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EOCENE BENTHIC FORAMINIFERAL ASSEMBLAGES OF THE PALO ALTO 7-1/2' QUADRANGLE, CALIFORNIA

by

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ABSTRACT

Spot samples examined from lower Tertiary strata exposed in the Palo Alto 7-1/2' quadrangle, California contain latest early Eocene to middle Eocene, Ulatisian and Narizian benthic foraminifers. Age diagnostic cosmopolitan benthic foraminiferal species suggest that the Ulatisian assemblages correlate best with other benthic foraminiferal assemblages coeval with planktic foraminiferal zone P10, although the assemblages may be as old as late P9 and as young as P11, and that the Narizian assemblages correlate best with benthic foraminiferal assemblages coeval with planktic foraminiferal zones late P12 through P14. The assemblages indicate deposition occurred at lower bathyal to abyssal depths during the Ulatisian and lower middle bathyal to lower bathyal depths during the early Narizian. Transported foraminiferal specimens are common in all all samples. The majority of the transported specimens have upper depth limits in the outer neritic and upper bathyal biofacies. Similar faunas are found in Vaca Valley, Pacheco Syncline and Tres Pinos sections. Although not discussed, coeval, shallower water benthic foraminiferal assemblages are present in the Lodo Gulch, Devils Den, Media Aqua Creek and Simi Valley sections.

INTRODUCTION

Lower Tertiary marine strata in the Palo Alto 7-1/2' quadrangle of the San Francisco Bay structural block (Nilsen and Brabb, 1979) has been previously assigned to the Chico Formation, Searsville Formation, Butano and Butano (?) Sandstone, and the Whiskey Hill Formation (Pampeyan, in press). These sedimentary rocks which are composed of conglomerate, sandstone, shale, siltstone and claystone, typically unconformably overlie the Franciscan Complex of Jurassic and Cretaceous age but in one exposure are in fault contact with Cretaceous shales (Pampeyan, in press), and in turn, they are unconformably overlain by or are in fault contact with Miocene rocks (Pampeyan, in press). The Whiskey Hill Formation may be as thick as 4,000 feet, but lack of exposure, faulting and chaotic structures makes any attempt at constructing a stratigraphic sequence difficult (Beaulieu, 1970; Pampeyan, in press). These lower Tertiary sediments have been considered to range in age from Paleocene to Eocene based on foraminiferal interpretations (Graham and Classen, 1955; Cummings and others, 1962; Graham, 1967; Beaulieu, 1970; Bukry and others, 1977; M.C. Israelsky, unpublished E and R reports, 1963; R.L. Pierce, unpublished E and R Reports, 1966; Pampeyan, in press).

A review of available microfossil samples and some newly collected material indicates that the Whiskey Hill Formation is middle Eocene in age. Most foraminiferal assemblages from this formation are assigned to the Ulatisian Stage which is equivalent to planktic foraminiferal zones late P9 through P12. This age assignment is supported by the sparse calcareous nannofossil data from the area which indicates an age range of middle Eocene, calcareous nannofossil zones CP12b to CP14a (Kheradyar, 1987; Bukry and others, 1977). One sample, Mf707, in the southern part of the study area contains a benthic foraminiferal fauna which is assigned to the early Narizian Stage and considered late middle Eocene in age.

This paper documents and discusses the benthic foraminiferal assemblages obtained from samples in the Eocene strata in the Palo Alto 7-1/2' quadrangle and attempts to correlate these assemblages to other Eocene assemblages in California.

Location and samples

The Palo Alto 7-1/2' quadrangle is on the San Francisco Peninsula between San Francisco Bay and the Santa Cruz Mountains (fig. 1). The San Francisco Bay structural block includes the area east of the San Andreas Fault and west of the Hayward Fault (Nilsen and Brabb, 1979). The extent of the Whiskey Hill Formation has been mapped by Brabb and Pampeyan (1983), Beaulieu (1970), and Pampeyan (in press). Sample locations are shown in figure 2. Although only one sample was examined from the Stanford Linear Accelerator section (SLA section) in the present study, previous workers examined material from this section (Beaulieu, 1970; Kheradyar, 1987).

Microfossil material examined is primarily from mapping and sampling in the Palo Alto 7-1/2' quadrangle by Earl Pampeyan, U.S. Geological Survey and from samples collected by Dr. Earl Brabb, U.S. Geological Survey. Pampeyan's samples were originally examined by M.C. Israelsky and R.L. Pierce of the U. S. Geological Survey in the 1960's (Appendix I). Available material consists of picked slides which were re-examined and the benthic foraminiferal species identified (Tables 1-4). No washed residues or bulk samples have been located.

New material collected by Earl Brabb in 1988, was disaggregated with solvent (kerosene) and washed in water through a 63 micron screen. Benthic foraminifers were picked and identified from the washed residue greater than 150 microns.

Microfossil slides are on file with the Branch of Paleontology and Stratigraphy, U.S. Geological Survey, Menlo Park, California.

Biostratigraphic Framework

Biostratigraphic zonations developed by Laiming (1939) and Mallory (1959) are the primary means of dating and correlating Paleogene benthic foraminiferal faunas in California. Planktic microfossil workers have, however, demonstrated that these benthic foraminiferal stages and zones are time transgressive (Schmidt, 1975; Steineck and Gibson, 1971; Gibson, 1976; Bukry and others, 1977; Warren, 1980, 1983; Poore, 1976, 1980). Recently several studies reduced the problem through a multidisciplinary approach which integrates benthic foraminiferal zonations with planktic chronologies (Almgren and others, 1988; McDougall, 1988).

The benthic foraminiferal zonation proposed by McDougall (1988) modifies the zonation of Mallory (1959) and calibrates the benthic foraminiferal stages with planktic foraminiferal and calcareous nannofossil zonations. Current work (McDougall, 1988, 1989, 1991, and unpub.) suggests that the Ynezian Stage correlates to planktic foraminiferal zone P4 (calcareous nannofossil zones late CP5 through lower CP6), the Bulitian Stage correlates to late P4 through early P6b (CP7 through CP8), the Penutian Stage correlates to P6b through early P9 (CP9 through CP11), and the Ulatisian Stage correlates to late P9 through at least P12 (CP12 through CP13) (fig. 3). Benthic foraminiferal assemblages younger than P10 and older than P4 have not been examined yet. The upper boundary of the Ulatisian Stage and the lower boundary of the Ynezian Stage have, therefore, not been accurately dated. Strata correlative to P5, P6a and early P6b (upper CP8) either contain a nondiagnostic arenaceous fauna or are missing from most California sections.

The ranges of cosmopolitan deep-water species and California species useful in recognition of these stages and found in the Whiskey Hill Formation are given in figure 4. The ranges of the California species may not represent total ranges yet as only a small number of sections have been examined. Both cosmopolitan and California species are discussed in Appendix II. For this paper, benthic foraminiferal ranges are given in terms of the planktic foraminiferal zones of Blow (1969, 1979) and Berggren (1972) or calcareous nannofossil zones of Bukry (1973, 1975), and Okada and Bukry (1980). Stage names are used and based on the modifications as proposed by McDougall (1988) and discussed above for the late Paleocene through middle Eocene.

AGE

Twenty-three samples were examined from sediments assigned to the Whiskey Hill Formation of Pampeyan (in press). The benthic foraminiferal faunas in these samples include a large group of diverse assemblages that indicate a middle Eocene age and a smaller group of low diversity assemblages that are not diagnostic of age (Tables 1 and 3). The diverse assemblages listed in (Table 1) and the poorly preserved assemblages (Table 2) are assigned to the Ulatisian Stage as modified by McDougall (unpub. data) and coeval with planktic foraminiferal zones late P9 through P11, although these assemblages are most likely coeval with planktic foraminiferal zone P10. One sample, Mf707, from the Whiskey Hill Formation is middle Eocene in age, assigned to the Narizian Stage, and considered coeval with planktic foraminiferal zones late P12 through P14. The variability in age interpretation for each sample based on benthic foraminifers is shown in figure 5.

The diverse foraminiferal assemblages in the Whiskey Hill Formation include many cosmopolitan species, most are long-ranging and provide little or no data on the age of the assemblages. Age diagnostic cosmopolitan species useful in restricting the age include *Bulimina callahani* (P6a-P10), *Cibicidoides subspiralis* (P9-P13), *Karreriella conversa* (Cretaceous-P11), *Orthomorphina havanensis* (P10-younger), *Pullenia eocenica* (P9-P17 with rare occurrences in zones P6b-P8), *Silicosigmoilina californica* (Cretaceous-P9 with rare occurrences in zones P10-P13), *Siphonodosaria gracillima* (P9-P15), and *Siphonodosaria subspinosa* (P10-Oligocene). Longer ranging cosmopolitan species which first appear in the early Eocene and continue through the middle Eocene include *Amphimorphina ignota, Cibicidoides grimsdalei, Karreriella elongata, Plectofrondicularia paucicostata*, and several species of *Cibicidoides, Bulimina, Buliminella*, and *Anomalina-Anomalinoides*. Age diagnostic California species present include *Uvigerina lodoensis mirimae* (late P7-P10) and *Zeauvigerina lodoensis* (P6b-P10) as well as species which are restricted to or first appear in the Ulatisian of California: *Amphimorphina california, Lenticulina ulatisian*, and *L.* cf. *L. welchi.*

Only one sample examined in the present study is from the SLA section (Mf748, field number SLA 24+50). The age based on benthic foraminifers of this sample is middle Eocene and ranges from P9 through P11. Nannofossils from this sample are assigned to unit 5 of Bramlette and Sullivan (1961) by Bramlette (in Kheradyar, 1987, and Pampeyan, in press). Unit 5 is equivalent to the *Rhabdospeara inflata* zone and the late CP12 Zone, and restricts the age of Mf748 to planktic foraminiferal zone early P10.

Poorly preserved samples (Mf708, Mf736 and Mf755) from the Whiskey Hill Formation contain low diversity assemblages that are composed primarily of arenaceous species such as *Bathysiphon, Cyclammina* and *Haplophragmoides* (Table 2). Species present are long ranging forms that at most suggest an Eocene age (fig. 5). Samples Mf731, Mf733, and Mf757 contain such sparse poorly preserved benthic foraminiferal assemblages that species and genera can not be identified. Samples Mf740 and Mf749 are from a limestone thought to represent the lowest part of the Eocene section and mapped as Whiskey Hill Formation (Pampeyan, in press). Two arenaceous specimens found in these samples are not diagnostic of age. The distribution of these poorly preserved assemblages is random and probably the result of weathering rather than ecologic conditions at the time of deposition.

One sample from the Whiskey Hill Formation (Mf707, Table 3) contains an abundant, diverse benthic foraminiferal assemblage that is middle Eocene in age and assigned to the early Narizian Stage (fig. 5). Cosmopolitan species present in this assemblage include many long ranging forms which first appear in the early Eocene and continue into the late Eocene or Oligocene such as *Alabamina wilcoxensis*, *Bulimina alazaensis*, *Globocassidulina subglobosa*, *Hanzawaia ammophila*, *Nuttaloides truempyi*, and *Oridorsalis umbonatus*. Critical age diagnostic species are primarily forms which first appear in the Narizian and are restricted to the West Coast or the North Pacific such as *Bulimina microcostata*, *Plectofrondicularia packardi*, *Uvigerina yazooensis*, *U. garzaensis*, *Valvulineria jacksonensis welcomensis*, and *V. tumeyensis*. At this time it is not clear whether deposition is continuous from the Ulatisian through the early Narizian or whether this sample is separated from the older middle Eocene faunas by an unconformity.

An Eocene age has been assigned to a number of other samples within the Palo Alto 7-1/2' quadrangle by previous workers. Samples Mf744, Mf745, Mf739, Mf1141, Mf1142, and Mf1143B were considered Eocene in age (Israelsky, unpublished E and R Reports, 1963; Pierce, unpublished E and R Reports, 1966; Pampeyan, in press). Samples Mf744 and Mf745 are from shales interbedded with Franciscan Complex (?) and were initially interpreted as middle Eocene or older (Israelsky, unpublished E and R, 1963; Pierce unpublished E and R, 1966). Foraminifers are not recognized in these samples and an age can not be determined. Sample Mf739 was assigned to the Eocene by Israelsky (unpublished E and R, 1963) although the rocks were mapped as Eocene (Pampeyan, in press). The single Tertiary planktic species present is probably the result of contamination as Cretaceous planktic and benthic species are more common. Sliter (personnal communication, 1992) assigns the fauna in Mf739 to the Campanian. Samples Mf1142 and Mf1143B are from rocks mapped as Cretaceous (Pampeyan, in press) and contain an arenaceous fauna which is not diagnostic of age (Table 4) despite the Eocene or older age given by Pierce (unpublished E and R, Report, 1966; Pampeyan, in press). Sample Mf1141, which is also from rocks mapped as Cretaceous, contains two lower Tertiary benthic foraminiferal species (Table 2), *Globocassidulina subglobosa* which first appears in the late Paleocene and ranges into the Eocene and younger strata, and *Reusella elongata* which occurs primarily in the early Eocene (Appendix II). These species suggest an early Eocene age for Mf1141 but a middle Eocene age can not be ruled out.

Re-evaluation of previous studies

Benthic foraminiferal samples examined by Graham and Classen (1955) were considered middle Eocene in age and assigned to the basal A-2 zone of Laiming (1939, 1940). Although the original slides and specimens of Graham and Classen have not been examined, a review of the taxonomy and a revised checklist (Table 5) indicates that the Woodside samples are middle Eocene in age and range from planktic foraminiferal zones P10 through P13 (fig. 6). Age diagnostic species include *Aragonia aragonensis* (P5-P14), *Cibicidoides grimsdalei* (P8-N4), *Pullenia eocenica* (P9-P17), *Silicosigmoilina californica* (Cretaceous through P9, with rare occurrences in P10-p13), *Siphonodosaria gracillima* (P9-P15), and *Siphonodosaria subspinosa* (P10-Oligocene). Sample 2 contains *Uvigerina garzaensis* which first appears in the late middle Eocene and restricts this sample to the early Narizian Stage. Other critical age diagnostic species which restrict the age further are either not present in the Woodside samples or not recognized in the taxonomic notes and plates of Graham and Classen (1955).

In another study of the Palo Alto 7-1/2' quadrangle, Beaulieu (1970) arranged spot samples from the Whiskey Hill Formation in a stratigraphic sequence which was thought to range from the early Eocene, Penutian Stage through the late Eocene Narizian Stage. His stratigraphic sequence contains a granular greenstone conglomerate near or at the base overlain by approximately 4000 feet of alternating arkosic sandstone and mudstone.

The conglomerate which consists mainly of greenstone with traces of chert and other rocks, is exposed at several localities on or near the north side of Jasper Ridge between rocks of the Franciscan Complex and the overlying sandstone (Branner and others, 1909; Graham, 1967; Beaulieu, 1970; Pampeyan, in press). The age of this conglomerate was reported as late Paleocene, Bulitian Stage or early Eocene, Penutian Stage (Graham, 1967; Beaulieu, 1970). The age of sample PA-126 (Beaulieu, 1970) recovered from the conglomerate was based on stratigraphic relationships and the presence of *Alabamina wilcoxensis* and *Discorbis baintoni* (sample PA-126, Table 6) which were believed to be restricted to the late Paleocene, Bulitian or early Eocene, Penutian Stages. *Alabamina wilcoxensis*, however, ranges from planktic foraminiferal zone P6a through P17 (latest Paleocene through late Eocene) with a questionable occurrence in zone P4 and *Discorbis baintoni* ranges from P7 through P10 (early Eocene through middle Eocene), with rare occurrences in P11 (see Appendix II); thus suggesting an Eocene rather than Paleocene age. Sample PA-126 also contains *Karreriella elongata* which ranges from late early Eocene planktic foraminiferal zone P8 to Oligocene. The Jasper Ridge granular greenstone conglomerate is therefore no older than late early Eocene and is probably middle Eocene in age.

Although most of Beaulieu's samples in the Whiskey Hill Formation above the conglomerate are barren of benthic foraminifers or only sparsly fossiliferous, the age of these samples is middle Eocene (fig. 6). A review of the taxonomy and a revised checklist

(Table 6) indicates that the majority of these samples can be assigned to the Ulatisian Stage and are correlative with plantkic foraminiferal zone P10 but may be as old as P8 and as young as P14. Age diagnostic benthic foraminiferal species are not common in these samples, but the presence of *Aragonia aragonensis* (P5-P14) and *Karreriella elongata* (P8-Oligocene) restrict the age to planktic foraminiferal zones P8 through P14. Two samples PA-258 and M1492 are assigned to the middle Eocene part of the Narizian Stage. This interpretation is based on the presence of *Plectofrondicularia packardi* and *Uvigerina garzaensis* which first appear in the Narizian Stage. M1492 is a megafossil sample from the same locality as Mf707 (this study) which was also assigned to the middle Eocene, Narizian Stage. Again it is not possible to determine if sedimentation was continuous from the Ulatisian through the early Narizian or whether these samples are from an overlying formation.

Both Beaulieu (1970) and Kheradyar (1987) examined microfossils from a thick section exposed during excavation of the Stanford Linear Accelerator trench (SLA section). Only two Paleogene samples examined by Beaulieu (1970) contained benthic foraminifers (Table 7). These assemblages were considered early Eocene. The presence of *Pullenia eocenica* (P9-P17) and *Silicosigmoilina californica* (Cretaceous - P9 with questionable occurrences in P10-P13) in these samples restricts the age to the latest early Eocene through middle Eocene coeval with planktic foraminiferal zones P9 through P13. Nannofossils which were interpreted as representing zones CP12 (*Rhabdospeara inflata* Zone) through CP14a (*Discoaster bifax* zone) (Kheradyar, 1987), range in age from latest early Eocene through middle Eocene (fig. 6) and supports the benthic foraminiferal interpretation.

ECOLOGY

Deposition of the Whiskey Hill Formation occurred at lower bathyal to abyssal depths ($\geq$ 2000 m) with considerable material transported from shallower depths, primarily the outer shelf and upper slope (outer neritic and upper bathyal biofacies, 100 to 500 m). The lower bathyal and abyssal depths are suggested by the presence of *Bulimina semicostata*, *Buliminella grata*, *Cibicidoides grimsdalei*, *Cibicidoides praemundulus*, and *Silicosigmolina californica,* which have upper depth limits in the lower bathyal biofacies, and various species of *Chrysalongonium*, *Glomerata*, *Pleurostomella*, and *Stilostomella*, which have upper depth limits primarily in the abyssal biofacies. Together these species comprise less than 20% of the assemblage but are present in all but one sample.

The early Narizian sample Mf707 contains no species with upper depth limits in the abyssal biofacies but does contain numerous lower middle bathyal and lower bathyal species indicating a slight shallowing of water depths. Although species with upper depth limits in shallower biofacies are common in the samples, most indicate transport. Species with upper depth limits in the outer neritic and upper bathyal biofacies are most common and include numerous species of *Dentalina*, *Lenticulina*, and *Nodosaria*. These specimens are worn and broken, and thus support the interpretation that they were transported.

Previous studies of the Whiskey Hill Formation have suggested that deposition occurred in the bathyal (slope) environment where turbidites and slides were occurring (Graham and Classen, 1955; Page and Tabor, 1967; Beaulieu, 1970; Kheradyar, 1987). The basal granular conglomerate was interpreted as being deposited in a neritic environment with high current action, possibly near a fault line scarp, and the overlying sandstones and mudstones were interpreted as being deposited at bathyal depths (Beaulieu, 1970). The presence of *Alabamina wilcoxensis* (upper depth limit: lower bathyal to abyssal; Tjalsma and Lohmann, 1983) and *Karreriella elongata* (upper depth limit: lower middle bathyal; Ingle, 1980) suggest that despite the presence of shallow water forms in the conglomerate (sample PA-126, Table 6; Beaulieu, 1970), deposition may have occurred at lower bathyal depths ($\geq$ 2000 m). The conglomerate was probably formed during the transgression which followed the low stand of sea level in the late early Eocene planktic foraminiferal zone P9.

SUMMARY AND CORRELATION

The Whiskey Hill Formation in the Palo Alto 7-1/2' quadrangle contains latest early Eocene to middle Eocene benthic foraminifers which are diagnostic of the Ulatisian Stage as modified by McDougall and coeval with planktic foraminiferal zones late P9 through at least P12 and calcareous nannofossil zones CP12 through CP13. Nannofossil studies also suggest a latest early Eocene to middle Eocene age and assign the Whiskey Hill Formation to calcareous nannofossil zones CP12 through CP13 and questionably to CP14a (Kheradyar, 1987; Bukry and others, 1977; Pampeyan, in press) which agrees with the benthic foramniferal interpretations. Benthic foraminiferal assemblages suggest deposition occurred at lower bathyal to abyssal depths.

A single sample in the present study (Mf707) and several samples from previous studies (#2, Graham and Classen, 1955; PA-258 and M1492, Beaulieu, 1970) contain benthic foraminiferal species which restrict the age of these samples to the latest middle Eocene, early Narizian Stage and coeval with planktic foraminiferal zoneslate P12 through P15. No planktic microfossil data is available to confirm this interpretation. It is unclear whether sedimentation was continuous from the Ulatisian through the Narizian or whether an unconformity separates these samples from the older middle Eocene faunas in the Whiskey Hill Formation.

Coeval strata are present in several key sections throughout California (figs. 7 and 8). Ulatisian strata occurs in the Vaca Valley (type Ulatisian Stage of Mallory, 1959; Boyd, 1949; Poore, 1976; Vaughan, 1976), Pacheco Syncline (Smith, 1957; Poore, 1976), Tres Pinos (Kaar, 1962; Poore, 1976), Lodo Gulch (Martin, 1943; Israelsky, 1951, 1955; Mallory, 1959; Bramlette and Sullivan, 1961; Schmidt, 1970; Poore, 1976; Berggren and Aubert, 1983), Devils Den (Mallory, 1959; Poore, 1976; Berggren and Aubert, 1983; Warren, 1983; McDougall, unpub. data, 1988), Media Aqua Creek (Mallory, 1959, 1970; Poore, 1976; McDougall, unpub. data, 1988), and Simi Valley sections (Browning, 1952; Grier, 1953; Filewicz and Hill, 1983; Schymiczek, 1983). The Vaca Valley, Pacheco Syncline and Tres Pinos sections were deposited at depths similar to the Whiskey Hill Formation and thus contain numerous species in common.

In the Vaca Valley section, the presence of *Karreriella elongata* (*Textularia elongata* of Vaughan, 1976), *Lenticulina ulatisian*, and *Uvigerina lodoensis mirimae* (*Pseudouvigerina vacavillensis* of Boyd, 1949 and of Vaughan, 1949) in the benthic foraminiferal assemblages indicates a latest early Eocene to middle Eocene age and places these assemblages in the Ulatisian Stage as modified by McDougall. Most of the cosmopolitan species used to restrict the age in the Whiskey Hill Formation samples seem to be missing from the Vaca Valley Section. This is, however, probably a problem of recognition as the original slides have not been examined and most species are not figured. Nannofossil data indicates an age of latest early Eocene to middle Eocene zones CP12 through CP13 (Poore, 1976; Vaughan, 1976). Early Eocene zone CP11 was recognized by Vaughan (1976) based on the absence of *Discoaster sublodoensis*. Poore (1976) also noted the absence of *Discoaster sublodoensis* but observed that the first occurrences of *Lophodolithus mochlophorus* and *Rhabdosphaera tenuis* approximate the first appearance of *Discoaster sublodoensis* where it is rare or absent.

In the Pacheco Syncline, the early Eocene (calcareous nannofossil zones CP10-CP11) Las Juntas Formation is overlain by the middle Eocene (calcareous nannofossil zones CP12-CP13) Muir Sandstone, Escobar Sandstone, and lower Alhambra formations (Poore, 1976; Bukry and others, 1977). Age diagnostic benthic foraminiferal faunas in this section are not readily recognized because of the taxonomic nomenclature. *Lenticulina ulatisian* and *Uvigerina lodoensis mirimae* (*Uvigerina* sp. of Smith, 1957) are present in the Muir Sandstone and suggest assignment of the Muir Sandstone to the Ulatisian Stage whereas the presence of *Uvigerina yazooensis* and *Uvigerina garzaensis* at the base of the Alahambra Formation suggest assignment of the lower part of this formation to the Narizian Stage (latest middle Eocene in age).

The distribution of benthic foraminiferal species in the Tres Pinos Section (Kaar, 1962; McDougall, unpub. data) suggests that the Bolado Park Formation is early Eocene, and the Tres Pinos Sandstone and Los Muertos Creek Formation are middle Eocene. Assemblages from the basal part of the Los Muertos Creek Formation (sample B-7242) are most similar to the Whiskey Hill Formation, however, age diagnostic species are missing from this section or not recognized due to problems in the taxonomic nomenclature and this sample can not be clearly assigned to the early or middle Eocene based on benthic foraminifers. Based on calcareous nannofossils, sample B7242 is assigned to zone CP11 (early Eocene) and sone Cp12 (middle Eocene) is tentatively placed above B-7242 in an unsampled interval of the Los Muertos Creek Formation. The upper part of the Los Muertos Creek Formation is assigned to calcareous nannofossil zone CP13 (Poore, 1976). The first appearance of benthic foraminifers *Uvigerina garzaensis* and *Valvulineria jacksonensis welcomensis* in the upper Los Muertos Creek Formations (sample B-7248 and B-7246) suggest the early Narizian Stage.

The Lodo Gulch, Devils Den, Media Aqua Creek and Simi Valley sections contain benthic foraminiferal assemblages assigned to the Ulatisian but deposition occurred at shallower depths (fig. 9). Comparisions of the benthic foraminiferal assemblages in these sections with those of the Whiskey Hill Formation have not been undertaken at this time.

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FIGURES

1. Simplified map of the western San Francisco Bay Region showing major tectonic blocks, faults and folds as well as location of the Palo Alto 7-1/2' quadrangle (modified from Nilsen and Brabb, 1979).

2. General geology and location of samples in the Palo Alto 7-1/2' quadrangle. U.S.G.S. microfossil localities and samples examined by Graham and Classen (1955) are also shown on this map. Geology is simplified from Pampeyan (in press). Sample Mf749 is just off the west edge of the map area near samples Mf744 and Mf745.

3. Calibration of the California benthic foraminiferal stages as modified by McDougall (1988, 1989, 1991, and unpub. data). Modified benthic foraminiferal stages are calibrated to the international time scale (Berggren and others, 1985; Aubrey and others, 1988), planktic microfossil zones (Blow, 1969, 1979; Berggren 1972; Bukry, 1973, 1975; Okada and Bukry, 1980), coastal onlap curves (Haq and others, 1987) and oceanographic events (Kennett and Stott, 1991). Many of these correlations have been summarized by Bartow (1992). Data on the benthic foraminifers and correlations to international time scale is primarily from unpublished data of McDougall.

4. Ranges of age-diagnostic benthic foraminifers in the Whiskey Hill Formation. Ranges of cosmopolitan and key California species shown here are discussed and summarized in Appendix II. Considerably more species can be used to recognize

the benthic foraminiferal stages in California (see McDougall, 1988, 1989, 1991) but only those present in the Whiskey Hill Formation are listed here.

5. Age of the Whiskey Hill Formation. Age ranges of samples from the Whiskey Hill Formation are based on the ranges of benthic foraminiferal species (Appendix II). Most benthic foraminiferal faunas from the Whiskey Hill Formation are middle Eocene in age, assigned to the Ulatisian Stage and coeval with planktic foraminiferal zone P10. The formation may be as old as early Eocene planktic foraminiferal zone P9 and as young as middle Eocene zone P11. One sample Mf707, although considered middle Eocene in age, is assigned to the Narizian Stage and coeval with planktic foraminiferal zones late P12 through P14.

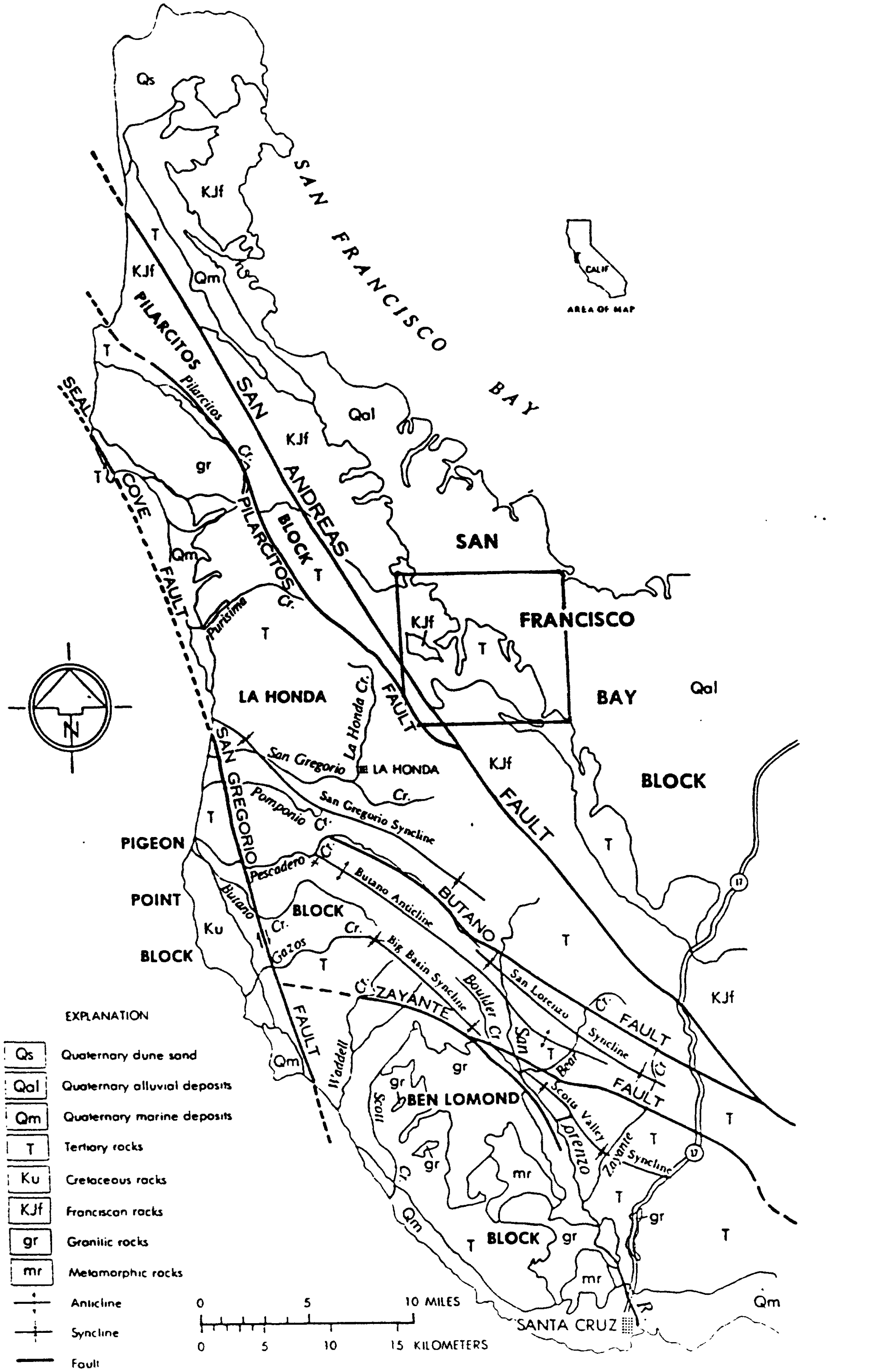
6. Age of the Whiskey Hill Formation as interpreted from previous studies and compared to the present study. Age of strata shown by heavy lines; possible or questionable range of strata shown by light lines. Benthic foraminiferal assemblages examined by Graham and Classen (1955) and reinterpreted during the present study suggest a middle Eocene age and are coeval with planktic foraminiferal zones P10 through P13. Sample 4 of Graham and Classen (1955) contains no age diagnostic species and sample 2 which contains *Uvigerina garzaensis*, is restricted to the Narizian and is probably coeval with planktic foraminiferal zones late P12 through P13. Although not as restricted, the benthic foraminiferal assemblages examined by Beaulieu (1970) from the Palo Alto 7-1/2' quadrangle (including the Stanford Linear Accelerator Section), and reinterpreted during the present study suggest a latest early Eocene through middle Eocene age and are coeval with planktic foraminiferal zones P8 through P14. Samples PA258 and M1492 are restricted to the early Narizian

stage and coeval with planktic foraminiferal zones late P12 through P14. Calcareous nannofossils from the SLA section range from CP12 through CP13 and questionably as young as CP14a (Kheradyer, 1987).

