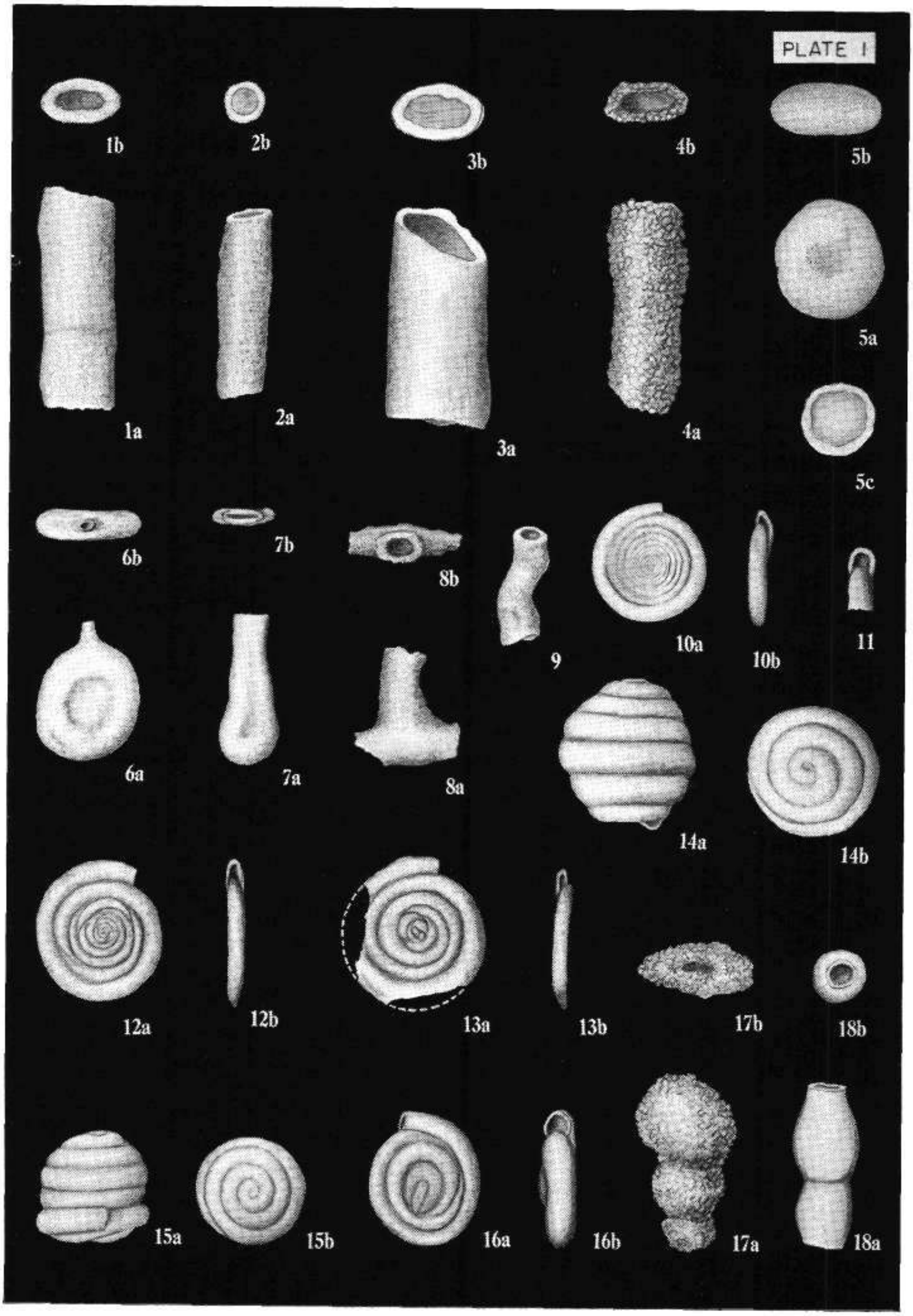
1. *Bathysiphon dubia* (WHITE). 66× ... 42
   a, Side view; b, end view; SU no. 9331
2. *Bathysiphon californicus* MARTIN, n. sp. 25× ... 43
   a, Side view; b, end view; SU no. 9331 A
3. *Bathysiphon* sp. 40× ... 43
   a, Side view; b, end view; SU no. 9332
4. *Psammosiphonella llanadoensis* MARTIN, n. sp. 16× ... 43
   a, Side view; b, end view; SU no. 9333
5. *Psammosphaera laevigata* WHITE. 17× ... 44
   a, Side view; b, end view; c, cross section; SU no. 9334
6. *Pelosina complanata* FRANKE. 38× ... 44
   a, Side view; b, end view; SU no. 9335
7. *Hyperammina elongata* H. B. BRADY. 32× ... 44
   a, Side view; b, end view; SU no. 9336

8, 9. *Saccorhiza ramosa* (H. B. BRADY). 18× ... 45
   a, Side view; b, end view; SU no. 9337

10, 11. *Involutina glabratus* (CUSHMAN and JARVIS). 26× ... 45
   a, Side view; b, end view; SU no. 9338
   11. Enlarged apertural view of another specimen.

12, 13. *Involutina irregularis* (REUSS). 55× ... 45
   a, Side view; b, end view; SU no. 9339

14. *Glomospira charoides* (JONES and PARKER). 60× ... 46
   a, Side view; b, end view; SU no. 9340
15. *Glomospira charoides corona* CUSHMAN and JARVIS. 50× ... 46
   a, Side view; b, end view; SU no. 9341
16. *Glomospira gordialis* (JONES and PARKER). 36× ... 46
   a, Side view; b, end view; SU no. 9342
17. *Reophax* sp. 28× ... 46
   a, Side view; b, end view; SU no. 9343
18. *Nodellum velascoensis* CUSHMAN. 29× ... 47
   a, Side view; b, end view; SU no. 9344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Explanation of Plate 2

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1. *Trochamminoides proteus* (KARRER). 41 × ... 47
   a, Side view; b, end view; SU no. 9345
2. *Haplophragmoides calcula* CUSHMAN and WATERS. 25 × ... 47
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3, 4. *Haplophragmoides impensus* MARTIN, n. sp. 35 × ... 48
   a, Side view; b, edge view; SU no. 9349
   3. Holotype; 4. Paratype illustrating usual deformity.
5. *Haplophragmoides glabra* CUSHMAN and WATERS. 42 × ... 48
   a, Side view; b, edge view; SU no. 9348
6, 7. *Haplophragmoides incognatus* MARTIN, n. sp. 41 × ... 49
   a, Side view; b, edge view; SU no. 9350
   6. Holotype; 7. Paratype showing usual deformity.
8. *Haplophragmoides excavata* CUSHMAN and WATERS. 18 × ... 48
   a, Side view; b, edge view; SU no. 9347
9. *Haplophragmoides kirki* WICKENDEN. 57 × ... 49
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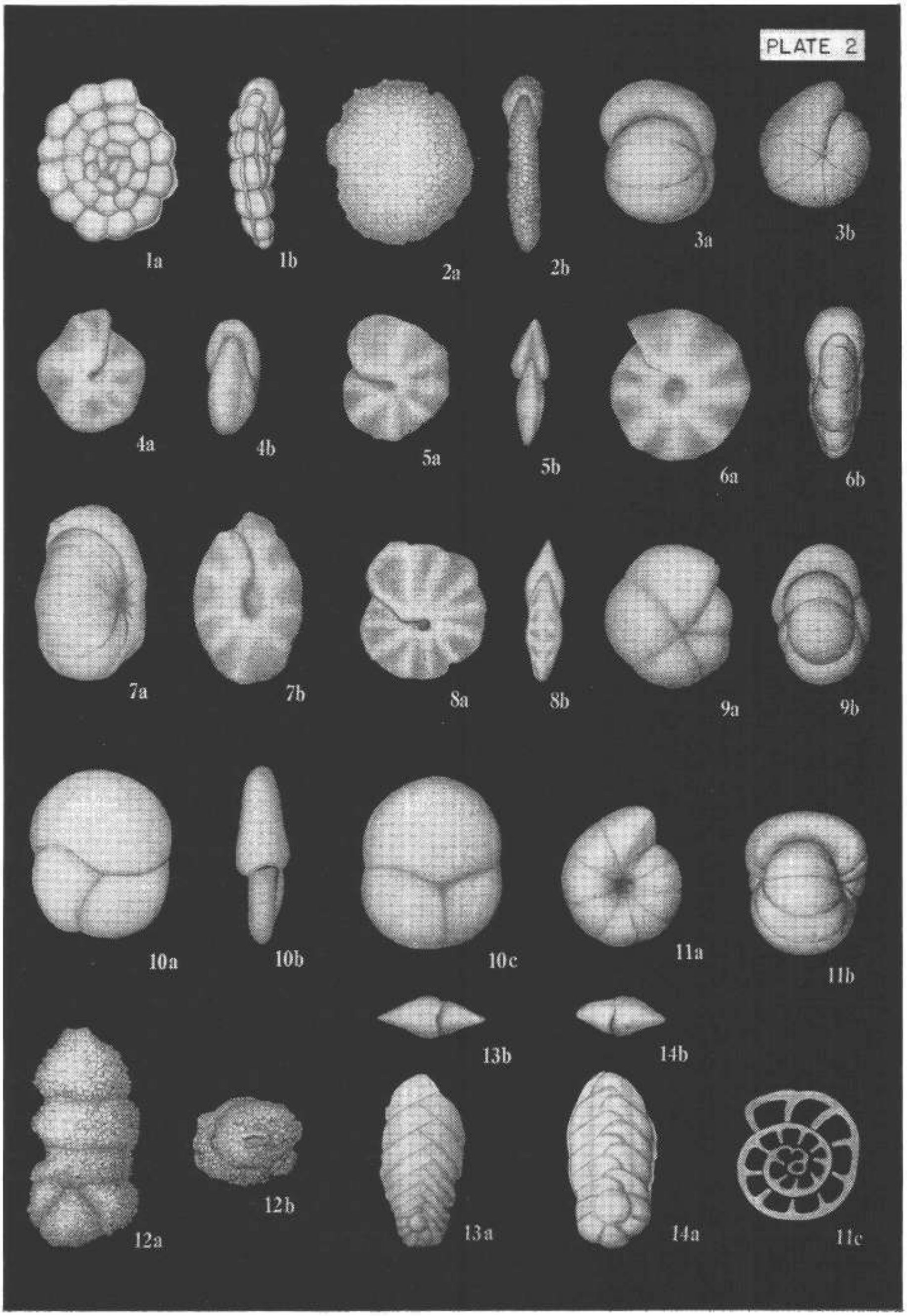
10. *Haplophragmoides trifolium* (EGGER). 42 × ... 49
   a, Side view; b, edge view; c, back view; SU no. 9352
11. *Cribrostomoides cretacea* CUSHMAN and GOUDKOFF. 52 × ... 50
   a, Side view; b, edge view; c, section showing simple chamber arrangement; SU no. 9353
12. *Ammobaculites* sp. 17 × ... 50
   a, Side view; b, end view; SU no. 9354
13. *Spiroplectammina chicoana* LALICKER. 36 × ... 51
   a, Side view; b, apertural view; SU no. 9355
14. *Spiroplectammina perplexa* ISRAELSKY. 55 × ... 51
   a, Side view; b, apertural view; SU no. 9356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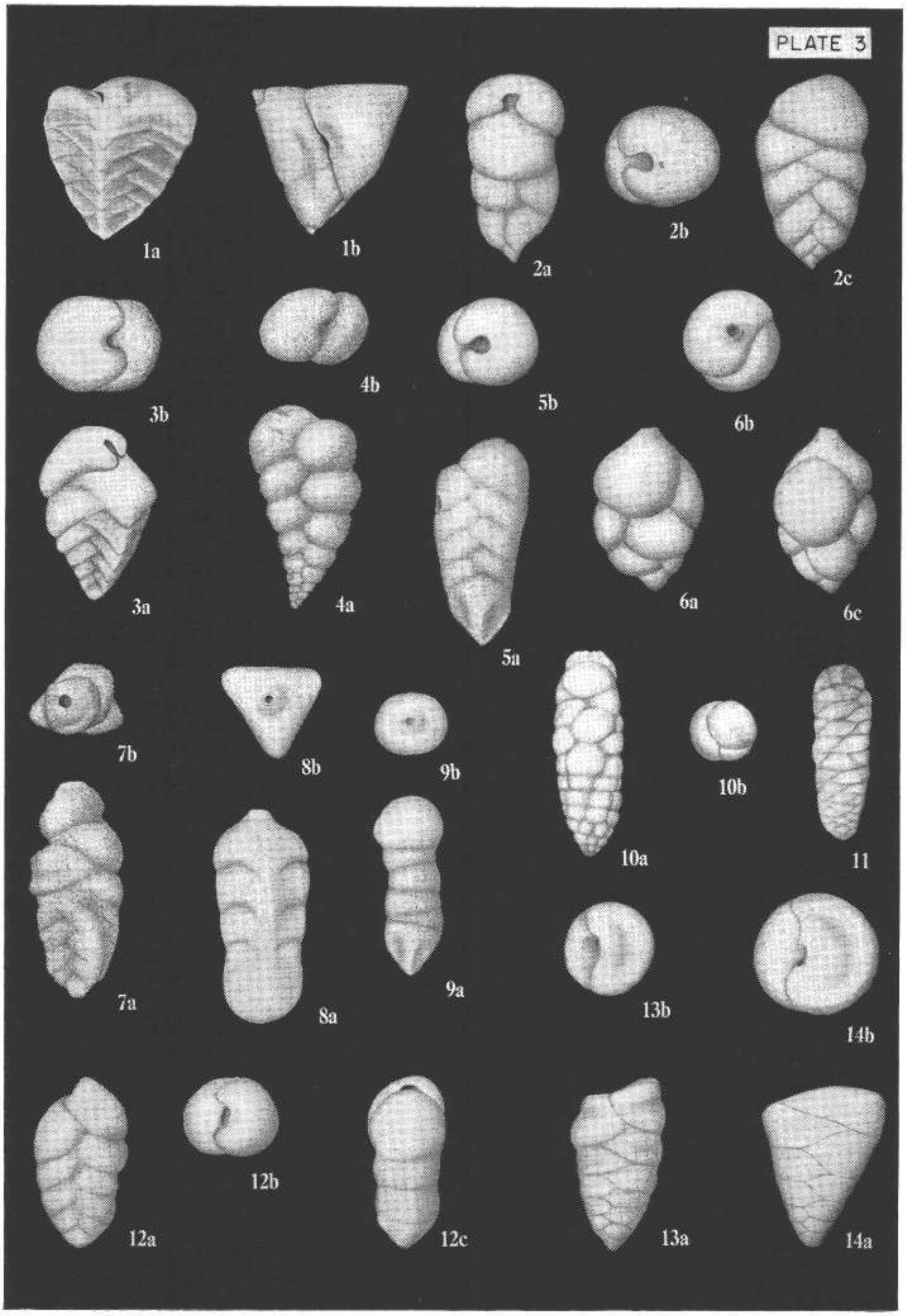
Explanation of Plate 3

Figure | Page

1. *Verneuilina münsteri* REUSS. 29× 51
   a, Side view; b, apertural view; SU no. 9357
2. *Gaudryina laevigata* FRANKE. 31× 52
   a, c, Side views; b, apertural view; SU no. 9358
3. *Gaudryina pyramidata* CUSHMAN. 30× 52
   a, Side view; b, apertural view; SU no. 9359
4. *Gaudryina rudita* SANDIDGE. 40× 53
   a, Side view; b, apertural view; SU no. 9360
5. *Gaudryina rudita diversa* CUSHMAN and GOUDKOFF. 25× 53
   a, Side view; b, apertural view; SU no. 9361
6. *Bermudezina uvigerinaeformis* MARTIN, n. sp. 36× 53
   a, Side view; b, apertural view; SU no. 9362
7. *Pseudogaudryinella capitosa* (CUSHMAN). 36× 54
   a, Side view; b, apertural view; SU no. 9363
8. *Clavulinoides trilaterus* CUSHMAN. 40× 54
   a, Side view; b, apertural view; SU no. 9364
9. *Clavulinoides* sp. 32× 54
   a, Side view; b, apertural view; SU no. 9365

10, 11. *Eggerella obscura* MARTIN, n. sp. 43× 55
   a, Side view; b, apertural view; SU no. 9366
   10. Holotype; 11. Paratype.

