Miocene Gastropods and Biostratigraphy of the Kern River Area, California

By W. O. ADDICOTT

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Systematic description and stratigraphic distribution of 182 early and middle Miocene gastropod taxa

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MIOCENE GASTROPODS AND BIOSTRATIGRAPHY OF THE KERN RIVER AREA, CALIFORNIA

By W. O. Addicott

ABSTRACT

Miocene strata were first recognized in California on the basis of mollusks collected from the Kern River area in the southern part of the San Joaquin Valley by William Blake during the Pacific Railroad surveys of more than 100 years ago. Description of the gastropod-rich Barker's Ranch fauna from exposures along Kern River northeast of Bakersfield by later workers led to the use of this fauna as the standard for middle Miocene correlation on the Pacific coast.

Marine formations of early and middle Miocene age are exposed in the Kern River area. Faunal assemblages from the subsurface Vedder Sand of this area and from exposures of the overlying Jewett Sand are referred to the "Vaqueros Stage," the early Miocene part of the Pacific coast megainvertebrate chronology of Weaver and others (1944). A few long-ranging mollusks occur in the overlying Freeman Silt. Foraminifera from this formation are indicative of an early Miocene age. Mollusks from the Olcese Sand and the overlying Round Mountain Silt form the faunal basis for recognition of the "Temblor Stage," a unit long regarded as the middle Miocene provincial megafaunal standard. Mollusks of late Miocene age are not known to occur in surface exposures in the Kern River area, although several assemblages have been reported from well cores of the Santa Margarita Formation in oil-field areas a few miles west of the lower and middle Miocene exposures.

Formational nomenclature for the Miocene sequence was originated during early exploratory and development drilling for petroleum in the Round Mountain-Mount Poso area, principally from subsurface data. Most of these units, though locally applicable in surface mapping, have not been adequately defined. Accordingly, formal description and review of the Miocene formations is undertaken to facilitate biostratigraphic characterization of the Miocene sequence.

The fauna of the lower part of the Jewett Sand, the lowest exposed marine formation in the Kern River area, includes 46 gastropod taxa, many of which are newly described herein. Almost half of these taxa do not occur higher in the local section. In most of the upper part of the formation, mollusks are widely scattered, but there are a few oyster biostromes near the top which contain *Ostrea eldridgei yneziana* and scattered *Chlamys hertleini*, a pectinid restricted to the "Vaqueros Stage." Important "Vaqueros" index species in the Jewett Sand include the gastropods *Turritella inezana*, *Ocenebra milicentana*, and *Epitonium clallamense* and the pelecypods *Lyropecten magnolia* and *Ostrea vaquerosensis*. Cores of the overlying Freeman Silt contain an assemblage characterized by the small pelecypods *Acila conradi*, *Cyclocardia subtenta*, and *Nuculana ochsneri*. Also occurring with this assemblage is the gastropod *Priscofusus medialis*, which seems to be restricted to the Jewett Sand and Freeman Silt. The small subsurface molluscan assemblages from the Freeman Silt are not diagnostic of position in the provincial megainvertebrate sequence, but indirect evidence from foraminiferal assemblages is suggestive of an early Miocene age.

Molluscan assemblages from the lower part of the overlying Olcese Sand, although relatively small, are similar to those from higher in the Olcese Sand and from the overlying Round Mountain Silt. Gastropods restricted to the "Temblor Stage" that make their initial appearance in the lower part of the Olcese Sand include *Crepidula rostralis*, *Megasurcula howei*, and *Ophiodermella temblorensis*. The gastropod fauna of the Olcese Sand and Round Mountain Silt consists of 157 taxa, about one-third of which are described herein as new. A significant number of the gastropods, about 15 percent, are stratigraphically restricted and of sufficiently widespread occurrence in the California Coast Ranges to be considered as useful index species. Moreover, there are many widespread gastropod taxa with stratigraphic ranges that overlap with the limits of the "Temblor Stage."

Scattered records of megainvertebrates from subsurface cores of the Santa Margarita Formation basinward from the lower and middle Miocene exposures of the Kern River area are indicative of an assemblage that includes several middle Miocene relicts. There is also an element with recorded ranges of Pliocene to Holocene, and this joint occurrence, together with records of the stratigraphically restricted gastropod *Nassarius pabloensis* and the pelecypod *Aequipecten discus*, provides evidence for a late Miocene age in the provincial chronology.

INTRODUCTION

Marine Miocene strata were first recognized in California on the basis of invertebrate fossils collected by Blake from the Kern River-Poso Creek area northeast of Bakersfield, Calif. (fig. 1) during the Pacific Railroad surveys (Blake, 1855). These fossils formed the nucleus of the so-called Barker's Ranch fauna, a gastropod-rich sublittoral molluscan fauna that has proved to be the largest, most diverse pre-Pliocene faunal unit of the Pacific Coast States. This fauna serves as the standard of reference (Anderson, 1905, p. 190–191) for the "Temblor Stage"[1] of the Pacific coast megafossil chronology, a provincial time-stratigraphic unit

[1] Quotation marks are used herein to signify that the stages of the Pacific coast megafossil sequence of Weaver and others (1944) have not been formally defined and to differentiate them from rock-stratigraphic units bearing the same name.

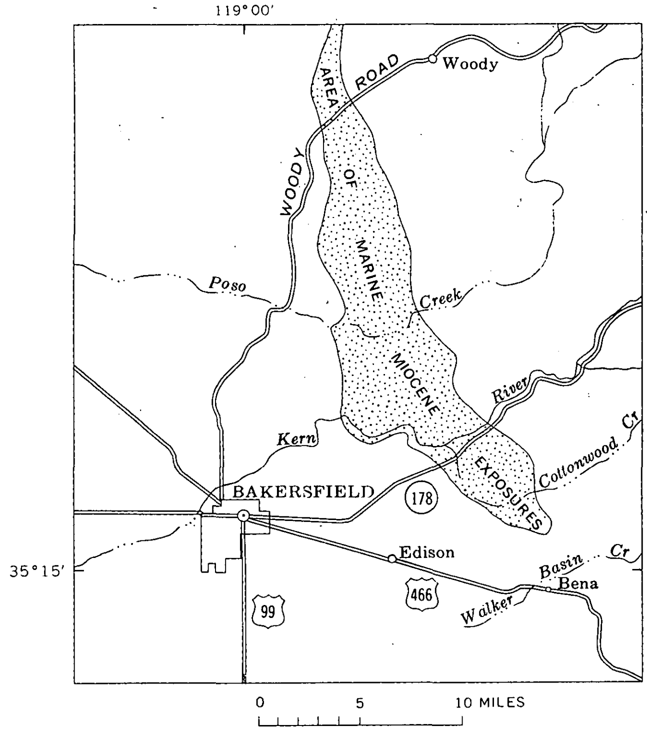

FIGURE 1.—Index map of the Kern River-Poso Creek area, Kern County, Calif., showing places referred to in text and generalized distribution of marine Miocene exposures.

regarded as middle Miocene by most molluscan paleontologists. The early biostratigraphic-paleontologic studies of the Kern River Miocene (Anderson, 1905, 1911; Anderson and Martin, 1914) have proved to be inadequate for confident stratigraphic correlation. It is intended herein to provide an improved standard of reference for recognition and correlation of the "Temblor Stage" of the Pacific coast through presentation and discussion of the paleontologic findings and stratigraphic distribution of gastropods in this classic section and review of their stratigraphic occurrence in other Miocene sections along the Pacific coast.

Well-preserved gastropods of both early and middle Miocene age are abundant in exposed marine formations of the Kern River area. Gastropods were selected for inital paleontologic study rather than the pelecypods because of their greater abundance and therefore their seemingly greater utility in biostratigraphy. General aspects of pelecypod biostratigraphy were recently treated in another report (Addicott, 1965a). Fauna assemblages referable to the lower Miocene "Vaqueros Stage" include 46 gastropod taxa, many of which are described herein as new. The much larger middle Miocene fauna of the Olcese Sand and Round Mountain Silt, including the unusually well preserved Barker's Ranch fauna, consists of 157 gastropods. The combined early and middle Miocene faunas of the Kern River area available for this study consisted of 182 taxa, almost one-third of which are new.

CHRONOLOGY OF LITERATURE (ANNOTATED) DEALING WITH MIOCENE GASTROPODS OF THE KERN RIVER AREA

The principal reports that consider the molluscan paleontology of the Kern River area are reviewed in this section. (See "Stratigraphy" for reports containing stratigraphic data.) Specific attention is placed on gastropods described or identified from this area by earlier workers, although the list includes most of the reports dealing with pelecypods. Other contributions to the paleontologic knowledge of the Kern River area dealing with such groups as diatoms, Foraminifera, sharks and rays, birds, and marine mammals are summarized by Church (1958), Mitchell (1965), and Howard (1966).

1855. Blake, W. P. Collected first Miocene fossils from the Kern River area from the base of a 160-foot measured section [Olcese Sand] on Ocoya [Poso] Creek in 1853. Judged fossils to be of Miocene or Pliocene age. Sent field drawings and some specimens (poorly preserved casts) to T. A. Conrad for identification.

1855. Conrad, T. A. Described 12 new species of mollusks from field sketches and poorly preserved casts collected by W. P. Blake from rocks that are now mapped as the Olcese Sand. Fossils considered to be Miocene because of similarity of two large pectinids to species from the Miocene of Maryland.

1857. Conrad, T. A. Reprinted descriptions of mollusks described in 1855 with line drawings of each. Included are drawings of eight species of gastropods, most of which are unrecognizable because of the poor quality of illustrations.

1869. Gabb, W. H. Listed two gastropods from the vicinity of Poso Creek: *Agasoma gravida* and *Neverita recluziana*, including Conrad's *Natica ocoyana* as a synonym of the latter. Suggested that Conrad's *N. geniculata* might prove to be identical to *A. gravida*.

1894. Watts, W. L. Included a list of 26 mollusks identified by J. G. Cooper that were collected from Barker's Ranch and Rio Bravo Ranch along Kern River and from Pyramid Hill near Poso Creek. Included were nine species of gastropods, four of which were regarded as undescribed: *Agasoma*? n. sp., *Cerithium* n. sp., *Cancellaria* n. sp., and *Myorella* [?*Myurella*] n. sp.

1894. Cooper, J. G. Described two new species of gastropods from localities on Barker's Ranch: *Agasoma barkerianum* and *Agasoma*? (*Trophosycon*) *kernianum*.

1905. Anderson, F. M. Included a list of 46 species of Miocene mollusks from the Kern River area in a report on stratigraphy of the Temblor Range and southern Diablo Range on the west side of San Joaquin Valley. Thirteen of 23 gastropod taxa collected from strata near Barker's Ranch that are now included in the upper part of the Olcese Sand were described as new.

1906. Arnold, Ralph. Listed an assemblage of 28 mollusks collected from exposures about a mile west of the mouth of Kern River Gorge from strata now mapped as the lower part of the Round Mountain Silt. Included were 17 gastropods, six of which were considered to be undescribed.

1911. Anderson, F. M. Recognized and named three faunal zones in a 2,000-foot marine section exposed along Kern River. The lowest, Zone A, named from exposures at the base of the marine section at Pyramid Hill (sec. 14, T. 28 S., R. 29 E.), included an assemblage of 40 mollusks, seven of which were gastropods. The middle unit, Zone B, included faunal assemblages from the vicinity of Barker's Ranch (headquarters formerly in sec. 5, T. 29 S., R. 29 E.) in the upper part of the marine sequence. Half of the 46 mollusks recorded from this zone were gastropods. The gastropod names were the same as in his 1905 report except that *Cuma biplicata* Gabb [? = *Molopophorus anglonanus* Anderson] was added and *Agasoma sinuatum* Gabb was deleted. The highest faunal unit, Zone C, contained only eight mollusks including three gastropods. It occurs near the top of the Round Mountain Silt and includes the shark-tooth and marine-mammal-bone bed that occurs stratigraphically below the mollusk-bearing stratum.

1914. Anderson, F. M., and Martin, Bruce. Described additional Miocene mollusks from the Kern River area, increasing known fauna to 90 species. Twenty-five of the 33 newly described middle Miocene mollusks were gastropods.

1914. English, W. A. Figured and redescribed Cooper's *Trophosycon kernianum* and "*Agasoma*" *barkerianum* from the Kern River area.

1918. Clark, B. L. Described *Natica recluziana andersoni* from the Kern River area.

1928. Wiedey, L. W. Figured two specimens of *Turritella bösei* Hertlein and Jordan from a locality near Barker's Ranch.

1929. Clark, B. L. Refigured several of Anderson and Martin's middle Miocene gastropods (1914) from the Kern River area.

1931 Grant, U. S., and Gale, H. R. Included synonymies, descriptions, and taxonomic notes on several middle Miocene gastropods from the Kern River area. [Their report (p. 746) that Anderson believed "Blake's collecting locality was almost surely on Pyramid Hill" (Anderson's Zone A, early Miocene) seems doubtful because some of Blake's specimens represent species that have never been reported from lower Miocene strata; moreover, Blake's measured section near Depot Camp (1855), which includes the fossil locality, is clearly from the Olcese Sand.]

1932. Loel, Wayne, and Corey, W. H. First recognized strata of the lower Miocene "Vaqueros Stage" in the Kern River area. They listed a fauna of 27 mollusks from five localities. Eleven of these taxa were gastropods. Presented a generalized list of the "Fauna of the Temblor horizon" from the Kern River area. The list included 127 molluscan taxa, of which 75 were gastropods.

1937. Clark, Alex. Rediscovered Blake's (1855) original Miocene locality on Poso Creek, the type locality of *Turritella ocoyana* Conrad. Concluded that "*Natica*" *geniculata Conrad* is a prior name for *Bruclarkia barkeriana* (Cooper).

1937. Durham, J. W. Included four species from the Kern River area in a review of the Epitoniidæ of the Pacific coast. A new early Miocene species from near Pyramid Hill, *Epitonium* (*Cirsotrema*) n. sp. A, was recognized.

1938. Hanna, G. D., and Hertlein, L. G. Described *Megasurcula howei* and *Natica posuncula* from the Olcese Sand.

1939. Keen, A. M. A new species of *Typhis* (*Talityphis*) from the Round Mountain Silt was compared with a Miocene species from the Gatun Formation of Panama.

1941. Merriam, C. W. Figured and described three Turritellas from the Kern River Miocene: *Turritella ocoyana* Conrad, *T. moodyi* n. sp., and *T.* n. sp. (aff. *T. freya* or *vanvlecki*).

1941. Hanna, G. D., and Hertlein, L. G. Figured middle Miocene mollusks from F. M. Anderson's Zone B (1911). Included six characteristic gastropods.

1942. Weaver, C. E. Refigured types of five Miocene gastropods described from the Kern River area by Anderson (1905) and Anderson and Martin (1914).

1943. Keen, A. M. Identified an assemblage of 75 species of middle Miocene mollusks from the lower part of the Round Mountain Silt near the mouth of Kern River Gorge. Included were 53 species of gastropods, of which 17 small or minute species were described as new.

1963. Moore, E. J. Figured some middle Miocene gastropods from the Kern River area in a report on the Astoria Formation of Oregon.

1965a. Addicott, W. O. Reviewed Miocene molluscan biostratigraphy of the Kern River area. Noted that Kern River sequence is the type section of the middle Miocene "Temblor Stage" of the Pacific coast megainvertebrate sequence. Figured and depicted local stratigraphic ranges of several characteristic early and middle Miocene mollusks.

1965b. Addicott, W. O. Described and figured two species of *Nassarius* from middle Miocene formations in the Kern River: *N. arnoldi* (Anderson) and *N. smooti* n. sp.

PRESENT STUDY

The writer's interest in Miocene mollusks of the Kern River area began in the summer of 1953 while curating the California Tertiary larger invertebrate collections of the Standard Oil Co. of California. These collections included excellent molluscan fossils from localities along Kern River. Several trips to localities across the Kern River from the old headquarters of Barker's Ranch produced collections of well-preserved mollusks and ultimately led to a research program on the stratigraphy of Miocene formations in this area at the University of California, Berkeley. Although that study (Addicott, 1956) was primarily concerned with the subsurface and surface stratigraphy of the Round Mountain-Mount Poso oil-field area northeast of Bakersfield, numerous stratigraphic collections of Miocene mollusks were made, and the general aspects of molluscan biostratigraphy were described. Because of the emphasis on physical stratigraphy, no systematic paleontologic work was included in the paper. Collections made during 1953 and 1954 are deposited in the

Museum of Paleontology, University of California, Berkeley.

Work on the present report was undertaken in 1962, when the writer became associated with the U.S. Geological Survey. University of California collections were supplemented with additional material collected during 1962 and 1964. Material from older University of California collections (UCMP 2713, 2714, and others) could not be incorporated into the stratigraphic tabulations because of inadequate locality descriptions. Extensive collections made by U.S. Geological Survey personnel during reconnaissance of the Tertiary rocks of the Sierra Nevada in 1911 were borrowed from the U.S. National Museum for study and incorporation into the biostratigraphy of this report. Collections at the University of California, Los Angeles and Riverside, California Academy of Sciences, Stanford University, and Los Angeles County Museum of Natural History have been searched for undescribed species and stratigraphic records. A few taxa included in the lists of earlier investigators were not recognized during this study (table 2). Identifications by Anderson (1905, 1911) and Loel and Corey (1932) could not be checked because specific reference was not made to the collections from which the determinations were made. Identifications of some species, such as *Agasoma sinuatum*, *Turritella temblorensis*, and *Melongena* spp., are regarded as doubtful.

PURPOSE AND SCOPE

Systematic treatment of early and middle Miocene gastropods, including description of new taxa and taxonomic review, is the principal objective of this report. Particular attention is focused on the middle Miocene gastropods, the so-called Barker's Ranch fauna or Temblor B zone of Anderson (1911), the standard of reference for the "Temblor Stage" of the Pacific coast chronology (Weaver and others, 1944). This report is a part of long-range paleontologic and biostratigraphic studies of Pacific coast Miocene molluscan faunas undertaken in order to formalize and refine this part of the provincial megafaunal sequence.

Middle Miocene mollusks of California have been described in many different reports over a period of 115 years. Although there is a monographic treatment of the molluscan fauna of the lower Miocene "Vaqueros Stage" (Loel and Corey, 1932), the middle Miocene "Temblor" fauna has not been brought together in a single report. This report tends to fulfill this need insofar as the gastropods are concerned, because practically all of the middle Miocene gastropods described from California are represented in the Kern River area. Many new species of gastropods and stratigraphic records are added to the literature in addition to those in Loel and Corey's lower Miocene report (1932).

The Kern River early and middle Miocene molluscan fauna is the largest yet known from the Pacific Coast States. The previously known gastropod fauna of this area (Loel and Corey, 1932; Keen, 1943) has been nearly doubled; that is, increased from 98 to 182 taxa. Several of the previously listed taxa from the Kern River area are synonymized herein.

The biostratigraphy of the Kern River molluscan fauna is of considerable importance in Pacific coast regional correlation. Part of the Miocene sequence of this area is the standard (Addicott, 1965a, p. C102) for the "Temblor Stage" of the megafaunal chronology. At such time as this stage is formally defined, the Kern River area, or possibly the Caliente Range of eastern San Luis Obispo County, Calif., should be selected as the type section. Although historical precedent favors selection of the Kern River sequence, the intertonguing marine-nonmarine sequence of the eastern Caliente Range contains largely undescribed early and middle Miocene molluscan faunas of comparable size that can be directly correlated with continental vertebrates representing three provincial mammalian ages (Repenning and Vedder, 1961). Although the contact with the underlying "Vaqueros Stage" is well defined in both areas, in neither are fossiliferous upper Miocene marine strata in depositional contact with fossilferous "Temblor" strata. Rather, fossiliferous upper Miocene rocks must be projected into the "Vaqueros" and "Temblor" sections. In the Kern River area this can be achieved by projecting downdip molluscan assemblages from well cores of the Santa Margarita Formation into the outcrop section. Fossiliferous upper Miocene strata occur only in a fault block along the southwest edge of the Caliente Range, where they overlie shales carrying middle Miocene Foraminifera.

In addition to local biostratigraphic data, stratigraphic records for lower and middle Miocene occurrences of the gastropods throughout the Pacific Coast States have been compiled from published reports. The stratigraphic ranges of gastropods in the Kern River section indicated herein should facilitate recognition of middle Miocene faunas and permit a greater degree of precision in correlation. Clearly, the "Temblor Stage" cannot be formalized and renamed until such time as the middle Miocene pelecypods of this section and elsewhere on the Pacific coast are studied in comparable detail.

Informal formational units introduced during petroleum exploration and oil-field development drilling on the east side of the San Joaquin Valley during the 1920's and 1930's are reviewed herein in order to permit description of the stratigraphic occurrence of Miocene species in the Kern River section. Stratigraphic descriptions are also intended to satisfy the requirements for formal adoption of formation names used. Accordingly, subsurface type sections and supplementary subsurface and surface sections are designated.

Finally, many new early and middle Miocene gastropod taxa are described. About one-third of the gastropods treated herein are recognized as new. Many of the new species are of genera that have not previously been reported from Miocene rocks of the Pacific Coast States.

In the systematic descriptions, emphasis is placed on species, because it is at this level that mollusks are most useful in stratigraphic correlation. Where possible, each species is figured with previously unillustrated material from the Kern River area that has been compared with type specimens. Synonymies have been prepared for all species. They include those literature references documented by figured material and occurrences listed in reports specifically dealing with the Kern River area. To this extent the synonymies are intended to be inclusive. They are arranged so as to group, chronologically, all references to a particular generic-specific combination.

Most of the specimens figured herein were collected during the present study; others were borrowed from west coast museum or university collections or are from collections made by U.S. Geological Survey reconnaissance parties more than 50 years ago. Some taxa, mostly doubtfully identified, are represented by material unsuitable for illustration. Descriptions of species named by Anderson (1905) are reprinted herein because of the limited availability of his publication, many copies of which were destroyed during the 1906 San Francisco fire prior to distribution.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge the assistance of numerous individuals who contributed in one way or another to the completion of this report. Norman F. Sohl, Druid Wilson, Ellen J. Moore, and John G. Vedder kindly took time from important work to review and criticize the manuscript.

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Fruitful discussions of gastropod taxonomy were held with F. S. MacNeil, Ellen J. Moore, J. G. Vedder, Saburo Kanno, S. S. Berry, R. E. Petit, A. Myra Keen, W. K. Emerson, L. G. Hertlein, Eugene Coan, and Judith Terry. Patsy B. Smith and R. L. Pierce provided data on Foraminifera. J. G. Vedder furnished unpublished faunal lists of early and middle Miocene mollusks from the Santa Ana Mountains and the San Joaquin Hills, Calif., in addition to many unpublished records from the Caliente Range. J. W. Miller and Ann Bartlett assisted in the preparation and illustration of fossil material and in preparing some of the tabular data. Photographs used were taken by Kenji Sakamoto, of the U.S. Geological Survey.

The early stages of this study (1953–55) were supervised by a research committee composed of J. W. Durham, R. M. Kleinpell, and R. L. Langenheim, of the University of California, Berkeley.

STRATIGRAPHY

Review of the stratigraphy of Miocene formations of the Kern River area and the designation of type sections for the many informal units are necessary to permit biostratigraphic description of the lower and middle Miocene section. Accordingly, the nomenclatorial history of each formation is reviewed, characteristic or typical subsurface sections designated, and surface sections briefly described.

Miocene formations of the Kern River area dip southwestward toward the center of the San Joaquin depositional basin and form a gentle homoclinal structural feature which is slightly bowed along a line roughly paralleling the course of Kern River from the Kern River Gorge to Elk Hills, about 30 miles to the southwest. This structural feature, known as the Kern River arch (Hoots and others, 1954), is discernible in the belt of Miocene exposures northeast of Bakersfield. In the northern part of the area, the beds strike slightly west of north, near Kern River, nearly northwest. Within the Miocene outcrop, local flattening, or slight reversals of the prevailing west to southwest dip occur in surface exposures (Hoots and others, 1954; Dibblee and others, 1965) and are shown on subsurface structural contour maps (Park and others, 1963).

Normal faulting is an important structural feature of this area. Most of the faults are alined nearly parallel to the strike. The amount of throw along these faults is greatest along the eastern margin of the outcrop. From south of Kern River northwestward to Poso Creek, the Neogene section is almost continuously in fault contact with basement rock. Along the Kern Gorge fault, a vertical displacement of more than 2,000 feet is indicated by an enormous west-dipping scarp in the vicinity of Kern River. The displacement decreases to the northwest, where the fault passes into the Miocene section. Throw on faults within the marine section southwest of the Kern Gorge fault is as much as 300 to 400 feet. In general, the amount of throw decreases basinward. Strike faults are generally downthrown to the west, although most of the oil produced from this area is trapped by east-dipping normal faults.

Most of the Miocene formations recognized in outcrop and in the subsurface in the southeastern part of the San Joaquin Valley were originally described from wells in the Kern River area. Many of the formation names were introduced in publications of the California Division of Oil and Gas following, by some years, their informal use in petroleum exploration and oil-field development drilling northeast of Bakersfield. Some of the named formations, although long since firmly entrenched as useful units in subsurface mapping (fig. 2), have never been adequately defined. For example.

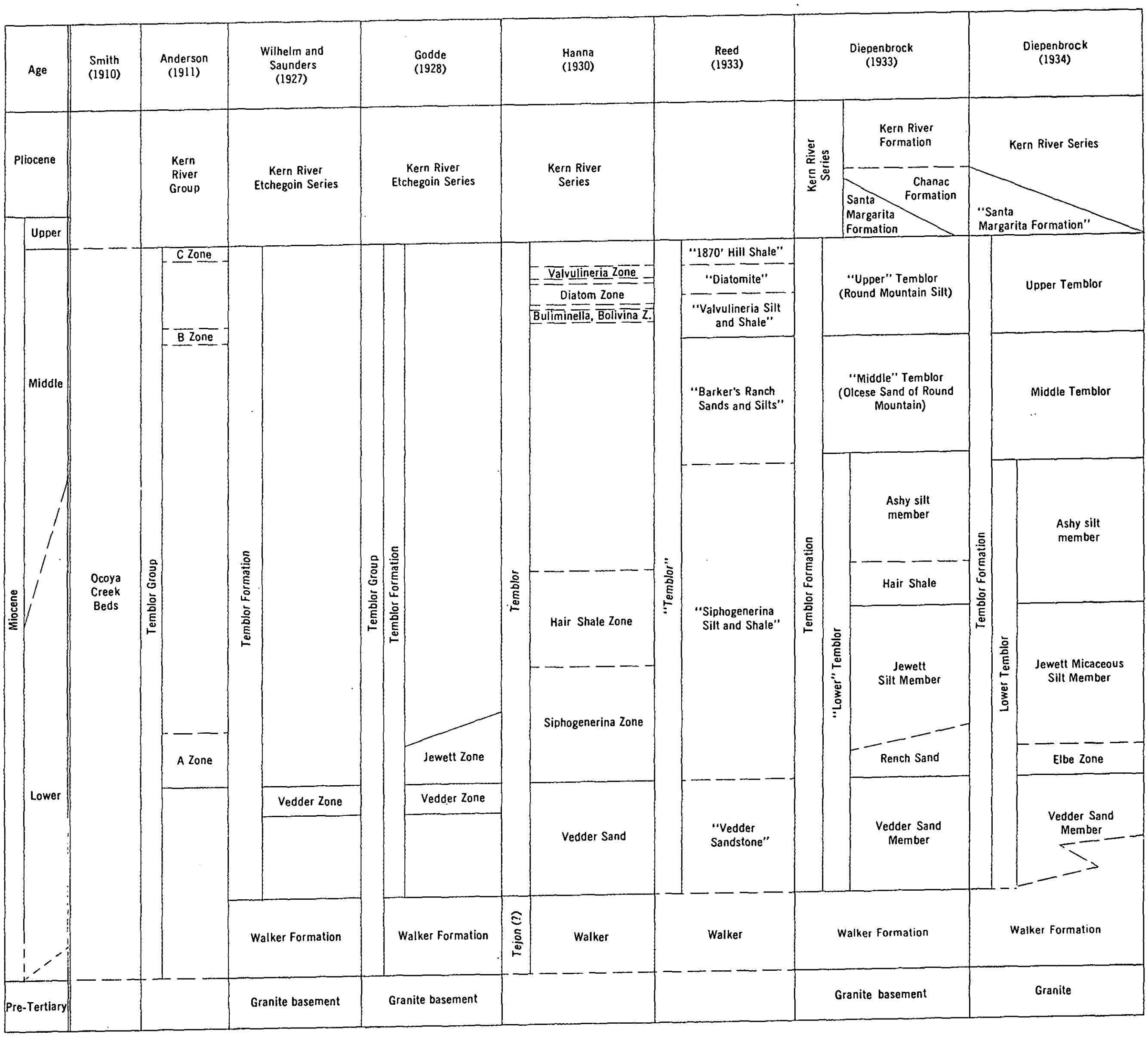
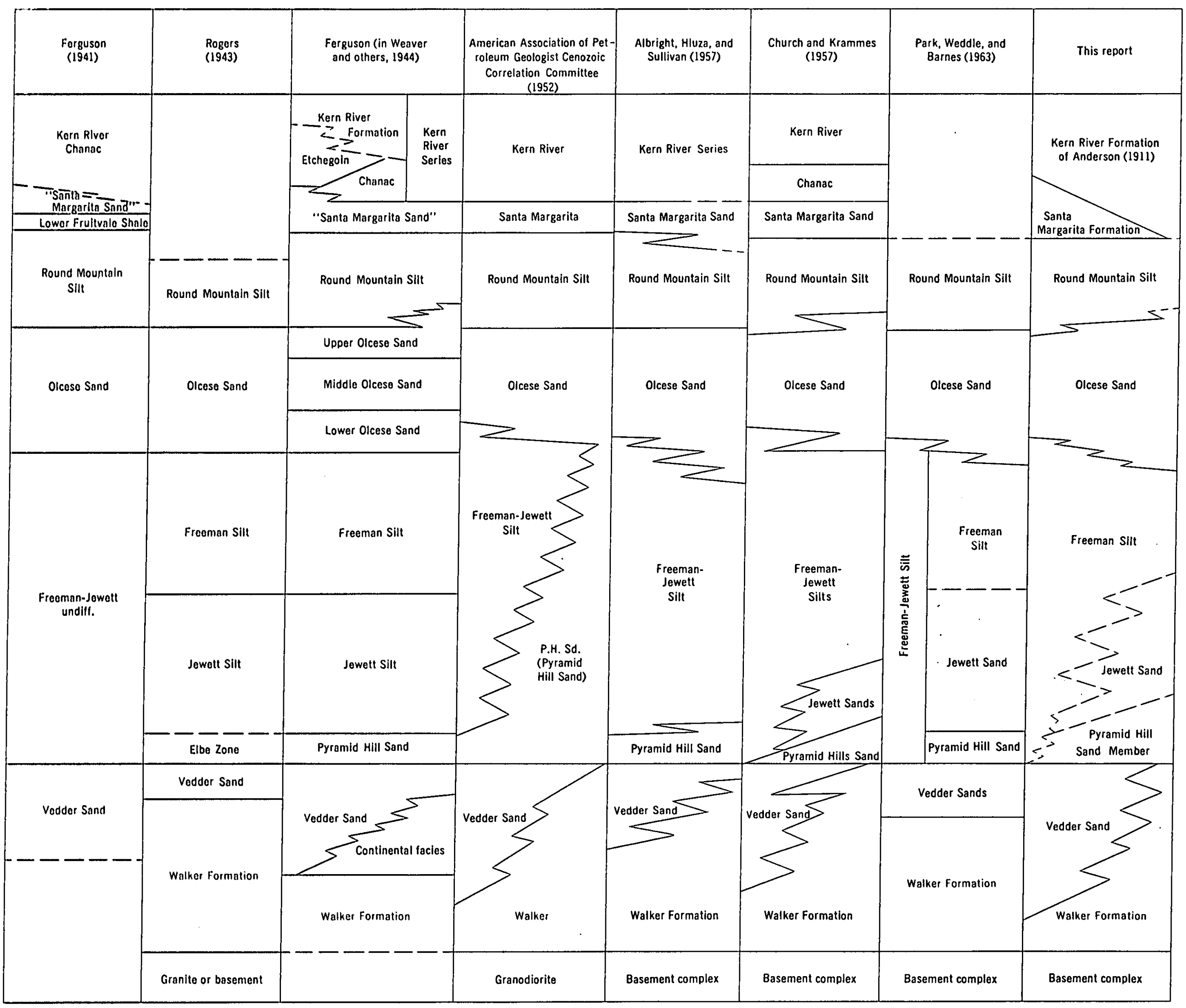


FIGURE 2.—Development of stratigraphic

a surface type section has been designated for only one Miocene unit, the Walker Formation (Dibblee and Chesterman, 1953). Nevertheless, lithologic and electric log characteristics, depositional relationships, and age of these formations are now well known from modern oil-field reports such as those of Albright (1956), Albright and others (1957), and Park and others (1963), in addition to correlation studies such as those of Church and Krammes (1957) and Park and Weddle (1959). Very little has been published on the surface geology and stratigraphy of this area, perhaps because of the extensive geological review of the area carried out in connection with petroleum exploration. Although there are no detailed published geologic maps of this area, there are several published generalized maps that include parts of it: Birch (in Keen, 1943), Hoots and others (1954), Hackel and Krammes (1958), and Dibblee and others (1965). The last two have been used in preparing a geologic index map of the Kern River-Poso Creek area (fig. 3).

Reports containing pertinent stratigraphic information include: Blake (1855), Whitney (1865), Goodyear (1888), Smith (1910), Anderson (1911), Stevens (1924), Wilhelm and Saunders (1927), Godde (1928), Fox (1929), Hanna (1930), Diepenbrock (1933, 1934), Kleinpell (1938), Ferguson (1941; in Weaver and others, 1944), Rogers (1943), Birch (in Keen, 1943), Bailey (1947), Brooks (1952), Beck (1952, 1958),



nomenclature in the Kern River area.

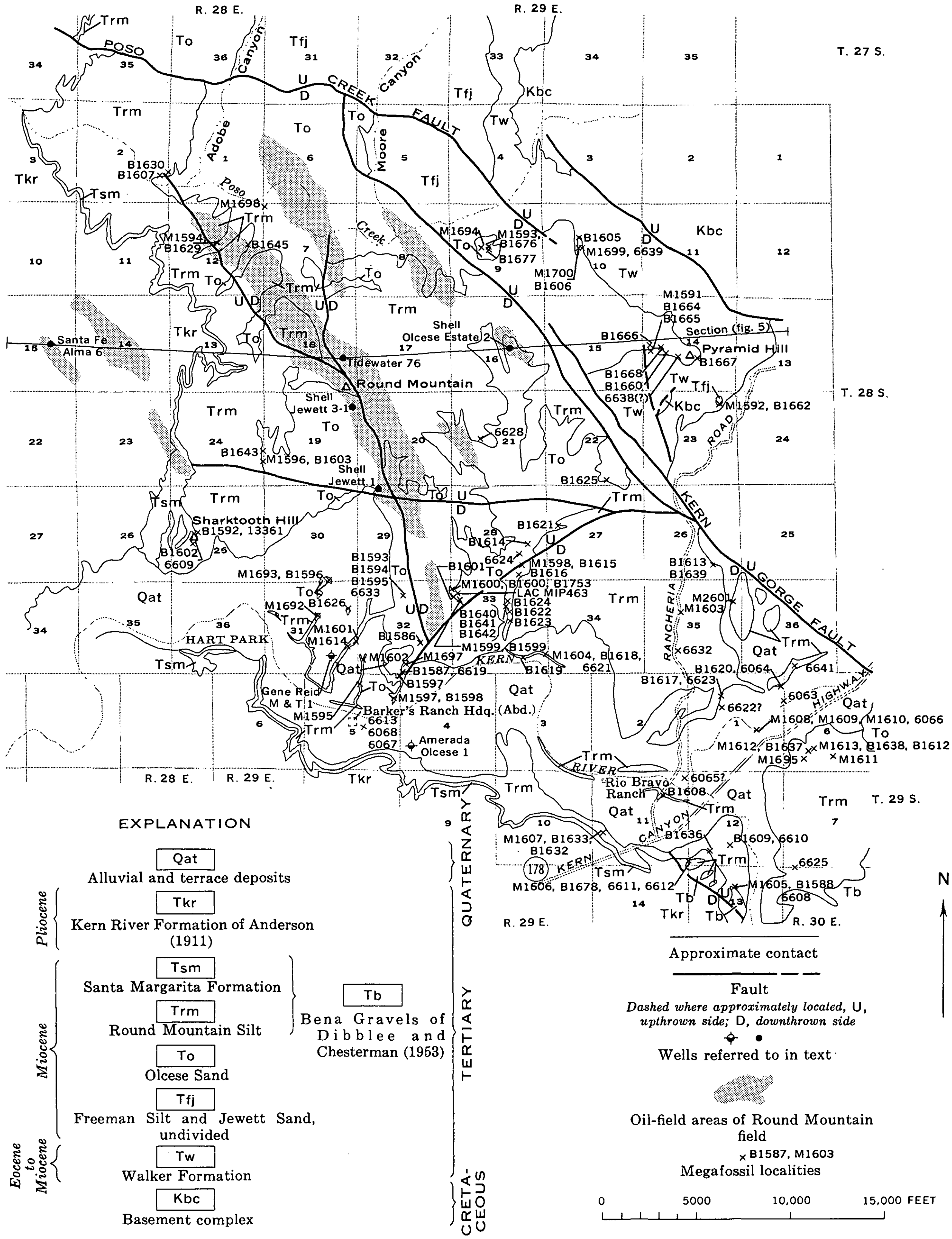


FIGURE 3.—Geologic index map of the Kern River-Poso Creek area, Kern County, Calif., showing generalized distribution of Tertiary formations, fossil localities, and places referred to in text [modified from Hackel and Krammes (1958) and Dibblee and others (1965)].

Pease (1952a, 1952b), Sperber (1952), Dibblee and Chesterman (1953), Matthews (1955, 1956, 1957), White (1955), Sullivan (1955), Addicott (1956), Albright (1956), Albright and others (1957), Church and Krammes (1957), Hackel and Krammes (1958), Church (1958), Beck (1958), Hluza (1958), Weddle (1959), Rudel (1965), AAPG Guidebook (1965), and Richardson (1966). The principal contributions of these workers are indicated in the ensuing stratigraphic discussion.

WALKER FORMATION

The lowest exposed Tertiary formation in the Kern River area is the Walker Formation, a nonmarine unit composed of green claystone, siltstone, and sandstone. It was named by Wilhelm and Saunders (1927, p. 9) for a "series of landlaid beds consisting of sands and shales of a characteristic greenish color" lying unconformably below their Temblor Formation and fully penetrated by three wells in the Mount Poso area. In these wells, the Walker varies from 370 to 594 feet in thickness.

Exposures along Walker Basin Creek (fig. 1), 1–2 miles northeast of Bena were designated as the type section of the Walker Formation by Dibblee and Chesterman (1953). The 2,000-feet unit of arkosic sandstone, conglomerate, and minor gritty clay that constitutes their type Walker differs considerably from the predominantly finer grained clastics of the Kern River area about 10 miles to the northwest.

The Walker Formation lies unconformably upon granitic basement rock in the Kern River area. It intertongues basinward with marine Eocene sandstone and siltstone (Addicott, 1956; Church and Krammes, 1957) and with sandstone and siltstone of early Miocene (Zemorrian) age toward the top of the formation. The continuously cored 414-foot interval from 2,653 feet to 3,067 feet in the Shell Oil "Vedder" 1 (sec. 9, T. 27 S., R. 28 E.), one of the wells from which the Walker Formation was originally defined by Wilhelm and Saunders (1927), is here designated the subsurface reference section of the Walker Formation. Included is a 20-foot marine tongue of "sand, shale, and sea shells" from 2,718 feet to 2,738 feet according to original core descriptions (Addicott, 1956, p. 107). This intertonguing relationship is shown by Church and Krammes (1957) and Albright and others (1957). Near the margin of the basin, the Walker Formation is overlain unconformably by marine Jewett Sand, a transgressive sandstone that locally overlaps the Vedder Formation and Walker Formation to rest directly on basement rock along Woody Road in sec. 13, T. 26 S., R. 28 E. (fig. 1).

Exposures of the Walker Formation are mostly of massive weathered claystone and siltstone with clayey sandstone interbeds. Claystone strata weather to green to white and are usually studded with scattered sand grains. They form prominent ledges in exposures north of Poso Creek. Sandstones weather to greenish white and are coarse grained, poorly sorted, and generally less than 20 feet thick.

Fossils seldom have been found in the Walker Formation. Dibblee and Chesterman (1953) found a few nonmarine mollusks and plant fossils in strata near the type section of the formation along Walker Basin Creek. However, intertonguing relationships with middle Eocene to lower Miocene marine rocks in the subsurface indicate an age equivalent to these rocks.

VEDDER SAND

Wilhelm and Saunders (1927, p. 9) introduced the name "Vedder zone" to designate 85 feet of medium- to coarse-grained oil-bearing sandstone within what was then called the Temblor Formation at Mount Poso oil field. Hanna (1930) first used the name Vedder sand and in a columnar section from the Richfield Oil "Boston" 1 (sec. 20, T. 28 S., R. 28 E.) extended the lower boundary to the top of the Walker Formation. Subsequently, Diepenbrock (1933, p. 18) redefined the Vedder Sand as a 250- to 750-foot member of the Temblor Formation overlying the Walker Formation and underlying the "Jewett Silt" at Mount Poso field. Although a type subsurface interval was not designated, it is believed that the name originated from the Shell Oil "Vedder" 1 (sec. 9, T. 27 S., R. 28 E.), the discovery well at Mount Poso field. The almost continuously cored 751-foot interval from 1,902 to 2,653 feet in this well is here designated as the type section of the Vedder Sand. Sand is the predominant material (Addicott, 1956, p. 104–107). Unfortunately, this well was drilled before the perfection and general use of electric logging technique, the principal means by which lithology can be deduced in modern wells, so that electric characteristics of the formation at the type well are unknown. Although most subsequent wells in this part of Mount Poso field have not fully penetrated the Vedder Sand, it was penetrated and logged in the Shell Oil "Vedder" 55 (SE¼ sec. 9, T. 27 S., R. 28 E.) about three-fourths of a mile southeast of the type well (Richardson, 1966). A copy of the electric log showing relationships to the Walker Formation and the Jewett Sand is shown in figure 4.

The Vedder Sand is a widespread subsurface unit in the southeastern part of the San Joaquin Valley where it extends from the vicinity of Pixley (T. 22 S., R. 25 E.) southward to Wheeler Ridge and North

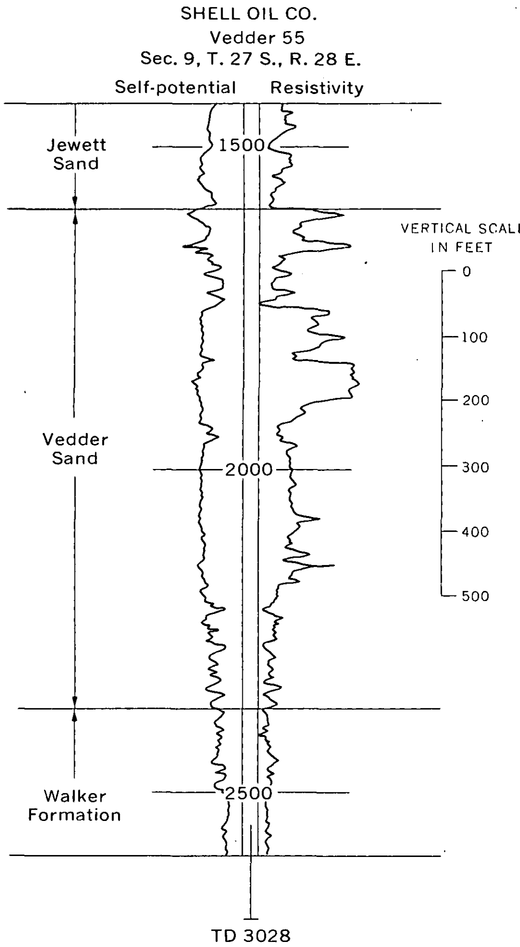


FIGURE 4.—Part of the electric log from Shell Oil "Vedder" 55 showing characteristics of lower Miocene formations (from Richardson, 1966).

Tejon fields in the San Emigdio Mountains (Richardson, 1966). It is the principal producing reservoir in the Mount Poso and Round Mountain fields and in many other fields from Jasmin field (T. 25 S., R. 27 E.) southward to North Tejon field (T. 10 N., R. 20 W.). At Pyramid Hill the Jewett Sand, rests unconformably on nonmarine beds of the Walker Formation.

Massive white- to greenish-white-weathering fine to coarse biotitic sand with interbedded green sandy claystone and siltstone that crops out north of Poso Creek is doubtfully referred to the Vedder Sand. This unfossiliferous unit is limited to a narrow belt immediately west of the basement outcrop. It is overlain by the basal conglomeratic sandstone of the Jewett Sand, which contains, locally, abundant large oysters (*Ostrea vaquerosensis* Loel and Corey) and barnacles. A 175-foot section of crossbedded sand with scattered calcareous concretions that may be referable to the Vedder Sand was measured by the writer in Moore Canyon (sec. 32, T. 27 S., R. 29 E.) in 1954.

Section of the Vedder(?) Sand and Jewett Sand up north-northwest-trending gully tributary to Moore Canyon near center N½ sec. 32, T. 27 S., R. 29 E., Woody 15-minute quadrangle.

	Thickness (feet)
Jewett Sand:	
10. Sand, concretionary, weathers to light-gray, with abundant limonitic staining; very fine, well sorted; massive; abundant bedded spherical sandstone concretions with mollusk, vertebrate, or wood nuclei. Exposures poor	20+
9. Sandstone, conglomeratic, weathers to light-tan to gray; composed of pebbles and very coarse quartz and chert grains in a silt and clay matrix; poorly sorted; composed of about 65 percent quartz grains, 20 percent black chert grains, and 15 percent granules and pebbles to a maximum diameter of about one-fourth of an inch; contains abundant *Ostrea*, *Dosinia* mold, indeterminate gastropod, mollusk fragments, and shark tooth (UCMP loc. B1652)	2
Unconformity.	
Vedder(?) Sand:	
8. Sand, very poorly exposed, weathers to white; medium to coarse with scattered black pebbles, poorly sorted; locally crossbedded; massive; poorly consolidated; scattered sandstone concretions	77
7. Sandy clay, poorly exposed; weathers to faded-green color; silty, micaceous; considerably weathered	14
6. Sand, silty, concretionary, weathers to white; fine to very fine; 10 percent dark-greenish-black grains; poorly consolidated; scattered limonitic streaks; scattered 6- to 12-in. calcareous sandstone concretions, abundant in uppermost 2 ft	15
5. Sandy clay and clayey sand, poorly exposed; weathers to dark to faded-green; very poorly sorted to unsorted; micaceous; poorly consolidated; considerably weathered; scattered iron oxide staining	37
4. Sandstone, calcareous, white, weathered surfaces limonitic stained; fine-grained, poorly sorted; very well indurated	1
3. Sand, white to grayish-white, weathers to buff; medium- to coarse-grained, very poorly sorted, unconsolidated	5
2. Sand, fine to very fine, well-sorted, clean, unconsolidated; weathers to white	10
1. Sand, concretionary, weathers to white to buff; very slight green tinge; fine to very fine, fairly well sorted, massive; usually silty; 5–10 percent weathered biotite; angular to subangular grains; abundant lenticular calcareous cemented sandstone concretions, very well indurated, as much as 2 ft thick and from 12 to 25 ft long; scattered limonitic pods ⅛–¼ in. in diameter	16

Shallow-water marine fossils are commonly found in cores of the upper part of the Vedder Sand from wells drilled along the eastern margin of the southeastern part of the San Joaquin Valley. A commonly occurring gastropod is the "Vaqueros" index *Turritella inezana* Conrad (Corey in Cushman and Laiming, 1931; Loel and Corey, 1932; Addicott, 1967a).

JEWETT SAND

Godde (1928, p. 6) proposed the name "Jewett zone" for a 50- to 550-foot "shaly sand zone" immediately overlying the Vedder Sand at Round Mountain and Mount Poso oil fields. This unit is equivalent to the Jewett Sand of the present report. The Shell Oil "Jewett" 1 in Round Mountain field (sec. 29, T. 28 S., R. 29 E.) was designated as the type well. The "Jewett zone" was proposed as a lithologic unit. Its base was defined by 3–15 feet of bluish-gray pebbly sand; its top apparently was defined by oil shows at Round Mountain field but by lithologic characteristics at Mount Poso field.

Subsequently, Diepenbrock (1933) used the term Jewett Silt Member for a 220-foot-thick "middle micaceous siltstone and very fine clayey sand member" of his lower Temblor Formation at Mount Poso field. He indicated that this unit was the lateral equivalent of Godde's Jewett zone (1928) of the Round Mountain field. Later, Diepenbrock (1934) recognized the Jewett Micaceous Silt Member at Round Mountain field as a 650-foot micaceous siltstone containing lenses of sand, a silty, very fine grained sand, and a basal pebbly "grit" bed. The upper 450 feet were included in the Jewett oil zone, and the lower 150 feet, in the Elbe oil zone. A 50-foot-thick siltstone separated these zones.

Subsequent usage has tended to modify and blur the original description of the "Jewett zone." The lower part (Diepenbrock's Elbe zone (1934)) was referred to as the Pyramid Hill Sand by Wilson (1935, p. 14), who included about 160 feet of "hard, white-to-brown sandstone" overlying "mudstone reefs" (Walker Formation) in sec. 12, T. 26 S., R. 28 E., about 14 miles northwest of Pyramid Hill. It is now widely used for subsurface correlation. The upper part of the "Jewett zone" proved to be of much more limited geographic distribution, being restricted, in large part, to the margin of the depositional basin in the vicinity of Round Mountain field. Because of the difficulty of separating that part of Diepenbrock's (1934) Jewett Micaceous Silt Member above the basal sand (Pyramid Hill Sand) from his overlying ashy silt member, subsequently referred to as the Freeman Silt (Kleinpell, 1938), the units were grouped together as the Freeman-Jewett by Ferguson (1941, p. 242). This practice has been generally followed since that time. Lenses or tongues of sand overlying the Pyramid Hill Sand of Wilson (1935) are recognized as the Jewett Sand in some oil fields along the eastern margin of the San Joaquin Valley (Bailey, 1947).

In this report, the name Jewett Sand is used as originally defined by Godde (1928) to include a marginal sand body that unconformably overlies the Vedder Formation or Walker Formation. The contact with the overlying Freeman Silt is gradational and intertonguing. The Pyramid Hill Sand is included as the lower member of the Jewett Sand because it is very difficult, if not impossible, to identify in surface exposures an upper contact that corresponds to the relatively well defined top of the subsurface unit. Accordingly, the Pyramid Hill Sand Member is recognized herein only in the subsurface.

The type section of the Jewett Sand is here designated as the 657-foot cored interval from 1,218 to 1,875 feet in the Shell Oil "Jewett" 1 (sec. 29, T. 28 S., R. 29 E.) in the southern part of Round Mount field (fig. 5). The type section for the lower part, the Pyramid Hill Sand Member, consists of a 185-foot cored interval (1,690–1,875 ft) of gray to brownish-gray

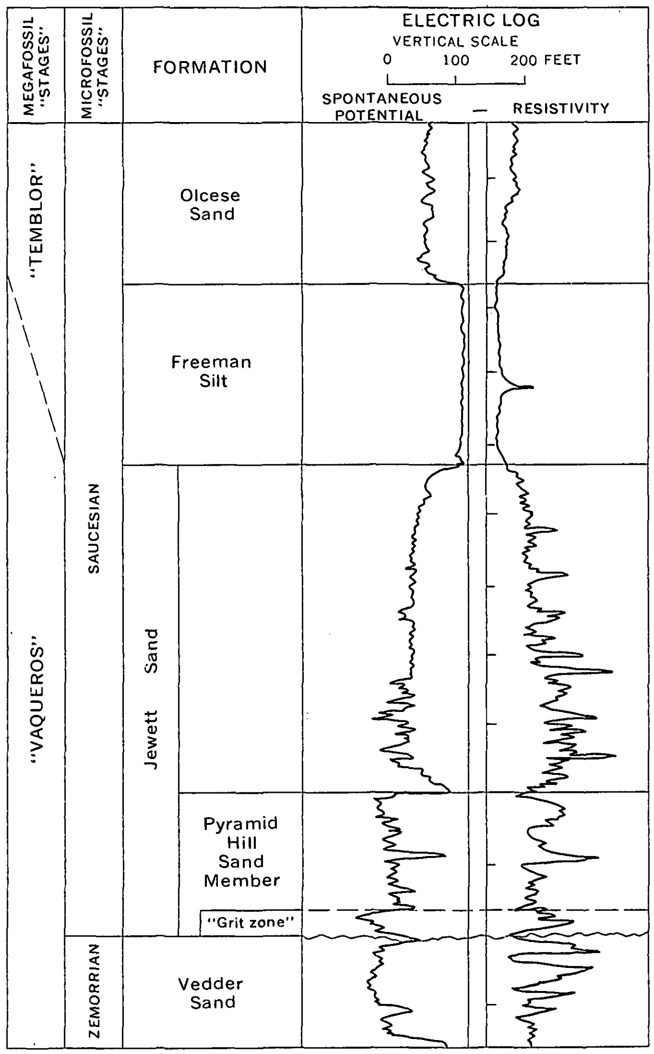


FIGURE 5.—Part of a composite electric log from Round Mountain field (from Park and others, 1963).

fossiliferous silty sand with local bentonitic and thin calcareous sandstone beds. On electric logs, spontaneous potential values are much larger in the Pyramid Hill Sand Member than in the overlying part of the Jewett Sand (Park and others, 1963, pl. 6). Moreover, this sand has a more massive or blocky appearance on electric logs than does the overlying interbedded sand and "shale" of the upper part of the Jewett. This change, although easy to recognize on electric logs, is usually difficult to recognize in cores. A very poorly sorted coarse-grained sand consisting of angular quartz grains and black pebbles and ranging from about 10 to 35 feet in thickness occurs at the base. This unit is commonly referred to as the "grit zone", and is one of the best marker beds for physical correlation and structure contouring in this area. It is the unit from which the prolific early Miocene molluscan assemblage at Pyramid Hill has been collected (USGS loc. M1591). It has been recognized along the eastern edge of the San Joaquin Valley from Jasmin field (Sperber, 1952) south to Race Track Hill field (Phillips, 1952).

Exposures of the Jewett Sand are typically silty concretionary very fine to fine-grained sandstone. The unconformable contact with underlying formations is well marked by a fossiliferous calcareous pebbly sandstone containing rounded black chert granules and angular quartz grains. This widespread unit is the so-called "grit zone" of the subsurface stratigraphic terminology. The contact with the overlying Freeman Silt is gradational and often poorly defined. In surface mapping, the Jewett Sand is mapped with the Freeman Silt, although in areas of favorable exposure it is possible to recognize the contact between these formations.

Reddish-brown-weathering "cannonball" concretions are characteristic of the poorly exposed massive very fine to fine-grained sandstone overlying the basal pebbly sandstone. In section, the spherical calcareous concretions show concentric accretion, often around an organic core such as plant fragments, wood riddled with "*Teredo*" borings, bones of marine mammals, or oysters and various other pelecypods. The outer ½-to 2-inch-thick shell is usually stained with iron oxide, but the inner parts are light gray. The average diameter of the concretions is about a foot, but some attain 5 feet.

Beds of small oysters averaging 1–2 feet in thickness occur in association with concretionary strata in the upper part of the Jewett Sand.

In the type well, the upper part of the Jewett Sand consists of a 472-foot interval (1,218–1,690 ft) of alternate gray and brown (oil-stained) fine to very fine silty sand and what was described as silty to sandy shale. The rocks in this interval consist of thin calcareous sandstone beds (the so-called "shells"), scattered megafossils, fish scales, and carbonaceous material. On electric logs from subsequent wells in the vicinity, such as the Shell Oil "Jewett-3" 1 in sec. 19, T. 28 S., R. 29 E., there is a suggestion that the alternate sand and siltstone sequence becomes increasingly sandy toward the base. The percentage of sand varies considerably. Near the type well it seems to be less than 50 percent (Diepenbrock, 1934, p. 11); in other areas, it is much greater than 50 percent (Park and others, 1963, pls. 5 and 6). The upper part of the Jewett Sand decreases rapidly in thickness basinward and along the strike from its maximum thickness in the vicinity of Round Mountain field. This change is attributed to gradation and intertonguing with the Freeman Silt. The upper part of the Jewett Sand is much less widely distributed basinward than the lower Pyramid Hill Sand Member.

The Jewett Sand is exposed in a narrow belt from Pyramid Hill northward at least as far as the Woody Road (sec. 13, T. 26 S., R. 28 E.). The best exposures occur from Borel Canyon to Adobe Canyon, about 7 miles north of Godde's (1928) type well, in parts of sec. 7, 8, 17–19, T. 27 S., R. 29 E., and sec. 12 and 13, T. 27 S., R. 28 E. In this area the average thickness is 300–400 feet.

The Jewett Sand grades laterally into siltstone and shale toward the center of the basin. Coarsening toward the margin of the basin is suggested south of Chalk Cliff (sec. 8, T. 27 S., R. 29 E.), where medium to very coarse sand intertongues with typical silty very fine to fine sand.

At Pyramid Hill the contact with the underlying Walker Formation is channeled; the basal 5 feet of the Jewett Sand is a chaotic mixture of granule conglomerate, arkosic sandstone, slabs and wisps of green claystone, and thinly bedded fine-grained sandstone. For a few miles north of Poso Creek, the Jewett lies disconformably on massive sands here referred to the Vedder Sand. North of Chalk Cliff (sec. 8, T. 27 S., R. 29 E.), the Jewett Sand overlaps the Vedder Sand and rests disconformably on the Walker Formation. Farther to the north, the contact with the Walker Formation becomes a clearly recognizable angular unconformity and is well exposed east of Horshoe Ranch in secs. 18 and 19, T. 26 S., R. 29 E. Along Woody Road (fig. 1), the fossiliferous Jewett Sand lies unconformably on basement rocks.