7. Location of key lower Tertiary sections in California.

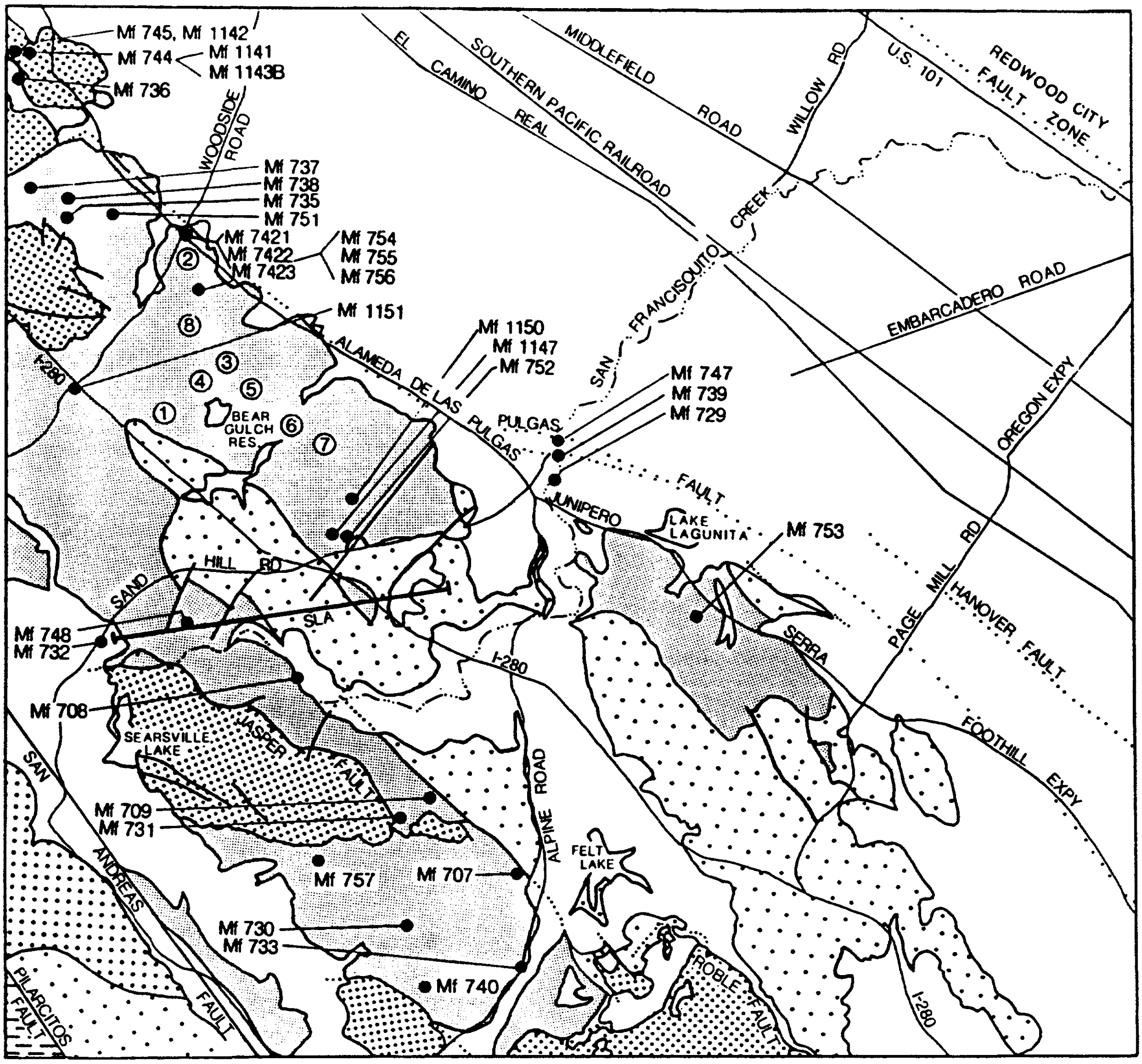
8. Age range of strata in key California lower Tertiary section and the Whiskey Hill Formation. Age of strata shown by heavy lines; possible or questionable range of strata shown by light lines and question marks.

9. Late Paleocene through middle Eocene paleobathymetery of several key California lower Tertiary sections and the Whiskey Hill Formation. Data compiled from Martin (1943), Boyd (1949), Israelsky (1951; 1955), Browning (1952), Grier (1953), Smith (1957), Mallory (1959; 1970), Bramlette and Sullivan (1961), Kaar (1962), Schmidt (1970), Poore (1976), Vaughan (1976), Berggren and Aubert (1983), Filewicz and Hill (1983), Schymiczek (1983), Warren (1983), and McDougall (1988) and revised by McDougall (1988; 1989; 1990; unpub. data).



26a

McDOUGALL
FIG 1



Mf xxx USGS Microfossil localities

Ⓧ Graham and Classen (1955) localities

Contact

Fault

Thrust fault

Quarternary

Miocene and Pliocene Fms.

Whiskey Hill Formation

Mesozoic Fms.

Eocene and Paleocene? Sandstone

Butano Sandstone

0 1 2 Miles

McDOUGALL
FIG 2

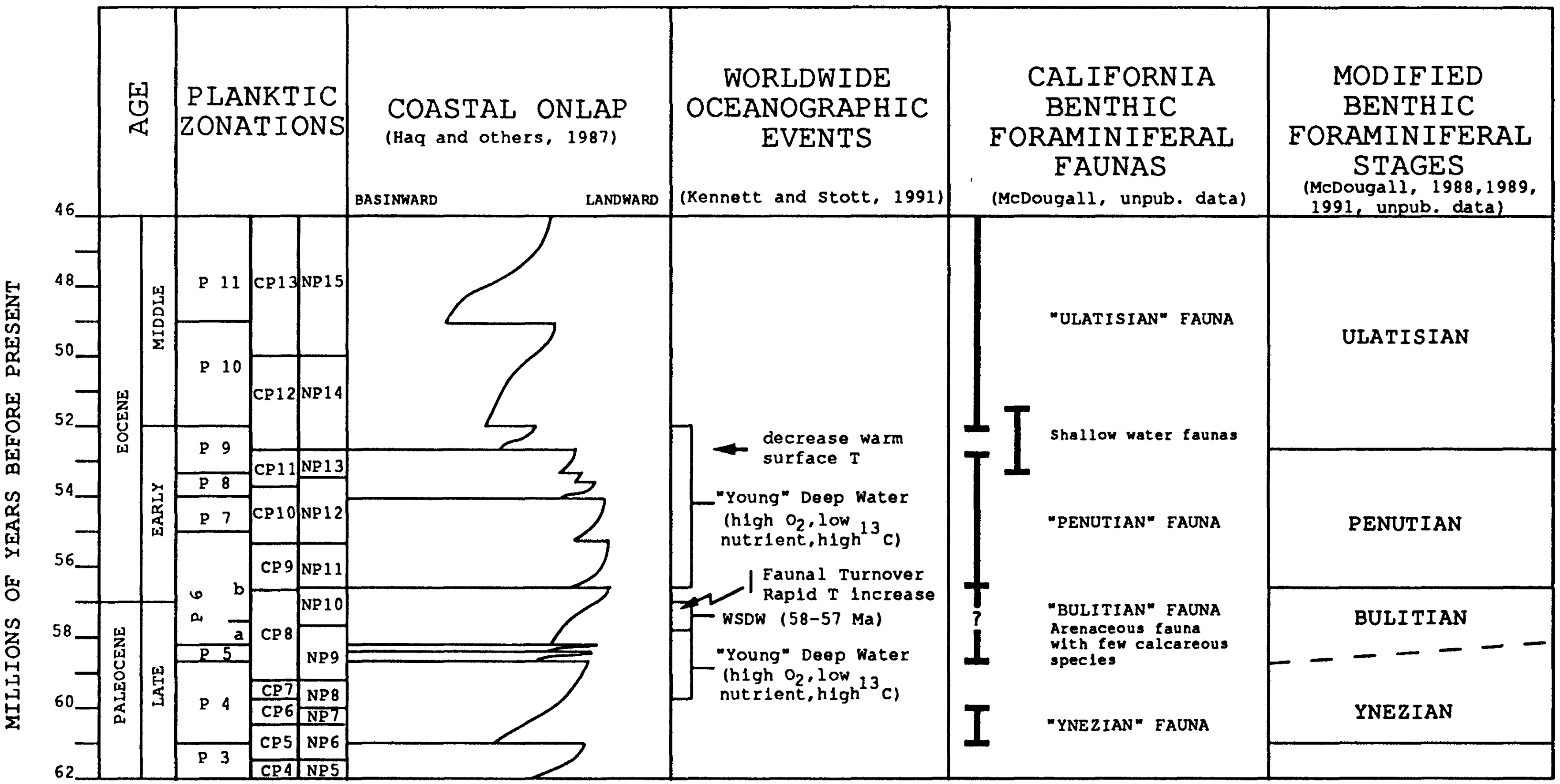


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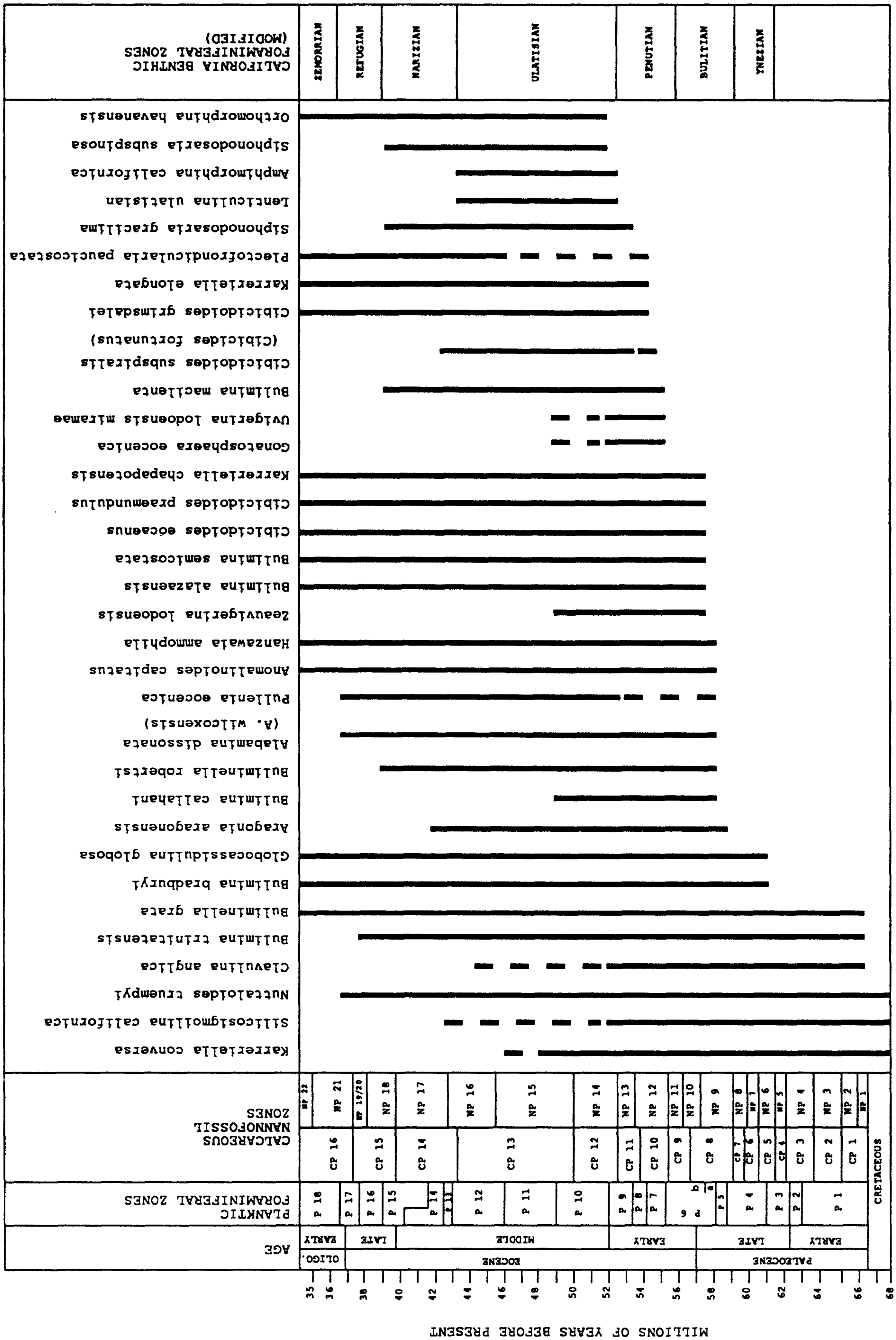
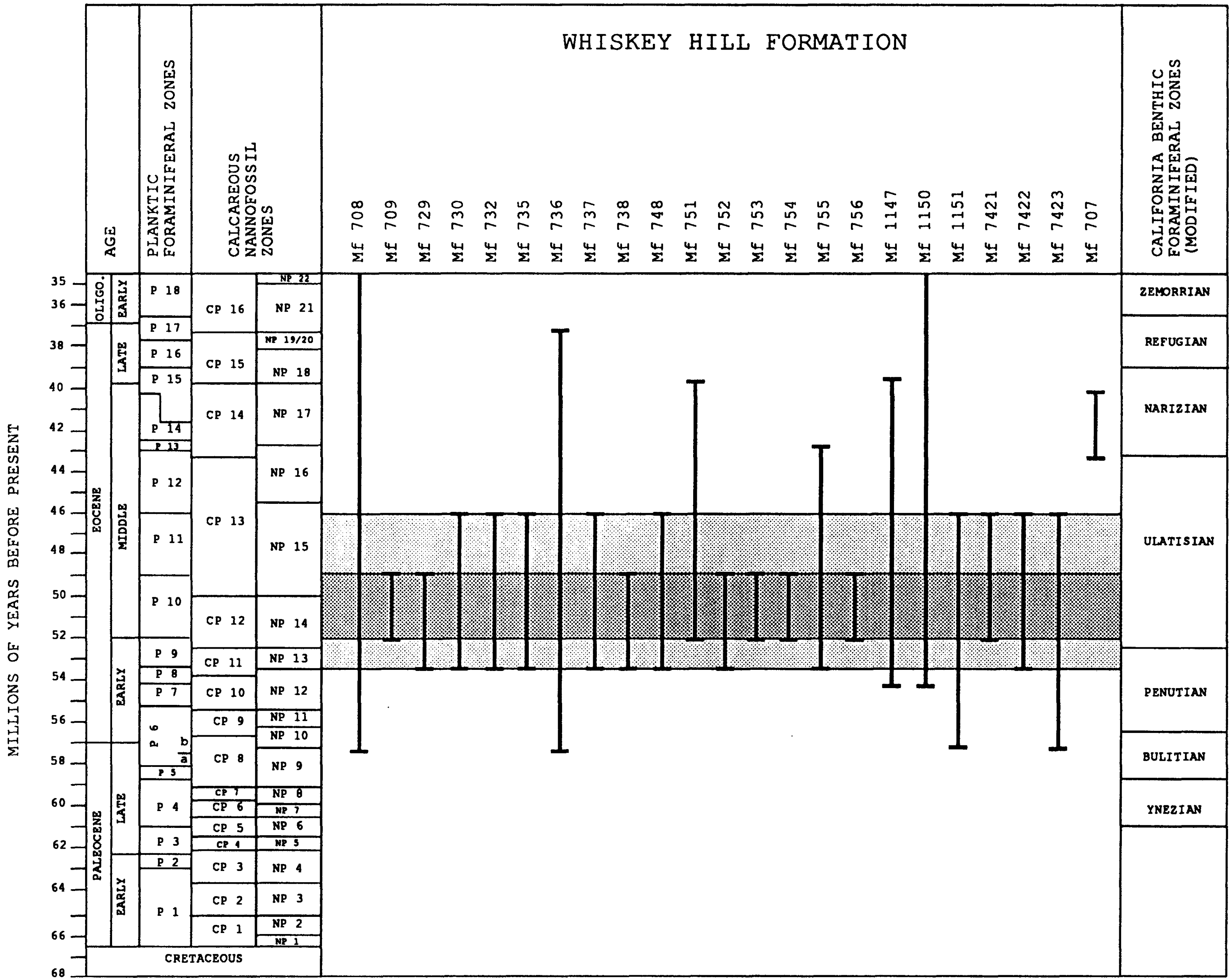
FIG 3



26 d

McDOUGALL
FIG 4

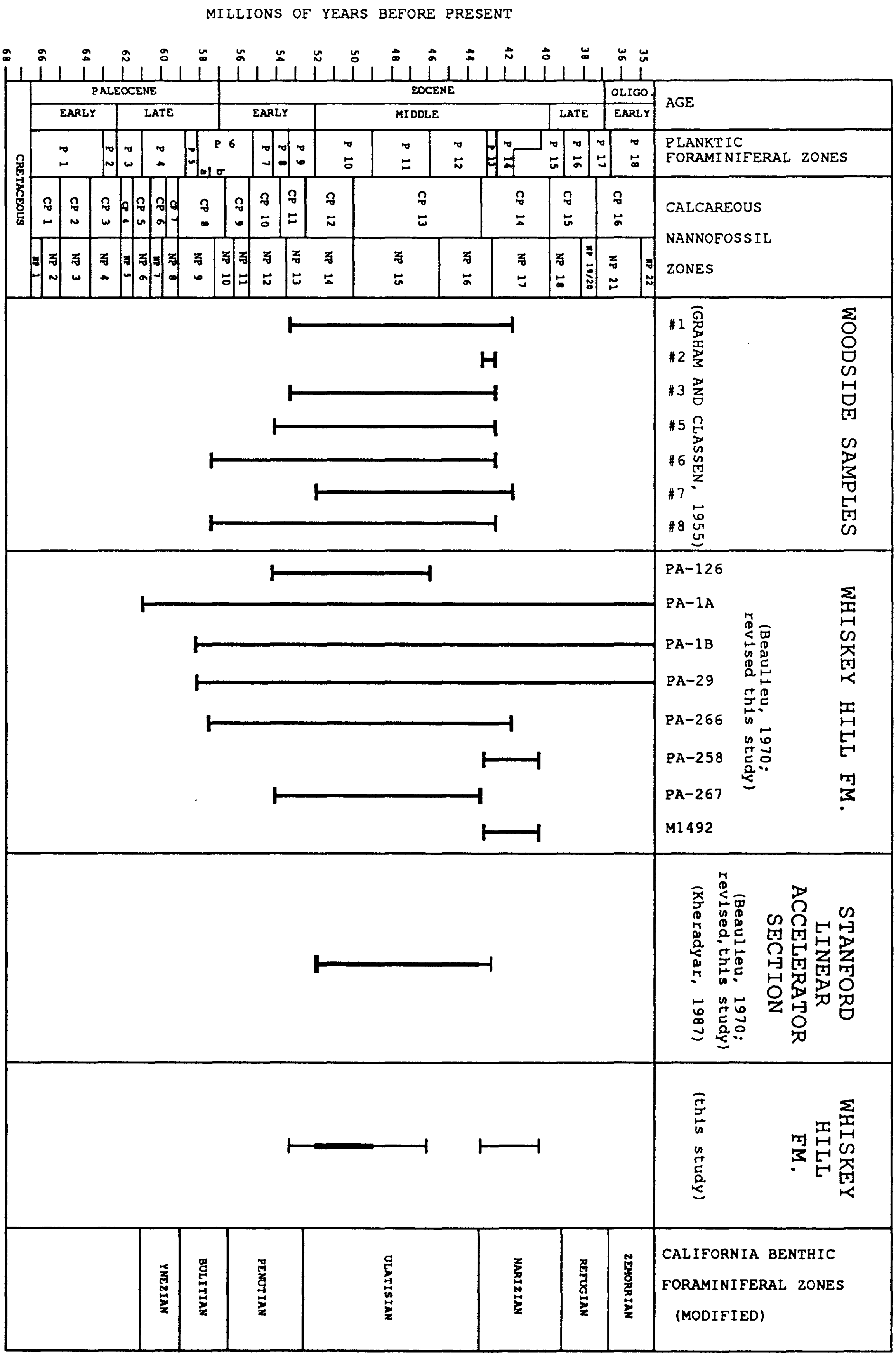


26 e

McDOUGALL
FIG 5

26 f

McDougall
Fig 6



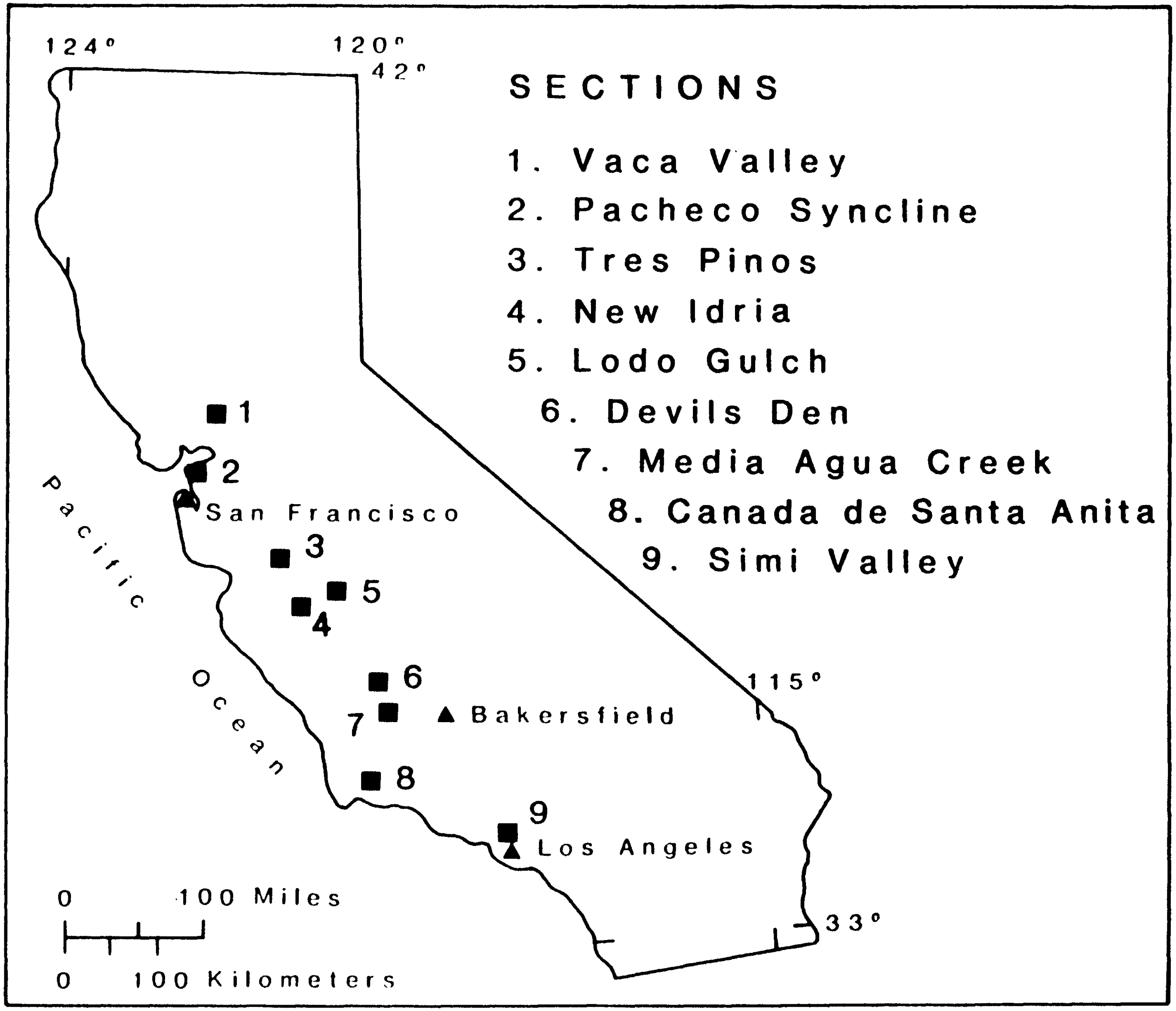


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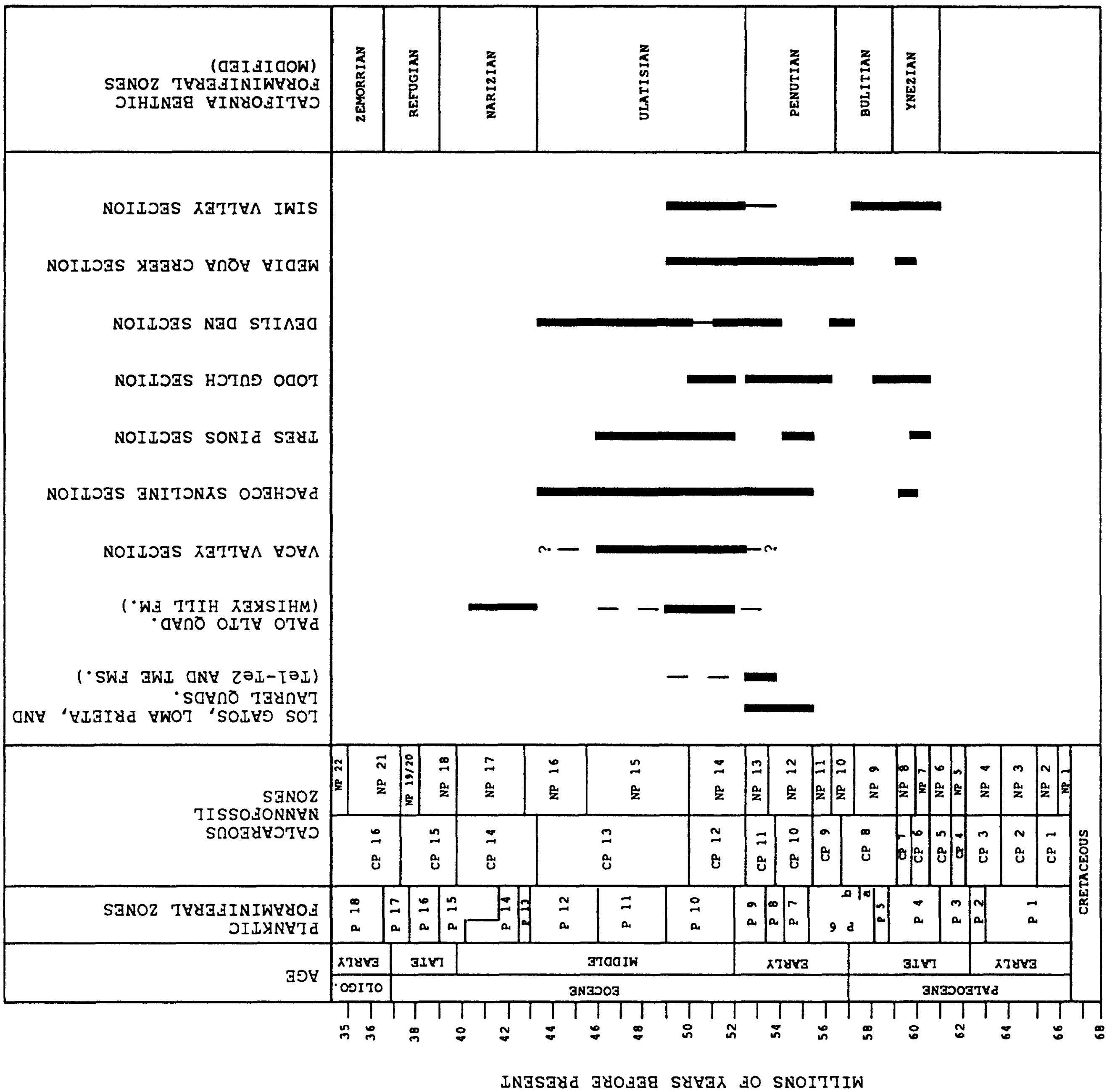
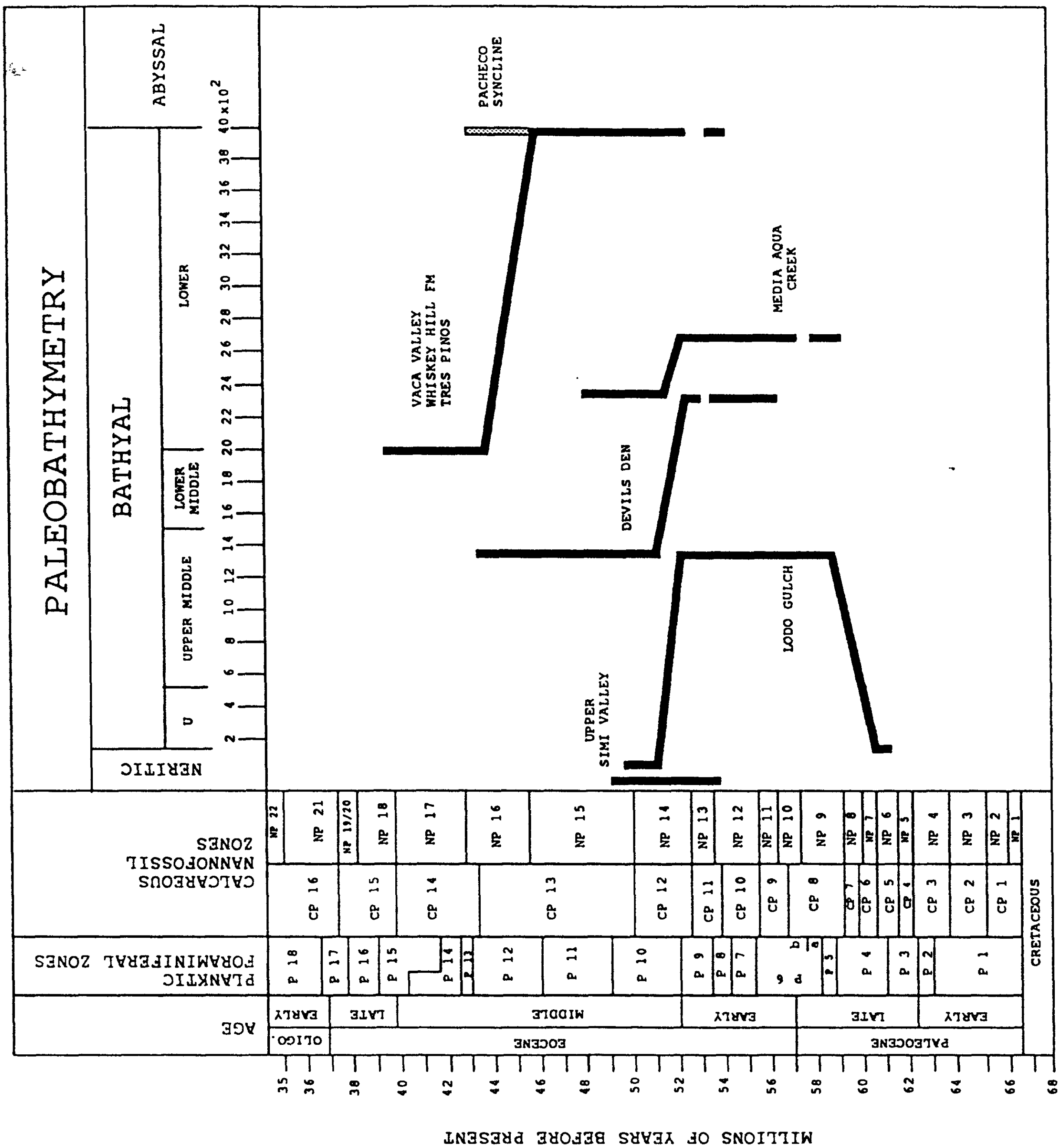
FIG 7



26 h

McDOUGALL
FIG 8



26i

McDOUGALL
FIG 9

TABLES

1. Diverse, well preserved benthic foraminifers from the Whiskey Hill Formation, Palo Alto 7-1/2' quadrangle.

2. Poorly preserved benthic foraminifers from the Whiskey Hill Formation, Palo Alto 7-1/2' quadrangle. Foraminiferal assemblages from samples Mf731, Mf733 and Mf755 are too poorly preserved to identify and thus not included in this table.

3. Narizian benthic foraminifers from the Whiskey Hill Formation, Palo Alto 7-1/2' quadrangle.

4. Benthic foraminifers from the Palo Alto 7-1/2' quadrangle mapped as Cretaceous (?) by Pampeyan (in press) but containing a Tertiary, probably middle Eocene assemblage. Foramniferal assemblages from samples Mf744 and Mf745 are too poorly preserved to identify and thus not included in this table.

5. Benthic foraminifers from the Woodside samples of Graham and Classen (1955). The taxonomic nomenclature has been revised where possible to conform with that used in this paper. See Appendix II for synonomies.

6. Benthic foraminifers from the Whiskey Hill samples of Beaulieu (1970). The taxonomic nomenclature has been revised where possible to conform with that used in this paper. See Appendix II for synonomies.

7. Benthic foraminifers from the Stanford Linear Accelerator Section of Beaulieu (1970). The taxonomic nomenclature has been revised where possible to conform with that used in this paper. See Appendix II for synonomies. The middle Miocene samples examined by Beaulieu (1970) are not included.