12. *Dorothia bulletta* (CARSEY). 24× 55
   a, c, Side views; b, apertural view; SU no. 9367
13. *Marssonella indentata* (CUSHMAN and JARVIS). 30× 55
   a, Side view; b, apertural view; SU no. 9368
14. *Marssonella oxycona* (REUSS). 36× 56
   a, Side view; b, apertural view; SU no. 9369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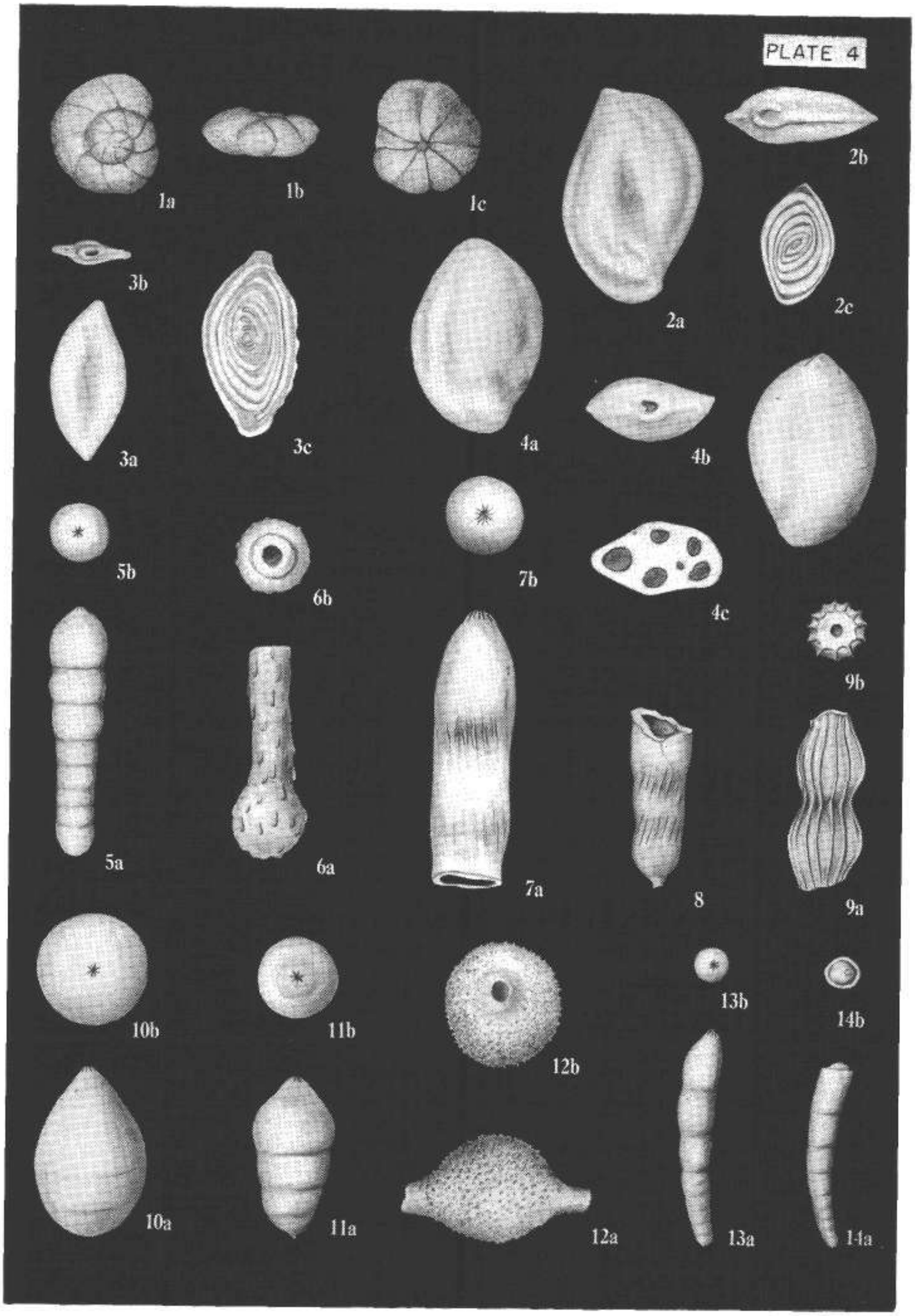
2.	*Rzehakina epigona lata* CUSHMAN and RENZ. 50× .... a, Side view; b, apertural view; c, section in reflected light; SU no. 9371	56
3.	*Rzehakina epigona minima* CUSHMAN and RENZ. 48× .... a, Side view; b, apertural view; c, section in reflected light; SU no. 9372	59
4.	*Silicosigmoilina californica* CUSHMAN and CHURCH. 32× .... a, Side view; b, apertural view; c, cross section; SU no. 9373	59
5.	*Nodosaria monile* v. HAGENOW. 34× .... a, Side view; b, apertural view; SU no. 9374	58
6.	*Nodosaria spinifera* CUSHMAN and CAMPBELL. 32× .... a, Side view; b, apertural view; SU no. 9375	58
7, 8.	*Nodosaria velascoensis* CUSHMAN and JARVIS. 21× .... a, Side view; b, apertural view; SU no. 9376	58
9.	*Nodosaria* sp. 22× .... a, Side view; b, end view; SU no. 9377	59
10.	*Glandulina parallela* MARSSON. 51× .... a, Side view; b, apertural view; SU no. 9378	59
11.	*Pseudonodosaria larva* (CARSEY). 48× .... a, Side view; b, apertural view; SU no. 9379	59
12.	*Dentalina aculeata* d'ORBIGNY. 34× .... a, Side view; b, end view; SU no. 9380	60
13.	*Dentalina basiplanata* CUSHMAN. 16× .... a, Side view; b, apertural view; SU no. 9381	60
14.	*Dentalina megalopolitana* REUSS. 21× .... a, Side view; b, apertural view; SU no. 9382	60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1. *Lingulina californiensis* TRUJILLO. 51 × a, Side view; b, apertural view; c, edge view; SU no. 9383	61
2. *Lagena acuticosta* REUSS. 90 × a, Side view; b, apertural view; SU no. 9384	61
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5. *Lagena amorpha paucicosta* FRANKE. 63 × a, Side view; b, apertural view; SU no. 9387	62
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7. *Lagena hispida* REUSS. 32 × a, Side view; b, apertural view; SU no. 9389	63
8. *Oolina* (?) *simplex* REUSS. 30 × a, Side view; b, apertural view; SU no. 9390	63
9. *Fissurina orbignyana* SEGUENZA. 29 × a, Side view; b, apertural view; SU no. 9391	63
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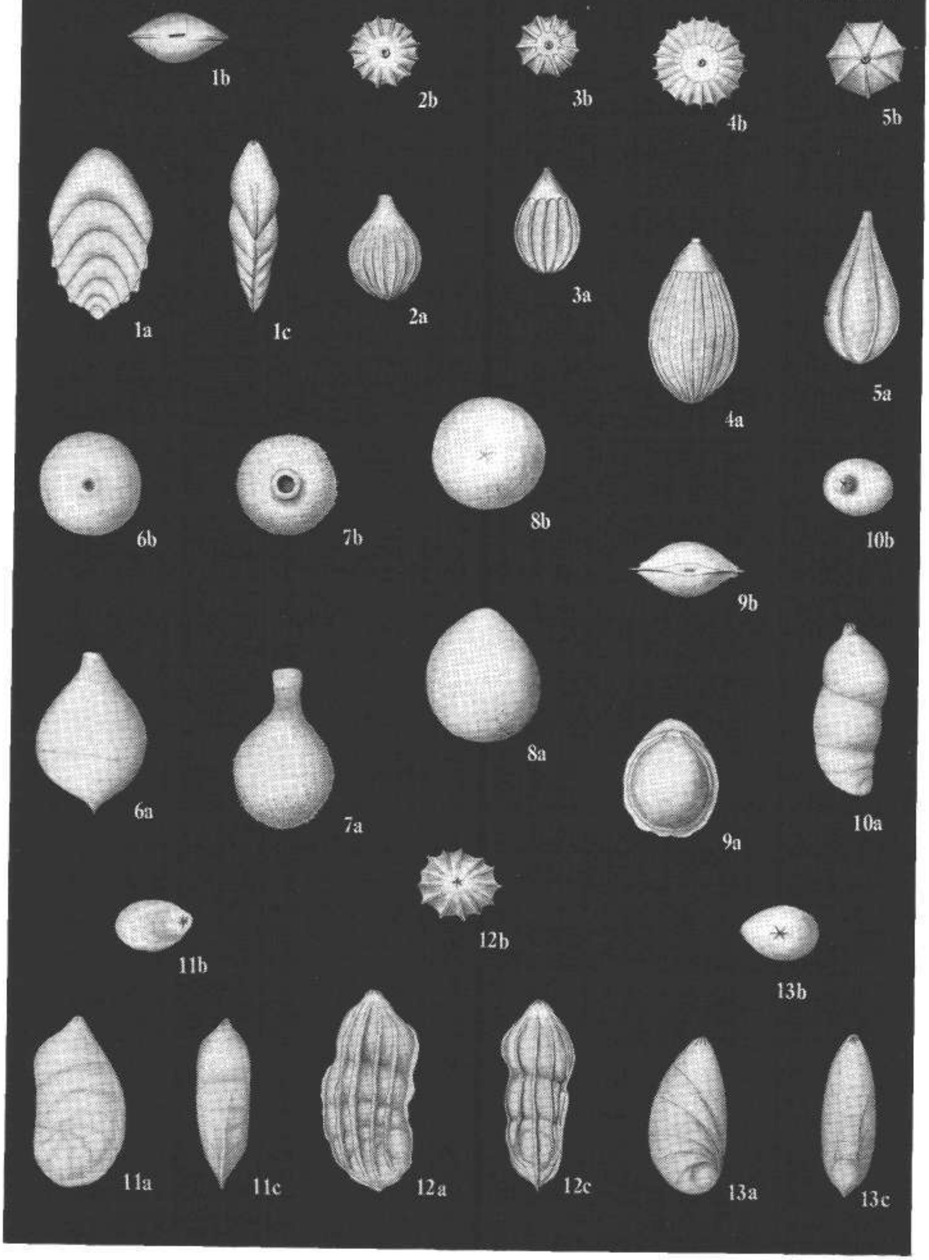
12. *Marginulina curvisepta* CUSHMAN and GOUDKOFF. 36 × a, Side view; b, apertural view; c, edge view; SU no. 9394	64
13. *Astacolus jarvisi* (CUSHMAN). 23 × a, Side view; b, apertural view; c, edge view; SU no. 9395	65