FREEMAN SILT

The name Freeman Silt has been informally applied to Diepenbrock's ashy silt member (1933, p. 15) of the "Lower Temblor" Formation at Mount Poso field.

Kleinpell (1938, fig. 14) first used the name Freeman Silt in a biostratigraphic column. The name was apparently taken from wells on the Shell Oil Freeman lease at Round Mountain field (sec. 20, T. 28 S., R. 29 E.). Rogers (1943, p. 580) subsequently described the Freeman Silt as "650 feet of firm micaceous to micromicaceous gray to blue-gray silt and very fine grained sandy siltstone with occasional calcareous streaks" overlying the Jewett Sand at Round Mountain field. Rogers did not designate a type section but did include a composite electric log.

The ashy silt member was originally defined by Diepenbrock (1933, p. 15) as approximately 850 feet of siltstone and claystone overlying his Jewett Micaceous Silt Member and underlying his "Middle Temblor," the Olcese Sand, described as follows:

> The top 230 feet of the beds are massive, light gray, ashy, very fine sand to silt; the next 350 feet are predominantly hard brownish dark gray, sandy siltstone with some light gray claystone beds; and the bottom 270 feet are the ash brittle fine sandy claystones and clayey siltstones referred to as 'hair shale' by Hanna [1930] * * *.

The Freeman Silt of this report is probably equivalent to the lower 620 feet of Diepenbrock's (1933) ashy silt member and the upper silty part of the underlying Jewett Micaceous Silt Member as originally defined for the Mount Poso field. The boundaries of the ashy silt member at Round Mountain field (Diepenbrock, 1934) are virtually the same as those of the Freeman Silt as here defined.

For the most part it is extremely difficult, if not impossible, to differentiate the Freeman Silt from Diepenbrock's Jewett Micaceous Silt in subsurface correlation, consequently the two units have been combined as Freeman-Jewett Silt (Ferguson, 1941). This part of the Miocene depositional sequence is limited by the Vedder Sand below and the Olcese Sand above. A basal sand in this interval, herein assigned to the Jewett Sand (fig. 3), can be readily recognized and correlated in the subsurface by electric-log characteristics. Siltstone in this interval, the lower part of which is gradational with the Jewett as recognized by earlier workers (Diepenbrock, 1933, p. 16), is here included in the Freeman Silt. Toward the center of the San Joaquin depositional basin, the Freeman makes up the entire interval between the Vedder and the Olcese Sands because of the basinward change from relatively coarse grained sediments along the margins to finer grained siltstone and shale toward the center.

The continuously cored 328-foot interval between 890 and 1,218 feet in the Shell Oil "Jewett" 1 (sec. 29, T. 28 S., R. 29 E.) is designated herein as the type section of the Freeman Silt (fig. 6). According to Shell Oil Co. records, the cores in this interval consist of massive gray micaceous sandy to clayey shale [siltstone?]. Electric logs from subsequently drilled wells in this part of Round Mountain field can be readily correlated with this interval and thus used as reference data for subsurface mapping of the Freeman Silt.

The Freeman Silt is characteristically a light- to brownish-gray friable massive micaceous clayey siltstone with very fine, silty sand beds near the top. Foraminifera and fish scales are abundant. The section contains bentonitic lenses, small pelecypods such as *Cyclocardia*, *Acila*, and *Nuculana*, and thin beds of calcareous siltstone ("shells"). On electric logs the formation is usually a well-defined shale or siltstone "neck" occurring stratigraphically above the Jewett or Vedder Sand (fig. 3). The upper contact is less well defined because the Freeman Silt grades upward and appears to intertongue with overlying silty, very fine-grained sand referred to the Olcese Sand. At places the upper contact is difficult to determine because of this gradation.

The Freeman Silt increases rapidly in thickness toward the center of the San Joaquin basin as the Jewett Sand, below, and the lower part of the Olcese Sand, above, grade laterally and appear to intertongue with siltstone away from the margin of the depositional basin (fig. 7). The Freeman Silt decreases in thickness along the strike from nearly 1,200 feet near the south end of Sharktooth field (T. 28 S., R. 28 E.) to about 500 feet near Dyer Creek field (T. 26 S., R. 27 E.) and only about 165 feet (Sperber, 1952) at Jasmin field (T. 25 S., R. 27 E.).

Outcrops of the Freeman Silt occur in a narrow north-south belt from Poso Creek to north of Granite Station road. It is well exposed in Borel Canyon about 6 miles north of Poso Creek. Characteristically the Freeman Silt is a poorly exposed sandy to clayey siltstone that weathers to very light gray. In Borel Canyon the Freeman Silt consists of about 200–250 feet of light-gray massive clayey to sandy micaceous siltstone containing fairly abundant Foraminifera. Gradation to calcareous silty claystone and shale and scattered beds of paper-thin shale occurs in this area. Toward the top of the formation, volcanic detritus, carbonaceous material, isolated concretions, and scattered impressions of mollusks are present. Scattered wood fragments and mollusks occur in siltstone concretions; the concretions are similar to those found in the Jewett Sand but are much less abundant. The top of the unit grades and intertongues with light-bluish-gray silty sandstone of the Olcese Sand.

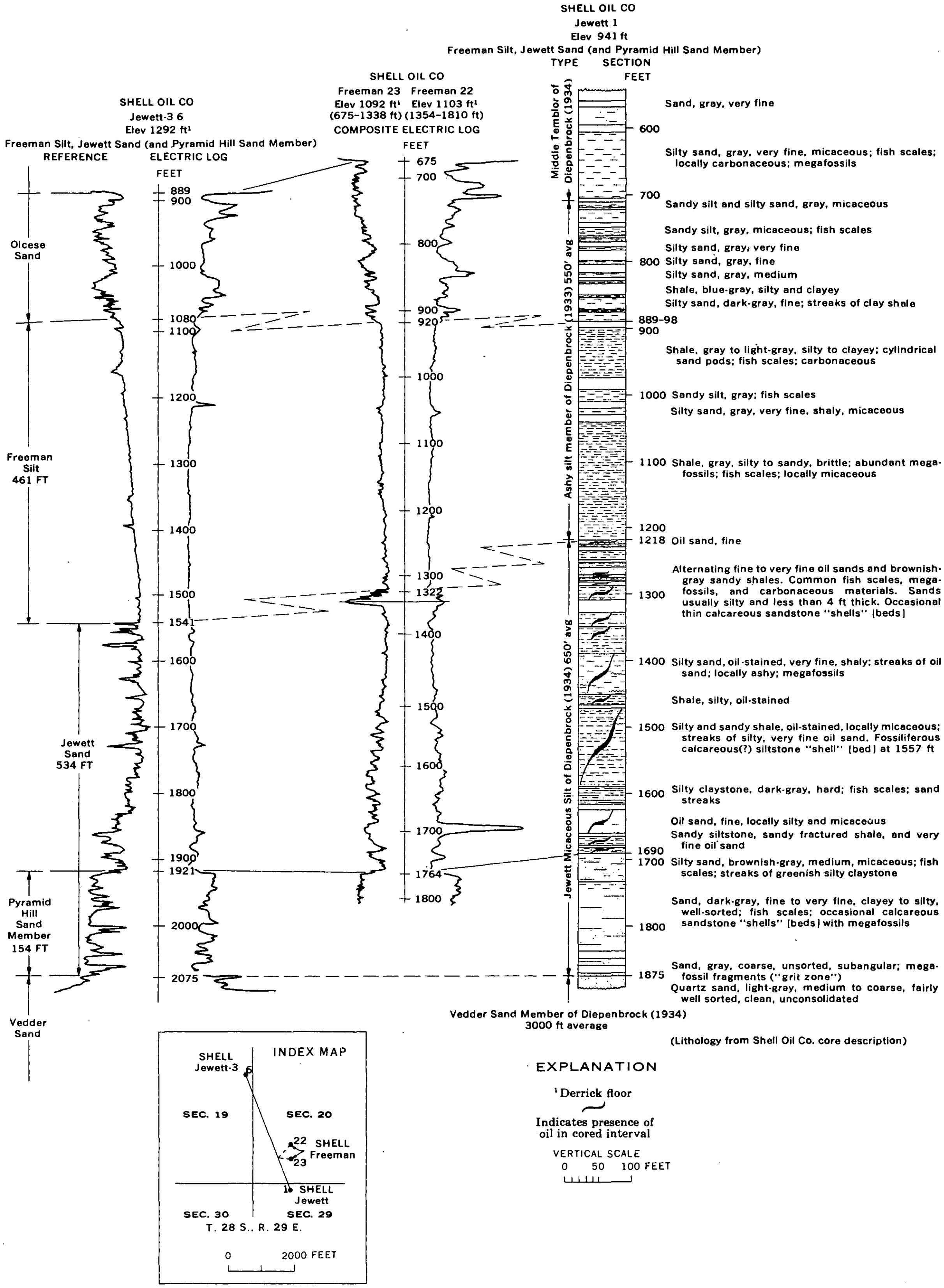


FIGURE 6.—Correlation of subsurface type sections of the Jewett Sand and Freeman Silt with electric logs from nearby wells.

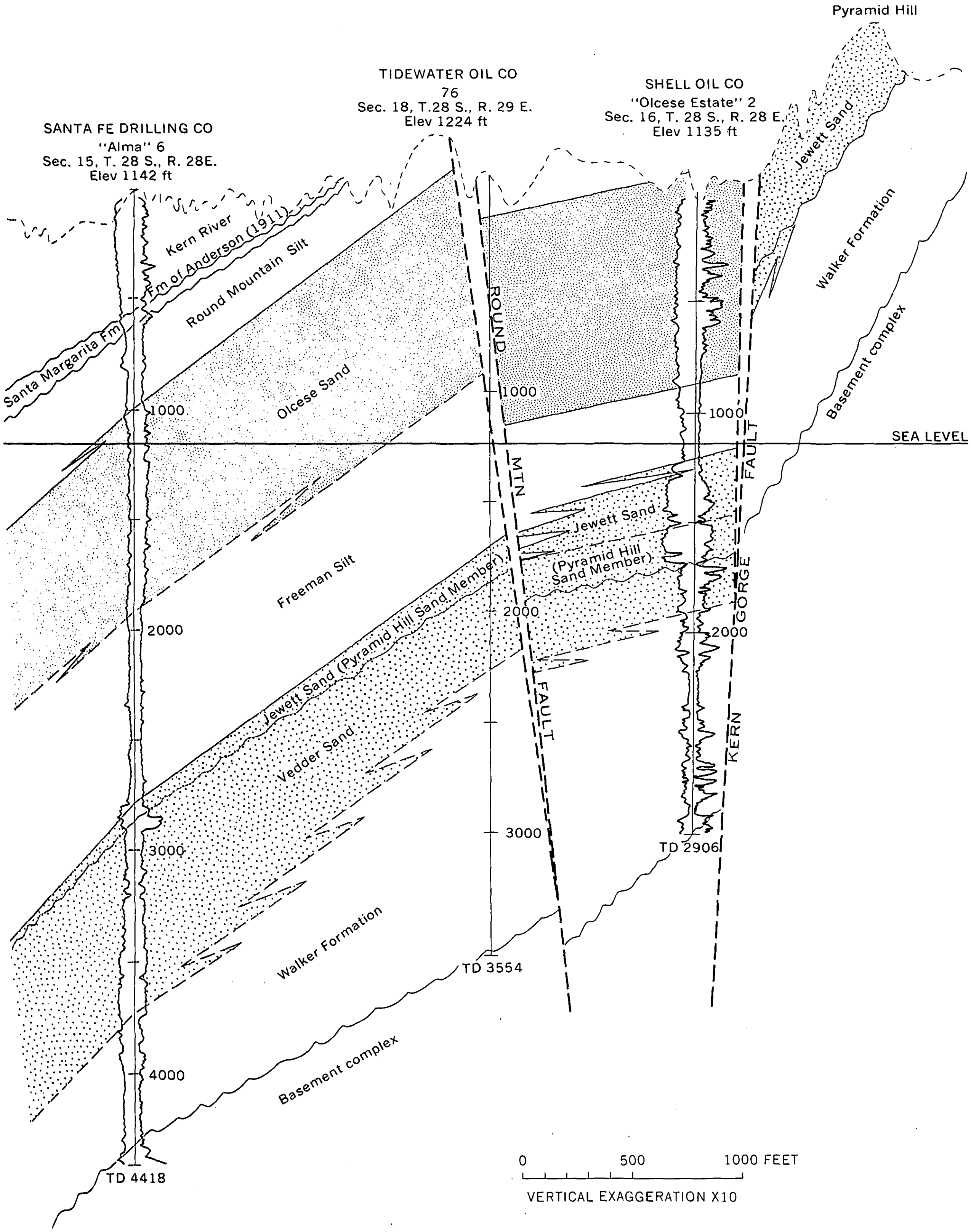


FIGURE 7.—Diagrammatic section from Pyramid Hill to the Alma area of Round Mountain field showing stratigraphic relations of Miocene formations (modified from Hackel and Krammes, 1958).

Section of Jewett Sand, Freeman Silt, and Olcese Sand on north side of east-west tributary of Borel Canyon just west of the center of sec. 18, T. 27 S., R. 29 E., Woody 15-minute quadrangle

	Thickness (Feet)
Olcese Sand:	
9. Sandstone, silty, very light bluish gray; weathers to white; very fine grained; scattered calcareous cemented concretions; massive; friable; forms a faintly "benched" or "stepped" slope. Contains *Nuculana* sp	39+
Freeman Silt:	
8. Mostly covered. Apparently friable siltstone and sandy siltstone with abundant silty clay shale chips in float in lower 20 ft	40
7. Clayey siltstone and shale, poorly exposed; weathered to white; best exposed in landslides in Borel Canyon where white-weathering "paper-thin" shale that weathers to white is interbedded with clayey siltstone; gypsiferous; siltstone locally well indurated gives rise to siltstone chips in float; break-in-slope at top of unit	45
6. Mostly covered. Very coarse to coarse-grained calcareous sandstone, 2–3 in. thick, 14 ft above base. Float changes to tan-white to white sandy silt; increasing calcareous siltstone chips; gypsiferous; appears to be a foraminiferal siltstone that weathers to white, somewhat micaceous. Prominent break-in-slope at top and bottom of unit	44
5. Siltstone, sandy, poorly exposed; weathers to light gray to tan; massive; gypsiferous	19
4. Sandstone, concretionary, silty, very light gray, very fine grained, well sorted; considerably weathered; gypsiferous; locally mappable. Poorly preserved pelecypods common	1
3. Siltstone, sandy, poorly exposed; weathers to light gray to tan; ranges from siltstone to very fine sand; massive; gypsiferous; tan silty soil with abundant very light gray calcareous siltstone chips	87
Jewett Sand:	
2. Siltstone, sandy, *Ostrea-Chlamys* bed; light-gray, weathers to orange to light brown; cemented with calcium carbonate; abundantly gypsiferous; scattered fish scales (UCMP loc. B1650)	1
1. Sandstone, concretionary, silty, weathers to light gray to tan, very fine, well sorted, massive, friable, biotitic; scattered Foraminifera, "cannonball" concretions 6–18 in. in diameter; spherical limonitic stained outer shell; calcareous cemented core, usually occurring in beds. *Ostrea* beds occur about one-half of a foot above base (UCMP loc. B1649) and 4 ft above base	46+

OLCESE SAND

Diepenbrock (1933, p. 14) first used the name Olcese Sand parenthetically as "Middle Temblor Sandstone (Olcese sand of the Round Mountain area)" in a report on Mount Poso oil field. It was not used, however, in his subsequent report on the Round Mountain Silt (Diepenbrock, 1934), in which the "Middle Temblor" was described as "800 to 850 feet of loose, medium-grained to coarse sand with some beds of fine silty sand and also beds of conglomerate." The name was subsequently used as the "Olcese Sandstone Member of the Temblor Formation" by Kleinpell (1938, p. 153). Initial definition of the Olcese Sand was made by Ferguson (1941, p. 241, 242), who recognized three parts: a lower sand with interbedded siltstone containing Foraminifera, an apparently nonmarine middle part, and an abundantly fossiliferous upper part. The age of the formation was regarded as late Saucesian to early Relizian.

The type area for the Olcese Sand should logically be in or near the Round Mountain oil field in keeping with Diepenbrock's original reference (1933, p. 14) to this name. In all probability the name was taken from one of the wells drilled on Olcese oil leases in the central and southern parts of Round Mountain field. The designation of the type locality, a well at the west edge of Mount Poso oil field several miles to the northwest (Ohio Oil "Glide" 1, sec. 13, T. 27 S., R. 27 E.), attributed to Keen (1943) by Keroher and others (1966, p. 2816) is in error and is therefore not taken into consideration here. Rogers' generalized description and composite electric log (1943, p. 580, 582) of the Olcese Sand at Round Mountain field can be taken as the original designation of a type locality for this unit. Inasmuch as the Olcese Sand is exposed at the surface in Round Mountain field, it has not been regarded as a potential oil-bearing reservoir and consequently has not been continuously cored. Therefore, recognition of the formation and determination of its depositional relationships to other formations is best determined from electric logs. Accordingly, electric logs from the Shell Oil Co. Freeman lease (SW¼ sec. 20, T. 28 S., R. 29 E.) in the southern part of Round Mountain field (Park and others, 1963, pl. 5) are collectively designated as reference electric logs.

The lower part of the Olcese Sand consists of gray very fine silty marine sand with interbedded sandy and clayey siltstone. In the Round Mountain field this unit is about 300–500 feet thick and consists of very fine to fine-grained micaceous carbonaceous sandstone with scattered megafossils and thin calcareous sandstone beds ("shells"). Toward the center of the basin (fig. 7), this unit grades laterally into siltstone of the underlying Freeman Silt. Above the basal very fine sand, the Olcese grades into fine to coarse gray to bluish-gray sand and gravel. In the outcrop this interval appears to be nonmarine, and the sand and gravel is strongly crossbedded. In the uppermost part of the formation, electric logs and cores indicate a 25- to 125-foot interval of fine to very fine silty sand which thins and grades to siltstone downdip (fig. 7).

Because of infrequent coring, the contacts of the

Olcese Sand are best determined from electric logs. The upper contact with the Round Mountain Silt is placed at the point on the log where massive sand changes abruptly to a siltstone "neck" formed by low resistivity and spontaneous potential values. This contact can be readily correlated in the oil-field areas northeast of Bakersfield, but it gradually drops stratigraphically basinward by gradation of the upper part of the Olcese Sand to siltstone or shale. East and northeast of Mount Poso field, the Kern River Formation of Anderson (1911) overlaps the Round Mountain Silt to lie unconformably on Olcese Sand in the subsurface. This sand-on-sand contact is difficult to identify on electric logs. The contact with the underlying Freeman Silt is gradational; it is drawn at the change from sand to siltstone or shale below (fig. 5).

Maximum subsurface development of the Olcese Sand occurs south and southwest of Round Mountain field. In the Gene Reid "M. and T." well 1 near Kern River (sec. 31, T. 28 S., R. 29 E.), the Olcese is about 1,365 feet thick. Northward along the strike, the formation thins to about 650 feet at Mount Poso field and 400 feet southeast of Dyer Creek field. The Olcese also decreases in thickness toward the southeast; at Ant Hill field south of Kern River, the average thickness is about 700 feet.

Exposures in sec. 6 and 7, T. 28 S., R. 29 E., and sec. 12, T. 28 S., R. 28 E., west of Coffee Canyon, are collectively designated as characteristic outcrops of the Olcese Sand. In this area, however, only the upper and middle parts of the formation are fully exposed. Of the lower part of the Olcese, only the upper 100 feet or so is exposed in this area; subsurface data indicate that this part of the formation is about 650 feet thick here.

Section of Olcese Sand and Round Mountain Silt

[This traverse loops up prominent northeast-trending ridge and then to the southwest from base located along north side of oil-field service road at the mouth of a small east-west gully 1,000 feet west from main road to Round Mountain near the center of sec. 7, T. 28 S., R. 29 E., Woody 15-minute quadrangle]

	Thickness (feet)
Round Mountain Silt, lower part:	
35. Siltstone, orangish-tan, tan, and gray; locally sandy; scattered white to grayish-white calcareous siltstone concretions; Foraminifera, *Acila* sp., and *Clementia*? sp	34+
34. Covered	6
33. Silt, sandy, gray and tan; abundant ¼–½ in. burrows	2
32. Mostly covered. Dark-brown silty soil with abundant gypsum and calcareous siltstone chips, becoming more gypsiferous 22 ft above base; badly weathered clayey silt 60 ft above base; sandy silt 83 ft above base (may include some Olcese Sand)	106
Olcese Sand, upper part:	
31. Covered. Ant hills and soil indicative of dark-gray fine to very fine sand	11
30. Sand, white, fine, locally very silty; poorly sorted, tuffaceous, carbonaceous; fairly abundant white and light-green mica; scattered leaf impressions, becoming more uniformly very fine above	31
29. Covered	2
28. Sand, very poorly exposed; gray, fine, poorly sorted	3
27. Sandstone, poorly exposed; light grayish tan, very fine grained, fairly well sorted, difficultly friable, locally well indurated, resistant	4
26. Siltstone, poorly exposed; weathers to whitish tan	4
25. Sandy silt, poorly exposed; weathers to whitish-tan; 10 percent very fine to coarse sand grains	13
24. Sandstone, white, medium-grained, clayey, well-indurated, ledge-forming; iron oxide stained	2
Olcese Sand, middle part:	
23. Sand, pebbly, weathers to yellowish-gray to tan; coarse, very poorly sorted to unsorted; iron oxide stained; apparently crossbedded; less pebbly above	32
22. Sand, silty, poorly exposed; white; weathers to very light tan to greenish-white; very fine grained	3
21. Clay, poorly exposed; white to greenish white, becoming silty above with some very fine sand near top; fairly abundant iron oxide stains	4
20. Sand, clayey and silty, weathers to very light greenish tan; very fine, fairly well to poorly sorted; increases clay toward top of unit	11
19. Sand, poorly exposed; weathers to white to whitish tan; fine to medium, very well sorted	7
18. Clayey and silty sand, weathers to greenish tan, very fine; forms gritty clayey soil	9
17. Sand, poorly exposed; weathers to buff-white; very fine, very well sorted	6
16. Silty sand, white, fine to very fine, poorly sorted; tuffaceous; contains scattered coarse to very coarse bluish-black rounded chert grains, increasing toward top	22
15. Sand, poorly exposed; weathers to very light orangish tan to white; fine	9
14. Sand, poorly exposed; weathers to orangish-brown; fine to coarse, poorly sorted; forms prominent 15- to 20-ft unit viewed from distance; 1½-ft resistant pebble conglomerate 4 ft above base	19
13. Covered	2
12. Conglomeratic sandstone, poorly exposed; weathers to very light grayish tan; very poorly sorted; scattered pebbles and cobbles as much as 1½ in. in diameter; resistant	35
11. Sandstone, light-gray to light-bluish-gray, very fine grained, massive, difficultly friable, ledge-forming	5
10. Sandstone, white, weathers to light-gray; medium grained, poorly sorted, well indurated; 1- to 2-ft, rust-weathering ledge at base of unit	9
9. Sandstone, yellowish- to bluish-white, weathers to grayish-tan; very fine grained, evenly sorted, massive; friable to somewhat difficultly friable; upper 3 ft crossbedded	31

Section of Olcese Sand and Round Mountain Silt—Continued

	Thickness (feet)
Olcese Sand, middle part—Continued	
8. Silty clay or claystone, white; considerably weathered; lenses out down dip	1
7. Sandstone, yellowish- to bluish-white, weathers to grayish-tan; very fine grained, massive; difficultly friable	7
6. Sand, very poorly exposed; weathers to blue and rust; poorly sorted; abundant bluish-black chert grains	3
5. Covered	8
4. Sand and gravel; weathers to blue and rust; sand is very coarse, poorly sorted; rounded bluish-black chert grains abundant	5
3. Conglomerate, weathers to rusty-red; rounded pebbles and cobbles as much as 2 in. in diameter; crossbedded	1
2. Sandstone, light-bluish-gray, fine- to medium-grained, fairly well to poorly sorted; 30 percent pumice grains; friable; strongly crossbedded; abundant limonitic stained bands	6
1. Shale, white, fissile, fairly brittle; apparently bentonitic	

The lower part of the Olcese Sand consists of silty very fine to fine-grained friable sandstone. It is best exposed north of Poso Creek. In Borel Canyon (sec. 12, T. 27 S., R. 28 E.) the lower 200 feet of the Olcese consists of light-gray-weathering tuffaceous very fine grained silty sandstone with scattered calcareous sandstone concretions, indeterminate megafossils, fish scales, and plant fragments. As previously mentioned, the sandstone beds crop out as terraced slopes on south-facing hillsides. At most places, the contact with the underlying Freeman Silt is difficult to recognize because of the lack of strong lithologic contrast. Where favorably exposed, however, the change upward from siltstone to sandstone and the terraced outcrop pattern of the lower part of the Olcese Sand are useful criteria in mapping the contact.

The middle part of the Olcese Sand seems to be predominantly nonmarine. Marine fossils have been found at only one locality in this unit on the south side of Poso Creek (Blake, 1855; Clark, 1937); elsewhere silicified wood fragments and tree trunks as much as 2 feet in diameter occur. This part of the formation is characterized by unconsolidated medium to very coarse crossbedded tuffaceous sand containing a variable fraction of well-rounded bluish-black chert pebbles, cobbles, and sand grains. Orange and reddish iron oxide stained laminae are characteristic. Thin silty claystone beds that are weathered to greenish-tan are scattered throughout the unit, which is about 225 feet thick in the surface reference section along Poso Creek. Contacts with the upper and lower parts of the Olcese are marked by crossbedded coarse to pebbly sand. The lower contact appears to be disconformable north of Poso Creek. Burrows of boring pelecypods at the contact with the finer grained marine sands of the upper part of the Olcese suggest that it too may be disconformable.

The upper part of the Olcese Sand consists of fossiliferous fine to very fine sand and siltstone, that are weathered to light gray to tan and that are best exposed between Kern River and Poso Creek. Along Poso Creek it is about 70 feet thick; west of Round Mountain field a 116-foot section was measured (sec. 24, T. 28 S., R. 28 E.). Along Poso Creek, sand in the upper part of the Olcese is usually tuffaceous, sparingly fossiliferous, silty and fine to very fine and is weathered to tan. Siltstone beds are generally sandy, fossiliferous, and tuffaceous. Several thin dark-gray crossbedded medium-grained sands occur near the contact with the posed between Kern River and Poso Creek. Along Poso Creek it is about 70 feet thick; west of Round Mountain field a 116-foot section was measured (sec. 24, T. *Tivela*, *Polinices*, and other mollusks. The lower contact is placed at the top of the strongly crossbedded unconsolidated coarse to pebbly sand of the middle part of the formation. The upper part of the Olcese Sand includes the Barker's Ranch molluscan fauna. North and east of the site of Barker's Ranch, several molluscan accumulations occur in calcareous sandstones near the top of the Olcese Sand. Anderson (1911) based his "B zone" on assemblages from this part of the Olcese.

ROUND MOUNTAIN SILT

Diepenbrock (1933, p. 14) first used the name "Upper Temblor (Round Mountain Silt)" as a paragraph heading in a description of the Temblor Formation at Mount Poso oil field. However, in the text of that report, and of a subsequent one on the Round Mountain field (Diepenbrock, 1934), he used the name "Upper Temblor" exclusively. A 220-foot cored interval of "Upper Temblor" consisting of diatomite, siltstone, and sand in the Ohio Oil "Glide" 1 (sec. 13, T. 27 S., R. 27 E.) was described by Diepenbrock (1933). This well was designated as the type locality of the Round Mountain Silt by Keen (1943, p. 30). The name was evidently derived from siltstone weathered to tan that caps Round Mountain 9 miles southeast of the type well. As with the Olcese Sand, the name was subsequently used by Kleinpell (1938, p. 201) as Round Mountain Silt Member of the Temblor Formation. It has since become a unit widely used for subsurface correlation in the southeastern part of the San Joaquin Valley (Ferguson, 1941, p. 240–241). The formation is overlain by the Santa Margarita Formation and rests conformably upon the Olcese Sand in the type well. North and west of Mount Poso field, local sand beds in the lowest part of the Round Mountain Silt have been called the McVan Sand (Beck, 1952; Sperber, 1952), a name apparently derived from wells in McVan field (sec. 14, T. 27 S., R. 27 E.), about 1½ miles west of the Ohio "Glide" 1.

The type section is here redefined as being the continuously cored 213-foot interval from 1,229 to 1,442 feet in the Ohio Oil "Glide" 1. This usage is in agreement with the definitive modern report on oil fields of the Mount Poso area although it differs from Diepenbrock's original definition of "Upper Temblor" (Albright and others, 1957). It excludes the basal 3 feet of gray foraminiferal siltstone and the overlying 57 feet of gray silty sand included in the "Upper Temblor" by Diepenbrock (1933, p. 14) but here included in the Olcese Sand. The basal 53 feet of gray sandy shale of his Santa Margarita Formation are here included in the Round Mountain Silt. According to the original core descriptions, the rocks in this interval consist of gray to brown sandy shale and diatomaceous clay shale (probably siltstone). Diepenbrock's description (1933, p. 14) of the upper 160 feet of his section is as follows:

	Thickness (feet)
Gray and brown diatomaceous and foraminiferal siltstone	70
Diatomite	50
Dark-gray siltstone; diatoms and Foraminifera common	40

The Round Mountain Silt is unconformably overlain by the Santa Margarita Formation; the contact is placed at the base of a massive sand that overlies sandy siltstone. The contact with the underlying Olcese Sand is drawn at the top of a very fine silty sand, which at some places is included in the Round Mountain Silt as the McVan Sand Member (Beck, 1952). Electric logs from the nearby Pacific Oil and Gas "Glide" 62–A (sec. 13, T. 27 S., R. 27 E.) serve as a reference section for subsurface recognition and correlation of the Round Mountain Silt. Diepenbrock's core description (1933) is compared with the redefined type section and reference electric logs in figure 8.

Because the Round Mountain Silt is not considered to be a potential oil-bearing unit, is has been the practice to drill through the formation and not to take any cores. Consequently, in most wells lithologic character in the subsurface must be interpreted from electric logs. In a few early exploratory wells, however, much or all of the formation was cored. In the vicinity of Round Mountain and Mount Poso fields the formation consists principally of foraminiferal and diatomaceous siltstone. At Jasmin field to the northwest (sec. 22, T. 25 S., R. 27 E), lenses or tongues of gray fine sand occur in the Round Mountain Silt (Sperber, 1952; Hluza, 1958).

The Round Mountain Silt may be divided into four principal lithologic units that are more or less characteristically present in the Shell Oil "Furhman" 1 near the south end of Mount Poso field (sec. 4, T. 28 S., R. 28 E.), an early well in which the formation was continuously cored. The lowest unit consists of about 100 feet of light- to dark-gray clayey siltstone containing abundant Foraminifera, mollusks, and fish scales. Local sand beds such as the McVan Sand of Sperber (1952) present in the lower part of the Round Mountain Silt north and west of Poso field suggest an intertonguing relationship with the upper part of the Olcese Sand. The next unit is composed of nearly 100 feet of tuffaceous diatomaceous siltstone and foraminiferal clay shale. The diatoms are locally concentrated in thin laminæ. Occasional interbeds of sand with phosphatic pellets, or "sporbo" (Galliher, 1931) occurring at the base of this unit may indicate that relations with underlying strata are locally disconformable. The third unit consists of about 100 feet of light-gray to greenish-black clayey siltstone with scattered diatoms, arenaceous and calcareous Foraminifera, and fish scales. The uppermost unit is a greenish-gray sandy siltstone about 20 feet thick from which arenaceous Foraminifera, fish remains, and carbonaceous material have been reported.

The Round Mountain Silt thickens southeastward from less than 100 feet at Mount Poso field (Albright and others, 1957) to nearly 800 feet at Kern River in the Amerada Oil "Olcese" 1 (sec. 4, T. 29 S., R. 29 E.). This rapid thickening is attributed, in part, to the gradation of the upper part of the Olcese Sand to siltstone south of Round Mountain. Thinning of the formation toward the margin of the basin north of Poso Creek results, in part, from the unconformable overlap of the Round Mountain Silt by the Santa Margarita Formation and, farther northeast, by the Kern River Formation of Anderson (1911).

The Round Mountain Silt is well-exposed in gullies and canyons from Poso Creek southward to Cottonwood Creek. Along Kern River the formation crops out almost continuously from Hart Park to the fault scarp at the mouth of the Kern River gorge. The Sharktooth Hill area about 2 miles southwest of Round Mountain is here designated as the surface reference locality for the Round Mountain Silt. However, because of low relief and near-horizontal attitudes, the formation is not fully exposed in this area. In the subsurface, half a mile to the northwest, the Round Mountain Silt is 470 feet thick.

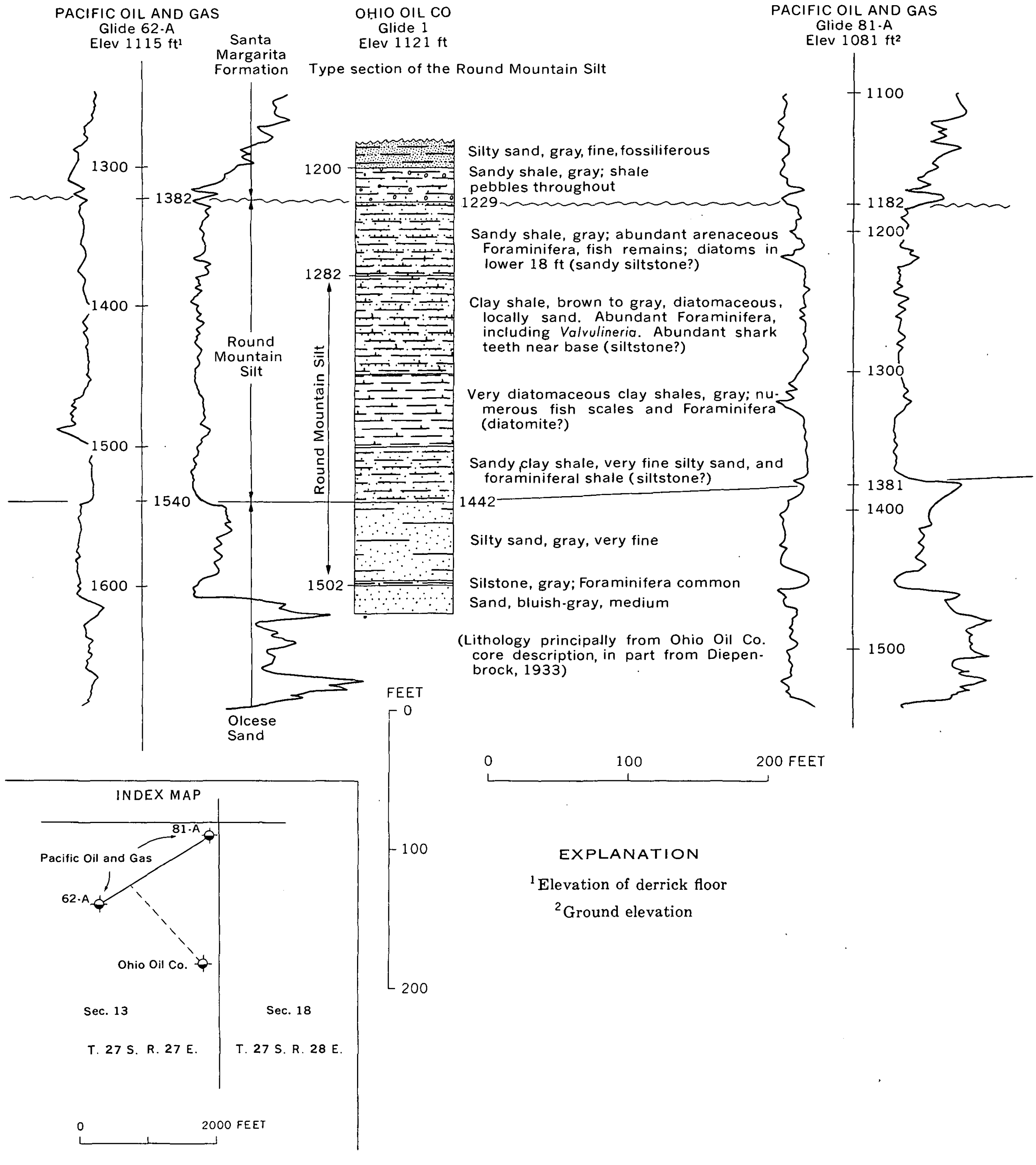


FIGURE 8.—Correlation of type section of the Round Mountain Silt with nearby wells.

South and southwest of Round Mountain, the basal part of the formation consists of 100–125 feet of chocolate-brown-weathering foraminiferal massive siltstone and clayey siltstone. Toward the southeast, basal siltstone beds grade into dark-grayish-brown micaceous platy siltstone with abundant *Anadara osmonti*. Northwest of Round Mountain, the basal siltstone grades into tan-weathering micaceous tuffaceous sandy siltstone.

About 125 feet of white-weathering diatomaceous shale and interbedded claystone and siltstone overlie this lowest unit. The diatomite is thin bedded to fissile and gypsiferous; it contains large discoidal diatoms and is locally foraminiferal. A foot-thick bed of fine-grained vitric tuff occurs near the top of the unit; fine-grained tuff beds occur in this interval from north of Poso Creek southward to Kern River. The diatomaceous shale and siltstone varies in thickness. East of Cottonwood Creek it appears to be more than 200 feet thick. Diatomaceous strata characterized by many large discoidal diatoms appear to grade laterally into siltstone, particularly east of Rancheria Road (T. 28 S., R. 29 E.). In general, the unit seems to become more diatomaceous toward the top. Hanna (1932) listed a flora of 80 species of diatoms from this interval.

South of Poso Creek the diatomaceous shale is overlain by tan-weathering massive claystone that grades upward into poorly exposed siltstone. The claystone contains plant debris and large fish scales. North of Poso Creek the diatomite is overlain by a cross-bedded calcareous conglomeratic sandstone and a sandy bioclastic limestone containing abundant fragments of mollusks. The limestone probably is correlative with the *Turritella ocoyana* bed that crops out at Sharktooth Hill and Cottonwood Creek. Between Kern River and Poso Creek, the claystone is overlain by clayey and sandy siltstone, about 85–110 feet thick, that is grayish tan, massive, locally carbonaceous and gypsiferous and that contains scattered calcareous siltstone concretions.

A light-gray massive silty sandstone containing abundant shark teeth and bones of marine mammals overlies the siltstone. The shark-tooth and bone bed averages about 15 feet in thickness; it can be traced by following float of bone debris and shark teeth from the northern part of Dorsey area of Mount Poso field southeastward to Cottonwood Creek. The vertebrate fauna of the shark-tooth bed includes sea lions, whales, a turtle, a desmostylian, birds, sharks, and rays (Mitchell, 1965).

Overlying the shark-tooth bed is a fossiliferous sandy siltstone that grades upward into silty very fine sand. This unit is about 65 feet thick near the mouth of Cottonwood Creek (sec. 11, T. 29 S., R. 29 E.).

Section through upper part of Round Mountain Silt up southwest-trending gully in SE¼SE¼ sec. 11, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle

	Thickness (feet)
Santa Margarita Formation:	
12. Boulder and cobble gravel; boulders rounded, maximum diameter 3½ ft; abundant iron oxide staining at contact with underlying unit	10+
Unconformity.	
Round Mountain Silt:	
11. Sand, silty, buff to greenish-buff; very fine, well sorted; micaceous; contains shark tooth	2
10. Silt, sandy, light-grayish-tan; micaceous	2
9. Sand, silty, light-greenish-tan; fine to very fine, well sorted; sugary texture	5

Section through upper part of Round Mountain Silt of southwest-trending gully in SE¼SE¼ sec. 11, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle—Continued.

	Thickness (feet)
Round Mountain Silt—Continued	
8. Sand, silty, light-greenish-tan; very fine, fairly well sorted; 10 percent biotite; scattered thin limonitic stained bands	8
7. Sand, light-gray to white; very fine, well sorted; sand grains subrounded; scattered limonitic stained bands	34
6. Sandstone, weathered to rust- to brown; very fine grained; calcareous, well indurated; abundant wood fragments and abundant *Dosinia merriami* Clark (USGS loc. M1606; UCMP B1678)	1
5. Sand, silty, poorly exposed, light-gray, soft	6
4. Silt, sandy, poorly exposed, weathered to tan to orangish-tan	6
3. Sand, silty, very light greenish gray to white, very fine, soft; probably the shark-tooth and bone bed	13
2. Sandstone, white, very fine grained, calcareous, moderately well indurated, micaceous	2
1. Silstone, tan-weathering, locally calcareous; abundant shark-tooth and bone-fragment float on hillside, presumably from base of unit 3 above	28

Nonmarine sand and gravel refer to the Cottonwood Creek Formation of Hackel and Krammes (1958) and the Bena Formation and Santa Margarita Sand of Dibblee, Bruer, Hackel, and Warne (1965) unconformably overlie the Round Mountain Silt along Kern River. North of Mount Poso field, the Round Mountain Silt is truncated by the Kern River Formation of Anderson (1911), which lies unconformably upon the Olcese Sand in the outcrop. East of Cottonwood Creek, gravels included in the Bena Formation (Dibblee and others, 1965) overlap the upper part of the Round Mountain Silt to rest unconformably on diatomaceous shale and siltstone. North of Kern River, the lower contact is placed at the top of a dark-gray to greenish-gray medium- to coarse-grained sand that contains local concentrations of *Tivela* and *Polinices*. Tongues of fossiliferous fine to medium gray sand occurring stratigraphically above the *Tivela* bed in the type area of the Barker's Ranch fauna south of Round Mountain field are included in the Olcese Sand. Beds included in the lower part of the Round Mountain Silt on the south side of Kern River east of Cottonwood Creek may be equivalent to coarser grained strata included in the Olcese Sand north of Kern River because of the previously noted southerly facies change from sand to siltstone in the upper part of the Olcese Sand evident in subsurface correlation by electric log. The Round Mountain-Olcese contact in this area (Dibblee and others, 1965) probably corresponds to the contact between the upper and middle parts of the Olcese Sand north of Kern River.

SANTA MARGARITA FORMATION

Hanna (1930, p. 78) first discussed usage of "Santa Margarita" for marine sediments overlying "typical upper Temblor" and underlying "clays and sands called Chanac" in wells of the Kern River area. He concluded, however, that the name should not be used in the eastern part of the San Joaquin Valley because there was not sufficient evidence to permit correlation of these strata with the type Santa Margarita Formation of San Luis Obispo County (Fairbanks, 1904). Since first used by Diepenbrock (1933, p. 13–14), however, the name has gained acceptance and as now used applies to a widely recognized subsurface unit. Some workers have indicated dissatisfaction with this name by using it in quotations (Birch in Keen, 1943; Ferguson in Weaver and others, 1944), and Savage (1955) has stressed need for a replacement name. The name was originally extended to a coarse sandstone in the Tejon Hills, about 22 miles south of Kern River, because of similarity of marine megafossils to the fauna of the type area near Santa Margarita, Calif. (Hoots, 1930). Similarly, recognition of this formation in the subsurface has been based, at least in part, on megafossil assemblages (Miller and Ferguson, 1943).

Subsurface recognition of the Santa Margarita Formation on electric logs is based upon the more or less abrupt change upward from a shale or siltstone "neck" in the Round Mountain Silt to expanded resistivity and self-potential curves indicative of sand (fig. 8). In some places the upper contact is difficult to determine on electric logs because of the similar sandy character of the Kern River Formation of Anderson (1911) and Brooks (1952). At the type Round Mountain Silt well west of Mount Poso field (sec. 13, T. 27 S., R. 27 E.), the basal part of the Santa Margarita Formation is described as a sandy shale (probably siltstone) containing gray shale pebbles, presumably from the underlying Round Mountain Silt.

In wells about a mile north of Kern Front field, the Santa Margarita Formation is 350–400 feet thick. The lower 100 feet is composed principally of gray massive carbonaceous fine to very fine sand containing scattered mollusks and fish remains. The sand coarsens toward the top of the formation. To the east, the Santa Margarita Formation is progressively overlapped by the Kern River Formation. In the main part of Mount Poso field, only the lower silty, very fine grained carbonaceous sand is present. Farther east the Kern River Formation overlaps the Santa Margarita Formation and the underlying Round Mountain Silt to lie unconformably on the Olcese Sand.

The Santa Margarita Formation has been mapped by Birch (in Keen, 1943) and Dibblee and others (1965) as a relatively thin unit of white coarse-grained sand and gravel best exposed in bluffs on the south side of Kern River from Hart Park to Cottonwood Creek. It was mapped as the Mon Bluff Formation by Hackel and Krammes (1958) and shown to be overlapped by the Kern River Formation of Anderson (1911), Brooks (1952), north of Poso Creek (sec. 3, T. 28 S., R. 28 E.), and near Cottonwood Creek (NE¼ sec. 14, T. 29 S., R. 29 E.)

Fossils have not been found in surface exposures of the Santa Margarita Formation in the Kern River area. Where cored, however, the Santa Margarita usually contains scattered mollusks, fish scales, or Foraminifera, which indicate marine deposition. Late Miocene megafossils have been reported from oil fields downdip (Preston, 1931; Grant and Gale, 1931; Miller and Bloom, 1937; Miller and Ledingham, 1943; Edwards, 1943b; and others). The largest and best known assemblage is from wells in Fruitvale field about 3 miles west of Bakersfield. Gale (in Preston, 1931) recorded an assemblage of 55 molluscan taxa of late Miocene age from wells in that area.

BIOSTRATIGRAPHY

PREVIOUS WORK

Anderson (1911) made the initial biostratigraphic study of the marine Miocene formations of the Kern River area. This work and his description of the molluscan fauna (Anderson, 1905; Anderson and Martin, 1914) form the basis of recognition of the middle Miocene "Temblor Stage" of the Pacific coast chronology. In 1911 Anderson defined three faunal zones based on marine mollusks. "Zone A" included 500 feet of concretionary sand at the base of the marine section (fig. 9). The originally reported assemblage of 40 molluscan taxa from near the base of this unit at Pyramid Hill is now placed in the lower Miocene (Loel and Corey, 1932; Addicott, 1965a). His "B zone" included about 100 feet of sand at the top of what is now mapped as the Olcese Sand. Forty-six taxa were listed from localities exposed in the hills on the north side of Kern River northeast of Barker's Ranch, the type area of the Barker's Ranch fauna. A 60-foot interval of very fine grained sand in the upper part of what is now mapped as the Round Mountain Silt was called the "C zone." This unit is characterized by abundant shark teeth and bones in the lower part and by a small assemblage of mollusks near the top.

Incompletely documented Miocene molluscan "zones" (assemblage or faunal zones) in the Kern River area were listed by Loel and Corey (1932, p. 99). Three of

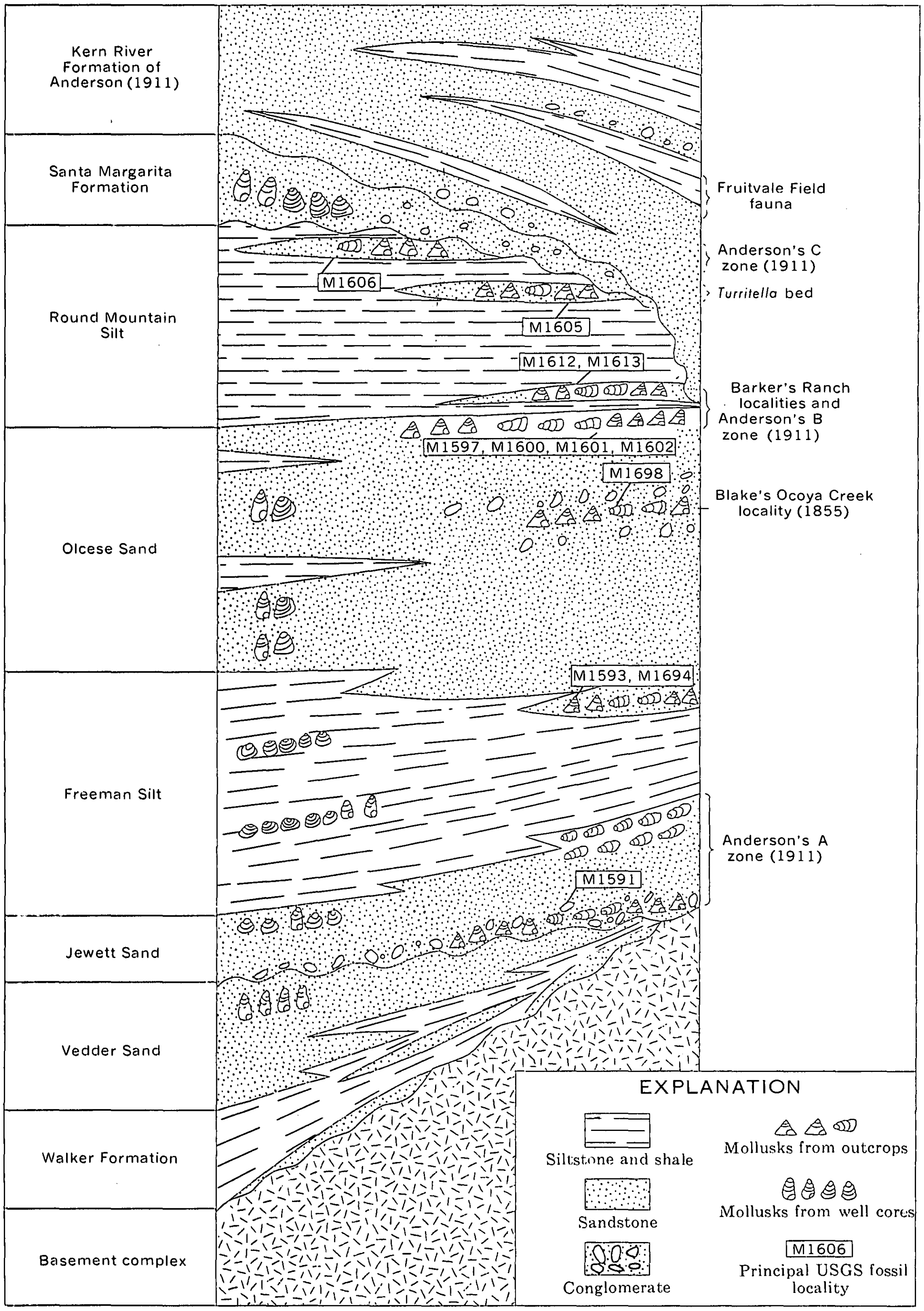


FIGURE 9.—Principal outcrop and subsurface occurrences of Miocene molluscan assemblages referred to in text.

the lower zones are from the Jewett Sand and appear to fall within the stratigraphic limits of Anderson's "A zone" (1911). Their lowest zone, a fossiliferous pebble bed containing "*Pecten*" *magnolia*, was considered to be definitely "Vaqueros" in age (Loel and Corey, 1932, p. 93). Three overlying zones, the "*Crepidula, Dentalium, Pecten perrini*-pine-cone zone," the "*Turritella inezana* cf. *sespeensis* zone," and the "*Ostrea* aff. *eldridgei, Pecten* aff. *sespeensis* zone" were assigned to their "Vaqueros-Temblor transition zone." Their "Vedder Sands" were mistakenly included in this part of the section and, contrary to Loel and Corey's statement (1932, p. 93), do not carry a "lower Temblor fauna." Their *Turritella inezana* zone, recognized only in the subsurface from "cores taken about 200 feet below top of Vedder Sands" (Loel and Corey, 1932, p. 99), is likewise out of normal stratigraphic position and should not be taken as an extension of the range of *T. inezana* above the basal part of the Jewett Sand. The two uppermost "Temblor-Monterey" zones, the "*Conus, Ficus, Trophon, Bruclarkia* zone" and the "*Turritella ocoyana, Turritella ocoyana bosei* zone," are from the uppermost part of the Olcese Sand and the upper part of the Round Mountain Silt, respectively.

GENERAL CONSIDERATIONS

Gastropods occur in abundance only in certain parts of the Miocene section, principally in fine-grained sands deposited in an inner sublittoral environment presumably below the zone of vigorous marine abrasion, which is limited to about 5 fathoms (Bradley, 1958). Pelecypods occur in abundance in a broad range of depositional environments, including coarse-grained shallow-water sands and outer sublittoral or shelf muddy sediments such as the Freeman Silt. Principal gastropod-bearing units are: (1) the lower 100 feet of the Jewett Sand, (2) the lower part of the Olcese Sand, (3) the upper part of the Olcese Sand and basal part of the Round Mountain Silt, (4) the middle part of the Round Mountain Silt, and (5) the uppermost part of the Round Mountain Silt above the shark-tooth and bone bed (fig. 9). In these parts of the marine section, gastropods and pelecypods are usually concentrated in relatively thin beds. Fossiliferous strata in the lower part of the Round Mountain Silt are lenticular and are usually less than 3 inches thick; in other parts of the marine section they reach a thickness of a foot or more.

The fauna of the Jewett Sand is distinctly different from assemblages representative of comparable shallow-water environments higher in the section. Included are several middle Tertiary taxa of northern aspect: *Epitonium clallamense, Priscofusus medialis, P. geniculus, Psephaea weaveri, Mediargo mathewsoni, Trichotropis* spp., and *Mytilus middendorffi*. This is the southernmost occurrence of these mollusks; only one of them, *P. medialis*, ranges any higher in the local stratigraphic section. The few mollusks known from the Freeman Silt—*Acila, Cyclocardia, Delectopecten, Katherinella*, and *P. medialis*—suggest a relatively deeper, outer sublittoral environment. The small assemblages in the lower part of the Olcese Sand include a few taxa that are not found elsewhere in the Kern River Miocene but are, for the most part, very similar to stratigraphically higher assemblages. Many commonly occurring species in the Kern River section are restricted to certain parts of the stratigraphic sequence (table 1). Although the stratigraphic ranges of these species may be useful for correlation with other sections in the southern part of the San Joaquin basin, in other Miocene basins of deposition some of these have different stratigraphic ranges.

Notable in collecting is the tendency for one species to be exceedingly abundant at a given locality or perhaps in several nearby localities from the same bed. *Tivela*, for example, is very abundant in a sand at the top of the Olcese Sand near Poso Creek. *Conus* is likewise extremely abundant at a locality near the top of the Round Mountain Silt west of the juncture of Cottonwood Creek and Kern River. *Turritella ocoyana* and *Tivela* maintain their numerical dominance in a fossiliferous bed for several miles of exposure, but in other beds, such as exposures of the basal part of the Jewett Sand from Pyramid Hill northward to Moore Canyon, the faunal composition changes rapidly along strike.

For the most part the fossil accumulations represent level-bottom molluscan associations that lived on sandy substrates. The occurrence of shells in layers suggests that they were death assemblages concentrated by current action or perhaps were accumulated approximately in place during periods of slow deposition. At all events the composition of the assemblages does not suggest appreciable mixing of mollusks from different environmental associations. There are marginal marine associations in the upper part of the Olcese Sand that include the brackish-water pelecypod *Corbicula* and scattered specimens of the large elongate oyster *Crassostrea ashleyi* (Hertlein). Mollusks representing a muddy, outer sublittoral environment occur in the Freeman Silt and in the lower part of the Round Mountain Silt. They ordinarily occur scattered throughout massive sandy siltstone in associations that seem to be unaffected by current or downslope transport after death.

TABLE 1.—*Stratigraphic occurrence of Miocene gastropods in the Kern River-Bakersfield area*

Species	Miocene							
	Lower "Vaqueros Stage" [1]		Middle "Temblor Stage" [1]					Upper
			Olcese Sand			Round Mountain Silt		
	Jewett Sand	Freeman Silt	Lower part	Middle part	Upper part	Lower part	Upper part	Santa Margarita Formation
Diodora (Diodora) n. sp	×							
Diodora? n. sp	×							
Tegula (Omphalius) dalli arnoldi Addicott, n. subsp					×			
Tegula (Omphalius) laevis Addicott, n. sp					×			
Gibbula (Tumulus?) baileyi Addicott n. sp						×		
Calliostoma carsoni Addicott, n. sp					×			
Calliostoma sp. A	×							
Calliostoma sp. B	×							
Astraea (Pomaulax) n. sp					×			
Astraea (Pomaulax) biangulata (Gabb)					×	?		
Nerita (Theliostyla?) joaquinensis Addicott, n. sp						×		
Lacuna carpenteri Anderson and Martin					×			
Vitrinella (Vitrinellops) lens (Keen)					×	×		
Turritella moodyi Merriam						×		
Turritella kernensis Addicott, n. sp					×	×		
Turritella (Torcula) cf. *T. (T.) inezana* Conrad	×[2]							
Turritella (Torcula) inezana pervulgata Merriam	(2)							
Turritella (Torcula?) cf. *T. (T.?) padronesensis* Grant and Eaton					×			
Turritella ocoyana Conrad			×	×	×	×		
Turitella ocoyana forma *topangensis* Merriam					×	×	×	
Cerithiopsis aff. *C. subgloriosa* Baker, Hanna and Strong					×			
Bittium topangensis (Arnold)	×[3]				×			
Batillaria ocoyana (Anderson and Martin)				×	×			
Epitonium (Cirsotrema) clallamense Durham	×							
Epitonium (Cirsotrema) posoense Anderson and Martin					×	?		
Epitonium (Gyroscala) barkerianum Addicott, n. sp					×			
Epitonium (Nitidiscala) tedfordi Addicott, n. sp					×	×		
Opalia (Rugatiscala) williamsoni (Anderson and Martin)					×	×		
Scalina durhami (Keen)						×		
Scalina whitei (Keen)					×	×		
Eulima gabbiana (Anderson and Martin)					×	×		
Balcis conchita Keen					×	×		
Balcis lutzi Addicott, n. sp					×	×		
Balcis petrolia Addicott, n. sp					×	×		
Balcis cf. *B. oldroydi* Bartsch					×			
Niso antiselli Anderson and Martin					×	×		
Niso cottonwoodensis Addicott, n. sp					×	×		
Trichotropis tricarinata Addicott, n. sp	×							
Trichotropis sp	×							

See footnotes at end of table.