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
21. *Bifarina* spp.			X																
22. *Buliminella grata* Parker and Bermudez	X	X			X			X			X		X	X					
23. *B. robertsi* (Howe and Ellis)		X				X	X	X			X		X						
24. *Bolivina antegressa* Subbotina							X												
25. *B. crenulata* Cushman		X																	
26. *B. midwayensis Cushman of Mallory* (1959)		X																	
27. *B.* spp.								X								X			
28. *B. explicata lodoensis* Mallory		X			X	X			X										
29. *Bulimina alazaensis* Cushman		X				X						X							
30. *B. cf. B. alazaensis* Cushman								X											
31. *B. bradburyi* Martin		X									X								
32. *B. cf. B. bradburyi* Martin				X															
33. *B. callahani* Galloway and Morrey		X						X			X		X						
34. *B. guayabalensis* Cole			X																
35. *B. macilenta* Cushman and Parker		X				X	X	X		X	X	X	X				X	X	
36. *B. cf. B. midwayensis* Cushman and Parker		X																	
37. *B. semicostata* Nuttall				X	X	X	X	X		X	X		X	X	X	X	X		
38. *B.* spp.					X	X		X											
39. *B. trigonalis ten* Dam							X												
40. *B. trinitatensis* Cushman and Jones		X				X		X			X	X	X			X			

= Absent

X = Present

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
1. *Alabamina* spp.				X															
2. *A. wilcoxensis* Toulmin	X	X	X			X		X				X							
3. *Allomorphina conica* Cushman and Todd		X																	
4. *A. trigonia* Reuss									X										
5. *Ammobacculites* spp.								X											
6. *Ammodiscus incertus* (d'Orbigny)	X	X	X		X	X	X	X		X	X	X	X		X		X	X	X
7. *A. pennyi* Cushman and Jarvis								X											
8. *Amphimorphina californica* Cushman and McMasters						X									X				
9. *A. ignota* Cushman and Siegfus		X			X	X	X	X	X		X		X				X		
10. *Anomalinoides capitatus* (Gumbel)		X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	
11. *Anomalina garzaensis* Cushman and Siegfus		X	X					X											
12. *A. cf. A. garzaensis* Cushman and Siegfus			X														X	X	X
13. *A. regina* Martin	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X			
14. *A.* spp.		X			X			X		X			X						
15. *Aragonia aragonensis* (Nuttall)	X	X	X	X	X		X	X	X	X	X	X	X	X		X		X	X
16. *Astacolus* sp.		X				X													
17. *Bathysiphon eocenicus* Cushman and Hanna			X						X								X	X	
18. *B. santecruis* Cushman and Kleinpell	X				X	X	X	X		X	X	X					X	X	X
19. *B.* spp.	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
20. *Bifarina eleganta* (Plummer)		X			X	X	X										X		

= Absent

X = Present

McDOUGALL

TABLE 1

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
141. *Hanzawaia* sp.										X									
142. *Haplophragmoides eggeri* Cushman	X		X			X		X		X	X		X						
143. *H. cf. H. eggeri* Cushman																	X	X	X
144. *H. glabra* Cushman and Waters					X			X		X	X								
145. *H. cf. H. glabra* Cushman and Waters												X							
146. *H. kirki* Wickenden																		X	
147. *H. lamella* (Grzybowski)												X							
148. *H.* spp.													X						
149. *Hormosina* sp.								X											
150. *Hyperammina elongata* Brady					X			X			X		X		X				
151. *Karreriella chapapotensis* (Cole)	X		X			X	X	X	X	X	X	X	X	X	X	X	X	X	
152. *K. cf. K. chapapotensis* (Cole)								X											
153. *K. conversa* (Grzybowski)		X	X	X	X	X		X		X	X					X	X	X	X
154. *K. aff. K. cubensis* Cushman and Bermudez					X	X							X						
155. *K. elongata* Mallory	X	X	X		X	X	X	X		X		X	X	X	X		X		
156. *K. horrida* Mjatliuk	X		X	X	X	X	X	X	X	X	X	X	X			X	X		
157. *Lagena acuticosta* Reuss	X																		
158. *L. alveolata* Brady												X							
159. *L. costata* (Williamson)		X				X													
160. *L. hexagona* (Williamson)		X																	

= Absent

X = Present

McDougall
Table 1
(continued)

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
161. *Lagena hispida* Reuss						X		X		X									
162. *L. laevis* (Montagu)		X			X														
163. *L. aff. L. plumigera* Brady		X			X							X							
164. *L. substriata* Williamson		X			X														
165. *L.* spp.	X	X		X	X	X				X			X						
166. *L. striata* (d'Orbigny)					X							X							
167. *L. cf. L. striata* (d'Orbigny)								X											
168. *L. sulcata* (Walker and Jacob)												X							
169. *Lenticulina altolimbatus* (Gumbel)	X	X	X	X		X				X			X				X		
170. *L. antipodum* (Stache)		X				X			X	X	X	X	X						
171. *L. arcuatostriata* (Hantken)																	X	X	
172. *L. carolinianus* (Cushman)						X		X		X	X	X	X						
173. *L. convergens* (Bornemann)			X			X		X	X		X	X	X			X			
174. *L. limbosa* (Reuss)	X	X	X	X		X		X	X	X									
175. *L. limbosa hockleyensis* (Cushman and Applin)														X			X		
176. *L. pseudocultratus* Cole				X		X		X	X	X	X		X			X			
177. *L. pseudovortex* (Cole)		X				X			X	X	X	X	X	X	X		X	X	
178. *L. cf. L. psuedovortex* (Cole)													X						
179. *L.* spp.		X			X	X	X	X		X	X		X		X				X
180. *L. terryi* (Coryell and Embich)								X						X					

= Absent

X = Present

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
41. *Cancris subconica* (Terquem)		X		X			X												
42. *C.* spp.						X													
43. *Cassidulina* sp.		X																	
44. *Chilostomella oolina* Schwager		X			X	X		X		X	X		X				X		
45. *Chrysalogonium elongatum* Cushman and Jarvis		X		X	X			X	X	X	X	X	X				X		
46. *C. laeve* Cushman and Bermudez	X		X			X	X	X	X	X	X	X	X						
47. *C. longiscatatum* Cushman and Jarvis						X													
48. *C. cf. C. longiscatatum* Cushman and Jarvis							X												
49. *C.* spp.						X		X	X				X						
50. *C. teniucostatum* Cushman and Bermudez			X	X	X		X	X	X	X	X	X	X		X		X		
51. *C. cf. C. teniucostatum* Cushman and Bermudez	X										X								
52. *Cibicides beatus* Martin		X																	
53. *C. felix* Martin					X														
54. *C. fortunatus* Martin								X				X	X			X			
55. *C. cf. C. fortunatus* Martin												X	X						
56. *Cibicidoides eocaenus* (Cushman)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
57. *C. eponidiformis* (Martin)		X			X			X	X	X	X	X	X			X			
58. *C. grimsdalei* (Nuttall)						X						X	X						
59. *C. micrus* Bermudez		X											X						
60. *C. praecursorius* (Schwager)		X																	

= Absent

X = Present

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
61. *Cibicidoides praemundulus* Berggren and Miller	X				X			X	X		X		X						
62. *C. subspiratus* (Nuttall)	X	X	X	X	X	X	X	X		X	X	X	X				X	X	
63. *C.* spp.	X	X	X	X		X		X	X		X		X	X	X		X	X	X
64. *C. venzuelanus* (Nuttall)	X		X		X	X		X				X							
65. *Cibicides spiropunctatus* Galloway and Morrey		X				X		X					X	X	X	X			
66. *Clavulina anglica* (Cushman)		X					X										X		
67. *Cribrostomoides trintatensis* Cushman and Jarvis				X	X		X	X	X	X	X	X	X			X			
68. *Cyclammina pacifica* Beck	X							X					X						
69. *C. samanica* Berry											X								
70. *C. simiensis* Cushman and McMasters		X	X		X	X	X	X		X	X		X		X	X	X	X	X
71. *C.* spp.			X					X				X							
72. *Dentalina colei* Cushman and Dusenbury		X						X	X	X		X	X		X		X		
73. *D. communis* (d'Orbigny)	X	X	X		X	X	X	X	X	X	X	X	X						
74. *D. consobrina* (d'Orbigny)			X														X		X
75. *D. hexacostata* Cushman and Siegfus															X				
76. *D. cf. D. hexacostata* Howe										X									
77. *D. intorta* (Dervieux)							X												
78. *D. jacksonensis* (Cushman and Applin)		X																	
79. *D. multilineata* Bornemann													X						
80. *D. soluta* Reuss												X							

= Absent

X = Present

McDOUGALL
TABLE 1
(CONTINUED)

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
81. *Dentalina* spp.	X			X				X	X										
82. *Discorbis baintoni* Mallory		X				X													
83. *D. devilensis* Cook		X																	
84. *Dorothia principiensis* Cushman and Bermudez			X	X		X		X	X	X	X	X	X				X	X	
85. *Ellipsoidina ellipsoides* Sequenza								X				X							
86. *Ellipsoglandulina exponens* (Brady)							X	X				X							
87. *E. aff. E. fragilis* Bramlette										X		X							
88. *E. labiata* (Schwager)					X	X		X				X							
89. *E. cf. E. laevigata* Silvestri													X						
90. *E. multicostata* (Galloway and Morrey)								X											
91. *E. principiensis* Cushman and Bermudez								X											
92. *E.* spp.													X						
93. *Ellipsodimorphina subcompacta* Liebus								X				X							
94. *Elphidium californicum* Cook							X												
95. *Epistominella* spp.																X			
96. *Eponides dorfi* Toulmin																	X		
97. *E. lodoensis* Martin		X	X					X	X										
98. *E. aff. E. lotus* (Schwager)							X			X	X	X							
99. *E. cf. E. plummerae* Cushman													X						
100. *Fissurina alveolata* (Brady)								X											

= Absent

X = Present

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TABLE 1
(CONTINUED)

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TABLE 1
(CONTINUED)

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
101. *Fissurina cf. F. alveolata* (Brady)								X	X										
102. *F. cf. F. subformosa* Parr		X																	
103. *F. cf. F. clathrata* (Brady)		X																	
104. *F. cucullata* Silvestri								X											
105. *F. cf. F. cucullata* Silvestri								X											
106. *F. fimbrata* (Brady)																		X	
107. *F. aff. F. flintiana* (Cushman)								X		X			X						
108. *F. marginata* (Montagu)			X		X	X	X	X											
109. *F. cf. F. marginata* (Montagu)													X						
110. *F. semimarginata* (Reuss)								X		X									
111. *F. solida* Sequenza		X		X	X		X	X											
112. *F. orbignyana* Sequenza		X			X								X						
113. *F.* spp.		X			X														
114. *Fursenkoina bramletti* (Galloway and Morrey)		X	X	X	X	X		X	X	X			X						
115. *F. cf. F. danvillensis* (Howe and Wallace)														X					
116. *F. sp. A of* Graham and Classen						X	X	X								X			
117. *F.* spp.					X				X										
118. *Gaudryina coalingaensis* Cushman and Hanna		X																	X
119. *Globobulimina pacifica* Cushman			X																
120. *Globocassidulina globosa* (Hantken)		X	X		X	X	X	X			X	X	X				X	X	

= Absent

X = Present

McDOUGALL
TABLE 1
(CONTINUED)

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
121. *Glandulina laevigata* (d'Orbigny)				X															
122. *G.* spp.					X														
123. *Globulina globosa* (von Munster)													X						
124. *G.* sp.								X											
125. *Glomospira charoides* (Jones and Parker)				X	X		X	X		X	X	X	X			X	X	X	
126. *G. gordialis* (Jones and Parker)								X		X	X								
127. *Gonatosphaera eocenica* Mallory									X		X								
128. *Guttulina irregularis* (d'Orbigny)		X					X	X			X								
129. *G. problema* d'Orbigny		X				X	X	X	X		X		X						
130. *G.* spp.			X																
131. *Gyroidina condoni* (Cushman and Schenck)		X																	
132. *G. cf. G. condoni* (Cushman and Schenck)											X								
133. *G. octocameratus* Cushman and Hanna	X		X	X		X				X		X	X						
134. *G. orbicularis planata* Cushman			X	X					X		X								
135. *G. orbicularis* d'Orbigny								X	X			X	X						
136. *G. cf. G. orbicularis* d'Orbigny		X																	
137. *G. soldanii* d'Orbigny					X	X	X	X	X	X		X	X	X	X	X	X	X	
138. *G.* spp.								X	X	X	X		X						
139. *Hanzawaia ammophila* (Gumbel)	X		X	X	X		X	X	X	X		X	X	X				X	
140. *H. mauricensis* (Howe and Roberts)		X																	

= Absent

X = Present

McDougall
TABLE 1
(CONTINUED)

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
181. *Lenticulina texana* (Cushman and Applin)						X													
182. *L. ulatisensis* Boyd						X													
183. *L. vortex* (Fichel and Moll)		X																	
184. *L. cf. L. welchi* (Church)	X																		
185. *Lituotuba lituiformis* (Brady)	X				X			X		X			X						
186. *Marginulina dominicana* Bermudez		X		X													X		
187. *M. exima* Neugeboren		X					X	X			X								
188. *M. glabra* d'Orbigny		X			X			X	X	X									
189. *M. subbullata* Hantken	X	X		X				X											
190. *M. subrecta* Franke									X	X									
191. *M.* spp.		X	X	X		X	X	X									X		
192. *M. yaquensis* Bermudez																	X		
193. *Martinottiella eocenica* Cushman and Bermudez			X		X	X		X				X							
194. *Nonionella turgida* (Williamson)		X																	
195. *Nodogenerina* spp.		X																	
196. *Nodosaria cf. N. amphioxys* Reuss		X																	
197. *N. deliciae* Martin		X	X	X		X													
198. *N. cf. N. deliciae* Martin			X																
199. *N. latejugata* Gumbel										X									
200. *N. longiscata* d'Orbigny	X	X	X	X		X	X	X	X	X	X	X	X					X	

= Absent

X = Present

McDOUGALL
TABLE 1
(CONTINUED)

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
201. *Nodosaria cf. N. longiscata* d'Orbigny								X											
202. *N. macneili* Cushman							X	X		X									
203. *N. pyrula* d'Orbigny						X													X
204. *N.* spp.	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	
205. *N. velascoensis* Cushman																		X	
206. *Nodosarella advena* Cushman and Siegfus	X		X		X			X	X		X	X	X						
207. *N. atlantisae hispidula* (Cushman)	X												X						
208. *N. constricta* Cushman and Bermudez					X	X	X	X				X							
209. *N. decurta* (Bermudez)			X																
210. *N. mappa* (Cushman and Jarvis)						X													
211. *N. subnodosa* (Guppy)					X	X	X	X				X	X						
212. *N.* spp.					X	X							X			X			
213. *Nonion florinensis* Cole		X																	
214. *N. havanense* Cushman and Bermudez	X	X	X		X	X				X	X	X					X		
215. *Nuttaloides truempyi* (Nuttall)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
216. *Oridorsalis umbonatus* (Reuss)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
217. *O. cf. O. umbonatus* (Reuss)			X																
218. *Orthomorphina havanensis* Cushman and Bermudez	X		X																
219. *O. heterosculpta* (Bermudez)		X																	
220. *O. rohri* (Cushman and Stainforth)					X			X					X						

= Absent

X = Present

McDougall
TABLE 1
(CONTINUED)

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
221. *Orthomorphina* spp.						X													
222. *Osangularia mexicana* (Cole)		X	X	X	X	X		X	X	X	X		X			X			
223. *Parafissurina* spp.		X								X									
224. *Planulina truncana* (Gumbel)								X	X	X				X					
225. *Plectina garzaensis* Cushman and Todd					X	X	X		X	X	X	X	X			X			
226. *Plectofrondicularia garzaensis* Cushman and Siegfus														X					
227. *P. packardi* Cushman and Schenck						X													
228. *P. paucicostata* Cushman and Jarvis		X						X											
229. *Pleurostomella acuta* Hantken		X			X			X	X	X		X			X	X	X		
230. *P. alternans* Schwager			X		X	X	X	X	X	X	X	X	X						
231. *P. cubensis* Cushman and Bermudez		X		X	X	X	X	X	X	X	X	X	X			X			
232. *P. gredalensis* Cook	X			X	X	X	X	X	X	X	X		X						
233. *P. nuttalli* Cushman and Siegfus					X	X		X	X	X			X				X		
234. *P. subnodosa* Reuss		X					X	X		X									
235. *P. sp. of Graham and Classen* (1955)		X				X		X				X	X						
236. *P.* spp.	X		X		X			X		X	X		X	X					
237. *Pseudonodosaria conica* (Neugeboren)																	X		
238. *P. aff. P. conica* (Neugeboren)								X											
239. *P. inflata* (Bornemann)		X			X	X	X	X	X	X			X						
240. *P. ovata* (Cushman and Applin)										X									

= Absent

X = Present

McDOUGALL
TABLE 1
(CONTINUED)

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
241. *Pseudonodosaria* sp.								X											
242. *Praeglobobulimina pupoides* (d'Orbigny)	X	X	X			X			X		X	X	X						
243. *Pullenia eocenica* Cushman and Siegfus	X		X		X	X		X				X	X						
244. *P. quatriloba* (Sequenza)								X											
245. *P. quinqueloba* (Reuss)	X	X	X	X	X	X	X	X	X	X		X	X				X	X	
246. *P. salisburyi* Stewart and Stewart								X	X				X				X		
247. *Pyrulina cylindroides* (Roemer)						X	X	X		X			X				X		
248. *P.* spp.		X		X			X	X											
249. *Quadrimorphina allomorphinoides* (Reuss)		X	X			X							X						
250. *Quinqueloculina cf. Q. josephina* d'Orbigny													X						
251. *Q.* spp.				X											X				
252. *Q. triangularis* d'Orbigny			X		X			X											
253. *Q. yequaensis* Weinzierl and Applin			X	X			X	X											
254. *Ramulina globulifera* Brady							X	X					X						
255. *Reophax* spp.													X						
256. *Reusella* spp.										X									
257. *R. elongata* (Terquem)		X																	
258. *Rhabdammina eocenica* Cushman and Hanna													X				X	X	X
259. *Saccammina* spp.								X		X									
260. *Saracenaria* spp.		X						X		X	X								

= Absent

X = Present

McDougall
TABLE 1
(CONTINUED)

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
261. *Sigmomorphina* spp.										X									
262. *Silicosigmoilina californica* (Cushman and Church)		X	X	X	X	X	X	X	X	X	X	X	X				X		
263. *Siphonodosaria aculeata* (Cushman and Renz)		X			X			X	X	X	X					X			
264. *S. gracillima* (Cushman and Jarvis)		X	X		X	X	X	X	X	X	X		X						
265. *S. subspinosa* (Cushman)	X		X			X			X		X	X	X				X	X	
266. *S.* spp.									X			X							
267. *Siphonina wilcoxensis* Cushman		X																	
268. *Spiroplectammina directa* (Cushman and Siegfus)	X	X	X			X		X		X		X							
269. *S. richardi* Martin		X						X											
270. *Spiroloculina cf. S. lamposa* Hussey		X		X	X		X												
271. *S.* sp.			X					X											
272. *Stainforthia* sp.		X																	
273. *Stilostomella adolphina* (d'Orbigny)							X					X	X				X	X	
274. *S. advena* (Cushman and Laiming)		X	X					X					X		X				
275. *S. cf. S. advena* (Cushman and Laiming)											X								
276. *S. gracilis* (Palmer and Bermudez)			X					X					X						
277. *S. lepidula* (Schwager)										X	X					X			
278. *S.* spp.									X	X								X	X
279. *Textularia adalta* Cushman	X																		
280. *T.* sp.			X		X	X		X	X	X	X	X	X						

= Absent

X = Present

McDougall
Table 1
(Continued)

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF709	MF729	MF730	MF732	MF735	MF737	MF738	MF748	MF751	MF752	MF753	MF754	MF756	MF1147	MF1150	MF1151	MF7421	MF7422	MF7423
281. *Trifarina advena californica* Mallory		X								X									
282. *T. wilcoxensis* (Cushman and Ponton)															X				
283. *Tritaxilina colei* Cushman and Siegfus	X	X	X	X	X	X	X	X	X	X	X		X	X		X	X		X
284. *T. cf. T. colei* Cushman and Siegfus													X						
285. *Trochamminoides contortus* Mallory								X			X	X	X			X			
286. *Trochammina globigeriniformis* (Parker and Jones)	X		X			X		X			X	X	X				X	X	X
287. *T.* spp.			X		X	X	X	X		X	X	X	X						
288. *Uvigerina alabamensis* Cushman and Garrett														X					
289. *U. garzaensis* Cushman and Siegfus		X				X													
290. *U. cf. U. gardnerae* Cushman									X										
291. *U. lodoensis miriamae* Mallory		X								X									
292. *U. aff. U. lodoensis miriamae* Mallory							X	X											
293. *Vaginulinopsis asperuliformis* (Nuttall)		X	X			X					X		X						
294. *V. saundersi* (Hanna and Hanna)		X				X					X			X					
295. *V.* spp.		X												X					
296. *Valvulineria cf. V. wilcoxensis* (Cushman and Ponton)		X																	
297. *Vernulina triangulata* Cook		X		X	X		X	X	X	X									
298. *Vulvulina curta* Cushman and Siegfus	X	X				X		X				X	X		X				
299. *Zeauvigerina lodoensis* Martin	X					X						X							

= Absent

X = Present

McDougall
Table 2

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF708	MF736	MF740	MF749	MF755	MF1141
1. *Allomorphina trigonia* Reuss					X	
2. *Ammodiscus incertus* (d'Orbigny)		X				
3. *Bathysiphon eocenicus* Cushman and Hanna		X				
4. *B. santecruis* Cushman and Kleinpell		X				
5. *B.* spp.	X	X	X			
6. *Chilostomella oolina* Schwager	X					
7. *Cyclammina simiensis* Cushman and McMasters		X				
8. *Fursenkoina bramletti* (Galloway and Morrey)	X				X	
9. *F.* spp.	X					
10. *Globobulimina pacifica* Cushman	X					
11. *Globocassidulina globosa* (Hantken)	X					X
12. *Glandulina* spp.					X	
13. *Glomospira charoides* (Jones and Parker)		X				
14. *Haplophragmoides eggeri* Cushman		X				
15. *H. glabra* Cushman and Waters		X				

= Absent

X = Present

McDOUGALL
TABLE 2 (CONTINU

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

Species	MF708	MF736	MF740	MF749	MF755	MF1141
16. *Karreriella horrida* Mjatliuk		X				
17. *Lagena* spp.	X					
18. *Nodosaria* spp.	X					
19. *Pseudonodosaria ovata* (Cushman and Applin)					X	
20. *Reusella elongata* (Terquem)						X
21. *Silicosigmoilina californica* (Cushman and Church)		X		X		
22. *Siphonodosaria gracillima* (Cushman and Jarvis)					X	
23. *Stilostomella* spp.					X	
24. *Tritaxilina colei* Cushman and Siegfus		X				
25. *Trochamminoides contortus* Mallory		X				
26. *Trochammina globigeriniformis* (Parker and Jones)		X				
27. *Uvigerina* spp.					X	
	MF708	MF736	MF740	MF749	MF755	MF1141

= Absent

X = Present

McDOUGALL
TABLE 3

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

MF707	Species
X	1. *Alabamina wilcoxensis* Toulmin
X	2. *Anomalina regina* Martin
X	3. *Bathysiphon eocenicus* Cushman and Hanna
X	4. *Bolivina kleinpelli* Beck
X	5. *Bulimina alazaensis* Cushman
X	6. *B. guayabalensis* Cole
X	7. *B. inflata* Sequenza
X	8. *Bulimna lirata* Cushman and Parker
X	9. *Bulimina microcostata* Cushman and Parker
X	10. *Cibicides cf. C. floridanus* (Cushman)
X	11. *Cibicidoides venzuelanus* (Nuttall)
X	12. *Epistominella danvillensis* (Howe and Wallace)
X	13. *Fursenkoina bramletti* (Galloway and Morrey)
X	14. *Globocassidulina globosa* (Hantken)
X	15. *Glandulina laevigata* (d'Orbigny)
X	16. *Gyroidina condoni* (Cushman and Schenck)
X	17. *G. orbicularis planata* Cushman
X	18. *G. soldanii* d'Orbigny
X	19. *Hanzawaia ammophila* (Gumbel)
X	20. *Lenticulina altolimbatus* (Gumbel)

MF707

= Absent

X = Present

McDOUGALL
TABLE 3 (CONTINUE

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

MF707	
X	21. *Lenticulina carolinianus* (Cushman)
X	22. *L. convergens* (Bornemann)
X	23. *L. limbosa* (Reuss)
X	24. *L. pseudocultratus* Cole
X	25. *L. pseudovortex* (Cole)
X	26. *L.* spp.
X	27. *L. vortex* (Fichel and Moll)
X	28. *L. welchi* (Church)
X	29. *Marginulina exima* Neugeboren
X	30. *M. glabra* d'Orbigny
X	31. *M. subbullata* Hantken
X	32. *M.* spp.
X	33. *Nodosaria longiscata* d'Orbigny
X	34. *N. pyrula* d'Orbigny
X	35. *N.* spp.
X	36. *Nuttaloides truempyi* (Nuttall)
X	37. *Oridorsalis umbonatus* (Reuss)
X	38. *Plectofrondicularia packardi* Cushman and Schenck
X	39. *Pseudonodosaria inflata* (Bornemann)
X	40. *Praeglobobulimina pupoides* (d'Orbigny)
MF707	

= Absent

X = Present

McDOUGALL
TABLE 3 (CONTINU

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

MF707	
X	41. *Pullenia quinqueloba* (Reuss)
X	42. *P. salisburyi* Stewart and Stewart
X	43. *Pyrulina cylindroides* (Roemer)
X	44. *Spiroloculina texana* Cushman and Ellisor
X	45. *Stilostomella advena* (Cushman and Laiming)
X	46. *S. lepidula* (Schwager)
X	47. *Textularia adalta* Cushman
X	48. *Uvigerina garzaensis* Cushman and Siegfus
X	49. *U. yazooensis* Cushman
X	50. *Valvulineria jacksonensis welcomensis* Mallory
X	51. *V. cf. V. tumeyensis* Cushman and Simonson
MF707	

= Absent

X = Present

McDOUGALL
TABLE 4

Benthic Foraminifers, Palo Alto 7-1/2 Quadrangle

MF1142	MF1143B	Species
	X	1. *Ammodiscus incertus* (d'Orbigny)
X	X	2. *Bathysiphon eocenicus* Cushman and Hanna
	X	3. *Chilostomella oolina* Schwager
	X	4. *Dorothia principiensis* Cushman and Bermudez
	X	5. *Glomospira charoides* (Jones and Parker)
	X	6. *Haplophragmoides eggeri* Cushman
	X	7. *H. excavata* Cushman and Waters
	X	8. *Silicosigmoilina californica* (Cushman and Church)

= Absent

X = Present

Table 5. Benthic foraminifers from the Woodside samples of Graham and Classen (1955).

	1	2	3	4	5	6	7	8
Ammobaculites cubensis	X	.	.	.	.	.	.	.
Ammodiscus incertus	X	.	X	.	X	.	.	X
Amphimorphina ignota	X	X	X	.	.	.	X	X
Anomalina garzaensis	.	X	X	X	X	X	X	
Anomalinoides capitatus	.	.	X	.	X	X	.	X
Anomalinoides semicribratus	X	.	.	.	.	.	.	.
Alabamina wilcoxensis	.	X	.	.	.	.	X	.
Aragonia aragonensis	X	.	X	.	.	.	X	X
Astacolus sp.	X	.	.	.	X	X	.	.
Bathysiphon eocenicus	X	X	X	.	X	X	X	.
Bathysiphon santecruis	X	.	.	X	.	.	.	.
?Bathysiphon sp.	X	.	.	.	.	X	X	.
Bulimina alazaensis	.	X	.	X	.	.	.	.
Bulimina guaybalensis	X	.	.	.	X	X	.	.
Bulimina semicostata	X	.	X	.	X	X	.	X
Bulimina trinitatensis	X	X	.	.	X	.	X	.
Buliminella grata	X	.	.	.	.	.	.	.
Cancris cf. C. cocoaensis	.	X	.	.	.	.	.	.
Cibicides sp. A	X	X	.	.	X	X	X	X
Cibicides sp. B	X	.	.	.	X	X	.	.
Cibicides sp. C	.	X	.	.	.	.	X	.
Cibicidoides grimsdalei	X	X	.	.	X	.	X	.
Cibicidoides spiropunctatus	X	X	.	.	X	X	.	X
Cibicidoides venezuelanus	.	X	.	.	.	.	.	.
Chilostomelloides cyclostoma	.	.	.	.	.	.	.	X
Chrysalogonium elongatum	.	.	.	.	X	.	.	.
Chrysalogonium tenuicostatum	X	.	X	.	X	.	.	X
Cyclammina simiensis	X	X	X	.	X	.	X	X
Dentalina colei	X	.	X	.	X	.	.	X
Dentalina communis	X	.	.	.	X	X	.	.
Dentalina consobrina	.	.	.	.	.	.	.	X
Dentalina globulicauda	X	X	X	.	X	X	X	X
Dentalina intorta	.	.	.	.	.	.	.	X
Dentalina sp. F	X	.	.	.	.	.	.	.
Dentalina soluta	.	X	.	.	.	.	.	.
Dorothia principiensis	X	.	.	.	X	.	.	.
Ellipsoglandulina labiata	X	X	X	.	X	X	.	X
Ellipsoglandulina multicostata	X	.	.	.	.	.	.	.
Ellipsoglandulina principiensis	X	.	.	.	.	.	.	.
Ellipsoglandulina sp. A	.	.	.	.	X	.	.	.
Ellipsoidella sp.	.	.	.	.	.	.	.	X
Fissurina marginata	X	.	.	.	X	X	.	X
Fissurina orbignyana	.	.	.	.	X	X	.	X
Fursenkoina cf. F. danvillensis	.	.	.	.	.	.	.	X

	1	2	3	4	5	6	7	8
Fursenkoina sp. A	.	.	.	.	.	.	.	X
Fursenkoina sp. B	.	.	.	.	.	.	.	X
Gaudryina brunswickensis	.	.	.	.	X	X	.	X
Globocassidulina globosa	X	X	.	.	X	.	.	.
Glomospira charoides	X	.	X	.	.	.	.	X
Guttulina irregularis	X	.	.	.	.	.	.	.
Gyroidina orbicularis	.	.	.	.	.	.	.	X
Gyroidina soldanii	X	X	.	.	X	X	X	X
Gyroidina sp.	.	.	.	.	.	.	X	.
Hanzawaia ammophila	X	X	X	.	.	.	.	X
Hanzawaia mauricensis	X	X	X	.	X	.	.	.
Haplophragmoides eggeri	X	X	.	.	.	.	.	.
Karreriella chapapotensis	X	X	.	.	X	X	.	X
Karreriella horrida	X	X	X	.	.	.	X	X
Lagena "costata"	.	.	.	.	.	X	X	.
Lagena sp.	X	.	.	.	.	.	.	.
Lagena substriata	.	.	.	.	.	.	.	X
Lenticulina altolimbatus	X	X	X	X	X	X	X	X
Lenticulina carolinianus	X	.	.	.	.	.	.	X
Lenticulina terryi	X	X	X	.	.	.	.	.
Loxostomum sp.	.	.	.	.	.	X	.	.
Marginulina eximia	X	.	.	X	.	.	.	X
?Marginulina sp.	X	.	.	.	.	.	.	.
Marginulina subbullata	X	X	X	.	X	.	.	.
Marginulinopsis sp.	X	.	.	.	.	.	.	.
Lituotuba cf. L. lituiformis	X	.	.	.	.	.	.	.
Nodosarella advena	X	.	X	.	X	X	.	.
Nodosarella sp.	X	.	.	.	.	.	.	.
Nodosaria latejugata	.	.	.	.	X	.	.	.
Nodosaria longiscata	X	X	.	.	.	X	X	.
Nonion havanense	X	.	.	.	.	X	.	.
Nonion sp.	.	X	.	.	.	.	X	.
Nuttaloides trumpyi	X	X	.	.	X	X	X	.
Oridorsalis umbonatus	X	.	X	.	X	X	X	X
Osangularia mexicana	.	X	X	.	X	.	.	X
Plectofrondicularia palmerae	X	.	X	.	.	.	.	.
Plectina garzaensis	X	.	X	X	.	.	.	.
Pleurostomella alternans	X	.	X	.	.	.	.	.
Pleurostomella nuttalli	X	X	.	.	X	X	.	X
Pleurostomella sp.	.	.	.	.	.	.	.	X
Pseudoglandulina ovata	X	.	.	.	.	.	.	.
Pullenia eocenica	X	X	.	.	X	X	.	.
Pullenia quinqueloba	.	X	X	.	.	.	X	.
Pyrulina cylindroides	X	.	.	.	.	.	.	.
Quadrimorphina allomorphinoides	.	X	.	.	X	.	.	.
Quinqueloculina yequaensis	.	.	.	.	.	.	.	X
Ramulina globulifera	.	.	.	.	.	X	.	.
Silicosigmoilina californica	X	X	X	.	X	X	.	X

	1	2	3	4	5	6	7	8
Siphonodosaria gracillima	X	.	X	.	.	.	.	.
Siphonodosaria subspinosa	.	.	.	.	.	.	X	.
?Siphonodosaria sp.	X	.	.	.	.	X	.	.
Spiroloculina texana	.	.	.	.	.	.	.	X
Spiroplectammina directa	X	X	.	.	.	.	X	.
Spiroplectammina richardi	X	.	.	.	X	.	.	.
Stilostomella gracilis	X	.	.	.	X	X	X	X
Textularia sp.	.	X	.	.	.	.	.	.
Trifarina sp.	.	.	.	.	.	.	X	.
Tritaxilina colei	X	X	.	X	X	X	.	.
Trochammina globigeriniformis	X	.	X	X	X	.	X	.
Uvigerina hispida	.	X	.	.	.	.	.	.
Uvigerina sp.	.	X	.	.	.	.	.	.
Vaginulinopsis asperuiliformis	X	X	.	.	.	.	.	X
Verneuilina triangulata	.	.	.	.	X	.	X	.
Vulvulina curta	X	.	.	.	X	X	.	.