PLATE 5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2.	*Lenticulina nuda* (REUSS). 22× .... a, Side view; b, edge view; SU no. 9397	65
3.	*Lenticulina praeconvergens* MARTIN, n. sp. 32× .... a, Side view; b, edge view; SU no. 9398	66
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5.	*Lenticulina rotulata* (LAMARCK). 37× .... a, Side view; b, edge view; SU no. 9400	67
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7.	*Lenticulina velascoensis* WHITE. 39× .... a, Side view; b, edge view; SU no. 9402	67
8.	*Lenticulina* sp. A. 33× .... a, Side view; b, edge view; SU no. 9403	68
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10.	*Robulus lepidulus* (REUSS). 25× .... a, Side view; b, edge view; SU no. 9405	68
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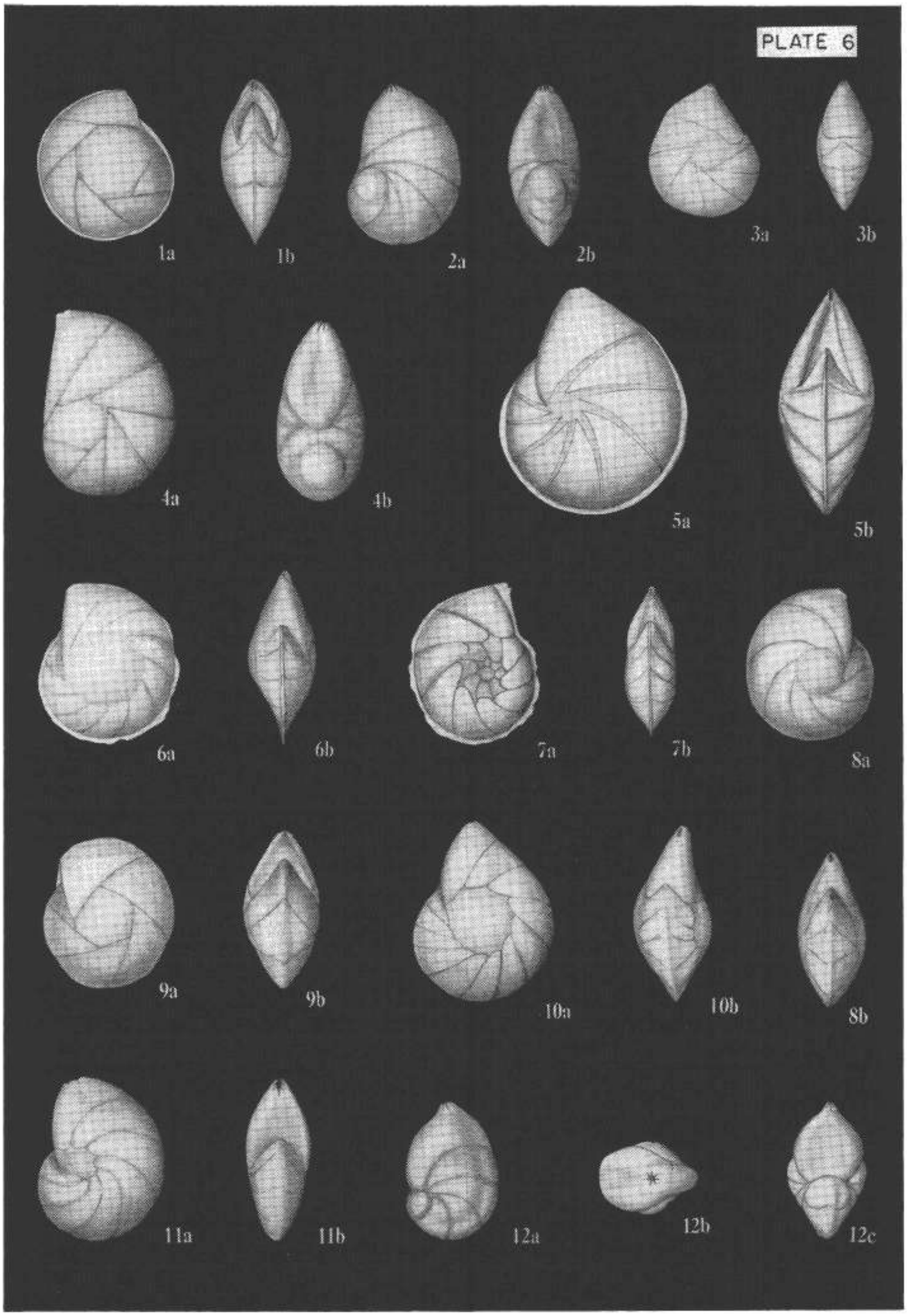
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3.	*Saracenaria acutauricularis* (FICHTEL and MOLL). 36× ..... a, Side view; b, edge view; SU no. 9410	70
4.	*Saracenaria pseudonavicula* MARIE. 34× ..... a, Side view; b, edge view; SU no. 9411	70
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9.	*Neoflabellina rugosa* (d'ORBIGNY). 32× ..... a, Side view; b, end view; c, edge view; SU no. 9416	72
10.	*Frondicularia archiaciana* d'ORBIGNY. 13× ..... a, Side view; b, end view; c, edge view; SU no. 9417	73
11.	*Apiopterina cylindroides* (ROEMER). 46× ..... a, Side view; b, end view; SU no. 9420	73
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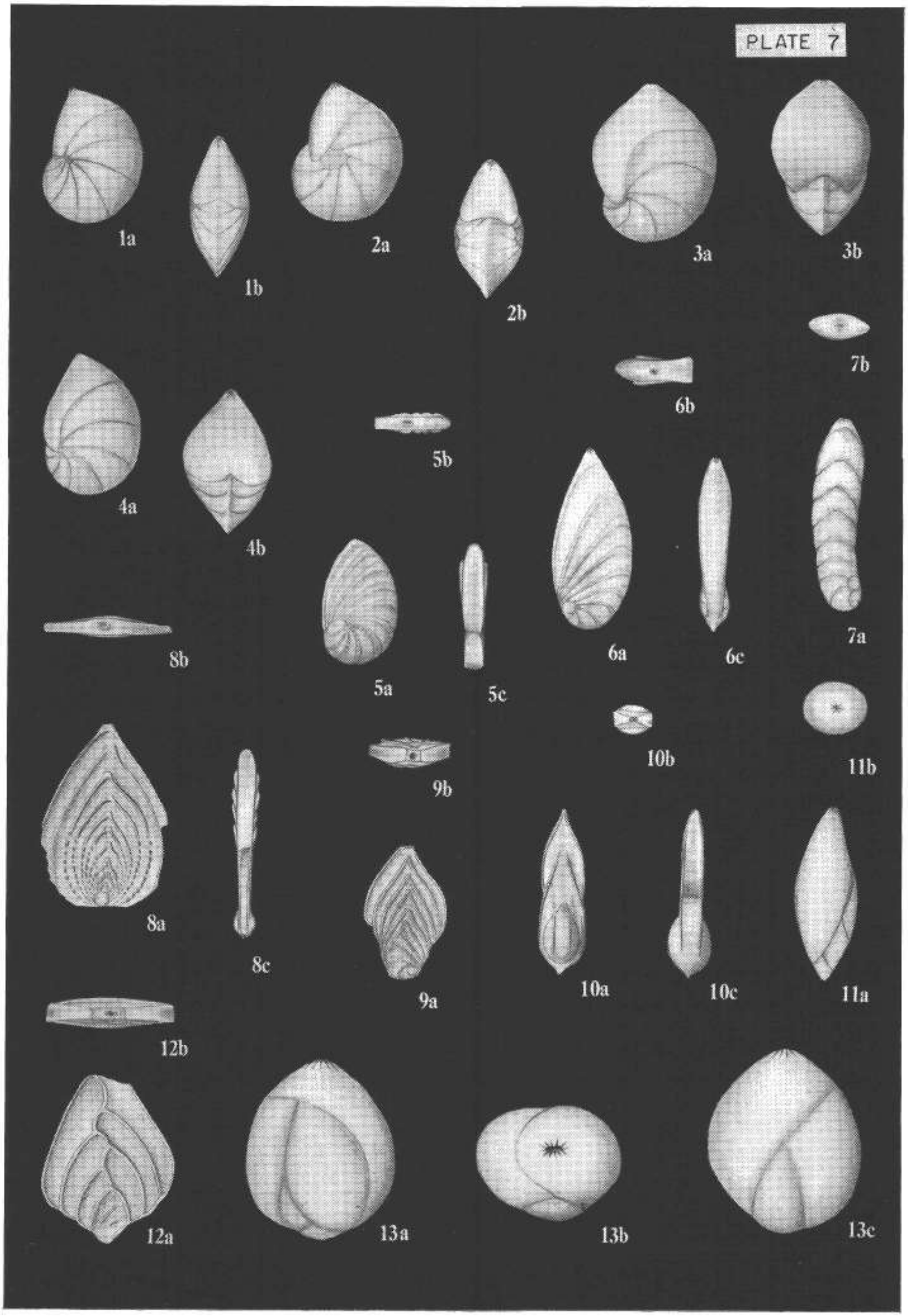
13.	*Globulina lacrima subsphaerica* (BERTHELEIN). 56× ..... a, c, Side views; b, apertural view; SU no. 9419	73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Explanation of Plate 8

Figure | Page

1. *Globulina lacrima subsphaerica* (BERTHELEIN). 59× 73
   a, c, d, Side views; b, e, end views; SU no. 9419
2. *Pleurostomella greatvalleyensis* TRUJILLO. 60× 74
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3. *Pleurostomella* sp. 34× 74
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4. *Ellipsoglandulina velascoensis* CUSHMAN. 53× 76
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5. *Ellipsonodosaria subnodosa* (GUPPY). 36× 75
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6. *Nodosarella gracillima* CUSHMAN. 35× 75
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7. *Nodosarella texana* CUSHMAN. 27× 57
   a, c, Side views; b, end view; SU no. 9424
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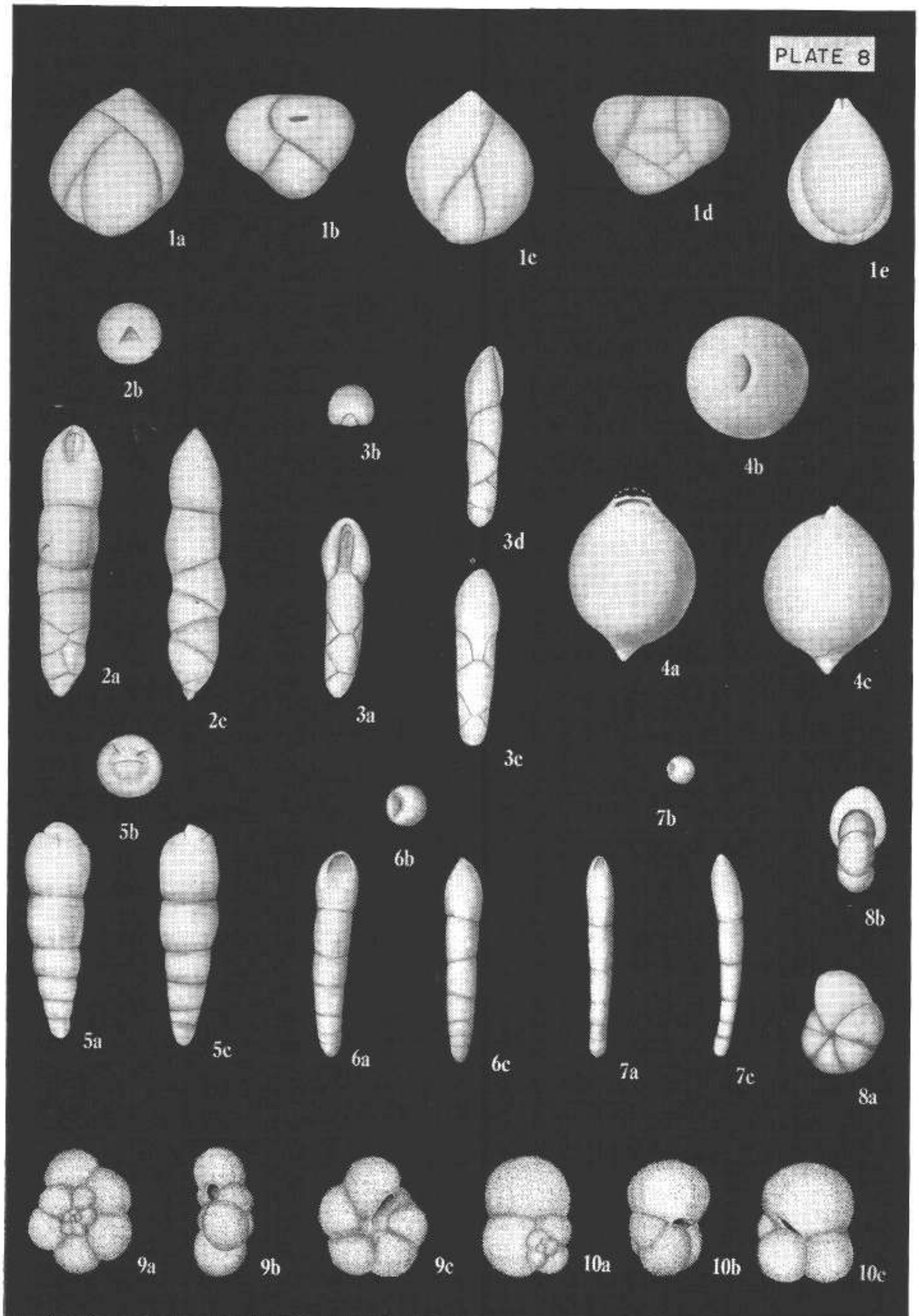
   a, Dorsal view; b, edge view; c, ventral view; SU no. 9428
10. *Globigerina triloculinoides* PLUMMER. 85× 77
    a, Dorsal view; b, edge view; c, ventral view; SU no. 9430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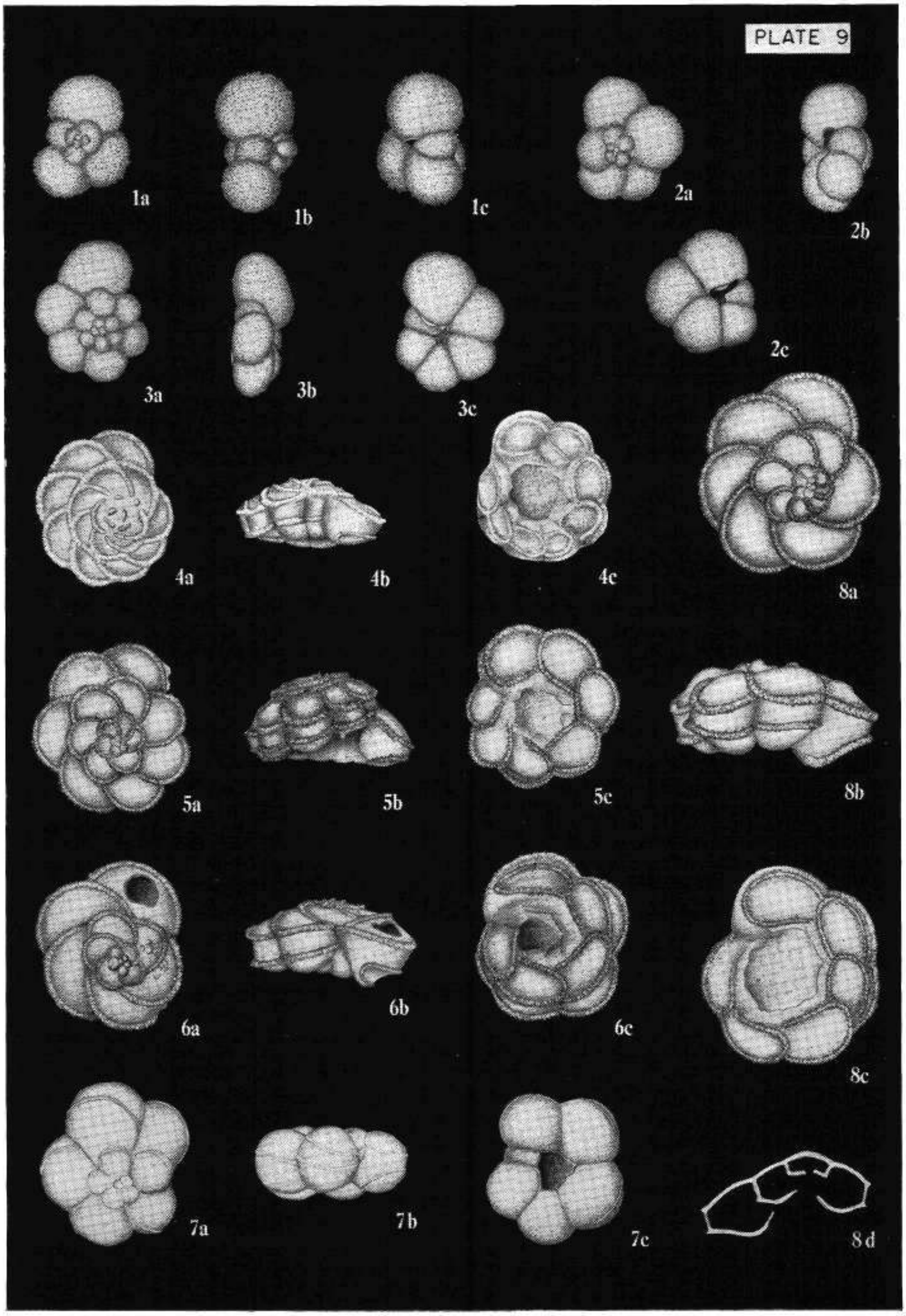
Explanation of Plate 9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1.	*Globotruncana goudkoffi* MARTIN, n. sp. 46 × .... a, Dorsal side; b, side view; c, ventral view; SU no. 9435	80
2.	*Globotruncana linneiana tricarinata* (QUEREAU). 38 × .... a, Dorsal view; b, side view; c, ventral view; SU no. 9437	81
3.	*Globotruncana linneiana* (d'ORBIGNY). 44 × .... a, Dorsal view; b, side view; c, ventral view; SU no. 9438	81
4.	*Globotruncana paraventricosa* (HOFKER). 44 × .... a, Dorsal view; b, side view; c, ventral view; SU no. 9439	81
5.	*Globotruncana rosetta* (CARSEY). 43 × .... a, Dorsal view; b, side view; c, ventral view; SU no. 9442	83
6.	*Rugoglobigerina rugosa* (PLUMMER). 68 × .... a, Dorsal view; b, side view; c, ventral view; SU no. 9443	83
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8, 9.	*Planomalina alvarezi* OLVERA. 63 × .... a, c, Side views; b, edge view; SU no. 9445	84
10.	*Heterohelix globulosa* (EHRENBERG). 64 × .... a, Side view; b, edge view; SU no. 9446	84