TABLE 1.—*Stratigraphic occurrence of Miocene gastropods in the Kern River-Bakersfield area*—Continued

Species	Miocene							
	Lower "Vaqueros Stage" [1]		Middle "Temblor Stage" [1]					Upper
			Olcese Sand			Round Mountain Silt		
	Jewett Sand	Freeman Silt	Lower part	Middle part	Upper part	Lower part	Upper part	Santa Margarita Formation
Calyptraea filosa (Gabb)					×	×		
Calyptraea coreyi Addicott, n. sp	×							
Calyptraea mamillaris Broderip					cf.			×[4]
Calyptraea (Trochita) cf. *C. (T.) spirata* (Forbes)	×							
Crucibulum cf. *C. scutellatum* (Wood)						×		
Crucibulum (Dispotaea) papulum Addicott, n. sp						×		
Crepidula bractea Addicott, n. sp					×	×		
Crepidula princeps Conrad	×		×					
Crepidula rostralis (Conrad)			×	×	×	×		
Crepidula cf. *C. aculeata* (Gmelin)						×		
Natica (Natica) teglandae Hanna and Hertlein					×	×		
Natica (Naticarius?) posuncula Hanna and Hertlein					×	×		
Polinices victoriana Clark and Arnold	×		cf.	×	×	×		
Neverita (Glossaulax) andersoni (Clark)	×		×	×	×	×	×	
Neverita (Glossaulax) alta Arnold					×	×		
Neverita (Glossaulax) jamesae Moore					×	×		
Neverita (Glossaulax) n. sp.?					×	×		
Sinum scopulosum (Conrad)	×				×	×		
Cymatium n. sp					×			
Mediargo dilleri (Anderson and Martin)					×			
Mediargo mathewsoni (Gabb)	×				×			
Ficus (Trophosycon) kerniana Cooper	×		×	×	×	×	×	×
Ceratostoma? aff. *C. perponderosum* (Dall)	×							
Forreria cancellaroides Arnold					×	×		
Forreria emersoni Addicott, n. sp	×							
Ocenebra wilkesana (Anderson)	cf.				×			×[4]
Ocenebra gabbiana (Anderson)					×			
Ocenebra trophonoides (Anderson and Martin)	×				×	×		
Ocenebra milicentana (Loel and Corey)	×							
Ocenebra clarki Addicott, n. sp					×			
Ocenebra topangensis Arnold	×							
Ocenebra sp	×							
Trophon (Austrophon) kernensis Anderson	×		×	×	×	×	×	
Trophon (Austrotrophon) kernensis medialis Addicott, n. subsp	×							
Typhis (Talityphis) lampada Keen						×		
Thais (Nucella) packi Clark	×			×				
Thais (Thaisella) edmondi (Arnold)	?				×	×		
Thais (Thaisella) blakei Anderson and Martin					×			
Morula (Morunella) granti Addicott, n. sp					×			
Anachis (Costoanachis) watsonae Keen						×		
Strombina sp						×		
Mitrella anchuela Keen					×	×	?	

TABLE 1.—*Stratigraphic occurrence of Miocene gastropods in the Kern River-Bakersfield area*—Continued

Species	Miocene							
	Lower "Vaqueros Stage" [1]		Middle "Temblor Stage" [1]					Upper
			Olcese Sand			Round Mountain Silt		
	Jewett Sand	Freeman Silt	Lower part	Middle part	Upper part	Lower part	Upper part	Santa Margarita Formation
Mitrella (Columbellopsis) alta Addicott, n. sp					×			
Bruclarkia barkeriana (Cooper)[5]	×		×	×	×	×	×	
Bruclarkia oregonensis (Conrad)			×		×			
Bruclarkia yaquinana (Anderson and Martin)	×							
Kelletia lorata Addicott, n. sp					×	×		
Kelletia posoensis (Anderson and Martin)	×							
Calicantharus kernensis (Anderson and Martin)					×	×		
Calicantharus rancherianus Addicott, n. sp	×							
Calicantharus woodfordi Addicott, n. sp				cf.	×	×		
Calicantharus cf. *C. kettlemanensis* (Arnold)						×		
Macron aethiops (Reeve)			×					
Triumphis? n. sp			×					
Molopophorus anglonanus (Anderson)	×				×	×		
Antillophos posunculensis (Anderson and Martin)	cf.				×	×	×	× [4]
Antillophos woodringi Addicott, n. sp	?				×			
Nassarius (Catilon) arnoldi (Anderson)				?	×	×		cf.[4]
Nassarius (Phrontis) smooti Addicott					×		cf.	
Nassarius (Phrontis) harrellensis Addicott, n. sp						×		
Nassarius (Phrontis) ocoyanus (Anderson and Martin)					×	×		
Nassarius (Phrontis?) posoensis Addicott, n. sp			×					
Priscofusus geniculus (Conrad)	×							
Priscofusus medialis (Conrad)	×	×						
Mitra (Atrimitra) andersoni Addicott, n. sp					×	×		
Psephaea (Miopleiona) weaveri (Tegland)	×							
Psephaea (Miopleiona) cf. *P. (M.) indurata* (Conrad)		× [6]						
Cancellaria (Euclia) condoni (Anderson)				?	×	×		
Cancellaria (Euclia) dalliana (Anderson)					×			
Cancellaria (Euclia) circumspinosa Addicott, n. sp					×	×		
Cancellaria (Euclia) ocoyana Addicott, n. sp			×	cf.	×	×		
Cancellaria (Euclia) oregonensis Conrad			×		×			
Cancellaria (Euclia) simplex Anderson			×	×	×	×	cf.	
Cancellaria (Euclia) joaquinensis Anderson					×			× [4]
Cancellaria (Euclia) pacifica Anderson					×	×		cf.[4]
Cancellaria (Euclia?) nevadensis Anderson and Martin					×	×		cf.[4]
Cancellaria (Pyruclia) lickana Anderson and Martin					×			× [4]
Cancellaria (Coptostoma) posunculensis Anderson and Martin					×			
Cancellaria dalli (Anderson and Martin)					×	×		
Cancellaria (Crawfordina) kernensis Addicott, n. sp						×		×
Cancellaria (Barkeria) sanjosei Anderson and Martin						×		
Cancellaria (Narona) birchi Addicott, n. sp						×		
Cancellaria keenae Addicott, n. sp						×		
Cancellaria galei Addicott, n. sp	×							
Oliva (Oliva) californica Anderson	cf.			×	×	×	×	
Oliva (Oliva) n. sp.?					×			
Olivella (Olivella) ischnon Keen					×	×		
Olivella sp	×							
Conus (Chelyconus) owenianus Anderson				?	×	×	×	
Conus (Lithoconus) hayesi Arnold							×	
Terebra (Terebra) cooperi Anderson					×	×		
Terebra (Terebra) n. sp					×			
Terebra (Fusoterebra?) adelaidana Addicott, n. sp					×	×		
Terebra (Strioterebrum) stirtoni Addicott, n. sp					×	×		
Terebra (Strioterebrum) n. sp.?					×			
Hastula gnomon Keen					×	×		
Polystira englishi Addicott, n. sp					×	?		
Xenuroturris antiselli (Anderson and Martin)	?				×	×		
Turricula ochsneri (Anderson and Martin)				cf.	×	×		× [4]
Turricula piercei (Arnold)				?	×	×	cf.	
Turricula? buwaldana (Anderson and Martin)					×	×		
Knefastia garcesana Addicott, n. sp							×	
Megasurcula condonana (Anderson and Martin)	×		×	×				
Megasurcula howei Hanna and Hertlein			×	×	×	×		
Megasurcula keepi (Arnold)					×	×	×	
Megasurcula wynoocheensis (Weaver)					×	×		
Crassispira olcesensis Addicott, n. sp					×	×		
Ophiodermella temblorensis (Anderson and Martin)			×		×	×		
Ophiodermella electilis (Keen)						×		
Mangelia (Notocytharella) kernensis (Anderson and Martin)					×	×		cf.[4]
Mangelia (Notocytharella?) hartensis Addicott, n. sp					×			
Mangelia (Agathotoma) howei Anderson and Martin					?	×		
Glyphostoma carinata Addicott, n. sp					×			
Acteon boulderanus Etherington					×			

See footnotes at end of table.

TABLE 1.—*Stratigraphic occurrence of Miocene gastropods in the Kern River-Bakersfield area*—Continued

Species	Miocene							
	Lower "Vaqueros Stage" [1]		Middle "Temblor Stage" [1]					Upper
			Olcese Sand			Round Mountain Silt		
	Jewett Sand	Freeman Silt	Lower part	Middle part	Upper part	Lower part	Upper part	Santa Margarita Formation
Acteon (Rictaxis) weaveri Addicott, n. sp						×		
Bullina sp					×	×		
Bulla cantuaensis Anderson and Martin						×		
Haminoea virescens Sowerby					×			
Scaphander jugularis (Conrad)	cf.				×	×		
Cylichna? loismartinae Keen					×			
Cylichna temblorensis Keen					×	×		
Sulcoretusa? israelskyi Addicott, n. sp					×	×		
Volvulella gluma Keen					×	×		
Volvulella joaquinensis Addicott, n. sp						×		
Pyramidella (Longchaeus) cooperi Anderson and Martin					×	×		
Pyamidella (Syrnola) ochsneri (Anderson and Martin)					×	×		
Odostomia (Chrysallida?) sequoiana Addicott, n. sp					×			
Odostomia (Chrysallida?) n. sp.?					×			
Odostomia (Belsa) rotundomontana (Keen)						×		
Odostomia (Menestho) repenningi Addicott, n. sp					×			
Odostomia (Evalea) andersoni Bartsch					×	×		? [4]
Odostomia (Evalea) aff. *O. (E.) donilla* Dall and Bartsch					×			
Odostomia (Evalea) sp					×			
Odostomia (Evelea?) n. sp.?					×			
Turbonilla (Chemnitzia) n. sp					×			
Turbonilla (Chemnitzia) hannai Addicott, n. sp					×			
Turbonilla (Chemnitzia?) n. sp					×			
Turbonilla (Pyrgiscus) bravoensis Keen					×	×		
Turbonilla (Pyrgiscus) hormigacuesta Addicott, n. sp					×			
Turbonilla (Pyrgiscus) n. sp					×			
Turbonilla (Pyrgolampros) mariposa Keen					×	×		
Turbonilla (Ptycheulimella) edisonensis Addicott, n. sp						×		
Turbonilla (Tragula) greenhornensis Addicott, n. sp					×			

[1] Provincial stages of the Pacific coast megafaunal classification (Weaver and others, 1944).
[2] Subsurface occurrence in underlying Vedder Sand.
[3] Reported by Loel and Corey (1932, p. 96).
[4] Subsurface occurrence near Bakersfield, Calif. (Gale in Preston, 1931).
[5] Includes specimens referable to *Bruclarkia barkeriana* forma *santacruzana* (Arnold).
[6] Subsurface occurrence in Freeman-Jewett Silt by Matthews (1955) near Edison Calif. (p. 416).

TABLE 2.—*Species listed by earlier workers that were not recognized during this investigation*

Species	*Report source*
Agasoma sinuatum Gabb	Anderson (1905).
Natica (rel. *N. lewisi* Gould)	Anderson (1911).
Neverita callosa Gabb.	
Calliostoma splendens (Cooper)	Loel and Corey (1932).
Calliostoma diabloensis Clark.	
Olivella pedroana (Conrad).	
Olivella subpedroana Loel and Corey.	
Fissurella rixfordi Hertlein.	
Turritella temblorensis Wiedey.	
Polinices recluzianus Deshayes.	
Ficus (Ficus) modestus (Conrad) Stewart?.	
Melongena californica Anderson and Martin.	
Melongena sanjuanensis Anderson and Martin.	
Nassarius antiselli (Anderson and Martin).	
Thais panzana Anderson and Martin.	
Calliostoma cf. *C. diabloensis* Clark	Keen (1943).
Nassarius antiselli (Anderson and Martin).	
Neverita callosa (Gabb).	

The early and middle Miocene molluscan faunas of the Kern River area are indicative of shallow-water marine climates much warmer than exist at this latitude today. The early Miocene fauna contains a mixture of tropical and subtropical mollusks. The warm-water element includes such gastropods as *Turritella (Torcula)*, *Ficus*, *Oliva*, and *Antillophos*, and in addition a few pelecypod genera, all of which are now restricted to the subtropical and tropical Surian (Valentine, 1966) and Panamic molluscan provinces of the eastern Pacific Ocean. The fauna also includes several mollusks known only from northerly, presumably cooler, early Miocene assemblages along the Pacific coast. Such gastropods as *Molopophorous*, *Psephaea (Miopleiona)*, *Priscofusus*, *Mediargo*, and *Trichotropis* and the pelecypod *Mytilus middendorffi* occur no farther south in early Miocene assemblages but range northward to Oregon, Washington, and Alaska. Their predominantly extropical zoogeographic distribution is suggestive, therefore, of identification with a warm temperate early Miocene molluscan province.

In contrast with the early Miocene fauna, the middle Miocene assemblages of the Barker's Ranch fauna—from the upper part of the Olcese Sand and the lower part of the Round Mountain Silt—are of a warmer aspect. About a third of the gastropods are now living or have modern analogs in subtropical and tropical molluscan provinces of the eastern Pacific Ocean. Included are many genera and subgenera that have not been previously reported from as far north as California. The larger percentage of taxa with warm-water affinities and the absence of a significant element of northward-ranging mollusks suggest that the middle Miocene seas of the southern San Joaquin basin were appreciably warmer than those of the early Miocene and that there was at least a local warm pulse in the progressive Cenozoic cooling trend of the northeastern Pacific Ocean. (Addicott, 1968).

JEWETT SAND

The lowest stratigraphic occurrence of marine mollusks in exposed formations in the Kern River area is in the basal conglomeratic sandstone of the Jewett Sand. Principal localities are on the southwest slope of Pyramid Hill north of Pyramid Road (SW¼ sec. 14 and SE¼ sec. 15, T. 28 S., R. 29 E.), where the Jewett Sand lies unconformably on greenish-white siltstone, claystone, and sandstone of the Walker Formation. This distinctive basal unit, the so-called grit zone of the subsurface Pyramid Hill Sand Member (Ferguson in Weaver and others, 1944), is about 11 feet thick at USGS locality M1591 at Pyramid Hill (fig. 9). Although material from 14 localities in the lower 100 feet of the Jewett Sand is available for study, nearly all of the mollusks from this part of the formation are in the collection from USGS locality M1591.

Included in the molluscan fauna from the lower part of the Jewett Sand are 46 gastropod taxa, many of which occur no higher in the local marine section (table 3).

Only a few widely scattered gastropods have been collected from the upper part of the Jewett Sand. They are so few in number and poorly preserved as to be of little use in biostratigraphic characterization of this part of the formation. There are, however, many oyster beds in the upper part of the Jewett Sand (fig. 9). Where favorably exposed they can be mapped as key beds. The dominant faunal element is the small oyster *Ostrea eldridgei yneziana* Loel and Corey. A small pectinid, *Chlamys hertleini* Loel and Corey, is commonly found associated with the oysters. Both species appear to be restricted to this part of the formation.

Priscofusus medialis (Conrad), one of the gastropods characteristic of the lower part of the Jewett Sand at Pyramid Hill, is reported as a commonly occurring species in cores of the Jewett Sand from Round Mountain field. (This gastropod was reported as "*Fusinus corpulentus*" by Rogers, 1943, p. 582.) The small pelecypods *Cyclocardia subtenta* (Conrad) and *Acila conradi* (Meek) are also listed by Rogers.

TABLE 3.—*Gastropods from the lower part of the Jewett Sand*

[Species marked with an astrisk (*) are restricted to this part of the formation]

**Diodora* n. sp.
**Diodora*? n. sp.
**Calliostoma* sp. A
**Calliostoma* sp. B
**Turritella* cf. *T. inezana* Conrad
**Epitonium clallamense* Durham
**Trichotropis tricarinata* Addicott, n. sp.
**Trichotropis* sp.
**Calyptraea coreyi* Addicott, n. sp.
Calyptraea cf. *C. spirata* (Forbes)
Crepidula princeps Conrad
Crepidula sp.
Neverita andersoni (Clark)
Polinices victoriana Clark and Arnold
Sinum scopulosum (Conrad)
**Mediargo* mathewsoni (Gabb)
Ficus kerniana (Cooper)
Ceratostoma? aff. *C. perponderosum* (Dall)
**Forreria emersoni* Addicott, n. sp.
**Ocenebra milicentana* (Loel and Corey)
Ocenebra topangensis (Arnold)
Ocenebra trophonoides (Anderson and Martin)
Ocenebra cf. *O. wilkesana* (Anderson)
Ocenebra sp.
**Trophon kernensis medialis* Addicott, n. subsp.
Thais packi (Clark)
Thais edmondi (Arnold)?
Bruclarkia barkeriana (Cooper)
Bruclarkia barkeriana forma *santacruzana* (Arnold)
**Bruclarkia yaquinana* (Anderson and Martin)
Bruclarkia sp.
Kelletia posœnsis (Anderson and Martin)
**Calicantharus rancherianus* Addicott, n. sp.
Molopophorus anglonanus (Anderson)
Antillophos woodringi Addicott, n. sp.?
Kelletia posoensis (Anderson and Martin)
Nassarius? sp.
**Priscofusus geniculus* (Conrad)
Priscofusus medialis (Conrad)
**Psephaea weaveri* (Tegland)
**Cancellaria galei* Addicott, n. sp.
Oliva cf. *O. californica* Anderson
Olivella sp.
Megasurcula condonana (Anderson and Martin)
Xenuroturris antiselli (Anderson and Martin)?
Scaphander cf. *S. jugularis* (Conrad)

FREEMAN SILT

Although megafossils have not been collected from surface exposures of the overlying Freeman Silt, which is a fine-grained foraminiferal siltstone unit with abundant fish scales, molds of small pelecypods have been observed in the field. Mollusks are reported from cores from early wells drilled in the Mount Poso-Round Mountain area. Reports on cores from wells in the vicinity of Mount Poso field by Alex Clark (Dept. Geology, California Univ., Riverside, unpub. data, 1930–35) indicate that the Freeman Silt contains an association of small pelecypods dominated by *Acila conradi* (Meek), *Cyclocardia subtenta* (Conrad), and *Nuculana ochsneri* (Anderson and Martin). Other commonly occurring mollusks are the pelecypods *Macoma arctata* (Conrad), *Modiolus* sp., *Delectopecten peckhami* (Gabb), and *Katherinella angustifrons* (Conrad). One gastropod occurs regularly in cores: *Priscofusus medialis* (Conrad) (listed as "*Fusinus corpulentus* (Conrad)"). This species is a useful biostratigraphic index for the Jewett Sand and Freeman Silt as it does not seem to range higher in the Kern River section.

OLCESE SAND

A small molluscan assemblage from the lower part of the Olcese Sand, principally from USGS localities M1593 and M1594 (fig. 9) and UCMP localities B1676 and B1677, includes 20 gastropods (table 4). Well-preserved megafossils are scarce in this part of the Olcese Sand. Where present, they are invariably preserved in well-cemented calcareous sandstone concretions. There are only four species that do not range higher or lower in the Kern River section: *Bruclarkia oregonensis* (Conrad), *Macron aethiops* (Reeve), *Nassarius posoensis* n. sp., and *Triumphis*? n. sp. The genus *Macron* occurs in the middle part of the Olcese Sand (USGS loc. M1698) and is doubtfully recorded from the upper part of the Round Mountain Silt. Excepting these species, all of which are known from only one locality, the faunal assemblage is indistinguishable from associations higher in the Olcese Sand. Several species that are common in the upper part of the Olcese Sand and the Round Mountain Silt make their initial appearance in the lower part of the Olcese Sand: *Cancellaria ocoyana* n. sp., *C. simplex* Anderson, *Crepidula rostralis* (Conrad), *Megasurcula howei* Hanna and Hertlein, and *Turritella ocoyana* Conrad.

The fossiliferous lower part of the Olcese Sand is separated from the abundantly fossiliferous upper part of the Olcese Sand by an interval of predominantly nonmarine sand and gravel here referred to as the middle part of the Olcese Sand. Marine interbeds occur at least locally in this unit, as shown by the classic Miocene locality on Poso Creek discovered by William Blake during the Pacific Railroad Surveys in 1853. Surprisingly Blake and his associates failed to find the prolific excellently preserved fossil beds of the upper part of the Olcese Sand that are exposed in the Kern River drainage only a few miles to the south of their Poso Creek locality. In early wells farther basinward, such as near Mount Poso field, the Olcese Sand is wholly marine, as indicated by abundant marine mollusks in well cores throughout the formation (Alex Clark, Dept. Geology, California Univ., Riverside, unpub. data, 1930–35. USGS collections from what is here taken to be Blake's Poso Creek locality (USGS M1698, fig. 9) include 21 gastropod taxa (table 4). Were it not for the poor preservation (external molds in a loosely cemented to friable coarse-grained sand), a much larger molluscan assemblage probably could be secured from this locality. The poor condition of the fossiliferous material and the crude drawings (Conrad, 1857) have rendered practically all of the originally described gastropods unrecognizable, notable exceptions being *Turritella ocoyana* and *Scaphander jugularis*.

With the exception of *Megasurcula condonana* (Anderson and Martin), all the gastropods range upward into the upper part of the Olcese Sand. The large

TABLE 4.—*Gastropods from the lower part of the Olcese Sand*

Turritella ocoyana Conrad
Crepidula princeps Conrad
Crepidula rostralis (Conrad)
Neverita andersoni (Clark)
Polinices cf. *P. victoriana* Clark and Arnold
Ficus kerniana (Cooper)
Trophon kernensis Anderson
Bruclarkia barkeriana (Cooper)
Bruclarkia cf. *B. barkeriana* forma *santacruzana* (Arnold)
Bruclarkia oregonensis (Conrad)
Macron aethiops (Reeve)
Triumphis? n. sp.
Nassarius posoensis Addicott, n. sp.
Cancellaria ocoyana Addicott, n. sp.
Cancellaria oregonensis Conrad
Cancellaria simplex Anderson
Megasurcula condonana (Anderson and Martin)
Megasurcula howei Hanna and Hertlein
Ophiodermella temblorensis (Anderson and Martin)

TABLE 5.—*Gastropods from the middle part of the Olcese Sand (USGS loc. M1698)*

Turritella ocoyana Conrad
Batillaria ocoyana (Anderson and Martin)
Crepidula rostralis (Conrad)
Neverita andersoni (Clark)
Polinices victoriana Clark and Arnold
Ficus kerniana (Cooper)
Trophon kernensis Anderson
Thais packi (Clark)
Bruclarkia barkeriana forma *santacruzana* (Arnold)
Calicantharus cf. *C. woodfordi* Addicott, n. sp.
Macron sp.
Nassarius arnoldi (Anderson)?
Cancellaria cf. *C. ocoyana* Addicott, n. sp.
Cancellaria simplex Anderson
Oliva californica Anderson
Conus owenianus Anderson?
Megasurcula condonana (Anderson and Martin)
Megasurcula howei Hanna and Hertlein
Turricula cf. *T. ochsneri* (Anderson and Martin)
Turricula piercei (Arnold)?

pectinid *Vertipecten nevadanus* (Conrad), presumably from this locality, has not been found higher in the Kern River Miocene sequence. Subsequent collections from this locality (USGS M1698) produced several fragments of a large pectinid that may represent this species. The large pectinid embedded in a sandstone slab figured as *Pecten catilliformis* Conrad (1857, p. 329, pl. 9, fig. 23) undoubtedly is *Lyropecten magnolia* Conrad (1857), as first suggested by Grant and Gale (1931). Presumably it was collected at a point upstream from the principal Depot Camp locality where the lower Miocene Jewett Sand crosses Poso Creek. Blake's indication (1857, p. 171) that the poorly preserved cast upon which this species was based had much larger ribs than *P. nevadanus* together with Conrad's figure, clearly suggests that it is *L. magnolia*. However, a case can be made for retention of Conrad's later name because the type of *P. catilliformis* is lost and the original illustration is too poor to permit unqualified identification.

Good exposures of strata containing the Barker's Ranch fauna occur in sec. 28, 32, and 33, T. 28 S., R. 29 E. on the north side of Kern River upstream from Hart Park. This area encompasses outcrops cited by Anderson (1911) as the type locality for his B zone. USGS locality M1597 in this area (NE¼NE¼ sec. 5, T. 29 S., R. 29 E.) contains most of the gastropods that have been found in this faunal unit. The thickness of the upper part of the Olcese Sand in this area is somewhat more than 100 feet; its stratigraphic limits are fairly well defined. In outcrop the lowermost fossiliferous strata are underlain by coarse crossbedded nonmarine sand and gravel of the middle part of the Olcese Sand. The upper limits are less well defined because the fossiliferous fine sands interfinger with siltstone referable to the Round Mountain Silt. Toward the southeast, the Barker's Ranch fauna is involved in an apparent lateral facies change from sand to sandy siltstone with thin fossiliferous interbeds of very fine sand. Accordingly, rocks mapped as the Round Mountain Silt on the south side of Kern River near the mouth of Kern River Gorge are the lateral equivalent of sand in the upper part of the Olcese Sand near Hart Park about 4 or 5 miles to the northwest. Although there are a few species unique to localities in the Round Mountain Silt in this area, as might be expected, the faunal assemblages are quite similar to those in the type area of the Barker's Ranch fauna. There is, however, a notable change in the composition of the pelecypod faunal element wherein most of the large thick-shelled species seem to be replaced by an association of small thin-shelled forms. Small gastropods also are characteristic of this assemblage but most of them are also represented in exposures near Hart Park to the northwest.

The abundant well-preserved mollusks of the upper part of the Olcese Sand, initially reported by Cooper (in Watts, 1894), have long been known as the Barker's Ranch fauna. This assemblage extends into the lower part of the Round Mountain Silt at localities along Kern River from Hart Park to near the mouth of Kern River. Owing in large part to the unique conditions of preservation, this fauna contains an unusually large proportion, nearly 85 percent, of stratigraphically restricted gastropods. Well-preserved ornate gastropods such as *Molopophorus anglonanus* (Anderson), *Bruclarkia barkeriana* (Cooper), many species of *Cancellaria*, *Antillophos posunculensis* (Anderson and Martin), *Trophon kernensis* Anderson, and *Ficus kerniana* (Cooper) are characteristic of, but not restricted to, the upper part of the Olcese Sand and lower part of the Round Mountain Silt. About 100 collections from the University of California (Berkeley), the U.S. Geological Survey, and the U.S. National Museum and material borrowed from collections at the California Academy of Sciences, Stanford University, University of California (Riverside and Los Angeles), and the Los Angeles County Museum have yielded a fauna of 147 gastropod taxa from the upper part of the Olcese Sand and lower part of the Round Mountain Silt. The gastropod fauna from the upper part of the Olcese Sand alone comprises 124 species. Some of the more commonly occurring gastropods (exclusive of melanellids and pyramidellids) that are restricted in stratigraphic occurrence to this part of the Miocene sequence are listed in table 6.

TABLE 6.—*Some gastropods restricted to the upper part of the Olcese Sand and lower part of the Round Mountain Silt*

Turritella moodyi Merriam
Batillaria ocoyana (Anderson and Martin)
Scalina whitei (Keen)
Crucibulum papulum Addicott, n. sp.
Mitrella anchuela Keen
Calicantharus kernensis (Anderson and Martin)
Nassarius ocoyanus (Anderson and Martin)
Cancellaria circumspinosa Addicott, n. sp.
Cancellaria condoni Anderson
Cancellaria dalliana Anderson
Cancellaria lickana Anderson and Martin
Cancellaria posunculensis Anderson and Martin
Cancellaria joaquinensis Anderson
Terebra cooperi Anderson
Terebra stirtoni Addicott, n. sp.
Turricula ochsneri (Anderson and Martin)
Turricula piercei (Arnold)
Ophiodermella temblorensis (Anderson and Martin)
Mangelia kernensis (Anderson and Martin)

ROUND MOUNTAIN SILT

Mollusks of the lower part of the Round Mountain Silt are included with assemblages from the upper part of the Olcese Sand in the Barker's Ranch fauna because of the small stratigraphic interval involved, about 200 feet, and the previously mentioned interfingering relationship between these formations. Excellent exposures of light-gray to chocolate-brown carbonaceous, sandy mudstone in the lower part of the Round Mountain Silt occur along Kern River east of Hart Park. Near Ming Lake (UCMP locs. B1618 and B1619) and along Rancheria Road (UCMP loc. B1605), a small assemblage of well preserved mollusks containing locally abundant *Anadara osmonti* (Dall) occurs in this part of the formation.

A widespread *Turritella ocoyana* bed occurs above the diatomaceous siltstone and shale of the Round Mountain Silt from Cottonwood Creek northward to Poso Creek. This faunal unit probably is equivalent to Loel and Corey's "*Turritella ocoyana, Turritella ocoyana bosei* zones" (1932, p. 99), but because of their [assemblage] zones were not described in detail, the equivalence is not certain. This bed is probably most fossiliferous on the west side of Cottonwood Creek about 1½ miles south of Kern River (sec. 13, T. 29 S., R. 29 E.), where it occurs as a 2- to 5-foot-thick stratum of silty very fine sand overlying diatomaceous rock (USGS loc. M1605).

Gastropods occurring in this bed include several forms of *Turritella ocoyana* (*T. ocoyana* forma *bosei* Hertlein and Jordan, *T. ocoyana* forma *wittichi* Hertlein and Jordan, and *T. ocoyana* forma *topangensis* Merriam), *Neverita andersoni* (Clark), *Calicantharus woodfordi* n. sp., and *Cancellaria sanjosei* Anderson and Martin. Of these, *C. sanjosei* is the only gastropod restricted stratigraphically to this part of the Round Mountain Silt. A flora of 80 species of diatoms was described from diatomaceous strata of the Round Mountain Silt by Hanna (1932). Mandra (1968) recently listed an assemblage of 11 silicoflagellates from the Round Mountain Silt.

The highest occurrence of Miocene mollusks in the marine section east of Bakersfield is near the top of the Round Mountain Silt. Mollusks occur in concretionary sandstone beds close to the top of a 60- to 75-foot sandy interval at the top of the Round Mountain Silt along Kern River. The base of this unit is defined by a fine to very fine sand, which contains abundant shark teeth and bones of marine mammals concentrated in a 1-foot-thick stratum. This bed is so fossiliferous that it can be recognized in areas of poor exposure by its abundant fossil float. More than 50 species of vertebrates including sharks, turtles, birds, and marine and terrestrial mammals are known from this bed (Mitchell, 1966), Anderson (1911) including the bone bed and an overlying mollusk-bearing stratum in his C zone. He designated exposures at Sharktooth Hill north of Hart Park as the type locality. Additional material from Anderson's original mollusk locality at Sharktooth Hill and several collections from other localities near the confluence of Cottonwood Creek and Kern River to the east have increased the gastropod assemblage from four to 22 taxa (table 7). The gastropod fauna of this part of the Round Mountain Silt is not significantly different from that of the upper part of the Olcese Sand, only two species *Knefastia garcesana*, n. sp. and *Conus hayesi* Arnold, are not recorded from lower in the marine section.

This faunal unit is most fossiliferous in the bluffs between Kern Canyon Highway (State Route 178) and Kern River (SW¼ sec. 11, T. 29 S., R. 29 E.) where three fossil beds occur in a 50-foot stratigraphic unit underlying the Santa Margarita Formation. *Conus owenianus* is the most abundant faunal element in that area. Better preserved fossils occur in southwest-trending gullies on the south side of Kern Canyon Highway about half a mile to the southeast. In this area, abundant specimens of *Dosinia merriami* Clark occur in a sandstone ledge about 50 feet stratigraphically below the top of the Round Mountain Silt.

Studies of the marine vertebrates of the shark-tooth and bone bed are summarized by Church (1958) and Mitchell (1965). Avian records from Sharktooth Hill were summarized by Howard (1966).

TABLE 7. —*Gastropods from the upper part of the Round Mountain Silt above the shark-tooth and bone bed*

Turritella ocoyana Conrad
Batillaria ocoyana (Anderson and Martin)
Calyptraea sp.
Neverita andersoni (Clark)
Ficus kerniana (Cooper)
Trophon kernensis Anderson
Mitrella anchuela Keen?
Bruclarkia barkeriana (Cooper)
Bruclarkia barkeriana forma *santacruzana* (Arnold)
?*Macron* sp.
Antillophos posunculensis (Anderson and Martin)
Nassarius cf. *N. smooti* Addicott
Cancellaria cf. *C. simplex* Anderson
Cancellaria sp.
Conus owenianus Anderson
Conus hayesi Arnold
Oliva california Anderson
Olivella sp.
Terebra sp.
Knefastia garcesana Addicott, n. sp.
Turricula cf. *T. piercei* (Arnold)
Megasurcula keepi (Arnold)

SANTA MARGARITA FORMATION

Unfossiliferous sand mapped as the Santa Margarita Sand by Dibblee, Bruer, Hackel, and Warne (1965) unconformably overlies the Round Mountain Silt along Kern River. Sublittoral mollusks are commonly found in cores of the Santa Margarita Formation farther basinward. However, detailed faunal data are available only for wells near Fruitvale field about 3 miles west of Bakersfield (Gale in Preston, 1931; Grant and Gale, 1931), from which Gale listed an assemblage of 55 mollusks of late Miocene age. Included were 25 gastropods, more than half of which also occur in middle Miocene exposures of the Kern River area about 12 miles to the northeast (table 1).

Megafossils have been reported but not listed from the Santa Margarita Formation (or Fruitvale Sand of Ferguson, 1941) in several oil fields in this area: Mountain View (Miller and Bloom, 1937; Miller and Ferguson, 1943), Kern Front (Edwards, 1943a), Edison (Edwards, 1943b), and Kern Bluff (Corwin, 1950). Additional mollusks, including the late Miocene guide fossil *Aequipecten raymondi* (Clark) [=*A. discus* (Conrad) according to Hall and Corbato (1967, p. 572)] were identified by Alex Clark (Dept. Geology, California Univ., Riverside unpub. data, 1930–35) from cores of the Santa Margarita Formation from wells in the Mountain View, Fruitvale, Edison, and Kern River fields. Most of the gastropods identified by Clark are either long-ranging forms or species that also occur in middle Miocene formations of the Kern River area such as *Antillophos posunculensis* (Anderson and Martin) [as *Phos dumbleanus* (Anderson)], *Neverita callosa* (Gabb), *N. andersoni* (Clark), *Ficus kerniana* (Cooper) [as *F. ocoyana* (Conrad)], *Terebra cooperi* Anderson, and *Oliva californica* Anderson. However, one gastropod, *Cancellaria pabloensis* Clark, seems to be restricted to the upper Miocene.

AGE AND POSITION IN THE PACIFIC COAST MEGAFAUNAL CHRONOLOGY

In the interest of stability of nomenclature, the provincial chronostratigraphic classification and correlation with the European Tertiary of Weaver and others (1944) is provisionally followed in this report. Accordingly, the "Vaqueros Stage" is considered to be early Miocene, and the "Temblor Stage," middle Miocene. This treatment is followed with the full realization that some microfaunal workers have long advocated adjustment, upwards, of the Oligocene-Miocene boundary in the Pacific coast chronology (Schenck, 1935; Kleinpell, 1938; Schenck and Childs, 1942). Moreover, indications are that most Pacific coast foraminiferal specialists now place the Oligocene-Miocene boundary at or near the top of the Zemorrian Stage (Kleinpell and Weaver, 1963; Lamb, 1964; Lipps, 1965, 1967; Rau, 1967; Bandy and Arnal, 1969). The boundary is thereby positioned near the middle of the biozone of the "Vaqueros" index species *Turritella inezana* which, in terms of the microfaunal sequence, definitely ranges from the upper Zemorrian to the lower Saucesian. The Oligocene-Miocene boundary of the megafossil sequence is here placed at the base of the biozone of *T. inezana* which point is taken as the base of the "Vaqueros Stage" and probably corresponds to the middle of the Zemorrian Stage. Occurrences of *T. inezana* in lower Zemorrian strata are doubtful (Addicott, 1967b).

It seems unlikely that correlation of benthic molluscan assemblages will ever permit accurate positioning of the European Oligocene-Miocene boundary in the Pacific coast middle Tertiary sequence. Part of the uncertainty is based upon disagreement among workers as to the original designation of the type Miocene in Europe. Secondly, and more importantly, is the problem of endemism in the later Tertiary molluscan faunas. Because of this characteristic, it is difficult to correlate even between adjacent mid-Tertiary molluscan faunal provinces along the Pacific coast (Addicott, 1967a) let alone from the eastern Pacific to the eastern Atlantic or Mediterranean Ocean areas. Radiometric dating or paleontologic correlation by planktonic organisms such as Foraminifera holds much promise in solving this problem.

Lipps (1967) has correlated the California Miocene with tropical zones by means of planktonic Foraminifera, and the tropical zones, in turn, have been correlated by others with some of the European Miocene stages. Indeed, recent planktonic correlations furnish by far the most convincing paleontologic tie with the European Tertiary. However, some doubt is cast upon middle latitude—tropic correlation of planktonic by Bandy's discovery (1966) that the planktonic genus "*Orbulina*" appears about two stages earlier in southern latitudes (base of the Saucesian Stage) than in middle latitudes (base of the Luisian Stage).

Radiometric age determinations seem to be the most promising tool for correlation with the European Tertiary. A recently completed study of the relationship of potassium argon dates to the Miocene benthonic foraminiferal chronology by Turner (1968) indicates that the boundary between the Zemorrian and Saucesian Stages of Kleinpell (1938) is about 22.5 million years. As previously indicated, this date would fall somewhere near the middle of the biozone of *Turritella inezana*, the early Miocene index fossil. The age of the uppermost and lowermost occurrences of this species are not known. However, the highest stratigraphic occurrence is near the middle of the Saucesian Stage and, as previously noted, the lowest, near the middle of the Zemorrian Stage. If the length of the Zemorrian Stage is of the same magnitude as the overlying Saucesian Stage (about 7 million years according to Turner's dates), the base of the biozone of *T. inezana* may correspond to the base of the European Miocene as recognized by many workers—about 26 million years (Harland and others, 1964). In short, currently available radiometric ages do not require raising of the Oligocene-Miocene boundary from its long recognized position in the Pacific coast megafaunal sequence of Weaver and others (1944).

WALKER FORMATION

The age of marginal nonmarine strata mapped as the Walker Formation is based upon subsurface relationships with marine deposits occurring toward the west. The scattered nonmarine mollusks and plant remains found in exposures of the Walker Formation (Dibblee and Chesterman, 1953) are not diagnostic of age. A lower age limit of middle Eocene is suggested, however, by the occurrence of mollusks referred to the "Domengine Stage" (Goudkoff in Addicott, 1956) in cores of marine strata that intertongue with the lower part of the Walker Formation. Other workers utilizing benthic foraminiferal data from basinward marine formations that intertongue with the Walker Formation consider the age to range from middle or late Eocene to early Miocene (Church and Krammes, 1957; Park and Weddle, 1959; and Rudel, 1965).

VEDDER SAND

The widespread occurrence of *Turritella inezana* Conrad in cores of the Vedder Sand from the Mount Poso, Round Mountain, and Edison oil fields (Loel and Corey, 1932; Corey in Cushman and Laiming, 1931; Addicott, 1967a; Alex Clark, Dept. Geology, California, Univ., Riverside unpub. data, 1930–35) indicates that the Vedder Sand was deposited during the biozone of this species, a time-stratigraphic unit considered to be equivalent to the lower Miocene "Vaqueros Stage." However, megafaunal data from well cores generally have not been published and collections are not readily available for study; the fauna of this subsurface formation is therefore not well known.

Subsurface foraminiferal assemblages from the Vedder Sand on the east side of the San Joaquin Valley indicate references to the Zemorrian Stage (Beck, 1952, 1958; Kleinpell and Weaver, 1963; Rudel, 1965). Kleinpell and Weaver (1963, fig. 5) indicate that the Vedder Sand is referable to the upper part of the Zemorrian Stage, the *Uvigerinella sparsicostata* zone, but question the occurrence of strata as old as early Zemorrian in the Vedder Sand.

JEWETT SAND

Many of the gastropods restricted to local stratal units here included in the lower Miocene "Vaqueros Stage" range into the fauna of the middle Miocene "Temblor Stage" in other sections on the Pacific coast. Previously described species that are restricted to or occur no higher than the "Vaqueros Stage" are: *Epitonium clallamense* (Durham), *Psephaea weaveri* (Tegland), *Ocenebra milicentana* (Loel and Corey), and the doubtfully identified index species *Turritella inezana* Conrad. The first two species, originally described from southern Vancouver Island and the northern Olympic Peninsula, are regarded as indices of the "Vaqueros Stage," although they have not been previously reported from as far south as California. They were heretofore known only from the "Blakeley Stage" of the Pacific Northwest, a time-stratigraphic unit that is equivalent at least in part to the "Vaqueros Stage" (Addicott, 1967a).

Pelecypods that are of common occurrence in the basal part of the Jewett Sand and that are restricted to the lower Miocene "Vaqueros Stage" include *Lyropecten magnolia* (Conrad) and *Crassostrea vaquerosensis* (Loel and Corey). *Crassatella granti* (Wiedey), a species that heretofore has been considered an index to the "Vaqueros Stage," was recently collected by J. A. Sutherland, of the Los Angeles County Museum, from the upper part of the Olcese Sand near the type locality of the Barker's Ranch fauna; thereby its range was extended into the middle Miocene "Temblor Stage."

Gastropods rarely occur in the upper part of the Jewett Sand. *Pricofusus medialis* (Conrad), an early to middle Miocene species, has been reported from well cores in this part of the formation, but has not, as yet, been collected from surface exposures. Evidence of the early Miocene age of the upper part of the Jewett Sand is based upon the occurrence of *Ostrea eldridgei yneziana* Loel and Corey and *Chlamys hertleini* Loel and Corey, pelecypods that seem to be restricted to the "Vaqueros Stage" (Addicott, 1965a).

Micropaleontologists have variously classified the basal part of the Jewett Sand (Pyramid Hill Sand of common usage in subsurface mapping) as upper Zemorrian (Kleinpell, 1938), upper Zemorrian and lower Saucesian (Beck, 1952; Kleinpell and Weaver, 1963), and Saucesian (Ferguson in Weaver and others, 1944; Church and Krammes, 1957; Rudel, 1965). The overlying part of the Jewett Sand and the Freeman Silt (Freeman-Jewett Silt of some authors) is generally assigned to the lower part of the Saucesian Stage; the Jewett, to the *Siphogenerina transversa* zone; and the Freeman, to the *Plectofrondicularia miocenica* zone (Beck, 1952; Park and Weddle, 1959).

FREEMAN SILT

The small pelecypod association of *Nuculana ochsneri* (Anderson and Martin), *Cyclocardia subtenta* (Conrad), and *Acila conradi* (Meek) found in well cores of the Freeman Silt in the Mount Poso-Round Mountain area is not diagnostic of age and position in the provincial megafaunal sequence. As mentioned above, foraminifers indicate assignment to the lower part of the Saucesian Stage. An early Miocene age for this formation is suggested because of the joint occurrence of mollusks of the "Vaqueros Stage" and lower Saucesian foraminifers elsewhere in central and southern California (Corey, 1954; Addicott, 1967a).

OLCESE SAND AND ROUND MOUNTAIN SILT

Although relatively small, the gastropod fauna of the lower part of the Olcese Sand contains several species restricted to the middle Miocene "Temblor Stage": *Crepidula rostralis* (Conrad), *Megasurcula howei* Hanna and Hertlein, and *Ophiodermella temblorensis* (Anderson and Martin). Moreover the occurrence of *Macron aethiops* (Reeve) is suggestive of a middle Miocene or younger age inasmuch as the genus has not been recorded from the early Miocene.

Foraminifera from the lower part of the Olcese Sand in the subsurface are referred to the upper part of the Saucesian Stage (Beck, 1952; Park and Weddle, 1959; Rudel, 1965).

Gastropods collected from a locality in the coarse-grained predominantly nonmarine middle part of the Olcese Sand about 300 feet below the top of the formation (USGS loc. M1968) do not differ markedly from the prolific assemblages of the Barker's Ranch fauna from the overlying upper part of the Olcese Sand. Two taxa that do not occur higher in the marine section, *Megasurcula condonana* (Anderson and Martin) and *Vertipecten nevadanus* (Conrad), may be of significance in regional correlation. *Vertipecten* became extinct during the middle Miocene, possibly during the early part, as there is a considerable thickness of marine section referable to the "Temblor Stage" above its highest occurrence in the Kern River area and other areas, including the eastern Caliente Range, San Joaquin Hills, and Santa Ana Mountains (J. G. Vedder, written commun., December 1967).

The upper part of the Olcese Sand includes many gastropods restricted to the middle Miocene "Temblor Stage." Many of them, however, have not been reported from outside of the Kern River area. Of those that have, many are known from only one other locality, which seems insufficient to establish their usefulness in correlation. Gastropods from the upper part of the Olcese Sand and lower part of the Round Mountain Silt that are restricted to the middle Miocene and that have been recorded elsewhere on the Pacific coast are listed in table 8.

Additional evidence of a middle Miocene age is the overlap or joint occurrence of several early to middle Miocene species, such as *Turritella ocoyana* Conrad, *Scaphander jugularis* (Conrad), *Conus owenianus* Anderson, *Bruclarkia barkeriana* (Cooper), *Molopophorus anglonanus* (Anderson), *Trophon kernensis* Anderson, and *Kelletia posoensis* (Anderson and Martin), with taxa that range from middle Miocene to late Miocene or younger rocks, such as *Astraea biangulata* (Gabb), *Neverita alta* Arnold, *Calicantharus* cf. *C. kettlemanensis* (Arnold), *Cancellaria joaquinensis* Anderson, *C. pacifica* Anderson, *C. lickana* Anderson and Martin, *C. kernensis* n. sp., and *Haminoea virescens* (Sowerby).

The faunal assemblage from the highest part of the

TABLE 8.—*Gastropods from the upper part of the Olcese Sand and the lower part of the Round Mountain Silt that are restricted to the middle Miocene "Temblor Stage"*

Turritella kernensis n. sp.
Turritella moodyi Merriam
Batillaria ocoyana (Anderson and Martin)
Opalia williamsoni (Anderson and Martin)
Eulima gabbiana (Anderson and Martin)
Niso antiselli (Anderson and Martin)
Crepidula rostralis (Conrad)
Natica posuncula Hanna and Hertlein
Mediargo dilleri (Anderson and Martin)
Ocenebra gabbiana (Anderson)
Typhis lampada Keen
Calicantharus kernensis (Anderson and Martin)
Nassarius arnoldi (Anderson)
Nassarius ocoyanus (Anderson and Martin)
Cancellaria dalliana Anderson
Cancellaria simplex Anderson
Cancellaria posunculensis Anderson
Cancellaria sanjosei Anderson and Martin
Olivella ischnon Keen
Conus hayesi Arnold
Terebra cooperi Anderson
Hastula gnomon Keen
Turricula piercei (Arnold)
Turricula? buwaldana (Anderson and Martin)
Megasurcula howei Hanna and Hertlein
Megasurcula keepi (Arnold)
Megasurcula wynoochcensis (Weaver)
Ophiodermella temblorensis (Anderson and Martin)
Mangelia kernensis (Anderson and Martin)
Acteon boulderanus Etherington

Round Mountain Silt above the shark-tooth and bone bed contains a number of species restricted to the "Temblor Stage" and others that became extinct before the end of the middle Miocene. Thus the middle Miocene age of the Round Mountain Silt is well established.

Two gastropod genera, *Bruclarkia* and *Molopophorus*, have their highest stratigraphic occurrence in rocks of middle Miocene age in the Kern River section, and, by inference, at other places on the Pacific coast. Other gastropod taxa that are still living but that do not range upward into rocks of late Miocene age in northern Baja California or in the Pacific Coast States include the *Turritella ocoyana* stock of Merriam (1941), *Nerita*, *Scalina*, *Potamides*, *Rugatiscala*, *Gyroscala*, *Typhis*, *Thaisella*, *Triumphis*?, *Lithoconus*, *Fusoterebra*?, *Knefastia*, *Bullina*, and *Hastula*. Most of these are warm-water taxa restricted in their modern distribution to the Panamic molluscan province of the eastern Pacific Ocean (Keen, 1958a).

Supraspecific taxa that have their lowest stratigraph occurrence in middle Miocene rocks of the Kern River area include: *Gibbula*, *Turritella cooperi* stock of Merriam (1941), *Turritella broderipiana* stock of Merriam (1941), *Dispotaea*, *Strombina*, *Pyruclia*, *Ophiodermella*, *Knefastia*, *Glyphostoma*, *Volvulella*, *Sulcoretusa*, and several pyramidellid subgenera.

Foraminiferal specialists seem to disagree as to the age of the upper part of the Olcese Sand. Kleinpell (1938; fig. 14) and Kleinpell and Weaver (1963) referred the upper part of the Olcese Sand (" 'Temblor B zone' sand of Barker's Ranch") to the upper part of the Saucesian Stage, as did Beck (1952). Ferguson (in Weaver and others, 1944, p. 582; Church and Krammes, 1957; Rudel, 1965), however, assigned the upper part of the Olcese Sand to the overlying Relizian Stage.

The lower part of the overlying Round Mountain Silt also was assigned to the upper part of the Saucesian Stage by Kleinpell (1938; and in Reinhart, 1943, p. 51), but the upper part of the formation was considered to be of Relizian age. Contrasting views of the age of this formation were advanced by Ferguson (in Weaver and others, 1944), who considered that part of the Round Mountain Silt occurring below the shark-tooth and bone bed to be of Relizian and Luisian age. Church and Krammes (1957) and Beck (1958) concurred with this usage. Exposures of the lower part of the formation along Kern River southeast of Round Mountain field have yielded Luisian Foraminifera (Patsy B. Smith, written commun., March 1963). Ferguson (in Weaver, 1944) also reported Luisian Foraminifera from this area.

SANTA MARGARITA FORMATION

Molluscan assemblages from cores of the upper Miocene Santa Margarita Formation in oil fields basinward from the Miocene outcrop belt contain an interesting association of middle Miocene relicts and living species with upper Miocene to Holocene ranges. The only stratigraphically restricted gastropod is *Nassarius pabloensis* (Clark) reported by Gale as "*Nassarius (Uzita) antiselli* (Anderson and Martin) *(pabloensis* Clark)" (in Preston, 1931, p. 16) from cores taken a few miles west of Bakersfield. The overlap in ranges of some middle and upper Miocene species such as *Cancellaria joaquinensis* Anderson, *C. lickana* Anderson and Martin, and "*Forreria*" *wilkesana* (Anderson) with upper Miocene to Holocene species such as *Pseudomelatoma penicillata* (Carpenter) and *Terebra pedroana* Dall (Gale in Preston, 1931, p. 16) further suggests a late Miocene age. Many living species of pelecypods and a species restricted to the upper Miocene, *Amiantis stalderi* (Clark), are also reported by Gale. Alex Clark (Dept. Geology, California Univ., Riverside, unpub. data 1930–35) reported several subsurface occurrences of the important late Miocene index species *Aequipecten raymondi* (Clark) [=*A. discus* (Conrad)] from east and southeast of Bakersfield.

Late Miocene mollusks are known from exposures of the Santa Margarita Formation at Comanche Point in the northern Tejon Hills about 20 miles south of Kern River (Clark in Merriam, 1916; Hoots, 1930; Addicott and Vedder, 1963). In addition to the occurrence of the late Miocene index species from well cores in the Bakersfield area, there are at Comanche Point shallow-water pelecypods such as *Crassostrea titan* (Conrad) and *Lyropecten crassicardo* (Conrad) that became extinct during the late Miocene. The Santa Margarita Formation at Comanche Point, however, cannot be correlated physically with the subsurface unit bearing the same name in oil fields of the Bakersfield area to the northwest generally assigned to the upper part of the Mohnian Stage (Beck, 1952; Park and Weddle, 1959) and the lower part of the Delmontian Stage (Ferguson in Weaver and others, 1944; Rudel, 1965).

CORRELATION WITH OREGON AND WASHINGTON

OREGON

Paleontologists have long recognized the similarity between molluscan assemblages of the Astoria Formation of Oregon and the Temblor Formation of the central California Coast Ranges (Arnold and Hannibal, 1913; Howe, 1926; Moore, 1963; and others). The fauna of the Astoria Formation near Newport, Lincoln County, Oreg. (Anderson and Martin, 1914; Howe, 1926; Vokes and others, 1949; Moore, 1963) is perhaps most similar to the California middle Miocene typified by the Barker's Ranch fauna of the upper part of the Olcese Sand and the lower part of the Round Mountain Silt northeast of Bakersfield.

Howe (1926) found that 43 percent of 89 determinable molluscan species from the Astoria Formation at Astoria and in Lincoln County also occur in the Miocene of Barker's Ranch. From this he concluded (p. 302) that "for all practical purposes, [the two faunas are] contemporaneous in time of depositon." His correlation thereby established the Astoria Formation, long thought to be of Oligocene age by most workers, as middle Miocene in terms of the megafaunal sequence. Subsequent workers have determined somewhat lower percentages of mollusks in common between the Astoria Formation of Oregon and the California Temblor Formation: 21 percent (Moore, 1963) and 31 percent (Addicott, in Snavely and others, 1964). But the relationship is still much stronger than with the earlier fauna of the "Vaqueros Stage" or the fauna of the upper Miocene of California.

The present study of the type area of the "Temblor Stage" indicates a lesser degree of similarity of the gastropods with those of the Astoria Formation, 16 of 47 gastropods (34 percent) identified as common (table 9), than reported by Howe (1926) for the entire molluscan fauna. The degree of correlation may be much stronger, as several of the 47 Astoria gastropods listed by Moore (1963) are doubtfully identified generically and are too poorly preserved to permit specific determination. Comparison of the early Miocene gastropods of the Kern River area with those of the Astoria Formation finds a much smaller percentage in common: eight of 47 (17 percent).

TABLE 9.—*Miocene gastropods from the Kern River area that occur in the Astoria Formation of Oregon and Washington*

Names used in this report	Astoria Formation		Kern River area	
	Oregon	Washington	"Temblor Stage"	"Vaqueros Stage"
Opalia williamsoni (Anderson and Martin)	×	----------	×	----------
Crepidula rostralis (Conrad)	×	×	×	----------
Polinices victoriana Clark and Arnold	×	----------	×	×
Neverita jamesae Moore	×	----------	×	----------
Sinum scopulosum (Conrad)	×	×	×	----------
Mediargo dilleri (Anderson and Martin)	×	----------	×	----------
Ficus kerniana (Cooper)	×	----------	×	----------
Trophon kernensis Anderson	×	----------	×	----------
Bruclarkia oregonensis (Conrad) (including *B. yaquinana* Anderson and Martin)	×	×	×	×
Molopophorus anglonanus (Anderson)	×	×	×	×
Antillophos posunculensis (Anderson and Martin)	×	×	×	×
Nassarius arnoldi (Anderson)	×	×	×	----------
Priscofusus medialis (Conrad)	×	----------	----------	×
Priscofusus geniculus (Conrad)	×	----------	----------	×
Cancellaria ocoyana Addicott, n. sp	----------	×	×	----------
Cancellaria oregonensis Conrad	×	----------	×	----------
Megasurcula condonana (Anderson and Martin)	×	×	×	×
Megasurcula howei Hanna and Hertlein	----------	×	×	----------
Megasurcula wynoocheensis (Weaver)	×	×	×	----------
Xenuroturris antiselli (Anderson and Martin)	×	×	×	×
Mangelia kernensis (Anderson and Martin)	----------	×	×	----------
Acteon boulderanus Etherington	----------	×	×	----------

WASHINGTON

There is a somewhat larger percentage of gastropods in common between the type "Temblor Stage" and the Astoria Formation of southwestern Washington. Thirteen of 36 specifically identified gastropods from the Astoria Formation listed by Etherington (1931, check list facing p. 48) also occur in the Round Mountain Silt or the Olcese Sand in the Kern River area (table 8). This amounts to 36 percent of the gastropods in the Astoria Formation of Etherington (1931). Only five (14 percent) of Etherington's gastropods occur in the lower Miocene of the Kern River area.

Miocene faunal assemblages from the Clallam Formation of the northwestern Olympic Peninsula (Reagan, 1909; Arnold and Hannibal, 1913; Weaver, 1916; Durham, 1944) and the Astoria Formation [Wahkiakum Formation of Weaver, 1912] of the Grays River area (Weaver, 1916) are too poorly known to permit quantitative comparison with Californian early and middle Miocene faunas.