Table 6. Benthic foraminifers from the Whiskey Hill samples of Beaulieu (1970).

	PA126	PA109	PA1A	PA1B	PA29	PA266	PA258	PA267	PA117	M1492
Alabamina wilcoxensis	X	.	.	.	.	.	.	X	.	.
Ammodiscoides sp.	X	.	.	.	.	.	.	.	.	.
Anomalina garzaensis	.	.	.	.	.	X	.	X	.	.
Anomalina spp.	X	X	.	.	.	.	.	X	.	.
Aragonia aragonensis	.	.	.	.	.	.	.	X	.	.
Bathysiphon sp.	.	X	.	X	.	.	.	X	.	.
Bolivina scabrata	.	.	.	.	.	.	.	X	.	.
Bulimina curtissima	.	.	.	.	.	.	X	.	.	.
Bulimina semicostata	.	.	.	.	X	.	.	X	.	.
Buliminella basistriata	.	.	.	.	.	.	.	X	.	.
Bulimina grata	.	.	.	.	.	.	.	X	.	.
Cibicides pseudoweullerstorffi	.	.	.	.	.	.	.	X	.	.
Cibicides spiropunctatus	.	.	.	.	.	.	.	X	.	.
Cibicides spp.	X	.	.	.	.	X	.	X	.	.
Cibicidoides eocenicus	.	.	.	.	.	X	.	X	.	.
Cyclammina simiensis	.	.	.	.	.	X	.	X	.	.
Cyclogyra cushmani	.	.	.	.	.	.	.	X	.	.
Dentalina mucronata	.	.	.	.	.	.	.	X	.	.
Dentalina quadrulata	.	.	.	.	.	.	.	X	.	.
Dentalina spp.	.	.	X	X	.	X	.	X	.	.
Discorbis baintoni	X	.	.	.	.	.	.	.	.	.
Ellipsoglandulina cf. E. labiata	.	.	.	.	.	.	.	X	.	.
Eponides sp.	X	.	.	.	.	.	.	.	.	.
Globocassidulina globosa	.	.	X	.	.	X	X	X	.	.
Glomospira charoides	.	.	.	.	.	.	.	X	.	.
Gyroidina soldanii	.	.	.	.	.	X	.	.	.	.
Hanzawaia ammophila	.	.	.	X	.	.	.	.	.	.
Hanzawaia mauricensis	.	.	.	.	X	.	.	X	.	.
Karreriella elongata	X	.	.	.	.	.	.	X	.	.
Lenticulina cultus	.	.	.	.	.	.	.	X	.	.
Lenticulina fractus	.	.	.	.	.	.	.	X	.	.
Lenticulina limbosus	.	.	.	.	.	.	.	X	.	.
Lenticulina spp.	X	.	X	.	.	X	.	X	.	.
Marsonella oxycona	X	.	.	.	.	.	.	.	.	.
Nodosarella advena	.	.	.	.	.	.	.	X	.	.
Nodosarella multicostata	.	.	.	.	.	.	X	.	.	.
Nodosaria armata	.	.	.	.	X	.	.	.	.	.
Nodosaria spp.	.	.	X	.	.	X	.	X	.	.
Nonion spp.	X	.	.	.	.	.	.	.	.	.
Nuttallides trumpyi	.	.	.	.	.	.	.	X	.	.
Oridorsalis umbonatus	.	.	.	.	.	X	.	X	.	.
Plectofrondicularia packardi	.	.	.	.	.	.	.	.	.	X
Pleurostomella cf. P. clavata	.	.	.	.	.	X	.	X	.	.
Pleurostomella elliptica	.	.	.	.	.	X	.	X	.	.
Pseudonodosaria inflata	.	.	.	.	.	.	.	X	.	.
Pullenia quinqueloba	.	.	.	.	.	.	.	.	.	.
Quinqueloculina sp.	X	.	.	.	.	.	.	.	.	.
Reusella sp.	X	.	.	.	.	.	.	.	.	.
Sigmoilina sp.	.	X	.	.	.	X	.	.	.	.
Siphonodosaria adolphina	.	.	.	.	.	.	.	X	.	.
Siphonodosaria hantkeni	.	.	.	.	.	.	.	X	.	.
Siphonodosaria cf. S. pauperata	.	.	X	.	.	.	.	.	.	.
Siphonodosaria sp.	.	.	.	.	.	.	.	.	.	.

	PA126	PA109	PA1A	PA1B	PA29	PA266	PA258	PA267	PA117	M1492
Spiroplectammina directa	.	.	.	.	.	X	.	X	.	.
Spiroplectammina sp.	.	.	.	X	.	.	.	.	.	.
Trifarina sp.	X	.	.	.	.	.	.	X	.	.
Uvigerina churchi	.	.	.	.	.	.	.	.	.	X
Uvigerina garzaensis	.	.	.	.	.	.	X	.	.	X
Uvigerina spp.	.	.	.	.	X	.	.	.	.	.
Valvulineria cf. V. peruviana	.	.	.	.	.	.	.	X	.	.

Table 7. Benthic foraminifers from the Stanford Linear Accelerator Section of Beaulieu (1970).

	2-36	5-25
Ammodiscus glabratus	.	X
Bathysiphon eocenicus	.	X
Chilostomella oolina	.	X
Cibicides cf. C. laimingi	X	X
Cibicides pseudoweullerstorfi	X	.
Cyclammina sp.	X	.
Dentalina cf. D. consobrina	.	X
Gaudryina brunswickensis	.	X
Glomospira charoides	.	X
Gyroidina chirana	.	X
Hanzawaia ammophila	X	X
Haplophragmoides sp.	.	X
Karreriella cf. K. arenaensis	.	X
Nodosarella advena	.	X
Nuttaloides trumpyi	X	.
Oridorsalis umbonatus	X	X
Pullenia eocenica	.	X
Rhabdammina eocenica	.	X
Silicosigmoilina californica	.	X
Tritaxilina colei	X	X
Trochammina globigeriniformis	X	X
Trochamminoides contortus	.	X

APPENDIX 1
LOCALITY AND SAMPLE DESCRIPTIONS

Mf707 (field number 62-161) Whiskey Hill Formation. Sample taken from a tan mudstone containing small mud pectens; about 150 feet below Miocene contact. Opposite fire hydrant at 207 Westridge Drive, 1,150 feet S. 53-1/2° W. of intersection of Westridge Drive and Alpine Road. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf707 (62-161) and 3 picked slides labelled MF709 (62-161). The latter group of slides is assumed to be mislabelled and is included with Mf707 rather than Mf709. Initial report prepared by M.C. Israelsky (shipment number EG-63-9M, 4/16/63) lists 49 benthic and 6 planktic foraminifers and a Narizian age was given. Subsequent work by W.O. Addicott (M1492) on the mollusk and David Bukry on the calcareous nannofossils gave ages of late Eocene and middle Eocene, respectively. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones late P12 through P14. The assemblage is assigned to the early Narizian Stage as modified by McDougall (unpub. data).

Mf708 (field number 62-158) Whiskey Hill Formation. Sample taken from a black shale and mudstone containing trace of FeS_2. In bottom of San Francisquito Creek 3,760 feet S., 49° W. of lat 37° 25' N., long 112° 12' 30" W. Sample collected by Earl Pampeyan. The P & S collection contains 2 picked slides labelled Mf708 (62-158). Initial report prepared by M.C. Israelsky (shipment number EG-63-9M, 4/16/63) lists 16 benthic and 2 planktic foraminifers and a Ulatisian age was given. The revised age based on benthic foraminifers is Eocene through Oligocene.

Mf709 (field number 62-299) Whiskey Hill Formation. Sample taken from an exposure containing siltstone, shale and calcareous shale, about 250 feet below the Miocene contact. La Mesa Road, 4,020 feet N., 66° W. of intersection of Westridge Drive and Alpine Road. Sample collected by Earl Pampeyan. The P & S collection contains 5 picked slides: 2 labelled Mf709 (62-299) and 3 labelled Mf709 (62-161). Only the slides labelled Mf709 (62-299) are considered. Initial report prepared by M.C. Israelsky (shipment number EG-63-9M, 4/16/63) lists 34 benthic foraminifers and a Ulatisian age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zone P10. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf729 (field number 63-340) Whiskey Hill Formation. Sample taken from a calcareous siltstone; east bank of San Francisquito Creek, 650 feet S. of Willow Road bridge (Stanford Golf Course). Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf729 (63-340). Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 6/19/63) lists 78 benthic foraminifers and a Ulatisian age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P9 through P11. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf730 (field number 63-167) Whiskey Hill Formation. Sample taken from an exposure composed of mudstone and shale beds with alternating sandstone beds. Cervantes Road, 100 feet east of Sierra Lane; 4100 feet N. 8° E. of lat 37°22' 30" N., long 112° 12' 30" W. Sample collected by Earl Pampeyan. The P & S collection contains 2 picked slides labelled Mf730 (63-167). Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 6/24/63) lists 49 benthic and 2 planktic foraminiferal species and a Ulatisian age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P9 through P11. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf731 (field number 62-165) Whiskey Hill Formation. Sample taken from a siltstone exposed in the yard of W. Bay's home on Westridge Drive; 4,960 ft. N. 79° W. of intersection of Westridge Drive and Alpine Road. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf731 (62-165). Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 6/18/63). Sample contained poorly preserved species which were only identified to genus.

Mf732 (field number 62-210) Whiskey Hill Formation. Sample taken from a calcareous mudstone exposed in a drainage ditch on east side of Sand Hill Road and Whiskey Hill Road intersection; altitude 292 feet. Sample collected by Earl Pampeyan. The P & S collection contains 2 picked slides labelled Mf732 (62-210). Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 7/1/63) lists 21 benthic and 2 planktic foraminiferal species and a Ulatisian age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P9 through P11. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf733 (field number 62-246) Whiskey Hill Formation. Sample taken from an exposure of mudstone and siltstone alternating with sandstone; roadcut on Alpine Road, 230 feet north of intersection of Arastradero and Alpine Roads. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf733 (62-246). Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 7/1/63) who reported it as containing a form found in Paleocene rocks of Monterey County, California (Pampeyan, in press). Slide contains several pyrite molds which are probably foraminifers but can not be identified to genus or species.

Mf735 (field number 63-390) Whiskey Hill Formation. Sample taken from a calcareous siltstone in the creek bottom at altitude 160'; 3800 feet west of Woodside Road and Alameda de la Pulgas, 3,370 feet SE. of lat. 37° 27' 30", long. 122° 15'. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf735 (63-390). Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 7/5/63) lists 53 benthic and 2 planktic foraminiferal species and a Ulatisian age was given. Pampeyan (in press) gives age as Narizian. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P9 through P11. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf736 (field number 63-383) Whiskey Hill Formation. Original report by M.C. Israelsky is missing. Sample collected and recollected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf736 (63-383). Report by R.L. Pierce (shipment number EG-66-33M, 11/28/66) based on recollected sample gives are as Eocene or older, possibly Paleocene or upper Cretaceous. The revised age based on benthic foraminifers is Eocene.

Mf737 (field number 63-409) Whiskey Hill Formation. Sample taken from a calcareous siltstone exposed in a creek bottom at altitude of 100'; 2,2020 ft. SE of lat. 37° 27' 30", long. 122° 15'. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf736 (63-409). Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 7/10/63) lists 98 benthic and 2 planktic foraminiferal species and a Ulatisian age was given. Pampeyan (in press) gives a Narizian age. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P9 through P11. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf738 (field number 63-411) Whiskey Hill Formation. Sample taken from a calcareous siltstone exposed in a cut behind house at 195 Harcross Road; 3,150 ft SE. of lat. 37° 27' 30", long. 122° 15". Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf738 (63-411). Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 7/12/63) lists 43 benthic and 3 planktic foraminiferal species and a Ulatisian age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P9 through P10. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf739 (field number 63-338) Sample taken from a small exposure of mudstone interbedded with siltsone and sandstone in the east bank of San Francisquito Creek on the south side of the Willow Road bridge. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf739 (63-344). Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 7/16/63) lists 25 benthic and 2 planktic foraminiferal species and a Narizian age was given. Although Tertiary species names can be given to some of the specimens, Cretaceous names are more appropriate. Both Tertiary and Cretaceous planktic foraminifers are present. The single Tertiary planktic specimen is probably contamination and this sample should be assigned to the late Campanian (Sliter, personnal communication, 1992). The assemblage is similar to sample Mf747 (field number 63-344) which is 100 feet geographically from Mf739 and also considered Cretaceous in age.

Mf740 (field number 62-172) Whiskey Hill Formation. Sample taken from a thin bedded argillaceous limestone in cut adjacent to swimming pool; 2,360 ft N. 11° E. of latitude 37° 22' 30" N., longitude 112° 12' 30" W. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf740 (62-172). Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 7/19/63) lists 10 benthic and 3 planktic foraminiferal species and a Ulatisian or Narizian age was given. The revised age based on benthic foraminifers is unknown.

Mf744 (field number 63-365) Sample taken from a shale interbedded with graywacke (Franciscan Complex ?) on Farm Hill Boulevard. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf744 (63-365). Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 7/23/63) gave no age determination. A later report by R.L. Pierce gave the age of sample is given as middle Eocene or older, probably no older than Paleocene (see Pampeyan, in press). Sample contains possible arenaceous fragments, but no age interpertation is possible.

Mf745 (field number 63-365W) Sample taken from a shale interbedded with graywacke (Franciscan Complex ?) on Farm Hill Boulevard. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf745 (63-365W). Initial report prepared by M.C. Israelsky and the age of sample is given as Eocene (?). Subsequent report by R.L. Pierce gave the age as Eocene or older (see Pampeyan, in press). Sample contains pyritized radiolarians and diatoms but no foraminifers were seen. The age is unknown.

Mf747 (Field number 63-344) Sample taken from a mudstone east bank of San Francisquito Creek, 100 feet north of the Willow Road bridge. Sample collected by Earl Pampeyan. Initial report prepared by M.C. Israelsky shipment number EG-63-16M, 8/1/63) gave the age of this sample as Campanian.

Mf748 (field number SLA24+50) Whiskey Hill Formation. Sample taken from a mudstone; station 24+50 in Linear Acceleration trench. Sample collected by Earl Pampeyan and Warren Addicott. The P & S collection contains 13 picked slides: 5 slides are labelled Mf748 (SLA 24-50) and 6 slides are labelled Mf748 Pampayen SLA 24-50, Addicott recollection. Initial report prepared by M.C. Israelsky (shipment number EG-63-16M, 8/1/63) lists 1 benthic foraminiferal species and no age was given. Pampeyan (in press) indicates a Ulatisian or Narizian age interpretation was given by M.C. Israelsky as well as a Laiming's A-2 and an early middle Eocene age interpretations given by N.M. Bramlette and Emile Pessagno, respectively. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P9 through P11. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf749 (field number 63-397) Whiskey Hill Formation. Sample taken from a yellow-gray limestone exposed on Jefferson Avenue, Woodside quadrangle. Sample collected by

Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf749 (63-397). Initial report prepared by R.L. Pierce and the age of sample is given as Cretaceous to Eocene (Pampeyan, in press). The revised age based on benthic foraminifers is Eocene.

Mf751 (field numbr 63-442) Whiskey Hill Formation. Sample taken from a calcareous claystone and clayey limestone in a cut behind house at 220 Woodside Drive, 2,400 ft. WNW of Alameda de las Pulgas-Woodside Road intersection. Sample collected by Earl Pampeyan. The P & S collection contains 2 picked slides labelled Mf751 (63-442). Initial report prepared by M.C. Israelsky (shipment number EG-63-23M, 9/12/63) lists 47 benthic and 2 planktic foraminiferal species and a Ulatisian age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P10 through P14. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf752 (field number 63-497) Whiskey Hill Formation. Sample taken from a calcareous claystone exposed at the Allstate Insurance Company building site on Sand Hill Road, 700 ft. WNW of BM 331 on Sand Hill Road. Sample collected by Earl Pampeyan. The P & S collection contains 2 picked slides labelled Mf752 (63-535). Initial report prepared by M.C. Israelsky (shipment number EG-63-23M, 9/12/63) lists 64 benthic and 2 planktic foraminiferal species and a Ulatisian age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P9 through P10. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf753 (field number 63-535) Whiskey Hill Formation. Sample taken from a calcareous siltstone exposed in the San Francisco Water Department pipeline trench south of Lake Lagunita; 1,800 ft. S. of elevation 152 on Junipero Serra Boulevard. Sample collected by Earl Pampeyan. The P & S collection contains 2 picked slides labelled Mf753 (63-535). Initial report prepared by M.C. Israelsky (shipment number EG-63-23M, 9/12/63) lists 50 benthic and 2 planktic foraminiferal species and a Ulatisian age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zone P10. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf754 (field number 63-556A) Whiskey Hill Formation. Sample taken from a calcareous claystone exposed in the parking lot cut of Woodside High School, across roadway from southeast corner of southernmost building (Building B). Composite sample of about 20 feet of beds. Sample collected by Earl Pampeyan. The P & S collection contains 2 picked slides labelled Mf754 (63-556A). Initial report prepared by M.C. Israelsky (shipment number EG-63-23M, 10/8/63) lists 65 benthic foraminiferal species and a Ulatisian age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zone P10. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf755 (field number 63-556C) Whiskey Hill Formation. Sample taken from a micaceous siltstone; same locality as Mf754 but separated from it by 20 feet of glauconite sandstone. Composite section of 30 feet of beds. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf754 (63-556C). Initial report prepared by M.C. Israelsky (shipment number EG-63-23M, 10/8/63) lists 13 benthic foraminiferal species and a Ulatisian or Narizian age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P9 through P13. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf756 (field number 63-556E) Whiskey Hill Formation. Sample from a calcareous claystone; same locality as Mf755 but separated from it by 40 feet of glauconitic sandstone and sandstone. Composite sample of 40 feet of beds. Sample collected by Earl Pampeyan. The P & S collection contains 3 picked slides labelled Mf756 (63-556E). Initial report prepared by M.C. Israelsky (shipment number EG-63-23M, 10/8/63) lists 75 benthic and 3 planktic foraminiferal species and a Narizian age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zone P10. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf757 (field number 62-74) Whiskey Hill Formation. Sample from an exposure of shale and siltstone in roadcut on eastside of Pinon Drive, 250 feet north or Westridge Drive. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf757 (62-74). Initial report prepared by M.C. Israelsky and the age of sample is given as Penutian to Narizian (Pampeyan, in press). This sample contains fragments of planktic foraminifers and molds of benthic foraminifers but no identification is possible. The age is unknown.

Mf1141 (field number 63-363) Sample taken in a shale interbedded with graywacke; driveway cut at 3528 Altamont Avenue, Redwood City, 2400 feet north of latitude 37° 27' 30" and longitude 122° 15'. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf1141 (63-363). Initial report prepared by R.L. Pierce (shipment number EG-66-33M, 7/25/66) lists 2 benthic and 1 planktic foraminiferal species and a Eocene or older (probably no older than Paleocene if the *Globigerina* sp. is in place) age was given. Sample contains 2 benthic foraminiferal species which are lower Tertiary in age, probably late Paleocene through middle Eocene.

Mf1142 (field number 63-365W, recollected) Sample taken 200 feet west of Mf1141. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf1142 (63-365W). The initial report prepared by R.L. Pierce (shipment number EG-66-33M, 7/25/66) lists 1 benthic foraminiferal species; a probably Eocene or older age was given. The species present is not, however, diagnostic of age.

Mf1143B (field number 63-383, recollected) Sample taken from a siltstone and shale exposed in a roadcut on the west side of Farm Hill Boulevard. opposite reservior, 1700 feet north of latitude 37° 27' 30", longitude 122° 15'. Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf1143B (63-383, recollected). Initial report prepared by R.L. Pierce (shipment number EG-66-33M, 7/25/66) lists 5 benthic foraminiferal species and a probably Eocene or older, possibly Paleocene or upper Cretaceous age was given.

Mf1147 (field number 63-658W) Whiskey Hill Formation. Sample taken from a silty claystone exposed in a roadcut on north side of Sand Hill Road, 750 feet west of BM 331; 1,860 feet northwest of latitude 37° 25' 00", longitude 122° 12' 30". Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf1147 (63-658W). Initial report prepared by R.L. Pierce (shipment number EG-66-33M, 7/25/66) lists 7 benthic and 2 planktic foraminiferal species and a lower Eocene or upper Paleocene, possibly the latter, age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P8 through P14. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf1150 (field number 63-662) Whiskey Hill Formation. Sample taken from a silty claystone exposed in a utility trench along Sharon Park Road (to golf course apartments), 3,070 feet N14° W of latitude 37° 25' 00", longitude 122° 12' 30". Sample collected by Earl Pampeyan. The P & S collection contains 1 picked slide labelled Mf1150 (63-662). Initial report prepared by R.L. Pierce (shipment number EG-66-33M, 7/25/66) lists 12 benthic and 5 planktic foraminiferal species and a lower Eocene or upper Paleocene, possibly the latter, age was given. The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P8 through P18. The assemblage is assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf1151 (field number 64-750) Whiskey Hill Formation. Sample taken from a sandstone, siltstone, and claystone sequence exposed in Junipero Serra Freeway out on Woodside Road; 400 feet S32° W of BM 275. Sample from 30 to 40 feet below original slope surface. Sample collected by Earl Pampeyan. The P & S collection contains 2 picked slides labelled Mf1151 (64-750). Initial report prepared by R.L. Pierce (shipment number EG-66-33M, 7/25/66) lists 8 benthic and 6 planktic foraminiferal species and a Paleocene, probably upper Paleocene age was given. The revised age based on benthic foraminifers is early to middle Eocene coeval with planktic foraminiferal zones P6b through P11. The assemblage is, however, assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

Mf7421 (field number 88CB2541), Mf7422 (field number 88CB2541A) and Mf7423 (field number 88CB2541B) Whiskey Hill Formation These samples were collected from a construction ditch along Woodside Road, Woodside California (latitude 37° 25' 43" N; longitude 122° 15' 09" W; Woodside 7-1/2' quadrangle). Samples collected by Earl Brabb. This location is approximately the same locality as Station 2 (M-587) of Graham and Classen (1955). The revised age based on benthic foraminifers is middle Eocene coeval with planktic foraminiferal zones P10 through P11, P9 through P11, and P5 through P11, respectively. The assemblages are assigned to the Ulatisian Stage as modified by McDougall (unpub. data).

APPENDIX II

TAXONOMIC NOTES

This appendix represents an attempt to bring California benthic foraminiferal taxonomic nomenclature into conformity with nomenclature used worldwide. This section is, therefore, a summary of work in progress and subject to further changes and additions. Data on age and environmental constraints will be continuously refined as more information becomes available. Current sources of environmental data on Paleogene benthic foraminifers are Ingle (1980), Tjalsma and Lohmann (1983), and van Morkhoven and others (1986). Stratigraphic ranges of benthic foraminiferal species given by Mallory (1959) are included in this summary; they may not be accurate and should be used with caution. Occurrence data for each species gives the quadrangle from the San Jose 2° sheet in which the species is found and formations as well as other California sections or formations. Formations are abbreviated as follows: Tb = Butano Sandstone, Tsl= San Lorenzo Formation, Tv = Vaqueros Formation, Tla = Lambert Shale, Te_1 = "mottled mudstone of Mt. Chual", Te_2 = "Marine sandstone and shale", and Tme = "marine shale and sandstone of Highland Way".

Specimens labelled "sp." or "spp." but not discussed in the following notes are recognizable to genus. Further identification is not possible usually because of preservation.

Specimens identified with a "cf." or "aff." are similar to the species but for some reason can not be clearly identified as that species. A specimen identified with a "cf." is closer to the species than one labelled "aff.". These forms may be included with the species or treated separately in the following notes.

Alabamina wilcoxensis Toulmin

Alabamina wilcoxensis Toulmin, 1941, Jour. Paleo., v. 15, p. 603, pl. 81, figs. 10-14.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 187, pl. 28, fig. 8.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 227, pl. 19, fig. 10.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 13.

Eponides beisseli (White) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 182, pl. 27, fig. 7.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 237.

Alabamina atlantisae (Cushman) *dissonata* (Cushman and Renz) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 26, pl. 4, fig. 13a,b.

COMMENTS: *Alabamina wilcoxensis* and *A. dissonata* may be synonymous.

RANGE: Mallory (1959) gave the range of *A. wilcoxensis* as early Bulitian to late Penutian and cites its occurrence as in the Media Aqua Creek and Devils Den sections. In the Media Aqua Creek Section, *Alabamina wilcoxensis* ranges from sample A7075 to A7088 (Bulitian to Penutian, Mallory, 1970). This interval has, however, been assigned to the early Eocene planktic foraminiferal zone P7 (Poore, 1976). *Alabamina wilcoxensis* is not listed in Mallory's Devils Den checklist and was not observed by Berggren and Aubert (1983) in this section. A rare occurrence of *Alabamina* cf. *A. wilcoxensis californica* is noted in the strata assigned to planktic foraminiferal zone P4 in the Media Aqua Creek Section, and in P8 and younger

Eocene strata of the Point of Rocks and Welcome Members, Kreyenhagen Formation, Devils Den Section (Mallory, 1959; Berggren and Aubert, 1983). *Alabamina wilcoxensis* has also been reported from the Paleocene Vine Hill Formation in strata assigned to planktic foraminiferal zone P4 (calcareous nannofossil zone CP7) (Smith, 1957; McDougall, unpub. data). *Alabamina dissonata* ranges from planktic foraminiferal zone P6a through P17 (latest Paleocene through late Eocene; Tjalsma and Lohmann, 1983) which approximates the range observed for *A. wilcoxensis* and the variety *A. wilcoxensis californica* in California, i.e. P7 through late Eocene with a questionable occurrence in P4.

ECOLOGY: *Alabamina dissonata* has a wide bathymetric distribution in the early Eocene but in the middle and late Eocene it is restricted to deeper sites (>2000 m) (Tjalsma and Lohmann, 1983).

OCCURRENCE: Loma Prieta Quad. (Tme); Laurel Quad. (Te_1); Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Alhambra); Goler Formation; Lodo Gulch

Allomorphina conica Cushman and Todd

Allomorphina conica Cushman and Todd, 1949, Cushman Lab. Foram. Res., Contr., v. 25, p. 62, pl. 11, fig. 8a,b,c.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 244, pl. 33, fig. 15a,b, pl. 37, fig. 14a,b.

RANGE: According to Mallory (1959), *Allomorphina conica* ranges from early Ynezian to early Ulatisian. The early Ynezian occurrence is not documented by Mallory (1959). The oldest documented occurence cited by Mallory (1959) is in the late Ynezian of Media Aqua Creek Section where *Allomorphina conica* occurs in late Ynezian through Ulatisian strata (Mallory, 1959) which is assigned to planktic foraminiferal zones P6b through P9 (Poore, 1976).

OCCURRENCE: Loma Prieta Quad. (Te_1); Laurel Quad. (Te_1); Lodo Gulch

Allomorphina trigonia Reuss

Allomorphina trigonia Reuss, 1850, K. Akad. Wiss. Wien, Math.-Nat. Cl., Wien, Austria, Bd. 1, p. 380. pl. 480, fig. 14.

- - Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 9 (list).

Allomorphina trigona - - Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 9 (list).

OCCURRENCE: Loma Prieta Quad. (Tsl); Laurel Quad. (Te_1); Lodo Gulch

Ammodiscus incertus (d'Orbigny)

Operculina incerta d'Orbigny, 1839, in Ramon de la Sagra, 1839, Histoire physique et naturelle de l'Ile de Cuba, A. Bertrand, Paris, France, p. 49, pl. 6, figs. 16-17.

Cornuspira incerta (d'Orbigny) emend. Loeblich and Tappan, 1954, Wash. Acad. Sci., Jour., v. 44, no. 10, p. 308, tf. 1.

Ammodiscus cf. *A. incertus* (d'Orbigny) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 108, pl. 1, figs. 11-12; pl. 39, fig. 2.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 27.

- - Smith, 1971, Univ. Calif. Publ. Geol. Sci., v. 91, p. 24.

Ammodiscus glabratus Cushman and Jarvis - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 6, pl. 1, fig. 6.

RANGE: According to Mallory (1959), *Ammodiscus incertus* ranges from Ynezian through Narizian.

OCCURRENCE: Loma Prieta Quad. (Te_1, Te_2, Tme); Laurel Quad. (Te_1); Goler Formation; Lodo Gulch

Ammodiscus pennyi Cushman and Jarvis

Ammodiscus pennyi Cushman and Jarvis, 1928, Cushman Lab. Foram. Res., Contr., v. 4, p. 87, pl. 12, figs. 4-5.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 108, pl. 1, fig. 13a,b.

Ammodiscus incertus d'Orbigny - - Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 9 (list).

RANGE: In Trinidad, *Ammodiscus pennyi* ranges from late Cretaceous (Maastrichtian) to late Paleocene planktic foraminiferal zone P6a (Kaminiski and others, 1988). Mallory (1959) restricts this species to the Ynezian Stage and indicates it is present in Media Agua and Lodo Gulch sections. In these sections *A. pennyi* occurs in strata assigned to planktic foraminiferal zones P4 (Mallory, 1959; Martin, 1943; Poore, 1976; Berggren and Aubert, 1983; McDougall, unpub. data).

OCCURRENCE: Lodo Gulch

Amphimorphina californica Cushman and McMasters

Amphimorphina californica Cushman and McMasters, 1936, Jour. Paleo., v. 10, p. 513, pl. 16, figs. 31-35.

- - Laiming, 1939, Sixth Pacific Sci. Cong. Proc., v. 2, p. 547 (list)
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 215, pl. 18, fig. 6.

RANGE: Mallory (1959) restricts *Amphimorphina californica* to the late Ulatisian, *Amphimorphina californica* zone.

Amphimorphina ignota Cushman and Siegfus

Amphimorphina ignota Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 11, p. 27, pl. 6, figs. 10-13.

- - Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 9 (list).
- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 18, pl. 3, figs. 10-11.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 215-216, pl. 18, fig. 7; pl. 33, fig. 9.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 100.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 22, pl. 14, fig. 18.

Amphimorphina sp. - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 19, pl. 3, fig. 12.

RANGE: Although Mallory (1959) gives range as late Ynezian to early Narizian (Paleocene through Eocene), the late Ynezian occurrences in the Media Aqua Creek section (sample A7078 to A7017 and questionably as high as A7007), are assigned to planktic foraminiferal zone P6b through P10 (Poore, 1976) and thus Eocene in age. Tjalsma and Lohmann (1983) find this species occurring sporadically throughout the Eocene (P6b-P18).

OCCURRENCE: Loma Prieta Quad. (Te_1); Laurel Quad. (Te_1); Pacheco Syncline (Las Juntas, Alhambra); Goler Formation; Lodo Gulch

Anomalina garzaensis Cushman and Siegfus

Anomalina garzaensis Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 11, p. 32, pl. 7, fig 3a,b,c.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 30, pl. 5, fig. 12a,b,c.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 259, pl. 31, fig. 1a,b,c.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 152.

RANGE: *Anomalina garzaensis* ranges from early Penutian to late Narizian (Mallory, 1959). The range in Media Aqua Creek is A7062-A4458 through A7005 which has been assigned to planktic foraminiferal zones P7 to P10 (Poore, 1976).