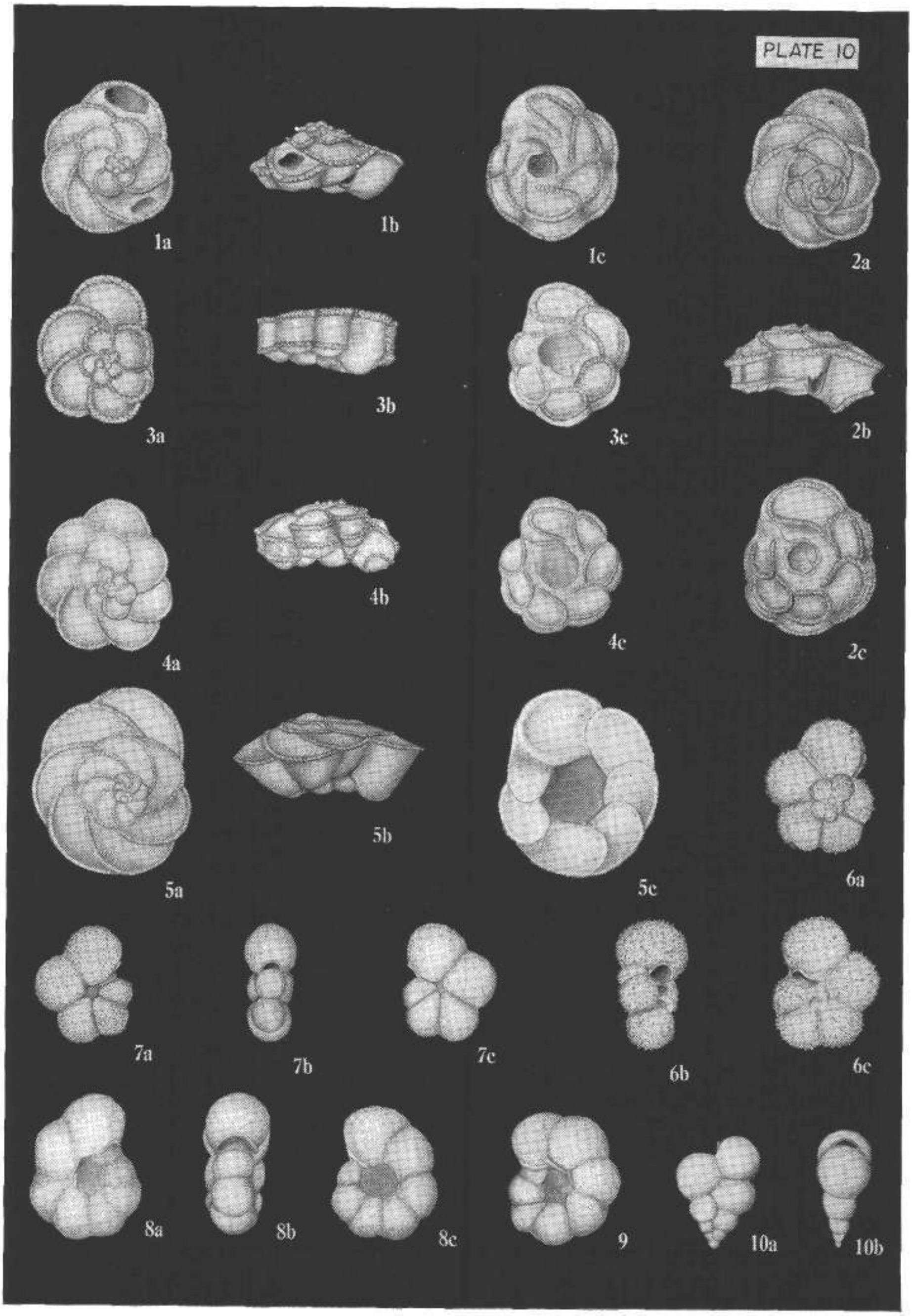
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Figure		Page
1.	*Heterohelix striata* (EHRENBERG). 51× .... a, Side view; b, edge view; SU no. 9447	85
2.	*Heterohelix pulchra* (BROTZEN). 47× .... a, Side view; b, edge view; SU no. 9448	85
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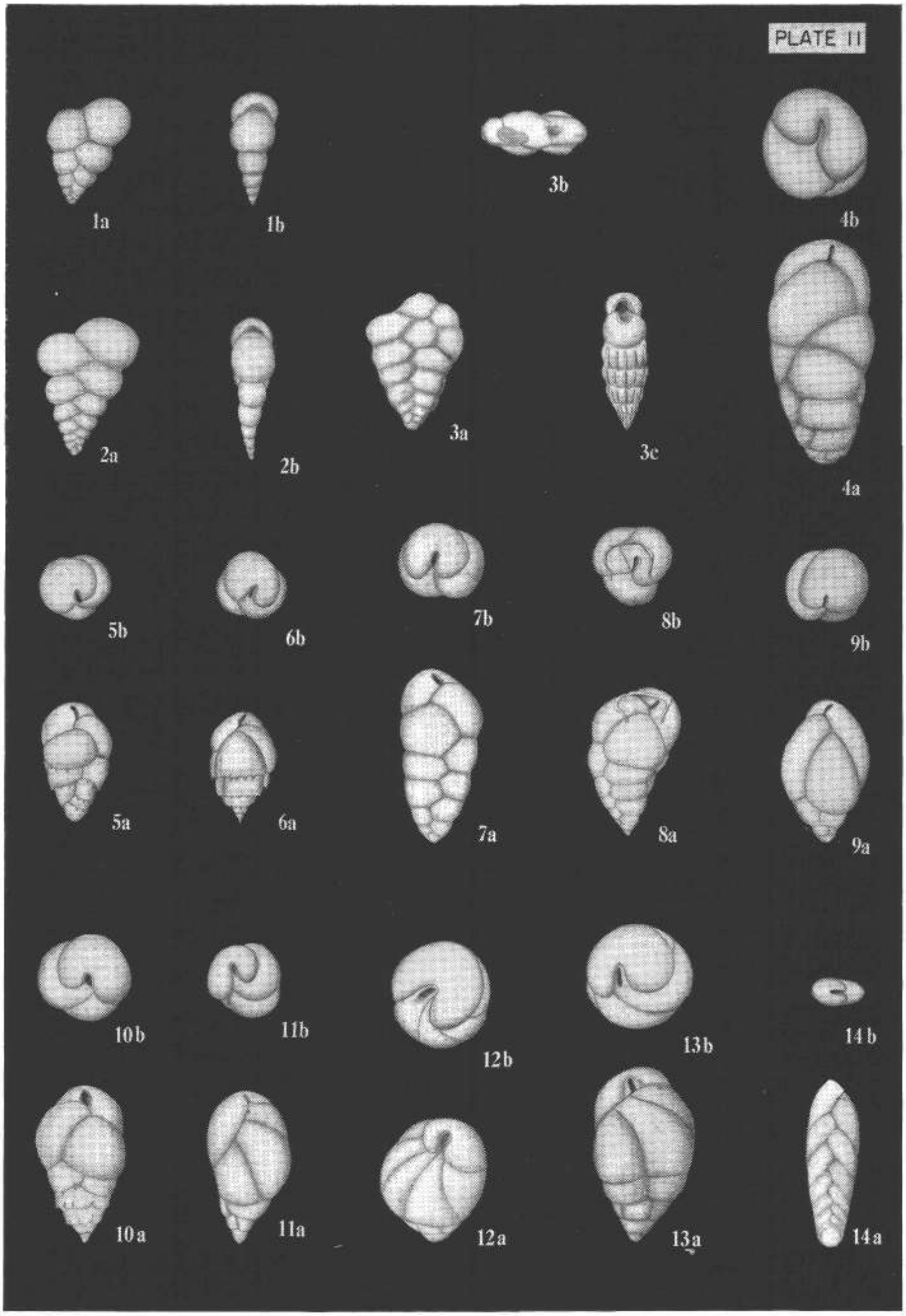
4.	*Bulimina aspera* CUSHMAN and PARKER. 75× .... a, Side view; b, end view; SU no. 9450	86
5, 6.	*Bulimina joaquinensis* MARTIN, n. sp. 58× .... a, Side view; b, end view; 5. macrospheric; 6. microspheric; SU no. 9451	87
7, 8.	*Bulimina prolixa* CUSHMAN and PARKER. 51× .... a, Side view; b, end view; 7. macrospheric; 8. microspheric; SU no. 9452	87
9.	*Bulimina reussi* MORROW. 70× .... a, Side view; b, end view; SU no. 9453	88
10.	*Bulimina spinata* CUSHMAN and CAMPBELL. 37× .... a, Side view; b, end view; SU no. 9454	88
11.	*Buliminella carseyae* PLUMMER. 52× .... a, Side view; b, end view; SU no. 9455	88
12.	*Buliminella colonensis* CUSHMAN and HEDBERG. 42× .... a, Side view; b, end view; SU no. 9456	89
13.	*Buliminella cushmani* SANDIDGE. 60× .... a, Side view; b, end view; SU no. 9457	89
14.	*Bolivina incrassata* REUSS. 38× .... a, Side view; b, end view; SU no. 9458	90

PLATE II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Explanation of Plate 12

Figure | Page

1. *Bolivinoides paynei* MARTIN, n. sp. 66× 90
   a, Side view; b, end view; c, edge view; SU no. 9459
2. *Bolivinoides decoratus latticeus* (CARSEY). 58× 90
   a, Side view; b, end view; SU no. 9460
3. *Bolivinitella eleyi* (CUSHMAN). 72× 91
   a, Side view; b, end view; SU no. 9461
4. *Reussella szajnoche* (GRZYBOWSKI). 33× 91
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5, 6. *Siphogenerinoides clarki* CUSHMAN and CAMPBELL. 30× 93
   a, Side view; b, end view; 5. macrospheric; 6. microspheric; SU no. 9463

7—9. *Siphogenerinoides whitei* CHURCH. 16× 93
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10. *Rotalia bandyi* MARTIN, n. sp. 58× 94
   a, Dorsal view; b, edge view; c, ventral view; SU no. 9465

11. *Rotalia minuta* MARTIN, n. sp. 58× 94
   a, Dorsal view; b, edge view; c, ventral view; SU no. 9466

12. *Gyroidina globosa* (HAGENOW). 80× 95
   a, Dorsal view; b, edge view; c, ventral view; SU no. 9468

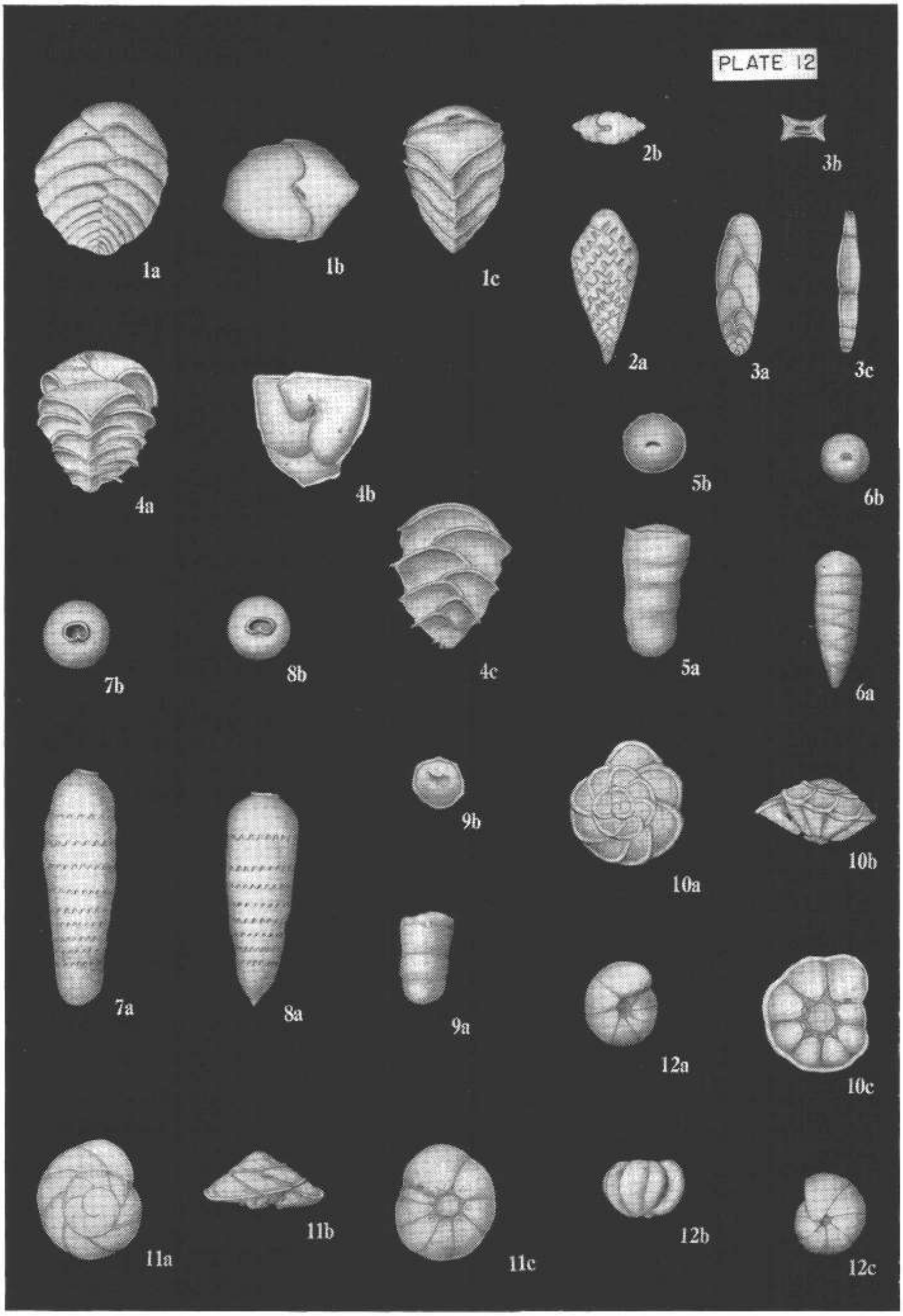


PLATE 12
1a
1b
1c
2b
3b
2a
3a
3c
4a
4b
5b
6b
4c
7b
8b
5a
6a
9b
10b
10a
7a
8a
9a
12a
10c
11a
11b
11c
12b
12c