PROPOSED NEW SPECIES OR SUBSPECIES

Tegula (Omphalius) dalli arnoldi
Tegula (Omphalius) laevis
Gibbula (Tumulus?) baileyi
Calliostoma carsoni
Nerita (Theliostyla?) joaquinensis
Turritella kernensis
Epitonium (Gyroscala) barkerianum
Epitonium (Nitidiscala) tedfordi
Balcis lutzi
Balcis petrolia
Niso cottonwoodensis
Trichotropis tricarinata
Calyptræa coreyi

Crucibulum (Dispotaca) papulum
Crepidula bractea
Forreria emersoni
Ocenebra clarki
Trophon (Austrotrophon) kernensis medialis
Morula granti
Mitrella (Columbellopsis) alta
Kelletia lorata
Calicantharus rancherianus
Calicantharus woodfordi
Antillophos woodringi
Nassarius (Phrontis) harrellensis
Nassarius (Phrontis?) posoensis
Mitra (Atrimitra) andersoni
Cancellaria (Euclia) circumspinosa
Cancellaria (Euclia) ocoyana
Cancellaria (Crawfordina) kernensis
Cancellaria (Narona) birchi
Cancellaria keenae
Cancellaria galei
Terebra (Fusoterebra) adelaidana
Terebra (Strioterebrum) stirtoni
Polystira englishi
Knefastia garcesana
Crassispira olcesensis
Mangelia (Notocytharella) hartensis
Glyphostoma carinata
Acteon (Rictaxis) weaveri
Sulcoretusa israelskyi
Volvulella joaquinensis
Odostomia (Chrysallida) sequoiana
Odostomia (Menestho) repenningi
Turbonilla (Chemnitzia) hannai
Turbonilla hormigacuesta
Turbonilla (Ptycheulimella) edisonensis
Turbonilla (Tragula) greenhornensis

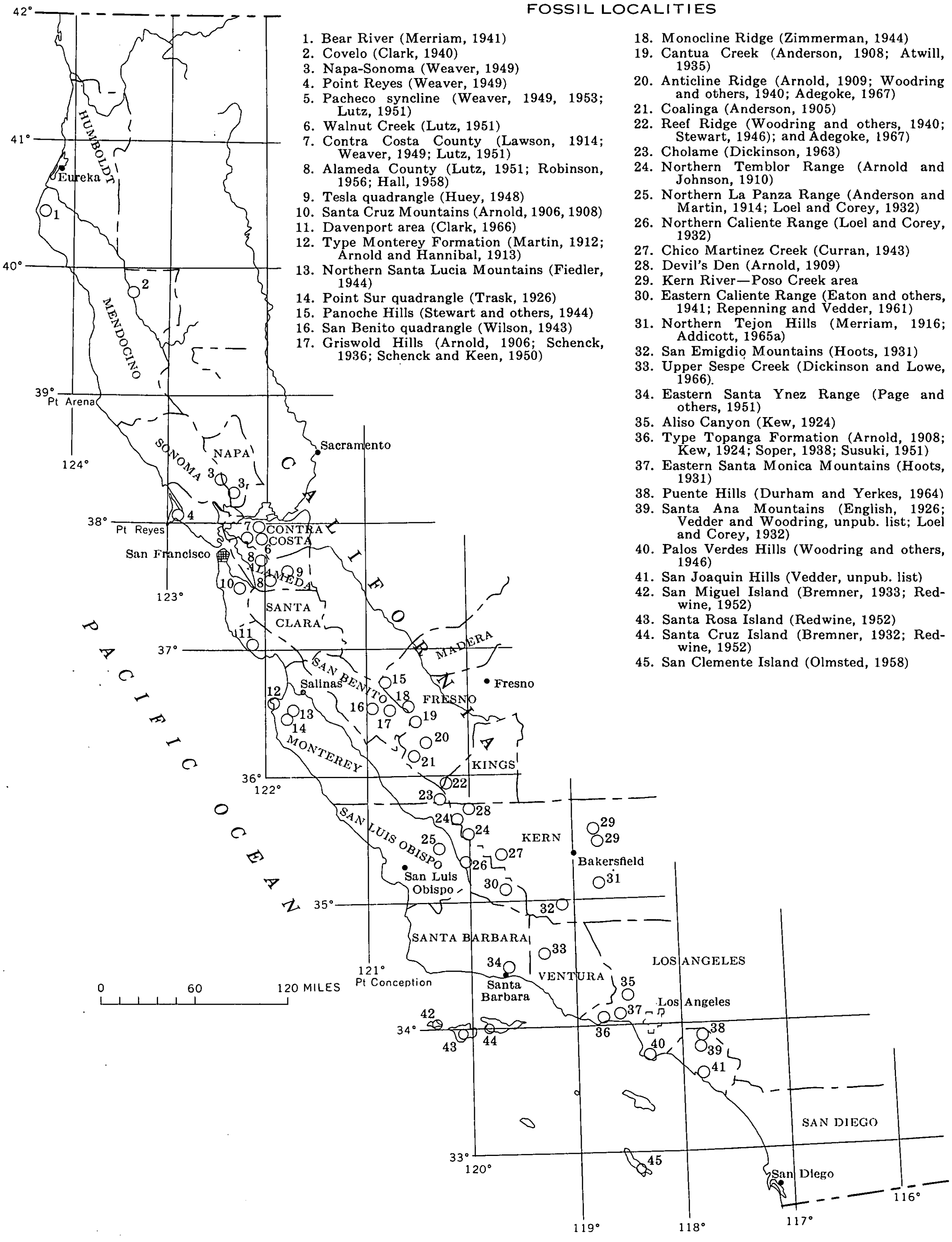
GENERIC AND SPECIFIC REASSIGNMENTS

Previous assignment	New assignment
Astraea raymondi (Clark)	*Astraea (Pomaulax) biangulata* (Gabb).
Calliostoma bicarinata Clark	*Astraea (Pomaulax) biangulata* (Gabb).
Calliostoma obliquistriata Trask	*Astraea (Pomaulax) biangulata* (Gabb).
Teniostoma (Teniostoma?) lens Keen	*Vitrinella (Vitrinellops)*.
Turritella n. sp. (affinity *T. freya* or *vanvlecki*) Merriam.	*Turritella kernensis* n. sp.
Cearithium topangensis Arnold	*Bittium*.
Thesbia ocoyana (Anderson and Martin).	*Batillaria*.
Epitonium (Cirsotrema) n. sp. A Durham.	*Epitonium (Cirsotrema) clallamense* Durham.
Ferminoscala durhami Keen	*Scalina*.
Ferminoscala whitei Keen	*Scalina*.
Polinices canalis Moore	*Polinices (Euspira) victoriana* Clark and Arnold.
"*Gyrineum*" *dilleri* (Anderson and Martin).	*Mediargo*.
Ficus (Trophosycon) ocoyana (Conrad).	*Ficus (Trophosycon) kerniana* Cooper.
Trophon gabbianum Anderson	*Ocenebra*.
Thais trophonoides Anderson and Martin.	*Ocenebra*.
Purpura milicentana Loel and Corey.	*Ocenebra*.
Thais (Stramonita) carrizoensis Loel and Corey.	*Thais (Nucella) packi* Clark.
Purpura edmondi Arnold	*Thais (Thaisella)*.
Bruclarkia santacruzana (Arnold)	*Bruclarkia barkeriana* (Cooper).
Searlesia kernensis (Anderson and Martin).	*Calicantharus*.
Amphissa posunculensis Anderson and Martin.	*Antillophos*.
Phos dumbleana Anderson in Hanna.	*Antillophos posunculensis* (Anderson and Martin).
Antillophos dumbleana chehalisensis (Weaver).	*Antillophos posunculensis* (Anderson and Martin).
Miopleiona scowensis Durham	*Psephaea (Miopleiona) weaveri* (Tegland).
Cancellaria ramonensis Clark	*Cancellaria (Euclia) oregonensis* Conrad.
Cancellaria andersoni Clark	*Cancellaria (Euclia) oregonensis* Conrad.
Cancellaria barkeri (Anderson in Hanna).	*Cancellaria dalli* (Anderson and Martin).
Oliva simondsi Trask	*Oliva (Oliva) californica* Anderson.
Conus juanensis Wiedey	*Conus (Chelyconus) juanensis* Anderson.
Thesbia antiselli (Anderson and Martin).	*Xenuroturris*.
Turricula wilsoni	*Turricula ochsneri* (Anderson and Martin).
Turricula libya Dall	*Turricula ochsneri* (Anderson and Martin).
Clathrodrillia temblorensis (Anderson and Martin).	*Ophiodermella temblorensis* (Anderson and Martin).
Moniliopsis electilis Keen	*Ophiodermella*.
Syrnola scandix Keen	*Pyramidella (Syrnola) ochsneri* (Anderson and Martin).
Chrysallida rotundomontana Keen	*Odostomia (Besla)*.

SYSTEMATIC DESCRIPTIONS

The geographic occurrence of middle Miocene faunal assemblages, and related place names, in the coast ranges of California, Oregon, and Washington is shown on index maps (figs. 10 and 11) included for use with the material under the headings the "Distribution and stratigraphic occurrence" for gastropod taxa in this section.

Abbreviations used in tabulating the stratigraphic



1. Bear River (Merriam, 1941)
2. Covelo (Clark, 1940)
3. Napa-Sonoma (Weaver, 1949)
4. Point Reyes (Weaver, 1949)
5. Pacheco syncline (Weaver, 1949, 1953; Lutz, 1951)
6. Walnut Creek (Lutz, 1951)
7. Contra Costa County (Lawson, 1914; Weaver, 1949; Lutz, 1951)
8. Alameda County (Lutz, 1951; Robinson, 1956; Hall, 1958)
9. Tesla quadrangle (Huey, 1948)
10. Santa Cruz Mountains (Arnold, 1906, 1908)
11. Davenport area (Clark, 1966)
12. Type Monterey Formation (Martin, 1912; Arnold and Hannibal, 1913)
13. Northern Santa Lucia Mountains (Fiedler, 1944)
14. Point Sur quadrangle (Trask, 1926)
15. Panoche Hills (Stewart and others, 1944)
16. San Benito quadrangle (Wilson, 1943)
17. Griswold Hills (Arnold, 1906; Schenck, 1936; Schenck and Keen, 1950)
18. Monocline Ridge (Zimmerman, 1944)
19. Cantua Creek (Anderson, 1908; Atwill, 1935)
20. Anticline Ridge (Arnold, 1909; Woodring and others, 1940; Adegoke, 1967)
21. Coalinga (Anderson, 1905)
22. Reef Ridge (Woodring and others, 1940; Stewart, 1946); and Adegoke, 1967)
23. Cholame (Dickinson, 1963)
24. Northern Temblor Range (Arnold and Johnson, 1910)
25. Northern La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932)
26. Northern Caliente Range (Loel and Corey, 1932)
27. Chico Martinez Creek (Curran, 1943)
28. Devil's Den (Arnold, 1909)
29. Kern River—Poso Creek area
30. Eastern Caliente Range (Eaton and others, 1941; Repenning and Vedder, 1961)
31. Northern Tejon Hills (Merriam, 1916; Addicott, 1965a)
32. San Emigdio Mountains (Hoots, 1931)
33. Upper Sespe Creek (Dickinson and Lowe, 1966).
34. Eastern Santa Ynez Range (Page and others, 1951)
35. Aliso Canyon (Kew, 1924)
36. Type Topanga Formation (Arnold, 1908; Kew, 1924; Soper, 1938; Susuki, 1951)
37. Eastern Santa Monica Mountains (Hoots, 1931)
38. Puente Hills (Durham and Yerkes, 1964)
39. Santa Ana Mountains (English, 1926; Vedder and Woodring, unpub. list; Loel and Corey, 1932)
40. Palos Verdes Hills (Woodring and others, 1946)
41. San Joaquin Hills (Vedder, unpub. list)
42. San Miguel Island (Bremner, 1933; Redwine, 1952)
43. Santa Rosa Island (Redwine, 1952)
44. Santa Cruz Island (Bremner, 1932; Redwine, 1952)
45. San Clemente Island (Olmsted, 1958)

FIGURE 10.—Principal California middle Miocene fossil localities and place names referred to.

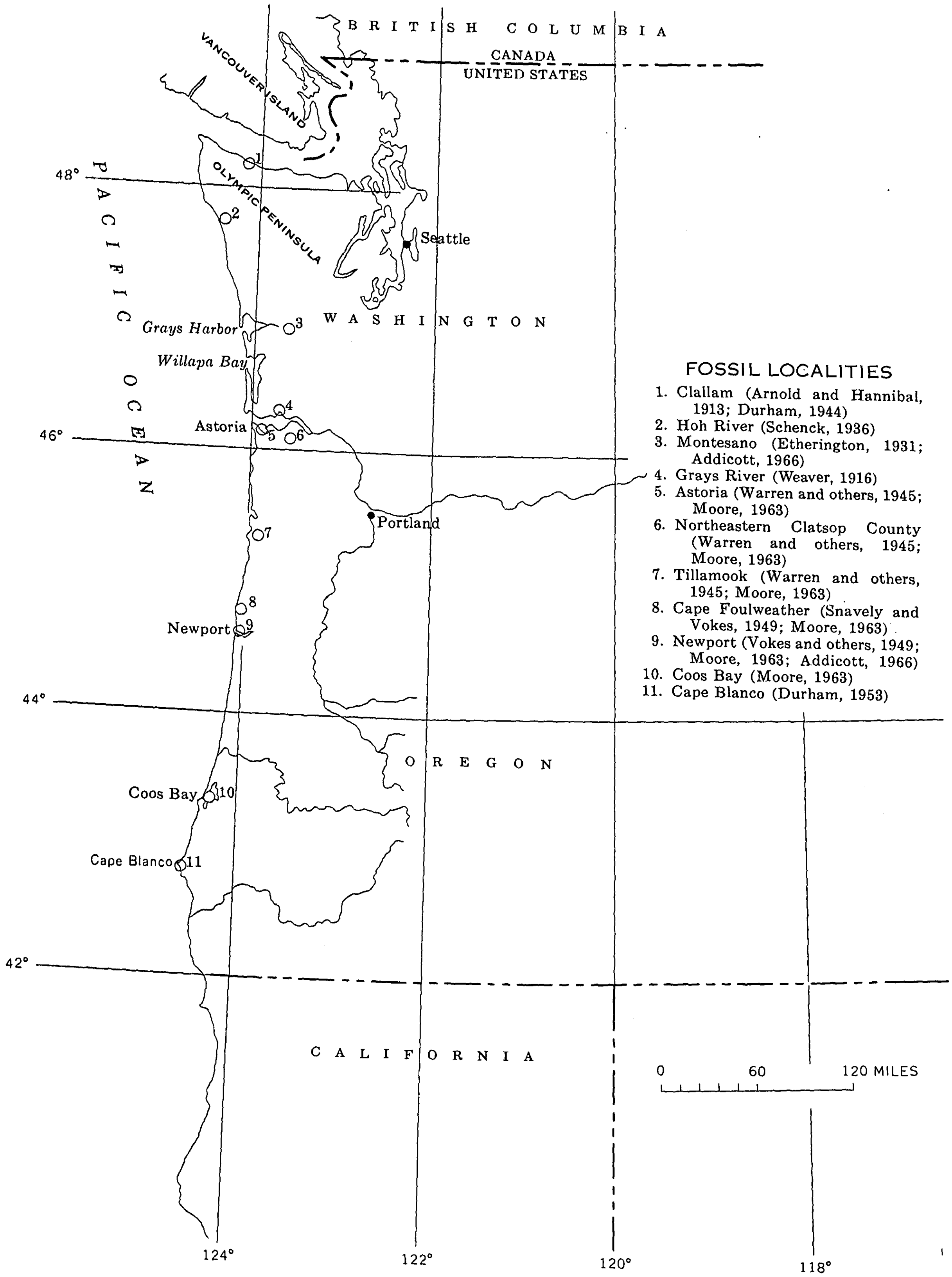


FIGURE 11.—Principal Oregon and Washington middle Miocene fossil localities and places referred to.

occurrence of gastropod taxa in the Kern River Miocene sequence are:

USGS	U.S. Geological Survey, Washington, D.C. locality register.
USGS M	U.S. Geological Survey, Menlo Park Cenozoic locality register.
CAS	California Academy of Sciences, San Francisco, Calif.
UCMP	California University Museum of Paleontology, Berkeley, Calif.
UCLA	California University, Los Angeles, Calif.
UCR	California University, Riverside, Calif.
SU	Stanford University, Stanford, Calif.
LACMIP	Los Angeles County Museum, Invertebrate Paleontology register, Los Angeles, Calif.

Anderson's original descriptions (1905) of Kern River gastropods are reprinted herein because most of the copies of his report were destroyed, prior to distribution, by the San Francisco fire of 1906. Supplementary descriptions based upon material available for this study are given for many species.

In the material under the headings "Geographic distribution and stratigraphic occurrence," certain conventions are used for the sake of convenience. Occurrences based upon what are here regarded as doubtful identifications are indicated by a question mark preceding the entry. Doubtful use of a formation name is indicated by a question mark following the name. Quotation marks inclosing a formation name are used to indicate usage that is now considered improper, the preferred name usually following in brackets. The San Ramon Formation and the Sooke Formation are classified as lower Miocene(?) in keeping with the classification of the upper part of the "Blakeley Stage" of Weaver and others (1944), to which both are referable (Durham, 1944; Addicott, 1967a).

Class GASTROPODA
Order ARCHAEOGASTROPODA
Family FISSURELLIDAE

Genus DIODORA Gray, 1821

Type (by monotypy): *Patella apertura* Montagu. Holocene, British Isles.

Diodora (Diodora) n. sp.

Plate 1, figures 1, 9, 24

?*Fissurella* sp. Loel and Corey, 1932, California Univ. Dept. Geol. Sci. Bull., v. 22, no. 3, p. 96.

Outline ovate, narrowing anteriorly from point of maximum diameter in posterior half of shell. Apical orifice subcircular, located slightly anterior to center. Exterior sculptured by fine radial ribs that become broader toward the periphery. Radial ribs beaded by a system of closely spaced, fine concentric ridges. A few irregularly spaced concentric folds superimposed upon the finely beaded radial sculpture.

Length (incomplete) 45 mm, width (incomplete) 35 mm, height (nearly complete) 15 mm.

Figured specimen: California Univ. Mus. Paleontology 10064. *Locality:* UCMP B1674, float from basal part of Jewett Sand about 500 feet south of 1,550-foot hill in NE¼NE¼ sec. 4, T. 28 S., R. 29 E., Woody quadrangle.

Diodora n. sp. is represented by an incomplete specimen embedded in very fine grained sandstone from the lower part of the Jewett Sand. The sculpture of beaded to finely imbricate radial ribs on the posterior part of a latex cast (pl. 1, fig. 1) is similar to *Stromboli beebei* (Hertlein and Strong, 1951, p. 113, pl. 10, figs. 3, 4, 5), a Holocene species from the Gulf of California, Mexico. However, the living species has alternate coarser and finer radial ribs and a nontruncate internal apical callus, whereas the lower Miocene species has the posteriorly truncated callus characteristic of *Diodora.*

The holotype of *Fissurella rixfordi* Hertlein (1928, p. 151–152, pl. 23, fig. 2), a species that might prove to be a *Diodora* if the details of the internal apical callus become known, differs from the Kern River district specimen by having an elliptical apical foramen, located more anteriorly than in *Diodora* n. sp. Moreover, it has closely spaced very widely noded radial ribs separated by deep grooves.

Occurrence: Lower part of Jewett Sand, USMP loc. B1674.

Diodora? n. sp.

Plate 1, figure 8

Small, with a low, symmetrical profile. Outline ovate, point of maximum diameter in posterior half of shell. Apical orifice centrally located. Anterior and posterior surfaces slope evenly toward margin from apex. Exterior sculptured by approximately 30 radial ribs with broad, deeply pitted interspaces containing weak secondary ribs. Radial ribs noded at intersection with system of about 10 regularly spaced concentric ridges.

Length (nearly complete) 18 mm, width (nearly complete) 11.5 mm, height 3.5 mm.

Figured specimen: California Univ. Mus. Paleontology 11031. *Locality:* UCMP B1605, about 25 feet below top of north-trending ridge in SW¼NW¼ sec. 10, T. 28 S., R. 29 E., Woody quadrangle. Near base of Jewett Sand, lower Miocene.

The generic assignment is questioned because the internal callus border is not preserved on the holotype, an external mold. Tentative assignment to *Diodora* is based upon close similarity in sculpture and profile to described species of the genus.

Pliocene and Holocene specimens of *Diodora alta* (Adams) from the Gulf of California (Durham, 1950, pl. 30, figs. 26, 27; Keen, 1958a, p. 251, fig. 30) have coarse radial ribs and deeply pitted interspaces similar to this Californian early Miocene species, but their apex is much higher and eccentric.

Occurrence: Lower part of Jewett Sand, UCMP loc. B1605.

Family TROCHIDAE

Genus TEGULA Lesson, 1835

Type (by monotypy): *Tegula elegans* Lesson [=*T. pellis-serpentis*]. Holocene, eastern Pacific Ocean from El Salvador to Ecuador.

Subgenus OMPHALIUS Phillippi, 1847

Type (by subsequent designation, Herrmannsen, 1847): *Trochus rusticus* Gmelin. Holocene, Japan.

Tegula (Omphalius) dalli arnoldi Addicott, n. subsp.

Plate 1, figures 14, 15, 18, 19, 23

Shell of medium size, low spired. Outer layer of shell material yellowish brown to light brown. Upper half of body whorl with broad, slightly protractive axial folds and a weak spiral cord near the middle; lower half with two spiral ridges of equal prominence which define a vertical segment of the whorl profile. Base flattened, devoid of spiral sculpture. Umbilical pit moderately deep, roofed over by callus.

Height 12.3 mm, width 15.7 mm (holotype).

Types: Holotype U.S. Nat. Mus. 650045; paratype, California Univ. Mus. Paleontology 11062.

Type locality: USGS M1599, bottom of southeast-trending gully, 900 feet south, 150 feet east of NW. cor. sec. 33, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle. Near top of Olcese Sand, middle Miocene.

This taxon is represented by incomplete or abraded specimens from several collections from the upper part of the Olcese Sand. It is closely related to the variable southern California middle Miocene species *Tegula dalli* (Arnold, 1907, p. 533–534, pl. 40, figs. 4–6a). An important sculptural trait of *T. dalli*, the spiral ribbing on the top and the base of the body whorl, is lacking in all of the Tegulas from the Olcese Sand. On most of the Kern River specimens fine axial growth lines are preserved. These lines suggest that spiral sculpture was never developed as in Arnold's species and its variants. Particularly noteworthy is the rich yellowish-tan to light-brown color, possibly original coloration.

Variation in this species seems comparable to that illustrated by Arnold for *Tegula dalli*, which was described as "a variable form, no two specimens being exactly similar" (1907, p. 533). Two figured specimens illustrate the kind of variation found in this species: An axially ribbed form with subdued spiral ridges (pl. 1, fig. 14) and a smooth low spired form with only the paired anterior spiral ridges (pl. 1, fig. 23).

An upper Miocene species from the upper San Pablo Group of Clark (1915), *Tegula nashae* Clark, seems closely related morphologically to *T. dalli* and *T. dalli arnoldi.* Presumably it links these taxa with the Pleistocene and Holocene species *T. aureotincta*, which today lives in the Californian and Panamic molluscan provinces from the Santa Barbara Islands to the Gulf of California (Burch, 1946, no. 57, p. 38). The spirally grooved base of the upper Miocene and Quaternary species serves to separate them from the middle Miocene group of *T. dalli.* Both Arnold and Clark recognized the affinities of these Miocene species to *T. aureotincta.* This lineage is represented in the California Pliocene by a related form, *Tegula* aff. *T. aureotincta*, from the Pico Formation of the eastern Ventura Basin (Winterer and Durham, 1962, loc. F61).

Occurrence: Upper part of Olcese Sand, USGS locs M1599–M1602; UCMP loc. B1599.

Tegula (Omphalius) laevis Addicott, n. sp.

Plate 1, figures 2, 3, 5–7

Of medium size, relatively low spired. Periphery of body whorl subrounded, set off by a poorly defined angulation near base and a somewhat stronger angulation above. Penultimate and body whorls with a narrow subsutural tabulation. Columella armed with a small tooth immediately below juncture with base of body whorl and a stronger tooth near the edge of umbilical ridge. Base smooth, flattened. Umbilicus moderately deep, closed, bordered by a sharp ridge terminating below apertural tooth. Surface smooth, light yellowish tan, patterned with darker colored fine growth lines. Penultimate whorl with random microscopic dark spiral threads.

Height 12.6 mm, width 17.2 mm (holotype).

Types: Holotype, U.S. Nat. Mus. 650043; paratype, USNM 650042.

Type locality: USGS M1602, west bank of east fork of gully in SW¼SW¼ sec. 32, T. 28 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

Tegula laevis is represented by specimens from two localities in the upper part of the Olcese Sand. The paratype and a figured specimen of *T. dalli arnoldi* (pl. 1, figs. 14, 15, 23) resemble an axially ribbed moderately high spired form of this species (pl. 1, fig. 7). An important difference between these taxa, however, is the absence, on specimens of *T. laevis*, of the peripheral spiral ridges on the body whorl. As defined herein, this species is as variable as *T. dalli*, to which it is closely related. Whereas the material at hand suggests recognition of separate species, it seems possible that additional specimens might expand the range of variation to include *T. laevis* as a form of *T. dalli arnoldi.*

Tegula brunnea fluctuosa Dall, a late Pleistocene and Holocene taxon from California and northwestern Baja California, has several morphological features in common with *T. laevis:* A narrow subsutural tabulation, orangish-brown shell, and somewhat irregular protractive axial ribs that disappear toward the base of the body whorl. It differs by being a more conical and higher spired species and by having a shallow umbilical pit.

Occurrence: Upper part of Olcese Sand, USGS locs. M1598, M1602.

Genus GIBBULA Risso, 1826

Type (by subsequent designation, Herrmannsen, 1847) : *Trochus magus* Linné. Recent, northeastern Atlantic Ocean and Mediterranean Sea.

Subgenus TUMULUS Monterosato, 1888

Type (by subsequent designation, Bucquoy, Dautzenberg, and Dollfus, 1898) : *Trochus umbilicaris* Linné.

Gibbula (Tumulus?) baileyi Addicott, n. sp.

Plate 1, figures 12, 16, 20

Shell small, conical, narrowly umbilicate. Spire of about three whorls, sutures channeled. Sculpture of very fine to microscopic spiral grooves and microscopic prosocline growth lines. Body whorl about three-fourths height of shell. Base sculptured by about 20 very fine spiral grooves that become more widely spaced toward the umbilicus, the spiral groove closest to the umbilicus being much wider than the rest. Umbilicus smooth, deep, bordered by a broad spiral swelling. Aperture rhombic. Umbilical margin of apertural lip straight; inner part of apertural lip straight above, sloping outward below.

Height 4.8 mm, width 6.0 mm (holotype).

Types: Holotype U.S. Nat. Mus. 650048; paratype USNM 650047.

Type locality: USGS 6065, north side of Kern River about 1 mile northeast of Rio Bravo Ranch. Along flume at edge of hills at center of first big re-entrant bend of river terrace border [NW¼ sec. 1, T. 29 S., R. 29 E., Rio Bravo Ranch quad.].

This small trochid is characterized by a nearly smooth conical spire, spirally grooved base, and rhombic aperture. Shell thickens at the juncture of the inner apertural lip with the base. The holotype is somewhat smaller than the largest specimens in the type lot. Some individuals have very fine spiral sculpture adjacent to the suture.

Gibbula was heretofore unreported from the Tertiary of the Pacific coast, although a Pleistocene and Holocene species, *G. adriatica canfieldi* Dall, has been recorded from California (Dall, 1921). The Kern River Miocene species does not seem to be closely related to the Quaternary gibbulid, but it does have several characters in common with species included in *Tumulus*, a European Miocene to Holocene subgenus. Similar spiral sculpture, apertural morphology, and overall form all suggest assignment to *Tumulus*, but because the comparisons are made on the basis of illustrations alone, the subgeneric assignment is provisional.

Occurrence: Lower part of Round Mountain Silt, USGS locs. 6064, 6065, 6623, M2480.

Genus CALLIOSTOMA Swainson, 1840

Type (by subsequent designation, Herrmannsen, 1846) : *Trochus conulus* Linne. Holocene, Mediterranean.

Calliostoma carsoni Addicott, n. sp.

Plate 1, figures 10, 13

?*Calliostoma splendens* (Cooper) [(Carpenter)] *diabloensis* Clark, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 273, pl. 64, fig. 2.

Moderately large, conical. Whorls five, slightly rounded, sutures subtabulate. Penultimate whorl sculptured by five spiral cords; three upper cords nodose, two lower cords smooth. Body whorl large, periphery broadly angulated, sculptured by six primary spiral cords, all of which bear closely spaced nodes. Nodes strongest on subsutural primary spiral, weaker toward the base of whorl. Interspaces with smooth secondary threads. Base gently rounded, imperforate, sculptured by 12 rounded spiral cords and fine closely spaced growth lines.

Height 16.7 mm, width 17.5 mm.

Type: California Univ., Los Angeles 45763.

Type locality: UCLA 3456, on west side of south-trending ridge stratigraphically above UCLA 2669, 1,700 feet north, 1,600 feet west of SE. cor. sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle. Upper part of Olcese Sand.

The sculpture and profile of this species closely resemble the holotype and a figured specimen of *Calliostoma coalingense* Arnold from Pliocene rocks near Coalinga, Calif. (Arnold, 1909, pl. 27, fig. 7; Woodring and others, 1940, pl. 11, figs. 2 and 3; pl. 15, figs. 15 and 16). The two can be distinguished by comparison of body whorl sculpture. On *C. coalingense* there is a change from noded spirals above the midline of the body whorl to smooth spirals below. This change is reflected by a faint break-in-slope on the holotype and the other figured specimens. The body whorl profile of *C. carsoni* is evenly rounded, and all of the primary spiral ribs are noded.

Calliostoma carsoni is similar to *C. diabloense* (Clark, 1915, p. 482, pl. 65, fig. 21) from the upper Miocene Cierbo and Neroly Formations of Contra County, Calif. The late Miocene species is smaller and more high spired than *C. carsoni*. Its whorls are angulated and the spirals above the angulation are relatively weaker than on *C. carsoni*.

Loel and Corey (1932, p. 273, pl. 64, fig. 2) figured a small individual from lower Miocene strata of the San Emigdio Mountains as *Calliostoma splendens diabloensis* Clark. Because of its small size and poor state of preservation, it is difficult to compare this specimen with other species. Yet the rounded periphery of the body whorl, relatively low spire, and spiral sculpture are similar to *C. carsoni* and it is therefore doubtfully included with *C. carsoni*. Loel and Corey's records of *C. diabloense* from the middle Miocene include occurrences in the La Panza Range and Santa Ana Mountains. As these records are not specific as to localities and the collections on which they were based, it cannot be determined whether or not they are related to *C. carsoni*.

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation, western Santa Ynez Mountains and San Emigdio Mountains (Loel and Corey, 1932); "Vaqueros Zone" [Jewett Sand], Kern River area (Loel and Corey, 1932, p. 96–97). Middle Miocene: upper part of Olcese Sand, Kern River area.

Range: Lower Miocene to middle Miocene.

Locality: Upper part of Olcese Sand, UCLA 3456.

Calliostoma sp. A

Plate 1, figure 11

A small incomplete and abraded *Calliostoma* that seems to differ from *C. carsoni* n. sp. was found in a collection of mollusks from the basal part of the Jewett Sand. The exterior shell layer is missing from all but a small area on the base of this moderately high spired specimen. The whorls are nearly flat in profile and are sculptured by five or six spiral cords of equal strength. The relatively flat base is sculptured by about eight spiral cords.

Calliostoma sp. A resembles rather closely the paratype of *C. lawsoni* Clark (1918, p. 163, pl. 22, fig. 14, UCMP 11228) from the San Ramon Sandstone at Walnut Creek, Calif., but seems to have more primary spiral ribs. The holotype of *C. lawsoni*, a much larger specimen, has angulate whorls and only three primary spirals.

Occurrence: Basal part of Jewett Sand, CAS loc. 37468.

Calliostoma sp. B

Plate 1, figure 4

A small trochid from the basal conglomeratic sandstone of the Jewett Sand at Pyramid Hill (USGS loc. M1591) is identified as *Calliostoma* sp. B. It is characterized by strong spiral cords between which faint secondary spirals are intercalated on the body whorl. The base is sculptured by eight rounded spiral cords that are more closely spaced toward the umbilicus.

This coarsely ribbed taxon is distinct from Miocene species described from the Pacific coast. It seems most closely related sculpturally to a broadly conical species from the lower Pliocene Empire Formation of southwestern Oregon, *Calliostoma cammani* Dall (1909, p. 96, pl. 2, figs. 8, 9), but the base of the Pliocene taxon does not have crisp spiral ribbing.

Occurrence: Basal part of Jewett Sand, USGS loc. M1591.

Family TURBINIDAE

Genus ASTRAEA Röding, 1798

Type (by subsequent designation, Suter, 1913): *Trochus imperialis* Gmelin. Holocene, New Zealand.

Subgenus POMAULAX Gray, 1850

Type (by subsequent designation, Fischer, 1873): *Trochus japonicus* Dunker. Holocene, Japan.

Astraea (Pomaulax) n. sp.

Plate 2, figure 1

Sculpture of five revolving rows of flat-topped nodes and plicae. Upper four-fifths of whorl has three rows of broad slightly protractive axial rib segments. Segments of uppermost row four times as long as wide but with interspaces of equal width. Second row equidimensional rhombic nodes and narrower interspaces. Next lower row of ribs twice as long as wide, interspaces narrower than ribs. Lowest two revolving cords noded with irregular enlarged retractive growth lines. Surface of whorl sculptured by submicroscopic growth lines slanting posteriorly at angle of approximately 45°.

Diameter of broken specimen 25 mm.

Figured specimen: California Univ. Mus. Paleontology 11064.

Locality: UCMP B1616, west bank of large canyon in SW¼ SE¼ sec. 28, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle. Upper part of Olcese Sand, middle Miocene.

Astraea n. sp. is represented by only one specimen, a fragment of a penultimate whorl of a moderately large individual, from the upper part of Olcese Sand that seems distinct from other species of *Astraea* in later Cenozoic of Pacific coast of North America. Another species of *Astraea* in the upper part of Olcese Sand, *A. biangulata* Gabb, differs from this species by having a pair of strong widely spaced basal cords separated by a secondary spiral cord and generally finer, more segmented axial sculpture.

Occurrence: Upper part of Olcese Sand, UCMP loc. B1616.

Astraea (Pomaulax) biangulata (Gabb)

Plate 2, figures 2, 3, 6–9

?Pachypoma biangulata Gabb, 1866, California Geol. Survey, Paleontology, v. 2, p. 15, pl. 3, fig. 26.

Astraea (Pachypoma?) biangulata (Gabb), Etewart, 1927, Acad. Nat. Sci. Philadelphia Proc., v. 78, p. 318, pl. 32, fig. 6.

Astralium raymondi Clark, 1915, California Univ., Dept. Geology Bull., v. 8, no. 22, p. 480, pl. 65, figs. 15, 16.

Astraea undosa raymondi (Clark), Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 34, fig. 4.

Calliostoma bicarinata Clark, 1915, California Univ., Dept. Geology Bull., v. 8, no. 22, p. 481–482, pl. 65, figs. 14, 19.

Calliostoma obliquistriata Trask, 1922, California Univ. Dept. Geology Sci. Bull., v. 13, no. 5, p. 153, pl. 7, figs. 7a, 7b.

Astraea morani Loel and Corey, 1932, California Univ. Dept. Geology Sci. Bull., v. 22, no. 3, p. 271 [in part], pl. 64, fig. 4 [not figs. 5, 6a, 6b].

Supplementary description based upon Kern River specimens.—Large, conical, somewhat broader than tall. Whorls of spire delicately sculptured. Upper half of penultimate whorl has sinuous protractive axial ribs which become nodose on body whorl. Two rows of fine to very fine nodes separate axial ribs from set of elongate, oblique nodes, describing a near-vertical basal segment of penultimate whorl profile. Nodes of basal row more strongly developed. Row of finer, more numerous nodes intercalated between prominent basal rows.

Type: Acad. Nat. Sci. Philadelphia, 4327.

Type locality: "Miocene south of Martinez," Contra Costa County, Calif. (Gabb, 1866, p. 15). Formations ranging in age from middle to late Miocene occur in this broadly designated area. Reported occurrences of *Astræa* in beds older than late Miocene.

Type of *Astralium raymondi* Clark: California Univ. Mus. Paleontology 31174; paratype, UCMP 11624.

Type locality: UCMP 1192, Lafayette Ridge about 1¼ miles north of Lafayette "upper San Pablo Group" (Clark, 1915, p. 421). Locality plots in unit mapped as Briones Sandstone by Lawson (1914).

Type of *Calliostoma bicarinatum* Clark: UCMP 11640.

Type locality: UCMP 1182, about one-eighth of a mile up gully from cor. sec. 15, T. 1 S., R. 2W., M. D. B. and M. "Upper San Pablo Group," upper Miocene (Clark, 1915, p. 421).

Stewart (1927, p. 318) concluded that the type of *Astraea raymondi* Clark was probably a smaller, immature specimen of *A. biangulata* which lacked the row of nodes between the noded primary spiral cords on the lower part of the whorls. Some specimens from the Olcese Sand confirm Stewart's suggestion, although the addition of the secondary row of nodes takes place at a relatively early stage of growth. Kern River Miocene specimens differ slightly from the holotype of *A. raymondi* by their relatively finer and more closely spaced spiral cords on the base of the body whorl. Other minor differences in sculpture here considered infrasubspecific are the position of the revolving rows of nodes on the upper part of the whorl of *A. biangulata*, as contrasted with axial aspect predominate in this area on *A. raymondi*, and greater relative height of *A. biangulata.*

Comparison of the early whorls of an imcomplete specimen with a moderately large fragment of the body whorl of another specimen from the Kern River area (pl. 2, fig. 6) illustrates the ontogenetic change from relatively coarse unbroken segments of axial ribs in immature specimens to finer discontinuous ribs in mature individuals. The latter is characteristic of Gabb's type (1869, pl. 3, fig. 26).

The holotype and a "plesiotype" [hypotype] of *Astraea morani* Loel and Corey (1932, p. 271, pl. 64, figs. 5, 6a, 6b), an early Miocene species from the Vaqueros Formation, differ from middle Miocene specimens of *A. biangulata* from the Kern River area by their relatively smooth whorl profile and very weakly impressed sutures. The sculpture is much finer and the more numerous axial ribs are continuous across the upper part of the body whorl. A poorly preserved, crushed "plesiotype" of *A. morani* (Loel and Corey, 1932, pl. 64, fig. 4) has fewer, much coarser axial ribs similar to those of *A. biangulata.* In the absence of large collections necessary to evaluate the range of variation in early Miocene specimens of *Astraea*, this specimen is here considered distinct from the holotype of *A. morani* and is included in the synonymy of *A. biangulata.*

Calliostoma bicarinatum Clark (1915, p. 481–482, pl. 65, figs. 14, 19), represented by two small specimens from the upper part of the San Pablo Group, is a synonym of *A. biangulata* based on immature specimens with subdued axial sculpture. The type material is from a locality at which *A. biangulata* [*A. raymondi*] was collected by Clark.

A poorly preserved small *Astraea*, *A. obliquistriata* (Trask, 1922, p. 153, pl. 7, figs. 7a, 7b) from the upper Miocene Briones Sandstone of Contra Costa County, Calif., differs from *A. biangulata* only by its coarser growth striae and weak axial sculpture. As these differences seem to be of infrasubspecific magnitude, *A. obliquistriata* is here considered a synonym of *A. biangulata.*

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation, San Joaquin Hills (Loel and Corey, 1932). Middle Miocene: Saltos Shale Member of the Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, unpub. data, 1968); Olcese Sand, Kern River area. Upper Miocene: Briones Sandstone, Contra Costa County

(Trask, 1922); upper San Pablo Group (= Neroly Formation), Contra Costa County (Clark, 1915; Weaver, 1949); Santa Margarita Formation—type section, San Luis Obispo County (Nomland, 1917a); Comanche Point (Addicott and Vedder, 1963, cf.). Modelo Formation of Oakeshott (1958), San Fernando quadrangle (Oakeshott, 1958).

Range: Lower Miocene to upper Miocene.

Localities: Upper part of Olcese Sand, UCMP B1615. Upper part of Olcese Sand or lower part of Round Mountain Silt, UCMP 2713.

Family NERITIDAE

Genus NERITA Linné, 1859

Type (by subsequent designation, Montfort, 1810): *Nerita peloronta* Linné. Holocene, West Indies.

Subgenus THELIOSTYLA Mörch, 1852

Type (by subsequent designation, Kobelt, 1879): *Nerita albicilla Linné.*

Nerita (Theliostyla?) joaquinensis Addicott, n. sp.

Plate 1, figures 17, 21, 22

Small light-yellowish-tan with darker spiral bands and very faint zigzag color pattern preserved immediately below suture. Spire immersed. Sculptured by microscopic, closely spaced incremental ridges. Aperture broadly rounded, flat above and flaring below, parietal segment nearly vertical. Outer lip thickened within, regularly denticulate. Columellar lip armed with pair of medial denticles. Labial area incompletely preserved, armed with three granules near middle.

Height 12.5 mm, width 13.9 mm (holotype).

Types: Holotype, U.S. Nat. Mus. 650051; paratype, USNM 650050.

Type locality: USGS M1613, east side of gully 20 feet stratigraphically above M1612, 1,300 feet north, 1,450 feet east of SW. cor. sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene.

The low spire and finely dentate outer apertural lip suggest assignment of this species to *Theliostyla*, but because the incompletely preserved labial area is only sparingly granulate, assignment to this subgenus is considered doubtful.

This is the first upper Tertiary occurrence of *Nerita* in California. An early Miocene species from Baja California, *Nerita beali* Loel and Corey (1932, p. 272, pl. 63, figs. 6a, 6b), is similar to *N. joaquinensis*. The holotype of the early Miocene species (UCMP 31600) is poorly preserved and does not clearly show the details of the inner apertural lip mentioned in the type description, the stated lack of denticles on the inner lip (Loel and Corey, 1932, p. 272) presumably being determined from other specimens. The presence of columellar denticles and the broadly inflated shell of *N. joaquinensis* permits differentiation from the early Miocene species. The holotype of *N. beali* is a flatter, less inflated shell than specimens of *N. joaquinensis*, possibly due, in part, to deformation.

Occurrence: Lower part of Round Mountain Silt, USGS locs. M1613, M1640.

Order MESOGASTROPODA

Family LAUNIDAE

Genus LACUNA Turton, 1827

Type (by subsequent designation, Gray, 1847): *Nerita pallidula* da Costa. Holocene, northern Europe.

Lacuna carpenteri Anderson and Martin

Plate 3, figures 1, 2, 22

Lacuna carpenteri Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 69, pl. 7, fig. 21.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Supplementary description.—Small, smooth, low spired. Consists of four or more gently convex whorls. Body whorl about three-quarters of shell height, periphery angulate, sculptured with sinuous axial lines of growth, prominent near the aperture. Base of body whorl convex, medial part sculptured by a narrow spiral rib originating in final quarter turn.

Type: California Acad. Sci. 147.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

Lacuna carpenteri seems to be closely related and possibly ancestral to the living *L. carinata* Gould, a species that has been doubtfully identified from beds as old as Pliocene in the Santa Maria basin (Woodring and Bramlette, 1950). It differs from the possible descendant by having a relatively flat sided whorl profile, a relatively smaller and less flaring aperture, and a strongly recurved inner apertural lip. Specimens of *L. carpenteri* from UCMP locality B1600 have tabulate whorls and rather deeply impressed sutures. A specimen from this locality (pl. 3, fig. 22) differs from the type of *L. carpenteri* by having a much shorter spire and a stronger basal angulation, but these characters are regarded as infrasubspecific.

Occurrence: Upper part of Olcese Sand, USGS loc. M1600; UCMP loc. B1600.

Family VITRINELLIDAE

Genus VITRINELLA Adams, 1850

Type (by subsequent designation, Bush, 1897): *Vitrinella helicoidea* C. B. Adams. Holocene, southeastern United States to West Indies.

Subgenus VITRINELLOPS Pilsbry and Olsson, 1952

Type (by original designation): *Vitrinella zonitoides* Pilsbry and Olsson. Holocene, west coast of Panama.

Included in this subgenus are species that differ from *Vitrinella* s. s. by their lack of an umbilical cord or keel.

Vitrinella (Vitrinellops) lens (Keen)

Plate 2, figures 4, 5, 10

Teinostoma (*Teinostoma*?) *lens* Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 51, pl. 4, figs. 7–9.

A small, umbilicate vitrinellid. Dorsal surface smooth. Sutures impressed, bordered by narrow concave channel on body whorl.

Type: Stanford Univ. paleontology type colln. 7545.

Type locality: SU 2121, in small gully close to terrace contact near center SW¼ sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

The profile and open umbilicus of this species indicate generic relationship to the Holocene northeastern Pacific Ocean species assigned to *Vitrinella.* Topotypes of a somewhat larger Miocene vitrinellid from the Astoria Formation near Newport, Oreg., *Cochlolepis? schoonerensis* Moore (1963, p. 24–25, pl. 1, figs. 19–21), differ from *V. lens* by their slightly elevated, relatively large spire with convex whorls and rather deeply impressed sutures.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597. Lower part of Round Mountain Silt, USGS loc. M1612.

Family TURRITELLIDAE

Genus TURRITELLA Lamarck, 1799

Type (by monotypy): *Turbo terebra* Linné. Holocene, tropical western Pacific.

Turritellas are fairly common in the upper part of the Olcese Sand and in the Round Mountain Silt. Lower in the Miocene section exposed east of Bakersfield, however, there are only two occurrences although there are a few scattered records from well cores in the lower Miocene Vedder Sand in this area (Kleinpell, 1938; Addicott, 1965a). The earliest members of two important late Tertiary and Quaternary *Turritella* stocks, *T. cooperi* and *T. broderipiana* (Merriam, 1941), make their initial appearance in the geologic record in the middle Miocene strata (upper part of the Olcese Sand) of the Kern River area. These stocks are represented by *T. moodyi* Merriam and by *T. kernensis* n. sp., respectively. The early and middle Miocene species *T. inezana* and *T. ocoyana* have mutually exclusive, though fragmentary, ranges in the Kern River area. *T. ocoyana* does not occur in faunal assemblages below the "Temblor Stage" in this area; in some other areas it ranges downward into assemblages referable to the underlying "Vaqueros Stage" that also contain *T. inezana* (Loel and Corey, 1932; Repenning and Vedder, 1961).

Subgenus? (Turritella cooperi stock of Merriam)

Turritella moodyi Merriam

Plate 2, figures 11–14

Turritella moodyi Applin MS, Merriam, 1941, California Univ., Dept. Geol. Sci. Bull., v. 26, no. 1, p. 121, pl. 33, figs. 5–7.

Small, weakly sculptured. Early profile subcarinate anteriorly; flat above, slightly concave below. Profile of later whorls gently convex. Anterior half of early whorls with strong spiral thread that becomes more subdued in later whorls. Secondary spiral sculpture of very fine, closely spaced, rounded threads usually present anterior to primary spiral cord but weakly developed or obsolete in posterior part of whorl. Secondary thread near posterior quarter line of later whorls, usually becoming more strongly developed than the others, giving a faint bicostate appearance to whorls. Strong secondary thread developed near middle of whorl on some specimens. Growth line with well-developed antispiral sinus; apex of sinus below midline of whorl. Growth-line angle about 20°–25°.

Type: California Univ. Mus. Paleontology 12452.

Type locality: UCMP 2713, Temblor loc. 1, Caliente quadrangle? Miocene.

Several well preserved specimens of *Turritella moodyi* at hand clearly show the cingulate ribbing of early whorls and growth line configuration characteristic of the *T. cooperi* stock (Merriam, 1941). Therefore, the first appearance of this stock can now be recognized as definitely middle Miocene.

The final whorls of some of the largest specimens (pl. 2, fig. 12) becomes rather convex and tend to pull apart at the sutures. Sculptural variation consisting of rather strong secondary threads and a spiral channel at the posterior quarter line are also shown by this specimen. A fragment of the early whorls of another specimen (pl. 2, fig. 14) is evenly, yet weakly, bicostate, an unusual condition among the many individuals available for study.

Turritella moodyi approaches very closely certain variants of *T. cooperi* in which the posterior primary rib may be rather weakly developed. However, the delicate very weakly developed sculpture, consistent lack of well-developed bicostate sculpture, and practically straight whorl profile permit differentiation of *T. moodyi* from the late Miocene to Holocene species.

Distribution and stratigraphic occurrence: Topanga Formation, Santa Monica Mountains (USGS loc. M2772).

Range: Middle Miocene.

Localities: Lower part of the Round Mountain Silt. USGS 3886, 6065, 6623, M1604, M1609–M1613, M1696, M2480; UCMP B1618, B1620, B1625, B1637, B1638.

Subgenus? (Turritella broderipiana stock of Merriam)

Turritella kernensis Addicott, n. sp.

Plate 2, figures 16, 17, 23–25

Turritella n. sp. (affinity *T. freya* or *vanvlecki*) Merriam, 1941, California Univ., Dept. Geol. Sci. Bull., v. 26, no. 1, p. 125, pl. 37, fig. 5.

Small, with broad apical angle. Nuclear whorls medially costate, adolescent whorls subangulate slightly anterior to midline; profile flat above, concave below. Basal primary of adolescent whorls produces an appressed suture. Adult whorl profile flat to gently convex. Medial and basal primary spirals much subdued to obsolete on later whorls. Secondary sculpture of fine, closely spaced cords on earlier whorls and tertiary threads on later whorls. Base of body whorl gently concave, ornamented as on sides of whorl. Growth line broad, shallow sinused, angle about 10°–15°.

Height (incomplete) 20.7 mm, width (almost incomplete) 8.5 mm (holotype).

Types: Holotype, U.S. Natl. Mus. 650059; paratypes, USNM 650058, USNM 650061.

Type locality: USGS M1598, west bank of large southward-trending canyon, 1,400 feet west, 700 feet north of SE. cor. sec. 28, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle. Near top of Olcese Sand, middle Miocene.

This species has been considered the earliest California representative of the tropical eastern Pacific *Turritella broderipiana* stock (Merriam, 1941, p. 50), apparently on the basis of its mesocostate nuclear sculpture, appressed sutural ribs, and fine, uniform adult sculpture. The growth-line angle is about 10°–15° on the holotype and the adult paratype specimens. This angle is approximately half of that listed for other Tertiary species referred to this stock by Merriam. The discrepancy may be the result of the relatively small size of specimens of *T. kernensis*.

Turritella kernensis occurs at only a few localities in the upper part of the Olcese Sand. The most characteristic morphologic feature of this species is the concave part of the whorl profile on the anterior half of the earlier whorls. In other respects, the sculpture and shape is often variable. A primary spiral cord is usually developed at or just below the midline of the earlier whorls but becomes obsolete on adult whorls. The basal primary becomes obsolete on the later whorls although still expressed as an abrupt angulation on the body whorl. The base of the body whorl varies from gently convex to nearly flat. Many specimens have very rapidly enlarging early whorls succeeded by adult whorls of nearly constant width. The resulting profile is characterized by a broad apical angle and bullet-shaped profile (pl. 2, fig. 17).

The growth-line sinus and the acute growth-line angle of *T. kernensis* distinguish this species from the similarly sculptured late Tertiary species *T. freya* Nomland and *T. vanvlecki* Arnold. Unforunately, fossils collected are seldom in a state of preservation that shows the growth line, so that ordinarily discrimination must be based on details of sculpture. *T. freya*, a late Miocene species from the Santa Margarita Formation of central California, differs from *T. kernensis* by having fewer and more coarse spiral ribs above the strong medial carina, a strong secondary cord immediately posterior to the basal primary spiral cord in the concave anterior part of the earlier whorls, and an open growth line which describes a moderately large growth-line angle. Comparison of the holotype and paratype of *T. freya* suggests a large range of variation in that species.

The coarse spiral ribbing of *Turritella vanvlecki* Arnold distinguishes that species from the more delicately sculptured *T. kernensis*. There is some difficulty, however, in distinguishing Merriam's two subspecies of *T. vanvlecki* (1941) from the Kern River Miocene species. Hypotypes of *T. vanvlecki teglandae* Merriam (1941, pl. 37, figs. 4, 6, 8–10) seem most closely related to the holotype of *T. kernensis*. They differ by having a strong medial keel and fewer but stronger spiral cords. Some variants have strong secondaries at the anterior quarter line and, occasionally, at the posterior quarter line. The finely ribbed type of *T. vanvlecki teglandae* also has a rather weak primary spiral near the anterior quarter line. Woodring and Bramlette (1950, p. 71, pl. 13, fig. 13) figured a specimen from the type locality of *T. vanvlecki teglandae* in the Santa Maria basin as *T. gonostoma hemphilli*, concluding that Merriam's two subspecies are synonyms and that they are more closely related to the Holocene *T. gonostoma* than to *T. vanvlecki*.

It is difficult to follow a consistent treatment of the *Turritella* stocks. The recognition of specific and subspecific taxa of the *T. gonostoma*-*T. vanvlecki* group in California, for example, is more greatly refined than the *T. ocoyana* stock, which may be equally variable, although represented by a single species in California. For the present, considerable variation is recognized within *T. kernensis*. Two varieties are a short, stout form with the medial carination present on only the earliest whorls (pl. 2, fig. 17) and a form with persistent unicostate sculpture (pl. 2, figs. 16, 25). The first form is comparable to *T. vanvlecki hemphilli*, the second to some of Merriam's hypotypes of *T. vanvlecki teglandae* (1941, pl. 37).

Distribution and stratigraphic occurrence: Temblor Formation, Reef Ridge (Merriam, 1941); reportedly from an unspecified formation (UCMP loc. 1212) near Muir Station, Contra Costa County (Merriam, 1941). [Weaver (1953, p. 64) lists *Turritella temblorensis* Wiedey from two localities in the middle Miocene Sobrante Formation of this general area]. Topanga Formation, Santa Monica Mountains (USGS loc. M1076).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597, M1598; UCMP B1598, B1614. Lower part of Round Mountain Silt, USGS M1611.

Subgenus TORCULA Gray, 1847

Type (by original designation).—*Turbo exoletus* Linné. Holocene, southern Florida and West Indies.

Turritella (Torcula) cf. T. (T.) inezana Conrad

A crushed, incomplete specimen from a core of the Vedder Sand (2,060 ft) in L. and B. Producing Jewett 1 (NE¼SW¼ sec. 19, T. 28 S., R. 29 E.) seems to be referable to *Turritella inezana.* Although unsuitable for figuring, this individual agrees reasonably well with Merriam's supplementary description (1941) of *Turritella inezana* Conrad. It has the sutural disjunction, obsolete adult sculpture, and strong growth lines that Merriam described as gerontic characters.

Three poorly preserved specimens from the basal conglomeratic sandstone of the Jewett Sand at Pyramid Hill (LACMIP loc. 462) also seem to be referable to this species. These large, flat-sided individuals are the first record of this species from lower Miocene exposures in the southeastern part of the San Joaquin Valley. There are, however, several unpublished subsurface records from the Vedder Sand in the vicinity of Round Mountain oil field (Alex Clark, Dept. Geology, California Univ., Riverside, unpub. data, 1930–35) which is 1½–3 miles basinward from lower Miocene outcrops. This species has been cored in an oil well southeast of Bakersfield, General Petroleum Kerwin 1, sec. 5, T. 30 S., R. 29 E. (Corey in Cushman and Laiming, 1931, p. 85).

The reported occurrence of *Turritella inezana* in beds stratigraphically above a Relizian Stage foraminiferal assemblage (Schenck, 1935, p. 524; Kleinpell, 1938, p. 73) led Kleinpell to depict the biozone of this lower Miocene guide fossil as extending into the upper part of his middle Miocene [Relizian and Luisian Stages]. This undocumented record, from the vicinity of Sulphur Springs Creek on the north side of the Caliente Range in eastern San Luis Obispo County, more likely is of a species closely related to the *T. inezana gens* that was later named *T. carrisaensis* var. *padronesensis* Grant and Eaton (Eaton and others, 1941, p. 236). The recent discovery of *T. ocoyana* at the type locality of *T. padronesensis* (J. G. Vedder, oral commun., 1965) required a change to middle Miocene from the original age assignment of late Miocene (Eaton and others, 1941). The Sulphur Springs Creek locality about 12 miles to the west of Padrones Spring is also of middle Miocene age based on the reported joint occurrence of *T. padronesensis* with *T. ocoyana* (Reed in Eaton and others, 1941, p. 256) and the position stratigraphically above Relizian foraminifers.

Occurrence: Upper part of Vedder Sand, UCR loc. PR 604. Basal part of the Jewett Sand, LACMIP loc. 462 (= USGS loc. M1591).

Turritella (Torcula) inezana pervulgata Merriam

Plate 2, figure 18

Turritella variata Conrad. Wiedey, 1928, San Diego Soc. Nat. History Trans., v. 5, no. 10, p. 120–121 [in part], pl. 12, fig. 8.

Turritella inezana (Conrad) *sespeensis* Arnold, Loel and Corey, 1932, California Univ. Dept. Geology Sci. Bull., v. 22, no. 3, p. 258–259 [in part], pl. 58, figs. 7, 14 [not figs. 6, 10, 13, 15].

Turritella inezana pervulgata Merriam, 1941, California Univ. Dept. Geology Sci. Bull., v. 26, no. 1, p. 108–109, pl. 25, figs. 7, 11.

Type: California Univ. Mus. Paleontology 31686.

Type locality: UCMP A330, north side Ojai to upper Ojai Valley Pass along ridge east of first west bend in new highway (not on Santa Paula quadrangle, 1910 ed.). Vaqueros Formation, lower Miocene.

This subspecies is represented by a broken specimen from a core of the Vedder Sand (Shell "Edison" 2–1, SE¼NW¼ sec. 33, T. 29 S., R. 29 E.) near the Edison Groves area of Edison oil field. It differs from the holotype by its broader subsutural carina and more closely spaced secondary spiral cords.

Other turritellas from a well near Round Mountain field to the north (UCR locs. PR 604 and PR 605, L. and B. Producing "Jewett" 1, sec. 19, T. 28 S., R. 29 E.) are doubtfully identified as this subspecies because of their very fine secondary spiral cords and, on one specimen, concave whorl profile. These specimens resemble a form that Eaton and others (1941, pl. 1, figs. 3, 3a) figured as *T. inezana* var. *sespeensis* Arnold. They differ, however, from Arnold's holotype (USNM 164,970) by the clear differentiation between the posterior carina and the much finer secondary spiral sculpture below. On the original figure of *T. inezana sespeensis* (Arnold, 1907, pl. 51, fig. 6) the associated matrix was cropped so that the specimen appears to taper toward the aperture. It seems possible that *T. inezana santana* Loel and Corey (1932, p. 259–260, pl. 59, figs. 10–15) should be included in the synonymy of Arnold's poorly illustrated subspecies because it too is characterized by anterior primary and sutural spiral cords of nearly equal strength separated from the posterior carina by a concave segment sculptured by fine spiral threads in some specimens.