ECOLOGY: Along the East Pacific Margin, *Anomalina garzaensis* has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1); Lodo Gulch

Anomalina regina Martin

Anomalina regina Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 28, pl. 9, fig. 3a,b,c.

- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 191, pl. 29, fig. 8.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 261, pl. 38, fig. 6a,b,c.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 154, pl. 9, fig. 3a,b,c.

Anomalina cf. *A. regina* Martin - - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 154, pl. 14, fig. 5.

Anomalina regina minor Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 192, pl. 29, figs. 2 and 4.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 261, pl. 23, fig. 6a,b,c.

Anomalinoides welleri (Plummer) - - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, p. 16.

COMMENTS: Smith (1957) descibed the varity *minor* to include specimens with 9 rather than 12 chambers and a smaller size. Specimens of *A. regina* and *A. regina minor* figured by Smith (1957) all contain 9 chambers. There is a slight size difference which is probably due to environmental conditions.

Anomalina regina differs from *Anomalina garzaensis* because *A. regina* is smaller, has fewer chambers (12 or less rather than $\geq$ 14), smaller pores and sutures, and an umbo ring which is not as limbate or heavy.

RANGE: Mallory (1959) gives range of *Anomalina regina* as early Bulitian (late Paleocene) to late Penutian (early Eocene). The variety *A. regina minor* Smith occurs in strata as young as late Narizian (late Eocene) (Mallory, 1959). McDougall (1988) gives range as P6b to P10 and notes that the upper limit may be extended. Bulitian localities listed by Mallory (1959) are from the Lodo Gulch section (Martin, 1943), Pacheco Syncline (Smith, 1957), and Media Agua Creek (Mallory, 1959, 1970). The oldest occurrence cited by Martin (1943; sample I-X7) is in strata assigned to planktic foraminiferal zones P5 (Poore, 1976; Berggren and Aubert, 1983), however, neither Berggren and Aubert or McDougall (unpub. data) have found *A. regina* in strata older than P8 in the Lodo Gulch section. The other Bulitian localites listed by Mallory (1959) are in strata assigned to P6b or younger zones.

ECOLOGY: Along the East Pacific Margin, *Anomalina regina* has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (*Melonis regina*, Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas, Alhambra); Goler Formation

Anomalinoides capitatus (Gumbel)

Rotalia capitata Gumbel, 1868, K. Bayer. Akad. Wiss., Math.-Physik Cl., Abh., Bd. 10, p. 653, pl. 2, fig. 92.

Anomalinoides capitatus (Gumbel) - - van Morkhoven and others, 1986, Bull. Des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 276-278, pl. 92, figs. 1-2.

Gavelinella capitata (Gumbel) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 31, pl. 16, figs. 4-5.

Anomalina dorri Cole, 1928, Bull. American Paleo., v. 14, p. 218, pl. 34, figs. 1-2.

Anomalina dorri aragonensis Nuttall, 1930, Jour. of Paleo., v. 4, p. 291, pl. 24, fig. 18; pl. 25, fig. 25.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 30, pl. 5, fig. 10a,b,c.

- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 191, pl. 31, figs. 1-2.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 259, pl. 35, fig. 5.

Anomalina aragonensis Nuttall - - Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 9 (list).

- - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, p. 10 (list), pl. 5, figs. 7, 8, 9.

Anomalina (?) sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 192, pl. 29, fig. 7.

Gavelinella rubiginosus - - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 155-156.

COMMENTS: *Anomalinoides dorri* and *A. dorri aragonensis* are distinquished on the basis of sutural differences. Tjalsma and Lohmann (1983), and van Morkhoven and others (1986) found too many transitional forms to justify the separation at species level. Van Morkhoven and others (1986) also felt that *A. dorri* and *A. aragonensis* were junior synonyms of *A. capitatus*.

RANGE: A late Paleocene (P6a) through early Oligocene (P18) range with doubtful occurrences in early Oligocene Zones P19 and P20 is given by van Morkhoven and others (1986). Forms transitional between *A. rubiginosus* (range K-P5) and *A. capitatus* have been observed in the middle Paleocene (P4) and early Eocene (P6b-P11) (van Morkhoven and others, 1986). In California, Berggren and Aubert (1983) found *A. aragonensis* in association with the early Eocene Lodo (P6-P9) and Kreyenhagen (P8-P9) formations. Almgren and others (1988) give the range of *Anomalinoides dorri aragonensis* as zones E and pseudo C which correspond to nannofossil zones CP5 through CP11 (planktic foraminiferal zones P4 through P9). The older occurrences noted by Almgren and others (1988) have not been exammined yet and may be the transitional forms noted by van Morkhoven and others (1986).

ECOLOGY: *Anomalinoides capitatus* was primarily a bathyal species but ranged to abyssal depths (van Morkhoven and others, 1986). Along the East Pacific Margin, Ingle (1980) considers this species to have an upper depth limit in the lower bathyal biofacies, $\geq$ 2000 m.

OCCURRENCE: Loma Prieta Quad. (Te_1); Laurel Quad. (Te_1); Pacheco Syncline (Las Juntas); Goler Formation; Lodo Gulch

Aragonia aragonensis (Nuttall)

Textularia aragonensis Nuttall, 1930, Jour. Paleo., v. 4, p. 280, pl. 23, fig. 6.

Bolivina aragonensis (Nuttall) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 199-200, pl. 28, fig. 19a,b.

Aragonia aragonensis (Nuttall) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 19, pl. 3, fig. 13a,b.

- - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, p.10 (list), p. 16 (list), pl. 2, figs. 15-17.

- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 23, pl. 11, figs. 2a,b.

- - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 308-314, pl. 101A, figs. 1-3; pl. 101B, figs. 1-4; pl. 101C, figs. 1-3.

Bolivina capdevilensis Cushman and Bermudez, 1937, Contr. Cushman Lab. Foram. Res., v. 13, p. 14, pl. 1, figs. 49, 50.

- - Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 9 (list).

Aragonia capdevilensis (Cushman and Bermudez) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 19, pl. 3, fig. 14a,b.

- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 23, pl. 11, figs. 3a,b.

COMMENTS: Tjalsma and Lohmann (1983) differentiate *A. aragonensis*, *A. capdevilensis* and *A. semireticulata* by the fairly compressed and strongly fan shaped test of *A. aragonensis*, by the less promeniently fan-shaped test and thick cross section of *A. capedevilensis* and by the very thin cross section and slightly raised ornamentation of *A. semireticulata*. Van Morkhoven and others (1986) consider these species as morphotypes of a single Eocene species. They do recognize that the forms vary in thickness and ornamentation and that the older members of the group may be flatter and less ornamented than the younger forms.

RANGE: The range of *Aragonia aragonensis* is late Paleocene (P5) through latest middle Eocene (P14) (Tjalsma and Lohman, 1983; van Morkhoven and others, 1986). Mallory (1959) gives range as late Ynezian to early Narizian. The late Ynezian occurrences in the Media Agua Creek Section are assigned to planktic zone P8, early Eocene not Paloecene (Poore, 1976). The early Narizian occurrences cited by Mallory (1959) in Devils Den section and the Canada Santa Anita are late middle Eocene in age (Poore 1976) and thus within the range given by Tjalsma and Lohmann (1983) and van Morkhoven and others (1986).

ECOLOGY: Along the East Pacific Margin, *Aragonia aragonensis* has an upper depth limit in the upper bathyal, 150-500 m (Ingle, 1980) but is considered primarily a lower bathyal and abyssal form (von Morkhoven and others, 1986).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1, Tme); Lodo Gulch

Astacolus sp. of Graham and Classen

Astacolus sp. of Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 10, pl. 2, fig. 1.

Bathysiphon eocenicus Cushman and Hanna

Bathysiphon eocenicus Cushman and Hanna, 1927, Calif. Acad. Sci., Proc., 4th Ser., v. 16, p. 270, pl. 13, figs. 2-3.
- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 6, pl. 1, fig. 1.
- - Smith, 1971, Univ. Calif. Publ. Geol. Sci., v. 91, p. 23.

Bathysiphon eocenica Cushman and Hanna - - Graham and Classen, 1955, Cushman Found. Foram. Res., v. 6, p. 6, pl. 1, fig. 1.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 148, pl. 17, fig. 1.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 105, pl. 1, fig. 4.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 25.

ECOLOGY: Along the East Pacific Margin, species of *Bathysiphon* such as *B. eocenicus* have upper depth limits in the lower bathyal biofacies, $\geq$ 2000 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Te_2, Tme, Tbs, Tsl); Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Muir, Alhambra); Goler Formation; Lodo Gulch

Bathysiphon santecruis Cushman and Kleinpell

Bathysiphon santecruis Cushman and Kleinpell, 1934, Cushman Lab. Foram. Res., Contr., v. 10, p. 1, pl. 1, figs. 1-2.
- - Smith, 1971, Univ. Calif. Publ. Geol. Sci., v. 91, p. 23, pl. 1, fig. 1.

Rhabdammina eocenica - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 148, pl. 17, fig. 4.

Suspected synonym:

?*Astrorhiza* sp. - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 5, pl. 1, figs. 2, 4, 5.

COMMENTS: *Bathysiphon santecruis* is usually smaller than *B. eocenicus*. The cement is siliceous with little arenaceous material.

ECOLOGY: Along the East Pacific Margin, species of *Bathysiphon* such as *B. santecruis* have upper depth limits in the lower bathyal biofacies, $\geq$ 2000 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (?Ku_1, Te_1, Te_2); Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Muir); Goler Formation

Bathysiphon spp.

?*Bathysiphon* sp. Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 6, pl. 1, fig. 3.

COMMENTS: Small compressed fragments composed of sand grains which give a coarse appearance to test.

OCCURRENCE: Loma Prieta Quad. (Te_1, Tbs); Laurel Quad (Te_1); Lodo Gulch

Bifarina eleganta (Plummer)

Siphogenerina eleganta Plummer, 1927, Univ. Texas Bull. 2644, p. 126, pl. 8, fig. 1.
Bifarina eleganta (Plummer) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 204, pl. 17, fig. 2.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 114.

RANGE: *Bifarina eleganta* ranges from early Penutian to late Narizian (Mallory, 1959).
OCCURRENCE: Loma Prieta Quad. (Te_1); Lodo Gulch

Bolivina antegressa Subbotina

Bolivina antegressa Subbotina, 1953, Trudy, VNIGRI, n.s., v. 6, p. 226, pl. 10, figs. 11a,b, 12, 13a,b, 14a,b, and 15-16.

Bolivina crenulata Cushman

Bolivina crenulata Cushman, 1936, Cushman Lab. Foram. Res., Spec. Pub., no. 6, p. 50, pl. 7, fig. 13.

Bolivina explicata lodoensis Mallory

Bolivina explicata Cushman and Hedberg *lodoensis* Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 200, pl. 16, fig. 19a,b.
- - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, p. 11 (list).

COMMENTS: "Differs from typical [*Bolivina explicata* Cushman and Hedberg] in much more compressed, less numerous lobations. Also related to *B. chirana* Cushman and Stone, but has fewer lobulate projections, not pointed at initial end, and not as compressed." (Mallory, 1959).
RANGE: *Bolivina explicata lodoensis* ranges from early Bulitian through late Ulatisian (Mallory, 1959). The early Bulitian and Penutian occurrences in the Media Aqua Creek section (samples A7075 through A7088) are in assemblages assigned to planktic foraminiferal zone P7. No Paleocene occurrences of this species have been found. Ulatisian occurrences are in the Oil City section in strata assigned to planktic foraminiferal zones P10 (Mallory, 1959; Poore, 1976) and in the Lodo Gulch Section (species not listed by Mallory, 1959 or Martin, 1943). *Bolivina explicata lodoensis* was recognized by Berggren and Aubert (1983) in Lodo Gulch in strata assigned to early Eocene planktic foraminiferal zones P8 and P9. The range of *Bolivina explicata lodoensis* in California is P7 to P10, early and middle Eocene.
OCCURRENCE: Lodo Gulch Section

Bolivina kleinpelli Beck

Bolivina kleinpelli Beck, 1943, Jour. Paleo., v. 17, p. 606, pl. 107, fig. 39.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 201, pl. 16, fig. 20.

RANGE: *Bolivina kleinpelli* occurs in the Narizian and Refugian with rare occurrences in the lower Ulatisian (Mallory, 1959; McDougall, 1980).
OCCURRENCE: Lodo Gulch Section

Bolivina midwayensis Cushman of Mallory

Bolivina midwayensis Cushman of Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 202, pl. 40, fig. 10.

COMMENTS: The test of *Bolivina midwayensis* illustrated by Mallory (1959) is nearly parallel sided and do not taper at the initial end. The cross section is more rounded than *Coryphostoma midwayensis* and suture angle is less than 45°.

RANGE: Hypotypes and specimens of *Bolivina midwayensis* illustrated by Mallory (1959) are from the middle Eocene.

ECOLOGY: Along the East Pacific Margin, *Bolivina midwayensis* of Mallory has an upper depth limit in the upper bathyal biofacies (Ingle, 1980).

Bulimina alazaensis Cushman

Bulimina alazaensis Cushman, 1927, Jour. Paleo., v. 1, p. 161, pl. 25, fig. 4.
- - Cushman and Parker, 1946, U.S.G.S., Prof. Paper 210-D, p. 103, pl. 24, figs. 14-16.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 187, pl. 36, fig. 15a,b,c.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub. 4, p. 24, pl. 14, fig. 4.

Bulimina corrugata Cushman and Siegfus, 1935, Cushman Lab. Foram. Res., Contr., v. 11, p. 92, pl. 14, fig. 7a,b.
- - Cushman and Parker, 1946, U.S.G.S., Prof. Paper 210-D, p. 93, pl. 22, fig. 2.
- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 19-20, pl. 3, fig. 17a,b.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 189, pl. 28, fig. 13a,b.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 105.

Bulimina truncanella Finley, 1940, Roy. Soc. New Zealand, Trans. Proc., v. 69, p. 455, pl. 64, figs. 89-91.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 197, pl. 36, fig. 18a,b,c.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 111.

Bulimina whitei Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 20, pl. 6, fig. 5a,b.
- - Cushman and Parker, 1946, U.S.G.S., Prof. Paper 210-D, p. 97, pl. 30, fig. 11.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 198, pl. 28, fig. 18a,b,c; pl. 36, fig. 19a,b,c.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 111, pl. 7, fig. 5a,b.

COMMENTS: Several small, costated buliminids have been identified from the California Eocene sediments: *B. alazaensis*, *B. corrugata*, *B. truncanella*, and *B. whitei*. Each of these species is described as a small, tapering form with longitudinal costate extending from the initial end to the base of the last whorl. Differences between species descriptions are in the number and character of the costae and slight variations in the width and length of the test. These differences appear to be largely related to the age of the specimen (juvinile verses adult). Type figures of *Bulimina alazaensis* and *B. corrugata* contain roughly the same number of costate, whereas the type figure of *Bulimina whitei* contains fewer costae. The illustrated specimen of *B. whitei* is, however, smaller than the other two species. The size difference may account for the smaller number of costae. Specimens of "*B. whitei*" from the Lodo Gulch Section, California, which are the same size as the type specimens of *B. alazaensis* and *B. corrugata* contain the same number of costae.

RANGE: The range of *B. alazaensis* is given as earliest Eocene (P6b) into the Oligocene (Tjalsma and Lohmann, 1983). This range spans the ranges give by Mallory (1959) for *B. corrugata* (early Ulatisian through late Narizian), *B. truncanella* (late Ynezian through late Narizian), and *B. whitei* (early Bulitian through early Narizian). Almgren and others (1988) give range of *B. corrugata* as pseudo C through A-2 zones which is equivalent to nannofossil zones CP11 through CP14b (planktic foraminiferal zones late P8-P14).

ECOLOGY: Along the East Pacific Margin, *Bulimina corrugata* and *Bulimina whitei* have upper depth limits in the lower middle bathyal biofacies, 500-1500 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas); Lodo Gulch Section.

Bulimina bradburyi Martin

Bulimina bradburyi Martin, 1943, Stanford Univ. Publ., Geol. Sci., v. 3, p. 19, pl. 6, fig. 4a,b.

- - Cushman and Parker, 1946, U.S. Geological Survey Professional Paper 210-D, p. 96-97, pl. 30, fig. 9.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 188, pl. 16, fig. 11.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 104.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 24, pl. 12, figs. 1, 2a,b.

COMMENTS: *Bulimina excavata* and *B. bradburyi* which are approximately the same size and shape, are not the same species. *B. excavata* has small depression along the suture lines which extend upward into the chambers, usually 1 per chamber. The specimen illustrated by Mallory (1959, pl. 16, fig. 13) as *B. excavata* may be *B. bradburyi* but preservation obscures the presence or absence of excavations.

Bulimina bradbury is morphologically close to *B. tuxapamensis* from which it differs by having a more slender test, somewhat inflated chambers, and its generally smaller size (Tjalsma and Lohmann, 1983).

RANGE: *Bulimina bradburyi* ranges from the late Paleocene (P4) into the early Oligocene (Tjalsma and Lohmann, 1983). Mallory (1959) gives range as late Ynezian to early Penutian. The late Ynezian and Bulitian occurrences (Paleocene of Mallory, 1959) are from the Media Aqua Creek and Simi Valley sections in strata assigned to planktic foraminiferal zones P4 through P7 (Poore, 1976; Heitman, 1983; Filewicz and Hill, 1983).

ECOLOGY: Along the East Pacific Margin, *Bulimina bradbury* has an upper depth limit in upper bathyal biofacies (Ingle, 1980).

OCCURRENCE: Lodo Gulch Section

Bulimina callahani Galloway and Morrey

Bulimina callahani Galloway and Morrey, 1931, Bull. American Paleo., v. 15, p. 350, pl. 40, figs. 6.

- - Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 9 (list).
- - Cushman and Parker, 1946, U.S.G.S., Prof. Paper 210-D, p. 87-88, pl. 20, figs. 20, 23.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 188, pl. 16, fig. 10.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 104
- - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, p. 10, 16.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 24-25, pl. 11, figs. 6a-7c.
- - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 322-327, pl. 105A, figs. 1-3; pl. 105B, figs. 1-4.

COMMENTS: *Bulimina callahani* is characterized by the reticulate ornamentation on the lower part of the test (Tjalsma and Lohmann, 1983).

RANGE: *Bulimina callahani* ranges from the Late Paleocene (P6a) through middle Eocene (P10) (Tjalsma and Lohmann, 1983; van Morkhoven and others, 1986). Mallory (1959) gives range as late Ynezian through early Ulatisian. These occurrences are in strata assigned to planktic foraminiferal zones P6b through P10.

ECOLOGY: *Bulimina callahani* is a middle and lower bathyal and abyssal species (van Morkhoven and other, 1986). Its upper depth limit is estimated as 600 m along the Pacific Margin (Berggren and Aubert, 1983). Ingle (1980) places the upper depth limit of this species in upper middle bathyal biofacies, 500-1500 m.

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1); Pacheco Syncline (Las Juntas); Lodo Gulch

Bulimina guaybalensis Cole

Bulimina guaybalensis Cole, 1927, Bull. Amer. Paleo., v. 14, p. 24, pl. 1, figs. 1, 2.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 191, pl. 16, fig. 3.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 106-107, pl. 6, fig. 8a,b.

Bulimina cf. *B. guaybalensis* Cole - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 20, pl. 3, figs. 18, 19a,b.

RANGE: Mallory (1959) gives range as late Penutian through early Narizian.

ECOLOGY: Along the East Pacific Margin, *Bulimina guaybalensis* has an upper depth limit in the upper bathyal biofacies (Ingle, 1980).

Bulimina inflata Sequenza

Bulimina inflata Sequenza, 1862, Accad. Giornia Sci. Nat. Catania, Att., Catania, Italia, ser. 2, tomo 18, p. 109, pl. 1, fig. 10.
- - Kleinpell, 1938, Miocene Stratigraphy of California, AAPG, p. 253.

RANGE: *Bulimina inflata* is restricted to the Saucesian, early Miocene (Kleinpell, 1938)

Bulimina lirata Cushman and Parker

Bulimina lirata Cushman and Parker, 1936, Cushman Lab. Foram. Res., Contr., v. 12, p. 43, pl. 8 fig. 2a,b,c.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 193, pl. 37, figs. 1a,b,c.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 108, pl. 6, fig. 10a,b.

RANGE: *Bulimina lirata* ranges from the Penutian through Narizian (Mallory, 1959).

Bulimina macilenta Cushman and Parker

Bulimina macilenta Cushman and Parker, 1936, Cushman Lab. Foram. Res., Contr., v. 11, p. 47, pl. 7, figs. 7-8.
- - Cushman and Parker, 1946, U.S.G.S., Prof. Paper 210-D, p. 98-99, pl. 23, figs. 2-3.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 193-194, pl. 28, fig. 15a,b,c.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 108.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 25, pl. 14, fig. 3.

Bulimina pachecoensis Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 175, pl. 24, fig. 14.

COMMENTS: *Bulimina macilenta* is described as having a medium size test with the margins of the chambers cut into more or less regular flutings or scallops that apparently cover the whole of the bottom of the test because of the narrowness of the chambers. Figures by Cushman and Parker (1946, pl. 23, figs. 2-3) show that the spines are restricted to the margins of the chambers in *B. macilenta*. "*Bulimina macilenta* differs from the Paleocene *B. midwayensis*, to which it seems related, mainly by the distinctive overhang of the chambers over those of the previous whorl, and by the costate basal part of the chambers. Transitional forms which show costae but lack the overhang occur during the latest Paleocene and Early Eocene" (Tjalsma and Lohmann, 1983).

RANGE: *Bulimina macilenta* occurs rare to frequently in zones P7 to P15 (Tjalsma and Lohman, 1983). Mallory (1959) gives range as late Ynezian through early Narizian.

ECOLOGY: Along the East Pacific Margin, *Bulimina macilenta* has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas Formation); Lodo Gulch

Bulimina microcostata Cushman and Parker

Bulimina microcostata Cushman and Parker, 1936, Cushman Lab. Foram. Res., Contr., v. 12, p. 39, pl. 7, fig. 2a,b,c.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 194, pl. 16, fig. 9.

RANGE: *Bulimina microcostata* is restricted to the Narizian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Bulimina microcostata* has an upper depth limit in the upper middle bathyal biofacies (Ingle, 1980).

Bulimina semicostata Nuttall

Bulimina semicostata Nuttall 1930, Jour. Paleo., v. 4, p. 274, pl. 23, figs. 15, 16.
- - Cushman and Parker, 1946, U.S.G.S., Prof. Paper 210-D, p. 93, pl. 21, figs. 28, 29.
- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 20, pl. 3, fig. 20.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 25, pl. 13, figs. 1-3.
- - van Markhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 279-281, pl. 93, figs. 1-5.

Bulimina cf. *B. semicostata* (Nuttall) - - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 110, pl. 7, fig. 3a,b.
Bulimina semicostata lacrima Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 196, pl. 16, fig. 8a,b,c.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 110.

COMMENTS: "Species variation mainly concerns the length/width ratio, the length of the triangular initial part of the test, the degree of inflation in the later chambers, and the coarseness of the costae on the initial part of the test. Specimens with a twisted initial part may have a basal spine" (Tjalsma and Lohmann, 1983).

RANGE: *Bulimina semicostata* ranges from the early Eocene (P6b) through early Oligocene (P18) (Tjalsma and Lohmann, 1983; van Morkhoven and others, 1986). Mallory (1959) gives range as early Ulatisian through early Narizian.

ECOLOGY: Although *Bulimina semicostata* is primarily a lower bathyal and abyssal species, it has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Ingle, 1980; van Morkhoven and others, 1986).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1, Tme); Lodo Gulch (aff.)

Bulimina trigonalis ten Dam

Bulimina trigonalis ten Dam, 1944, Geol. Stichting, Meded., Haarlem, Netherlands, ser. C, v. 5, no. 3, p. 112, pl. 3, figs. 16-17.

Bulimina trinitatensis Cushman and Jarvis

Bulimina trinitatensis Cushman and Jarvis, 1928, Cushman Lab. Foram. Res., Contr., v. 4, p. 102, pl. 14, fig. 12.
- - Cushman and Parker, 1946, U.S.G.S. Prof. Paper 210-D, p. 86, pl. 20, figs. 16, 17.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 7-8.
- - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213.
- - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 299-303, pl. 98a, figs. 1-2; pl. 98B, figs. 1-4.

Bulimina serratospina Finlay - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 20, pl. 3, fig. 21a,b.
Bulimina sp. - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 20, pl. 3, fig. 22a,b.

RANGE: *Bulimina trinitatensis* ranges from the early Paleocene (P1) through late Eocene (P16) (Tjalsma and Lohmann, 1983; van Morkhoven and others, 1986).

ECOLOGY: *Bulimina trintatensis* was primarily a bathyal to abyssal species (van Morkhoven and others, 1986). During the Eocene the upper depth limit may have been as shallow as 500-600 m (Barr and Berggren, 1981; Tjalsma and Lohmann, 1983; van Morkhoven and others, 1986).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas); Lodo Gulch

Buliminella grata Parker and Bermudez

Buliminella grata Parker and Bermudez, 1937, Jour. Paleo., v. 11, p. 515, pl. 59, fig. 6a,b,c.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 20, pl. 3, figs. 23a,b.
- - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 163-165, p. 54, figs. 1-2.

RANGE: An early Paleocene (P1) through middle Miocene (N12) range is given by van Morkhoven and others (1986).

ECOLOGY: *Buliminella grata* is primarily a bathyal species; maximum abundances occurred at depths of 1-2 km in Atlantic (Tjalsma and Lohmann, 1983; von Morkhoven and others, 1986)

OCCURRENCE: Loma Prieta Quad. (Te_1); Laurel Quad. (Te_1)

Buliminella robertsi (Howe and Ellis)

Bulimina robertsi Howe and Ellis, 1939, p. 63, pl. 8, figs. 32-33.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 173, pl. 24, fig. 10.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 186, pl. 15, fig. 14.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 103.

Turrilina robertsi (Howe and Ellis) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 37, pl. 14, fig. 5.

RANGE: *Buliminella robertsi* ranges from latest Paleocene (P6a) through late Eocene (P15) (Tjalsma and Lohmann, 1983).

ECOLOGY: Along the East Pacific Margin, *Buliminella robertsi* has an upper depth limit on the outer shelf (Ingle, 1980).

OCCURRENCE: Pacheco Syncline (Las Juntas); Lodo Gulch

Cancris subconica (Terquem)

Cancris subconicus (Terquem) - - King, 1989, in Jenkins and Murray, Stratigraphic Atlas of fossil foraminifera, Second Edition, Ellis Horwood Limited, p. 470, pl. 9.5, figs. 14, 15.

RANGE: *Cancris subconicus* ranges from late Eocene to early Oligocene in the North Sea and from the middle Eocene to late Oligocene in onshore sequences (King, 1989)

Chilostomella oolina Schwager

Chilostomella oolina Schwager, 1878, Uff. Geol. (R. Com. Geol. Ital.), Boll. Roma, Italia, v. 9, p. 527, pl. 1, fig. 16.
- - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 34.

ECOLOGY: Along the East Pacific Margin, the upper depth limit of *Chilostomella oolina* is in the upper bathyal biofacies (*C. cylindroides*, Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tsl)

Chrysalogonium elongatum Cushman and Jarvis

Chrysalongonium elongatum Cushman and Jarvis, 1934, Contr. Cushman Lab. Foram. Res., v. 10, p. 73, pl. 10, figs. 10-11.
- - Cushman and Stainforth, 1945, Cushman Lab. Foram. Res., Special Pub., v. 14, p. 26, pl. 3, fig. 30; pl. 16, figs. 3-4.

?*Chrysalongonium granti* (Plummer) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 10-11, pl. 2, fig. 2.
OCCURRENCE: Lodo Gulch

Chrysalogonium laeve **Cushman and Bermudez**

Chrysalogonium laeve Cushman and Bermudez, 1936, Cushman Lab. Foram. Res., Contr., v. 12, p. 27, pl. 5, figs. 1, 2.
- - Bermudez, 1949, Cushman Lab. Foram. Res., Spec. Publ., no. 25, p. 150, pl. 10, fig. 5.

COMMENTS: The Loma Prieta specimens have rectangular shaped chambers without costae and the sutures are not indented. They resembles *C. arkansasanum* Cushman and Todd (see Cushman, 1951, p. 25, pl. 7, figs. 11-12). Similar specimens of *C. laeve* are found in the Devils Den section (sample DDM-14, McDougall, unpub. data, 1989)
OCCURRENCE: Loma Prieta Quad. (Te_1); Devils Den (DDM-14); Lodo Gulch

Chrysalongonium longiscatatum **Cushman and Jarvis**

Chrysalongonium longiscatatum Cushman and Jarvis, 1934, Cushman Lab. Foram. Res., Contr., v. 10, p. 74, pl. 10, fig. 12.
- - Cushman and Stainforth, 1945, Cushman Lab. Foram. Res., Spec. Publ. v. 14, p. 25, pl. 3, fig. 26; pl. 16, fig. 2.

Chrysalogonium tenuicostatum **Cushman and Bermudez**

Chrysalogonium tenuicostatum Cushman and Bermudez, 1936, Cushman Lab. Foram. Res., Contr., v. 12, p. 27, pl. 5, figs. 3-5.
- - Bermudez, 1949, Cushman Lab. Foram. Res., Spec. Pub., no. 25, p. 151, pl. 10, fig. 2.

Nodosaria boffalorae Martinotti of Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 15, pl. 2, fig. 31.
Nodosaria cf. *N. velascoensis* Cushman - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 16, pl. 2, figs. 37, 38, 39.
OCCURRENCE: Loma Prieta Quad. (Te_1); Devils Den (DDM-14); Lodo Gulch

Cibicides beatus **Martin**

Cibicides beatus Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 30, pl. 8, fig. 6a,b,c.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 263, pl. 36, fig. 1a,b,c.

Cibicides felix **Martin**

Cibicides felix Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 31, pl. 8, figs. 7a,b,c.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 265, pl. 25, fig. 2a,b,c.

RANGE: *Cibicides felix* ranges from the late Ynezian through early Penutian (Mallory, 1959).

Cibicides fortunatus Martin

Cibicides fortunatus Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 31, pl. 8, fig. 5a,b,c.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 265, pl. 24, fig. 1.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 158.

- - Berggren and Aubert, 1983, U.S.G.S. Prof. Paper 1213, pl. 5, figs. 22-24.

RANGE: *Cibicides fortunatus* ranges from the late Ynezian to late Penutian (Mallory, 1959). The late Ynezian occurrences in the Media Agua Creek section where *Cibicides fortunatus* ranges from A7078-A7076 which has been assigned to planktic foraminiferal zone P6b.

ECOLOGY: Along the East Pacific Margin, *Cibicides fortunatus* has an upper depth limit in the upper bathyal biofacies (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch

Cibicides spiropunctatus Galloway and Morrey

Cibicides spiropunctatus Galloway and Morrey, 1931, Jour Paleo., v. 5, p. 346, pl. 39, fig. 7.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 270, pl. 25, fig. 3a,b,c.

RANGE: *Cibicides spiropunctatus* ranges from the early Bulitian through late Narizian (Mallory, 1959).

Cibicidoides eocaenus (Gumbel)

Rotalia eocaena Gumbel, 1868, K. Bayer. Akad. Wiss., Math.-Physik. Cl., Abh., 10, p. 650, pl. 2, fig. 87.

Cibicidoides eocaenus (Gumbel) - - van Morkhoven and others, 1986, Bull. Des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 256-263, pl. 86A, figs. 1-4; pl. 86B, figs. 1-2; pl 86C, figs. 1-3; pl. 86D, figs. 1-2.

Cibicides tuxapamensis Cole, 1928, Bull. American Paleo., v. 14, p. 219, pl. 32, figs. 2-3; pl. 3, figs. 5-6.

Cibicides perlucida Nuttall, 1932, Jour. Paleo., v. 6, p. 33, pl. 8, figs. 10-12.

Cibicides perlucidus Nuttall - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 31, pl. 6, figs. 6a,b, 7a,b,c.

Cibicides spiropunctatus Galloway and Morrey - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 270, pl. 25, fig. 3.

Cibicides whitei Martin, 1943, Stanford Univ. Publ. Geol. Sci. v. 3, p. 122, pl. 8, figs. 4a,b,c.

Cibicidoides whitei Martin - - Berggren and Aubert, 1983, U.S.G.S., Prof. Paper 1213, p. 10 (list), p. 16 (list).

COMMENTS: Mallory (1959, p. 272) believes that *C. whitei* may belong in the same group as *C. perlucidus* and *C. spiropunctatus*, and may not be a valid species. *Cibicidoides whitei* was recorded by Berggren and Aubert (1983) from the Lodo Gulch Section. These authors do not, however, record *C. eocaenus* in their assemblages and appear to have used this name instead.