Explanation of Plate 13

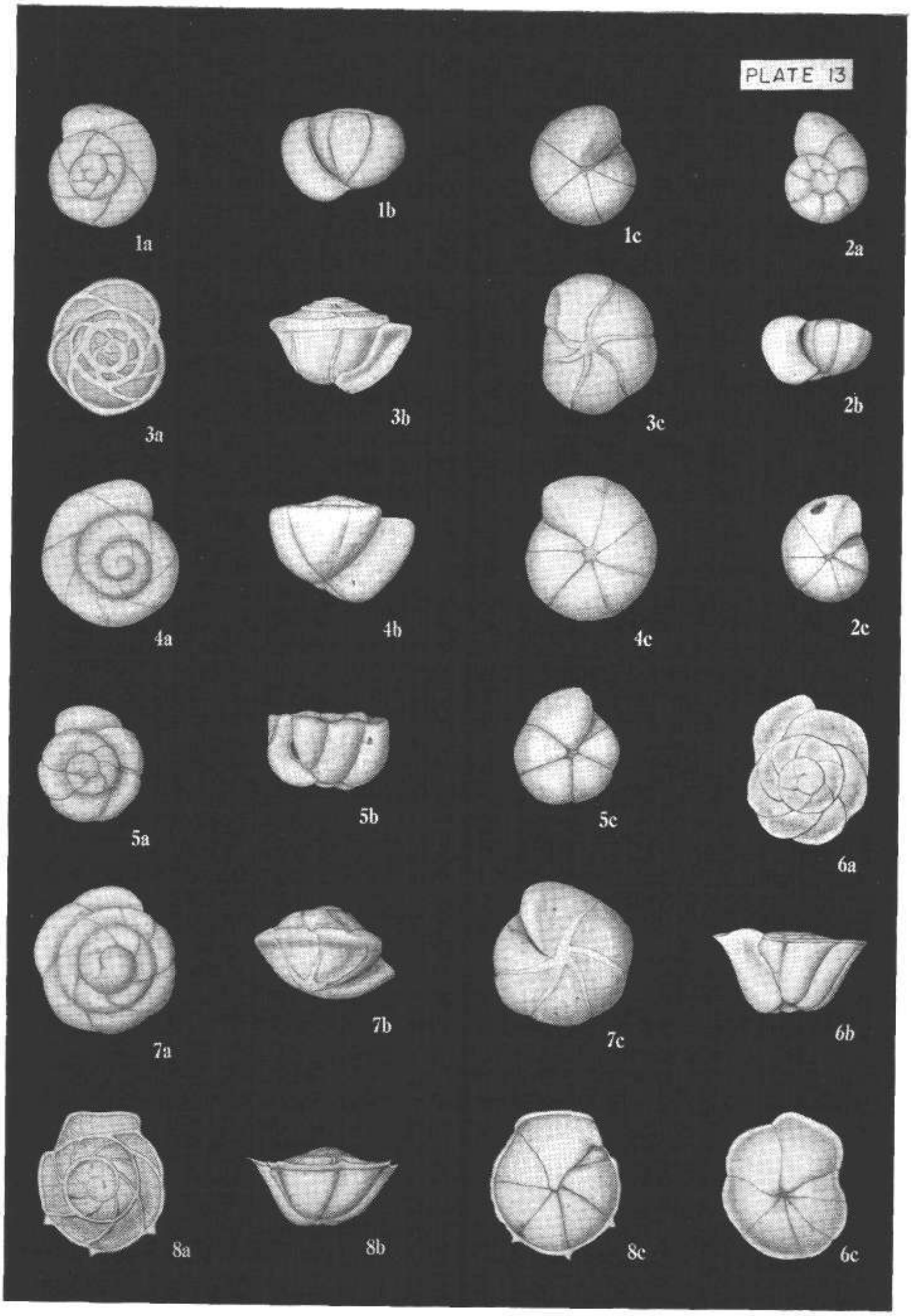


PLATE 13
1a
1b
1c
2a
3a
3b
3c
2b
4a
4b
4c
2c
5a
5b
5c
6a
7a
7b
7c
6b
8a
8b
8c
6c

Explanation of Plate 14

Figure		Page
1.	*Gavelinella orolomaensis* (CUSHMAN and GOUDKOFF). 40 × .... a, Dorsal view; b, edge view; c, ventral view; SU no. 9478	98
2, 3.	*Gavelinella turbinata* MARTIN, n. sp. 32 × .... a, Dorsal view; b, edge view; c, ventral view; SU no. 9477 a—b	99
4.	*Globorotalites michelinianus* (d'ORBIGNY). 69 × .... a, Dorsal view; b, edge view; c, ventral view; SU no. 9478	99
5.	*Globorotalites rosaceus* MARTIN, n. sp. 51 × .... a, Dorsal view; b, edge view; c, ventral view; SU no. 9479	99
6.	*Globorotalites subconicus* (MORROW). 48 × .... a, Dorsal view; b, edge view; c, ventral view; SU no. 9480	100
7.	*Stensiöina excolata* (CUSHMAN). 47 × .... a, Dorsal view; b, edge view; c, ventral view; SU no. 9481	100
8.	*Stensiöina exsculpta* (REUSS). 42 × .... a, Dorsal view; b, edge view; c, ventral view; SU no. 9482	101

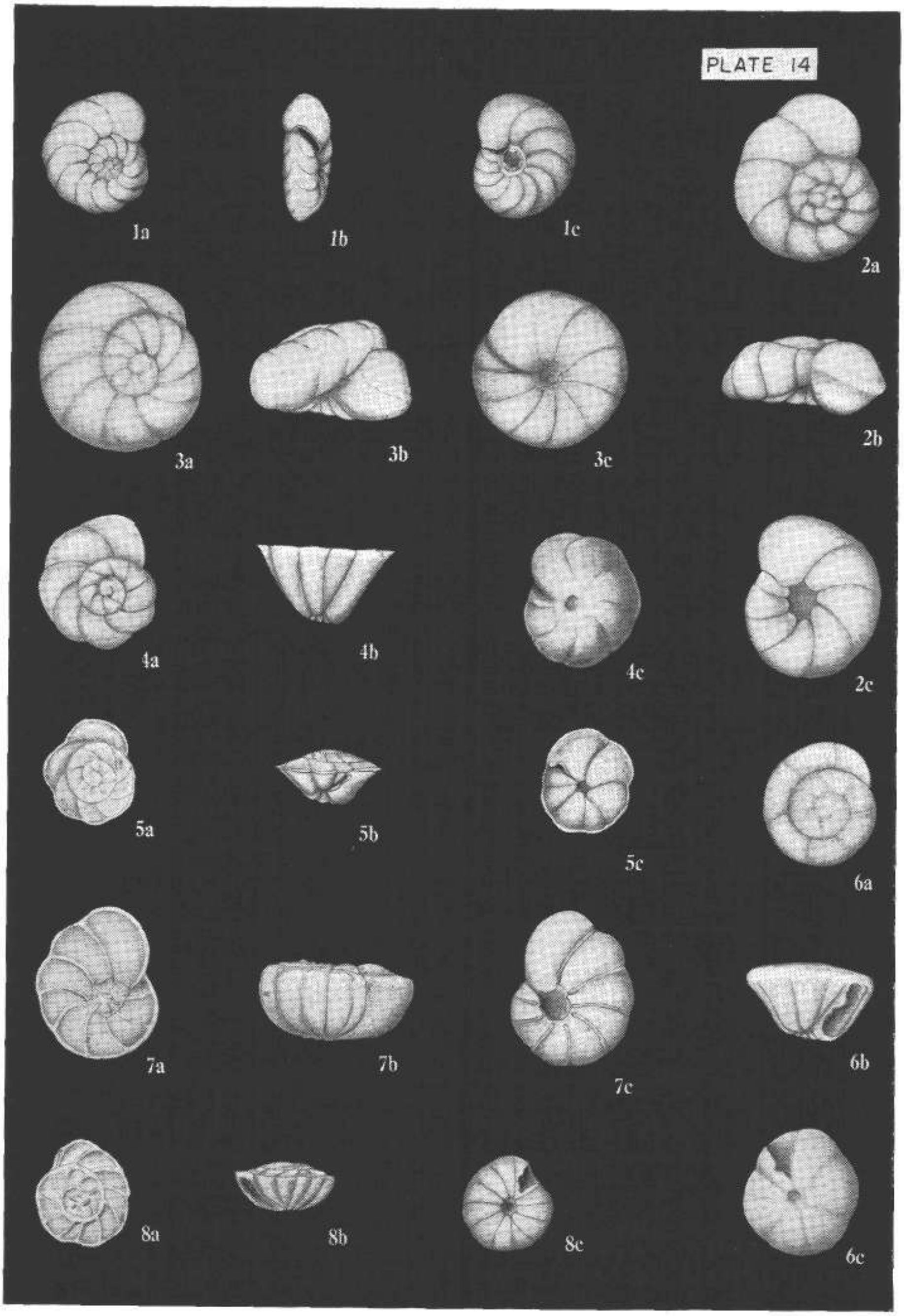


PLATE 14
1a
1b
1c
2a
3a
3b
3c
2b
4a
4b
4c
2c
5a
5b
5c
6a
7a
7b
7c
6b
8a
8b
8c
6c

Explanation of Plate 15

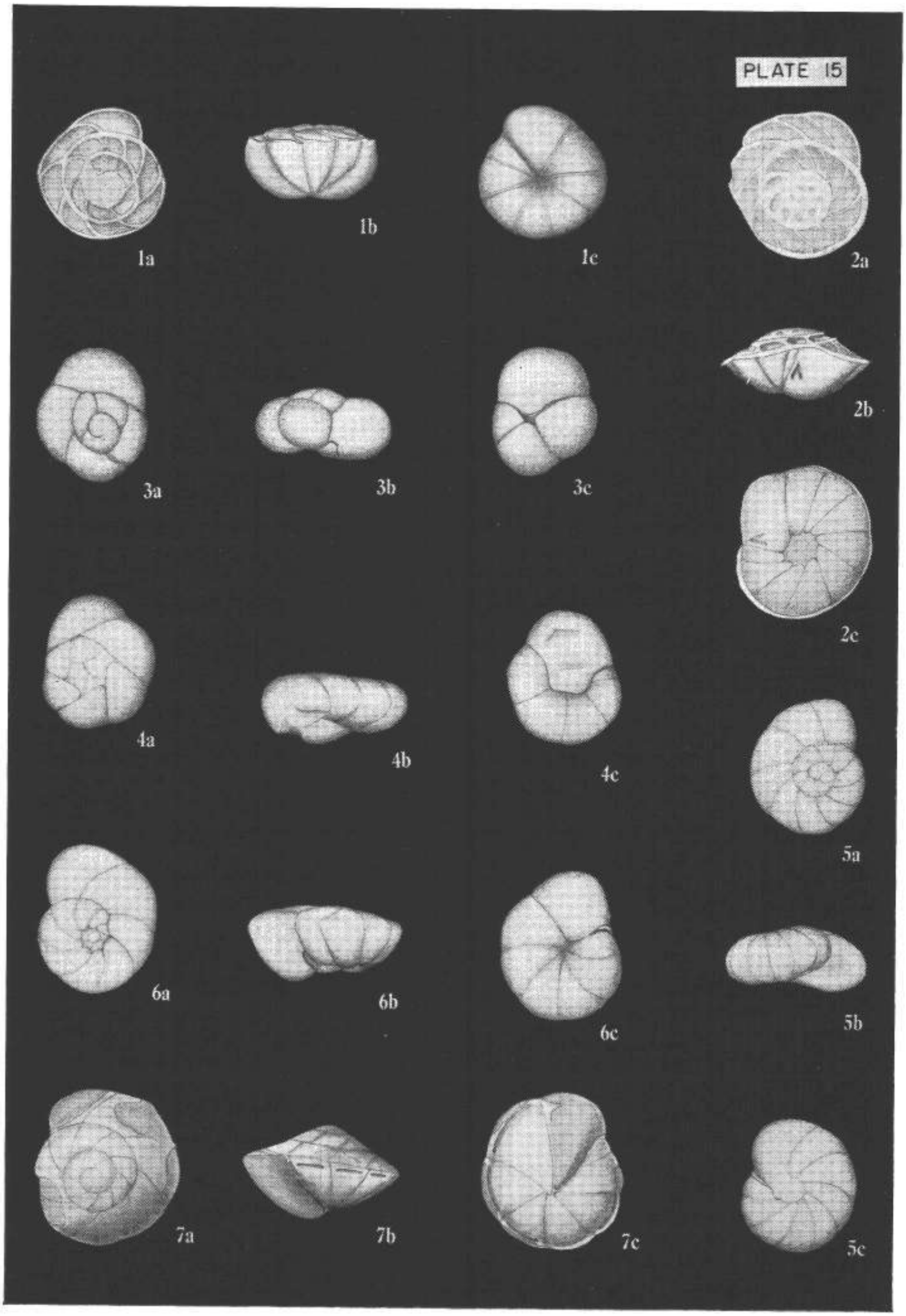


PLATE 15
1a
1b
1c
2a
2b
2c
3a
3b
3c
4a
4b
4c
5a
5b
5c
6a
6b
6c
7a
7b
7c

Explanation of Plate 16

Figure | Page

1. *Anomalina* sp. 63× 105
   a, Dorsal view; b, edge view; c, ventral view; SU no. 9490
2. *Anomalina becki* MARTIN, n. sp. 48× 105
   a, Dorsal view; b, edge view; c, ventral view; SU no. 9491
3. *Anomalina occidentalis* MARTIN, n. sp. 80× 105
   a, Dorsal view; b, edge view; c, ventral view; SU no. 9492
4. *Anomalina whitei* MARTIN, n. sp. 50× 106
   a, Dorsal view; b, edge view; c, ventral view; SU no. 9493
5. *Cibicidoides validus* MARTIN, n. sp. 55× 107
   a, Dorsal view; b, edge view; c, ventral view; SU no. 9496
6. *Planulina popenoei* TRUJILLO. 57× 106
   a, Dorsal view; b, edge view; c, ventral view; SU no. 9494
7. *Planulina mascula* BANDY. 54× 107
   a, Dorsal view; b, edge view; c, ventral view; SU no. 9495