Occurrence and stratigraphic distribution: Lower Miocene: Salinas Valley, San Luis Obispo area, Ojai Valley, Piru quadrangle, Mount Pinos quadrangle, western Santa Monica Mountains (Merriam, 1941); well cores east of Bakersfield (Addicott, 1967a); (?) Cajon Pass, San Bernardino County (Corey in Van Amringe and Kilkenney, 1964 [as *T. inezana* var. *sespeensis*]).

Range: Lower Miocene.

Localities: Upper part of Vedder Sand, UCR 1301, PR 604 cf., PR 605 cf.

Turritella (Torcula?) cf. T. (T.?) padronesensis Grant and Eaton

Plate 2, figure 19

This species is doubtfully represented by abraded fragments of a medium-sized shell from UCMP locality B1616 in the upper part of the Olcese Sand. The whorl profile is concave and is marked by a strong subsutural keel that is subangular where best preserved. Spiral sculpture consists of a prominent subsutural keel and two broad cords of secondary strength near the anterior quarter line and at the base of the whorl. Tertiary spiral threads are present but badly worn. Growth lines are not preserved.

The worn *Turritella* fragments are tentatively compared to *T. padronesensis* because, where not badly abraded, the subsutural keel seems to be subangular. The angularity of the keel was the principal character by which a group of rather poorly preserved topotypes of *T. padronesensis* in U.S. Geological Survey collections from the Caliente Range, eastern San Luis Obispo County, could be satisfactorily differentiated from specimens of *T. inezana altacorona* Loel and Corey (1932, p. 256, pl. 57, figs. 1–7). Most of the better preserved topotype specimens of the *T. padronesensis* have a secondary spiral cord at about the anterior one-third line, as do many specimens of *T. inezana altacorona.* Because there is a much closer degree of morphological similarity between *T. padronesensis* and *T. inezana altacorona* than between the former species and *T. carrisaensis* Anderson and Martin (1914, p. 70–71, pl. 4, fig. 4), *T. padronesensis* is tentatively grouped with species of the *T. inezana* lineage. Heretofore, members of this lineage have not been recognized in strata above the lower Miocene "Vaqueros Stage" of the Pacific coast larger invertebrate chronology of Weaver and others (1944). Features by which *T. padronesensis* and *T. inezana altacorona* may be distinguished are minor, and it seems possible that careful study of well-preserved material might result in treating *T. padronesensis* as a junior synonym.

The type of *Turritella carrisaensis* differs from *T. padronesensis* by lacking an appressed suture, by having a sharply angular subsutural keel with a relatively long, straight slope between the suture and the periphery, and by having a relatively straight whorl profile below the keel. *T. carrisaensis* ranges from middle Miocene to upper Miocene in California (Repenning and Vedder, 1961).

Turritella padronesensis was described from a marine lens in the nonmarine Caliente Formation in the eastern Caliente Range (Eaton and others, 1941), where it is associated with "*Siphonalia*" *danvillensis* Clark and *Lyropecten* cf. *L. estrellanus* (Conrad) (Repenning and Vedder, 1961). As discussed under *T. inezana*, Vedder's recent discovery of *T. ocoyana* at the type locality of *T. padronesensis* indicates a middle Miocene rather than late Miocene age. Another joint occurrence of *T. padronesensis* with *T. ocoyana* in the northwestern part of the Caliente Range has been reported by Reed (in Eaton and others, 1941, p. 236). Loel and Corey's specimens of *T. inezana altacorona* (1932, pl. 57, figs. 4, 5, 7) from strata in the La Panza Range considered transitional between the lower Miocene "Vaqueros Stage" and the middle Miocene "Temblor Stage" may belong with *T. padronesensis.* These specimens were considered to be doubtfully identified as *T. inezana altacorona* by Merriam (1941, p. 109).

Occurrence: Upper part of Olcese Sand, UCMP loc. B1616.

Subgenus? (Turritella ocoyana stock of Merriam)

Turritella ocoyana Conrad

Plate 2, figures 20–22, 26–28

Turritella ocoyana Conrad, 1855, U.S. 33d Cong., 1st sess., House Ex. Doc. 129, p. 19.
Conrad, 1857, U.S. 33d Cong., 2d sess., Senate Ex. Doc. 78, Appendix art. 2, p. 329, pl. 8, figs. 73, 73a, b, and possibly unnumbered internal mold.
Arnold, 1909, U.S. Geol. Survey Folio 163, illus. 2, fig. 43.
Arnold, 1909, U.S. Geol. Survey Bull. 396, pl. 8, figs. 1, 2.
Arnold and Anderson, 1910, U.S. Geol. Survey Bull. 398, pl. 30, figs. 1, 2.
McLaughlin and Waring, 1914, California Mining Bur. Bull. 69, map folio, fig. 34.
Hertlein and Jordan, 1927, California Acad. Sci. Proc., ser. 4, v. 16, no. 19, pl. 19, fig. 2.
Wiedey, 1928, San Diego Soc. Nat. History Trans., v. 5, no. 10, p. 120, pl. 10, figs. 1–9.
Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 29, fig. 13.
Loel and Corey, 1932, California Univ. Dept. Geol. Sci. Bull., v. 22, no. 3, p. 260–261, pl. 60, figs. 1 [reproduction of Conrad's original fig. 73a], 2, 5–8, 10–12, pl. 61, figs. 1, 4, 6.
Bremner, 1933, Santa Barbara Mus. Nat. History Occasional Paper 2, pl. 3, fig. 4.
Reed, 1933, Geology Californina, p. 288, fig. 58, no. 10.
Merriam, 1941, California Univ. Dept. Geol. Sci. Bull., v. 26, no. 1, p. 112–114, pl. 28, figs. 1–6, 8–10; pl. 29, figs. 2, 5, 6; pl. 30, fig. 7; pl. 31, fig. 1.
Grant and Eaton, 1941, Am. Assoc. Petroleum Geologists Bull., v. 25, no. 2, pl. 1, figs. 7, 7a, 7b.

Turritella ocoyana Conrad—continued

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

Hanna and Hertlein, 1943, California Div. Mines Bull. 118, p. 172, fig. 63–6.

Shimer and Shrock, 1944, Index fossils of North America, p. 495, pl. 202, fig. 16.

Woodring and others, 1946, U.S. Geol. Survey Prof. Paper 207, pl. 28, fig. 2.

Stewart, 1946, U.S. Geol. Survey Prof. Paper 205–C, pl. 17, fig. 10.

Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, pl. 2, fig. 15.

Turritella bösei Hertlein and Jordan, 1967, California Acad. Sci. Proc., ser. 4, v. 16, no. 19, p. 634–635, pl. 21, figs. 1, 2.

Wiedey, 1928, San Diego Soc. Nat. History Trans., v. 5, no. 10, p. 117–119, pl. 10, fig. 7, pl. 11, figs. 1–3, 5.

Turritella ocoyana bösei Hertlein and Jordan, Bremner, 1932, Santa Barbara Mus. Nat. History, Occasional Paper 1, pl. 3, fig. 3.

Loel and Corey, 1932, California Univ. Dept. Geol. Sci. Bull., v. 22, no. 3, p. 262–263, pl. 60, figs. 3, 4, 9; pl. 61, fig. 5.

Grant and Eaton, 1941, Am. Assoc. Petroleum Geologists Bull., v. 25, no. 2, pl. 1, figs. 8, 8a, 8b.

Hanna and Hertlein, 1943, California Div. Mines Bull. 118, p. 174, fig. 63–23.

Turritella ocoyana (Conrad) var. bösei (Hertlein and Jordan), Bremner, 1933, Santa Barbara Mus. Nat. History, Occasional Paper 2, pl. 3, fig. 7.

Merriam, 1941, California Univ. Dept. Geol. Sci. Bull., v. 26, no. 1, p. 114, pl. 29, fig. 3.

Turritella wittichi Hertlein and Jordan, 1927, California Acad. Sci. Proc., ser. 4, v. 16, no. 19, p. 22, pl. 21, figs. 3, 4.

Turritella ocoyana (Conrad) wittichi (Hertlein and Jordan), Loel and Corey, 1932, California Univ. Dept. Geol. Sci. Bull., v. 22, no. 3, p. 263–265, pl. 61, fig. 3.

Turritella ocoyana var. *wittichi* Hertlein and Jordan, Merriam, 1941, California Univ. Dept. Geol. Sci. Bull., v. 26, no. 1, p. 114–115, pl. 29, fig. 1.

Lectotype: California Univ. Mus. Paleontology 31641 (designated by Merriam, 1941).

Type locality: UCMP 2713, "Poso Creek, Kern River region, east of Bakersfield" (Merriam, 1941, p. 188). Locality register at Berkeley, Calif., contains this description: Temblor loc. 1. Caliente quad.?, Miocene.

Type of *Turritella bösei* Hertlein and E. K. Jordan: Stanford Univ. paleontology type colln. 5893.

Type locality: SU 66, San Ignacio Arroyo, 8 km southwest of San Ignacio, Lower California. Isidro Formation of Heim (1922), lower Miocene.

Type of *Turritella wittichi* Hertlein and Jordan: Stanford Univ. paleontology type colln. 5894.

Type locality: Turritella bed above San Gregorio Lagoon, on trail from Arroyo Mesquital to La Purisima, 120 miles north of Magdalena Bay, Lower California.

Turritella ocoyana was originally described from field sketches of casts and molds from a stratum in the upper part of the Olcese Sand along Poso [Ocoya] Creek. Although the original material is known only from the published field drawings, there has been little difficulty in recognizing this species in a broad sense. A latex cast of a specimen from what is probably Blake's original locality (1857, p. 179) is figured on plate 2, figure 27. This locality (USGS Cenozoic loc. M1689) is about 200–300 feet below the top of the Olcese Sand. A lectotype selected by Merriam (1941, pl. 29, fig. 5) from an unspecified locality in the Kern River area, east of Bakersfield, seems to adequately represent the original drawings of *T. ocoyana* as well as specimens subsequently collected from locality M1689. It should be noted, however, that the lectotype is definitely from a higher stratigraphic position and presumably from the Kern River drainage to the south of Poso Creek.

Two species of *Turritella* from the Miocene Isidro Formation of Heim (1922) of Baja California, *T. bösei* Hertlein and Jordan and *T. wittichi* Hertlein and Jordan, have been generally recognized as forms that intergrade with *T. ocoyana* (Grant and Gale, 1931, p. 775; Loel and Corey, 1932, p. 262–263; Merriam, 1941, p. 114–115). Originally *T. bösei* was differentiated from *T. ocoyana* by its angulate carina and also its slightly concave profile and relatively coarse ribbing above the carina. Subsequently, Wiedey (1928, p. 117–118) synonymized figured specimens of *T. ocoyana* that were sharply carinate under *T. bösei.* While this treatment may have seemed reasonable from the standpoint of Conrad's original figures alone, collections from higher in the Miocene section in the Kern River area and elsewhere (Loel and Corey, 1932) often include suites of individuals that demonstrate an intergradation between the sharply and weakly carinate forms. Woodring (1928, p. 96) first implied varietal relationship of the two Baja California forms with *T. ocoyana.* Hertlein and Jordan and some subsequent authors have considered *T. wittichi* with its weakly carinate, more evenly convex adult volutions to be more distinct from *T. ocoyana* than is *T. bösei.* Wiedey (1928), however, placed *T. wittichi* in the synonymy of *T. ocoyana.*

Wiedey (1928) and Loel and Corey (1932) included a form with wide apical angle and relatively short whorls from middle Miocene strata in the Santa Monica Mountains and the Kern River area with *T. bösei.* This stout strongly carinated form was later named *T. ocoyana* var. *topangensis* by Merriam (1941, p. 115). He pointed out that *T. bösei* could be differentiated by its slender apical angle and relative elongation of the shell and treated this taxon as a variety of *T. ocoyana.* His careful description of variability of *T. ocoyana* s. s., however, seems broad enough to permit inclusion of Kern River specimens that appear to be referable to this variety.

Those specimens that resemble *T. bösei* and *T. wittichi* in collections from the Kern River Miocene sequence are included with *T. ocoyana* as unnamed forms, this treatment being predicated on finding apparent intergradation of forms with strongly carinate and relatively convex whorl profiles in the collections. The intergradation is best shown in specimens from the top of a diatomaceous mudstone unit in the upper part of the Round Mountain Silt about 1 mile south of the junction of Cottonwood Creek with Kern River (UCMP loc. B1588). Most specimens collected from this bed would be classified as *T. ocoyana* s. s. or *T. ocoyana* forma *bösei*. A few individuals approach *T. ocoyana* forma *topangensis* and *T. ocoyana* forma *wittichi*. Loel and Corey (1932, p. 265) described a suite of *T. ocoyana* from the Vaqueros ["Stage"] of the La Panza Mountains which showed a similar intergradation.

There are many exceptionally well preserved juvenile specimens of *Turritella ocoyana* in collections from USGS locality M1597. These show an early sculptural pattern similar to that of the northern California to Washington middle Miocene species *T. oregonensis* (pl. 2, fig. 15). A pair of primary spiral cords is in the anterior half of the sculpture of the first few postnuclear whorls. Whereas this bicostate pattern remains dominant in the later whorls of *T. oregonensis*, several additional primary spirals are added on the later whorls of *T. ocoyana*, and eventual accentuation of the whorl profile near the position of the anterior spiral produces the characteristic anterior keel of this species.

The strongly carinate late Pleistocene species *Turritella granti* Valentine and Susuki (1959, text fig. 2) is similar to *T. ocoyana* in whorl profile but can be distinguished from it by the presence of a unique growth line, the spiral sinus of which describes a negative growth-line angle.

Woodring (1957, p. 107) noted that *Turritella ocoyana* is a tropical immigrant, there being earlier species referable to the *T. ocoyana* stock in low latitudes. Although this stock extinct in California at the end of the middle Miocene, there are survivors in the late Miocene of tropical America.

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation—Caliente Range (Eaton and others, 1941; Repenning and Vedder, 1961), La Panza Range, Channel Islands, western Santa Monica Mountains, and San Joaquin Hills (Loel and Corey, 1932). Middle Miocene: Lompico Sandstone of Clark (1966), Santa Cruz Mountains; Temblor Formation—northern Santa Lucia Mountains (Trask, 1926; Herold, 1935), Panoche Hills (Payne, 1951), Monocline Ridge (Zimmerman, 1944), Cantua Creek (Anderson, 1908; Atwill, 1935), Anticline Ridge (Arnold and Anderson, 1910; Woodring and others, 1940; Adegoke, 1967), Cholame Hills (Dickinson, 1963), Reef Ridge (Woodring and others, 1940; Stewart, 1946; Adegoke, 1967), Belridge oil field, western Kern County (Wharton, 1943), La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932), Caliente Range (Eaton and others, 1941); unnamed formation of middle Miocene age, Caliente Range (Dougherty, 1940); Twisselmann Sandstone Member of the Monterey Formation of Heikkila and MacLeod (1951, cf.), northern Temblor Range; "Temblor" Sandstone, central Santa Ynez Mountains (Dibblee, 1967); "Temblor or Vaqueros," Tejon Hills (Clark in Merriam, 1916); Vaqueros Formation—Griswold Hills (Anderson and Pack, 1915), Devil's Den area and northern Temblor Range (Arnold, 1909); Monterey Group, upper Santa Ynez River (Kew, 1919); Monterey Shale—western Ventura basin (Bailey in Redwine, 1952), Santa Cruz Island (Kennett in Redwine, 1952); Mount Pinos quadrangle and Simi Valley (Merriam, 1941); Topanga Formation—Santa Monica Mountains (Woodring, in Hoots, 1931; Grant in Soper, 1938; Neuerberg, 1953), San Joaquin Hills (Vedder and others, 1957), Santa Ana Mountains (English, 1926; Vedder and Woodring, unpub. data, 1953), eastern Puente Hills (Vedder in Durham and Yerkes, 1964); San Onofre Breccia, northwestern Peninsular Range (Woodford, 1925); Conejo Volcanics of Kennett in Redwine and others (1952), Santa Rosa Island.

Range: Lower Miocene to middle Miocene.

Localities: Lower part of Olcese Sand, USGS M1593. Middle part of Olcese Sand, USGS M1698. Upper part of Olcese Sand, USGS M1597, M1598, M1600, M1622; UCMP B1596, B1600, B1603, B1616, B1622, B1623, B1640, B1643. Round Mountain Silt, USGS 6063, 6608, 6610, 6611, 6623, 6625, 13361, M1605, M1606, M1608, M1611, ?M2480; UCMP B1588, B1592, B1609, B1611, B1625, B1630, B1636, B1638, B1678.

Turritella ocoyana forma topangensis Merriam

Plate 2, figures 29–31

Turritella ocoyana var. *topangensis* Merriam, 1941, California Univ., Dept. Geol. Sci. Bull., v. 26, no. 1, p. 115, pl. 30, figs. 1–3, 5.

Turritella ocoyana topangensis Merriam, Schenck and Keen, 1950, California fossils for the field geologist, p. 70, pl. 14, fig. 6.

Turritella ocoyana Conrad, Arnold, 1907, U.S. Natl. Mus. Proc., v. 32, p. 546, pl. 51, figs. 7–9.

Eldridge and Arnold, 1907, U.S. Geol. Survey Bull. No. 309, pl. 41, figs. 7–9.

Turritella ocoyana (Conrad) *bösei* (Hertlein and Jordan), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 262–263 (in part), pl. 61, figs. 7, 9, 10; pl. 62, fig. 1.

Turritella ocoyana bösei Hertlein and Jordan, Hanna and Hertlein, 1943, California Div. Mines Bull. 118, p. 174, fig. 63–22.

Type: California Univ. Mus. Paleontology 31648.

Type locality: UCMP A556, shell breccia zone corresponding to locality A554 including *Turritella* bed 3 feet below along top of Mesa Peak and down to saddle in trail to northwest. North-central part sec. 24, T. 1 S., R. 18 W., Calabasas quadrangle. "Temblor, Miocene."

This form was originally recognized by Loel and Corey (1932, p. 262), who included it as an unnamed variant of *Turritella ocoyana bösei*, from which it was said to differ by having a broad apical angle and a very strong carina near the base. Subsequently, Merriam (1941) differentiated this distinctive form from *T. ocoyana bösei*. He noted that these strongly keeled forms of *T. ocoyana* differ principally in apical angle and relative elongation of the shell. He states (p. 114) that the Baja California variety, *T. ocoyana bösei*, differs from *T. ocoyana topangensis* "in having a pleural angle only a little over half that of the California variety."

T. ocoyana topangensis is represented in collections from the Kern River area by a few specimens from the *Turritella* bed near the mouth of Cottonwood Creek (UCMP loc. B1588; USGS M1605). At this and a few other localities in the upper part of the Round Mountain Silt, many individuals are strongly carinate, but, as a rule, do not have the extremely wide apical angle of *T. ocoyana topangensis*. It is probably from this stratigraphic interval that Loel and Corey (1932) first recognized this broad strongly carinate variant in the Kern River area.

Distribution and stratigraphic occurrence: Lower Miocene: "Vaqueros" strata of the Caliente Range (J. G. Vedder, written commun., December 1967); Vaqueros Formation, San Joaquin Hills (Vedder, unpub. data, 1958, cf.); Temblor Formation, La Panza Range (Merriam, 1941); Temblor Formation of Page and others (1951), Santa Ynez Mountains; Topanga Formation—Santa Monica Mountains (Loel and Corey, 1932; Merriam, 1941); San Joaquin Hills (Vedder, unpub. data, 1958), Santa Ana Mountains (Vedder and Woodring, unpub. data, 1953).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS 6628; UCMP B1598. Round Mountain Silt, USGS M1605; UCMP B1588.

Family CERITHIOPSIDAE

Genus CERITHIOPSIS Forbes and Hanley, 1851

Type (by monotypy): *Murex tubercularis* Montagu. Recent, Europe.

Cerithiopsis aff. C. subgloriosa Baker, Hanna, and Strong

A fragment of a small cerithiopsid from the upper part of the Olcese Sand (USGS loc. M1597) resembles a living species from the Gulf of California, *Cerithiopsis subgloriosa* Baker, Hanna and Strong (1938, p. 218–219, pl. 18, fig. 7). The final two whorls are nearly complete. The sculpture consists of three spiral cords that are crossed by about 20 axial ribs. The body whorl has a strong peripheral keel which is not exposed in the suture of earlier whorls. It is bordered, on the base, by a sulcus bordered, in turn, by an indistinct broad spiral swelling.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Family CERITHIIDAE

Genus BITTIUM Leach in Gray, 1847

Type (by subsequent designation, Gray, 1847): *Murex reticulatus* Montagu. Holocene, Europe.

Bittium topangensis (Arnold)

Plate 3, figures 4–7, 13, 14

Cerithium topangensis Arnold, 1907, U.S. Natl. Mus. Proc., v. 32, no. 1545, p. 531, pl. 40, figs. 7, 8.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 252, pl. 46, figs. 13, 14.

Cerithium arnoldi Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 71, pl. 7, fig. 12. [not *Bittium arnoldi* Bartsch, 1911, U.S. Natl. Mus. Proc., v. 40, no. 1826, p. 411–412, pl. 56, fig. 1.]

?*Cerithiopsis turneri* Clark, 1915, California Univ., Dept. Geology Bull., v. 8, no. 22, p. 490, pl. 65, figs. 1, 2.

?*Bittium trampasensis* Clark, 1915, California Univ., Dept. Geology Bull., v. 8, no. 22, p. 489–490, pl. 65, figs. 3, 5.

Type: U.S. Natl. Mus. 164976.

Type locality: Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, Calif. Topanga Formation, middle Miocene.

Type of *Cerithium arnoldi* Anderson and Martin: California Acad. Sci. 151.

Type locality: CAS 64, in bottom of small canyon about 1¼ miles due north of Barker's ranchhouse. Upper part of Olcese Sand, middle Miocene.

The short anterior canal, subtruncate base of the body whorl, and lack of a posterior canal suggest reassignment of this species to *Bittium*. Although the apertures of specimens in the collections are incomplete, there is no evidence of the recurved base of the columella and the well-developed anterior and posterior canals characteristic of *Cerithium*. Subgeneric assignment is doubtful because it is uncertain whether the poorly preserved nuclear whorls were originally smooth or the apical parts were smoothed by subsequent abrasion.

Specimens of "*Cerithium*" *arnoldi* Anderson from the general vicinity of the type locality were compared with Arnold's holotype of "*C.*" *topangensis* (1907, pl. 40, figs. 7, 8). Although they clearly differ from the finely papillose type figure, they do differ significantly from the type specimen. Details of sculpture on Arnold's types are obscured by extensive wear and leaching of the original shell surface. Furthermore the figures were inaccurately retouched so that a nonexistent finely papillose sculpture is indicated. The number and configuration of spiral and axial ribs on well-preserved specimens from the Olcese Sand are closely comparable with those on the holotype. Sculptural detail is much better preserved on the nonapertural side of Arnold's figured specimens.

The late Miocene species *Bittium turneri* (Clark, 1915, p. 490, pl. 65, figs. 1, 2) is considered a possible synonym because of similarity of Clark's paratype (UCMP 11609) to *B. topangensis*. The holotype is a somewhat slender, more elongate shell with finer sculpture. The discrepancy in size between the late Miocene individuals and specimens of *B. topangensis* make comparison very difficult.

The holotype of *Bittium trampasensis* Clark (1915, pl. 65, fig. 3), though relatively small, has sculpture similar to the paratype of *B. turneri*. Therefore, this species may also be a synonym of *B. topangensis*. It is clear from Clark's description (1915, p. 490) that the complete specimen was intended to be the type, although not specifically mentioned as such. The other figured type (Clark, 1915, pl. 65, fig. 5) has been lost. The specimen is labeled as a syntype.

Bittium topangensis can be distinguished from many of the living species on the west coast of North America assigned to this genus (Bartsch, 1911) by the presence of four, rather than three, well-defined spiral ribs on the early whorls of the spire. Distinguishing features of this species are its papillose sculpture and moderately curved axial ribs.

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation—northern Santa Lucia Range, southern Santa Lucia Range, northern La Panza Range, San Emigdio Mountains, western Santa Ynez Range, western Santa Monica Mountains, San Joaquin Hills, and Santa Ana Mountains (Loel and Corey, 1932). Middle Miocene: Temblor Formation—La Panza Range (Loel and Corey, 1932); "Temblor" Formation, eastern Santa Ynez Mountains (Page and others, 1951); Topanga Formation—central Santa Monica Mountains (Arnold, 1907; Susuki, 1951), eastern Puente Hills (Vedder in Durham and Yerkes, 1964), Santa Ana Mountains (Loel and Corey, 1932; Vedder and Woodring, unpub. data, 1953). Upper Miocene: lower San Pablo Group [Cierbo Sandstone] and upper(?) San Pablo Group [Neroly Sandstone], Mount Diablo area (Clark, 1915).

Range: Lower to upper Miocene.

Localities: Basal part of Jewett Sand, reported by Loel and Corey (1932, p. 96). Upper part of Olcese Sand, USGS M1599, M1600; UCMP B1600, B1601, B1622.

Genus BATILLARIA Benson, 1842

Type (by monotypy): *Cerithium zonalis* Brugiére. Holocene, Australia.

Batillaria ocoyana (Anderson and Martin)

Plate 3, figures 3, 8–12

Drillia ocoyana Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 93–94, pl. 7, figs. 1a, b.

Thesbia ocoyana (Anderson and Martin), Weaver, 1942, Washington Univ. [Seattle] Pubs. Geology, v. 5, p. 539 [in part], pl. 99, figs. 16, 25 [not figs. 21–23].

Type: California Acad. Sci. 228.

Type locality: CAS 64, in bottom of small canyon about 1½ miles due north of Barker's ranchhouse. Upper part of Olcese Sand, middle Miocene.

Two forms of this rather low-spired cerithiid are found in collections from the upper part of the Olcese Sand, a lirate form represented by the type specimen, and a beaded form which seems to be intergradational with the former.

The lirate form of *Batillaria ocoyana* (pl. 3, figs. 3, 11, 12) has a body whorl that is equal to or somewhat longer than the rapidly tapering, bullet-shaped spire. Available specimens are considerably worn. The sculpture of the earlier whorls is obliterated. Classed with this form are specimens with broad spiral cords of variable width separated by channeled interspaces. The suture is appressed. The growth line is gently concave on the spire and broadly S-shaped on the body whorl. The shell is broadest at the rounded, basal angulation of the body whorl.

The beaded form (pl. 3, figs. 8–10) differs by having a somewhat higher, more uniformly tapering spire sculptured by axial ribs that form knobs where they cross the spiral ribs. The axials are slightly arched backward on the spire. They are weak on the body whorl, becoming obscure toward the base. Spiral sculpture differs from the lirate form in that secondary cords appear between the primaries on the later whorls of the spire. On some specimens they become broader toward the aperture so that on the body whorl the primary ribs appear to be evenly split. The suture on the body whorl is appressed, but on the spire it is impressed. Although the aperture is defective on the best preserved specimen of the beaded form of *Batillaria ocoyana*, the suture climbs up onto the penultimate whorl as it is traced forward. This fact suggests that at least a small posterior notch was present at the juncture of the outer lip with a body whorl.

The beaded form seems to approach *Bittium topangensis* in sculpture, but its broader apical angle, growth-line configuration on the body whorl, and much larger size of the body whorl are distinct.

The lirate form, which is perhaps most typical of this species, resembles "*Cerithium*" *simplicius* Grant and Gale (1931, p. 757, pl. 24, fig. 11), a poorly figured cerithiid with appressed sutures, fine spiral sculpture, and rapidly tapering spire from the Pliocene of the eastern Ventura basin, California. The three or four "broad axial undulations" described by Grant and Gale (1931, pl. 24, fig. 11), but not apparent on their figure, are not developed on specimens of *Batillaria ocoyana*.

Collections from USGS locality M1599, in the upper part of the Olcese Sand, contain specimens that clearly suggest these forms belonged to one variable population. Both forms occur together at other localities.

Specimens from the Astoria Formation of southwestern Washington identified as this species by Etherington (1931, p. 111, pl. 14, figs. 14, 21) have a relatively deep growth-line sinus quite distinct from the shallow concavity of the growth line of *Batillaria ocoyana*.

Batillaria ocoyana has long been placed in the Turridae, and most recently in the genus *Thesbia* by Weaver (1942, p. 539). However, the sculpture, basal truncation of the broad aperture, poorly defined anterior canal, and simple growth-line pattern clearly suggest classification in the Cerithiidae. It is here included in the genus *Batillaria* on the close degree of similarity of apertural, growth-line, and sculptural characteristics with the Holocene Japanese species, *B. cumingi* (Crosse). Comparison has been made with introduced specimens of the variable, slender western Pacific taxon from the mouth of Bennett Slough, sec. 7, T. 13 S., R. 2 E., Monterey County, Calif., collected by D. W. Taylor.

Distribution and stratigraphic occurrence: Topanga Formation, Santa Monica Mountains (Susuki, 1951).

Range: Middle Miocene.

Localities: Middle part of Olcese Sand, USGS M1698. Upper part of Olcese Sand. Lirate form—USGS 6612, 6624, 6627, M1597, M1599, M1600–M1602, M1604; UCMP B1597, B1599, B1622, B1641. Beaded form—USGS M1597, M1599, M1601, M1602; UCMP B1600.

Family EPITONIIDAE

Genus EPITONIUM Röding, 1798

Type (by subsequent designation, Suter, 1913): *Turbo scalaris* Linné. Holocene, western Pacific Ocean.

Subgenus CIRSOTREMA Mörch, 1852

Type (by monotypy): *Scalaria varicosa* Lamarck, 1811. Recent, western Pacific Ocean.

Epitonium (Cirsotrema) clallamense Durham

Plate 3, figures 15, 16, 34–37

?*Epitonium* (*Opalia*) (cf. *O. rugiferum* Dall) Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100.

Epitonium (*Cirsotrema*) *clallamense* Durham, 1937, Jour Paleontology, v. 11, no. 6, p. 491, pl. 56, figs. 27, 28.

Weaver, 1942, Washington Univ (Seattle) Pubs. Geology, v. 5, p. 311, pl. 65, fig. 2, pl. 67, figs. 26, 27.

Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, pl. 1, fig. 10.

Epitonium (*Cirsotrema*) n. sp. A. Durham, 1937, Jour Paleontology, v. 11, no. 6, p. 491, pl. 56, fig. 21.

Type: California Acad. Sci. 7003.

Type locality: CAS 210, east end of Clallam Bay, Wash., upper member of Twin River Formation, lower Miocene(?).

Type of *Epitonium* (*Cirsotrema*) n. sp. A. Durham: California Acad. Sci. 7005.

Type locality: CAS 673, near Pyramid Hill, Kern River area [Jewett Sand, lower Miocene].

Epitonium clallamense is abundant in collections from the basal conglomeratic bed of the Jewett Sand on the southwest slope of Pyramid Hill.

This is probably the species referred to by Anderson (1911, p. 100) as "*Epitonium* (*Opalia*) (cf. *O. rugiferum* Dall)" from the "A zone" at Pyramid Hill.

Differences between specimens from the Jewett Sand and *Epitonium clallamense* from northwestern Washington are minor. Most of the specimens from USGS locality M1591 (=UCMP B1665) at Pyramid Hill have seven or eight broad axial ribs; a few mature specimens have nine ribs. *E. clallamense* is described as having from eight to 10 axial ribs (Durham, 1937); the paratype has eight axial ribs, the holotype 10. Study of 17 specimens from USGS Cenozoic locality M1591 has shown that the number of varices is related in a general way to the stage of development of an individual specimen. On the largest specimen (34 mm), for example, the varix count ranged from nine on the body whorl to seven on the antepenultimate whorl. Other specimens show a similar, if not as uniform, decrease in number of varices on earlier whorls. In cross section the varices vary from bladelike to blocky.

Spiral sculpture, present on many specimens of *Epitonium clallamense*, usually is equally as well developed on the axial ribs as in the interspaces. This is the most variable sculptural characteristic of this species. There are as many as nine spiral ribs on some specimens. On the type of *E. clallamense*, a specimen that has had some of the shell material leached away, there are at least six faint spiral ribs, three often stronger than the rest. The spiral ribs continue across the varices on which they form nodes.

Epitonium n. sp. A Durham (1937), presumably collected from the same stratigraphic interval at Pyramid Hill, is a variant of this species. The late Oligocene to early Miocene species *E. saundersi* Tegland from Washington differs from this species by having a greater number of varices, 14 on the holotype and 15 on the paratype (Durham, 1937, p. 491), which tend to be relatively thin.

The age of the beds at the type locality of *Epitonium clallamense* in terms of the Pacific coast invertebrate chronology (Weaver and others, 1944) is probably early Miocene rather than middle Oligocene, as stated by Durham (1937) and Weaver (1942). Unpublished mapping by Howard Gower (oral commun., 1965) indicates that the type locality would fall in either the upper member of the Twin River Formation or the Clallam Formation. These units carry foraminiferal assemblages of Zemorrian and Saucesian age (Rau, 1964, p. 5) in the Pysht quadrangle a few miles east of the type locality and are therefore compatible with a probable early Miocene age as opposed to a middle Oligocene age. Mollusks of the upper part of the Twin River Formation are referred to the *Echinophoria apta* zone of the "Blakeley Stage" by Durham (1944), a unit regarded as early Miocene by many megafossil workers (Weaver and others, 1944). Evidence for the correlation of at least part of the "Blakeley Stage" with the lower Miocene "Vaqueros Stage" is discussed by Addicott (1967a).

Distribution and stratigraphic occurrence: Sooke Formation, Carmanah Point, Vancouver Island, British Columbia and upper(?) member of the Twin River Formation, Clallam Bay, Wash (Durham, 1937). "Middle Oligocene," Grays Harbor County, Wash. (Weaver, 1942).

Range: Middle Miocene.

Localities: Basal part of Jewett Sand, USGS M1590, M1591; UCMP B1606, B1665.

Epitonium (Cirsotrema) posoense Anderson and Martin

Plate 3, figures 29, 32

Epitonium posoensis Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 68, pl. 7, fig. 10.
Loel and Corey, 1932, California Univ., Dept., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Epitonium (Cirsotrema) posoense Anderson and Martin, Durham, 1937, Jour. Paleontology, v. 11, no. 6, p. 492.

Supplementary description.—Shell small, strongly tabulate, spire incomplete. Body whorl of holotype with 11 irregular varices, uniquely club shaped in cross section. Outer surface of varices with fine growth lamellae in a scalloped pattern corresponding to spiral ribs in the interspaces. Scallopėd pattern strongest on apertural side of varices, very fine spiral striae visible on abapertural side of some varices. Interspaces nearly concealed by the overhanging varices, sculptured by four spiral ribs with narrower interspaces. Aperture circular. Basal disk with very fine undulating growth lamellae and a well-defined medial sulcus.

Type: California Acad. Sci. 144.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

This spectacularly sculptured species is known from the type locality in the upper part of the Olcese Sand north of Kern River and from a collection of uncertain stratigraphic position that is probably from the lower part of the Round Mountain Silt (UCLA loc. AC–14–34) on the basis of matrix in the aperture. These are the only specimens known to have been collected from the Kern River area. The late Oligocene species *Epitonium* (*Cirsotrema saundersi* Tegland (1933, p. 133, pl. 13, figs. 7–9) from the *Echinophoria rex* Zone (Durham, 1944) of Washington differs from this species by its much narrower axial ribs, which continue across the basal keel to the aperture. *E. clallamense* from lower Miocene strata at Pyramid Hill has fewer less strongly sculptured ribs, usually eight, and lacks the relatively smooth basal disk of *E. posoense.*

The specimen from the lower part of the Round Mountain Silt is much larger and more complete than the holotype. It has a larger number of varices on the body whorl, about 15, more irregular than on the holotype. Its base is marked by a comparable number of lenticular pits that correspond to the interspaces between varices on the body whorl. The holotype has 11 irregular varices that are club shaped in cross section and nearly conceal the interspaces. The varices are sculptured by fine growth lamellae arranged in a scalloped pattern corresponding to the spiral ribs in the interspaces.

Occurrence: Upper part of Olcese Sand, CAS loc. 65. Lower part of Round Mountain (?) Silt, UCLA loc. AC–14–34.

Subgenus GYROSCALA de Boury, 1887

Type (by original designation) : *Scalaria commutata* Monterosato. Holocene, tropical western Atlantic Ocean.

Epitonium (Gyroscala) barkerianum Addicott, n. sp.

Plate 3, figure 19

Shell small, consisting of five convex, rapidly enlarging whorls. Body whorl sculptured by 15 thin rounded axial lamellae between which are smooth interspaces approximately three times as wide. Axial lamellae staggered from one whorl to the next, terminate abruptly at basal disk. Basal disk smooth.

Height (almost complete) 4.9 mm, width (incomplete) 2.5 mm.

Type: U.S. Natl. Mus. 650077.

Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center Quadrangle. Upper part of Olcese Sand, middle Miocene.

This species is referred to the subgenus *Gyroscala* on the basis of the thin varices, lack of spiral sculpture, and the strong basal disk. The discontinuous varices seem to be characteristic of the section *Circuloscala* de Boury.

Only one specimen is available for description. The only other Tertiary species assigned to this subgenus, *Epitonium effingeri* Durham (1937, p. 485, pl. 56, fig. 25), is from the Gries Ranch beds of early Oligocene age in southwestern Washington. It differs from *E. barkerianum* by having fewer axial ribs, only 10, that are continuous across the basal disk and are not offset across the sutures.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Subgenus NITIDISCALA de Boury, 1909

Type (by original designation) : *Scalaria unifasciata* Sowerby, 1847. Holocene, West Indies.

Epitonium (Nitidiscala) tedfordi Addicott, n. sp.

Plate 3, figures 17, 18

Epitonium (Nitidiscala) indianorum (Carpenter), Durham, 1937, Jour. Paleontology, v. 11, no. 6, p. 487–488, pl. 56, fig. 14.

Epitonium cf. *E. indianorum* (Carpenter), Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

Small, thin, with about seven whorls. Whorls convex, sutures deeply impressed. Body whorl with 12–15 thin coronate varices that are slightly reflected abaperturally. Varices relatively weak and slightly staggered across the sutures. Faint basal angulation emphasized by abrupt basal curvature of varices. Aperture ovate.

Height 7.8 mm, width 2.8 mm.

Type: U.S. Natl. Mus. 650075.

Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

A few specimens of this small fragile epitoniid are in collections from the upper part of the Olcese Sand and the lower part of the Round Mountain Silt. Most of the individuals are less than 5 mm in length and have noticeably worn varices. Although the holotype has only 12 varices, specimens from most of the other localities have 13–15. Some individuals have a somewhat broader apical and relatively larger body whorl than the holotype.

Although closely resembling the Pliocene to Holocene species *Epitonium indianorum* Carpenter, *E. tedfordi* can be distinguished by its very thin coronate varices and perhaps by its apparently smaller adult size. The number of varices on *E. indianorum*, 10–15 according to Palmer's study of the type lot (1958, p. 187), is comparable. Another similar Holocene species, *E. tinctum*, although comparably small, has varices that ascend the spire in an unbroken spiralling line.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597; UCMP loc. B1601. Lower part of Round Mountain Silt, USGS locs. 3886, M1608, M1609, M1611, M1612, cf. M1613, M2480; UCMP locs. B1637, B1638.

Genus OPALIA H. and A. Adams, 1853

Type (by subsequent designation de Boury, 1886): *Scalaria australis* Lamarck, 1822. Holocene, Australia.

Subgenus RUGATISCALA de Boury, 1913

Type (by original designation): *Opalia levesquei* de Boury. Eocene, Paris Basin.

Opalia (Rugatiscala) williamsoni (Anderson and Martin)

Plate 3, figures 23, 30, 31

Epitonium williamsoni Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 68–69, pl. 7, figs. 9a, b.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Opalia (Rugatiscala) williamsoni (Anderson and Martin), Durham, 1937, Jour. Paleontology, v. 11, no. 6, p. 505–506.

Epitonium cf. *posocnsis* Anderson and Martin, Schenck and Keen, 1940, California fossils for the field geologist, p. 68, pl. 35, fig. 2 (reprinted, 1950, as *Epitonium* cf. *E. posoense* Anderson and Martin).

Opalia (Rugatiscala) cf. *O. (R.) williamsoni* (Anderson and Martin), Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 26, pl. 1, fig. 23.

Types: Holotype, California Acad. Sci. 145; paratype, CAS 146.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

A few broken specimens of *Opalia williamsoni* have been collected from the Kern River area; all are from localities in the upper part of the Olcese Sand. They exhibit a considerable degree of variation in the number of ribs, 14–20. There are 18 ribs on the type specimen.

This species is restricted to strata of middle Miocene age on the Pacific coast. A comparable but apparently different form has been identified from the Topanga Formation of the San Joaquin Hills by J. G. Vedder (unpub. faunal list, 1958). The subgenus *Rugatiscala* is not represented in post-middle Miocene faunas of the Pacific coast.

Distribution and stratigraphic occurrence: Temblor Formation, Griswold Hills, Vallecitos area (Schenck and Keen, 1940, cf.); eastern San Luis Obispo County (Anderson and Martin, 1914). Astoria Formation, Lincoln County, Oreg. (Moore, 1963, cf.).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597, M1599, M1602; UCMP B1599, B1600. Lower part of Round Mountain Silt, USGS 6065, M1611; UCMP B1637.

Genus SCALINA Conrad, 1865

Type (by subsequent designation, Palmer, 1937): *Scala (Scalina) staminea* Conrad, 1865. Eocene, Claiborne, Ala.

There are many Eocene and Oligocene species of *Scalina* from the Pacific coast of North America but only two Miocene species, both of which were described from the Kern River area. The subgenus apparently became extinct in California following the middle Miocene but persisted into the Holocene in warmer, southern latitudes.

Scalina durhami (Keen)

Plate 3, figures 21, 24

Ferminoscala durhami Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 46, pl. 4, fig. 31.

Type: Stanford Univ. paleontology type colln. 7534.

Type locality: SU 2121, in small gully close to terrace contact near center SW¼ of sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

Only two mature specimens of *Scalina durhami* were collected from the Kern River Miocene. Although not easily distinguished from *S. whitei*, they do have obscure axial sculpture and less strongly convex whorls. The whorls are also relatively higher and the sutures broadly excavated. Still the possibility that *S. durhami* may be but a variant of the strongly sculptured *S. whitei* poses a question that cannot be satisfactorily answered by the material in the collections. A fairly large collection of *S. whitei* from USGS locality M1613 suggests a wide range of variation in width and prominence of the varices. Two immature specimens from that locality (pl. 3, figs. 20, 21) can be readily differentiated on the basis of axial sculpture; the adult specimens are not as readily separable.

Occurrence: Lower part of Round Mountain Silt, USGS locs. M1611, M1613, cf. M1696.

Scalina whitei (Keen)

Plate 3, figures 20, 25–28

Ferminoscala whitei Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 46, pl. 4, figs. 32, 33.

Type: Stanford Univ., paleontology type colln. 7535.

Type locality: SU 2121, in small gully close to terrace contact near center SW¼ of sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of the Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

Scalina whitei differs from *S. durhami* principally by having strong varices. It is by far the most abundant species of *Scalina* in the collections. The axial lamellae vary considerably in strength, although the spacing is relatively constant. The whorls are convex and the sutures appear to be channeled. Worn specimens have greatly subdued axial sculpture, but traces ordinarily remain in the recessed interspaces between spiral ribs.

The Holocene *Scalina ferminiana* (Dall, 1908, p. 316, pl. 8, fig. 8), a member of the Panamic molluscan fauna that ranges from the Gulf of California to Panama (Strong in Burch, 1945, no. 52, p. 21), differs from this species by its angulated early whorls and nonrounded spiral ribs. A more northern Holocene species, *S. brunneopictum* (Dall, 1908, p. 316–317, pl. 8, fig. 10), from off the west coast of central Baja California, has subdued spiral sculpture with only three primary spiral ribs in addition to many secondary spirals and extremely thin, almost obsolete varices.

Distribution and stratigraphic occurrence: Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December, 1967). Topanga Formation, San Joaquin Hills, Orange County, Calif. (J. G. Vedder, unpub. data, 1958 cf.).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, UCMP B1601. Lower part of Round Mountain Silt, USGS 6064, M1608, M1612, M1613, M2480; UCMP B1601, B1638.

Family EULIMIDAE

Genus EULIMA Risso, 1826

Type (by subsequent designation, Hermannsen, 1846): *Turbo subulatus* Donovan. Holocene, northeastern Atlantic to Mediterranean.

Eulima gabbiana (Anderson and Martin)

Plate 20, figures 5, 6

Eulimella gabbiana Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 68, pl. 7, fig. 20.

Melanella (Melanella) gabbiana (Anderson and Martin), Bartsch, 1917, U.S. Natl. Mus. Proc., v. 53, no. 2207, p. 316–317, pl. 38, fig. 3.

Pyramidella (Eulimella) gabbiana (Anderson and Martin), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173.

Eulima gabbiana (Anderson and Martin), Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 45, pl. 4, fig. 6.

Type: California Acad. Sci. 143.

Type locality: CAS 64, in bottom of small canyon about 1¼ miles due north of Barker's ranchhouse. Upper part of Olcese Sand, middle Miocene.

This slender species has a large body whorl and elongate, slender aperture. It is of rare occurrence in collections from the upper part of the Olcese Sand and lower part of the Round Mountain Silt. The holotype is a broken specimen with only the final whorls preserved.

Eulima riversi Bartsch (1917, p. 339, pl. 45, fig. 3), a Pleistocene species from southern California, is similar to this Miocene taxon. The holotype of *E. riversi* (USNM 251390) can be differentiated from specimens of *E. gabbiana* by its rather convex whorls and larger sutural angle.

Distribution and stratigraphic occurrence: Monterey Shale, western Napa County, Calif. (Weaver, 1949).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597. Lower part of Round Mountain Silt, USGS 6065, M1612, M1613; UCMP B1637.

Genus BALCIS Leach in Gray

Type (by monotypy): *Balcis montagui* Leach in Gray. Holocene, northern Europe.

Balcis conchita Keen

Plate 20, figures 1, 32

Balcis conchita Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 43, pl. 4, fig. 5.

Type: Stanford Univ. paleontology type colln. 7538.

Type locality: SU 2121, in small gully close to terrace contact near center SW¼ sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

This minute, slender gastropod is rare in the collections from the lower part of the Round Mountain Silt. The holotype and specimens collected by the writer are slightly flexed, a characteristic that distinguishes this species from other species of *Balcis* from the Kern River Miocene as well as from the Pleistocene and Holocene species, *B. rutila* (Carpenter), with which it was compared by Keen (1943, p. 43). It is similar to *B. catalinensis* (Bartsch, 1917, p. 329, pl. 40, fig. 7), a living species which ranges from Carmel, Calif., southward to San Hipolito Point, Baja California (Burch, 1945, no. 53, p. 10). It is less strongly flexed than the Recent species and has a proportionately shorter aperture.

Occurrence: Upper part of Olcese Sand, USGS loc. M1624. Lower part of Round Mountain Silt, USGS loc. M1612.

Balcis lutzi Addicott n. sp.

Plate 21, figures 13–15

Of medium size, straight, polished. Body whorl and penultimate whorl flattened, sutures appressed. Earlier whorls taper rapidly toward narrow, pointed apex consisting of three whorls. Whorls of spire slightly convex in profile, sutures weakly impressed. Body whorl greater than one-half height of shell, point of greatest diameter in lower part. Aperture narrow posteriorly, outer lip culminating in a knife edge, base broadly rounded, inner lip short, inclined. Parietal wall covered with well-developed narrow callus.

Height 5.5 mm, width 1.7 mm.

Types: Holotype, U.S. Natl. Mus. 650309; paratypes, USNM 650307, 650308.

Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

This is the most abundant eulimid in collections from the Kern River district. It is distinguished from other species by the very large body whorl and tapered spire. A similar living species, *Balcis compacta* (Carpenter), figured by Bartsch (1917, pl. 37, fig. 3), ranges from San Pedro, Calif., to Point Abreojos, Mexico. The holotype of the Holocene species (USNM 153176) has a profile similar to *B. lutzi* but is much broader, has a proportionately longer aperture and a less sharply pointed apex.

Occurrence: Upper part of Olcese Sand, USGS loc. M1596, M1597, M1602; UCMP loc. B1624. Lower part of Round Mountain Silt, USGS locs. M1608, M1612, M2601; UCMP loc. B1638.

Balcis petrolia Addicott n. sp.

Plate 20, figure 13; plate 21, figure 16

Of medium size, straight, polished. Spire slender, smooth, tip broken. Sutures impressed, bordered anteriorly by a darker band occupying about one-third of whorl. Sutural angle nearly horizontal. Body whorl broadly rounded, about one-third height of shell. Aperture subovate, edge of outer lip broken. Inner lip callused, columellar and parietal segments meet in a broadly obtuse angle.

Height (nearly complete) 6.4 mm, width 2 mm.

Type: California Univ. Mus. Paleontology 37112.

Type locality: UCMP B1600, east side of gully trending southeastward through sec. 33, T. 28 S., R. 29 E., 650 feet south, 100 feet east of NW. cor. of sec. 33. Rio Bravo Ranch quadrangle. Near the top of Olcese Sand, middle Miocene.

Balcis petrolia is clearly distinct from other Miocene species from the Kern River district and from known Pleistocene and Holocene species from the northeastern Pacific area. It is characterized by a smooth, perfectly conical spire and a relatively short body whorl. A closely similar and possibly analagous living species is *Balcis baldra* (Bartsch, 1917, p. 314–315, pl. 37, fig. 2) described from near San Hipolito Point, Baja, California. *Balcis petrolia* is more slender and has a relatively larger, more elongate aperture than the Holocene species (holotype, USNM 32297).

Occurrence: Upper part of Olcese Sand, USGS locs. M1597, M1601; UCMP locs. B1600, B1601. Lower part of Round Mountain Silt, USGS locs. 6623, M1608, M1609, M1612, M1613; UCMP loc. B1638.

Balcis cf. B. oldroydi Bartsch

Plate 21, figure 10

A small, moderately elongate *Balcis* occurs with the two other species of this genus in the upper part of the Olcese Sand at USGS locality M1597. The faint sutures are nearly horizontal. The body whorl is angulated near the midpoint, defining a straight profile above and a rounded one below.

This taxon seems to be closest to *Balcis oldroydi* Bartsch (1917, p. 309–310, pl. 36, figs. 5–7), a late Pleistocene and Holocene species from southern California and Baja California. The Miocene *Balcis* is considerably smaller than *B. oldroydi* and has a stronger basal angulation. The differences are slight and it is possible that large suites of the Miocene specimens might indicate a sufficiently broad range of variation to include them with *B. oldroydi.*

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Genus NISO Risso, 1826

Type (by monotypy): *Niso eburnea* Risso. Pliocene, northern Italy.

Niso antiselli Anderson and Martin

Plate 20, figures 22–24

Niso (?) *antiselli* Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 65, pl. 7, fig. 22.

Bartsch, 1917, U.S. Natl. Mus. Proc., v. 53, no. 2207, p. 351–352, pl. 48, fig. 2.

Type: California Acad. Sci. 135.

Type locality: CAS 125, on top of hill in SW. cor. SE¼ sec. 29, T. 28 S., R. 15 E., Pozo quadrangle, San Luis Obispo County, Calif.

Niso antiselli is represented by a few specimens from the upper part of the Olcese Sand and lower part of the Round Mountain Silt. It has not been previously reported from the San Joaquin Valley. This species has a smooth, conical profile, relatively broad apical angle, and strong basal angulation. Among the Holocene northeastern Pacific species of *Niso*, *N. lomana* Bartsch (1917, p. 350, pl. 49, fig. 4) a species doubtfully placed in this genus (Emerson, 1965) seems to be most closely related to *N. antiselli*, but its narrower apical angle and rather deeply impressed sutures permit discrimination from the Miocene species.

Distribution and stratigraphic occurrence: Temblor Formation, northern La Panza Range (Anderson and Martin, 1914).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597. Lower part of Round Mountain Silt, USGS 6065, cf. M1612, M1613, M2480, M2601.

Niso cottonwoodensis Addicott n. sp.

Plate 20, figures 19–21

Of medium size, conical, smooth, polished. Spire of nine slightly rounded whorls separated by impressed sutures, tip broken. Whorls marked with irregularly spaced, simple varices. Periphery of body whorl indistinctly angulated, base broadly convex. Umbilical opening broad. Aperture subrhomboidal, outer and inner lips thin.

Height (nearly complete) 13.5 mm, width 5.6 mm.

Type: U.S. Natl. Mus. 650291.

Type locality: USGS M1640, bottom of east fork of gully in SW¼ sec. 6, T. 29 S., R. 30 E., 1,350 feet east, 1,250 feet north of SW. cor. sec. 6. Eight-foot interval, 10 feet stratigraphically above USGS M1613. Lower part of Round Mountain Silt, middle Miocene.

This species differs from *Niso antiselli* Anderson and Martin (1914, p. 65, pl. 7, fig. 22), with which it occurs, by its slightly convex whorls and the rounded rather than angulated periphery of the body whorl.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597. Lower part of Round Mountain Silt, USGS locs. 6623 cf., M1640, M1696.

Family TRICHOTROPIDIDAE

Genus TRICHOTROPIS Broderip and Sowerby, 1829

Type (by subsequent designation, Herrmannsen, 1849): *Turbo bicarinata* Sowerby. Holocene, Arctic, North Pacific, and North Atlantic Oceans.

Trichotropis tricarinata Addicott, n. sp.

Plate 4, figures 12, 13

Of medium size. Whorls angulated near midpoint with vertical profile below and strongly inclined profile above. Body whorl large, tricarinate; upper carina is continuation of angulation of spire and strongest of three carinas. Shell relatively thin, sculptured by fine spiral threads. Umbilicus well developed, deep.

Height (incomplete) 31 mm, width (almost complete) 22.3 mm.

Type: U.S. Natl. Mus. 650091.

Type locality: USGS M1590, fossil quarry in small gully on south side of prominent ridge trending southwestward through SE¼ sec. 15, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle, Kern County, Calif. Basal part of Jewett Sand, lower Miocene.

Although incomplete and part exfoliated, this thin-shelled gastropod is referred to *Trichotropis* on the basis of the broad anterior part of the aperture, weak anterior canal, and deep well-developed umbilical perforation. It closely resembles the drawing of *Trichotropis insignis* Middendorff, variety of Aurivillus from the northern Pacific ocean reproduced in Tryon (1887, p. 43, 45, pl. 7, fig. 59), which (as noted by Tryon) does not appear to be very close to *T. insignis*. It differs from that figure by having a higher spire and a more anterior primary angulation of the spire and body whorl.

This and another species from the Jewett Sand are the first occurrences of *Trichotropis*, a northern, cool-water genus in the Tertiary of California. The genus is represented in the deeper water fauna of southern California and northern Baja California by two species, *T. kelseyi* Dall and *T. lomana* Dall. Apparently it does not range farther south, as it is not among the living mollusks of the Panamic province cataloged by Keen (1958a). The genus has been identified from the Oligocene Gries Ranch beds of southwestern Washington (Effinger, 1938) and from the upper part of the Astoria Formation of middle Miocene age in the same part of the State (Etherington, 1931; Weaver, 1942; Addicott, 1966). The holotype of the Oligocene species *T. alienensis* Effinger (1938, pl. 46, fig. 22) is a small, incomplete specimen which, although similar to *T. tricarinata*, differs by having a sharply angulate outline and a less elongate aperture and narrow umbilicus.

Occurrence: Basal part of Jewett Sand, USGS loc. M1590.

Trichotropis sp.

Plate 3, figure 33

A fragment of the body whorl of a large, very thin shelled trichotropid from the same locality as *Trichotropis tricarinata* is sculpturally similar to strongly carinate species assigned to this genus. The prominent bicarinate sculpture and the short, broad body whorl are features characteristic of *T. bicarinata* (Sowerby), an Arctic Ocean species that ranges southward to Japan and Alaska. However, secondary sculpture of three spiral ribs, one between the two primaries, the other two below the lower primary, and the retractive segment of the growth lines between the keels distinguish this specimen from the modern cool-water species.

Trichotropis tricarinata n. sp. has three, rather than two, primary keels in addition to a relatively slender body whorl. Although both *Trichotropis* sp. and *T. tricarinata* n. sp. are represented by individual specimens that are poorly preserved, they seem to represent two distinct species.

Occurrence: Basal part of Jewett Sand, USGS loc. M1590.

Family CALYPTRAEIDAE

Genus CALYPTRAEA Lamarck, 1799

Type (by monotypy): *Patella chinensis* Linné. Holocene, western Europe.

Calyptraea filosa (Gabb)

Plate 4, figures 2, 3, 8, 9

Trochita filosa Gabb, 1866, Paleontology of California, v. 2, p. 15, pl. 2, figs. 25, a.
Arnold, 1907, U.S. Natl. Mus. Proc., v. 32, no. 1545, pl. 50, figs. 2, 2a.
Eldridge and Arnold, 1907, U.S. Geol. Survey Bull. 309, pl. 40, figs. 2, 2a.
Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100.
Calyptraea filosa (Gabb), Clark, 1915, California Univ. Dept. Geology Bull., v. 8, no. 22, p. 421, pl. 65, figs. 23, 24.
Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 34, fig. 10.
Loel and Corey, 1932, California Univ. Dept. Geol. Sci. Bull., v. 22, no. 3, p. 268–269, pl. 63, fig. 7.
Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 36.
Hall, 1958, California Univ., Dept. Geol. Sci. Bull., v. 34, p. 56, pl. 9, fig. 4.
Calyptraea cf. *C. filosa* (Gabb), Woodring, Stewart, and Richards, 1940, U.S. Geol. Survey Prof. Paper 195, p. 86, pl. 8, fig. 7.