RANGE: An early Eocene (P6b) through late Oligocene (P22) range is given by van Morkhoven and others (1986).

ECOLOGY: *Cibicidoides eocaenus* was primarily a bathyal species although it ranged from outer neritic to abyssal depths. Ingle (1980) condsidered the upper depth limit of *C. perlucidus* to be in the lower middle bathyal and of *C. spiropunctatus* to be in the upper bathyal biofacies.
OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1, Tme)

Cibicidoides eponidiformis (Martin)

Cibicides eponidiformis Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 50, pl. 6, fig. 7a,b,c.
Cibicidoides eponidiformis (Martin) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 273-274, pl. 38, fig. 9a,b,c.
RANGE: *Cibicidoides eponidiformis* ranges from the late Ynezian through at least late Narizian (Mallory, 1959).

Cibicidoides grimsdalei (Nuttall)

Cibicides grimsdalei Nuttall, 1930, Jour. Paleo., v. 4, p. 291, pl. 25, figs. 7, 8, 11.
Cibicidoides grimsdalei (Nuttall) - - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 247-251, pl. 83A, figs. 1-3; pl. 83B, figs. 1-7.
RANGE: An early Eocene (P8) through Miocene (N4) range is given by van Morkhoven and others (1986).
ECOLOGY: *Cibicidoides grimsdalei* was a lower bathyal and abyssal species. Ingle (1980) gives the upper depth limit of this species along the Pacific Margin as in the lower bathyal biofacies. Greatest abundances of this species are reported at paleodepths of 2,000-4,000 m in the Atlantic by Tjalsma and Lohmann (1983).
OCCURRENCE: Loma Prieta Quad. (Te_1 cf.)

Cibicidoides micrus (Bermudez)

Cibicides micrus Bermudez, 1949, Cushman Lab. Foram. Res., Spec. Publ. no. 25, pl. 302, pl. 24, figs. 34-36.
Cibicidoides micrus (Bermudez) - - van Morkhoven and others, 1986, p. 267-269, pl. 88, figs. 1-2.
Range: *Cibicidoides micrus* ranges from early Eocene (P6b) through late Oligocene (P21b) (von Morkhoven and others, 1986)
ECOLOGY: *Cibicidoides micrus* occurs in the outer neritic to abyssal biofacies (van Morkhoven and others, 1986).

Cibicidoides praecursorius (Schwager)

Cibicides praecursorius (Schwager) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 269, pl. 32, fig. 10.
RANGE: *Cibicidoides praecursorius* was restricted to the Ynezian by Mallory (1959).
OCCURRENCE: Lodo Gulch

Cibicidoides praemundulus Berggren and Edwards

Cibicidoides praemundulus Berggren and Edwards, 1985, in van Morkhoven and others, Bull. Des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 264-266, pl. 87, figs. 1-2.
Cibicides ungerianus (d'Orbigny) - - Tjalsma and Lohman, 1983, Micropaleo., Spec. Pub., no. 4, p. 28-29, pl. 18, fig. 1; pl. 21, figs. 5-6.
Cibicides cf. *C. ungerianus* (d'Orbigny) - - Almgren and others, 1988, Paleogene of the West Coast, SEPM, Pacific Section, fig. 5 (list).

probably not *Cibicides* cf. *C. ungeriana* (d'Orbigny) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 272.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 160, pl. 15, fig. 3a,b,c.

RANGE: An early Eocene (P6b) through late Oligocene (P22) range is given by van Morkhoven and others (1986). Almgren and others (1988) restrict this species to zone D which is equivalent to nannofossil zone CP9 and planktic foraminiferal zone P6b.
ECOLOGY: *Cibicidoides praemundulus* was primarily a lower bathyal and abyssal form, but occurs sporadically in middle bathyal sediments. Greatest abundances are found at abyssal depths (van Morkhoven and others, 1986).
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas)

Cibicidoides subspiralis (Nuttall)

Cibicides subspirata Nuttall, 1930, Jour. Paleo., v. 4, p. 292, pl. 25, figs. 9, 10, 14.
Cibicidoides subspiratus (Nuttall) - - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 314-316, pl. 102, figs. 1a,b,c.
RANGE: A late early Eocene (P9) through late middle Eocene (P13) range is given by van Morkhoven and others (1986).
ECOLOGY: *Cibicidoides subspiralis* is a bathyal and abyssal species (van Morkhoven and others, 1986).
OCCURRENCE: Loma Prieta Quad. (Te_1, Tme)

Cibicidoides venezuelanus (Nuttall)

Cibicides venezuelana Nuttall, 1935, Jour. Paleo., v. 9, p. 131, pl. 15, figs. 25-27.
Cibicides venezuelanus (Nuttall) - - Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 10 (list).
- - Bermudez, 1949, Cushman Lab. Foram. Res., Spec. Pub. no. 25, p. 308, pl. 26, figs. 19-21.
- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 32, pl. 6, fig. 8a,b,c.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 274, pl. 31, fig. 6a,b,c.

Cibicidoides venezuelana (Nuttall) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 197, pl. 1a,b,c, 5a,b,c.
COMMENTS: The similarity of *C. venezuelana* to *A. cocoaensis* is striking. The dorsal side of *Anomalina cocoaensis* Cushman is described as 1) "a low spire appearing almost as a low smooth boss, the area about depressed and then rising to the raised, rounded border" (Cushman, 1928), and 2) "gently concave"... "with a low smooth, raised spire, moderate concavity between spire and periphery" (Bandy, 1949, p. 103)

whereas *C. venezuelana* is descrided as having a flattened dorsal side and a central shell growth. These subtle differences are used to differentiate these species; however, these differences may describe environmental rather than taxonomic differences. Further study is needed.

RANGE: *Cibicidoides venezuelanus* ranges from early Bulitian through late Narizian, but no Bulitian occurrences are cited (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad (Te_1)

Clavulina anglica (Cushman)

Pseudoclavulina anglica Cushman, 1936, Cushman Lab. Foram. Res. Spec. Publ., no. 6, p. 18, pl. 3, fig. 5.

Clavulina anglica (Cushman) - - Proto Decima and De Biase, 1975, in Bolli (editor) Monografia Micropaleontologica sul Paleocene e l'Eocene di Possagno, Provincia Treviso, Italia, p. 92, pl. 1, fig. 32.

- - King, 1989, in Jenkins and Murray (editors), Stratigraphical atlas of fossil Foraminifera, p. 454, pl. 9.1, fig. 22.

- - Murray and others, 1989, in Jenkins and Murray (editors), Stratigraphical atlas of fossil Foraminifera, p. 508, pl. 10.1, figs. 3-4.

RANGE: King (1989) observes *C. anglica* in the North Sea sediments in the early Paleocene to early Eocene, Zones NSB 1a-1b and 3a-3b. These zones are equivalent to planktic foraminiferal zones P1-early P4 and late P6b to early P9. Murray and others (1989), and Proto Decima and De Biase (1975) also observe this species in the early Eocene, but report rare occurrences as young as P14 in Italy.

ECOLOGY: normal marine shelf (Murray and others, 1989)

Cribrostomoides trinitatensis Cushman and Jarvis

Cribrostomoides trinitatensis Cushman and Jarvis, 1928, p. 91, pl.. 12, figs. 12a,b.

- - Kaminski and others, 1988, p. 188, pl. 6, figs. 1a-3.

RANGE: In Trinidad, *Cribrostomoides trinitatensis* ranges from late Cretaceous (Maestrichtian) through the late Paleocene, planktic foraminiferal zone P6a (Kaminski and others, 1988).

Cyclammina pacifica Beck

Cyclammina pacifica Beck, 1943, Jour. Paleo., v. 17, p. 591, pl. 98, figs. 2, 3.

- - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 34.

RANGE: *Cyclammina pacifica* ranges from the late Ulatisian through late Narizian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Cyclammina pacifica* has an upper depth limit in the lower middle bathyal biofacies, 1500-2000 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Tbs, Tsl); Laurel Quad. (Tsl); Lodo Gulch

Cyclammina samanica Berry

Cyclammina samanica Berry, 1928, Eclog. Geol. Helv., v. 21, p. 393, text fig. 5a,b,c.

Haplopragmoides excavata Cushman and Waters of Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. , pl. 2, fig. 7a,b.

Haplophragmoides (?) sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 149, pl. 17, fig. 10.

not *Cyclammina samanica* Berry of Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 115, pl. 2, fig. 15a,b.

RANGE: *Cyclammina samanica* ranges from the late Bulitian through late Narizian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Cyclammina samanica* has an upper depth limit in the lower middle bathyal biofacies (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1); Lodo Gulch

Cyclammina simiensis Cushman and McMasters

Cyclammina simiensis Cushman and McMasters, 1936, Jour. Paleo., v. 10, p. 509, pl. 74, fig. 3a,b.

- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 6, pl. 1, fig. 9.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, pl. 2, fig. 17.

COMMENTS: The test of *Cyclammina simiensis* is compressed with a rounded periphery which is often lobate.

OCCURRENCE: Loma Prieta Quad. (Te_1, Te_2, Tme); Laurel Quad. (Te_1); Pacheco Syncline (Vine Hill); Lodo Gulch

Dentalina colei Cushman and Dusenbury

Dentalina colei Cushman and Dusenbury, 1934, p. 54, pl. 7, figs. 10-12.

- - Mallory, 1959, Lower Tertiary of the California Coast Ranges, AAPG, p. 162, pl. 12, fig. 9; pl. 41, fig. 3.

Dentalina approximata (Reuss) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 164, pl. 22, fig. 5.

Dentalina communis (d'Orbigny) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 165, pl. 22, fig. 9.

Dentalina mucronata Neugeboren - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 11, pl. 2, figs. 9, 10.

Dentalina cf. *D. wilcoxensis* - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 11-12, pl. 2, fig. 15.

Dentalina sp. A - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 12, pl. 2, figs. 12, 13.

Dentalina sp. B - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 12, pl. 2, fig. 16.

Dentalina sp. C - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 12, pl. 2, fig. 17.

Dentalina sp. D - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 12, pl. 2, fig. 18.

Dentalina sp. E - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 12, pl. 2, fig. 19.

Siphonodosaria cf. *S. pauperata* (d'Orbigny) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 21, pl. 3, figs. 30, 31.

OCCURRENCE: Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Muir; Smith, 1957); Lodo Gulch

Dentalina communis (d'Orbigny)

Nodosaria (Dentalina) communis d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 254.

Dentalina communis (d'Orbigny) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 162, pl. 12, fig. 11; pl. 41, fig. 6.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 78.

Dentalina cf. *D. communis* (d'Orbigny) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 11, pl. 2, fig. 3.

RANGE: *Dentalina communis* ranges from the late Ynezian through late Narizian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1); Lodo Gulch

Dentalina consobrina (d'Orbigny)

Nodosaria (Dentalina) consobrina d'Orbigny, 1846, Foraminiferes fossiles du bassin tertiaire de Vienne (Sutriche), Gide et Comp., Paris, p. 46, pl. 2, figs. 1-3.

Nodosaria consobrina d'Orbigny - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p.

Dentalina consobrina (d'Orbigny) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 163, pl. 12, fig. 12; pl. 41, fig. 5.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 78.

Nodosaria cf. *N. approximata* - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 11.

COMMENTS: Specimens included here are restricted to forms with a spherical initial chamber, followed by square chamber then a rectangular chamber. Forms with same basic chamber arrangement but square and rectangular chambers and are more elongated (see Kellough, 1965, pl. 6, fig. 10, p. 101) are now included in *D. consobrina* not *C. elongatum.*

RANGE: *Dentalina consobrina* ranges from the late Ynezian through late Narizian (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme); Lodo Gulch

Dentalina hexacostata Howe

Dentalina hexacostata Howe, 1939, Louisiana Geol. Survey Bull., v. 14, p. 44, pl. 5, fig. 13.

Dentalina hexacostata Howe? - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 164, pl. 12, fig, 15, pl. 28, fig. 2.

Dentalina intorta d"Orbigny

Dentalina intorta d'Orbigny, 1846, Foraminiferes fossil du basin tertiare de Vienne (Autriche), Gide et Comp., Paris, France, p. 44, pl. 1, figs. 50-51.

Dentalina havanensis Cushman and Bermudez - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 11, pl. 2, fig. 11.

Dentalina jacksonensis (Cushman and Applin)

Nodosaria jacksonensis Cushman and Applin, 1926, AAPG Bull., v. 10, p. 170, pl. 7, figs. 14-16.

Dentalina jacksonensis (Cushman and Applin) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 165, pl. 12, fig. 18.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 80.

RANGE: *Dentalina jacksonensis* ranges from the late Ynezian through late Narizian (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad. (Te_1 cf.); Lodo Gulch

Dentalina multilineata Bornemann

Dentalina multilineata Bornemann, 1855, Deutsch. Geol. Ges., Zeitschr., Deutschland, Bd. 7, Heft. 2, p. 325, pl. 13, fig. 12.

OCCURRENCE: Loma Prieta Quad. (Te_1 cf.)

Dentalina soluta Reuss

Dentalina soluta Reuss, 1851, Deutsch. Geol. Ges., Zeitschr., Deutschland, Bd. 3, p. 60, pl. 3, fig. 4.

Dentalina soluta (?) Reuss - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 167, pl. 12, fig. 18.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 82.

COMMENTS: *Dentalina* cf. *D. soluta* of Graham and Classen (1955, p. 11, pl. 2, fig. 14) probably belongs with this group but illustrated specimen is composed of too few chambers to verify.

RANGE: *Dentalina soluta* ranges from the late Ynezian through late Narizian (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad. (Te_1); Lodo Gulch

Discorbis baintoni Mallory

Discorbis baintoni Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 228, pl. 19, fig. 16a,b,c.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 125, pl. 9, figs. 5-6, 8.

RANGE: *Discorbis baintoni* ranges from the early Bulitian through late Ulatisian (Mallory, 1959). Paleocene, Bulitian occurrences of *Discorbis baintoni* are from the Media Agua Creek Section (Mallory, 1959, 1970) where it ranges from sample A7075 (Bulitian) to A7049 (Ulatisian). According to Poore (1976) and a revision of the age of the Media Agua Creek Section (McDougall, unpub. data), the Bulitian interval (A7075 through A7064) is early Eocene in age and contains planktic foraminifers indicative of planktic foraminiferal zone P7. The range of *Discorbis baintoni* is thus Penutian through Ulatisian (planktic foraminiferal zones P7 through P10, possibly P11) based on occurrences in the Media Agua Creek Section and the La Jolla Group of Southern California (Mallory, 1959; Link and Abbott, 1991).

ECOLOGY: Along the East Pacific Margin, *Discorbis baintoni* has an upper depth limit on the inner shelf (*Discorbis* spp., Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Discorbis devilensis Cook

Discorbis devilensis Cook in Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 229, pl. 33, fig. 12a,b,c.

OCCURRENCE: Lodo Gulch

Dorothia principiensis Cushman and Bermudez

Dorothia principiensis Cushman and Bermudez, 1936, Cushman Lab. Foram. Res., Contr. v. 12, p. 57, pl. 10, figs. 3-4.
- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 9, pl. 1, fig. 26.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 154, pl. 19, fig. 4.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 125, pl. 27, fig. 8; pl. 33, fig. 2; pl. 36, fig. 3.

RANGE: *Dorothia principiensis* ranges from the late Ynezian through late Narizian (Mallory, 1959).

OCCURRENCE: Laurel Quad (Te_1); Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Vine Hill Sandstone, Alhambra)

Ellipsoglandulina exponens (Brady)

Ellipsoidina exponens Brady, 1892, Quart. Jour. Geol. Soc. London, v. 48, p. 198.

Ellipsoglandulina* aff. *E. fragilis Bramlette

Ellipsoglndulina aff. *E. fragilis* Bramlette - - Beckmann, 1953, Ecol. Geol. Helv., v. 46, p. 379, pl. 23, fig. 7.

Ellipsoglandulina labiata (Schwager)

Glandulina labiata Schwager, 1866, Norara-Exped., Geol. Thril, v. 2, p. 237, pl. 6, fig. 77.

Ellipsoglandulina labiata (Schwager) - - Bermudez, 1949, Cushman Lab. Foram. Res., Special Pub., no. 25, p. 228, pl. 14, figs. 42-43.
- - Beckmann, 1953, Eclog. Geol. Helv., v. 46, p. 379, Pl. 23, figs. 9-11.

Ellipsoglandulina cf. *E. labiata* (Schwager) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 22, pl. 3, figs. 40a,b, 41.

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1)

Ellipsoglandulina* cf. *E. laevigata Silvestri

Ellipsoglandulina cf. *E. laevigata* Silvestri - - Beckmann, 1953, Ecol. Geol. Helv., v. 46, p. 379, pl. 23, fig. 12.

Ellipsoglandulina multicostata (Galloway and Morrey)

Daucina multicostata Galloway and Morrey, 1929, Bull. Amer. Paleo., v. 15, p. 42, pl. 6, fig. 13.

Ellipsoglandulina multicostata (Galloway and Morrey) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 23, pl. 3, fig. 39a,b.

OCCURRENCE: Lodo Gulch

Ellipsoglandulina principiensis Cushman and Bermudez

Ellipsoglandulina principiens Cushman and Bermudez, 1937, Contr. Cushman Lab. Foram. Res., v. 13, p. 18, pl. 2, figs. 1-3.
- - Bermudez, 1949, Cushman Lab. Foram. Res., Special. Pub. no. 25, p. 228, pl. 14, figs. 40-41.
- - Beckmann, 1953, Ecol. Geol. Helv., v. 46, p. 380.

Ellipsoglandulina sp. B - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 23, pl. 3, fig. 43.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Ellipsoidina ellipsoides Sequenza

Ellipsoidina ellipsoides Sequenza 1859, Eco Peloritano, Messina ser. 2, anno 5, fasc. 9, p. 12, figs. 1-3.

Ellipsomorphina subcompacta Liebus

Ellipsomorphina subcompacta Liebus, 1922, Lotos (Prag)., Bd. 70, p. 57, pl. 2, fig. 13.
- - Beckmann, 1953, Ecol. Geol. Helv., v. 46, p. 378, pl. 23, figs. 1-4.

Elphidium californicum Cook

Elphidium californicum Cook in Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 184, pl. 15, fig. 10a,b; pl. 33, fig. 8a,b.

RANGE: Mallory (1959) gives range of *E. californicum* as late Bulitian through late Ulatisian.

ECOLOGY: Along the East Pacific Margin, *Elphidium californicum* has an upper depth limit in the inner shelf biofacies (Ingle, 1980).

Epistominella danvillensis (Howe and Wallace)

Parrella danvillensis Howe and Wallace, 1932, Louisiana Geol. Survey Bull., v. 2, p. 71, pl. 13, fig. 7a,b,c.

Pseudoparrella cf. *P. danvillensis* (Howe and Wallace - - Mallory, 1959, Lower Tertiary of the California Coast Ranges, AAPG, p. 240, pl. 21, fig. 6a,b,c.

Eponides dorfi Toulmin

Eponides dorfi Toulmin, 1941, Jour Paleo., v. 15, p. 601, pl. 81, figs. 8, 9.
- - Mallory, 1959, Lower Tertiary of the California Coast Ranges, AAPG, p. 237, pl. 30, figs. 2a,b,c.

RANGE: *Eponides dorfi* ranges from late Ynezian through early Narizian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1)

Eponides lodoensis Martin

Eponides lodoensis Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 22, pl. 6, fig. 8a,b,c.
- - Mallory, 1959, Lower Tertiary of the California Coast Ranges, AAPG, p. 237, pl. 41, fig. 11a,b,c.

RANGE: *Eponides lodoensis* ranges from early Bulitian through late Penutian (Mallory, 1959).
OCCURRENCE: Lodo Gulch

Fissurina alveolata (Brady)

Lagena alveolata Brady, 1884, Report Challenger Expedition, London, England, Zool., pt. 22, v. 9, p. 487, pl. 60, figs. 30, 32.

Fissurina cucullata Silvestri

Fissurina cucullata Silvestri, 1902, Accad. Pont. Romana Nuovi Lincei, Mem., Roma, Italia, v. 19, p. 146, tfs. 23-25.

Fissurina fimbrata (Brady)

Lagena fimbrata Brady, 1881, Quart. Jour. Micr. Sci., London, England, n.s., v. 21, p. 61.

Fissurina marginata (Montagu)

Vermiculum marginatum Montagu, 1803, Testacea Britannica or natural history of British Shells, marine, land and fresh-water, including the most minute, J.S. Hollis, Romsey, England, p. 524.
Fissurina marginata (Walker and Boys) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 20, pl. 3, fig. 24.
- - McDougall, 1991, U.S.G.S. Open-file Rept. 91-13, p. 38.
OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch

Fissurina semimarginata (Reuss)

Lagena marginata semimarginata Reuss, 1870, K. Acad. Wiss. Wien, Math.-Naturw. Cl., Sitzber., Wien, Osterreich, Bd. 62, Abt. 1, p. 468.

Fissurina solida Sequenza

Fissurina solida Sequenza, 1862, Dei terreni Terziarii del distretto di Messina; Parte II - Descrizione dei foraminiferi Montalamici delle marine mioceniche del distreltodi Messina. Messina, Italia, T. Capra, p. 56, pl. 1, fig. 42.

Fissurina orbignyana Sequenza

Fissurina orbignyana Sequenza, 1862, Deii terreni Terziarii del distretto di Messina; Parte II - Descriptione dei foraminiferi monotalamici delle marne mioceniche del distretto de Messina T. Capra, p. 66, pl. 2, figs. 25-26.
Fissurina cf. *F. orbignyana* Sequenza - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 21, pl. 3, fig. 25.
OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1)

Fursenkoina bramletti (Galloway and Morrey)

Virgulina bramletti Galloway and Morrey, 1929, Bull. American Paleo., v. 15, p. 37, pl. 5, fig. 14a,b.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 198.

Fursenkoina bramletti (Galloway and Morrey) - - McDougall, 1980, SEPM, Paleo. Monograph, no. 2, p. 35.

RANGE: *Fursenkoina bramletti* is restricted to the early Narizian (Mallory, 1959). The actual range is much broader.

OCCURRENCE: Loma Prieta Quad. (Te_1, Tsl cf.)

***Fursenkoina* sp. A**

Virgulina sp. A of Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 22, pl. 3, fig. 37.

Gaudryina coalingensis Cushman and Hanna

Gaudryina jacksonensis coalingensis Cushman and Hanna,

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 122, pl. 27, fig. 7; pl. 39, fig. 3.

Gaudryina (Pseudogaudryina) sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, pl. 18, figs. 10, 13-14.

OCCURRENCE: Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Muir Sandstone; Smith, 1957); Media Aqua Creek (Lodo Formation; Cox samples)

Glandulina laevigata (d'Orbigny)

Nodosaria (Glanduline) laevigata d'Orbigny, 1826, Tableau methodique de la classe des Cephalododes, Ann. Sci. Nat., Paris, France, ser. 1, tome 7, p. 252, pl. 10, figs. 1-3.

ECOLOGY: *Glandulina laevigata ovata* has an upper depth limit in the upper middle bathyal biofacies (Ingle, 1980).

Globobulimina pacifica Cushman

Globobulimina pacifica Cushman, 1927, Cushman Lab. Foram. Res., Contr., v. 3, p. 67, pl. 14, fig. 12.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 198, pl. 16, fig. 17.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 111-112.

Guttulina (?) sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 170, pl. 23, fig. 13.

RANGE: *Globobulimina pacifica* ranges from the late Ulatisian through late Narizian with rare occurrences in the late Bulitian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Globobulimina pacifica* has an upper depth limit in the upper bathyal biofacies, 150-500 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Tsl); Lodo Gulch; Loma Prieta Quad. (Tsl)

Globocassidulina globosa (Hantken)

Cassidulina globosa Hantken, 1875, K. Ungar. Geol. Anst., Mitt. Jahrb., Bd. 4, Heft. 1, p. 64, pl. 16, figs. 2a,b.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 26, pl. 4, fig. 14a,b.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 226, pl. 33, fig. 11a,b.

Globocassidulina subglobosa (Brady) - - Tjalsma and Lohmann, 1983, Micropaleo. Special Publ., no. 4, p. 31, pl. 16, fig. 9.

RANGE: *Globocassisulina globosa* ranges from the early Penutian through late Narizian (Mallory, 1959). Tjalsma and Lohmann (1983) indicate that this species first appears in the Paleocene planktic zone P4 and ranges throughout the Eocene and into younger strata.

ECOLOGY: Along the East Pacific Margin, the upper depth limit of *G. globosa* is in the outer shelf biofacies, 50-150 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1, Tme)

Globulina globosa (von Munster)

Polymorphina globosa von Munster in Roemer, 1938, Die Cephalopodendes Nord - Deutschen tertiaren Meersandes. Neues Jahrb. Min. Geogn. Geol. Petref.-Kunde, Stuttgart, Deutschland, p. 386, pl. 3, fig. 33.

Globulina gibba globosa (von Muenster) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 177, pl. 14, fig. 16.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 90.

Glomospira charoides (Jones and Parker)

Trochammina squamata charoides Jones and Parker, 1860, Geol. Soc. London, Quart. Jour., v. 16, p. 304.

Glomospira charoides (Jones and Parker) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 6, pl. 1, fig. 7.

Glomospira charoides corona Cushman and Jarvis - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 109.

RANGE: *Glomospira charoides* ranges from the early Ynezian through late Narizian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Glomospira charoides* has an upper depth limit in the lower bathyal biofacies, $\geq$ 2000 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1)

Glomospira gordialis (Jones and Parker)

Trochammina squamata Jones and Parker *gordialis* Jones and Parker, 1860, Quart. Jour. Geol. Soc. London, England, v. 16, p. 304.

Glomospira gordialis (Jones and Parker) - - Kaminiski and others, 1988, Abh. Geol. B.-A. Bd. 41, p. 185, pl. 3, fig. 17.

RANGE: *Glomospira gordialis* ranges from planktic foraminiferal zone P4 (late Paleocene) to P7 (early Eocene) (Kaminski and others, 1988).

Gonatosphaera eocenica Mallory

Gonatosphaera eocenica Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 225, pl. 18, fig. 19.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 124, pl. 9, fig. 2.

Gonatosphaera multicosta Laiming, 1939, (not Costa), Sixth Pacific Sci. Cong. Proc., v. 2, p. 550, (list).

RANGE: *Gonatosphaera eocenica* occurs rarely in the early Penutian through early Ulatisian (Mallory, 1959). *Gonatosphaera eocenica* occurs in the Media Agua Creek Section in benthic foraminiferal assemblages assigned to the Penutian Stage by McDougall (1988, 1991) and with planktic foraminifers assigned to zone P8 (Poore, 1980). In the Pacheco Syncline section, *G. eocenica* occurs with benthic foraminiferal assemblages interpreted as Penutian (McDougall, unpub. data) and in association with nannofossils assigned to zone CP10/CP11 (Bukry, unpub. data, 1988). Although the range appears to be restricted to the Penutian (planktic foraminiferal zones P7-early P9), occurrences in the Ulatisian Stage have not been ruled out yet.

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Pacheco Syncline (Las Juntas)

Guttulina irregularis (d'Orbigny)

Globulina irregularis d'Orbigny, 1846, Foraminifers fossiles du bassin tertiaire de Vienna, (autriche), Gide et Comp., Paris, France, p. 226, pl. 13, figs. 9-10, p. 226, pl. 13, figs. 9-10.

Guttulina irregularis (d'Orbigny) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 177, pl. 14, fig. 13.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 90.

Glandulina sp. - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 17, pl. 3, fig. 1a,b.

ECOLOGY: Along the East Pacific Margin, *Guttulina irregularis* has an upper depth limit in the outer shelf biofacies (*G. problema*, Ingle, 1980).

Guttulina problema d'Orbigny

Guttulina problema d'Orbigny, 1826, Ann. Sci. Nat., v. 7, p. 266.
- - Cushman and Ozawa, 1931, Proceedings U.S. Nat. Mus., v. 77, p. 19-22, pl. 2, figs. 1-6; pl. 3, fig. 1a,b,c.

ECOLOGY: Along the East Pacific Margin, *Guttulina problema* has an upper depth limit in the outer shelf biofacies, 50-150 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1)

Gyroidina condoni (Cushman and Schenck)

Eponides condoni Cushman and Schenck, 1928, Calif. Univ., Dept. Geol. Sci., Bull., v. 17, p. 313, pl. 44, figs. 6-7.

OCCURRENCE: Laurel Quad. (Tsl); Goler Formation (cf.)

Gyroidina octocamerata Cushman and Hanna

Gyroidina soldanii octocamerata Cushman and Hanna, 1927, p. 223, pl. 14, figs. 16-18.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 181, pl. 27, fig. 5.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 236, pl. 30, fig. 1; pl. 42, fig. 1.

Gyroidinoides soldanii (d'Orbigny) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 25, pl. 4, fig. 10a,b,c not fig. 9a,b,c.

ECOLOGY: Along the East Pacific Margin, *Gyroidina octocamerata* has an upper depth limit in the lower bathyal biofacies (Ingle, 1980).

Gyroidina orbicularis d'Orbigny

Gyroidina orbicularis d'Orbigny, 1826, Ann. Sci Nat., Paris, France, ser. 1, tome 7, p. 278, modeles, no. 13.

ECOLOGY: Along the East Pacific Margin, *Gyroidina orbicularis* has an upper depth limit in the lower bathyal biofacies (Ingle, 1980).

Gyroidina orbicularis planata Cushman

Gyroidina orbicularis planata Cushman, 1935, p. 45, pl. 18, fig. 3a,b,c.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 235, pl. 29, fig. 16a,b,c.

ECOLOGY: Along the East Pacific Margin, the upper depth limit of *Gyroidina soldanii planata* is upper bathyal, 150-500 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Tsl); Lodo Gulch

Gyroidina soldanii d'Orbigny

Gyroidina soldanii d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 278.

Gyroidinoides soldanii (d'Orbigny) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 25, pl. 4, fig. 9a,b,c not fig. 10a,b,c.

ECOLOGY: Along the East Pacific Margin, *Gyroidina soldanii* has an upper depth limit in the lower bathyal biofacies, ≥ 200 m (Ingle, 1980)

OCCURRENCE: Laurel Quad. (Te1); Loma Prieta Quad. (Te_1, Tme, Tsl)

Hanzawaia ammophila (Gumbel)

Rotalia ammophila Gumbel, 1868, K. Bayer. Akad. Wiss., Math.-Physik. Cl. Abh., Munchen, v. 10, p. 652, pl. 2, fig. 90.

Hanzawaia ammophila (Gumbel) - - van Morkhoven and others, 1986, Bull. Des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 168-171, pl. 56, figs. 1-3.

Cibicidies cushmani Nuttall, 1930, Jour. Paleo., v. 4, p. 168, pl. 25, figs. 3, 5, 6.

- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 192, pl. 31, fig. 4.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 264, pl. 31, fig. 3.

Hanzawaia cushmani (Nuttall) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 32, pl. 17, fig. 1.

Cibicides americanus (Cushman) - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 31, pl. 6, fig. 1.

Anomalina sampsoni Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 262, pl. 23, fig. 7.

Anomalina crassisepta (Cushman and Siegfus) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 258, pl. 32, fig. 4.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 30, pl. 5, fig. 11a,b,c.

COMMENTS: Tjalsma and Lohmann (1983) note the similarity between *H. ammophila* and *H. cushmani* but separate species because *H. ammophila* has a more rapidly uncoiling spire and thus a flatter test. Van Morkhoven and others (1986) note this morphologic variation only in the Miocene forms and consider *H. cushmani* to be a junior synonym of *H. ammophila.*

Specimens assigned to *A. crassiseptus* and *A. sampsoni* by Mallory should be placed in synonomy with *H. ammophila.* Mallory lists the difference between these two species as the number of chambers in the final whorl, size, thickening of the periphery, and curvature of the chambers. The range of these features falls within the scope of *H. ammophila.*

RANGE: A range of latest Paleocene (P6a) through middle Miocene (N11) is given by van Morkhoven and others (1986). The form frequently assigned to H. cushmanni is most commonly found in the Eocene (P6a) to Oligocene (P18). Mallory (1959) gave the range as late Bulitian through late Narizian.

ECOLOGY: The depth range of *Hanzawaia ammophila* is outer neritic to upper bathyal; it may also be found at abyssal depths (van Morkhoven and others, 1986). Ingle (1980) gives the upper depth limit of this species along the Pacific Margin as in the lower middle bathyal biofacies, 1500-2000 m.

OCCURRENCE: Loma Prieta Quad. (Tme); Media Agua Creek section: Lodo Formation

Hanzawaia mauricensis (Howe and Roberts)

Cibicides mauricensis Howe and Roberts, 1939, Louisiana Dept. of Conservation, Geol. Survey Geol. Bull., no. 14, p. 87, pl. 13, figs. 4-5.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 31, pl. 6, figs. 3a,b,c, 4a,b, and 5a,b,c.