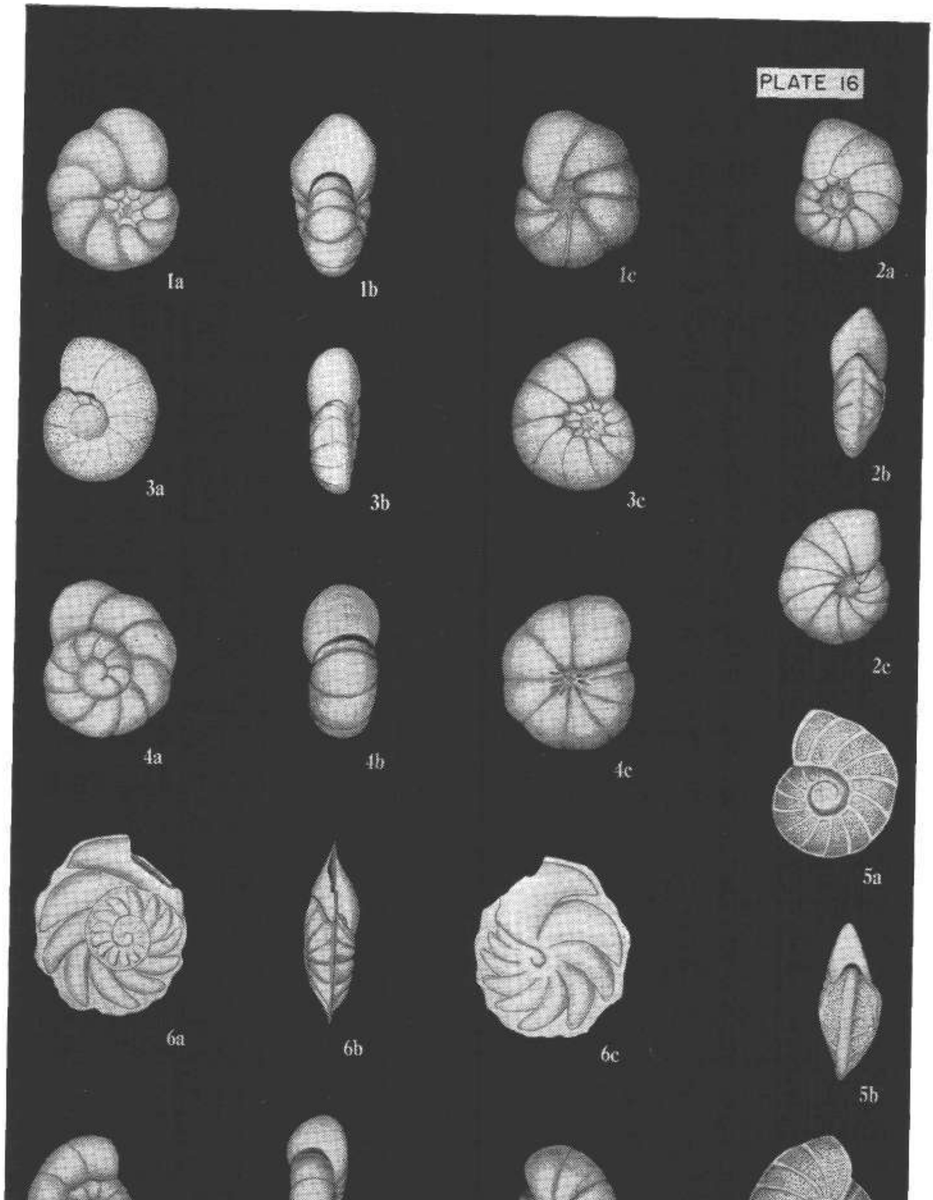


PLATE 16
1a
1b
1c
2a
3a
3b
3c
2b
2c
4a
4b
4c
5a
6a
6b
6c
5b
7a
7b
7c
5c

Index of Species

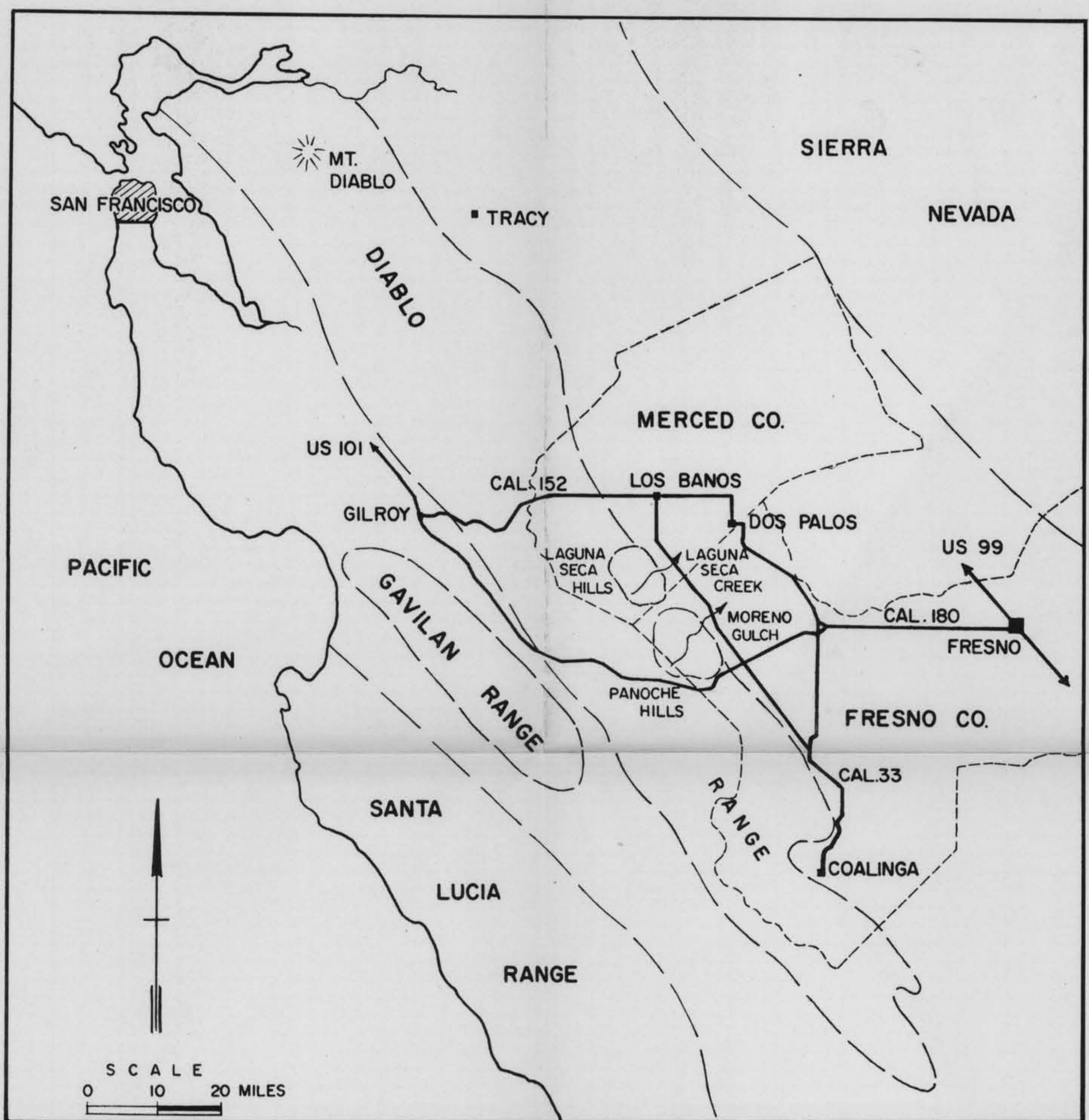


FIG. I

INDEX MAP OF CENTRAL CALIFORNIA

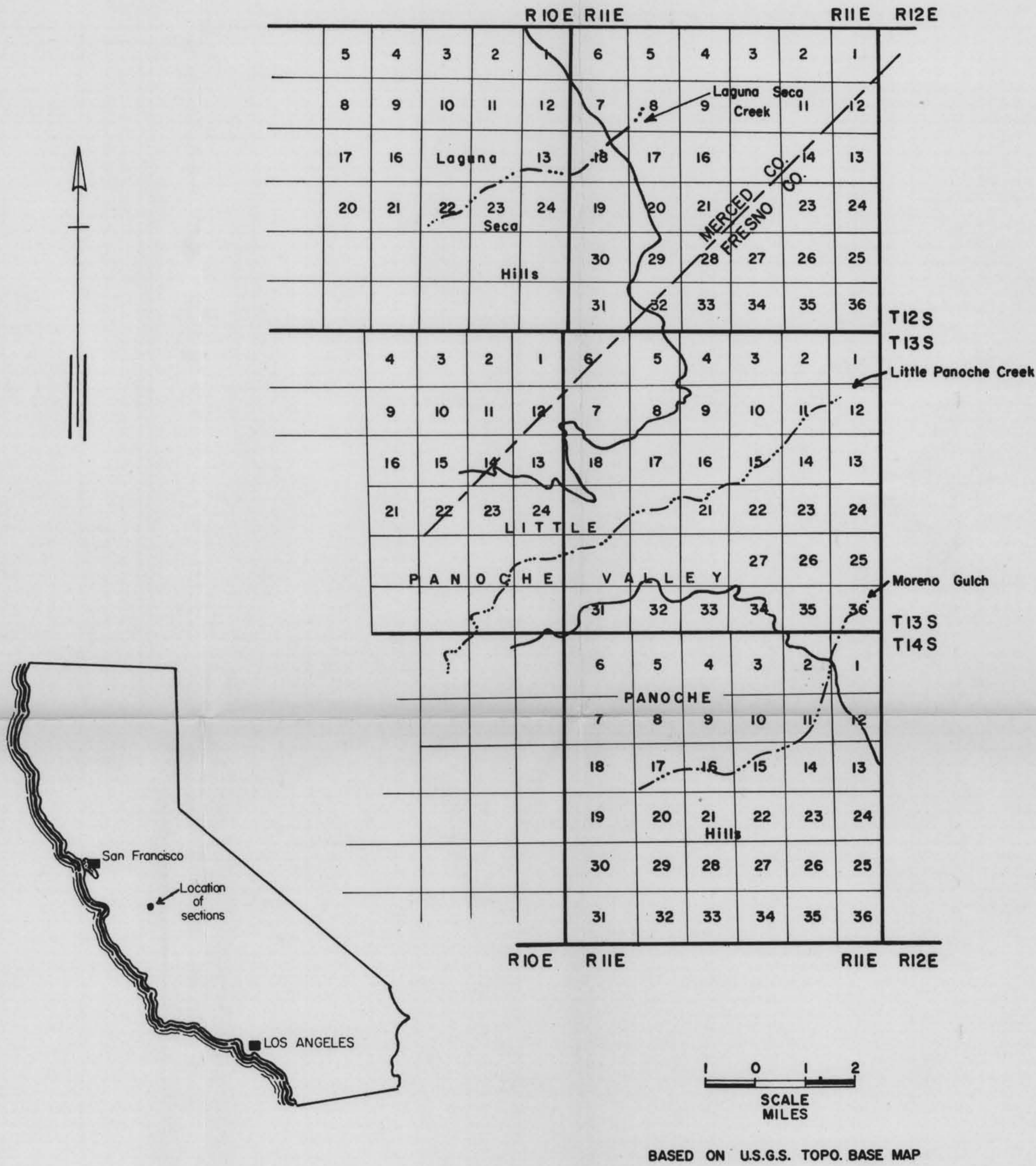


FIG. 2

LOCATION MAP OF MORENO GULCH AND LAGUNA CREEK SECTIONS, WEST SIDE OF SAN JOAQUIN VALLEY, CALIFORNIA

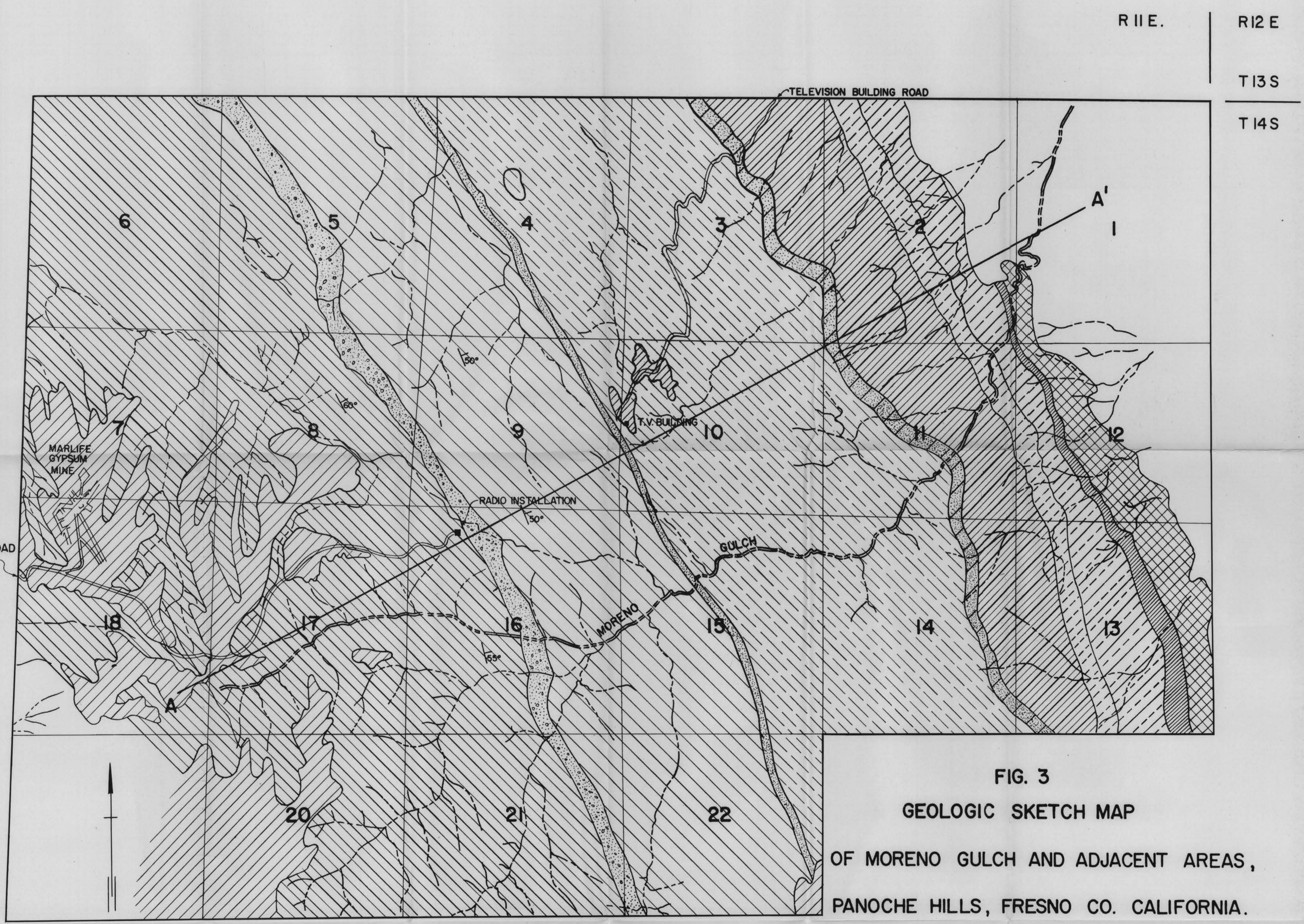


FIG. 3
GEOLOGIC SKETCH MAP
OF MORENO GULCH AND ADJACENT AREAS, PANOCHE HILLS, FRESNO CO. CALIFORNIA.

SCALE: 1" = 1667'

Modified from M.B. Payne, 1959
Based on Survey by Pacific Telephone and Civil Aeronautics Administration.
Compiled to correct distortion in Airphotos as much as possible.
Geology after Sutton and Payne, 1959.