Supplementary description based upon specimens from the Kern River area.—Of medium size, with thin shell. Apex eccentric, sharply pointed. Whorl profile gently convex with concave areas corresponding to sutures, generally not visible. Sculptured by an estimated 150–200 slightly sinuous, rounded, radiating ribs with narrower interspaces. Rib count increases toward periphery by random addition of ribs. Surface microscopically decussated by very fine concentric growth threads. Interior smooth, margin crenulated by external radial ribs.

Type: Apparently lost (Stewart, 1927, p. 291).
Type locality: Miocene, Walnut Creek, Contra Costa County, Calif.

This distinctive species is abundantly represented in marine formations of late Tertiary age. The numerous, very fine radial ribs distinguish *Calyptraea filosa* from other Cenozoic species described from the Pacific coast of North America.

Small, extensively worn calyptraeids from the upper part of the Olcese Sand and the lower part of the Round Mountain Silt are identified as *Calyptraea* sp. They probably represent *C. filosa* but the exteriors are worn smooth.

Distribution and stratigraphic occurrence: Lower Miocene: "* * * General in Vaqueros horizons from lower California to Monterey Bay, particularly in southern California and in the northern Vaqueros Gulf [Salinas Valley]" (Loel and Corey, 1932, p. 269).
Middle Miocene: Monterey Shale, Napa County (Weaver, 1949); Sobrante Sandstone, western Contra Costa County (Weaver, 1949). Temblor Formation—Monocline Ridge (Zimmerman, 1944), Coalinga area (Loel and Corey, 1932; Adegoke, 1967), northern Temblor Range (Heikkila and MacLeod, 1951), La Panza Range (Loel and Corey, 1932), Caliente Range (Eaton and others, 1941); Topanga Formation—central Santa Monica Mountains (Susuki, 1951), San Joaquin Hills (Vedder, unpub. data, 1958), and Santa Ana Mountains (Vedder and Woodring, unpub. data).
Upper Miocene: Briones Formation—Contra Costa County (Trask, 1922; Weaver, 1949, 1953), Alameda County (Hall, 1958); San Pablo Group, Contra Costa County (Clark, 1915; Weaver, 1949); Santa Margarita Formation, Coalinga area (Nomland, 1917a); Modelo Formation, Ventura County (Hudson and Craig, 1928).
Pliocene: Ohlson Ranch Formation of Peck (1960), northwestern Sonoma County; lower Merced Formation, San Francisco, and Etchegoin Formation, southern Santa Clara County (Martin, 1916); Pancho Rico Formation, Salinas Valley (Durham and Addicott, 1965); Jacalitos and Etchegoin Formations, Coalinga area (Nomland, 1917b); Purisima Formation, Half Moon Bay (Martin, 1916); San Joaquin and Etchegoin Formations, Kettleman Hills (Woodring and others, 1940, cf.); upper part of Towsley Formation and Pico Formation, eastern Ventura Basin (Winterer and Durham, 1962, cf.).
Range: Lower Miocene to upper Pliocene.
Localities: Upper part of Olcese Sand, USGS 6890, M1596, M1597, M1600, M1693; UCMP B1593, B1600, B1614, B1622, B1641. Lower part of Round Mountain Silt, USGS 3886, 6063, 6065, 6613, 6622, 6623, M1604, M1608, M1612, M1613, M1696; UCMP B1608, B1618, B1638.

Calyptraea coreyi Addicott, n. sp.

Plate 4, figures 1, 4, 18

Calyptræa inornata (Gabb), Loel and Corey, 1932, California Univ. Dept. Geol. Sci. Bull., v. 22, no. 3, p. 269, pl. 63, figs. 8, 9.

Large, thick shelled, moderately high with shouldered whorl profile. Whorls gently rounded with area of greatest convexity near anterior one-third whorl. On later whorls, posterior part of whorl profile becomes slightly concave, emphasizing tabulation to a greater degree. Surface smooth. Apex eccentric, pointed. Suture impressed, situated near top of concave segment of whorl profile.

Diameter (nearly complete) 37.5 mm, height (nearly complete) 26 mm.

Types: Holotype, U.S. Natl. Mus. 650085; paratype, California Univ. Mus. of Paleontology 15452.

Type locality: USGS M1591, on north side of westward-trending gully on southwest flank of Pyramid Hill in NW¼ SW¼ sec. 14, T. 28 S., R. 29 E. Basal part of Jewett Sand, lower Miocene.

There has been considerable confusion over the names *Calyptraea inornata* (Gabb) and *C. mamillaris* Broderip. Stewart, in his study of Gabb's type gastropods (1927, p. 341), concluded that the type of *C. inornata* from the Purisima Formation of Pliocene age near Half Moon Bay, Calif., was inseparable from the Holocene, low spired *C. mamillaris*. He therefore included Gabb's species in the synonymy of *C. mamillaris*. In the most recent study of the Purisima Formation in this area, Cummings, Touring, and Brabb (1962, pl. 24 and photograph 19, no. 3) have identified a *Calyptraea* as *C. fastigiata*, a living species that ranges from Port Etches, Alaska, to Redondo Beach, Calif. (Burch, 1946, no. 56, p. 22). Both *C. mamillaris*, which is living from Magdalena Bay, Baja California, to Peru (Keen, 1958a, p. 311), and the northern *C. fastigiata* are low-spired species with much more symmetrical, smooth-profiled shells than *C. coreyi*. Furthermore, they do not have the convex, subtabulate whorl profile characteristic of *C. coreyi*. A small, very high spired species from Pliocene rocks of the Kettleman Hills area identified as *Calyptraea* cf. *C. inornata* by Woodring (in Woodring and others, 1940, p. 86, pl. 11, fig. 7; pl. 15, fig. 10; pl. 20, fig. 6) does not have the characteristic convex whorl profile of the Miocene species. This species was considered by Woodring to be similar to, but presumably distinct from, the Holocene *C. fastigiata* and *C. mamillaris*.

Loel and Corey (1932, p. 269) noted that specimens from several lower Miocene localities in California that they identified as *C. inornata* differed from that species by possessing more convex whorls and by having a relatively higher spired shell. These can be confidently referred to *C. coreyi*, whereas the several middle Miocene records of *C. inornata* that are unaccompanied by figured material (Loel and Corey, 1932; Grant in Soper, 1938; Huey, 1948; Weaver, 1949, 1953) cannot be readily evaluated. Stewart's *C. mammilaris* (1946, table 2) from the Temblor Formation at Reef Ridge may also belong here.

A figured specimen of *Calyptraea inornata* from the Pliocene Empire Formation of coastal Oregon (Dall, 1909, pl. 6, fig. 4), although badly worn, has broad axial folds near the periphery of the body whorl that are clearly reflected in the configuration of growth lines. In this feature it is clearly distinct from all the previously discussed species and perhaps should be classified as *Trochita*. Moore's *Trochita*? n. sp.? (1963, p. 26, pl. 1, figs. 6, 7) from the Astoria Formation of Oregon could possibly represent the young of this species. The type is a very low form, not unlike Dall's immature specimen (1909, pl. 5, fig. 11) in overall proportions.

Some variation is indicated in the few specimens collected from USGS locality M1591 and UCMP locality B1665 at Pyramid Hill. A large (44 mm) unfigured specimen has a fine pointed apex and a spire that is lower than that of other specimens. There is a fairly strong angulation below the middle of the whorl on the broken paratype (pl. 4, fig. 18) where the strongly concave profile of the posterior part of the whorl meets the convex anterior segment.

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation—northern La Panza Range, Santa Ynez Mountains, Ventura basin, Santa Ana Mountains, San Joaquin Hills, west coast of Baja California (Loel and Corey, 1932). Forms reported from the Temblor Formation by Loel and Corey (1932) and other authors as *Calyptraea inornata* might represent this species but they have not been examined.

Range: Lower Miocene to middle (?) Miocene.

Localities: Basal part of Jewett Sand, USGS M1591; UCMP B1660, B1665.

Calyptraea cf. mamillaris Broderip

Three poorly preserved specimens of a low-spired evenly conical calyptraeid from the upper part of the Olcese Sand are similar to the Holocene warm water species *Calyptraea mamillaris*. The gypsum and sand-encrusted shells are not suitable for figuring but are sufficiently well preserved to permit differentiation from the higher spired finely ribbed *C. filosa* from the Round Mountain Silt and Olcese Sand and the thick shouldered shell of *C. coreyi* from the lower Miocene Jewett Sand.

Occurrence: Upper part of Olcese Sand, LACMIP loc. 463.

Subgenus TROCHITA Schumacher, 1817

Type (by subsequent designation, Rehder, 1943): *Trochita spiralis* Schumacher. Holocene, Ecuador to Chile.

Calyptraea (Trochita) cf. C. (T.) spirata (Forbes)

A moderately large (50 mm) calyptraeid with patches of shell material showing coarse protractive axial ribbing is comparable to the modern *Calyptraea (Trochita) spirata* (Forbes) from the northern part of the Panamic molluscan province. The one specimen collected from the basal part of the Jewett Sand was too poorly preserved to photograph. This species was

378-855 O—70——5

reported from the Jewett Sand by Loel and Corey (1932, p. 96) as *C. costellata* (Conrad).

Occurrence: Basal part of Jewett Sand, USGS loc. M1591.

Genus CRUCIBULUM Schumacher, 1817

Type (by subsequent designation, Burch, 1946): *Crucibulum planum* Schumacher (= *Patella auricula* Gmelin). Holocene, Florida and West Indies.

Crucibulum cf. C. scutellatum (Wood)

Plate 5, figures 11, 12, 15

A fragment of a large, coarsely ribbed *Crucibulum* from a *Turritella ocoyana* bed in the upper part of the Round Mountain Silt (UCMP loc. B1588) is comparable and possibly identical to the modern *C. scutellatum*, a variable warm-water species that ranges from Cedros Island off Baja California to Ecuador (Keen, 1958.). The axial ribs are numerous and very fine on the pointed apex but become coarse and irregular at the break in slope a short distance below the apex. The narrow interspaces occasionally contain a small secondary rib.

There are no closely related species reported from Tertiary strata in California.

Occurrence: Round Mountain Silt, UCMP loc. B1588.

Subgenus DISPOTAEA Say, 1824

Type (by subsequent designation Olsson and Harbison, 1953): *Calyptraea costata* Say, 1820. Miocene, Maryland.

Crucibulum (Dispotaea) papulum Addicott, n. sp.

Plate 5, figures 5, 6, 8, 9, 13

?*Crucibulum* n. sp., Arnold, 1906, U.S. Geol. Survey Prof. Paper 47, p. 84.

Small, cap shaped, apex hooked. In lateral view, posterior slope straight to gently concave, anterior slope evenly convex. Apex sharply pointed, excentric. Surface sculptured by irregular concentric lines of growth. Radial sculpture lacking. Interior smooth. Cup funnel shaped, aperture ovate, attached to wall along a broad area on right side.

Diameter (incomplete) 11.5 mm, height (nearly complete) 9 mm (holotype).

Types: Holotype, U.S. Natl. Mus. 650098; paratype USNM 650097.

Type locality: USGS 6623, north bank of Kern River, 10–11 miles northeast of Bakersfield. In bluffs about 1¼ miles northeast of Rio Bravo Ranch and about three-fourths of a mile below bridge that is three-fourths of a mile below mouth of canyon. Round Mountain Silt, middle Miocene.

The shape of the internal cup and the width of the area of attachment are variable. On a specimen from USGS loc. M2480, the cup is subtriangular in outline with a very broad area of attachment. On other specimens the cup is kidney shaped and the area of attachment rather narrow.

Crucibulum papulum marks the appearance of the subgenus *Dispotaea* in the Tertiary of the Pacific Coast States. It is a uniquely smooth shell; all of the described species referable to this subgenus being radially sculptured. Deformed specimens from the Topanga Formation of the central Santa Monica Mountains (USGS loc. M1070) may represent this species. The subgenus is represented in middle and late Miocene formations of Panama, Trinidad, and Columbia by *C. springvaleense* Rutsch, a coarsely ribbed species (Woodring, 1957, p. 83–84).

A coarsely ribbed species of *Dispotaea* from the lower Pliocene Pancho Rico Formation of the Salinas Valley (Durham and Addicott, 1965) is the last occurrence of this subgenus in the California Tertiary. A comparable Holocene species, *C. pectinatum* Carpenter, occurs in the Panamic molluscan province (Woodring, 1957).

Occurrence: Lower part of Round Mountain Silt, USGS loc. 3886, 6623, M1608, M1613, M1696, M2480; UCMP loc. B1638.

Family CREPIDULIDAE

Genus CREPIDULA Lamarck, 1799

Type (by monotypy).—Patella fornicata Linné Holocene, Atlantic and Gulf coasts of the United States.

Crepidula bractea Addicott, n. sp.

Plate 4, figures 5–7, 15, 17

Small, flat, very thin. Outline subelliptical. Beak almost terminal, obscure, twisted slightly to the left, located somewhat above the plane of the aperture at or near margin of shell. Slightly convex, area of greatest convexity posterior and to right of center. Septum relatively large, very delicate, attached near midline of shell.

Length 5.9 mm, width 4.5 mm, thickness 1 mm.

Types: Holotype, U.S. Natl. Mus. 650088; paratype, California Acad. Sci. 12931.

Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center Quadrangle. Upper part of Olcese Sand, middle Miocene.

Specimens of *Crepidula bractea* from the type locality are less than 7 mm in length. All are very weakly inflated and have an elliptical outline. There is a much larger specimen (16.5 mm), however, from the upper part of the Olcese Sand that has many features in common with the minute shells and is therefore considered to be the adult of the species. This specimen (pl. 4, fig. 7) has early growth stages that closely resemble the outline of the smaller specimens. The adult is less symmetrical in outline, the growth taking place in a faint spiral pattern resulting in a broadly convex left margin and a nearly straight right margin.

This small, thin-shelled species can be readily distinguished from young specimens of *Crepidula rostralis* (Conrad) from the same locality. The latter have a very highly arched, laterally compressed shell as well as a prominent, hooked beak which extends outward beyond the apertural margin of the shell (pl. 4, fig. 14).

A similar species from lower Miocene localities in southern California, *C. diminutiva* Loel and Corey (1932, p. 267, pl. 63, figs. 13-15), differs in several respects from *C. bractea.* The outline of *C. diminutiva* is more orbicular and the anterior part is sinuous, whereas specimens of *C. bractea* have an evenly rounded, subelliptical outline. In addition, specimens of *C. diminutiva* are more convex and have a more strongly developed beak.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597; UCMP loc. B1598; CAS loc. 2064. Lower part of Round Mountain Silt, UCMP loc. B1608.

Crepidula princeps Conrad

Plate 4, figures 16, 19–21

Crepidula princeps Conrad, 1855, U.S. 33d Cong., 1st sess., House Ex. Doc. 129, p. 16.

Conrad, 1857, U.S. 33d Cong., 2d sess., Senate Ex. Doc. 78, app., art. 2, p. 326, pl. 6, figs. 52, 52a.

Arnold, 1907, U.S. Geol. Survey Bull. 321, p. 78, pl. 13, figs. 1a–c.

Arnold and Anderson, 1907, U.S. Geol. Survey Bull. 322, pl. 24, fig. 1, 2.

Arnold, 1909, U.S. Geol. Survey Bull. 396, pl. 23, fig. 2.

Arnold and Anderson, 1910, U.S. Geol. Survey Bull. 398, pl. 45, fig. 2.

Dall, 1909, U.S. Geol. Survey Prof. Paper 59, p. 84–85, pl. 8, figs. 1–4, pl. 9, fig. 5, pl. 10, fig. 2.

Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100.

Loel and Corey, 1932, California Univ. Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Bremner, C. S. J., 1932, Santa Barbara Mus. Nat. History Occasional Papers, no. 1, pl. 2, fig. 1.

Schenck and Keen, 1940, California fossils for the field geologist, pl. 51, fig. 5.

Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 358, pl. 73, figs. 13, 19 [not fig. 4].

Hanna and Hertlein, 1943, California Div. Mines Bull. 118, fig. 64–3.

Shimer and Shrock, 1944, Index fossils of North America, p. 489, pl. 201, figs. 20, 21.

Woodring, Bramlette, and Kew, 1946, U.S. Geol. Survey Prof. Paper 207, p. 70, pl. 32, figs. 5, 6.

Woodring and Bramlette, 1950, U.S. Geol. Survey Prof. Paper 222, p. 71–72, pl. 7, figs. 3, 4, 9, pl. 10, fig. 4, pl. 11, fig. 5.

[?] Cummings, Touring, and Brabb, 1962, California Div. Mines Bull. 181, photograph 16, no. 3.

?*Crepidula*, n. sp.?, Loel and Corey, 1932, California Univ. Dept. Geol. Sci. Bull., v. 22, no. 3, p. 96.

?*Crepidula* cf. *praerupta* Conrad, Loel and Corey, 1932, California Univ. Dept. Geol. Sci. Bull., v. 22, no. 3, p. 267, pl. 63, fig. 16.

Type: U.S. Natl. Mus. 1839.

Type locality: Conrad's description (1857, p. 326), "Recent formation at Santa Barbara, California," presumably is the Santa Barbara Formation of late Pliocene and early Pleistocene age. *Crepidula princeps* has not been reported from the late Pleistocene terraces of the Santa Barbara area.

Specimens from the basal part of the Jewett Sand at Pyramid Hill (USGS loc. M1591) are referred to this species on the basis of large size, configuration of the internal septum, and massive twisted nonadherent beak.

The anterior part of the holotype of *Crepidula princeps* is broken, but there is enough of the septum remaining to clearly show the characteristic medial curvature and the extreme anterior point of attachment on the left side of the shell. Although the tip of the beak is also broken, restoration of the missing part would indicate curvature of more than 90° from the vertical. This severe twisting is characteristic of the early Miocene specimens from the Jewett Sand and of specimens from the Pliocene Empire Formation of southwestern Oregon. Another figured specimen from the Santa Barbara Formation (Arnold, 1907, pl. 13, figs. la–lc) has a much less swollen beak that is twisted much less than 90° and is only slightly separated from the outer shell wall.

It is difficult to distinguish moderate-size *Crepidula princeps* from specimens from the Miocene Astoria Formation of Oregon and Washington identified as *C. praerupta* Conrad. The most distinguishing characteristic is the medial indentation or curvature of the edge of the internal septum on *C. princeps* (Woodring and others, 1946, p. 70). The deck is not exposed on the lectotype of *C. praerupta;* the insertions are preserved, however, on one of Conrad's original specimens, an internal mold figured by Moore (1963, pl. 1, fig. 22). A rubber cast of this moderately small specimen indicates that the insertion on the right side is slightly posterior to that on the left side. Unfortunately, it was not possible to recover the leading edge of the septum on the cast.

Although this cast suggests a probable difference in septal configuration, the few available specimens of middle Miocene crepidulas from Oregon and Washington that would ordinarily be identified as *Crepidula praerupta* on the basis of size and external features do not show any consistent configuration of the leading edge of the septum. A specimen in the collections from the Astoria Formation at the U.S. National Museum, USGS locality 18038, has a deck similar to that of *C. princeps*, as does a specimen from Washington figured by Etherington (1931, pl. 11, fig. 2). On the other hand, another specimen from nearly the same locality as Etherington's (pl. 5, fig. 7) has an entirely different septal pattern with the points of insertion almost opposite each other. The beak of this specimen is twisted less than 90° from the vertical. Clearly, the decks of many more individuals need to be exposed and studied in order to determine if this characteristic can be used to differentiate *C. praerupta* from *C. princeps*. It is altogether possible that some, if not many, of the Pacific coast middle Miocene specimens identified as *C. praerupta* may prove to be smaller but otherwise indistinguishable forms of *C. princeps*.

It seems doubtful that *Crepidula princeps* of small and medium size can be satisfactorily distinguished from *C. praerupta* on the basis of some of the other supposed differences cited in the literature, such as degree of convexity of shell, whether or not the apex is appressed, thickness of beak, and relative bluntness of beak are variable characteristics on undoubted specimens of *C. princeps*.

In addition to the possible difference in deck configuration and in adult size, the upturned and sometimes severely twisted beak of *C. princeps* seems to be unique. On specimens of *C. praerupta* from the Astoria Formation of Oregon, the beak is recurved parallel to the plane of the aperture (Moore, 1963, p. 26). It is not necessarily adherent, however, as illustrated by a small specimen from near Newport, Oreg., figured by Moore (pl. 1, fig. 16). When working with immature specimens, it is doubtful that this feature will permit satisfactory discrimination.

The supposed living descendant of this species (Grant and Gale, 1931, p. 790), *Crepidula grandis* of the northern Pacific fauna, differs from specimens of *C. princeps* in USGS collections at Menlo Park, Calif., by having a relatively thin, only weakly inflated shell with a semicircular, less deeply recessed deck, an orbicular rather than elliptical outline, and a very small beak. Woodring (in Woodring and others, 1940, p. 71) expressed doubt that these species are closely related.

In the Kern River Miocene, *Crepidula princeps* ranges from the basal conglomerate of the Jewett Sand to the lower part of the Olcese Sand. It is distinct from the smaller *C. rostralis*, a commonly occurring species in the upper part of the Olcese Sand and the Round Mountain Silt.

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation, Santa Cruz Mountains (Arnold, 1908) and Caliente Range (J. G. Vedder, oral commun., 1963); Jewett Sand, Kern River area. Middle Miocene: Astoria (?) Formation, Washington and Oregon; Sobrante Sandstone, Pacheco-Walnut Creek area (Weaver, 1949, 1953; Lutz, 1951); Temblor Formation, Kern River area (Anderson and Martin, 1914; Loel and Corey, 1932); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967); Topanga Formation, Santa Monica Mountains (Grant in Soper, 1938). Upper Miocene: Montesano Formation of Weaver (1912), southwestern Washington; San Pablo Group, Contra Costa County (Clark, 1915); Santa Margarita Formation, Coalinga area (Nomland, 1917a) and doubtfully at Comanche Point (Addicott and Vedder, 1963); Castaic Formation of Stanton (1966), eastern Ventura Basin. Pliocene: Empire Formation, southwestern Oregon (Dall, 1909; Weaver, 1945), common throughout California. Pleistocene: recorded from several lower Pleistocene localities in southern California; very rare in the upper Pleistocene.

Range: Lower Miocene to upper Pleistocene.

Localities: Jewett Sand, USGS 6638?, M1590, M1591, M1609; UCMP B1660, B1665. Lower part of Olcese Sand, USGS M1694.

Crepidula rostralis (Conrad)

Plate 4, figures 10, 11, 14; plate 5, figures 10, 16

Crepidula ———? Conrad *in* Dana, 1849, U.S. Exploring Exped., Geology, app. 1, p. 727, pl. 19, figs. 11a, 11b [text reprinted in Dall, 1909, U.S. Geol. Survey Prof. Paper 59, p. 155].

Crypta rostralis Conrad, 1865, Am. Jour. Conchology, v. 1, p. 151.

Crepidula rostralis (Conrad), Dall, 1909, U.S. Geol. Survey Prof. Paper 59, p. 83.

Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 27, fig. 3 (?).

Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 91, pl. 11, figs. 9–11.

Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 359, pl. 72, figs. 13, 15.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

Crepidula rostrata Conrad, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull, v. 22, no. 3, p. 172.

Crepidula praerupta Conrad, Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 204, pl. 16, figs. 68, 69.

Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100.

Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 43.

Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 26–27 [in part], pl. 1, fig. 24.

?*Crepidula* cf. *praerupta* Conrad, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Supplementary description based upon specimens from the Kern River area.—Of moderate size, elongate, thin shelled. Aperture subelliptical, larger anteriorly. Shell strongly inflated. Compressed laterally, right side more so than left side, which flares somewhat. Beak robust, sharply pointed, usually oriented at right angles to plane of aperture but in some specimens reaches a 45° angle with respect to apertural surface. Internal septum confined to the beak area, deeply recessed, anterior margin semicircular. Exterior smooth except for incremental lines of growth.

Type: U.S. Natl. Mus. 110447.
Type locality: Astoria, Oreg. Astoria Formation, middle Miocene.

This is one of the more common species in the upper part of the Olcese Sand. There is considerable variation in the degree of inclination of the plane defined by the beak, as well as in the degree of coiling within this plane. The aperture may vary from subcircular to subelliptical, and, occasionally the shells have a recumbent appearance because of the greater apparent compression of one side.

The type of *Crypta rostralis* Conrad is an internal mold of an individual somewhat smaller than the average size of specimens from the Olcese Sand. It has been well figured by Moore (1963, p. 26–27, pl. 1, fig. 23), who placed this species in the synonymy of *Crepidula praerupta* for the reason that, of the many specimens of *Crepidula* in collections from the type area and elsewhere in Oregon, no additional ones referable to *C. rostralis* have been found. She concluded that the holotype is probably a flattened immature specimen of *C. praerupta*. Earlier, Etherington (1931, p. 91, pl. 11, figs. 9-11) identified specimens from the basal part of the Astoria Formation in southwestern Washington as *C. rostralis*. Although the holotype of *C. rostralis* is perhaps too poorly preserved to be certainly identified with the Washington and California specimens and appears to be deformed as noted by Moore, the name has been associated with what is here considered a valid species. The question of whether the holotype is a synonym of *C. praerupta*, as it may well be, can be argued at length and probably will not be solved to everyone's satisfaction. It is here recognized as a valid species, however, because of the straight extended beak and the small deeply recessed semicircular internal septum.

There is little difficulty in distinguishing *Crepidula rostralis* from specimens identified as *C. praerupta*. The shell is relatively narrow and highly arched; the elongate beak is directed at right angles, or nearly so, to the plane of the aperture (pl. 4, fig. 11). The internal septum is distinctive; its "U shape" differs markedly from the septal configuration of other crepidulas from Oregon and Washington. It should be reemphasized, however, that details of the septum in type material of *C. praerupta* are as yet unknown. Possibly many of the identifications of *C. prærupta* from Miocene localities in California are, in fact, *C. rostralis*, or possibly *C. princeps*, as suggested earlier.

The young of *Crepidula rostralis* often have the appearance of the cap-shaped Pliocene to Holocene species *C. adunca*, but the latter apparently has a much more extensive internal deck, which extends over nearly half of the aperture (Oldroyd, 1927, v. 2, pt. 3, p. 119). Grant and Gale (1931, p. 791) observed that Miocene specimens identified as *C. adunca* were likelier to be *C. prærupta* or some other species. Of the Holocene crepidulas from the northeastern Pacific Ocean, *C. coei* Berry (1950), a Pleistocene to Holocene species now living in the northern part of the Californian molluscan province, seems to be most closely allied to *C. rostralis*. Specimens of *C. coei* from late Pleistocene deposits at Newport Bay, Calif. (USGS loc. M1722) can be differentiated from *C. rostralis* by their more extensive, less arcuate internal septum.

Distribution and stratigraphic occurrence: Astoria Formation: southwestern Washington (Etherington, 1931), northwestern Oregon (Conrad, 1849); Empire Formation of Diller (1903) near Cape Blanco, Oreg. (USGS loc. M2142); Temblor Formation: Anticline Ridge, Coalinga area (Woodring and others, 1940, cf.), Reef Ridge (Adegoke, 1967), La Panza Range (Loel and Corey, 1932).
Range: Middle Miocene.
Localities: Lower part of Olcese Sand, USGS M1593. Middle part of Olcese Sand, USGS M 1698. Upper part of Olcese Sand, USGS 6619, 6624, M1596–M1602, M1693, M1697; UCMP B1586, B1593–B1595, cf. B1596, B1599, B1600, B1616, B1621–B1623, B1626, B1641, B1642. Lower part of Round Mountain Silt, USGS 6622, 6623, M1604, M1608, M1613; UCMP B1611, B1612, B1625, B1637, B1638.

Crepidula cf. C. aculeata (Gmelin)

A fragment of a relatively flat *Crepidula* with numerous finely spinose ribs radiating outward from the strongly recurved beak resembles the modern eastern Pacific Ocean species *C. aculeata*. The length-width ratio of the fossil specimen from the Round Mountain Silt is comparable to that of the modern species, according to measurements listed by Keen (1958a, p. 313).

Occurrence: Lower part of Round Mountain Silt, USGS loc. 6065.

Family NATICIDAE
Subfamily NATICINAE

Genus NATICA Scopoli, 1777

Type (by subsequent designation, Harris, 1897): *Nerita vitellus* Linné. Holocene, western Pacific Ocean.

Subgenus NATICA, s. s.

Natica (Natica) teglandae Hanna and Hertlein

Plate 5, figures 1, 2, 20

Natica (Natica) dalli Tegland, 1933, California Univ., Dept. Geol. Sci. Bull., v. 23, no. 3, p. 138, pl. 14, figs. 8–12 [not *Tectonatica dalli* Cossmann, 1925, Paleoconchologie Comparee, v. 13, p. 121.]
Natica teglandi Hanna and Hertlein, 1938, Jour. Paleontology, v. 12, no. 1, p. 108.
Natica (Tectonatica) teglandae Hanna and Hertlein, Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 33, pl. 68, figs. 5–7.

Types: Holotype, California Univ. Mus. Paleontology 32215; paratypes, UCMP 32189, 32190.

Type locality: UCMP 681, Blakeley Formation of Weaver (1912), Restoration Point, Kitsap County, Washington.

Natica teglandae is represented by a few specimens from the lower part of the Round Mountain Silt. It is a relatively small species that can be readily distinguished from other Miocene naticids by its small, weakly developed funicular rib. It is similar to the more abundant *N. posuncula* of the Olcese Sand and Round Mountain Silt but differs by its widely open umbilicus with a relatively small umbilical rib which terminates in a slender funicular callus.

This species is most closely related to *Natica vokesi* Addicott (1966, p. 638–639, pl. 77, figs. 2–5), a middle Miocene species from the upper part of the Astoria Formation of the Newport Embayment, Oreg. Principal differences between these species are the much higher spire and strongly shouldered whorls of *N. vokesi.*

Natica teglandae is rare in the upper part of the Olcese Sand. It is a relatively small species compared with the other Miocene naticids of this area and can readily be separated from them by the small funicular rib ending anteriorly as a small swelling of callus on the apertural lip.

Natica s.s. is a warm-water genus. Along the margin of the eastern North Pacific Ocean it ranges from Magdalena Bay on the southwestern coast of Baja California southward to Peru (Keen, 1958a, p. 320–321). *Natica chemnitzi* Pfeiffer (Keen, 1958a, p. 320), an intertidal species that is common on mudflats from Magdalena Bay to Peru, appears to be the modern analog of *N. teglandae*. Comparison with modern *Natica* is complicated by the definition of some species on the basis of sculpture of the calcareous operculae. Naticid operculae are very rare in the collections, in part because of the comparative scarcity of *Natica* in Miocene strata of the Kern River area. The operculum figured on plate 5, figure 14, presumably is from this species or from *N. posuncula.*

Distribution and stratigraphic occurrence: Upper Oligocene: Blakeley Formation of Weaver (1912), Puget Sound area, Washington (Tegland, 1933; Weaver, 1942; Durham, 1944). Lower Miocene: *Echinophoria apta* Zone, northwestern Washington (Durham, 1944).

Range: Upper Oligocene to middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1602. Lower part of Round Mountain Silt, USGS 6064 cf., cf. 6068, ?6613, ?6623, 6641, M1608, cf. M1612; UCMP B1618.

Subgenus NATICARIUS Duméril, 1806

Type (by monotypy): *Nerita carena* Linné. Holocene, eastern Florida and West Indies.

Natica (Naticarius?) posuncula Hanna and Hertlein

Plate 5, figures 3, 4

Natica posuncula Hanna and Hertlein, 1938, Jour. Paleontology, v. 12, no. 1, p. 107–108, pl. 21, fig. 6.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

Type: California Acad. Sci. 7084.

Type locality: CAS 65, hills northeast of Barkers Ranch, immediately north of Kern River [probably same as UCMP B1586, near center NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

Specimens of *Natica posuncula* figured herein have a more pointed, somewhat higher spire than the holotype, which appears to have been abraded. They are from a locality near the top of the Olcese Sand that is from the same general area and stratigraphic position as the holotype. Most individuals from the Kern River area, however, are considerably smaller. The large funicular callus is located toward the anterior edge of the umbilicus. It is bordered by a subcircular cleft of variable width that spreads open posteriorly.

Assignment to *Naticarius* is suggested by the faint axial wrinkles bordering the sutures on some specimens. Moreover, a faint color pattern of spiral rows of light-brown spots, similar to that described on the type species of *Naticarius*, *N. carena* Linné, by Abbott (1954, p. 191), occurs on a well-preserved specimen from USGS locality M1597. However, no operculae with the characteristic sculpture of *Naticarius* have been found in the Kern River area. For this reason and because strong axial wrinkles do not occur on *N. posuncula* the subgeneric assignment is not firm. Living *Naticarius* are found in the subtropical and tropical eastern Pacific Ocean (Woodring, 1957). The umbilical opening of this species, although somewhat variable, seems to be consistently larger than that of *Tectonatica*, a subgenus with an almost completely plugged umbilicus.

A similar middle Miocene naticid from the Astoria Formation of Oregon, *Natica vokesi* Addicott (1966, pl. 77, figs. 2–5), has a widely open umbilicus with a narrow funicular callus and smooth, strongly shouldered whorls.

Etherington (1931, p. 93) first noted the occurrence of this species from the Kern River area, which he considered a variety of *Natica clarki*, a small species from the Astoria Formation in southwestern Washington. Specimens of *N. clarki* differ from *N. posuncula* by having shouldered whorls, a higher spire, and a very broad but weak umbilical rib.

Distribution and stratigraphic occurrence: Temblor Formation: Reef Ridge area (Stewart, 1946); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597, cf. M1598, cf. M1599, cf. M1697; UCMP B1601, B1616, B1622. Lower part of Round Mountain Silt, USGS 3886, 6065, ?6066, cf. 6623, M1604, M1608, M1610, M1612, M1613, M1696, M2480; UCMP B1638 cf.

Subfamily POLINICINAE

Genus POLINICES Montfort, 1810

Type (by original designation): *Polinices albus* Montfort. Holocene, West Indies.

Polinices victoriana Clark and Arnold

Plate 5, figures 17, 18, 21

Polinices (*Euspira*) *victoriana* Clark and Arnold, 1923, California Univ., Dept. Geol. Sci. Bull., v. 14, no. 5, p. 170, pl. 33, figs. 1a, b, 5a, b.

Weaver, 1944, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 335–336, pl. 68, figs. 10–12, 14.

Polinices canalis Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 28, pl. 2, figs. 18, 22.

Types: Holotype, California Acad Sci. 582; "cotype" [paratype], California Univ. Mus. Paleontology 30203.

Type locality: CAS 231, in sea cliffs east of the mouth of Kirby Creek, 6 miles west of Sooke, Vancouver Island, British Columbia. Sooke Formation, lower Miocene (?).

[The paratype of *Polinices victoriana* is from the middle Miocene of the Kern River area (UCMP loc. 2713)].

Type of *Polinces canalis* Moore: U.S. Natl. Mus. 56134.

Type locality: USGS 18806, in beach cliffs forming first headland south of fill at Spencer Creek, Lincoln County, Oreg. Astoria Formation, middle Miocene.

This species has a heavy parietal callus with a faint transverse channel and corresponding projection of the callus margin above the umbilicus. However, these features are found only on the better preserved specimens. The character of the umbilicus is variable. On most specimens from the Kern River area, the umbilicus is broad and has only a faint suggestion of a broad funicular rib within (pl. 5, figs. 18, 21). On this form the inner edge of the parietal-columellar callus describes a more or less straight line. There is also a fairly strong channel near the base of the umbilicus that indents the apertural lip and spirals outward from the umbilicus (pl. 5, fig. 8). This also seems to be a variable characteristic developed on perhaps less than half of the individuals referable to this form of *Polinices victoriana*. Specimens from near the type locality of *P. canalis* at the mouth of Spencer Creek, Lincoln County, Oreg., also have this peculiar outwardly directed spiral groove.

A second form of this species is generally smaller and has a more constricted umbilical opening because of the enlargement of the funicular rib (pl. 5, fig. 17). There is a fairly distinct funicular callus set off above by a slight indentation corresponding to the posterior umbilical groove. Specimens that seem to be intermediate between these two forms are in the collections from USGS locality M1597.

The form with the constricted umbilicus can be differentiated from *Natica posuncula* by its more elongate shell, less widely flaring aperture, and smaller, less elongate funicular callus.

Distribution and stratigraphic occurrence: Lower Miocene (?): Sooke Formation, Vancouver Island, British Columbia (Clark and Arnold, 1923). Middle Miocene: Astoria Formation—Skamokawa quadrangle, southwestern Washington (USGS loc. M2513) and coastal Oregon (Moore, 1963).

Range: Lower Miocene to middle Miocene.

Localities: Basal part of Jewett sand, USGS 6638?, M1591. Lower part of Olcese Sand, USGS M1694 cf. Middle part of Olcese Sand, USGS M1698. Upper part of the Olcese Sand, USGS M1597, M1600–M1602, M1604, M1693, M1697; UCMP B1587, B1593, B1596–B1600, B1616, B1621, B1624, B1640, B1641. Round Mountain Silt, USGS 6613?, M1608–M1613.

Genus NEVERITA Risso, 1826

Type (by monotypy): *Neverita josephinia* Risso. Holocene, Mediterranean.

Subgenus GLOSSAULAX Pilsbry, 1929

Type (by original designation): *Neverita reclusiana* (Deshayes). Holocene, northern California to central Mexican coast.

Neverita (Glossaulax) andersoni (Clark)

Plate 5, figures 22–24

?*Natica ocoyana* Conrad, 1855, U.S. 33d Cong., 1st sess., House Ex. Doc. 129, p. 18.

Conrad, 1857, U.S. 33d Cong., 2d sess., Senate Ex. Doc. 78, app., art. 2, p. 328, pl. 7, fig. 51, 51a [not 57, 57a, as stated on p. 328] here considered a nomen dubium.

Neverita callosa Gabb, Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 188.

Arnold, 1907, U.S. Natl. Mus. Bull., v. 32, no. 1545, pl. 44, figs. 4, 4a.

Eldridge and Arnold, 1907, U.S. Geol. Survey Bull. 309, pl. 31, figs. 4, 4a.

Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100.

?Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 5, v. 4, p. 43.

Natica (*Neverita*) *recluziana andersoni* n. var., Clark, 1918, California Univ., Dept. Geology Bull., v. 11, no. 2, p. 168–169, pl. 20, figs. 3, 10, 11, 12.

Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 27, fig. 2.

Polinices recluzianus andersoni Clark, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173, 270, pl. 63, figs. 4a, b, 5a, b.

Lutz, 1951, California Univ., Dept. Geol. Sci. Bull., v. 28, no. 13, p. 391, pl. 18, fig. 4.

Neverita andersoni Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

?*Neverita reclusiana* (Deshayes), Woodring and Stewart *in* Woodring and others, 1940. U.S. Geol. Survey Prof. Paper 195, p. 86 [in part], pl. 15, fig. 19.

Type: California Univ. Mus. Paleontology 11212.

Type locality: UCMP 1131, in creekbed half a mile southwest of Walnut Creek about 100 yards east of Oakland and Antioch bridge, altitude 150 feet, Contra Costa County, Calif. San Ramon Formation, upper Oligocene or lower Miocene.

This is the most common naticid in the Miocene formations of the Kern River area. It is readily separable from other naticids in this area on the basis of the large anteriorly-grooved callus pad that ordinarily plugs the umbilicus. Other unique features are the flattened sides of the body whorl, low spire, and thick parietal callus.

Neverita andersoni is closely related to *N. reclusiana* (Deshayes), a variable species encompassing several seemingly distinct forms. *Neverita reclusiana* s.s., as recognized by Grant and Gale (1931, p. 800–801), is not present in collections from the Kern River district. This species is relatively high spired and has a characteristic outline formed by a shelflike, concave segment immediately below the suture. It has been reported, however, from several middle Miocene localities in California (Loel and Corey, 1932; Stewart, 1946; Weaver, 1949) and from the upper Oligocene or lower Miocene San Ramon Formation (Weaver, 1949, 1953, Moore, 1963). The variety *N. reclusiana imperforata* (Arnold) [discussed by Pilsbry (1929, p. 111–113, pl. 6, figs. 2–4)] most closely approaches *N. andersoni* in morphology. It is here considered separable, however, on the basis of the greatly flattened shell, an evenly rounded profile above the basal angulation of the body whorl, and the point of attachment of the outer apertural lip, usually relatively lower than on *N. andersoni*. As observed by Woodring and others (1946, p. 71–72) in a careful discussion of *Neverita reclusiana* and its varietal forms, it is difficult to recognize immature specimens from other forms of *N. recluziana*, the problem being the incomplete development of the umbilical callus on most small shells.

Many species from the upper part of the Olcese Sand are referred to a similar but very high spired species, *Neverita alta* (Dall). This species has an incompletely plugged umbilicus characterized by a tonguelike extension of the posterior part of the umbilical callus. It has been treated as a form of *N. reclusiana* by many workers but is considered a separate and distinct species herein.

A specimen from the Pliocene San Joaquin Formation of the Kettleman Hills in central California figured by Woodring and others (1940, pl. 15, fig. 19; pl. 20, fig. 4) as *Neverita reclusiana* short variety is more cylindrical in outline and seems to be more compressed laterally than *N. andersoni*. It was noted that the subcylindrical specimens resembled *N. callosa* Gabb in outline and that no Holocene specimens in the U.S. National Museum or the Philadelphia Academy of Sciences resembled this cylindrically shaped form (Woodring and others, 1940, p. 86).

Grant and Gale's *Polinices reclusianus* var. *andersoni* (1931, p. 802) presumably includes forms other than are here included in *Neverita andersoni* because they describe its body whorl profile as "sloping off at a low angle [below the suture] and curving around broadly, with constantly increasing convexity, to the umbilicus." As such their statement that this form is more common than *N. reclusianus* s.s. in the modern fauna need not be taken as evidence of a range extension of *N. andersoni* into the Holocene. The form that they describe more likely is *N. reclusiana imperforata*.

Admittedly it is difficult to reach a decision as to whether *N. andersoni* should be treated as a separate species or as a form of *N. reclusiana* as some workers have done (Clark, 1918; Grant and Gale, 1931; Lutz, 1951; Hall, 1958). Because there are no clear indications of integradation between the relatively constant morphology of *N. andersoni* and the described variants of *N. reclusiana* in collections from the Kern River area, *N. andersoni* is here treated as a distinct species. A few large specimens, however, do approach the low, conical outline of *N. reclusiana* forma *imperforata*.

It is probable that Conrad's *Natica ocoyana* (1857, p. 328, pl. 7, figs. 51, 51a) is this species. This name is here considered a nomen dubium because the type, an incomplete internal mold judging from the drawing, cannot be specifically identified or even classified as a naticid from Conrad's figure and description. Moreover, there are at least two naticid taxa in the collection from USGS locality M1698, which is probably the same as the type locality of *Natica ocoyana*. Because the type has been lost (Keen and Bentson, 1944, p. 177), it is unlikely that Conrad's species can ever be recognized.

Neverita callosa Gabb, another Miocene species referable to *Glossaulax* on the basis of the grooved umbilical callus, is also difficult to recognize because the type material has been lost (Stewart, 1927, p. 291) and the original figures and description do not permit careful comparison with fossil material. The overall outline of *N. callosa* (Gabb, 1869, pl. 2, fig. 17) differs considerably from specimens here referred to *N. andersoni*. Although both species have a very low, poorly developed spire, *N. callosa* has an evenly rounded, globose body whorl, whereas *N. andersoni* has a flat-sided body whorl, the general aspect of which resembles the outline of a lamp shade. Gabb (1866, p. 10) compared his species with a similar "form * * * found by Dr. Cooper at San Pedro" [probably *N. reclusiana*

(Deshayes)]. Gabb noted that this similar form had a better developed spire and a broader body whorl.

Arnold's *Neverita callosa* (1907, pl. 44, figs. 4, 4a) from the Topanga Formation in the Santa Monica Mountains is a low-spired, cylindrical-shaped specimen with the broadest part of the body whorl at the basal angulation. The profile is identical to that of *N. andersoni* and quite distinct from the rounded profile of the type figure of *N. callosa*. Earlier records of *N. callosa* in the Kern River area (Anderson, 1905, 1911; Anderson and Martin, 1914; Keen, 1943) presumably are of *N. andersoni*. No specimens referable to *N. callosa* have been recognized in collections from the Kern River Miocene during this study.

A recently described species from the middle Miocene Astoria Formation of Oregon, *Neverita jamesae* Moore (1963, p. 28–29, pl. 2, figs. 5, 15, 19) differs from *N. andersoni* principally by its smaller, poorly developed medially grooved umbilical callus that does not plug the umbilical opening and its evenly rounded, conical outline.

Distribution and stratigraphic occurrence: Lower Miocene (?): San Ramon Formation, Contra Costa County (Clark, 1918). Lower Miocene: Vaqueros Formation—Santa Cruz Mountains, northern Gabilan Range, Santa Lucia Range, La Panza Range, San Emigdio Mountains (Loel and Corey, 1932); Caliente Range (Eaton and others, 1941); Nipomo quadrangle, San Luis Obispo County (Hall and Corbato, 1967) western Santa Ynez Range, Ventura basin, Channel Islands, western Santa Monica Mountains, San Joaquin Hills, Santa Ana Mountains (Loel and Corey, 1932); Middle Miocene: Sobrante Formation, Pacheco-Walnut Creek area (Lutz, 1951); Oursan Sandstone, Pleasanton area (Hall, 1958); Oursan(?) Sandstone, Tesla quadrangle (Clark in Huey, 1948); Temblor Formation, Coalinga area, La Panza Range (Loel and Corey, 1932), Caliente Range (Eaton and others, 1941); Topanga Formation, Santa Monica Mountains (Woodring in Hoots, 1931, cf.; Loel and Corey, 1932), Santa Ana Mountains (Loel and Corey, 1932). Upper Miocene: Santa Margarita Formation, Coalinga area (Nomland, 1917a; Clark, 1918). Pliocene: "Lower Fernando" (Clark, 1918).

Range: Lower Miocene to Pliocene.

Localities: Jewett Sand, USGS 6638 cf., 6639, M1590, M1591; UCMP B1660, B1666, B1667, cf. B1668. Lower part of Olcese Sand, USGS M1694; UCMP 1646, B1657, B1676. Middle part of Olcese Sand, USGS M1698. Upper part of Olcese Sand, USGS 6890, M1596–M1602, M1693, M1697; UCMP B1586, B1587, B1593–B1601, B1603, B1614–B1616, B1621–B1624, B1629, B1641, B1642, B1644, B1753. Round Mountain Silt, USGS 6065?, cf. 6068, 6611, 6613, ?6622, 6623, cf. 6641, 13361, M1605, M1606, M1608, M1611–M1613, cf. M1696, M2480; UCMP B1588, B1612, M1613, B1625, B1636–B1638, B1678.

Neverita (Glossaulax) alta Arnold

Plate 5, figures 19, 25

[*Polinices* (*Neverita*) *recluziana*] var. *alta* Arnold, 1903, California Acad. Sci. Mem., v. 3, p. 315.

Neverita recluziana variety *alta* Dall, 1909, U.S. Geol. Survey Prof. Paper 59, p. 88.

Neverita recluziana Petit *alta* Dall, Arnold, 1909, U.S. Geol. Survey Bull. 396, pl. 20, figs. 5, 5a.

Arnold and Anderson, 1910, U.S. Geol. Survey Bull. 398, pl. 42, figs. 5, 5a.

Neverita alto ('Dall' Arnold) Pilsbry, 1929, Nautilus, v. 42, p. 110–111, pl. 6, figs. 5–9.

In a discussion of *Neverita reclusiana* that is generally taken to be the original description of this form, Dall states (1909, p. 88) "There is a variety *alta* Dall, with small narrow shell and exceptionally elevated spire."

Lectotype: U.S. Natl. Mus. 147436 (designated by Pilsbry, 1929, p. 111).

Type locality: Oliver and Pacific Streets, San Pedro, Calif. Palos Verdes Sand, upper Pleistocene.

Several specimens in the collections from the upper part of the Olcese Sand and the Round Mountain Silt are tentatively referred to this species. The slender body whorl, high spire, and incompletely plugged umbilical opening are characters that distinguish this species from *Neverita reclusiana* and *N. andersoni*. The unique tonguelike posterior lobe of the umbilical callus characteristic of this species, however, is not always well developed in the Kern River Miocene specimens. This species differs from *N. jamesae* Moore (1963, p. 28–29, pl. 2, figs. 5, 15, 19) from the Astoria Formation in Oregon chiefly in the relatively high spire, the elongate posterior lobe of the umbilical callus, and the anterior location of the umbilical groove.

Neverita alta has been variously treated as a valid species (Pilsbry, 1929, p. 110–111; Burch, 1946, no. 56, p. 31; Kanakoff and Emerson, 1959) or as a variety or subspecies of *N. reclusiana* (Woodring and others, 1946; Valentine, 1961). As this taxon seems reasonably distinct from the other Miocene naticids with which it occurs, it is here afforded full specific rank.

Well-preserved specimens from USGS locality 6641 in the Round Mountain Silt have cream-colored subsutural and basal color bands comparable to the orange color banding of some Recent specimens. The subsutural band is relatively broad. Similar banding has been observed on some immature specimens of *N. andersoni*.

Distribution and stratigraphic occurrence: Pliocene: Etchegoin Formation, Coalinga area (Arnold, 1909). Pleistocene: Lomita Marl and Timms Point Silt Members of the San Pedro Formation, and Palos Verdes Sand, Palos Verdes Hills (Woodring and others, 1946), upper Pleistocene marine terraces, northwestern Baja California (Valentine, 1957). Holocene: Monterey, Calif. to Ensenada, Baja California (Burch, 1946).

Range: Middle Miocene to Holocene.

Localities: Upper part of Olcese Sand, USGS M1596 cf., M1597, M1599, M1602; UCMP B1599, B1624. Round Mountain Silt, USGS 3886, cf. 6063, ?6067, 6622, 6623, 6641, M1603, cf. M1606, M1612, M1613, M1696; UCMP B1617?.

Neverita (Glossaulax) jamesae Moore

Plate 6, figures 8, 10

Neverita (Glossaulax) jamesae Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 28–29, pl. 2, figs. 5, 15, 19.

Polinices vancouverensis Clark and Arnold, Durham, 1944, California Univ., Dept. Geol. Sci. Bull., v. 27, no. 5, p. 160.

Type: U.S. Natl. Mus. 563129.

Type locality: About 17 feet above base of section exposed in big headland in beach cliff about 600 yards north of Spencer Creek, Lincoln County, Oreg. Astoria Formation, middle Miocene.

Specimens referred to *N. jamesae* are characterized by a thick, bilobed umbilical callus and a broad umbilical area. The callus groove is oriented at right angles to the axis of the shell, whereas in the other species of *Neverita* from the Kern River area it is hooked in an anterior direction, making an acute angle with the shell axis. Immature shells are difficult to differentiate from other Miocene species in this area, but larger specimens are easily separable from *N. andersoni* and *N. alta* by their incomplete umbilical callus and the low conical outline. *N. alta* Dall is similar to *N. jamesae* but differs by having an enlarged posterior lobe of the umbilical callus and a relatively high, conical outline.

Two specimens identified by Durham (1944, p. 160) as *Polinices vancouverensis* Clark and Arnold from the *Echinophoria apta* zone of upper part of the Twin River Formation (UCMP loc. A3709) in northwestern Washington are identical to this species. Although poorly preserved, both have the characteristic shape and small, grooved umbilical callus pad of *N. jamesae.*

Distribution and stratigraphic occurrence: Lower Miocene(?): Upper part of the Twin River Formation, northwestern Washington (Durham, 1944 [as *Polinices vancouverensis* Clark and Arnold]. Middle Miocene: Astoria Formation, coastal Oregon (Moore, 1963).

Range: Lower Miocene(?) to middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597, M1599, M1600, cf. M1601, cf. M1602; UCMP B1621 cf. Lower part of Round Mountain Silt, USGS 6641?, M1604, M1606, M1612, M1613, M1696, cf. M2480. Olcese Sand or Round Mountain Silt, UCMP 2713.

Neverita (Glossaulax) n. sp.?

Plate 6, figures 1, 9

Of medium size, moderately high spired. Body whorl globular, deeply umbilicate. Umbilical callus narrow, margin incised by subhorizontal notch.

Height 18.8 mm, width 16.2 mm (figured specimen, pl. 6, fig. 9).

Figured specimen: California Univ. Mus. Paleontology 15492.

Locality: UCMP B1638, east side of gully about 25 feet above base and 20 feet stratigraphically above B1637, 1,300 feet north, 1,450 feet east of SW. cor. sec. 6, T. 29 S., R. 30 E. Oil Center quadrangle. Lower part of Round Mountain Silt, middle Miocene.

This deeply umbilicate *Neverita* is distinct from named species that occur in the Kern River area and appears to be undescribed. Specimens from four localities in the upper part of the Olcese Sand and lower part of the Round Mountain Silt have a uniformly narrow, characteristically notched umbilical callus.

Neverita jamesae, a similar but low-spired species that occurs in the Kern River area, has a flattened body whorl, broad umbilical opening, and much larger, swollen umbilical callus. Specimens of *N. reclusiana* and *N. alta* that have an open, or partly open, umbilicus have a relatively broader umbilical callus. The upper lobe of their callus extends much farther anteriorly than the posterior one, whereas on *N.* n. sp.? the lobes are more nearly equally developed.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597. Lower part of Round Mountain Silt, USGS locs. 6622, M1612; UCMP loc. B1638.

Subfamily SININAE

Genus SINUM Röding, 1798

Type (by subsequent designation, Dall, 1915): *Helix haliotoidea* Linné (cited by Roding as Gmelin). Holocene, western Pacific(?).

Sigaretus Lamarck is a synonym of this genus. Apparently there is some uncertainty as to the provenance of the type species; Woodring (1928, p. 389) cited "western Pacific?," which is used above, and Olsson and Harbison (1953, p. 271) West Africa.

Sacco (1891a, p. 97–104, pl. 1) recognized three subgenera under *Sigaretus* (= *Sinum* of this paper), *Sigaretotrema* for greatly inflated forms, *Cryptostoma* Blainville for flattened forms, and *Sigaretus* s.s. for apparently intermediate forms. As observed by Cossmann (1924, p. 143), the type of *Sigaretus* [and of *Sinum*], *Helix haliotoidea*, is a greatly flattened shell. This fact makes *Cryptostoma* a junior synonym. Although it is possible to classify greatly flattened species under *Sinum* s.s. and inflated or globose species as *Sigaretotrema*, the problem of properly allocating species with shells of intermediate inflation, such as *Sinum scopulosum*, casts some doubt on the usefulness of these subgenera as presently defined.

Sinum scopulosum (Conrad)

Plate 6, figures 5–7, 11

Sigaretus scopulosus Conrad, 1849, U.S. Exploring Exped., Geol., app. 1, p. 727, pl. 19, figs. 6, 6a [not figs. 6b, c, d, fide Moore, 1963, p. 29–30].

Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, no. 1, p. 203–204, pl. 16, figs. 72, 73.

?Reagan, 1909, Kansas Acad. Sci. Trans., v. 22, p. 194–195, pl. 3, fig. 30.

Arnold, 1909, U.S. Geol. Survey Bull. 396, p. 154, pl. 24, fig. 1.

Arnold and Anderson, 1910, U.S. Geol. Survey Bull. 398, p. 326, pl. 46, fig. 1.
Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100.
Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 43.
Sinum scopulosum (Conrad), Dall, 1909, U.S. Geol. Survey Prof. Paper 59, p. 91–92, pl. 4, fig. 10; pl. 5, fig. 8.
Clark, 1918, California Univ., Dept. Geology Bull., v. 11, no. 2, p. 169–170.
Stewart, 1927, Acad. Nat. Sci. Philadelphia Proc., v. 78, p. 327–328, pl. 32, fig. 4.
Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 95–96, pl. 12, fig. 13.
Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 270, pl. 63, figs. 1a, b, 3a, b.
Schenck and Keen, 1940, California fossils for the field geologist, pl. 35, fig. 3 [reprinted in 1950 issue].
Weaver, 1942, Washington Univ. (Seattle) Pubs. Geol., v. 5, p. 349–350, pl. 71, figs. 12, 14, 17, 18.
Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.
Woodring and Bramlette, 1950, U.S. Geol. Survey Prof. Paper 222, p. 73, pl. 12, fig. 5.
Morris, 1952, A field guide to shells of the Pacific coast and Hawaii, p. 95, pl. 24, fig. 17.
Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 29–31, pl. 1. figs. 2, 3; pl. 2, figs. 20, 21.
Morris, 1966, A field guide to shells of the Pacific coast and Hawaii * * *, p. 79, pl. 35, fig. 9.
?*Sinum scopulosum*? Conrad, Tegland, 1933, California Univ., Dept. Geol. Sci. Bull., v. 23, no. 3, p. 140, pl. 14, fig. 23.
Sinum planicostum Gabb, 1869, Paleontology of California, v. 2, p. 49, pl. 14, fig. 6 [refigured by Stewart, 1927, Acad. Nat. Sci. Philadelphia Proc., v. 78, p. 327–328, pl. 32, fig. 4 as *Sinum scopulosum* (Conrad)].
Sinum californicum Oldroyd, 1917, Nautilus, v. 31, p. 13.
Oldroyd, 1927, Stanford Univ. Pubs. Geol. Sci., v. 2, pt. 3, 131–132, pl. 92, figs. 13, 14.

Lectotype: U.S. Natl. Mus. 3553 (designated by Moore, 1963, p. 29).

Type locality: Astoria, Oreg. [presumably from the Astoria Formation].

Type of *Sinum planicostum* Gabb: Acad. Nat. Sci. Philadelphia 4326.

Type locality: "Pliocene, San Fernando" (Stewart, 1927, p. 328) [Pico Formation, Ventura basin, California].

Type of *Sinum californicum* Oldroyd: Stanford Univ. paleontology type colln. 6446.

Type locality: San Pedro, Calif., Holocene.