Cibicidina mauricensis (Howe and Roberts) - - Bandy, 1949, p. 93, pl. 15, fig. 3.

Cibicidina mauricensis subinvoluta Bandy, 1949, p. 93, pl. 16, fig. 5.

Cibicides sp. - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 273, pl. 23, fig. 12.

Cibicides spp. - - Mallory, 1970, p. 161 (in part).

Anomalina umbonata Cushman - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 262, pl. 31, fig. 2.

COMMENTS: Specimens of *Anomalina umbonata* illustrated by Mallory (1959, pl. 31, fig. 2, hypotype 42016) is not the same as illustrated by Mallory (1970, pl. 14, fig. 4, hypotype 42015) under the same name. The specimen illustrated in 1959 is *Hanzawaia mauricensis* whereas the specimen illustrated in 1970 is *Anomalina keenae. Anomalina umbonata* Cushman (1925) is from the Eocene of Mexico and is similar to *A. keenae.* Mallory's 1970 figure is probably correct. The 1959 figure may be an incorrect drawing (wrong drawing labelled as *A. umbonata*).

RANGE: Bandy (1949) records *Hanzawaia mauricensis* from the middle Eocene of the Gulf Coast. In California, *Hanzawaia mauricensis* ranges from the late Eocene, Narizian and late Ulatisian (Mallory, 1959).

OCCURRENCE: Media Agua Creek section: Lodo Formation, Point of Rocks sandstone (Mallory, 1959, 1970)

Haplophragmoides eggeri Cushman

Haplophragmoides eggeri Cushman, 1926, AAPG, Bull., v. 10, pl. 15, fig. 1.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 111, pl. 2, fig. 6.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 32.

Haplophragmoides sp. - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 6, pl. 1, fig. 10.

RANGE: *Haplophragmoides eggeri* ranges from the Ynezian through lower Narizian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (?Ku_1, Te_1, Te_2, Tme, Tbs)

Haplophragmoides excavata Cushman and Waters

Haplophragmoides excavata Cushman and Waters, 1927, Cushman Lab. Foram.Res., Contr., v. 2, p. 82, pl. 10, fig. 3a,b.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 112, pl. 2, fig. 7a,b.

Haplophragmoides glabra Cushman and Waters

Haplophragmoides glabra Cushman and Waters, 1927, Cushman Lab. Foram. Res., Contr., v. 2, p. 83, pl. 10, fig. 6a,b.

Haplophragmoides kirki Wickenden

Haplophragmoides kirki Wickenden, Trans. Roy. Soc. Canada, 3rd Ser., v. 26, sec. 4, p. 83, pl. 10, fig. 1a,b,c.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 112, pl. 2, fig. 5a,b.

Haplophragmoides lamella (Grzybowski)

Trochammina lamella Grzybowski, 1898, p. 34, Rozprawy Wyd. Matemat.-przyrod., Ajad. Umiejet. Krakowie, ser. 2, v. 41, pl. 11, fig. 25.

Haplophragmoides lamella (Grzybowski) - - Kaminski and others, 1988, Abh. Geol. B.-A., Bd. 41, Wien, p. 189, pl. 5, fig. 11a,b.

Hyperammina elongata Brady

Hyperammina elongata Brady, 1878, Ann. Mag. Nat. Hist., England, ser. 5, v. 1, p. 433, pl. 20, fig. 2a,b.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 106, pl. 1, fig. 8; pl. 27, fig. 2.
- - Smith, 1971, Univ. Calif. Publ. Geol. Sci., v. 91, p. 24.

OCCURRENCE: Loma Prieta Quad. (Te_1, Tbs)

Karreriella chapapotensis (Cole)

Textularia chapatoensis Cole, 1928, Bull. American Paleo., v. 14, p. 206, pl. 33, fig. 9.

Karreriella chapapotensis (Cole) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 32.

Karreriella chapapotensis monumentensis Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 126, pl. 5, fig. 3.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 47.

Karreriella chilostomella (Reuss) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 9, pl. 1, fig. 27a,b.

COMMENTS: Tjalsma and Lohmann (1983) consider Mallory's variation to represent the microspheric form of *K. chapapotensis* which ranges from the early Eocene to Oligocene.

RANGE: Mallory (1959) gives the range of *K. chapapotensis monumentensis* as early Ulatisian through early Narizian. Tjalsma and Lohmann give the range of *K. chapapotensis* as from early Eocene (P6b) into the Oligocene.

ECOLOGY: Along the East Pacific Margin, *Karreriella chapapotensis* has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1, Tme)

Karreriella conversa (Gryzbowski)

Gaudryina conversa Grzybowski, 1901, Acad. Sci. Cracovie, Cl. Sci. Math. Nat., Bull Interna., Krakow, no. 4, p. 224, pl. 8, figs. 15-16.

Karreriella conversa (Grzybowski) - - Kaminski and others, 1988, Abh. Geol. B.-A., Band 41, pl 196, pl. 9, figs. 17-18b.

RANGE: Late Cretaceous (Maestrichtian) through at least early Eocene (P8) (Kaminski and others, 1988). Gradstein and others (1988) indicate this species ranges into the middle Eocene (approximately 46 Ma, planktic zone P11) in the North Sea.

Karreriella aff. *K. cubensis* Cushman and Bermudez

Karreriella cf. *K. cubensis* Cushman and Bermudez - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 33, pl. 9, fig. 4a,b.

Karreriella sp. - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 127, pl. 5, fig. 2a,b.

RANGE: P11 through Oligocene (Tjalsma and Lohmann, 1983)

Karreriella elongata Mallory

Karreriella elongata Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 127, pl. 5, fig. 4a,b,c.

COMMENTS: Differs from *K. chilostoma* in narrower test, greater length, more oblique chambers (Mallory, 1959). *Karreriella elongata* is probably a junior synonym of *Karreriella subglabra* (Gumbel).

RANGE: Mallory (1959) finds this species restricted to the early Narizian. The range of *K. subglabra* is P8 through Oligocene (Tjalsma and Lohmann, 1983)

ECOLOGY: Along the East Pacific Margin, *Karreriella elongata* has an upper depth limit in the lower middle bathyal biofacies, 1500-2000 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1, Tme)

Karreriella horrida Mjatliuk

Karreriella horrida Mjatliuk, 1970, Trudy, VNIGRI, v. 282, Lenningrad, p. 114-115, pl. 5, fig. 9; pl. 33, fig. 15-16c.

Dorothia asiphonia (Andreae) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 9, pl. 1, fig. 25.

RANGE: *Karreriella horrida* ranges from the late Paleocene through early Oligocene (Gradstein and others, 1988).

Lagena acuticostata Reuss

Lagena acuticosta Reuss, 1862, K. Akad, Wiss. Wien, Math.-Naturw. Cl., Sitzber., Wien, Osterrich, Bd. 44, Abth. 1, p. 305, pl. 1, fig. 4.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 174, pl. 14, fig. 1a,b; pl. 28, fig. 10a,b; pl. 41, fig. 8a,b.

Lagena costata (Williamson)

Entosolenia costata Williamson, 1858, On the Recent Foraminifera of Great Britian, R. Soc. Lond., p. 9, pl. 1, fig. 18.

Lagena costata (Williamson) - - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 35.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 175, pl. 14, fig. 3a,b; pl. 41, fig. 7a,b.

RANGE: *Lagena costata* ranges from the early Bulitian through early Narizian (Mallory, 1959).

OCCURRENCE: Lodo Gulch; Loma Prieta Quad. (Te_1, Tme)

Lagena hexagona (Williamson)

Lagena hexagona (Williamson) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 175, pl. 14, fig. 7.

Lagena hispida Reuss

Lagena hispida Reuss, 1863, K. Akad. Wiss. Wien, Math.-Naturw. Cl., Sitzber., Wien, Osterreich. Bd. 46, Abth. 1, p. 335, pl. 6, figs. 77-79.

Lagena laevis (Montagu)

Vermiculum laeve Montagu, 1803, Testacea Britannica or Natural history of British shells, marine, land and fresh-water, including the most minute, J.S. Hollis, Romsey, England, p. 524.

Lagena sulcata (Walker and Jacob)

Serpula sulcata Walker and Jacob, 1798, in Kanmacher, F., Adams' Essays on the microscope. Ed. 2, London, England, Dillon and Keating, p. 634, pl. 14, fig. 5.

Lagena striata (d'Orbigny)

Oolina striata d'Orbigny, 1839, Voyage dans l'Amerique Meridionale, Foraminiferes, v. 5, tome 5, p. 21, pl. 5, fig. 12.

Lagena substriata Williamson

Lagena substriata Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, v. 1, p. 15, pl. 2, fig. 12.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 13, pl. 2, fig. 22.

Lenticulina altolimbatus (Gumbel)

Robulina alto-limbata Gumbel, 1868, K. Acad. Wiss Munchen, Math.-Physik. Cl., Abh., Bd. 10, Abt. 2, p. 641, pl. 2, fig. 70.

Robulus alto-limbata (Gumbel) - - Bandy, 1949, Bull. Am. Paleo., v. 131, p. 58, pl. 8, fig. 1a,b.

- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 156, pl. 20, fig. 1.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 133, pl. 6, fig. 16; pl. 27, fig. 11.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 54.

SUSPECTED SYNONYMS:

Robulus inornatus - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 17, pl. 2, fig. 42a,b, 43a,b,c.

Robulus sp. A - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 17, pl. 2, fig. 44a,b.

COMMENTS: "Test lenticular, close-coiled, biumbonate, with large central umbos not projecting greatly above the general surface but distinct; edge angled, with narrow keel; periphery smooth; chambers distinct, not inflated, about seven or eight in number; sutures distinct, limbate, flush, oblique and gently curved aperture at the peripheral edge of last septal face radiate with a slight extension down into the septal face" (Bandy, 1949).

RANGE: *Lenticulina altolimbatus* ranges from the early Penutian through upper Narizian (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Lenticulina antipodum (Stache)

Robulus antipodum (Stache) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 134, pl. 6, fig. 2.

RANGE: *Lenticulina antipodum* ranges from the late Ynezian through late Narizian (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Lenticulina arcuatostriata (Hantken)

Cristellaria (Robulina) arcuato-striata Hantken, 1868, Magyarh. Foldt. Tars., Munk., Pest, Magyarorszag, kot. 4, p. 93, pl. 2, fig. 30a,b,c.

Lenticulina carolinianus Cushman

Robulus arcuatostriatus carolinianus Cushman, 1933, Contr. Cushman Lab. Foram. Res., v. 9, p. 4, pl. 1, fig. 9.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 16, pl. 2, fig. 41a,b.

Robulus carolinianus - - Bandy, 1949, Bull. Am. Paleo., v. 131, p. 58, pl. 8, figs. 2a,b.

RANGE: Mallory (1959) gives range as late Ulatisian through late Narizian with rare occurrences in the early Penutian.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Lenticulina convergens (Bornemann)

Cristellaria convergens Bornemann, 1855, Deutsch. Geol. Ges., Zeitschr., Berlin, Deutschland, Bd. 7, Heft. 2, p. 327, pl. 13, figs. 16-17.

Lenticulina limbosus (Reuss)

Cristerallaria limbosus Reuss, 1863, K. Acad. Wiss., Math.-Naturw. Cl., Osterreich. Bd. 48, Abt. 1, p. 55, pl. 6, fig. 69, p. 55, pl. 6, fig. 69.

Robulus limbosus (Reuss) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 138, pl. 6, fig. 14.

Lenticulina limbosus hockleyensis Cushman and Applin

Cristellaria limbosa hockleyensis Cushman and Applin, 1926, AAPG, Bull. v. 10, p. 171, pl. 8 figs. 3-4.

Robulus limbosus hockleyensis (Cushman and Applin) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 139, pl. 6, fig. 15a,b.

RANGE: *Lenticulina limbosus hockleyensis* ranges from the late Ulatisian through late Narizian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1)

Lenticulina pseudocultratus (Cole)

Robulus pseudocultratus Cole, 1927, Bull. American Paleo., v. 14, p. 19, pl. 1, fig. 5.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 140, pl. 7, fig. 10a,b; pl. 27, fig. 10a, b.

RANGE: *Lenticulina pseudocultratus* ranges from the late Bulitian through late Narizian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1)

Lenticulina pseudovortex (Cole)

Robulus pseudovortex Cole, 1927, Bull. American Paleo., v. 14, p. 19, pl. 1, fig. 12.

- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 158, pl. 20, figs. 12-13.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 141, pl. 7, figs. 2-3; pl. 27, fig. 13.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 60.

RANGE: *Lenticulina pseudovortex* ranges from the early Bulitian through early Narizian (Mallory, 1959).
OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1); Vine Hill Sandstone, Las Juntas, Muir)

Lenticulina terryi (Coryell and Embich)

Robulus terryi Coryell and Embich, 1937, Jour. Paleo., v. 11, p. 299, pl. 41, fig. 17.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 141, pl. 6, fig. 1.
Robulus sp. B - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 17, pl. 2, fig. 45.
RANGE: *Lenticulina terryi* ranges from the late Ynezian through early Narizian (Mallory, 1959).
OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1)

Lenticulina texana (Cushman and Applin)

Cristellaria articulata texana Cushman and Applin, 1926, AAPG, Bull., v. 10, p. 170, pl. 8, figs. 1,2.
Robulus articulata texanus (Cushman and Applin) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 135, pl. 6, fig. 13a,b.

Lenticulina ulatisensis Boyd

Robulus ulatisensis Boyd in Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 142, pl. 6, fig. 10a,b; pl. 40, fig. 4a,b.
RANGE: *Lenticulina ulatisensis* ranges from the late Penutian through early Narizian (Mallory, 1959).
OCCURRENCE: Loma Prieta Quad. (Te_1)

Lenticulina vortex (Fitchel and Moll)

Robulus vortex (Fitchel and Moll) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 159, pl. 21, fig. 2.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 142, pl. 7, fig. 1a,b.
OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1); Pacheco Syncline (Vine Hill Sandstone)

Lenticulina welchi (Church)

Robulus welchi Church, 1931, Calif. Dept. Nat. Res., Div. Mines, v. 27, pl. C, figs. 13, 14.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 143, pl. 7, fig. 8a,b.
RANGE: *Lenticulina welchi* first appears in the late Ulatisian and ranges into the late Narizian (Mallory, 1959).

Lituotuba lituiformis (Brady)

Lituotuba cf. *L. lituiformis* (Brady) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 109, pl. 1, fig. 17.
- - McDougall, 1991, U.S.G.S. Open-file Rept., 91-13, p. 43.

?*Trochamminoides* sp. A - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 7, pl. 1, fig. 11.

?*Trochamminoides* sp. B - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 7, pl. 1, fig. 12.

RANGE: *Lituotuba lituiformis* occurs in the Ulatisian and there are rare occurrences reported in the late Ynezian and early Penutian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1)

Marginulina dominica Bermudez

Marginulina dominica Bermudez, 1949, Cushman Lab. Foram. Res., Special Pub., no. 25, p. 140, pl. 9, fig. 26.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Marginulina exima Neugeboren

Marginulina exima Neugeboren, 1851, Siebenb. Ver. Naturw. Hermannstadt. Verh. Mitt., Jahrg. 2, p. 129, pl. 4, fig. 17.

Marginulina cf. *M. exima* Neugeboren - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 13, pl. 2, fig. 24.

SUSPECTED SYNONYMS:

Marginulina tumida - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 13-14, pl. 2, fig. 26.

Marginulina sp. - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 14 pl. 2, fig. 27.

RANGE: *Marginulina exima* ranges from the early Bulitian through early Narizian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1, Tsl)

Marginulina glabra d'Orbigny

Marginulina glabra d'Orbigny, 1826, Ann. Sci. Nat., Paris, France, ser. 1, tome 7, p. 259, modeles, no. 55.

Marginulina subbullata Hantken

Marginulina subbullata Hantken, 1875, K. Ungar. Geol. Anst., Mitt., Jahrb., v. 4, p. 46, pl. 4, figs. 9-10.; pl. 5, fig. 9.
- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 13, pl. 2, fig. 25.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 151, pl. 9, figs. 13-15.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 69.

Marginulina bullata augens Cushman and Todd - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 161, pl. 21, fig. 15.

Enantiomarginulina sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 170, pl. 23, fig. 16.

RANGE: *Marginulina subbullata* ranges from the late Ynezian through late Narizian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1)

Marginulina subrecta Franke

Marginulina subrecta Franke, 1927, Danmarks Geol., v. 2, p. 19, pl. 1, fig. 28.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Marginulina yaquensis Bermudez

Marginulina yaquatensis Bermudez, 1949, Cushman Lab. Foram. Res., Spec. Pub., no. 25, p. 142, pl. 9, fig. 29.

Martinotiella eocenica Cushman and Bermudez

Listerella gracillima Cushman and Bermudez, 1973, Contr. Cushman Lab. Foram. Res., v. 13, p. 6, pl. 1, figs. 27-28.

Martinotiella eocenica Cushman and Bermudez in Cushman, 1947, Cushman Lab. Foram. Res., Spec. Pub., no. 8A, p. 48.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 128, pl. 5, fig. 8a,b.

RANGE: *Martinotiella eocenica* ranges from the early Penutian through late Narizian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Martinotiella eocenica* has an upper depth limit in the upper middle bathyal biofacies (Ingle, 1980).

OCCURRENCE: Lodo Gulch; Loma Prieta Quad. (Te_1, Tme, Tsl cf.)

Nodosarella advena Cushman and Siegfus

Nodosarella advena Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 15, p. 30, pl. 6, figs. 19-20.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 23, pl. 3, figs. 45, 46a,b.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 220, pl. 18, fig. 22a,b; pl. 29, fig. 12a,b.

RANGE: *Nodosarella advena* ranges from the early Ulatisian through early Narizian (Mallory, 1959). *Nodosarella advena* has been found in strata assigned to nannofossil zone CP12 in the Devils Den section, sample DDM-14-89 (McDougall and Bukry, unpub. data, 1989) and strata assigned to planktic foraminiferal zone P8 through P9 in the Media Agua Creek section (Mallory, 1959; Poore, 1980) which suggests its first appearance is in the Penutian Stage.

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1)

Nodosarella atlantisae hispidula (Cushman)

Ellipsonodosaria atlantisae hispidula Cushman, 1939, p. 70, pl. 12, fig. 5.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 221, pl. 19, fig. 2.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 121.

Nodosarella constricta Cushman and Bermudez

Nodosarella constricta Cushman and Bermudez, 1937, Cushman Lab. Foram. Res., Contr., v. 13, p. 18, pl. 2, figs. 4-7.
- - Beckmann, 1953, Ecol. Geol. Helv., v. 46, p. 376, pl. 22, fig. 21.

Nodosarella decurta (Bermudez)

Ellipsonodosaria decurta Bermudez, 1937, Mem. Soc. Cubana Hist. Nat., v. 11, p. 144, pl. 17, figs. 13-14.

Nodosarella decurta (Bermudez) - - Bermudez, 1949, Cushman Lab. Foram. Res., Special Pub., no. 25, p. 231, pl. 14, fig. 32.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Nodosarella mappa (Cushman and Jarvis)

Ellipsonodosaria mappa Cushman and Jarvis, 1934, Contr. Cushman Lab. Foram. Res., v. 10, p. 73, pl. 10, fig. 8.

Nodosarella mappa (Cushman and Jarvis) - - Beckmann, 1953, Eclog. Geol. Helv., v. 46, p. 376, pl. 22, fig. 22-23.

OCCURRENCE: Loma Prieta Quad. (Te_1)

Nodosarella subnodosa (Guppy)

Ellipsoidina subnodosa Guppy, 1894, Proc. Zool. Soc. London, p. 650, pl. 61, fig. 12.

Nodosarella subnodosa (Guppy) - - Beckmann, 1953, Ecol. Geol. Helv., v. 46, p. 377, pl. 22, figs. 30, 31.

Nodosaria* cf. *N. amphioxys Reuss

Nodosaria cf. *N. amphioxys* Reuss - - Cushman, 1951, U.S.G.S. Prof. Paper 232, p. 24, pl. 7, fig. 8.

COMMENTS: The type of *Nodosaria amphioxys* is from the late Cretaceous of Saxony. Cretaceous specimens have also been noted in the Taylor marl and Navarro group in the southeastern United States and in the Campanian to Maestrichtian of California (Sliter, 1968). Paleocene forms questionably assigned to this species are from the southeastern United States (Cushman, 1951).

RANGE: Several specimens were found in the Devils Den section (McDougall, unpub. data, 1989) in association with calcareous nannofossils diagnostic of zone CP12 (Bukry, unpub. data, 1989).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Nodosaria deliciae Martin

Nodosaria deliciae Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 17, pl. 6, fig. 3.

- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 167, pl. 22, fig. 18.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 170, pl. 13, fig. 13; pl. 36, fig. 10.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 85.

Nodosaria deliciae murensis Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 167, pl. 22, figs. 19-20.

COMMENTS: *Stilostomella paleocenica* in Berggren and Aubert (1983, pl. 2, fig. 2) strongly resembles *Nodosaria deliciae* and may be synonomous.

RANGE: *Nodosaria deliciae* ranges from the late Bulitian through late Penutian with rare occurrences in the early Narizian (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad. (Te_1); Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Muir, and Alhambra); Devils Den (DDM-14)

Nodosaria latejugata Gumbel

Nodosaria latejugata Gumbel, 1868, K. Acad. Wiss Munchen, Math.-Physik. Cl., Abh., Bd. 10, Abt. 2, p. 619, pl. 1, fig. 32.
- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 16, pl. 2, fig. 33, 34.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 167, pl. 22, fig. 23.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 171, pl. 13, fig. 20; pl. 28, fig. 8; pl. 41, fig. 1.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 85.

COMMENTS: "It [*N. latejugata*] differs from *N. afinis* Reuss mainly in the greater inflation of the chambers and consequent strongly depressed sutures. Some specimens are rather difficult to allocate and the two species are evidently closely related." (Cushman, 1951).

Specimens from Lodo Gulch assigned to this species have indented sutures and inflated chambers. Most are broken and maybe the upper portion of *N. affinis*. Specimens from the Goler Formation are broken and represented by single spherical chambers; similar to *N. lateugata* illustrated by Mallory (1959) from the Canos Member of the Kreyenhagen Formation. Specimens from the Pacheco Syncline (Smith, 1957) are straight-sided.

RANGE: *Nodosaria latejugata* ranges from the early Ynezian through late Ulatisian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1)

Nodosaria longiscata d'Orbigny

Nodosaria longiscata d'Orbigny, 1846, Foraminiferes fossiles du bassin tertiaire de Vienne, Gide et Comp., France, p. 32, pl. 1, figs. 10, 12.
- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 16, pl. 2, figs. 35, 36.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 171.

Nodosaria arundinea Schwager - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 169, pl. 13, fig. 10; pl. 28, fig. 7; pl. 41, fig. 4.

Nodosaria arundinea Schwager (?) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 166, pl. 22, fig. 21.

Nodosaria ewaldi Reuss - - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 85.

Dentalina cf. *D. consobrina* d'Orbigny - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 11, pl. 2, figs. 4-6.

Nodosaria clavaeformis Neugeboren - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 15, pl. 2, fig. 32.

RANGE: *Nodosaria longiscata* ranges from the early Bulitian through late Narizian (Mallory, 1959).

OCCURRENCE: Lodo Gulch; Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Vine Hill Sandstone and Las Juntas)

Nodosaria macneili Cushman

Nodosaria macneili Cushman, 1944, Cushman Lab Foram. Res., Contr., v. 20, p. 37, pl. 6, fig. 9.

- - Cushman, 1951, U.S.G.S. Prof. Paper 232, p. 24, pl. 7, fig. 7.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 172, pl. 13, fig. 16.
- - Kellough, 1965, Gulf Coast Assoc. Geol. Soc. Trans., v. 15, p. 100, pl. 5, fig. 7.

COMMENTS: Specimens assigned to this species have approximately 20 costae and spherical chambers which are constricted at the sutures.

RANGE: *Nodosaria macneili* ranges from the late Bulitian with rare occurrences in the late Ynezian (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad. (Te_1); Pacheco Syncline (Vine Hill Sandstone)

Nodosaria pyrula d'Orbigny

Nodosaria pyrula d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, v. 7, p. 253.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 172, pl. 13, fig. 19; pl. 41, fig. 2.

RANGE: *Nodosaria pyrula* ranges from the late Penutian through late Narizian (Mallory, 1959).

OCCURRENCE: Lodo Gulch; Loma Prieta Quad. (Te_1, Tme)

Nodosaria velascoensis Cushman

Nodosaria velascoensis CushmanMallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 172, pl. 13, fig. 24.

Nonion florinensis Cole

Nonion florinense Cole, 1927, Bull. Am. Paleo., v. 14, p. 22, pl. 4, fig. 4.

Nonionella florinense (Cole) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 183, pl. 15, fig. 8a,b,c.

Nonion havanense Cushman and Bermudez

Nonion havanense Cushman and Bermudez, 1937, Cushman Lab. Foram. Res., contr., p. 19, pl. 2, figs. 12, 13.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 18, pl. 3, fig. 4a,b.

- - Tjalsma and Lohmann, 1983, Micropaleo. Spec. Pub. no. 4, p. 17, pl. 7, fig. 6a,b.

RANGE: *Nonion havanense* ranges from the early Pliocene (P1) to Oligocene (Tjalsma and Lohmann, 1983)

ECOLOGY: *Nonion havanense* has a wide bathymetric distribution (Tjalsma and Lohmann, 1983).

Nonionella turgida (Williamson)

Rotalina turgida Williamson, 1958, On the Recent foraminifera of Great Britain, Roy. Soc. London, England, p. 50, pl. 4, figs. 95-97.

Nonionella turgida (Williamson) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 183-184, pl. 15, fig. 9a,b,c.

Nuttaloides truempyi (Nuttall)

Eponides truempyi Nuttall, 1930, Jour. Paleo., v. 4, p. 287, pl. 24, figs. 9, 13, 14.

Nuttaloides truempyi (Nuttall) - - van Morkhoven and others, 1986, Bull. des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 288-295, pl. 96A, figs. 1-4; pl. 96B, figs. 1-3; pl. 96C, figs. 1-4; pl. 96D, figs. 1-2.

Nuttallides trumpyi (Nuttall) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 25, pl. 4, fig. 12a,b,c.

Astigerina crassaformis Cushman and Siegfus, 1935, Cushman Lab. Foram. Res., Contr., v. 11, p. 94, pl. 14, fig. 10.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 242, pl. 37, fig. 13a,b,c.

Astigerina crassaformis umbilicatula Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 242, pl. 22, fig. 1a,b,c.

COMMENTS: *Astigerina crassaformis umbilicatula* which ranges from early Penutian through early Narizian, has the large clear umnbilical boss which is characteristic of many middle and late Eocene forms of the species *Nuttalides truempyi.*

RANGE: A late Cretaceous (Campanian) through late Eocene (P17) range is given by van Morkhoven and others (1986). Berggren and Aubert (1983) considered the extinction of *N. truempyi* a useful event for identification of the Eocene/Oligocene boundary in deep-water sediments. Mallory (1959) gave the range of *Astigerina crassaformis* as early Ulatisian through late Narizian and the range of *A. crassaformis umbilicatulum* as early Penutian through early Narizian. Both ranges fall within the broader range given for *Nuttalides truempyi.* The range of *Astigerina crassaformis umbilicatula* given by Almgren and others (1988) is zones C through A-2 which are equivalent to nannofossil zones CP9 through CP14 (planktic foraminiferal zones P7-P14) and also falls within the broader range of *Nuttalides truempyi.*

ECOLOGY: Along the East Pacific Margin, the upper depth limit of *Nuttalides truempyi* is in the lower bathyal biofacies, 1500-2000 m (Ingle, 1980) but *Nuttalides truempyi* is most common at abyssal depths (van Morkhoven and others, 1986).

OCCURRENCE: Laurel Quad (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas)

Oridorsalis umbonatus (Reuss)

Rotalina umbonata Reuss, 1851, Deutsch. Geol. Ges., Zeitschr., Berlin, Bd. 3, p. 75, pl. 5, fig. 35.

Eponides umbonata (Reuss) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 183, pl. 27, figs. 12, 14.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 239, pl. 30, fig. 3; pl. 37, fig. 11.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 133.

Eponides umbonatus (Reuss) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 24, pl. 4, figs. 5a,b, 6.

Oridorsalis umbonatus (Reuss) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 18, pl. 6, fig. 8.

RANGE: *Oridorsalis umbonatus* ranges from the late Ynezian through late Narizian (Mallory, 1959).

ECOLOGY: Ingle (1980) gives upper depth limit of *Oridorsalis umbonatus* as upper bathyal in the Paleogene and as upper middle bathyal in the Neogene along the East Pacific Margin.

OCCURRENCE: Laurel Quad. (Te_1, Tsl); Lodo Gulch; Loma Prieta Quad. (Te_1, Tme); Pacheco Syncline (Las Juntas)

Orthomorphina havanensis (Cushman and Bermudez)

Nodogenerina havanensis Cushman and Bermudez, 1937, Cushman lab. Foram. Res., Contr., v. 13, p. 14, pl. 1, figs. 47, 48.

- - Cushman and Stainforth, 1945, Cushman Lab. Foram. Res., Spec. Pub., no. 14, p. 39, pl. 5, fig. 24.

Orthomorphina havanensis (Cushman and Bermudez) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 34, pl. 14, fig. 11.

RANGE: *Orthomorphina havanensis* ranges from the middle Eocene (P10) into the Oligocene (Tjalsma and Lohman, 1983).

Orthomorphina heterosculpta (Bermudez)

Nodogenerina heterosculpta Bermudez, 1949, p. 178, pl. 11, fig. 58.

Orthomorphina heterosculpta (Bermudez) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 34, pl. 14, fig. 10.

RANGE: *Orthomorphina heterosculpta* ranges from the late Eocene (P15) into Oligocene (Tjalsma and Lohmann, 1983).

Orthomorphina rohri Cushman and Stainforth

Orthomorphina rohri Cushman and Stainforth, 1945, Cushman Lab. Foram. Res., Spec. Pub., no. 14, pl. 39, pl. 5, fig. 26.

Osangularia mexicana (Cole)

Pulvinulinella culter mexicana Cole, 1927, Bull. American Paleo., v. 14, p. 31, pl. 1, figs. 15-16.

Eponides lodoensis martini Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 182 (in part).

Osangularia mexicana (Cole) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 25, pl. 4, figs. 11a,b.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 35, pl. 20, fig. 6.

RANGE: Similar forms identified by Mallory (1959) as *Parrella culter midwayana* and *Parrella tenuicarinata* range from early Ynezian through the early Narizian and late Bulitian through late Narizian. Tjalsma and Lohmann (1983) give the range as early Eocene (P6b) into the Oligocene.

ECOLOGY: Along the East Pacific Margin, *Osangularia mexicana* has an upper depth limit in the upper middle bathyal biofacies (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1, Tme); Pacheco syncline (Las Juntas, and Muir)

Planularia truncana (Gumbel)

Cristellaria truncana Gumbel, 1868, K. Bayer. Acad. Wiss. Munchen, Math.-Physik. Cl., Abh., Munchen, Deutschland, Bd. 10, Abt. 2, p. 639, pl. 1, fig. 68.

Planularia truncana (Gumbel) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 148, pl. 9, fig. 8a,b; pl. 27, fig. 17a,b.

Plectina garzaensis Cushman and Siegfus

Plectina garzaensis Cushman and Siegfus, 1935, Cushman Lab. Foram. Res., Contr., v. 11, p. 92, pl. 14, figs. 3-4.
- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 9, pl. 1, fig. 29.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 126, pl. 4, fig. 13.

RANGE: *Plectina garzaensis* ranges from the early Ulatisian through late Narizian with rare occurrences in the early Penutian (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad. (Te_1, Tme, Tsl)

Plectofrondicularia garzaensis Cushman and Siegfus

Plectofrondicularia garzaensis Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr. v. 15, p. 26, pl. 6, fig. 9.

Plectofrondicularia packardi Cushman and Schenck

Plectofrondicularia packardi Cushman and Schenck, 1928, Univ. Calif. Pub. Geol. Sci., v. 17, p. 311, pl. 43, figs. 14-15.
- - McDougall, 1980, SEPM, Paleo. Monograph, no. 2, p. 37.

RANGE: *Plectofrondicularia packardi* ranges from the late Narizian into the Oligocene (Mallory, 1959). This species has, however, been found throughout the Narizian as well as the Oligocene.

OCCURRENCE: Loma Prieta Quad. (Tsl)

Plectofrondicularia paucicostata Cushman and Jarvis

Plectofrondiuclaria paucicostata Cushman and Jarvis, 1929, Contr. Cushman Lab. Foram. Res., v. 5, p. 10, pl. 2, figs. 11-12, 13.