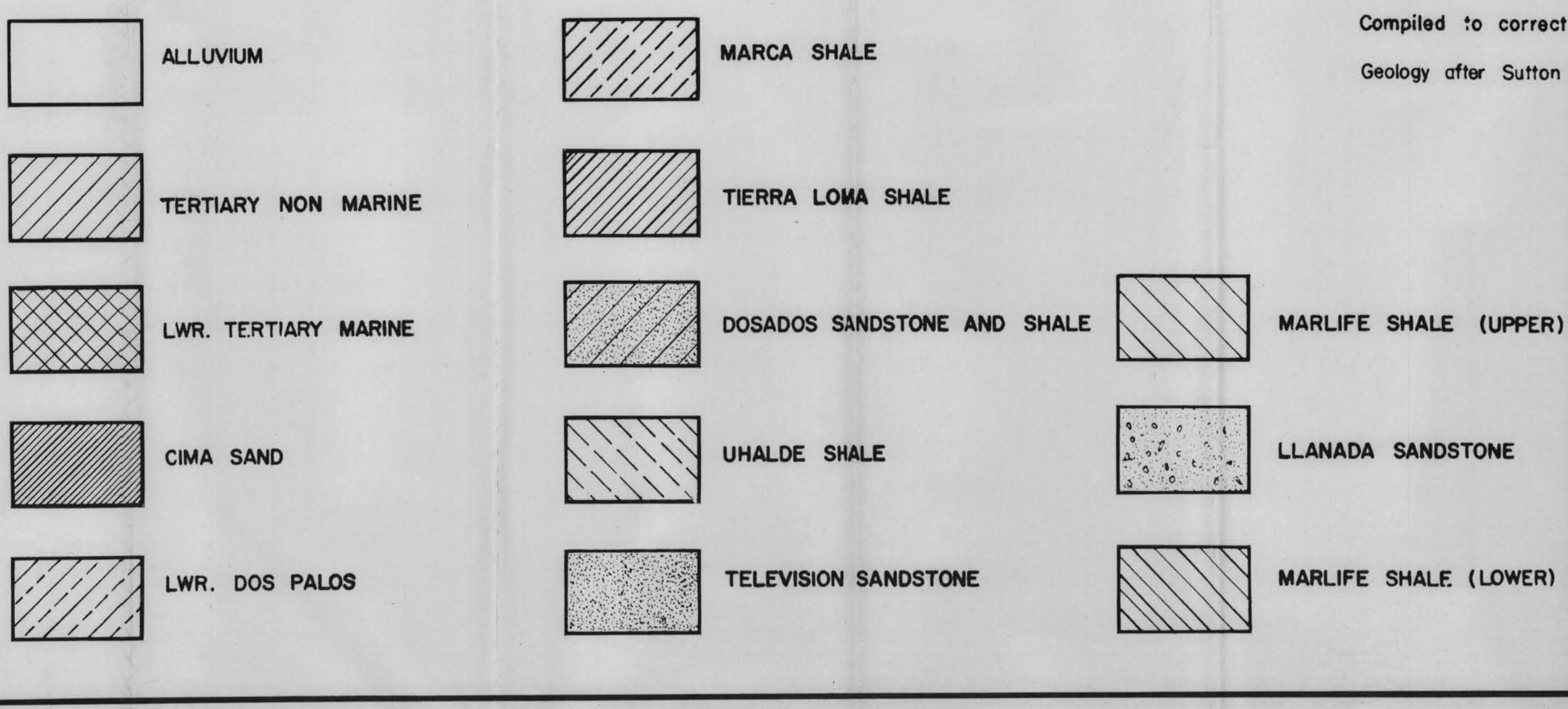


FIG. 4A

MORENO GULCH SURFACE SAMPLE LOCATION MAP

BASED ON PLANE TABLE TRAVERSE
BY J.Q.ANDERSON AND R.R.SIMONSON

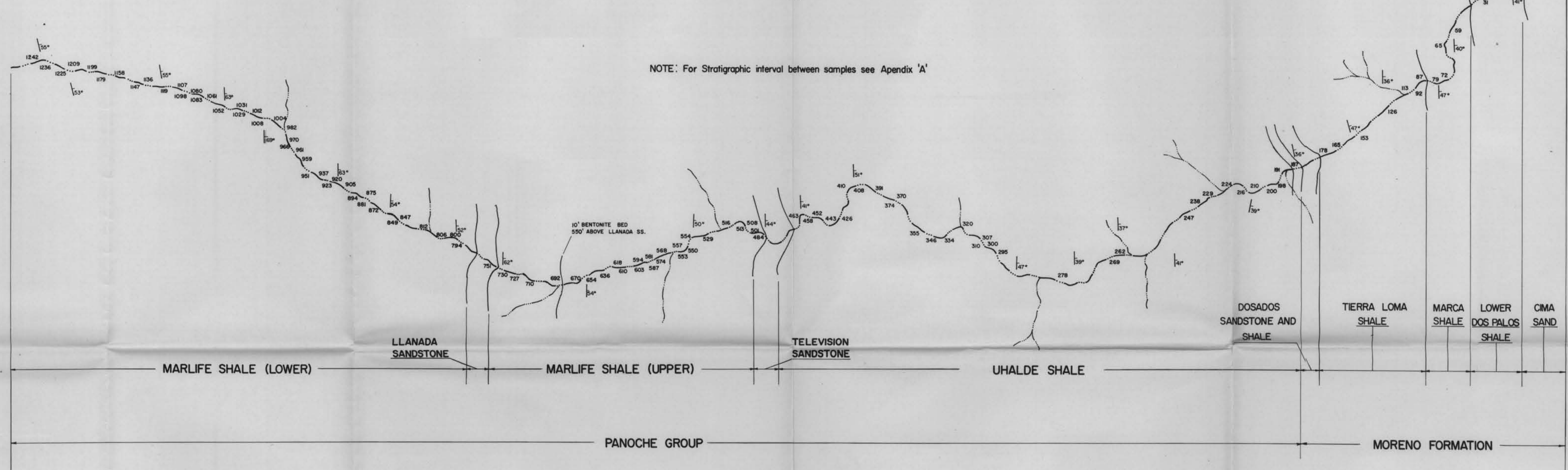
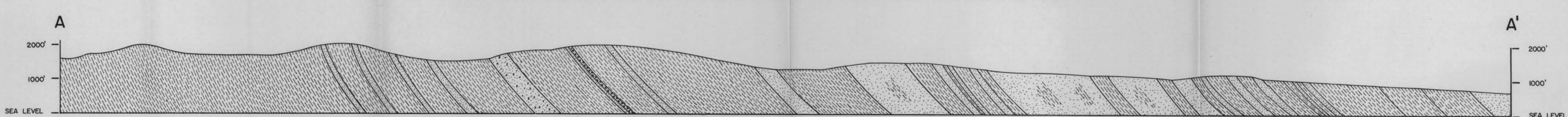


FIG. 4B

GEOLOGIC SECTION ACROSS EASTERN PORTION OF PANOCHE HILLS, FRESNO CO., CALIFORNIA



BEARING N 60° E (SEE FIG. 3)

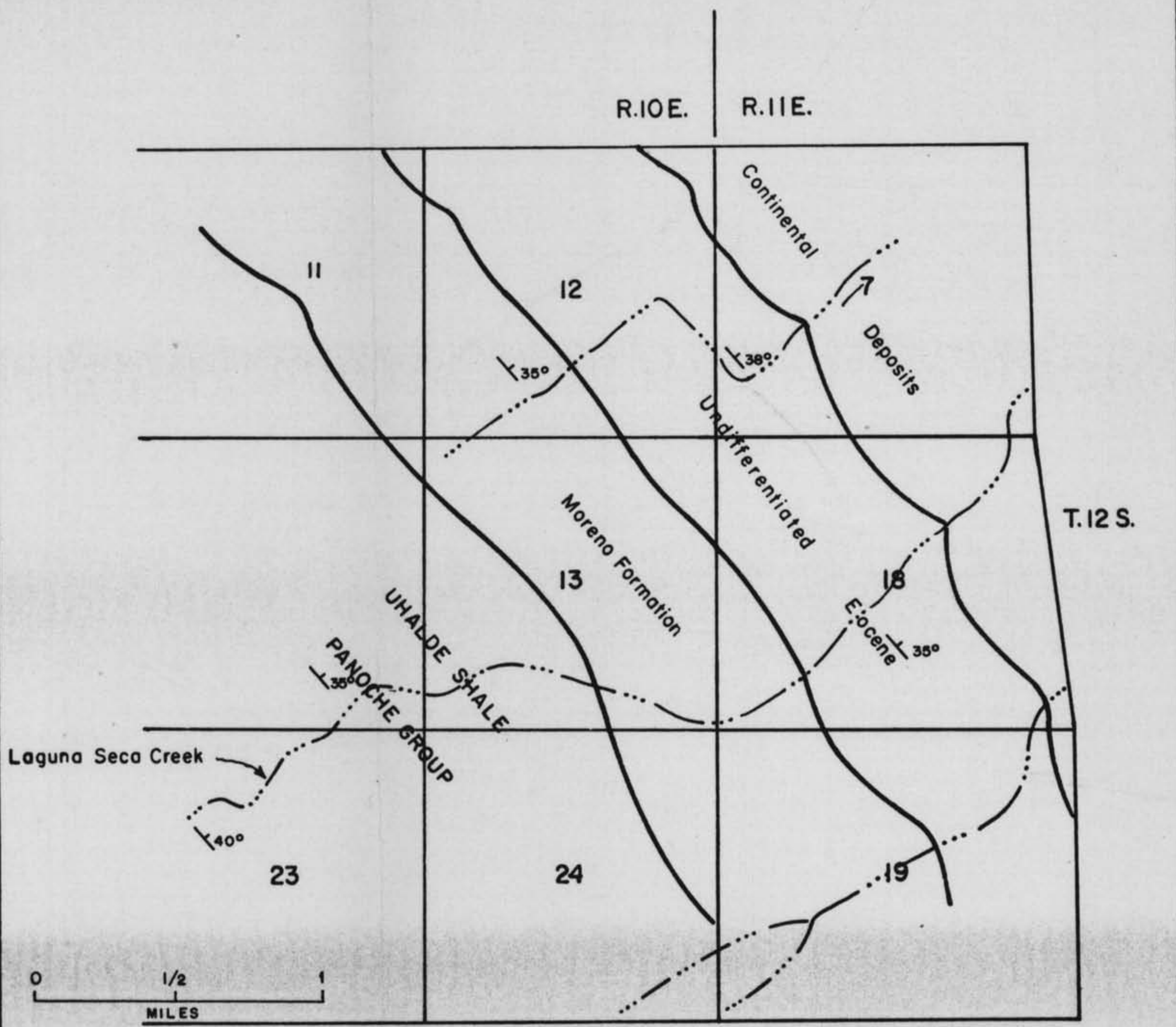


FIG. 5
GEOLOGICAL SKETCH MAP OF LAGUNA SECA CREEK, LAGUNA SECA HILLS, MERCED CO., CALIFORNIA.

Dr. L.H.C

TABLE I
NOMENCLATURAL DEVELOPMENT OF THE MORENO FORMATION AND PANOCHE GROUP

Anderson, 1905 COALINGA	Arnold & Anderson, 1908 COALINGA	Arnold & Anderson, 1910 COALINGA	Anderson & Pack, 1915 PANOCHE HILLS	Payne, 1941, 1951 PANOCHE HILLS	Payne, 1951 (MORENO) Sutton, 1952 (PANOCHE) Sutton & Payne, 1959 (PANOCHE)	
KREYENHAGEN SHALE (Upper Eocene)	TEJON SHALE (Lower part) (Middle Eocene)	UPPER CHICO DIVISION: PURPLE SHALE (Upper Cretaceous)	MORENO SHALE	MORENO SHALE FRM.: DOS PALOS SHALE ◁ CIMA SAND MARCA SHALE TIERRA LOMA SHALE DOSADOS SANDSTONE & SHALE	MORENO SHALE FRM.: DOS PALOS SHALE ◁ CIMA SAND MARCA SHALE TIERRA LOMA SHALE DOSADOS SANDSTONE & SHALE	Stratigraphic Interval Studied in Present Paper (from Dos Palos Shale to Marlife Shale (Lower brown shale))
AVENAL SANDSTONE — — — CHICO DIVISION	KNOXVILLE — CHICO ROCKS: UPPER DIVISION	UPPER CHICO DIVISION: SANDSTONE AND SHALE	PANOCHE FORMATION: SANDSTONE — — — SHALE — — — SANDSTONE	PANOCHE FORMATION: UPPER 5.000' — — — MIDDLE 5.000'	PANOCHE GROUP: UHALDE SHALE TELEVISION SANDSTONE MARLIFE SHALE (Upper gray shale) LLANADA SANDSTONE MARLIFE SHALE (Lower brown shale)	
	MIDDLE DIVISION	MIDDLE DIVISION	SHALE	LOWER 8.000 TO 10.000	CIERO SHALE ◁ ORTIGALITA SANDSTONE BENITO SANDSTONE	
KNOXVILLE DIVISION	LOWER DIVISION	LOWER DIVISION			REDIL SHALE ◁ PAPANATAS CONGLOMERATE	
Franciscan Group	Franciscan Group	Franciscan Group	Franciscan Group	Franciscan Group	Franciscan Group	

Dr. L.H.C.

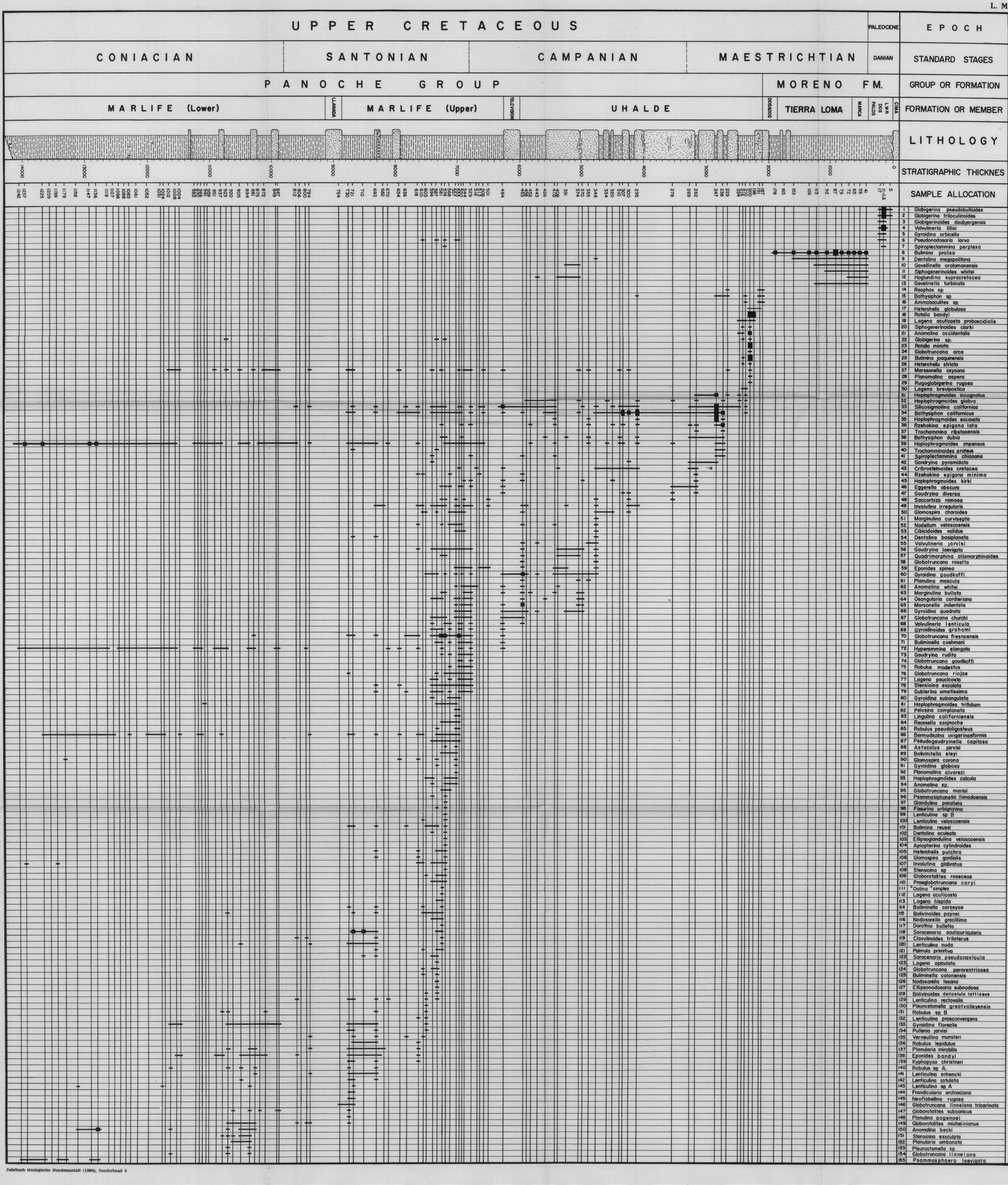


TABLE 2
STRATIGRAPHIC DISTRIBUTION OF FORAMINIFERA IN MORENO GULCH, PANOCHE HILLS, FRESNO COUNTY, CALIFORNIA
DISTRIBUTION: — 5-50; ▬ 50-100; █ 100 +.