This species is rare in Miocene rocks of the Kern River area. A few specimens are in the collections from the upper part of the Olcese Sand and the lower part of the Round Mountain Silt. Loel and Corey (1932) reported *Sinum scopulosum* from a lower Miocene locality northwest of Pyramid Hill. There is a doubtfully identified specimen in a collection from USGS locality M1699 from the same area. In general the Kern River specimens are smaller and more flattened than the lectotype from the Astoria Formation (Moore, 1963, pl. 1, figs. 2, 3). However, the largest specimens tend to be fairly high spired. This fact suggests that the shells become more inflated in the later stages of growth. Comparison of sculpture is difficult because the lectotype has only a small amount of shell material adhering to the mold. Other specimens from the Astoria Formation of Oregon, however, are sculptured much like the California material. Variation in the width and number of spiral ribs and in the number of interribs is apparent in the material at hand. Irregularity of the ribs and interspaces on specimens of *S. scopulosum* from the Astoria Formation was noted by Moore (1963).

The Holocene *Sinum debile* (Gould), a warm temperate to tropical species that ranges from southern California to Panama, has a small, greatly flattened shell distinct from *S. scopulsoum.*

Sinum obliquum (Gabb), an upper Eocene to Oligocene species from the Pacific coast, is a small, flattened species with fine, rounded spiral ribs.

Distribution and stratigraphic occurrence: Upper Oligocene: Twin River Formation [*Echinophoria rex* zone], northern Olympic Peninsula, Washington (Durham, 1944); type Blakeley Formation of Weaver (1912), Puget Sound, Washington (Tegland, 1933). Lower Miocene(?): Twin River Formation, northern Olympic Peninsula (Arnold and Hannibal, 1913; Durham, 1944 [*Echinophoria apta* zone]); San Ramon Sandstone(Contra Costa County, California (Clark, 1918; Weaver, 1953). Lower Miocene: Vaqueros Formation—northern Santa Lucia Range, La Panza Range, western Santa Ynez Range, Ventura basin (Loel and Corey, 1932); Caliente Range (Eaton and others, 1941). Middle Miocene: Clallam Formation, northern Olympic Peninsula, Washington (Reagan, 1909; Arnold and Hannibal, 1913; Durham, 1944); Astoria Formation—southwestern Washington (Etherington, 1931), coastal Oregon (Conrad, 1849; Moore, 1963); Monterey Shale, Carneros Creek, Napa County, California (Weaver, 1949); Monterey Group, western Contra Costa County (Weaver, 1949); Temblor Formation—Vallecitos area (Schenck and Keen, 1940), Reef Ridge (Stewart, 1946, cf.), La Panza Range (Loel and Corey, 1932); Saltos Shale Member of the Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967); Topanga Formation—Santa Monica Mountains (Susuki, 1951), Santa Ana Mountains (Vedder and Woodring, unpub. data, 1953). Upper Miocene: Montesano Formation of Weaver (1912), southwestern Washington (Weaver, 1916; Etherington, 1931); Santa Margarita Formation—Coalinga area (Nomland, 1917a), Comanche Point (USGS loc. M1619); Castaic Formation of Crowell (1955), eastern Ventura basin (Stanton, 1966, 1967). Pliocene: Empire Formation, southwestern Oregon (Dall, 1909; Weaver, 1942, 1945); Pancho Rico Formation, Salinas Valley (Durham and Addicott, 1965); Etchegoin Formation, Coalinga area (Nomland, 1917b); Careaga Sandstone, Santa Maria basin (Woodring and Bramlette, 1950); Pico Formation, eastern Ventura basin (Kew, 1924; Grant and Gale, 1931; Woodring and others in Winterer and Durham, 1962); Fernando Formation, Puente Hills (Vedder in Durham and Yerkes, 1964, cf.). Lower Pleistocene: lower San Pedro "Series," San Pedro (Oldroyd, 1925). Upper Pleistocene: terrace deposits, western Los Angeles basin (Willett, 1937; Valentine, 1956); Palos Verdes Sand, Newport Bay area (Kanakoff and Emerson, 1959). Holocene: Monterey Bay, California to Todos Santos Bay, Baja California (Abbott, 1954).

Range: Upper Oligocene to Holocene.

Localities: Jewett Sand, USGS M1699. Upper part of Olcese Sand, USGS M1597, M1602. Lower part of Round Mountain Silt, USGS 6065, 6622, 6623, M2480; UCMP B1637, B1638.

Family CYMATIIDAE

Genus CYMATIUM Röding, 1798

Type (by subsequent designation, Dall, 1904): *Cymatium femorale* Linné. Holocene, West Indies.

Cymatium n. sp.

Plate 6, figure 12

Of medium size, with six rapidly enlarging whorls. Whorls of spire bulbous, indistinctly angulated near midpoint. Penultimate whorl sculptured by about 16 spiral cords of varying strength and about 10 irregularly spaced axial folds which are well developed near midpoint of whorl but weaken near sutures. Body whorl large and rugose and sculptured by irregularly distributed spiral cords of primary to tertiary strength and irregular randomly spaced varices that become obsolete near the base. Surface of varices nodose where crossed by primary spiral cords. Aperture oval.

Height (incomplete) 37 mm, width (nearly complete) 25.5 mm.

Figured specimen: California Acad. Sci. 12932.

Locality: CAS 2064 (= CAS 65), on west bank of small canyon 1¼ miles northeast of Barker's ranchhouse. Probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle. Upper part of Olcese Sand, middle Miocene.

Although represented by an incomplete considerably worn specimen, this cymatiid seems distinct from the known Tertiary species of western North America. The only other occurrence of *Cymatium* in the California Miocene is an unrecorded species collected from the lower Miocene Vaqueros Formation in the Felton quadrangle, Santa Cruz Mountains, by Joseph C. Clark.

"*Gyrineum*" sp. (Moore, 1963, pl. 5, fig. 21), a specimen from the Astoria Formation of Oregon, which is nearly devoid of shell material, resembles *Cymatium* n. sp. in size, profile, and sculpture as far as can be determined from the small areas of remaining shell material. The smooth internal mold, however, suggests that the Oregon specimen may well be a *Mediargo* related to *M. dilleri* as implied by Moore.

Occurrence: Upper part of Olcese Sand, CAS loc. 2064.

Genus MEDIARGO Terry, 1968

Type (by original designation): *Gyrineum mediocre* Dall. Pliocene, Pacific Coast States.

Moore (1963, p. 32) first observed that Anderson and Martin's *Argobuccinum dilleri* (1914) could not be satisfactorily assigned to described cymatiid genera and further noted its probable generic relationship to *G. mediocre* Dall (1909). Subsequently, Terry (1968) erected *Mediargo* to include *M. mediocris* and *M. mathewsoni*, Pacific coast cymatiids characterized by two more or less continuous varices, tabulate whorls, fine columellar plications, and, in immature individuals, a denticulate outer lip. The genus is here extended to include *M. dilleri*, a middle Miocene species that is difficult to distinguish from the ancestral early Miocene species *M. mathewsoni.*

Mediargo dilleri (Anderson and Martin)

Plate 6, figures 13, 15, 17, 18; plate 7, figure 11

Argobuccinum dilleri Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 5, p. 71–72, pl. 4, fig. 7.

Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 420, pl. 83, fig. 6.

"*Gyrineum*" *dilleri* (Anderson and Martin), Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 31—32, pl. 2, figs. 8, 9.

Type: California Acad. Sci. 152.

Type locality: CAS 35, sea cliff a little south of the mouth of Wade Creek about 6 miles north of Yaquina Bay, Lincoln County, Oreg. (Moore, 1963). Astoria Formation, middle Miocene.

Mediargo dilleri (Anderson and Martin) has not been previously reported from Miocene strata in California. However, "*Argobuccinum* n. sp. (large)," listed by Loel and Corey (1932, p. 171) from an unspecified locality in the Temblor Formation of the La Panza Range, could be this species.

There is considerable variation in the spiral sculpture of specimens from the upper part of the Olcese Sand. Most of the specimens have strong primary spiral ribs on the body whorl that are usually, but not always, split by a medial spiral groove; all have three riblets in the interspaces. In general the primary sculpture is decidedly stronger than on specimens from the Astoria Formation of northwestern Oregon but specimens from UCMP locality B1622 and CAS locality 65 have weakly developed split primary ribs very similar to those of the type specimen.

This species can be consistently differentiated from the ancestral early Miocene species from the Jewett Sand, *Mediargo mathewsoni* (Gabb), by the development of three riblets in the interspaces between the primary spirals.

Distribution and stratigraphic occurrence: Middle Miocene: Astoria Formation, coastal Oregon (Anderson and Martin, 1914; Moore, 1963).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597, M1602; UCMP B1622; CAS 65.

Mediargo mathewsoni (Gabb)

Plate 6, figures 2–4

Ranella mathewsoni Gabb, 1866, Paleontology of California, v. 2, p. 8, pl. 2, fig. 13.

Bursa mathewsonii (Gabb), Clark, 1918, California Univ., Dept. Geology Bull., v. 11, no. 2, p. 173, pl. 20, figs. 1, 2.
"*Bursa*" cf. *B. matthewsonii* [(Gabb)], Schenck and Keen, 1940, California fossils for the field geologist, pl. 35, fig. 1.
Argobuccinum cf. *mathewsoni*? (Gabb), Tegland, 1933, California Univ., Dept. Geol. Sci. Bull., v. 23, no. 3, p. 134–135, pl. 13, figs. 12–14.
?*Bursa vancouverensis* Clark and Arnold, 1923, California Univ., Dept. Geol. Sci. Bull., v. 14, no. 5, p. 163, pl. 37, figs. 1a, b, 2a, b.
?*Argobuccinum vancouverense* (Clark and Arnold), Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 421, pl. 83, figs. 8, 12.

Type: Apparently lost (Stewart, 1927, p. 291).

Type locality: Miocene south of Martinez, Contra Costa County, Calif.

Types of *Bursa vancouverensis* Clark and Arnold: Holotype, California Acad. Sci. 578; paratype, Stanford Univ. paleontology type colln. 284 [not California Univ. Mus. Paleontology 30081 as indicated by Clark and Arnold].

Type locality: SU NP–129, sandstone and conglomerate of the Sooke Formation in sea cliffs between mouths of Muir and Kirby Creeks, west of Otter Point, Sooke, Vancouver Island, British Columbia.

Although the type material of "*Ranella*" *mathewsoni* is lost (Stewart, 1927), it seems probable that Clark's *B. mathewsoni* (Gabb) (1918, p. 173, pl. 20, figs. 1, 2) from the lower Miocene(?) San Ramon Sandstone of Contra Costa County may represent Gabb's doubtful species. The only similar Miocene cymatiid known to occur in this area, "*Bursa*" *trampasensis* Clark (1915, p. 492, pl. 67, fig. 3) from the lower part of the upper Miocene San Pablo Group, has weak spiral ribbing that seems distinct from Gabb's description (1866, p. 8) of square-topped ribs and flat interspaces carrying a fine riblet.

Mediargo mathewsoni is fairly abundant in the basal conglomeratic sand of the Jewett Sand. Unfortunately, nearly all of the specimens are encrusted with gypsum and could not be photographed satisfactorily, although the general sculptural features are reasonably clear. They are characterized by coarsely noded whorls with paired varices that tend to ascend the spire in a nearly straight line. There is a nodose subsutural tabulation on many of the specimens. The spiral sculpture of the penultimate and body whorls compares favorably with the specimens from the San Ramon Sandstone figured by Clark (1918), but the details of secondary spiral sculpture are not clearly preserved. One well preserved, but decorticated, specimen from the basal part of the Jewett Sand (pl. 6, figs. 3, 4) has flat spiral ribs that are split by a medial groove and a well-developed secondary spiral riblet in the interspaces. This specimen also has a strongly tabulate suture. Perhaps these features may be accentuated because of the exfoliation of the outermost shell layers. At all events this specimen suggests an ancestral relationship to specimens from the upper part of the Olcese Sand that are identified as *M. dilleri* (Anderson and Martin). The principal differences between the two are the more strongly split primary ribs and the development of three riblets in the interspaces of *M. dilleri.* These characteristics are best shown by fragmentary specimens from UCMP locality B1622.

Mediargo vancouverensis (Clark and Arnold, 1923) is very similar to *M. mathewsoni*, as noted in the original description. The principal difference between the two species is the absence of varices on the whorls of the spire of *M. vancouverensis*, although the body whorl has a strong varix behind the apertural lip and a faint one on the opposite side. Possibly this is a variable characteristic, but as it stands there are insufficient specimens of *M. vancouverensis* to bear this out. Accordingly, it is doubtfully included as a synomyn of *M. mathewsoni.*

Distribution and stratigraphic occurrence: Upper Oligocene: Blakeley Formation of Weaver (1912), Puget Sound, Washington (Tegland, 1933). Lower Miocene(?): Sooke Formation, Vancouver Island, British Columbia (Clark and Arnold, 1923); San Ramon Sandstone, Contra Costa County, California (Clark, 1918). Middle Miocene: Temblor Formation, Griswold Hills, Vallecitos area, California (Schenck and Keen, 1940, cf.).

Range: Upper Oligocene to lower Miocene and possibly middle Miocene.

Localities: Basal part of Jewett Sand, USGS 6638 cf., M1591; UCMP B1665.

Family FICIDAE

Genus FICUS Röding, 1798

Type (by tautonymy): *Bulla ficus* Gmelin (originally cited in synonymy of *F. variegata* Röding and *F. communis* Röding). Recent, western Pacific.

Subgenus TROPHOSYCON Cooper, 1894

Type (by monotypy): *Agasoma*? (*Trophosycon*) *kernianum* Cooper. Miocene, Kern River area, California.

Ficus (Trophosycon) kerniana (Cooper)

Plate 6, figures 14, 16; plate 7, figures 3–5, 8, 14, 17

Unnamed molds, Conrad, 1857, U.S. 33d Cong., 2d sess, Senate Ex. Doc. 78, app. art. 2, pl. 7, figs. 64, 64a, 65, 65a [not figs. 72, 72a (*Sycotopus ocoyanus* Conrad)].
Ficus nodiferus Gabb, 1866, Geol. Survey California, Paleontology, v. 2, p. 48, pl. 14, fig. 5. [Not *Pyrula nodifera* Binkhorst, 1861, Mon. Gast. Ceph. Craie Sup. Limbourg, p. 67, pl. 3, fig. 11 (Stewart, 1927, p. 343)].
Trophosycon nodiferum (Gabb), English, 1914, California Univ., Dept. Geology Bull., v. 8, no. 10, p. 247–248, pl. 25, figs. 2, 4.
Agasoma? (*Trophosycon*) *kernianum* Cooper, 1894, California Mining Bur. Bull. 4, p. 53–54, pl. 3, fig. 52 [not pl. 5, fig. 63 as stated in plate explanation].

Agasoma kernianum Cooper, Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 188.

Arnold, 1908, U.S. Natl. Mus. Proc., v. 34, pl. 34, fig. 2.

Branner, Newsom, and Arnold, 1909, U.S. Geol. Survey Geol. Atlas, Santa Cruz Folio 163, p. 4, illus. sheet 2, fig. 40.

Anderson, 1911, Calif. Acad. Science Proc., ser. 4, v. 3, p. 100, 101.

McLaughlin and Waring, 1914, California Mining Bur. Bull. 69, map folio (separate), fig. 30.

Trophosycon kernianum Cooper, English, 1914, California Univ., Dept. Geology Bull., v. 8, no. 10, p. 248–249, pl. 24, figs. 4–6.

Hanna and Hertlein, 1943, California Div. Mines Bull. 118, p. 174, fig. 63–21.

Ficus kernianus (Cooper), Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 43.

Agasoma stanfordensis Arnold, 1908, U.S. Natl. Mus., Proc., v. 34, p. 384–385, pl. 35, fig. 5.

Branner, Newsom, and Arnold, 1909, U.S. Geol. Survey Geol. Atlas, Santa Cruz Folio 163, p. 6, illus. sheet 2, fig. 54.

Trophosycon stanfordense (Arnold), English, 1914, California Univ., Dept. Geology Bull., v. 8, no. 10, p. 249–250, pl. 24, figs. 2, 3.

Ficus (*Trophosycon*) *oregonensis* (Conrad), Stewart, 1927, Acad. Nat. Sci. Philadelphia Proc., v. 78, p. 373–375 [in part], pl. 31, figs. 8, 8a.

Ficus (*Trophosycon*) *ocoyanus* (Conrad), Clark, 1929, Statigraphy and faunal horizons of the Coast Ranges of California, pl. 27, fig. 4.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 251, pl. 48, fig. 13.

Ficus (*Trophosycon*) *ocoyana* (Conrad), Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 743–746, pl. 30, figs. 3, 8a, b, 11.

Lutz, 1951, California Univ., Dept. Geol. Sci. Bull., v. 28, no. 13, p. 391, pl. 18, figs. 7, 9, 10, 13.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

Trophosycon ocoyana (Conrad), Schenck and Keen, 1940, California fossils for the field geologist, p. 70, pl. 35, fig. 4.

Trophosycon ocoyanum (Conrad), Shimer and Shrock, 1944, Index fossils of North America, p. 500, pl. 205, figs. 9–11.

Trophosycon cf. *T. ocoyanum* (Conrad), Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 33, pl. 3, figs. 14–16.

Ficus (*Trophosycon*) *ocoyana* (Conrad) var. *contignata* Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 749, pl. 29, figs. 1a, b; pl. 30, figs. 1, 2, 4, 9a, b.

Ficus (*Trophosycon*) *ocoyana* (Conrad) var. *ruginodosa* Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 746, 748, pl. 29, figs. 2, 2a; pl. 30, figs. 5, 10a, b.

Ficus (*Trophosycon*) *ocoyana* (Conrad) cf. *clallamensis* Weaver, Grant, and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, pl. 30, fig. 7.

?*Ficus* (*Trophosycon*) *clallamensis* Weaver var. *nodibulbosa* Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 751, pl. 30, figs. 6, 6a.

Type: Probably destroyed in San Francisco Fire of 1906 (Keen and Bentson, 1944, p. 126).

Type locality: Kern County, presumably from upper part of Olcese Sand in vicinity of Barker's Ranch.

Neotype (here designated): California Acad. Sci. 5717, figured by Hanna and Hertlein (1943, fig. 63–21).

Neotype locality: CAS loc. 64, in small gulch about 1¼ miles northeast of Barker's Ranchhouse.

Type of *Ficus nodiferus* Gabb: Harvard Univ. Mus. Comp. Zoology, 27824.

Type locality: Uncertain, either Temblor Formation, "the Miocene at Griswold's between San Juan and New Idria" [Griswold Hills], San Benito County, or from the Pliocene at San Fernando Pass, Los Angeles County. Stewart (1927, p. 374) reasoned that the neotype was from the Temblor Formation because the specimen which Gabb did not figure was from the Los Angeles County Pliocene locality on the basis of associated matrix. Grant and Gale (1931, p. 747–748), however, presented equally good if not more convincing arguments that the type was from the San Fernando Pass area.

Type of *Agasoma stanfordensis* Arnold: Stanford Univ. paleontology type colln. 425.

Type locality: SU C304, in ravine beside county road, 2½ miles south of Mayfield, Santa Clara County, Calif. Miocene above the basalt flow (Arnold, 1908) [middle Miocene].

Type of *Ficus* (*Trophosycon*) *ocoyana* var. *contignata* Grant and Gale: San Diego Soc. Nat. History 4.

Type locality: Hill slope on northwest bank of Elsmere Canyon below big waterfall, SE¼NW¼ sec. 8, T. 3 N., R. 15 W. Los Angeles County, Calif. Lower Pliocene.

Type of *Ficus* (*Trophosycon*) *ocoyana* var. *ruginodosa* Grant and Gale: San Diego Soc. Nat. History 3.

Type locality: Elsmere Canyon, below forks and on north side, SW¼NW¼ sec. 8, T. 3 N., R. 15 W., Los Angeles County, Calif. Lower Pliocene.

Ficus kerniana is one of the most abundant and characteristic species found in the upper part of the Olcese Sand and the Round Mountain Silt. It ranges throughout the marine Miocene strata of the Kern River district but occurs infrequently in the lower part of the Olcese Sand and the Jewett Sand. There is a wide range of variation in this species. At one extreme is a weakly noded, rounded form with only an upper row of nodes on the body whorl (pl. 7, fig. 14). At the other is an elegant, coarsely sculptured form with spinose nodes. Grant and Gale (1931, p. 743–751) synonymized several species and added two newly named varieties under Conrad's "*Sycotopus*" *ocoyanus* (1855), a name here considered to be invalid, as will be shown subsequently. Their broad basis for this species seems reasonable in the light of the great morphologic variation of specimens from localities in the upper Olcese Sand along the Kern River, the same area and stratigraphic interval from which the type specimen of *Ficus kerniana* (Cooper) was probably obtained.

Conrad's "*Sycotopus*" [*Sycotypus*] *ocoyana* (Conrad, 1855, p. 19; 1857, pl. 7, figs. 72, 72a) is neither *Trophosycon* nor *Ficus*. The drawing of the type specimen, an internal cast devoid of shell material presumed to be lost, is of a slender gastropod with a narrow, elongate aperture. It is probably *Oliva californica* Anderson, a commonly occurring species in the upper part of the Olcese Sand. Internal casts of *O. californica*, prepared by removing the shell material from specimens collected from hard sandstone, show the very close resemblance of *O. californica* to the type of *Sycotypus ocoyana* but are clearly distinct from internal casts of *F. kerniana*. Conrad (1857) did figure the characteristic noded internal molds of *Ficus* (*Trophosycon*) (pl. 7, figs. 64, 64a, 65, 65a) but these were unnamed and presumably were considered different from his *Sycotypus ocoyana*. In naming *Agasoma? kernianum*, Cooper stated (1894, p. 54) "Figs. 72 and 72a, which he [Conrad] named '*Syctopus ocoyanus*,' may represent a cast of young shell, but it is too uncertain a name to be retained."

The nomenclatural history of this species is long and complicated. This species was generally known as *Ficus* (*Trophosycon*) *kerniana* from the time of Cooper's original description until about 1930, when Clark (1929) and Grant and Gale (1931) resurrected Conrad's species, *F. ocoyana*. Grant and Gale (1931, p. 745–746), apparently not noting the long narrow aperture suggested by Conrad's drawing of *Sycotypus ocoyanus*, believed that the figure could be satisfactorily recognized as *Ficus* (*Trophosycon*) on the basis of the incurved columella and double angulations of the body whorl suggested by the internal mold. By a process of elimination, they reasoned that Conrad's species must be a valid prior name for *F. kerniana* and, with some reluctance, concluded that *F. kerniana* should be placed in the synonymy of *F. ocoyana*.

Somewhat earlier Stewart (1927, p. 373–375) placed *Ficus kerniana*, *F. nodifera*, and *F. stanfordensis* in the synonymy of *F.* (*Trophosycon*) *oregonensis* (Conrad, 1848, p. 433) in the belief that the type figure of Conrad's "*Fusus*" *oregonensis* was a *Ficus* and was conspecific with the California species, a notion originated by Dall (1909, p. 75). Apparently, Howe (1926, p. 304) first recognized that "*Fusus*" *oregonensis* Conrad was not a *Ficus*-like species and placed the species in *Agasoma*. Later workers in the Tertiary of Oregon and Washington have placed this species in *Bruclarkia*. The only documentation of Conrad's species is a poor line drawing (reprinted in Dall, 1909, p. 150, fig. 13) of a form that looks somewhat similar to *F. kerniana* but, because of the apparent sutural collar, seems better referred to *Bruclarkia*. Stewart (1927, p. 374) indicated that should the California species prove to be different from "*F.*" *oregonensis*, Gabb's (1866, p. 48) *F. nodifera* would be the name applicable to it. However, this species name is preoccupied under *Ficus* by *Pyrula nodifera* Binkhorst. This fact leaves *Ficus kerniana* Cooper as the next available name.

The large Pliocene varieties described by Grant and Gale (1931) as *Ficus ocoyana* var. *ruginodosa* and *F. ocoyana* var. *contignata* are more strongly sculptured than some of the specimens of *F. kerniana* from the Olcese Sand. Yet their status as forms of *F. kerniana* seems to be confirmed by the occurrence of comparably spinose or strongly nodose specimens in collections from the Kern River district. The type of *F. ocoyana* var. *ruginodosa* characterized by three strong spiral ribs near the lower angulation on the body whorl appears to be the more distinct of the two varieties. It is not clearly represented in material collected from the upper Olcese Sand, but some early Miocene specimens from Pyramid Hill have strong primary spirals on the lower part of the body whorl similar to the Pliocene form. There are, however, many specimens from the upper part of the Olcese Sand with doubly nodose angulations and a few specimens with three rows of nodes on the lower angulation. Although smaller than the type of *F. kerniana* var. *contignata*, these individuals are almost as strongly nodose.

The bulbous northern species *Ficus clallamensis* Weaver (1912, p. 74, pl. 9, fig. 73) from the middle Miocene Clallam Formation of the northern Olympic Peninsula, Wash., is represented by an internal mold that bears some resemblance to *F. kerniana* according to Grant and Gale (1931, p. 750). However, the extreme breadth of the upper part of the body whorl and the weak, vertically elongate nodes restricted to the upper angulation of the body whorl suggest that this might be a different species.

Grant and Gale's *Trophosycon clallamensis nodibulosa* (1931, p. 751, pl. 30, fig. 6a, 6b) differs from *Ficus kerniana* by having a straight, relatively noncurved columella and uniform fine spiral sculpture. The lower set of nodes seems to occur at a much lower position than on specimens of *F. kerniana* from the Kern River area. It may be the same as *F. rodeoensis* English (1914, p. 246–247, pl. 24, fig. 1) according to Grant and Gale (1931).

Several forms of *F. kerniana* could be recognized in the stratigraphic interval encompassing the type locality on the basis of strength and numbers of nodes on the body whorl. Other characters, such as curvature of the columella, height of the spire, and regular development of primary through quaternary spiral ribs are fairly uniform. The most weakly sculptured specimens carry a single row of pointed nodes on the upper angulation and none on the indistinct lower angulation, at least on the last half-revolution of the whorl (pl. 7, fig. 14). The opposite extreme is a strongly noded form with two rows of nodes on the upper angulation and three on the lower. This form is comparable to Grant and Gale's var. *contignata* (1931). The most common form is one with a single row of nodes on the upper angulation and a double row on the lower. Lower Miocene specimens from the basal part of the Jewett Sand at Pyramid Hill attain a much larger adult size (as much as 90 mm), have stronger primary spirals, and are less strongly nodose than middle Miocene specimens. They are similar to Grant and Gale's var. *ruginodosa* (1931, p. 746, 748). Moore's large specimen of *Trophosycon* cf. *T. ocoyanum* from the Astoria Formation of coastal Oregon (1963, pl. 3, fig. 15) closely resembles some of the large forms from Pyramid Hill.

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation—Santa Cruz Mountains (Arnold, 1906, 1908), northern and southern Santa Lucia Range (Loel and Corey, 1932), Caliente Range (Eaton and others, 1941; Repenning and Vedder, 1961), western Santa Ynez Range, Ventura Basin, Channel Islands, western Santa Monica Mountains (Loel and Corey, 1932). Middle Miocene: "Monterey Formation," northern Olympic Peninsula (Arnold and Hannibal, 1913); Astoria Formation, coastal Oregon (Moore, 1963), Sobrante Sandstone, Contra Costa County, California (Lutz, 1951); Monterey Shale—western Napa County (Weaver, 1949), type area near Monterey (Arnold and Hannibal, 1913), Caliente Range (Repenning and Vedder, 1961); Monterey Formation, Nipomo quadrangle, San Luis Obispo County (Hall and Corbato, 1967); unnamed sandstone of Dibblee (1966b), Stanford University lands (SU loc. SLAC 85–10); Temblor Formation—Vallecitos area (Schenck and Keen, 1940), Cantua Creek (Anderson, 1908), Coalinga district (Arnold, 1909; Woodring and others, 1940), Reef Ridge (Stewart, 1946), La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932), Caliente Range (Eaton and others, 1941); unnamed middle Miocene formation, Caliente Range (Dougherty, 1940); Twisselmann Sandstone Member of the Monterey Formation of Heikkila and MacLeod (1951), northern Temblor Range: "Vaqueros" Formation of Hoots (1930), Tejon Hills (Addicott, 1965a); Topanga Formation—Santa Mountains (Eldridge and Arnold, 1907, cf.), San Joaquin Hills (Loel and Corey, 1932), Santa Ana Mountains (English, 1926, cf.; Loel and Corey, 1932). Upper Miocene: Reef Ridge Shale, Kettleman Hills oil field (Barbat and Johnson, 1934); Santa Margarita Formation, Fruitvale oil field (Gale in Preston, 1931); Castaic Formation of Crowell (1955), eastern Ventura basin (Stanton, 1966, 1967); Modelo Formation, Ventura County (Hudson and Craig, 1928). Pliocene: Jacalitos Formation, Coalinga area (Nomland, 1917b); Pico Formation, eastern Ventura basin (Kew, 1924; Grant and Gale, 1931); San Diego Formation, San Diego area (Grant and Gale, 1931).

Range: Lower Miocene to Pliocene.

Localities: Jewett Sand, USGS 6638, M1591, M1592; UCMP B1660, B1665, B1668. Lower part of Olcese Sand, USGS M1593, M1594; UCMP B1646. Middle part of Olcese Sand, USGS M1698. Upper part of Olcese Sand, USGS 6890, M1597, M1598, M1601, M1602, M1698; UCMP B1586, B1587, B1693, B1694, B1596–B1599, B1601, B1614, B1616, B1621–B1624, B1641, B1753. Round Mountain Silt, USGS 3886, 6064, 6065, 6068, 6611, 6613, 6621–6623, 6625, 6641, 18724, M1604, cf. M1606, M1608, M1609, ?M1611, M1612, M1613, M1696; UCMP B1611, B1618, B1619, B1633, B1637, B1638, B1678.

Order NEOGASTROPODA
Family MURICIDAE

Genus CERATOSTOMA Herrmansenn, 1846

Type (by monotypy): *Murex* (*Cerostoma*) *nuttalli* Conrad, 1837. Holocene, central California to Magdalena Bay, Baja California.

Ceratostoma? aff. C. perponderosum (Dall)

Plate 7, figure 19

A single worn specimen of a large, thick-shelled muricid with three massive varices per whorl has been collected from the basal part of the Jewett Sand at Pyramid Hill. The varices are bordered anteriorly by a strongly incised wavy line. Although the body whorl is worn nearly smooth, areas of very faint broad spiral ribbing are preserved posterior to the varices. The large aperture is nearly one-half the length of the shell. The anterior canal is apparently short and nearly closed.

Although this large gastropod seems to be a *Ceratostoma* because of the large aperture and apparently anterior canal, it is here tentatively referred to the genus because the anterior part of the outer apertural lip is missing. It is represented by an abraded incomplete specimen from the basal part of the Jewett Sand at Pyramid Hill. The rounded varices may have originally been strongly produced or bladelike. The irregular segments of the incised lines boardering the varices anteriorly on the body whorl suggest that the surface originally had moderately developed spiral ribbing.

Ceratostoma perponderosum (Dall, 1909, p. 46, pl. 2, figs. 2, 5) from the Empire Formation in southwestern Oregon seems to be closely allied to this species. Dall's type is a much more abraded specimen with perhaps stronger spiral ribbing and more massive varices that are continuous from the body whorl onto the spire. Howe (1922, p. 93) suggested that Dall's species might be a synonym of the Holocene *C. foliatum* (Gmelin). Although the specimen is from an unspecified locality in the Empire Formation, the extensively abraded condition of the holotype is consistent with the reworked fossiliferous material in the Coos Conglomerate, a conglomerate within the Empire Formation. In this regard it is noteworthy that early or middle Miocene mollusks have been dredged from the ship's channel near the type section of the Empire Formation (Moore, 1963, p. 13–14) and more recently found in nearby exposures stratigraphically below the Empire Formation (Baldwin, 1966). There would therefore seem to be a definite possibility that *C. perponderosum* might have been reworked from Miocene strata into the Coos Conglomerate, as were the Pliocene mollusks from the overlying basal part of the Empire Formation.

Ceratostoma? aff. *C. perponderosum* has several morphological characters in common with the Holocene *C. nuttalli* (Conrad) and *C. foliatum* (Gmelin). Features such as thick varices, large aperture, and weak spiral sculpture accentuated on the posterior side of the varices suggest a closer relationship with *C. nuttalli*. It differs from the Holocene species, however, by lacking prominent nodes between the varices on the body whorl. There does appear to be, however, a faint swelling between two varices on the body whorl of the poorly preserved early Miocene species. The basal part of the varices of *C. foliatum* is much thinner than on *C*? aff. *C. perponderosum*. Moreover, the aperture is much shorter, only about one-third the length of the shell, and the spiral sculpture is strong.

If properly classified as *Ceratostoma*, this species is the earliest known occurrence of the genus. The first definite occurrence of the genus is in the middle Miocene Oursan Sandstone of central California (Hall, 1959, p. 428, 433). The middle Miocene record is based on *C. delorae* Hall (1958, p. 57, pl. 10, figs. 1–3), a species that has very strong spiral sculpture and which has been assigned to an unnamed taxonomic group of subgeneric rank typified by *C. foliatum* (Hall, 1959, p. 428). *Ceratostoma*? aff. *C. perponderosum* seems to be referable to a second group characterized by *C. nuttalli*. As such, it may represent a much earlier origin for this group than suggested by the previously known Pleistocene to Holocene range.

Occurrence: Basal part of Jewett Sand, USGS loc. M1591.

Genus FORRERIA Jousseaume, 1880

Type (by original designation): *Murex belcheri* Hinds. Holocene, Point Mugu, Ventura County, Calif., to Scammon's Lagoon, Baja California.

Forreria cancellaroides Arnold

Plate 7, figures 6, 7, 10

Trophon (Forreria) gabbianum, F. M. Anderson, Arnold, 1909, *laroides* Arnold, 1909, U.S. Geol. Survey Bull. 396, p. 60, pl. 6, fig. 5.

Arnold and Anderson, 1910, U.S. Geol. Survey Bull 398, pl. 28, fig. 5.

Trophon (Forreria) gabbianum, F. M. Anderson, Arnold, 1909, U.S. Geol. Survey Bull. 396, pl. 5, fig. 5.

Arnold and Anderson, 1910, U.S. Geol. Survey Bull. 398, pl. 27, fig. 5.

Trophon (Forreria) gabbianus Anderson, Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 29, fig. 18.

Trophon (Forreria) gabbianum Anderson, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 174.

Type: U.S. Natl. Mus. 165605.

Type locality: "Reef Beds" in NW¼ sec. 23, T. 25 S., R. 19 E., Kern County, Calif. (Escudo Formation of Vancouvering and Allen, 1943), middle Miocene.

This rather small *Forreria* has been incorrectly identified by most workers since Arnold (1909, pl. 5, fig. 5) figured it as *F. gabbiana* Anderson. Anderson's species is an *Ocenebra* rather than a *Forreria*, although there is a superficial resemblance between the two. Accordingly, the first available name for the spirally sculptured middle Miocene *Forreria* is *F. cancellaroides*, a name originally applied to a spinose form from Wagon Wheel Mountain on the west side of the San Joaquin Valley (Arnold, 1909, p. 60, pl. 6, fig. 5). The typical, less spinose form was also listed from this locality by Arnold (1909, p. 18).

Several specimens of *Forreria cancellaroides* are in the collections from the upper part of the Olcese Sand and the lowest part of the Round Mountain Silt. They indicate a considerable variation in sutural pattern, inclination of the subsutural slope of the body whorl, strength of basal furrow, and strength of spiral sculpture. Most specimens have a clasping suture, tabulate body whorl, and weak spiral sculpture. On some there is a weak spiral furrow below the primary furrow at the basal angulation of the body whorl. Spiral sculpture includes closely spaced alternating primary and secondary ribs discernible between the axial ribs on specimens. The furrow at the basal angulation of the body whorl is poorly developed on some of the smaller specimens, on others it appears to weaken posteriorly. This fact suggests that this character might not be developed on immature specimens. Even so, it can be distinguished from immature *Trophon kernensis medialis* n. subsp. by its much shorter, more strongly recurved anterior canal.

The following distributional list has not been verified by examination of specimens other than those of Arnold (1909) and Arnold and Anderson (1910). Presumably these occurrences refer to Arnold's specimen rather than "*Trophon*" *gabbiana* Anderson (1905) because of classification of many as *Forreria*.

Distribution and stratigraphic occurrence: Lower Miocene: Painted Rock Sandstone Member of the Vaqueros Formation of Hill, Carlson, and Dibblee (1958) Caliente Range, San Luis Obispo County (J. G. Vedder, unpub. data, 1967). Middle Miocene: Monterey Shale, western Napa county (Weaver, 1949); "Vaqueros Formation"—Anticline Ridge and Devil's Den area (Arnold, 1909; Arnold and Anderson, 1910); Temblor Formation—Coalinga area and Reef Ridge (Adegoke, 1967), Caliente Range (Eaton and others, 1941); Topanga Formation, Santa Monica Mountains (Susuki, 1951, cf.).

Range: Lower Miocene to middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597. Lower part of Round Mountain Silt, UCMP B1612.

Forreria emersoni Addicott n. sp.

Plate 7, figures 9, 12, 13, 16

Shell small and slender for genus. Spire short, apex defective. Penultimate whorl of spire ornamented with eight to nine broad axial ribs and a weak spiral rib near the middle of the whorl. Suture impressed, wavy. Poorly defined angulation near posterior one-quarter line of body whorl. Surface sculptured by faint spiral ribs, irregularly spaced axial ribs that are strongest at angulation, and two varices. Basal angulation set off by incised furrow that terminates in a tooth at apertural lip. Aperture elliptical, outer lip thickened. Anterior canal short, slightly twisted to left. Siphonal fasciole well developed.

Height (nearly complete) 29 mm, width 22.2 mm.

Type: U.S. Natl. Mus. 650118.

Type locality: USGS M1591, on north side of westward-trending gully on southwest flank of Pyramid Hill in NW¼ SW¼ sec. 14, T. 28 S., R 29 E. Basal part of Jewett Sand, lower Miocene.

Forreria emersoni from the Jewett Sand and *F. cancellaroides* from the lower Miocene of the Caliente Range, southeastern San Luis Obispo County, are the earliest known occurrences of the genus in the Tertiary of the Pacific coast of North America. *F. emersoni* is much smaller, more slender, and less strongly shouldered than later species of this genus. It differs from the early to middle Miocene species *F. cancellaroides* by having very weak, randomly spaced axial plicae on the body whorl, a narrow body whorl, and very faint spiral sculpture.

This species is extremely variable. Some specimens have a fairly strong angulation and prominent axial ribs on the body whorl. On others the body whorl is well rounded and almost smooth.

Abraded or poorly preserved specimens on which the basal furrow is obscure rather closely resemble the Pliocene species *Thais etchegoinensis* Arnold from the Kettleman Hills area and the smooth Pleistocene and Holocene form of *Thais lamellosa* (Gmelin). However, the axial sculpture of the early whorls of *Forreria emersoni* is usually sufficiently well preserved to permit differentiation.

Stewart (1946, p. 100) lists an undescribed species of *Forreria* from the upper member of the Temblor Formation at Reef Ridge. The specimen has not been examined by the writer.

Occurrence: Basal part of Jewett Sand, USGS loc. M1591; UCMP locs B1665, B1668.

Genus OCENEBRA Gray, 1847

Type (by original designation): *Murex erinaceus* Linné, Holocene, Mediterranean.

Ocenebra wilkesana (Anderson)

Plate 7, figure 15; plate 8, figure 11

Fusus (Hemifusus) wilkesana Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 205, pl. 16, figs. 81, 82.

?*Chicorcus (Murithais) wilkesanus* (Anderson), Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 730, pl. 32, fig. 12.

Hemifusus wilkesanus Loel and Corey, 1932, California Univ., Dept. Geol. Bull., v. 22, no. 3, p. 174.

Ocinebra topangensis Arnold, 1909, U.S. Geol. Survey Bull. 396, p. 18, 124, pl. 9, fig. 4.

Arnold and Anderson, 1910, U.S. Geol. Survey Bull. 398, pl. 31, fig. 4.

?*Purpura* cf. *topangensis* (Arnold) (n. var.?), Loel and Corey, 1932, California Univ., Dept. Pub. Geol. Sci. Bull., v. 27, no. 3, p. 247, pl. 48, figs. 5, 6 [not fig. 4].

Type: California Acad. Sci. 75.

Type locality: Reef beds 9 miles north of Coalinga according to label with holotype. (See Anderson, 1908, p. 19.) Anderson (1905, p. 205) cited the "Temblor Beds" at Kreyenhagen oil wells southeast of Coalinga as the type locality but did not include this species in a subsequent list of fossils from that area (Anderson, 1908, p. 25).

Ocenebra wilkesana (Anderson) has not been reported previously from the Kern River area, specimens possibly having been referred to "*Thais*" *trophonoides* Anderson and Martin. This species is distinguished from *O. trophonoides* by its sharply angulated, spinose whorls. The angulation appears at a much earlier stage of growth than the weak angulation that is developed on some of the larger specimens of *O. trophonoides.*

A small lower Miocene specimen from the basal conglomerate of the Jewett Sand (pl. 8, figs. 1, 2) is doubtfully identified as this species. It has a fairly strong angulation on the body whorl, but its axial ribs become indistinct on the final quarter turn of the body whorl.

Grant and Gale (1931, pl. 32, fig. 12) figured a specimen as *Chicoreus (Murithais) wilkesanus* (Anderson) from a well core of the upper Miocene Santa Margarita Formation near Fruitvale oil field west of Bakersfield. In some respects this specimen is similar to *Ocenebra wilkesana*, but it has an entirely different spire and may represent an unnamed species. The apical angle of their specimen is relatively broad, and the short spire is nearly devoid of the coarse axial plicae characteristic of *O. wilkesana.* This specimen is doubtfully referred to *O. wilkesana.*

The relationship to *Ocenebra topangensis* Arnold is not as clear. A small specimen from the Temblor Formation north of Coalinga figured by Arnold (1909, pl. 9, fig. 4) as *O. topangensis* is referred to *O. wilkesana.* Arnold (1909) recognized that these species were very closely related. Yet the type of *O. topangensis* from the Topanga Formation in the Santa Monica Mountains seems to be separable from *O. wilkesana* on the basis of the strongly tabulate area above the angulation on the body whorl and the frill-like varices. The last character is not reliable when working with worn fossil specimens.

Loel and Corey's observation (1932, p. 247) that many specimens of *O. topangensis* from the type locality show no marked nodes, frills, or angulation of the whorl suggests that either two species are present or there is only one extremely variable species. In the event of the latter, the species would take the name *O. wilkesana*. As such, the frilled form could take the infrasubspecific name *O. wilkesana* forma *topangensis*. Evaluation of the relationship of forms of *O. topangensis* to *O. wilkesana* should take into account collections from the type locality of *O. topangensis* in the Santa Monica Mountains. Because such material is not at hand and because these species can be satisfactorily discriminated in collections from the Kern River Miocene, two species are recognized in this report. Grant and Gale (1931, p. 729) concluded that *O. topangensis* was either a synonym of *wilkesana* or very closely related to that species; Arnold (1909, p. 19) first suggested that these species might be synonymous.

Ocenebra edmondi (Aronld, 1907, p. 530, pl. 40, fig. 33a) from the Topanga Formation of the Santa Monica Mountains differs from *O. wilkesana* by having less strongly impressed sutures on the spire, which produces a relatively smooth, conical outline. The axial scupture of the spire is weaker than in *O. wilkesana*, there being only nodes at the angulation rather than strong ribs that are continuous from suture to suture.

Distribution and stratigraphic occurrence: Middle Miocene: Unnamed Miocene formation, Panoche Hills (Woodring in Stewart and others, 1944, cf.); Temblor Formation—Cantua Creek, Fresno County (Anderson, 1905), Coalinga District (Loel and Corey, 1932; Adegoke, 1967), Reef Ridge (Anderson, 1908; Stewart, 1946, cf.; Adegoke, 1967); Topanga Formation, Santa Monica Mountains(?) (Loel and Corey, 1932); Saltos Shale Member of the Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967). Upper Miocene: Santa Margarita Formation, Fruitvale oil field (Gale in Preston, 1931; Grant and Gale, 1932).

Range: Lower Miocene(?) to upper Miocene.

Localities: Basal part of Jewett Sand, USGS M1591 cf. Upper part of Olcese Sand, USGS M1599, M1601; UCMP B1596 cf., B1597, B1599, B1621.

Ocenebra gabbiana (Anderson)

Plate 7, figures 1, 2

Trophon gabbiana Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 203, pl. 16, figs. 79, 80.

Trophon gabbianus Anderson, Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 81, pl. 5, fig. 1.

Original description.—Shell not large, laminate, spinose on angles; canal short, recurved; spire high, sloping above; body whorl tapering below. The mouth narrows regularly toward the canal. The spines are often considerably suppressed on the angles, and on the lower part of the last whorl there are numerous spiral lines.

Type: California Acad. Sci. 80.

Type locality: Coalinga Beds [Temblor Formation, middle Miocene] of Mount Diablo Range, 9 miles north of Coalinga, Calif., in the S½ sec. 20, T. 19 S., R 15 E. (Keen and Bentson, 1944, p. 205).

A single well-preserved specimen of *Ocenebra gabbiana* (pl. 7, figs. 1, 2) compares very closely with Anderson's holotype. Both have a long, relatively straight subsutural slope terminating in a row of coarse nodes in the anterior half of the penultimate whorl. There are a few faint spiral ribs below the spinose angulation on the body whorl. The Kern River specimen is more deeply umbilicate than the holotype. The acute angle described by the siphonal fasciole and the columella is also greater on the specimen from the upper part of the Olcese Sand.

Ocenebra gabbiana has been confused with a small early to middle *Forreria* characterized by fine spiral sculpture and a well-defined spiral furrow on the lower part of the body whorl. The mistaken identifications stem from Arnold's excellent figure (1909, pl. 5, fig. 5), which, because of its superiority over the line drawing of the holotype of *Trophon gabbiana* (Anderson, 1905, pl. 16, figs. 79, 80), apparently became the standard of reference for this species. The incorrectly identified species is here included under *Forreria cancellaroides* Arnold.

Distribution and stratigraphic occurrence: Temblor Formation, Anticline Ridge (Anderson, 1905), La Panza Range (Anderson and Martin, 1914).

Range: Lower Miocene to middle Miocene.

Locality: Upper part of Olcese Sand, USGS 6624.

Ocenebra trophonoides (Anderson and Martin)

Plate 8, figures 4, 5, 9, 10

Thais trophonoides Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 81–82, pl. 6, figs. 1a, 1b.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173.

Type: California Acad. Sci. 178.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586—near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

Ocenebra trophonoides is characterized by rounded whorls with coarse axial folds on smaller individuals and a weakly angulated body whorl on larger specimens. The smaller specimens, about 30 mm or smaller, have strong axial ribs, a relatively straight anterior canal, and an evenly rounded whorl profile. With increasing size these forms gradually develop a weak angulation on the upper part of the body whorl. The point of growth at which the change from a rounded to an angulate profile takes place is variable. This change is well illustrated by apertural and nonapertural views of a specimen from the upper part of the Olcese Sand (pl. 8, figs. 4, 5).

The similar *Ocenebra wilkesana* (Anderson), with which this species occurs at some localities, has a sharply angulate, spinose whorl profile that develops at an early stage of growth.

Distribution and stratigraphic occurrence: Middle Miocene: Monterey Shale—western Napa County and Contra Costa County (Weaver, 1949); Temblor Formation—Reef Ridge (Stewart, 1946, cf.), La Panza Range (Loel and Corey, 1932); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967); Topanga Formation—Santa Monica Mountains (Loel and Corey, 1932; Grant in Soper, 1938; Susuki, 1951), San Joaquin Hills (J. G. Vedder, written commun., December 1967).

Range: Lower Miocene to middle Miocene.

Localities: Basal part of Jewett Sand, USGS M1591. Upper part of Olcese Sand, USGS M1598–M1600, M1602; UCMP B1597, B1599, B1622, B1628. Lower part of Round Mountain Silt, UCMP B1612.

Ocenebra milicentana (Loel and Corey)

Plate 8, figures 18, 19

Purpura milicentana Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 246, pl. 48, figs. 7a, b, 8a, b.

Type: California Univ. Mus. Paleontology 31886.

Type locality: UCMP 6128, west side of Plano Trabuco, Santa Ana Mountains, Orange County, Calif. Near the top of Vaqueros Formation, lower Miocene.

Ocenebra milicentana is represented by three specimens from the basal conglomerate of the Jewett Sand. The alternating strong and weak axial ribs of the body whorl are unique among Miocene muricids of the Kern River area. Axial ribs of the spire are of approximately equal strength. Spiral ribs are present on the body whorl below the subsutural angulation but are badly worn.

This species is broader than the somewhat similar *Ocenebra topangensis* Arnold, with which it has been compared by Loel and Corey (1932, p. 247). In addition to the axial plicae of alternating strength on the body whorl, *O. milicentana* has a tabulate area at the top of the body whorl and lacks the well-developed spiral sculpture of the other species.

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation—Santa Ana Mountains and San Joaquin Hills (Loel and Corey, 1932).

Range: Lower Miocene

Locality: Basal part of Jewett Sand, USGS M1591.

Ocenebra clarki Addicott, n. sp.

Plate 8, figures 6–8

Of medium size, slender, light-orangish brown. Penultimate whorl sculptured by nine rounded spiral cords of about equal strength that are crossed by seven rounded axial ribs separated by wide interspaces. Sutures appressed, wavy, not clearly defined. Body whorl large, rounded, sculptured by about 30 spiral cords that are minutely imbricated by very fine axial growth ridges and seven axial ribs that are more or less continuous up spire. Base of body whorl indistinctly angulated. Aperture ovate, outer lip thickened externally by strong varix, four denticles within. Inner lip calloused. Anterior canal open, moderately long, gently curved to the left. Columella imperforate.

Height (almost complete) 29.5 mm, width 15 mm.

Type: California Univ., Los Angeles 45765.

Type locality: UCLA AC 8–34, upper Olcese Sand, Kern River.

Ocenebra clarki is a rather high spired, slender muricid represented by two specimens from the upper part of the Olcese Sand. This species is named in honor of Alex Clark, who made significant contributions to Cenozoic stratigraphic paleontology during the 1930's. The holotype was collected by Clark in 1934. He recognized it as an undescribed species, his notation on the specimen label reads "*Tritonalia* n. sp. A." The precise locality of the specimen selected as the holotype is not known. Presumably it is the same area from which the second specimen was collected, which is in the immediate vicinity of Anderson and Martin's CAS locality 65 (1914).

The two specimens upon which this species is based show some variation in the strength of spiral and axial sculpture. The number of ribs, however, is essentially the same. The more strongly sculptured specimen (pl. 8, fig. 8) resembles a late Miocene species from the upper part of the San Pablo Group of central California—*O. dalli* (Clark, 1915, p. 501, pl. 67, figs. 4, 9). It can be distinguished from the younger species, which appears to be a lineal antecedent, by the greater number of spiral and axial ribs and the longer, open anterior canal.

Among the muricids of the Kern River Miocene, *Ocenebra clarki* most closely resembles the smoothly rounded form of *O. trophonoides* (Anderson and Martin, 1914). It differs from that taxon by having a slender, high-spired profile and a long, relatively straight anterior canal.

Occurrence: Upper part of Olcese Sand, UCMP loc. B1599; UCLA loc. AC 8–34.

Ocenebra topangensis Arnold

Plate 8, figure 3

Ocinebra topangensis Arnold, 1907, U.S. Natl. Mus. Proc., v. 32, p. 530, pl. 43, fig. 4.
Eldridge and Arnold, 1907, U.S. Geol. Survey Bull. 309, p. 232, pl. 30, fig. 4.
Purpura topangensis (Arnold), Loel and Corey, 1932, California Univ., Dept. Geol. Sci., v. 22, no. 3, pl. 48, fig. 4 [not fig. 5 and 6].
Ocenebra topangensis Arnold, Hanna and Hertlein, 1943, California Div. Mines Bull. 118, p. 172, fig. 63–15.
Type: U.S. Natl. Mus. 164995.
Type locality: At head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, Calif. Topanga Formation, middle Miocene.

Ocenebra topangensis is here differentiated from *O. wilkesana* on the basis of a more elongate outline, a narrow, strongly tabulate subsutural area on the body whorl, and the produced, frill-like varices. These characters have not been found among specimens of *O. wilkesana* from the upper Olcese Sand. Despite these differences, it is possible that only one extremely variable species including *O. topangensis* and *O. wilkesana* as end members is present. Study of specimens from the type locality of *O. topangensis* in the Santa Monica Mountains led Loel and Corey (1932, p. 247) to treat *O. topangensis* as an extremely variable species. Forms in both the Vaqueros and Topanga Formations referable to *O. wilkesana* were considered to be variants of *O. topangensis* by Loel and Corey. If careful study of specimens from the type locality of *O. topangensis* shows an intergradation between that species and *O. wilkesana*, the former would become a synonym of *O. wilkesana*.

The figured specimen from the basal part of the Jewett Sand (pl. 8, fig. 3) compares favorably with Arnold's holotype, although it is much smaller. Other early Miocene occurrences of this species are doubtfully identified (Loel and Corey, 1932; Eaton and others, 1941). Specimens figured as *Purpura* cf. *topangensis* (Arnold) n. var.? by Loel and Corey (1932, pl. 48, figs. 5, 6) are here included with *Ocenebra wilkesana*.

Distribution and stratigraphic occurrence: Lower Miocene: Painted Rock Sandstone Member of the Vaqueros Formation of Hill, Carlson, and Dibblee (1958), Caliente Range J. G. Vedder, written commun., December 1967). Middle Miocene: Unnamed Miocene formation, Panoche Hills (Woodring in Stewart and others, 1944, cf.); Temblor Formation—Coalinga area, La Panza Range (Loel and Corey, 1932); Topanga Formation—Santa Monica Mountains (Arnold, 1907; Eldridge and Arnold, 1907; Woodring in Hoots, 1931; Loel and Corey, 1932; Grant in Soper, 1938), Santa Ana Mountains (Loel and Corey, 1932). Upper Miocene: Castaic Formation of Crowell (1955), eastern Ventura Basin (Stanton, 1966, 1967, cf.).

Range: Lower Miocene to middle Miocene. Doubtfully reported from upper Miocene.

Locality: Basal part of Jewett Sand, USGS M1591.

Ocenebra sp.

Plate 8, figures 20, 21

A fragment of the body whorl of a fairly large *Ocenebra* is in a California Academy of Science collection from the basal part of the Jewett Sand at Pyramid Hill (CAS loc. 37468). Enough of the shell is preserved to indicate that it is distinct from the other Miocene muricids of the Kern River area. The body whorl is sculptured with 18 rounded spiral cords that tend to alternate in size on the upper part of the whorl. The surface of the cords is imbricate. The profile of the body whorl is more or less evenly rounded. There are two weak varical ridges on the body whorl and a strong thickening adjacent to the aperture. The aperture is oval, and the rather short anterior canal is twisted to the right.

Genus TROPHON Montfort, 1810

Type (by original designation): *Murex magellanicus* Gmelin (=*M. geversianus* Pallas). Holocene, Straits of Magellan to Chile.

Subgenus AUSTROTROPHON Dall, 1902

Type (by subsequent designation, Grant and Gale, 1932): *Trophon cerrosensis* Dall. Holocene, Cedros Island, Baja California, to Acapulco, Mexico.

Trophon (Austrotrophon) kernensis Anderson

Plate 8, figures 12, 13, 22–27

Trophon kernensis Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 202, pl. 16, figs. 64, 65.
Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100.
Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 44.
Loel and Corey, 1932, California Div., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173, 245, pl. 48, fig. 1.
Hanna and Hertlein, 1943, California Div. Mines Bull. 118, p. 173, fig. 63–17.
Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.
Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 33–34, pl. 4, figs. 1, 5.
Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, p. C106, fig. 4k, n.
Trophon oregonensis Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 80–81, pl. 5, fig. 5.
Weaver, 1943, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 401, pl. 78, fig. 1.

Original description.—Shell rather large, length from 2–3 inches, width 1½ inches; graceful in outline, narrowing rapidly before; spire rather short, conical, and angular, but sloping above, bearing tubercules, or very short spines on the angles, more prominent on very young shells; surface ornamented chiefly by lines of growth, but bearing faint spiral lines on the lower part of the whorl, noticeable especially in young shells; aperture pear-shaped, and narrowing to a long canal; inner lip crusted; canal long and narrow.

Type: California Acad. Sci. 73.

Type locality: In the vicinity of Barker's Ranch [headquarters formerly near the center of sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle]. This and other newly described species were collected "chiefly north of the river" (Anderson, 1905, p. 187).

Type of *Trophon oregonensis* Anderson and Martin: California Acad. Sci. 176.

Type locality: CAS 38, "beach section on Oregon coast on south side of Yaquina Head, 5½ miles north of entrance to Yaquina Bay, Lincoln County, Oregon" (Moore, 1963). Astoria Formation, middle Miocene.

Well-preserved specimens of *Trophon kernensis* from the Olcese Sand and, in particular, the Round Mountain Silt (UCMP loc. B1619) have the characteristics of the subgenus *Austrotrophon* Dall described by Grant and Gale (1932, p. 726). These are: a very long anterior canal, lamellar varices that become spinose at the angulation of the whorls, a yellow or light-brown shell, and weak spiral sculpture. Recent species of *Austrotrophon* range from Redondo Beach, southern California, to Acapulco, Mexico, in relatively shallow water (12–75 fathoms, Burch, 1945, no. 51, p. 55). Specimens of *T. kernensis* from the Round Mountain Silt are similar to the living *T. cerrosensis* Dall but have a shorter, less acute spire and less strongly developed varices and spines. *Austrotrophon* is separable from *Forreria*, a genus to which *T. kernensis* has been assigned by some workers, by the lack of a furrow below the basal angulation of the body whorl, an observation made by Keen (1958a, p. 364). Some variants of the upper Miocene species *F. carisaensis* (Anderson), such as *F. carisaensis* var. *mirandensis* Grant and Eaton (Eaton and others, 1941, pl. 2, fig. 8), are similar to *Trophon kernensis* but can be readily distinguished by their characteristic furrow.