- - van Morkhoven and others, 1986, Bull. Des Centres de Recherches Elf-Aquitaine, Mem. 11, p. 273, pl. 91, figs. 1-2.

Plectofrondicularia kerni Cook - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 212, pl. 18, fig. 2; pl. 33, fig. 10a,b.

RANGE: *Plectofrondicularia paucicostata* ranges from the middle Eocene (P12) through early Oligocene (P20) with doubtful occurrence from early Eocene P8 through middle Eocene P11 (van Morkhoven and others, 1986). Mallory (1959) gives range as early Penutian through early Narizian.

ECOLOGY: *Plectofrondicularia paucicostata* is a middle bathyal to abyssal species (van Morkhoven and others, 1986).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1); Pacheco Syncline (Las Juntas)

Pleurostomella acuta Hantken

Pleurostomella acuta Hantken, 1875, K. Ungar. Geol. Anst., Mitt. Jahrb., Budapest, Bd. 4, p. 44, pl. 13, fig. 18.

RANGE: Mallory (1959) gives range as late Ynezian through late Narizian.

ECOLOGY: Along the East Pacific Margin, *Pleurostomella acuta* has an upper depth limit in the lower bathyal biofacies, 1500-2000 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1, Tme)

Pleurostomella alternans Schwager

Pleurostomella alternans Schwager, 1866, Novara Exped., Geol. Theil, Bd. 2, Abt. 2, p. 238, pl. 6, figs. 79-80.

Pleurostomella cf. *P. elliptica* Galloway - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 23, pl. 4, figs. 1a,b.

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1)

Pleurostomella cubensis Cushman and Bermudez

Pleurostomella cubensis Cushman and Bermudez, 1936, Mem. Soc. Cubana Hist. Nat., v. 10, p. 294, pl. 17, figs. 7, 8.

Pleurostomella gredalensis Cook

Pleurostomella gredalensis Cook in Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 218, pl. 18, fig. 15; pl. 35, fig. 3a,b.

COMMENTS: Morphologically this species is very similar to *P. nuttalli.*

RANGE: *Pleurostomella gredalensis* is reported by Mallory (1959) in the upper Ynezian of Media Agua Creek section.

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1)

Pleurostomella nuttalli Cushman and Siegfus

Pleurostomella nuttalli Cushman and Siegfus, 1939, Contr. Cushman Lab. Foram. Res., v. 15, p. 29, pl. 6, figs. 17, 18.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 24, pl. 4, fig. 2a,b..

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 219, pl. 18, fig. 16.

RANGE: *Pleurostomella nuttalli* ranges from the early Bulitian through early Narizian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Pleurostomella nuttalli* has an upper depth limit in the lower bathyal biofacies, 1500-2000 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1)

Pleurostomella subnodosa Reuss

Pleurostomella subnodosa Reuss, 1860, K. Akad. Wiss. Wien Math.-Naturw. Cl., Sitzber., Wien, Osterrich, Bd. 40, p. 204, pl. 8, fig. 2.

***Pleurostomella* sp.** of Graham and Classen

Pleurostomella sp. of Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 24, pl. 4, fig. 3a,b.

Praeglobobulimina pupoides (d'Orbigny)

Bulimina pupoides d'Orbigny, 1846, Foraminiferes fossiles du bassin tertiaire de Vienne (Autriche), Paris, France, Gide et Comp., p. 185, pl. 11, figs. 11-12.

- - Cushman and Parker, 1946, U.S. G. S. Prof. Paper 210-D, p. 105-106, pl. 25, figs. 3-7.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 195, pl. 28, fig. 16a,b,c; pl. 36, fig. 17a,b,c.

RANGE: *Praeglobobulimina pupoides* ranges from the early Penutian through late Narizian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Praeglobobulimina pupoides* has an upper depth limit in the upper bathyal biofacies, 150-500 m (Ingle, 1980).

OCCURRENCE: Lodo Gulch; Loma Prieta Quad. (Te_1, Tme)

Pseudonodosaria conica (Neugeboren)

Glandulina conica Neugeboren, 1850, Siebenb. ver. Naturw. Hermannstadt, Verh. Mitt., Hermanstadt, v. 1, p. 51, pl. 1, fig. 5a,b.

Pseudoglandulina conica (Neugeboren) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 173, pl. 33, fig. 4, pl. 36, fig. 11a,b.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 87.

RANGE: Pseudonodosaria conica ranges from late Ynezian through late Narizian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1)

Pseudonodosaria inflata (Bornemann)

Glandulina inflata Bornemann, 1855, Deutsch. Geol. Ges., Zeitschr., Berlin, v. 7, p. 320, pl. 12, figs. 6-7.
Pseudonodosaria inflata (Costa) - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 37.
OCCURRENCE: Laurel Quad. (Te_1, Tsl); Loma Prieta Quad. (Te_1, Tme, Tsl)

Pseudonodosaria ovata (Cushman and Applin)

Nodosaria (Glandulina) laevigata d'Orbigny *ovata* Cushman and Applin, 1926, AAPG, Bull, v. 10, p. 169, pl. 7, figs. 12, 13.
Pseudonodosaria ovata (Cushman and Applin) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 16, pl. 2, fig. 40.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 174.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 88.

ECOLOGY: Along the East Pacific Margin, *Pseudonodosaria ovata* has an upper depth limit in the upper middle bathyal biofacies (Ingle, 1980).

Pullenia eocenica Cushman and Siegfus

Pullenia eocenica Cushman and Siegfus, 1939, Contr. Cushman Lab. Foram. Res., v. 15, p. 31, pl. 7, fig. 1a,b.
- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 27, pl. 4, fig. 16a,b.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 246, pl. 30, fig. 4a,b.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Publ., no. 4, p. 36, pl. 16, fig. 2.

RANGE: *Pullenia eocenica* is common from early Eocene zone P9 through late Eocene P17 with rare occurrences as old as P6a (late Paleocene) (Tjalsma and Lohmann, 1983). *Pullenia eocenica* ranges late Bulitian through late Narizian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Pullenia eocenica* has an upper depth limit in the upper middle bathyal biofacies, 500-1500 m (Ingle, 1980).
OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1, Tme)

Pullenia quatriloba (Sequenza)

Nonionina quatriloba Sequenza, 1880, R. Accad. Lincei, Rome, Cl. Sci. Fis., Mat., Nat., Riem., Roma, Italia, ser. 3, v. 6, p. 430, pl. 17, fig. 15.

Pullenia quinqueloba (Reuss)

Nonionina quinqueloba Reuss, 1851, Deutsch. Geol. Ges., Zeitschr., Berlin, v. 3, p. 71, pl. 5, fig. 31.
Pullenia quinqueloba (Reuss) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 27, pl. 4, fig. 17a,b.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 246, pl. 34, fig. 1a,b.
- - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 36, pl. 16, fig. 2.

RANGE: *Pullenia quinqueloba* ranges from the late Ynezian through early Narizian (Mallory, 1959).
ECOLOGY: Ingle (1980) gives the upper depth limit of this species as in both outer shelf and upper middle bathyal biofacies. The upper middle bathyal depth is used in this paper.
OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1)

Pullenia salisburyi Stewart and Stewart

Pullenia salisburyi Stewart and Stewart, 1930, Jour. Paleo., v. 4, p. 72, pl. 8, fig. 2.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 188, pl. 28, fig. 11.
RANGE: *Pullenia salisburyi* ranges from the Narizian into younger strata (Mallory, 1959; McDougall, 1980).
ECOLOGY: Along the East Pacific Margin, *Pullenia salisburyi* has an upper depth limit in the outer shelf biofacies, 50-150 m (Ingle, 1980).
OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1); Pacheco Syncline (Las Juntas)

Pyrulina cylindroides (Roemer)

Polymorphina cylindroides Roemer, 1853, Neues Jahrb. Min. Geogn. Geol. Petref.-Kund, p. 385, pl. 3, fig. 26a,b.
Pyrulina cylindroides (Roemer) - - McDougall, 1980, SEPM Paleo. Monograph, no. 2, p. 37.
Pyrulina sp. - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 17, pl. 3, fig. 2a,b.
OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1)

Quadrimorphina allomorphinoides (Reuss)

Quadrimorphina allomorphinoides (Reuss) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 245, pl. 22, fig. 5a,b,c; pl. 34, fig. 2a,b,c.
Quadrimorphina advena (Cushman and Siegfus) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 28, pl. 4, fig. 18a,b,c.
OCCURRENCE: Lodo Gulch

Quinqueloculina cf. *Q. josephina* d'Orbigny

COMMENTS: Specimen extremely worn but probably is *Q. josephina*. (see Mallory, 1959, p. 130, pl. 39, fig. 6a,b,c).

Quinqueloculina triangularis d'Orbigny

Quinqueloculina triangularis d'Orbigny - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 155, pl. 19, fig. 7.
RANGE: *Quinqueloculina triangularis* is restricted to the late Ulatisian (Mallory, 1959).
ECOLOGY: Along the East Pacific Margin, *Quinqueloculina triangularis* has an upper depth limit in the inner shelf biofacies (Ingle, 1980).
OCCURRENCE: Pacheco Syncline (Vine Hill Sandstone)

Quinqueloculina yequaensis Weinzierl and Applin

Quinqueloculina yequaensis Weinzierl and Applin, 1929, Jour. Paleo. v. 3, p. 393, pl. 44, fig. 4a,b.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 131, pl. 5, fig. 12a,b.

Quinqueloculina sp. - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 8, pl. 1, figs. 23a,b.

Ramulina globulifera Brady

Ramulina globulifera Brady, 1879, Quart. Jour. Micr. Sci. London, England, N.S., v. 19, p. 272, pl. 8, figs. 32-33.

Ramulina cf. *R. globulifera* Brady - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 18, pl. 3, fig. 3.

Reussella elongata (Terquem)

Reussella cf. *R. elongata* (Terquem) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 203, pl. 16, fig. 26.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 114.

Bulimina minsseni Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 194, pl. 15, fig. 17.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 108, pl. 6, fig. 11.

COMMENTS: *Bulimina minsseni* Mallory appears to be a well preserved *Reussella elongata* whereas specimens assigned to *Reussella elongata* are poorly preserved. Both species have approximately the same range and types are from the same samples.

RANGE: Both *Reussella* cf. *R. elongata* and *Bulimina minsseni* range from the Bulitian to Penutian (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Rhabdammina eocenica Cushman and Hanna

Rhabdammina eocenica Cushman and Hanna, 1927, Calif. Acad. Sci. Proc., 4th ser., v. 16, p. 209, pl. 13, fig. 3.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 104, pl. 1, figs. 1-2; pl. 27, fig. 1.
- - Smith, 1971, Univ. Calif. Publ. Geol. Sci., v. 91, p. 23.

Rhabdammina sp. - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 148, pl. 17, fig. 3 (in part).

ECOLOGY: Along the East Pacific Margin, *Rhabdammina eocenica* has an upper depth limit in the upper middle bathyal biofacies, 1500-2000 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1, Tme, Tbs, Tsl); Pacheco Syncline (Vine Hill Sandstone)

Silicosigmoilina californica Cushman and Church

Silicosigmoilina californica Cushman and Church, 1929, Calif. Acad. Sci. Proc., 4th ser., v. 18, p. 502, pl. 36, figs. 10-12.
- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 10, pl. 1, fig. 32.
- - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 155, pl. 19, figs. 8 and 12.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 129.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 50.

COMMENTS: *Silicosigmoilina californica* is probably a junior synonym of *Rzehakina epigona* (Rzehak). Sliter (1968) seperates these species in the Cretaceous and lists several differences between the two species: *S. californica* is larger, less circular in outline and has sigmoidal chambers and an apertural tooth.

RANGE: The range of *Rzehakina epigona* is late Cretaceous (Campanian through early Eocene (P9) doubtful occurrence in middle Eocene zones P10 through P13 (van Morkhoven and others, 1983). The range of *Silicosigmoilina californica* given by Mallory is Ynezian through Narizian and it is most characteristic of the Paleocene. Almgren and others (1988) give range as zones D through A-2 which is equivalent to nannofossil zone CP4 through CP14 (planktic foraminiferal zones P4 thorugh P14). Only rare or questionable occurrences of *S. californica* are noted in zone A-2 (P10-P14) (Almgren and others, 1988).

ECOLOGY: *Rzehakina epigona* is common in bathyal and abyssal environments (van Morkhoven and others, 1986).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (?Ku_1, Te_1, Te_2, Tme, Tbs); Pacheco Syncline (Vine Hill Sandstone and Las Juntas)

Siphonodosaria aculeata (Cushman and Renz)

Ellipsonodosaria nuttalli Cushman and Jarvis var. *aculeata* cushman and Renz, 1948, p. 32, pl. 6, fig. 10.

Stilostomella aculeata (Cushman and Jarvis) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 36, pl. 14, fig. 12

RANGE: *Siphonodosaria aculeata* first appears in the early Eocene (P7) and ranges into younger strata; it is particularily abundant in the Atlantic in zone P11 through P14 (Tjalsma and Lohmann, 1983).

Siphonodosaria gracillima (Cushman and Jarvis)

Ellipsonodosaria nuttalli Cushman and Jarvis *gracillima* Cushman and Jarvis, 1934, Cushman Lab. Foram. Res., v. 10, p. 72, pl. 10, fig. 7.

Stilostomella gracillima (Cushman and Jarvis) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 36, pl. 14, figs. 13-15.

Siphonodosaria cf. *S. cocoaensis* (Cushman) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 21, pl. 3, fig. 27.

RANGE: *Siphonodosaria gracillima* ranges from the early Eocene (P9) to late Eocene (P15) and it is particularily abundant in P11 (Tjalsma and Lohmann, 1983).

ECOLOGY: *Siphonodosaria gracillima* is restricted to the "shallow" Atlantic sites of Tjalsma and Lohmann (1983), i. e., 800-1800 m.

Siphonodosaria subspinosa (Cushman)

Ellipsonodosaria subspinosa Cushman, 1943, Cushman Lab. Foram. Res., Contr., v. 19, p. 92, pl. 16, figs. 6, 7.

Stilostomella subspinosa (Cushman) - - Tjalsma and Lohmann, 1983, Micropaleo., Spec. Pub., no. 4, p. 36, pl. 14, figs. 16-17.

Siphonodosaria sp. - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 21, pl. 3, fig. 32.

RANGE: *Siphomodosaria subspinosa* is rare in the middle Eocene (P10) but common in the late Eocene (Tjalsma and Lohmann, 1983).

Siphonia wilcoxensis

Siphonia wilcoxensis Cushman, 1927, U.S. Nat. Mus. Proc., v. 72, art. 20, p. 3, pl. 2, figs. 1-3.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 242, pl. 21, fig. 9a,b,c, pl. 33, fig. 14a,b,c.

COMMENTS: The only differences between *S. wilcoxensis* and *S. jacksonensis* appears to be the number of chambers (*S. wilcoxensis* = 6; *S. jacksonensis* = 5). *Siphonia jacksonensis* has seniority. The drawing also shows *S. jacksonensis* as fatter with a very rounded and although a keel is mentioned it is not shown in the drawing. *Siphonia wilcoxensis* is unequally biconvex.

RANGE: *Siphonia wilcoxensis* ranges from early Ynezian to late Penutian (Mallory, 1959)

Spiroloculina* cf. *S. lamposa Hussey

Spiroloculina cf. *S. lamposa* Hussey - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 155, pl. 18, fig. 11a,b.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 131, pl. 5, fig. 13a,b; pl. 36, fig. 6a,b.

Spiroloculina sp. - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 9, pl. 1, fig. 24.

Spiroloculina texana Cushman and Ellisor

Spiroloculina texana Cushman and Ellisor, 1944, Cushman Lab. Foram. Res., Contr., v. 20, p. 51, pl. 8, figs. 14-15.

Spiroloculina sp. - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 9, pl. 1, fig. 24.

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1, Tme)

Spiroplectammina directa (Cushman and Siegfus)

Spiroplectoides directa Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 15, p. 26, pl. 6, figs. 7-8.

Spiroplectammina directa (Cushman and Siegfus) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 116, pl. 3, fig. 5a,b.

Spiroplectammina sp. - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 7, pl. 1, figs. 14, 15, 16.

COMMENTS: *Sprioplectammina directa* is probably a junior synonym of *S. specialis* which ranges from the Cretaceous to late middle Eocene planktic foraminiferal zone P14 (approximately 40 Ma, Gradstein and others, 1988).
RANGE: *Spiroplectammina directa* occurs in the Ulatisian and Narizian Stages (Mallory, 1959). This species has, however, been found in early Eocene assemblages in association with calcareous nannofossil assemblages which are diagnostic of zone CP11 (early Eocene planktic foraminiferal zones late P8 and P9) (McDougall and Bukry, unpub. data, 1988).
OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1, Tme, Tsl)

Spiroplectammina richardi Martin

Spiroplectammina richardi Martin, 1943, Stanford Univ. Publ. Geol. Sci., v. 3, p. 14, pl. 5, fig. 3a,b.
- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 118, pl. 3, fig. 9; pl. 27, fig. 5.
- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 38.
Spiroplectammina? cf. *S. richardi* Martin - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 118, pl. 3, fig. 10.
Spiroplectammina adamsi Lalicker - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 7, pl. 1, fig. 13.
Textularia mississippiensis (Cushman) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 151-152, pl. 18, figs. 1-3.
COMMENTS: *Spiroplectammina*? cf. *S. richardi* of Mallory (1959) is from the lower Point of Rocks in the Media Agua Creek Section. This form is a variation of the type; additional specimens have been identified from lower in the Lodo Formation at Media Agua Creek (Cox material).
RANGE: *Spiroplectammina richardi* ranges from the early Bulitian through early Narizian. Almgren and others (1988) give the range of *Spiroplectammina gryzbowski* as zones E through A-2 which is equivalent to nannofossil zones CP4 through CP14 (planktic foraminiferal zones P4 through P14).
ECOLOGY: Along the East Pacific Margin, *Spiroplectammina richardi* has an upper depth limit in the outer shelf biofacies, 50-150 m (Ingle, 1980).
OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1); Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Muir, Alhambra); Media Agua Creek (Lodo Formation, Cox samples)

Stilostomella adolphina (d'Orbigny)

Dentalina adolphina d'Orbigny, 1846, Foraminiferes fossile du bassin tertiaire de Vienne (Autriche), Gide et Comp., Paris, France, p. 51, pl. 2, figs. 18-20.
Nodogenerina adolphina (d'Orbigny) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 216, pl. 18, fig. 8; pl. 41, fig. 10.
Ellipsonodosaria nuttalli gracillima Cushman and Jarvis - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 180, pl. 25, figs. 8, 11.
ECOLOGY: Along the East Pacific Margin, *Stilostomella adolphina* has an upper depth limit in the lower middle bathyal biofacies (Ingle, 1980).
OCCURRENCE: Pacheco Syncline (Vine Hill Sandstone, Las Juntas, Muir; Smith, 1957)

Stilostomella advena (Cushman and Siegfus)

Nodosarella advena Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 15, p. 30, pl. 6, figs. 19, 20.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 220, pl. 18, fig. 22a,b; pl. 29, fig. 12a,b.

RANGE: *Stilostomella advena* ranges from the early Ulatisian through early Narizian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Stilostomella advena* has an upper depth limit in the lower middle bathyal biofacies, 1500-200 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Stilostomella gracilis (Palmer and Bermudez)

Ellipsonodosaria gracilis Palmer and Bermudez, 1936, Soc. Cubana Hist. Nat. Mem., v. 10, p. 296, pl. 18, figs. 18-19.

Siphonodosaria gracilis (Palmer and Bermudez) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 21, pl. 3, figs. 28, 19.

OCCURRENCE: Loma Prieta Quad. (Te_1 cf.)

Stilostomella lepidula (Schwager)

Nodosaria lepidula Schwager, 1866, Wien Osterreich, Geol. Theil., Bd. 2, Abt. 2, p. 210, pl. 5, figs. 27-28.

Nodogenerina lepidula (Schwager) - - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 217, pl. 18, fig. 10.

RANGE: Stilostomella lepidula ranges from the late Ulatisian through late Narizian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Stilostomella lepidula* has an upper depth limit in the lower middle bathyal biofacies, 1500-2000 m (Ingle, 1980).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Textularia adalta Cushman

Textularia adalta Cushman, 1926, Cushman Lab. Foram. Res., Contr., v. 2, p. 29, pl. 4, fig. 2.

- - McDougall, 1980, SEPM, Paleo. Monograph, no. 2, p. 37.

Textularia cf. *T. adalta* Cushman - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 51, pl. 18, fig. 5.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 119.

RANGE: *Textularia adalta* ranges from the early Ynezian through early Narizian (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad. (Te_1); Laurel Quad (Te_1)

Trifarina advena californica Mallory

Trifarina advena californica Mallory, 1959, p. 210-211, pl. 17, fig. 14a-d; pl. 29, fig. 6a,b,c; pl. 40, fig. 11a,b.

Trifarina wilcoxensis (Cushman and Ponton)

Pseudouvigerina wilcoxensis Cushman and Ponton, 1932, Cushman Lab. foram. Res., Contr., v. 8, p. 66, pl. 8, fig. 18.

Angulogerina wilcoxensis (Cushman and Ponton) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 179, pl. 25, fig. 9.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 211, pl. 37, fig. 6.

- - Mallory, 1970, Burke Museum Res. Rept., no. 2, p. 117, pl. 8, fig. 5.

COMMENTS: Criteria used to separate this species from *T. advena californiensis* include the presence of two distinct ribs at each corner angle and a channel between. Also chambers in *T. wilcoxensis* are more lobate and do not form the smooth sides as seen in *T. advena californiensis.*

RANGE: *Trifarina wilcoxensis* ranges late Bulitian through early Penutian with a questionable occurrence in the late Ulatisian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Trifarina wilcoxensis* has an upper depth limit on the outer shelf biofacies and is transitional to upper bathyal biofacies (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch

Tritaxilina colei Cushman and Siegfus

Tritaxilina colei Cushman and Siegfus, 1935, Cushman Lab. Foram. Res., Contr., v. 11, p. 92, pl. 14, figs. 5-6.

- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 10, pl. 1, figs. 30, 31.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 128, pl. 27, fig. 9a,b.

Massonella oxycona (Reuss) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 9, fig. 28a,b.

COMMENTS: *Tritaxilina colei* and *Tritaxilina indentata* (= *Gaudryina indentata* Cushman and Jarvis) which is commonly used in European literature to describe the Paleogene *Tritaxilina* are similar. *Tritaxilina indentata* which was described from late Cretaceous sediments in Trinidad, has the middle portion of each adult chamber (biserial chamber) indented and the sutures raised in rounded ridges. These characteristics are probably related to environmental and preservational factors rather than evolution. Many of the European specimens do not exhibit this feature thus European references to *T. indentata* in the Paleogene are placed in synonmy with *T. colei.*

RANGE: *Triaxilina colei* ranges from the late Ynezian through late Narizian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Loma Prieta Quad. (Te_1, Tme)

Trochammina globigeriniformis (Parker and Jones)

Lituola globigeriniformis Parker and Jones, 1865, R. Soc. London Philos. Trans., v. 155, p. 407, pl. 15, figs. 46-47.

Trochammina globigeriniformis (Parker and Jones) - - McDougall, 1980, SEPM, Paleo. Monograph, no. 2, p. 38.

Trochammina cf. *T. globigeriniformis* (Parker and Jones) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 156, pl. 19, fig. 14-16.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 133, pl. 5, fig. 16.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 51.

?*Trochammina* sp. - - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 10, pl. 1, figs. 33, 34.

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1, Te_2; Tsl)

Trochamminoides contortus Mallory

Trochamminoides contortus Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 110, pl. 2, fig. 1a,b.

RANGE: *Trochamminoides contortus* ranges late Bulitian through early Narizian with questionable occurrences in the late Ynezian (Mallory, 1959).

OCCURRENCE: Loma Prieta Quad. (Te_1)

Uvigerina alabamensis Cushman and Garrett

Uvigerina alabamensis Cushman and Garrett, 1939, Cushman Lab. Foram. Res., Contr., p. 83, pl. 14, figs. 26, 27.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 206, pl. 29, fig. 5a,b,c.

Uvigerina garzaensis Cushman and Siegfus

Uvigerina garzaensis Cushman and Siegfus, 1939, Cushman Lab. Foram. Res., Contr., v. 15, p. 28, pl. 6, fig. 15a,b.

- - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 22, pl. 3, fig. 34.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 208, pl. 37, fig. 2a,b.

COMMENTS: *Uvigerina garzaensis* and *Uvigerina hispida* are probably synonyms. *Uvigerina hispida* is presently restricted to the late Tertiary (Boersma, 1984).

RANGE: *Uvigerina garzaensis* ranges from the early Narizian into the Refugian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Uvigerina garzensis* has an upper depth limit in the lower bathyal biofacies (Ingle, 1980).

OCCURRENCE: Lodo Gulch

Uvigerina lodoensis miriamae Mallory

Uvigerina lodoensis miriamae Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 209, pl. 17, figs. 8-9; **not** pl 40, fig. 9.

Uvigerina spp. Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 179, pl. 25, fig. 10, **not** pl. 26, fig. 3.

RANGE: Mallory (1957) gives range of *Uvigerina lodoensis miriamae* as Penutian through Ulatisian. Specimens occur in the Penutian of Media Agua Creek (Cox sample BT-142-2, CP10, Bukry, unpub. data, 1989; Mallory, 1959, pl. 17, figs. 8, 9), and the Pacheco Syncline (A6662, CP10/CP11, Bukry, 1988, pl. 25, figs. 10 and 12 of

Smith, 1957). These specimens occur with nannofossils charateristic of early Eocene zones CP10 and CP10/CP11 undifferentiated (Bukry, unpub. data, 1988 and 1989) equivalent to late P7 to P9. This range agrees closely with the range noted by King (1989) for *Uvigerinella abbreviata* in the North Sea. *Uvigerinella abbreviata* (Terquwm) ranges from NSB3a to 3b (equivalent to late P6b to early P9) in the North Sea and to the middle Eocene in the onshore sequences (King, 1989). The range of *U. lodoensis miriamae* in California appears to continue into younger strata as it has been observed in the "Poppin Shale" sample (DDM-14-89, McDougall, unpub. data, 1989) which is early Ulatisian (CP12a, Bukry, unpub. data, 1989, *i.e.* planktic foraminiferal zone P10). The Ulatisian specimen figured by Mallory (1959, pl. 40, fig. 9) has convolute sutures and does not appear to be as triangular in outline as the Penutian specimens. Smith (1957) included several different species under *Uvigerina* spp. and thus the stratigraphic range of *Uvigerina lodoensis miriamae* is difficult to determine. Other Ulatisian occurrences given by Mallory have not be confirmed.

OCCURRENCE: Loma Prieta Quad. (Te_1); Laurel Quad. (Te_1); Lodo Gulch; Pacheco Syncline (Las Juntas); Media Aqua Creek, Lodo Formation (Cox); "Poppin Shale" (McLaughlin sample DDM-14-89)

Uvigerina yazooensis Cushman

Uvigerina yazooensis Cushman, 1933, Cushman Lab. Foram. Res., Contr., v. 9, p. 13, pl. 1, fig. 29.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 210, pl. 37, fig. 4a,b.

- - Boersma, 1984, p. 189-191, figs. 1-3 on p. 189.

RANGE: In California, *Uvigerina yazooensis* is restricted to the late Narizian (Mallory, 1959). Worldwide, *Uvigerina yazooensis* ranges from the middle Eocene through early Oligocene. It first appears in P9 in North Africa, P14 in western Africa and P15 (late Eocene) in the Caribbean and Gulf Coast where it ranges into the early Oligocene (P18) (Boersma, 1984).

ECOLOGY: *Uvigerina yazooensis* has an upper depth limit in the upper bathyal biofacies (Ingle, 1980).

Vaginulinopsis asperuliformis (Nuttall)

Cristellaria asperuliformis Nuttall, 1930, Jour. Paleo., v. 4, p. 282, pl. 23, figs. 9, 10.

Vaginulinopsis asperuliformis (Nuttall) - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 17, pl. 2, figs. 46, 47, 48.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 155, pl. 27, fig. 20a,b.

RANGE: Mallory (1959) gives range as late Bulitian through early Narizian. Almgren and others (1988) give range as zone C through A-2 (rare) which correspond to nannofossil zones CP9 through CP14 (planktic foraminiferal zones P6b-P14).

ECOLOGY: Along the East Pacific Margin, *Vaginulinopsis asperuliformis* has an upper depth limit in the outer shelf biofacies, 50-150 m (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1); Media Agua Creek (Lodo formation, Cox samples)

Vaginulinopsis saundersi (Hanna and Hanna)

Cristellaria saundersi Hanna and Hanna, 1924, Univ. Washington Pub. Geol. Sci., v. 1, p. 61, pl. 13, figs. 5, 6, 15.

Vaginulinopsis saundersi (Hanna and Hanna) - - Smith, 1957, Univ. Calif. Publ. Geol. Sci., v. 32, p. 162, pl. 22, figs. 1-2.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 157, pl. 11, fig. 10.

- - Mallory, 1970, Burke Museum, Res. Rept., no. 2, p. 74, pl. 4, fig. 13.

RANGE: Almgren and others (1988) give range as zones B-4 through B-2 which is equivalent to nannofossil zones CP10 through CP11 (planktic foraminiferal zones late P7-P9).

OCCURRENCE: Laurel Quad. (Te_1, Tsl); Lodo Gulch; Loma Prieta Quad. (Te_1)

Valvulineria jacksonensis welcomensis Mallory

Valvulineria jacksonensis welcomensis Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 231, pl. 20, figs. 3a,b,c; 5a,b,c.

RANGE: *Valvulineria jacksonensis welcomensis* ranges from the early Narizian through Refugian (Mallory, 1959; McDougall, 1980).

Valvulineria tumeyensis Cushman and Simonson

Valvulineria tumeyensis Cushman and Simonson, 1944, Jour. Paleo., v. 18, p. 201, pl. 33, figs. 13, 14.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 232.

RANGE: *Valvulineria tumeyensis* ranges from the early Narizian through the Refugian (Mallory, 1959; McDougall, 1980).

Valvulineria wilcoxensis Cushman and Ponton

Valvulineria wilcoxensis Cushman and Ponton, 1932, Cushman Lab. Foram. Res., Contr. v. 8, p. 70, pl. 9, figs. 6a,b,c.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 233, pl. 20, fig. 4a,b.

RANGE: *Valvulineria wilcoxensis* ranges from the Bulitian through the early Ulatisian with a questionable occurrence in the late Ynezian (Mallory, 1959).

Verneuilina triangulata Cook

Verneuilina triangulata Cook in Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 120, pl. 4, fig. 1a,b,c; pl. 33, fig. 1a,b.

Clavulinoides sp. - - Graham and Classen, 1955, Cushman Found. Foram. Res., Contr., v. 6, p. 8, pl. 1, fig. 20a,b, and 21a, b.

RANGE: *Verneuilina triangulata* is restricted to the early Penutian (Mallory, 1959).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1)

Vulvulina curta Cushman and Siegfus

Vulvulina curta Cushman and Siegfus, 1935, Cushman Lab. Foram. Res., Contr., v. 11, p. 91, pl. 14, figs. 1, 2.

- - Graham and Classen, 1955, Contr. Cushman Found. Foram. Res., v. 6, p. 8, pl. 1, fig. 19.

RANGE: *Vulvulina curta* ranges from the late Ynezian through late Narizian (Mallory, 1959).

ECOLOGY: Along the East Pacific Margin, *Vulvulina curta* has an upper depth limit in the lower middle bathyal biofacies (Ingle, 1980).

OCCURRENCE: Laurel Quad. (Te_1); Lodo Gulch; Loma Prieta Quad. (Te_1, Te_2)

Zeauvigerina lodoensis Martin

Zeauvigerina lodoensis Martin, 1943, Stanford Univ. Pub. Geol. Sci., v. 3, p. 21, pl. 5, fig. 1a,b,c.

- - Mallory, 1959, Lower Tertiary Biostratigraphy of the California Coast Ranges, AAPG, p. 211-212.

RANGE: Mallory (1959) reports three occurrences of this species: late Ynezian (Media Aqua Creek), early Penutian (Lodo Gulch), and early Narizian (in range chart but Ulatisian of Devils Den, p. 212). The late Ynezian occurrence has been interpreted as early Eocene and assigned to planktic foraminiferal zone P6b; the Lodo Gulch occurrence is within planktic zone P8; and the Devils Den occurrence is not documentd, however the Gredal Shale Member in the Devils Den section ranges from P8 to P10 (Berggern and Aubert, 1983). The range of *Zeauvigerina lodoensis* is tentantly considered to be early to early middle Eocene, planktic foraminiferal zones P6b through P10.