TABLE 3
STRATIGRAPHIC DISTRIBUTION OF FORAMINIFERA FROM LAGUNA SECA CREEK, LAGUNA SECA HILLS, MERCED CO., CALIF.

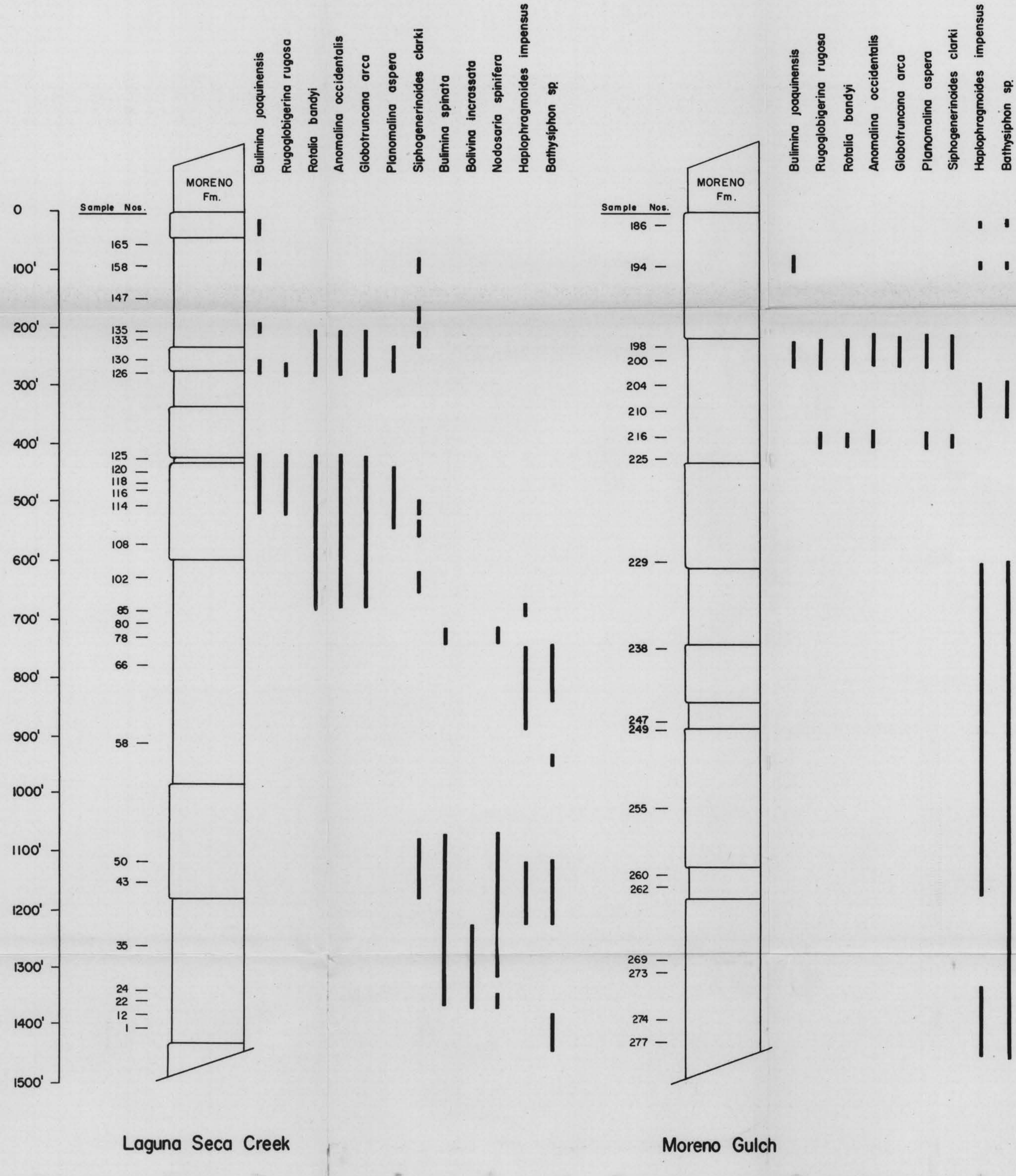


TABLE 4

CORRELATION OF UPPERMOST 1500 FEET OF UHALDE SHALE, PANOCHE GROUP IN LAGUNA SECA CREEK AND MORENO GULCH WEST SIDE OF SAN JOAQUIN VALLEY, CALIFORNIA

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TABLE 5

STRATIGRAPHIC DISTRIBUTION OF SOME DIAGNOSTIC AND COMMON FORAMINIFERA FROM MORENO GULCH AND LAGUNA SECA CREEK, WEST SIDE OF SAN JOAQUIN VALLEY, CALIFORNIA.

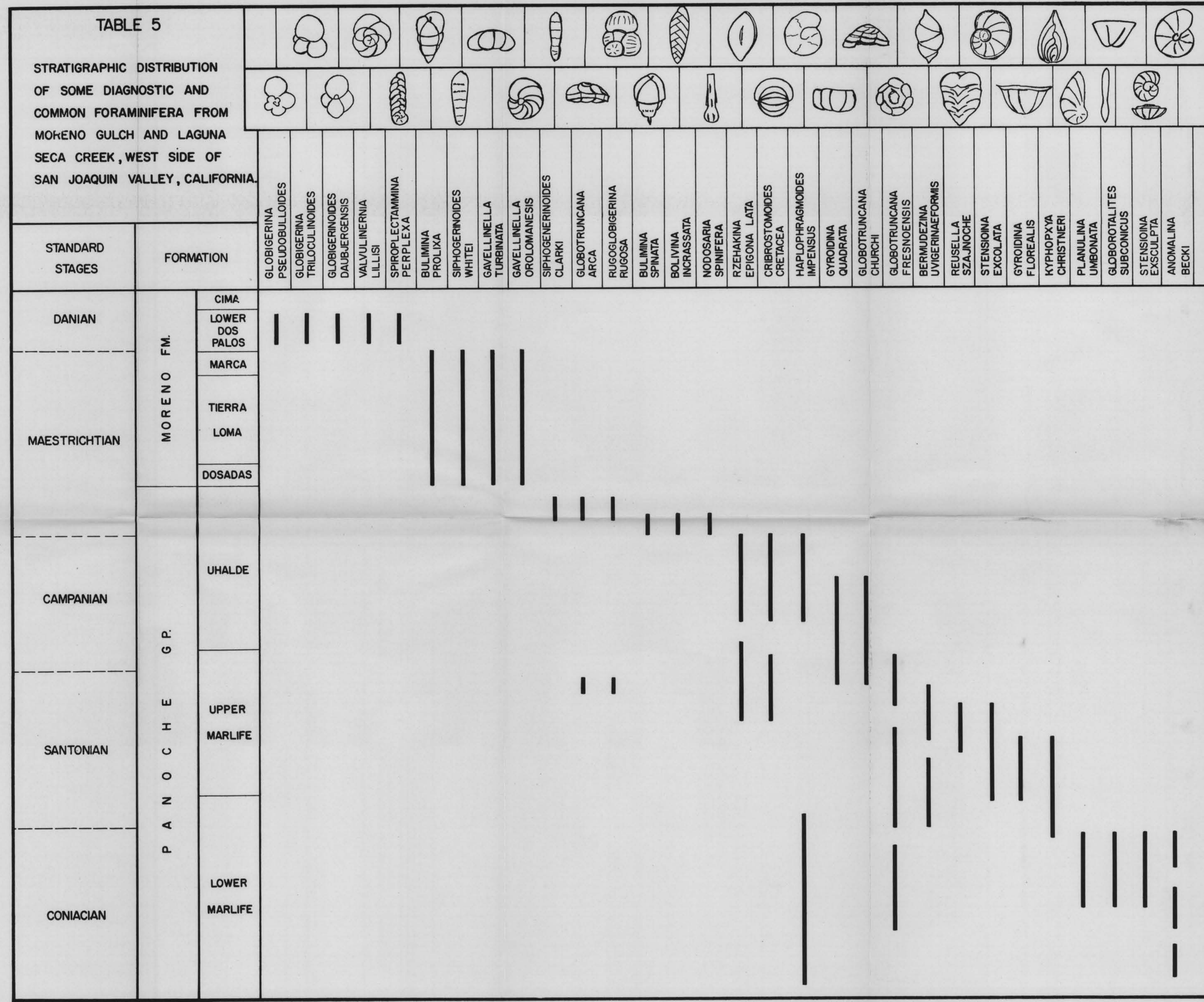

TABLE 6

ANALYSIS OF SELECTED MORENO GULCH FORAMINIFERAL ASSEMBLAGES

BIONOMIC GROUPS	SAMPLE No 11	SAMPLE No 200	SAMPLE No 247	SAMPLE No 463	SAMPLE No 574	SAMPLE No 727
CALCAREOUS BENTHONIC	60%	79%		61%	47%	61%
CALCAREOUS PLANKTONIC	39%	18%		8%	17%	14%
ARENACEOUS	1%	3%	100%	31%	36%	25%
FAMILY						
RHIZAMMINIDAE			35%	5%	9%	5%
TOLYPAMMINIDAE		1%	5%	5%	2%	4%
LITUOLIDAE			48%	6%	11%	5%
VERNEUILINIDAE			2%	5%	6%	6%
VALVULINIDAE		2%		5%	3%	3%
RZEHAKINIDAE			8%	5%	5%	2%
NODOSARIIDAE	6%	6%		7%	12%	21%
ORBULINIDAE	25%	6%			2%	3%
HANTKENINIDAE		4%			2%	
GLOBOROTALIIDAE	14%					
GLOBOTRUNCANIDAE		5%		8%	11%	7%
HETEROHELICIDAE		3%			2%	4%
BULIMINIDAE		22%			7%	6%
ROTALIIDAE	40%	37%		36%	23%	26%
ANOMALINIDAE		16%		15%	3%	6%
OTHERS	15%	4%	2%	3%	2%	2%

Dr. L. H. C.

TABLE 7

STRATIGRAPHIC DISTRIBUTION OF BIONOMIC GROUPS IN MORENO GULCH, PANOCHE HILLS, FRESNO CO., CALIFORNIA

DISTRIBUTION: SPARSE, COMMON, ABUNDANT

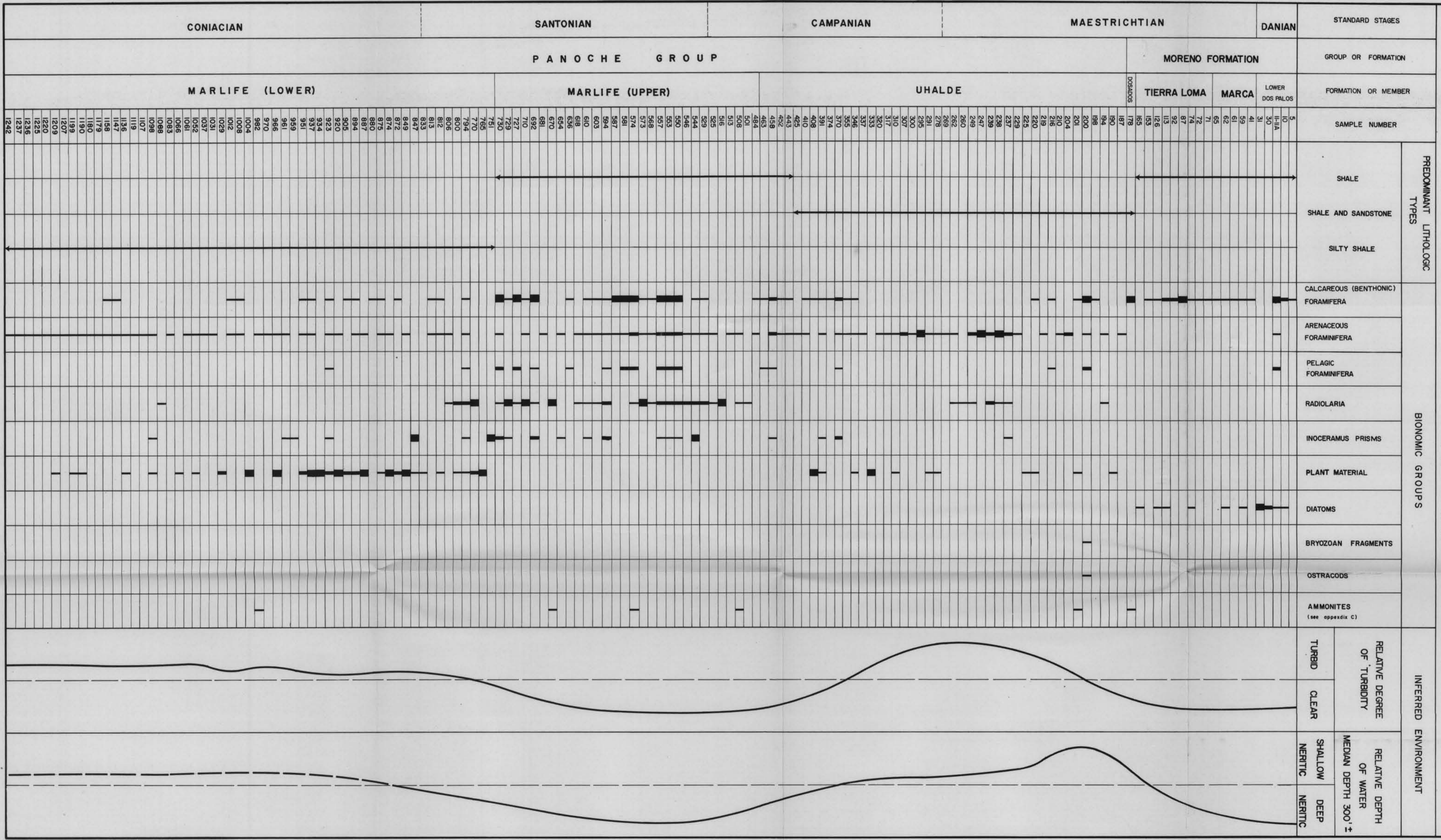

TABLE 8
BIOSTRATIGRAPHIC CORRELATION OF SOME CALIFORNIA CRETACEOUS SEDIMENTS

AGE	EUROPEAN STANDARD STAGES	MORENO GULCH PRESENT STUDY		CUSHMAN & CHURCH, 1929	CUSHMAN & CAMPBELL, 1935	BANDY 1951	GRAHAM & CHURCH, 1959	TRUJILLO 1960
PALEOCENE	DANIAN	MORENO FORMATION	CIMA SAND					
PALEOCENE	DANIAN	MORENO FORMATION	Lwr. DOS PALOS SHALE					
UPPER CRETACEOUS	MAESTRICHTIAN	MORENO FORMATION	MARCA, TIERRA LOMA SHALES					
UPPER CRETACEOUS	MAESTRICHTIAN	MORENO FORMATION	DOSADOS SAND & SHALE					
UPPER CRETACEOUS	MAESTRICHTIAN	PANOCHE GROUP (Upper part)	UHALDE SHALE		TRACY			
UPPER CRETACEOUS	CAMPANIAN	PANOCHE GROUP (Upper part)	UHALDE SHALE	ALCALDE HILLS		CARLSBAD AREA	STANFORD UNIVERSITY CAMPUS	
UPPER CRETACEOUS	SANTONIAN	PANOCHE GROUP (Upper part)	MARLIFE SHALE (Upper)					REDDING AREA MEMBER VI
UPPER CRETACEOUS	CONIACIAN	PANOCHE GROUP (Upper part)	MARLIFE SHALE (Lower)					MEMBERS IV & V