Trophon oregonensis Anderson and Martin, from the Astoria Formation of Oregon, was originally separated from *T. kernensis* on the basis of a higher spire, a more tabulate body whorl, and pits at the base of the spines (Anderson and Martin, 1914, p. 81). These are infrasubspecific characters. Moore (1963, p. 33) noted that excavated spines are present on many specimens of *T. kernensis* and that some specimens from near the type locality of *T. oregonensis* did not have the excavated spines.

Ordinarily, the larger specimens of *Trophon kernensis* have a smooth exterior with smoothly rounded varices and only nodose shoulders. This condition seems to be a result of abrasion, as most specimens have a defective apex and show other signs of wear. Most specimens are relatively low spired and have a strong angulation high on the body whorl. Immature specimens best show the characteristic spiral ribbing below the angulation, pitted spines, and the long anterior canal. Only a few specimens retain the delicate, bladelike varices of the body whorl. Similarly, the long anterior canal is seldom preserved in its entirety.

There is some difficulty in distinguishing immature specimens of *Trophon kernensis* from some of the other muricids of the Kern River Miocene formations. The strong spiral sculpture of early whorls is similar to that of *Ocenebra wilkesana*, but on *T. kernensis* the subsutural slope is strongly concave and more nearly approaches the horizontal.

Trophon bartoni Arnold (1909, p. 59–60, pl. 7, fig. 3), a closely allied species as originally noted by Arnold, is tentatively considered distinct from *T. kernensis* on the basis of the subsutural spiral sculpture which persists on the body whorl and is reflected as prominent nodes on the varices. This condition has not been observed on any of the Kern River specimens or on specimens from the Astoria Formation in Oregon. On the type of *T. bartoni*, the body whorl appears to be much broader than it actually is, owing to slight deformation and an unusually long well-preserved spine at the aperture.

Trophon kernensis is one of the characteristic gastropods of the upper part of the Olcese Sand and the Round Mountain Silt. In the Kern River area its lowest stratigraphic occurrence is in the lower part of the Olcese Sand, which carries a faunal assemblage referable to the "Temblor Stage." It seems to be the lineal antecedent of the closely related subspecies, *T. kernensis medialis* n. subsp. from the lower Miocene Jewett Sand. Elsewhere in California, *T. kernensis* occurs with mollusks referred to the "Vaqueros Stage."

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation—La Panza Range (Loel and Corey, 1932), Caliente Range (Eaton and others, 1941), Santa Cruz Island (Loel and Corey, 1932), San Joaquin Hills (Vedder, unpub. data, 1958), Santa Ana Mountains (Vedder and Woodring, unpub. data, cf.). Middle Miocene: Astoria Formation, Oregon (Moore, 1963); Monterey Shale, western Napa County, and Monterey Group, western Contra Costa County (Weaver, 1949); unnamed sandstone of Dibblee (1966b), Stanford Univ. lands, San Mateo County (SU loc. SLAC 85+10); Temblor Formation—Reef Ridge (Stewart, 1946), La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932), Caliente Range (Eaton and others, 1941); Tejon Hills (Clark, in Merriam, 1916); Topanga Formation, San Joaquin Hills (Vedder, unpub. data 1958).

Range: Lower Miocene to middle Miocene.

Localities: Lower part of Olcese Sand, UCMP B1646. Middle part of Olcese Sand, USGS M1698. Upper part of Olcese Sand, USGS 6624, 6890, M1596–M1601, ?M1602, M1697, M1698; UCMP B1586, B1587, M1598, B1595, B1599, B1600, B1601, B1603, ?B1614, B1615, B1616, B1621, ?B1624, B1626, B1628, B1753. Round Mountain Silt, USGS 3886, 6063–6065, 6068?, 6623, M1604–M1606, M1608, M1611–M1613, M2480; UCMP B1612?, cf. B1618, ?B1633, B1637, B1645.

Trophon (Austrotrophon) kernensis medialis Addicott, n. subsp.

Plate 8, figures 14–16

Of medium size, strongly angulate and spinose. Apical angle relatively broad. Spire with about eight coarsely spinose nodes on the anterior part of the whorls. Sculptured by fine spiral cords separated by narrow furrows, angulation bearing a somewhat stronger cord. Body whorl with medial row of bluntly pointed nodes continuing above and below the angulation as smooth varices. Nodes usually pitted anteriorly, varices bordered anteriorly by a finely incised furrow. Surface sculptured by evenly developed spiral cords that are more prominent below the angulation. Body whorl without a basal angulation. Aperture subovate. Anterior canal moderately long, gently twisted to the left. Outer shell material light brown, inner layer chalky white.

Height (nearly complete) 23.5 mm, width 15.7 mm.

Type: U.S. Natl. Mus. 650127.
Type locality: USGS M1591, on north side of westward-trending gully on southwest flank of Pyramid Hill in NW¼SW¼ sec. 14, T. 28 S., R. 29 E. Basal part of Jewett Sand, lower Miocene.

Trophon kernensis medialis is separated from *Trophon kernensis* s. s. on the basis of a more acute, relatively higher spire, a more strongly inclined convex slope between the angulation and the suture, and the presence of well-developed spiral sculpture on most specimens. The anterior canal of *T. kernensis* is straighter and the spines or nodes are reflected upward rather than outward. Because of the apparent close genetic relationship with *T. kernensis*, the newly described early Miocene taxon is included as a subspecies.

There is little difficulty in distinguishing small specimens of *Trophon kernensis* from *T. kernensis medialis.* (See pl. 8, figs. 12–15.) But in larger specimens the greater amount of abrasion and a greater range of variation render discrimination somewhat more difficult. On some of the larger specimens of *T. kernensis medialis*, secondary spiral cords are intercalated between the primary spirals on the lower part of the body whorl.

The spiral sculpture and general outline of *Forreria cancellaroides* (Arnold) are similar to *Trophon kernensis medialis* n. subsp., but the furrow below the basal body whorl angulation characteristic of *Forreria* can be used to readily distinguish these species.

Trophon kernensis medialis is fairly abundant in the basal marine conglomeratic sandstone of the Jewett Sand at Pyramid Hill (USGS loc. M1591).

Occurrence: Basal part of Jewett Sand, USGS loc. M1591; UCMP loc. B1665.

Genus TYPHIS Montfort, 1810

Type (by original designation): *Purpura tubifer* Bruguière. Eocene, France.

Subgenus TALITYPHIS Jousseaume, 1882

Type (by original designation): *Typhis expansus* Sowerby. Holocene, West Indies.

Typhis (Talityphis) lampada Keen

Plate 8, figure 17; plate 9, figures 5, 18

Typhis (*Talityphis*) n. sp. Keen, 1937, Geol. Soc. America Bull., v. 50, no. 12, pt. 2, p. 1972.
Typhis (*Talityphis*) *lampada* Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 53–54, pl. 3, figs. 14, 19, 23.
Keen, 1944, Jour. Paleontology, v. 18, no. 1, p. 65.
Type: Stanford Univ. paleontology type colln. 7548.
Type locality: SU 2121, in small gully close to terrace contact near center SW¼ sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

In the Kern River district, *Typhis lampada* has been found only in the lower part of the Round Mountain Silt, where it is relatively scarce. Middle Miocene specimens from the Caliente Range in eastern San Luis Obispo County, Calif., collected by J. G. Vedder seem to be referable to this species. The genus has not been found elsewhere in California. A Holocene analog, *T. latipennis* Dall (Keen, 1958, p. 367, fig. 382) is known from the southern part of the Gulf of California. This species and two late Tertiary species from central America, *T. alatus obesus* Gabb and *T. olssoni* Keen, differ from *T. lampada* by having relatively much smaller apertures. A similar late Oligocene or early Miocene species from Colombia, *T. precursor* Keen and Campbell (1964, pl. 9, figs. 14, 18, 21, 22), has a relatively high spire and therefore a more or less obconic outline as contrasted with the low-spired, triangular profile of *T. lampada.*

Occurrence and stratigraphic distribution: Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range, eastern San Luis Obispo County (USGS loc. M3338).
Range: Middle Miocene.
Localities: Lower part of Round Mountain Silt, USGS 6065, M1613; UCLA AC–13.

Family THAISIDAE

Genus THAIS Röding, 1798

Type (by subsequent designation, Stewart, 1927): *Thais lena* Röding (= *Murex fucus* Gmelin = *Murex neritoideus* Linné = *Nerita nodosa* Linné). Holocene, eastern Atlantic.

Subgenus NUCELLA Röding, 1798

Type (by subsequent designation, Winkworth, 1932): *Nucella theobroma* Röding (= N. *lapillus*

Linné). Holocene, northern Atlantic Ocean from northeastern United States to Portugal.

Rehder's case (1962) for retention of *Nucella* Röding for this temperate to boreal group of thaisids is followed herein rather than Clench's earlier case (1947, p. 85–86) for the use of *Polytropa* Swainson, a later name that can be clearly fixed on *N. lapillus*. Clench (1947) considered *N. theobroma* Röding as a doubtful name based on the figures originally cited. Although the designation of *N. theobroma* as the type of *Nucella* does not directly relate this taxon to *N. lapillus* (Linne), Rehder (1962) has shown that *N. theobroma* is a variant of *N. lapillus*. Moreover, usage subsequent to Clench's report (1947) favors retention of *Nucella*, the technically available, earlier name.

Thais (Nucella) packi Clark

Plate 9, figures 1–4, 19

Purpura lima Martyn, Anderson, 1911, p. 100, in part ("A zone" only).

Thais packi Clark, 1918, California Univ., Dept. Geology Bull., v. 11, no. 2, p. 177, pl. 19, figs. 2, 13.

Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 18, figs. 1, 2.

Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, p. 104, fig. 3h.

Thais (*Stramonita*) *carrizoensis* Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 249–250, pl. 47, figs. 2, 3a, b.

Nucella packi (Clark) var. *talea* Stewart, 1946, U.S. Geol. Survey Prof. Paper 205–C, p. 102, pl. 17, fig. 11.

Thais sp. Lutz, 1951, California Univ., Dept. Geol. Sci. Bull., v. 28, no. 13, p. 392, pl. 18, figs. 2, 5 [listed as "*Thais*, n. sp." on plate description].

Thais cf. *T.* n. sp. Lutz, Hall, 1958, California Univ., Dept. Geol. Sci. Bull., v. 34, no. 1, p. 58, pl. 9, figs. 8, 9.

Thais (*Polytropa*) aff. *T.* (*P.*) *lima* Gmelin, Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 35.

Type: California Univ. Mus. Paleontology 11246.

Type locality: UCMP 1309, Santa Fe railroad cut 1¼ miles northeast of Muir Station, altitude 150 feet [east limb of Pacheo syncline near boundary of Concord and Carquinez 15-minute quadrangles). San Ramon Formation, lower Miocene(?)].

Type of *Thais carrizoensis:* California Univ. Mus. Paleontology 31578.

Type locality: UCMP A501, Carrizo Creek, La Panza Range, San Luis Obispo County, Calif. Vaqueros Formation, lower Miocene.

Type of *Nucella packi* var. *talea:* U.S. Natl. Mus. 498749.

Type locality: USGS 14390, first arroyo west of Beltran, upper three layers of *Anadara* just beneath 12-foot silt, sec. 25, T. 22 S., R. 15 E., Dark Hole quadrangle, Fresno County, Calif. Lower member of the Temblor Formation, middle Miocene.

Type of *Thais* sp. Lutz: California Univ. Mus. Paleontology 35165.

Type locality: UCMP A4931, fire trail cut northwest of road summit between Lawson Hill and Oursan Ridge about 30 feet below base of Claremont Shale in T. 1 N., R. 3 W., Concord quadrangle, Contra Costa County, Calif. Sobrante Sandstone, middle Miocene.

Thais packi, a species characterized by broad spiral cords with deeply excavated interspaces, is limited to the lower Miocene of the Kern River area, although it has been collected elsewhere from middle Miocene formations. It occurs abundantly in the basal marine stratum at Pyramid Hill. Larger individuals are very thick shelled. There is considerable variation in the strength of spiral ribbing, in part due to abrasion. Continuous gradation from the broad ribbed form of *T. packi* (pl. 9, fig. 1) to individuals with narrower ribs and deeply excavated interspaces (pl. 9, fig. 4) is well illustrated in the collection from USGS locality M1591. Some specimens have a fairly well developed spire and a smoothly rounded body whorl. Others may be low spired and may have a faint angulation in the upper part of the body whorl. A few specimens have faint broad axial folds on the body whorl (pl. 9, fig. 4).

All specimens are smaller than the type of *T. packi* from the San Ramon Sandstone of Contra Costa County and have from two to four fewer spiral ribs. In other respects, however, the variable specimens from the Jewett Sand are closely comparable with *T. packi.*

The type of *T. carrizoensis* Loel and Corey (1932, p. 249, pl. 47, figs. 3a, 3b) is a small, low-spired specimen with only 11 spiral ribs. Other specimens, however, are said to have more spiral cords and a higher spire than the type specimen. These characteristics suggest that their figured specimens are immature. A small individual collected from Pyramid Hill (pl. 9, fig. 19) compares favorably with Loel and Corey's type material.

Thais packi forma *talea* Stewart (1946, p. 102, pl. 17, fig. 11) from the Temblor Formation of the Reef Ridge area, Fresno County, is somewhat narrower than typical specimens.

This species has long been confused with the living *Thais lima* (Gmelin), which has been identified from beds as old as early Miocene. The oldest authenticated occurrence of *T. lima*, however, is middle Miocene (Etherington, 1931, p. 97). *T. packi* can be readily distinguished from *T. lima* by its broad spiral ribs with uniformily narrow interspaces, faint axial folds on the spire, thick shell, and denticulate outer apertural lip. It is probable that some of the middle Miocene records of *T. lima* are, in fact, *T. packi.*

Specimens from the middle Miocene Astoria Formation of coastal Oregon identified by Moore (1963, p. 35) as *Thais* aff. *T. lima* Gmelin are referable to *T. packi.* Collections from near Newport and Coos Bay (USGS locs. 18907 and 18284, respectively) include specimens that have been compared with Kern River material. This species has also been collected from the

Astoria Formation in the Montesano quadrangle, southwestern Washington (USGS loc. M1518).

Anderson's (1905, pl. 5, figs. 62, 63) "*Purpura lima* Martyn" from the upper Olcese Sand of the Kern River district is a cancellariid. It was renamed *Cancellaria andersoni* Arnold (1909, p. 60–61). Anderson's later record of "*Purpura lima* Martyn" (1911, p. 100) from the A zone of Pyramid Hill presumably is of *Thais packi.*

Distribution and stratigraphic occurrence: Lower Miocene(?): San Ramon Sandstone—western Napa County (Weaver, 1949), Contra Costa County (Clark, 1918; Weaver, 1953). Lower Miocene: Vaqueros Formation—La Panza Range and San Emigdio Mountains (Loel and Corey, 1932). Midddle Miocene: Astoria Formation—southwestern Washington (USGS loc. M1518) and coastal Oregon (Moore, 1963, as *Thais* aff. *T. lima* Gmelin); Empire Formation of Diller (1903), near Cape Blanco, Oreg. (USGS loc. M2142, M3637; unnumbered collections at the University of Oregon); Sobrante Sandstone, Contra Costa County, Calif. (Lutz, 1951); Oursan Sandstone, Pleasanton area, Alameda County (Hall, 1958); Temblor Formation, Reef Ridge area (Stewart, 1946).

Range: Lower Miocene to middle Miocene.

Localities: Lower part of Jewett Sand, USGS M1590, M1591; UCMP B1606, B1665, B1667, B1669, ?B1671. Middle part of Olcese Sand, USGS M1698.

Subgenus THAISELLA Clench, 1947

Type (by original designation): *Purpura trinitatensis* Guppy. Holocene, Guatemala to Brasil.

Thais (Thaisella) edmondi (Arnold)

Plate 9, figures 14, 15

Purpura edmondi Arnold, 1907, U.S. Natl. Mus. Proc., v. 32, no. 1545, p. 530, pl. 40, figs. 3, 3a.

Eldridge and Arnold, 1907, U.S. Geol. Survey Bull. 309, p. 226, pl. 27, fig. 3, 3a.

?Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173.

Type: U.S. Natl. Mus. 164983.

Type locality: Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, Calif. Topanga Formation, middle Miocene.

Two specimens from the Kern River Miocene are referable to this species. The smaller specimen (pl. 9, fig. 15) is most similar to Arnold's holotype. Although considerably worn, there are subsutural depressions on the body whorl that closely resemble the pocketlike interspaces between the axial ribs of the type. Locality data for this specimen are missing (Takeo Susuki, written commun. 1964), but the associated matrix suggests that it was collected from the upper part of the Olcese Sand or the lower part of the Round Mountain Silt.

The specimen from USCG locality M1691 differs from the holotype by the smoothness of its body whorl, which has but a solitary node near the aperture. The body whorl is not noticeably angulated. On the few patches of original outer shell layer, there is a suggestion of broad spiral ribs similar to the sculpture on the holotype. This specimen is considered to be a weakly noded form of *Thais edmondi.*

Thais edmondi may be distinguished from the middle Miocene *T. blakei* Anderson and Martin (1914, p. 82, pl. 6, figs. 4a, 4b), a rather slender species with a moderately angulated body whorl, by its thicker shell, one or more prominent nodes on the body whorl, and a longer anterior canal.

Distribution and stratigraphic occurrence: Topanga Formation, Santa Monica Mountains (Arnold, 1907; Eldridge and Arnold, 1907; Loel and Corey, 1932; Susuki, 1951), San Joaquin Hills (Vedder, unpub. data, 1958), Santa Ana Mountains, cf. (Vedder and Woodring, unpub. data, 1953).

Range: Middle Miocene.

Occurrence: Basal part of Jewett Sand, USGS loc. M1591?. Upper part of Olcese Sand, USGS loc. M1601. Lower part of Round Mountain Silt, UCLA loc. AC–34–14.

Thais (Thaisella) blakei Anderson and Martin

Plate 9, figures 6, 7

Thais blakei Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 82, pl. 6, figs. 4a, b.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173.

Type: California Acad. Sci. 180.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

Thais blakei is known only from the type locality. The specimen figured in this report (pl. 9, figs. 6, 7), a topotype, is simlar to the holotype by being practically devoid of the thin original outer layer of shell material. The remaining part is yellow in color and apparently smooth above the body whorl angulation but sculptured by broad spiral ribs below. There is some suggestion of irregular axial sculpture on the body whorl. This species is similar to *T. edmondi* (Arnold, 1907, p. 540, pl. 40, figs. 3, 3a), as originally noted by Anderson and Martin (1914), but lacks the noded body whorl angulation of that species. It also seems to be more slender and has a longer anterior canal.

Occurrence: Upper part of Olcese Sand, CAS loc. 65.

Genus MORULA Schumacher, 1817

Type: Ricinula morus Lamarck. Holocene, Polynesia.

Subgenus MORUNELLA Emerson and Hertlein, 1964

Type: Buccinum lugubre Adams. Pleistocene and Holocene, eastern Pacific Ocean. Holocene range: southern California to Panama.

Morula (Morunella) granti Addicott n. sp.

Plate 11, figures 15, 16

Small, low spired. Penultimate whorl broadest near base, sculptured by 11 axial ribs and five spiral ribs, the lower four of which occur in pairs. Posterior primary set off anteriorly by a deeply excavated interspace on penultimate and body whorls. Suture impressed, wavy. Body whorl slender, broadly convex, sculptured by about 12 primary spiral cords of unequal strength. Aperture elongate-ovate, outer lip smooth within. Parietal-columellar lip smooth. Anterior canal short, slightly inclined to the left.

Height (almost complete) 10.5 mm, width 4.9 mm.

Type: U.S. Natl. Mus. 650160.

Type locality: USGS M1597, in an abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

A small specimen closely similar to the Pleistocene and Holocene Californian-Panamic species *Morula lugubris* (Adams) occurs in the upper part of the Olcese Sand. Apertural configuration and whorl proportions are similar to late Pleistocene specimens of *M. lugubris* collected by J. G. Vedder from the Bay Point Formation, San Diego, Calif., and terrace deposits at Laguna Beach, Calif. (USGS loc. M1018). Principal differences from specimens of *M. lugubris* of comparable size are the weaker axial sculpture and shorter, less concave subsutural profile of the body whorl.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Family COLUMBELLIDAE

Genus ANACHIS H. and A. Adams, 1853

Type (by subsequent designation, Tate, 1875): *Columbella scalarina* Sowerby. Holocene, Mazatlan, Mexico to Panama.

Subgenus COSTOANACHIS Sacco, 1890

Type (by subsequent designation, Pace, 1902): *Columbella turrita* Sacco. Miocene, Italy.

Anachis (Costoanachis) watsonae Keen

Plate 9, figures 11, 12

Anachis watsonae Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 42–43, pl. 4, figs. 1, 2.

Supplementary description.—Shell of medium size, thick, moderately high spired. Body whorl and part of penultimate whorl devoid of axial sculpture; earlier whorls corrugated with strong axial ribs separated by interspaces of equal width. Axial ribs crossed by from four to six indistinct spiral ribs that continue onto the body whorl. Sutures subtabulate, strongly impressed. Base of body whorl with a band of about 12 spiral cords separated by finely channeled interspaces. Aperture subquadrate, outer lip thickened externally and marked with five internal spiral plaits. Columellar lip with a sharply margined callus and a near vertical ridge bearing three or more ill-defined pustules.

Type: Stanford Univ. paleontology type colln. 7530.

Type locality: SU 2121, in small gully close to terrace contact near center SW¼ sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

The holotype of *Anachis watsonae* is a poorly preserved specimen with a large area of shell material missing from the body whorl. The outer lip is broken and most of the external shell layer is missing from the spire. A well-preserved specimen from beds stratigraphically equivalent to the type locality (USGS loc. 6065) is figured and described herein (pl. 9, figs. 11, 12). The fine subsutural band on the spire of the holotype is a subsurface feature. It does not continue onto small areas of original shell material remaining on the type, nor does it occur in other specimens collected from the lower part of the Round Mountain Silt.

Occurrence: Lower part of Round Mountain Silt, USGS locs. 6065, M1612.

Genus STROMBINA Mörch, 1852

Type (by subsequent designation, Cossmann, 1901): *Columbella lanceolata* Sowerby. Holocene, Ecuador and Galapagos Islands.

Strombina sp.

Plate 9, figures 20, 26

A small, smooth *Strombina* occurs in the *Turritella ocoyana* bed (USGS loc. M1605) in the Round Mountain Silt. The shell material has been encrusted and at least partly replaced by gypsum with a consequent loss of detail of sculpture. The spire is less than one-half the height of the shell. The aperture is subovate; there is a longitudinal thickened band behind the outer lip.

Strombina has not previously been reported from the Pacific coast Tertiary north of the Gulf of California. The present species is similar to an early Miocene species from the San Gregorio Formation of northwestern Mexico, *S. carlosensis* Durham (1950, p. 110, pl. 26, figs. 11, 13), but has a stouter shell in addition to a smaller, much more ovate aperture.

There are three additional unreported middle Miocene occurrences of this tropical genus in California. One is from the Saltos Shale Member of the Monterey Shale of Hill, Carlson, and Dibblee (1958) in the Caliente Range (USGS loc. M1923 and M3291). The others are from the Topanga Formation of the Santa Ana Mountains and the San Joaquin Hills. The *Strombina* from the Santa Ana Mountains was doubtfully identified as *S. carlosensis* (Vedder and Woodring, unpub. faunal list, 1953).

Occurrence: Round Mountain Silt, USGS loc. M1605.

Genus MITRELLA Risso, 1826

Type (by subsequent designation, Cox, 1927: *Mitrella flaminea* Risso (= *Murex scriptus* Linné). Holocene, Mediterranean.

Subgenus?

Mitrella anchuela Keen

Plate 9, figures 9, 10, 21, 22

Mitrella anchuela Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 48, pl. 4, fig. 12.

Supplementary description.—Shell small, stout, spire and aperture of about same length. Spire with six gently convex whorls. Sutures tabulate, strongly impressed. Surface smooth, glossy in some specimens, microscopic sculpture of irregularly spaced finely incised spiral lines and finer axial lines of growth. Aperture broad, anterior two-thirds with subparallel sides, not particularly constricted into an anterior canal. Outer apertural lip usually with five denticles, the posterior strongest. Inner lip with three somewhat weaker teeth. Body whorl very weakly angulated near midpoint, base with five to eight flat-topped spiral cords separated by narrow, channeled interspaces. Base of inner lip slightly deflected to left on some specimens.

Type: Stanford Univ. paleontology type colln. 7539.

Type locality: SU 2121, in small gully close to terrace contact near center SW¼ sec. 6, T. 29 S., R. 30 W., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

Mitrella anchuela is a rather variable species which closely resembles the living tropical species *M. dorma* Baker, Hanna, and Strong (1938, p. 248-249, pl. 24, fig. 6) from the Gulf of California. It differs from the somewhat smaller Holocene analog by having tabulate sutures and a definite basal angulation. In other respects, the two species appear to be inseparable. Young specimens of *M. anchuela* frequently have a shorter spire and are much broader than adult shells. The strength of the basal angulation of the body whorl is variable, on some specimens it is extremely weak. Columellar teeth are not present in all specimens; where present, they vary from one to four in number. There are usually five denticles within the outer lip of the aperture; in most specimens, however, that part of the outer lip bearing apertural teeth has been broken away. In some of these specimens, the incomplete aperture appears to be somewhat constricted into an anterior canal similar to *Mitrella alta* n. sp. (pl. 9, figs. 8, 16, 17).

Although represented by an incomplete, poorly preserved specimen, Loel and Corey's *Mitrella* cf. *M. richthofeni* (Gabb) (1932, p. 241, pl. 46, figs. 18a, 18b) from their lower Miocene Vaqueros Formation seems to be distinct from *M. anchuela* on the basis of its more tabulate whorls and deeply channeled suture.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597; UCMP loc. B1598. Round Mountain Silt, USGS locs. 3886, 6063, 6065, 6622, 6623, ?M1604, ?M1606, M1608–M1610, M1612, M1613; UCMP locs. B1600?, cf. B1618, B1637, B1638.

Subgenus COLLUMBELLOPSIS Dautzenburg and Dollfus 1882

Type (by original designation): *Columbella minor* Scacchi. Holocene, Mediterranean.

Mitrella (Columbellopsis) alta Addicott, n. sp.

Plate 9, figures 8, 16, 17

Shell small, elongate. Spire with six slightly convex whorls. Sutures tabulate, deeply incised. Body whorl slightly longer than spire, with broad angulation at base. Aperture narrow, outer lip with five denticles of which the posterior one is the strongest; base constricted into well-defined anterior canal. Columellar lip thickened, bearing one denticle, base reflected rather strongly to left. Six faint spiral cords on base of body whorl separated by narrow, channeled interspaces.

Length 5.5 mm, width 2.3 mm.

Type: U.S. Natl. Mus. 650135.

Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

Mitrella alta resembles most closely *M. tuberosa* (Carpenter), a Holocene species ranging from Alaska to the Gulf of California, Mexico, which is recorded from beds as old as late Miocene (Gale in Preston, 1931, p. 16) and has been doubtfully identified from a middle Miocene assemblage from the Altamira Shale Member of the Monterey Shale of the Los Angeles basin (Woodring and others, 1946). It differs principally from syntypic specimens figured by Palmer (1958, pl. 26, figs. 9–12) by having a more slender body whorl that has at least twice as many spiral ribs on the base. From *M. anchuela*, with which it occurs at USGS locality M1597, it differs by being more elongate, by having a narrow aperture which is constricted into an anterior canal, and by having a relatively large basal segment of the columellar lip inclined to the left. By way of contrast, *M. anchuela* has a broad aperture, a straight columellar lip, and a short, stubby spire. Both species have a basal angulation and a similar number of spiral ribs on the base of the body whorl.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Family NEPTUNEIDAE

Genus BRUCLARKIA Trask in Stewart, 1927

Type (by original designation): *Clavella gravida* Gabb. Lower Miocene, Contra Costa County, Calif.

Bruclarkia barkeriana (Cooper)

Plate 9, figures 13, 23–25, 27, 28; plate 10, figures 1–3, 5, 7, 9, 10

?*Natica geniculata* Conrad, 1855, U.S. 33d Cong. 1st sess., House Ex. Doc. 129, p. 18–19.
Conrad, 1857, U.S. 33d Cong. 2d sess., Senate Ex. Doc. 78, App. art. 2, p. 328, pl. 7, fig. 67. Nomen dubium.

Bruclarkia geniculata (Conrad), Clark, 1937, Geol. Soc. America Proc. for 1936, p. 387.
Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 36. Nomen dubium.

Agasoma barkerianum Cooper, 1894, California Mining Bur. Bull. 4, p. 53, pl. 5, fig. 63 [not pl. 3, fig. 52 as stated in explanation of plates].
English, 1914, California Univ., Dept. Geology Bull., v. 8, no. 10, p. 252, pl. 25, figs. 3, 13, 14.
Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 42.

Bruclarkia barkerianum (Cooper), Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 28, figs. 1, 2.
Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 171.

Bruclarkia barkeriana (Cooper), Hanna and Hertlein, 1943, California Div. Mines Bull. 118, p. 174, fig. 63–19.
Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, p. 106, figs. 4a, b.

Agasoma gravidum Gabb, Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 188.
Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100.

Agasoma santacruzana Arnold, 1908, U.S. Natl. Mus. Proc., v. 34, p. 379–380, pl. 34, fig. 7.
Branner, Newsom, and Arnold, 1909, U.S. Geol. Survey Geol. Atlas, Santa Cruz Folio 163, p. 6, illus. 2, fig. 44.
Arnold, 1909, U.S. Geol. Survey Bull. 396, p. 18, 116, pl. 8, fig. 5.
Arnold and Anderson, 1910, U.S. Geol. Survey Bull. 398, p. 85, 294, pl. 30, fig. 5.

Agasoma barkerianum Cooper, var. *santacruzanum* Arnold, English, 1914, California Univ., Dept. Geology Bull., v. 8, no. 10, p. 252–253, pl. 25, figs. 11, 12.

Bruclarkia barkerianum (Cooper) *santacruzanum* (Arnold), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 171, 250, pl. 48, figs. 10, 11, 12.

Bruclarkia barkeriana forma *santacruzana* (Arnold), Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, p. C106, fig. 4c.

Agasoma barkerianum Cooper, var. *clarki* English, 1914, California Univ., Dept. Geology Bull., v. 8, no. 10, p. 253, pl. 25, figs. 9, 10.

Type: Probably destroyed in San Francisco fire of 1906 (Keen and Bentson, 1944, p. 126).

Lectotype: California Acad. Sci. 2860 (figured by English, 1914, pl. 25, fig. 14. Here designated.

Locality: CAS 64, west bank of small ravine 1¼ miles due north of Barker's ranchhouse. Upper part of Olcese Sand, middle Miocene.

Type of *Agasoma santacruzana:* Stanford Univ. paleontology type colln., 5369 [not No. 1072 as stated by Arnold (1909, p. 380)].

Type locality: SU C301, on hill 1 mile north-northeast of the north end of Searsville Lake, San Mateo County, Calif. [Hill "503" on north side of Sand Hill Road, Palo Alto 7½-minute quadrangle].

Type of *Agasoma barkerianum* var. *clarki:* California Univ. Mus. Paleontology 11902.

Type locality: UCMP 1352, at Monterey-Martinez contact near Selby Station (JCM loc. 408), Contra Costa County, Calif.

Conrad's species, *Natica geniculata* (1857, pl. 7, fig. 67) from Poso Creek, is known only from a drawing of an internal cast. It may well be a *Bruclarkia*, as first suggested by Clark (1937, p. 387), who considered it a prior name for *B. barkeriana*. However, the original drawing is of a low-spired, strongly collared specimen that might possibly be confused with specimens of *Molopophorus anglonana* Anderson. The shell material was removed from specimens of *B. barkeriana* and *M. anglonana* in order to compare them with each other and with Conrad's drawing. It is extremely difficult to distinguish between the internal casts of these species. In general the internal cast of *Molopophorus anglonana* is higher spired, more strongly collared, and narrower than that of *Bruclarkia barkeriana;* but taking into account the variation in spire height and strength of the subsutural collar in both species, it is apparent that specific recognition of Conrad's species is extremely difficult, if not impractical on this basis. It is here proposed to discard *Natica geniculata* as a nomen dubium and use the next available name, *Bruclarkia barkeriana* (Cooper), as has been the practice of many workers. The inadequacy of Conrad's type figure as a standard of reference for this important species is probably best illustrated by Conrad's comparison of *Natica geniculata* with an Eocene ampullospirid. Although the holotype of *Bruclarkia barkeriana* (Cooper, 1894, p. 53, pl. 5, fig. 63) is also missing, it is an unmistakeable, well-illustrated species. Moreover its name is especially well suited for the most characteristic gastropod of the Barker's Ranch fauna, the informal molluscan standard for the middle Miocene "Temblor Stage" of California and adjacent areas.

Specimens of *Bruclarkia barkeriana* from near the type locality exhibit a considerable range of variation in spiral sculpture and in spire height. The typical form has three primary spirals on the middle part of the body whorl that may vary from continuous spiral cords to elongate or nearly round nodes; the uppermost spiral is the strongest. Frequently one or more additional weak primaries are developed on the lower part of the body whorl. Most of the immature specimens and some adults have a relatively smooth body whorl sculptured by fine spiral cords alternating in strength. This form has been named *Bruclarkia santacruzana* (Arnold, 1908, p. 379–380 from a specimen collected from middle Miocene strata in San Mateo County about 3 miles west of Stanford University. Although it occurs with the typical form at many middle Miocene localities, and clearly is intergradational with *B. barkeriana* at USGS locality M1597, it is the principal form in the lower Miocene strata of the Kern River district, as elsewhere in California (Loel and Corey, 1932, p. 250). The widespread earlier occurrence of the weakly sculptured form known as *santacruzana* suggests that it is ancestral to typical *B. barkeriana*. There are, however, at least two lower Miocene occurrences of *B. barkeriana*. One is a specimen from the basal conglomerate of the Jewett Sand at Pyramid Hill (USGS loc. M1591). An earlier chart (Addicott, 1965a) indicating that this species did not range downward to the base of the lower Miocene Jewett Sand should be corrected to include this occurrence. The other is from the Caliente Range of eastern San Luis Obispo County, and was the basis of the recently reported range extension of typical *B. barkeriana* into lower Miocene strata (Repenning and Vedder, 1961, p. C237). This specimen differs from typical *B. barkeriana* and the weakly sculptured form *santacruzana* by having only two primary spiral ribs, borne low on the body whorl. The stronger lower spiral defines a basal angulation on the body whorl, a sculptural feature that probably is of no more than varietal significance. A similar specimen has been collected from the lower part of the Olcese Sand near Poso Creek (Pl. 10, fig. 3).

One reason for tentative recognition of *Bruclarkia barkeriana* forma *santacruzana* is that stratigraphic range is apparently greater than that of *B. barkeriana*. In addition to its possible earlier appearance in the lower Miocene (Loel and Corey, 1932), it ranges to near the top of the middle Miocene Round Mountain Silt in the Kern River area (USGS locs. 6611, 6612, M1606), whereas the characteristic noded form has not been found above the lowest part of the Round Mountain Silt.

Bruclarkia barkeriana forma *clarki* (English, 1914, pl. 25, figs. 9, 10) is a sculptural variant with finely noded primary spiral ribs. Development of a strongly noded subsutural collar at a relatively early stage of growth is characteristic of *B. barkeriana*. The unique feature of this form is its greater number of primary spiral ribs, seven instead of the four or five characteristic of *B. barkeriana*. The type locality of this form is not clearly established. In the locality register it is listed as near Selby, Contra Costa County, yet there is a notation that it equals JCM locality 408, which is near Vallejo Junction in Napa County. The label with the type specimen indicates the Contra Costa County locality; therefore, it is listed herein as the type locality.

The more northerly ranging middle Miocene species, *Bruclarkia oregonensis* (Conrad, 1848, p. 433, fig. 13), is similar to *B. barkeriana* but less strongly sculptured. As noted by Moore (1963, p. 36), *B. oregonensis* lacks the strong sutural collar of *B. barkeriana* and has an angulation on the whorls of the spire. Its primary spiral sculpture is borne higher on the body whorl. *B. barkeriana* has a unique broad parietal callus, the uppermost part of which extends above the collar and can be traced backward as an irregular, wavy suture concealing much of the penultimate whorl (pl. 9, figs. 24, 28).

Bruclarkia yaquinana (Anderson and Martin), a relatively small, high-spired species which occurs in the lower Miocene Jewett Sand at Pyramid Hill, lacks the strong sutural collar of *B. barkeriana* and has four to five strongly raised primary spiral ribs. It can be readily distinguished from specimens of *B. barkeriana* of comparable size.

Further study of specimens from other areas is needed in order to better define the range of variation in this speci^s and to determine if such features as the development of a strong basal primary have real stratigraphic significance.

Distribution and stratigraphic occurrence: Lower Miocene [all are records of *Bruclarkia barkeriana* forma *santacruzana* except Repenning and Vedder (1961)]: Vaqueros Formation—Santa Cruz Mountains (Arnold, 1908; Branner and others, 1909), northern Gabilan Range, northern and southern Santa Lucia Range, La Panza Range, San Emigdio Mountains, Ventura Basin, and San Joaquin Hills (Loel and Corey, 1932), Nipomo quadrangle, San Luis Obispo County (Hall and Corbató, 1967). Middle Miocene: Monterey Shale, western Napa County (Weaver, 1949); Monterey Group, western Contra Costa County (Lawson, 1914; Weaver, 1949); Sobrante Sandstone—Pacheco-Walnut Creek area (Weaver, 1949), Alameda County (Woodring and Trumbull, in Robinson, 1956); unnamed sandstone of Dibblee (1966b), Stanford University lands, San Mateo County (SU loc. SLAC 90 + 00); unnamed sandstone [Buttonbed Sandstone of Dibblee (1963)], northern Temblor Range (A. Clark, in Schenck, 1936); Temblor Formation—Anticline Ridge (Arnold, 1909; Woodring and others, 1940), Reef Ridge (Stewart, 1946; Adegoke, 1967), La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932), Caliente Range (Eaton and others, 1941); Salinas Shale of English (1918), southern Salinas Valley (Wilson, 1931); "Vaqueros Formation", San Emigdio Mountains (Hoots, 1930);

Saltos Shale Member of the Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (Repenning and Vedder, 1961); unnamed middle Miocene formation, Caliente Range (Dougherty, 1940); Topanga Formation—Santa Monica Mountains (Loel and Corey, 1932; Susuki, 1951), San Joaquin Hills (Vedder, unpub. data, 1958), Santa Ana Mountains (Vedder and Woodring, unpub. data, 1953).

Range: Lower Miocene to middle Miocene.

Localities: Jewett Sand, USGS 6638, M1591, ?M1699; UCMP B1660, B1665. Lower part of Olcese Sand, USGS M1593; UCMP B1657, B1646. Middle part of Olcese Sand, USGS M1698. Upper part of the Olcese Sand, USGS 6619, 6890, M1596–M1602, M1693, M1697, M1698; UCMP B1586, B1587, B1593–B1601, B1603, B1616, B1621–B1624, B1626, B1641, B1643, B1753. Round Mountain Silt, USGS 3886, 6611, 6612, 6622, 6623, 6625, ?18724, M1605, M1606, M1608; UCMP B1612, B1625.

Bruclarkia oregonensis (Conrad)

Plate 10, figures 4, 14–16

Fusus oregonensis Conrad, 1848, Am. Journ. Sci., ser. 2, v. 5, p. 433, fig. 13.

Agasoma oregonense Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 74, pl. 4, figs. 3a, 3b.

Bruclarkia oregonensis (Conrad), Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 104–105, pl. 11, figs. 1, 3–5, 7.

Schenck and Keen, 1940, California fossils for the field geologist, pl. 35, fig. 5.

Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 444, pl. 86, figs. 21, 22.

Lutz, 1951, California Univ., Dept. Geol. Sci. Bull., v. 28, no. 13, p. 391, pl. 18, figs. 1, 6.

Hall, 1958, California Univ., Dept. Geol. Sci. Bull., v. 34, no. 1, p. 58, pl. 11, figs. 1?, 2.

Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 35 [in part], pl. 3, figs. 2, 3, 13 [probably not figs. 8, 11].

Agasoma andersoni Wiedey, 1928, San Diego Soc. Nat. History Trans., v. 5, no. 10, p. 115.

?*Bruclarkia* sp. Lutz, 1951, California Univ., Dept. Geol. Sci. Bull., v. 28, no. 13, p. 391–392, pl. 18, fig. 11.

Type: Missing from collections at Academy of Natural Sciences of Philadelphia and presumed to be lost (Moore, 1962, p. 111).

Type locality: Astoria Formation, Astoria, Oreg.

Type of *Agasoma oregonense* Anderson and Martin: California Acad. Sci. 159.

Type locality: CAS 168, 10 miles west of Scappoose, Oreg. [mapped as "Upper Oligocene marine," Scappoose Formation and said to be of "Blakeley" age by Wells and Peck, 1961].

Two specimens from the Olcese Sand are identified as *Bruclarkia oregonensis*. A latex cast prepared from a broken external mold collected from the lower part of the Olcese Sand (pl. 10, fig. 14) is closely similar to specimens of *B. oregonensis* from the Astoria Formation at Coos Bay, Oreg. (pl. 10, figs. 15, 16). A larger broken specimen from the upper part of the Olcese Sand (pl. 10, fig. 4) has a strongly angulated penultimate whorl in addition to three strong posterior spiral cords and three weaker anterior cords on the body whorl. Unlike the more typical specimen from the lower part of the Olcese Sand, two upper spirals on the body whorl are composed of coarse, elongate nodes.

The added spiral rib near the top of the body whorl which is expressed as a shoulder on the weakly sculptured forms and the angulated whorls of the spire can be used to distinguish *B. oregonensis* from the similar California species, *B. barkeriana*. A further difference between this species and *B. barkeriana* is the development of a strong subsutural collar on medium and large specimens of the latter.

Anderson and Martin's *Agasoma oregonense* (1914, p. 74, pl. 4, figs. 3a, b) from the Scappoose Formation northwest of Portland, Oreg., is here considered a narrow, high-spired variant of *B. oregonensis*. Wiedey (1928, p. 115) renamed this species *Agasoma andersoni*. Although very slender, it has the angulated whorls of the spire and the body whorl angulation of *B. oregonensis*. Several specimens of *B. oregonensis* in collections from the Scappoose Formation (USGS loc. M1975) indicate an early(?) Miocene rather than Oligocene age for this formation. The lack of strong primary spiral ribs on the body whorl recalls the relationship of *B. barkeriana* forma *santacruzana* to *B. barkeriana*.

Distribution and stratigraphic occurrence: Lower Miocene: Scappoose Formation, northwestern Oregon (Anderson and Martin, 1914). Middle Miocene: Hoh Formation of Weaver (1916), northwestern Olympic Peninsula, Wash. (Schenck, 1936); Astoria Formation—southwestern Washington (Etherington, 1931; Moore, 1963), coastal Oregon (Moore, 1963), Tillamook County, Oreg. (Warren and others, 1945), Lincoln County, Oreg. (Vokes and others, 1949), Cape Blanco, Oreg. (Durham, 1953); Sobrante (?) Sandstone, Pacheco-Walnut Creek area, California (Lutz, 1951); Oursan Sandstone, Alameda County, Calif. (Hall, 1958); Temblor Formation—San Benito quadrangle (Wilson, 1943), Vallecitos area (Schenck and Keen, 1940); Buttonbed Sandstone Member of Temblor Formation and Twisselmann Sandstone Member of Monterey Formation of Heikkila and MacLeod (1951), northern Temblor Range; unnamed Miocene formation, Santa Cruz Mountains, Calif. (Howe, 1922a); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967).

Range: Lower Miocene to middle Miocene.

Localities: Lower part of Olcese Sand, USGS M1593. Upper part of Olcese Sand, UCMP B1593.

Bruclarkia yaquinana (Anderson and Martin)

Plate 10, figures 8, 12, 13

Agasoma yaquinanum Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 75, pl. 4, figs. 5a, 5b.

Bruclarkia yaquinana (Anderson and Martin), Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 444–445, pl. 87, fig. 6.

Agasoma gravidum Gabb, Anderson, 1911, California Acad. Sci. Proc. ser. 4, v. 3, p. 100 [in part].

?*Bruclarkia oregonensis* (Conrad), Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 35–36 [in part], pl. 3, figs. 8, 11.

Type: California Acad. Sci. 161.

Type locality: CAS 39, Oregon coast, a little north of entrance to Yaquina Bay [Astoria Formation, middle Miocene].

This is a rather small, strongly sculptured *Bruclarkia* that occurs abundantly in the basal marine conglomeratic sandstone of the Jewett Sand at Pyramid Hill. In the Kern River district it is limited to beds considered to be of early Miocene age, although at the type locality and in the Caliente Range in eastern San Luis Obispo County, Calif., it occurs in beds of middle Miocene age. This species has not previously been reported from California localities. It was identified as *B. gravida* by Anderson (1911, p. 100) and may have been identified as *B. oregonensis* or *B. barkeriana* by others.

Bruclarkia yaquinana is characterized by four strongly raised, noded spiral cords on the body whorl. The primary spirals decrease regularly in strength downward. A few specimens have a weakly developed fifth spiral near the base of the body whorl. The regular development of these primary ribs distinguishes this species from the closely related but less spectacularly sculptured species *B. oregonensis* (Conrad), with which it has been grouped by Moore (1963, p. 35-36). The Kern River specimens are smaller and more robust than *B. oregonensis*. *Bruclarkia yaquinana* is here given full specific rank because of its unique sculpture and because, as far as is known in the San Joaquin Valley, its stratigraphic occurrence and that of *B. oregonensis*, as here defined, are mutually exclusive. Its stratigraphic utility argues strongly, therefore, for retention of the name at least as a form of *B. oregonensis*. It is interesting that the ancestral relationship with *B. oregonensis* implied by its close similarity and earlier appearance in the California Miocene record is opposite to that of *B. barkeriana* forma *santacruzana* and *B. barkeriana:* in the former, a more highly sculptured form appears first in the record; in the latter, a weakly sculptured form seems to be ancestral.

This species resembles somewhat *Bruclarkia gravida* (Gabb) from the San Ramon Sandstone of Contra Costa County, Calif. In fact, specimens from Pyramid Hill were at one time identified as that species (Anderson, 1911, p. 111). *Bruclarkia gravida* differs from *B. yaquinana* by having only three primary spirals on the body whorl, the lower two close together. The primary ribs consist of strong nodes that are much more widely spaced than on *B. yaquinana*. The uppermost row of nodes is well developed on the penultimate whorl of the lectotype (Stewart, 1927, pl. 31, fig. 10).

Distribution and stratigraphic occurrence: Lower Miocene: Nye Mudstone, Lincoln County, Oreg. (USGS loc. M2020); Painted Rock Sandstone Member of the Vaqueros Formation of Hill, Carlson, and Dibblee (1958), Caliente Range, San Luis Obispo County, Calif. (J. G. Vedder, written commun., December 1967). Middle Miocene: Clallam Formation, northwestern Washington (Durham, 1944, cf.); Astoria Formation, coastal Oregon (Anderson and Martin, 1914; Weaver, 1942); basal part of the Saltos Shale Member of the Monterey Shale of Hill, Carlson, and Dibblee (1958), San Luis Obispo County, Calif. (Vedder, unpub. data, 1967).

Range: Lower Miocene to middle Miocene.

Localities: Basal part of Jewett Sand, USGS M1590 cf., M1591; UCMP B1665.

Genus KELLETIA Fischer, 1884

Type (by monotypy): *Siphonalia kelletii* Forbes. Holocene, Santa Barbara, Calif., to San Quintin Bay, Mexico.

Kelletia lorata Addicott n. sp.

Plate 10, figures 11, 17

Shell small for genus. Spire shorter than aperture. Sutures appressed, undulatory. Sculptured by broad, flat-topped spiral ribs of variable width separated by narrow, deeply channeled grooves. Whorls angulated a little below the midpoint. On penultimate whorl, ribs increase by intercalation of secondary ribs above angulation and by splitting of primary ribs below angulation. Body whorl sculptured by about 40 spiral ribs, a few of which are of secondary strength, and by eight axial ribs that produce a strongly noded angulation. Aperture subovate; outer lip broken, lirate within. Anterior canal moderately long, reflected to the left.

Type: California Univ. Mus. Paleontology 32834.

Type locality: UCMP B1598, in an abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

Kelletia lorata is represented by the holotype and by specimens from UCLA locality AC-2-34 and AC-14 from the Round Mountain Silt labeled "*Siphonalia* n. sp. A" by Alex Clark. Although this species is only about one-third as large as the holotype of *Kelletia posoensis* (Anderson and Martin, 1914, p. 79-80, pl. 4, fig. 2), an early to middle Miocene species from central California, it can be readily distinguished from that species. The angulation of the spire on *K. posoensis* occurs at the anterior quarter of the whorls rather than near the midpoint. This angulation results in an entirely different whorl profile than in *K. lorata*. In this respect, *K. posoensis* is more nearly comparable with the living species to *K. kelletii*, although the latter species has a unique, strongly concave profile above the angulation.

Kelletia kelletii differs from *K. lorata* by having a strongly inflated body whorl, strongly nodose whorls, fewer and well-defined spiral ribs below the angulation, and a fairly strong basal angulation on the body whorl. There is a suggestion of diminution in strength of the axial sculpture on the final quarter turn of the body whorl of the holotype of *K. lorata.*

Occurrence: Upper part of Olcese Sand, USGS loc. M1599; UCMP loc. B1598. Round Mountain Silt, USGS loc. M1608?; UCLA locs. AC–2–34, AC–14.

Kelletia posoensis (Anderson and Martin)

Plate 10, figures 20, 21

Siphonalia posoënsis Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 79–80, pl. 4, fig. 2.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173.

Siphonalia (Kelletia) posoënsis Anderson and Martin, Ruth, 1942, California Univ., Dept. Geol. Sci. Bull., v. 26, no. 3, p. 297, pl. 48, fig. 6.

Type: California Acad. Sci. 174.

Type locality: CAS 126, in the bed of a small creek near the center of sec. 34, T. 28 S., R. 15 E., San Luis Obispo County, Calif. Temblor Formation, middle Miocene.

The figured specimen differs somewhat from the holotype by the slightly convex subsutural slope of its body whorl. Another difference, the relatively larger sutural angle of the Kern River specimen, is the result of slight axial compression of the shell, which also creates a more slender profile in apertural view. Because of an encrustation of gypsum and sand grains that adheres to the shell, it was impossible to prepare the specimen for satisfactory photographic reproduction of spiral sculpture. Patches of shell material that are observable through the gypsum coating indicate that relatively narrow spiral cords occur above the angulation; below there are primary cords and very narrow secondary cords crossed by fine axial lines of growth.

A smaller middle Miocene species from the upper part of the Olcese Sand and the Round Mountain Silt, *Kelletia lorata* n. sp., may be distinguished by its broad, nonspinose axial folds that occur near the middle of the whorls of the spire rather than near the base.

A fragmentary external mold of a large neptuneid that seems to be identical to *Kelletia posoensis* is in the collections from the Kern River area at the University of California at Los Angeles. A rubber cast of the mold (pl. 11, fig. 29) has a long, slightly concave, subsutural slope and nodes near the anterior suture, features characteristic of *K. posoensis.* The spiral sculpture, consisting of closely spaced deep grooves that define somewhat irregular, strap-like cords, is also similar to that of *K. posoensis.* The locality, UCLA WR163, is given as "1½ miles northwest of Pyramid Hill" on the card accompanying the specimen. This description suggests a position very close to USGS locality M1699, a locality in the lower part of the Jewett Sand. The rock type is light-grayish-brown very fine sandstone, which is characteristic of the lower part of the Jewett Sand in this area. This occurrence is a new stratigraphic record for the species, which was heretofore known only from middle Miocene strata.

Distribution and stratigraphic occurrence: Middle Miocene: Temblor Formation—La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932) and northern Temblor Range (USGS loc. M2659); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958) (Repenning and Vedder, 1961).

Range: Lower Miocene to middle Miocene.

Localities: Jewett Sand, USGS M1591; cf. UCLA WR163.

Genus CALICANTHARUS Clark, 1938

Type (by original designation): *Pisania fortis* Carpenter, 1866. Pleistocene, Santa Barbara, Calif.

Discrimination of this genus from the similar temperate to cool-water *Searlesia* is based largely on the clasping or collared suture and the sometimes strongly angulated whorls characterized by a flat to concave subsutural slope. *Calicantharus* occurs in the California Eocene and may be represented in the "Meganos Stage" of the Paleocene (Clark, 1938, p. 715). The genus became extinct during the Pleistocene.

Calicantharus kernensis (Anderson and Martin)

Plate 7, figure 18; plate 10, figures 18, 19

Chrysodomus kernensis Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 78–79, pl. 4, figs. 6a, b.

Searlesia kernensis (Anderson and Martin), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173.

Type: California Acad. Sci. 172.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

Calicantharus kernensis seems to be limited to beds of middle Miocene age in California. It occurs at a few localities in the upper part of the Olcese Sand in the Kern River district. It is reported as occurring abundantly in the Temblor Formation of the La Panza Range by Loel and Corey (1932, p. 173) and has been identified tentatively by Stewart (1946) from the Temblor Formation at Reef Ridge.

This species is the most slender and weakly angulated *Calicantharus* in the late Tertiary of California. As such it is readily distinguished from the variable Pliocene species of this genus.

"*Searlesia*" *miocenica* Etherington (1931, pl. 12, figs. 11, 18), a small, slender species known only from the type locality near the base of the Astoria Formation in southwestern Washington, may represent immature or dwarfed specimens of *C. kernensis*. The fine axial ribs of the spire, the collared suture, and the concave segment of the whorl profile beneath the suture all suggest close relationship to *C. kernensis*. The paratype of "*S.*" *miocenica* is a much shorter, broader specimen than the holotype. These characteristics suggest considerable variation in that species. Its overall appearance is that of *Calicantharus* rather than *Searlesia*.

Calicantharus carlsoni (Anderson and Martin, 1914, p. 89, pl. 5, figs. 2a, 2b), a *Priscofusus*-like taxon from the Astoria Formation of Oregon, has a much stronger angulation and finer, more numerous spiral ribs than *C. kernensis*. The angulation of *C. carlsoni* occurs lower on the spire and body whorl. This angulation produces an entirely different profile from *C. kernensis*. Axial ribbing is variable (Moore, 1963, p. 37) but much coarser than on *C. kernensis*.

The newly described *Calicantharus woodfordi* from the Olcese Sand and Round Mountain Silt has strongly angulated whorls studded with spinose nodes, thereby differing from *C. kernensis*.

Distribution and stratigraphic occurrence: Temblor Formation, Reef Ridge (Stewart, 1946, cf.), La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597–M1599, M1602; UCMP B1586, cf. B1587, B1616, ?B1621–B1623. Lower part of Round Mountain Silt, UCMP B1618.

Calicantharus rancherianus Addicott, n. sp.

Plate 11, figures 5, 20, 21

Small, low-spired, strongly noded. Subsutural collar developed on penultimate whorl. Body whorl angulated near posterior one-third line; profile concave above, convex below. Angulation bearing about 10 slightly elongate axial nodes. Spiral sculpture of alternating coarser and finer ribs below the body whorl angulation; primary spirals on upper part of the body whorl finer and of uniform strength. Aperture elongate; outer lip angulate, constricted anteriorly into a moderately long canal that is slightly twisted to the left.

Length (almost complete) 22.5 mm, width 11.3 mm.

Type: U.S. Natl. Mus. 650156.

Type locality: USGS M1591, on north side of westward-trending gully on southwest flank of Pyramid Hill in NW¼ SW¼ sec. 14, T. 28 S., R. 29 E. Basal part of Jewett Sand, lower Miocene.

Several specimens of *Calicantharus rancherianus* are in the collections from locality M1591, all of which are either encrusted with gypsum and sand grains or have much of the original shell material replaced by gypsum. As a result, it is extremely difficult to record sculptural detail in photographs, yet these details are sufficiently well preserved beneath the semitransparent coating on many specimens to permit comparison with related species.

Calicantharus rancherianus bears some resemblance to the Pliocene taxon *C. fortis* forma *angulata* Arnold (1908, p. 536, pl. 50, figs. 6, 7). The Miocene species is much more slender and has a longer anterior canal. It is slenderer, more strongly noded, and more sharply angulated than *C. fortis* Carpenter, a Pliocene to late Pleistocene (Vedder and Norris, 1963, p. 44) species.

Searlesia branneri Clark and Arnold (1923, p. 159, pl. 30, figs. 3a, 3b) from the lower Miocene (?) Sooke Formation of southern Victoria Island, British Columbia, is similar to *Calicantharus rancherianus* but has less strongly shouldered, more regularly convex whorls, a shorter anterior canal, and a weakly nodose body whorl. *Searlesia dalli* Clark (1918, p. 175, pl. 20, figs. 5, 9, 15) from the San Ramon Sandstone of Contra Costa County, Calif., also has regularly convex whorls and generally lacks axial sculpture on the body whorl. Apparently the degree to which axial sculpture is developed on the body whorl of these species is a variable characteristic and may not be as important a distinguishing feature as the angulate whorl profile of *C. rancherianus*.

Calicantharus has not been previously reported from strata of early Miocene age in California that are generally referred to the "Vaqueros Stage," although two species are known from formations assigned to the upper part of the "Blakeley Stage," which is regarded as coeval, at least in part, with the "Vaqueros Stage" (Addicott, 1967a).

Occurrence: Basal part of Jewett Sand, USGS loc. M1591.

Calicantharus woodfordi Addicott, n. sp.

Plate 10, figure 6; plate 11, figures 17, 18

Of medium size, strongly angulated with moderately fine spiral sculpture. Spire stout, later whorls with a collared suture. Whorl profile flat to concave above the angulation, vertical below. Body whorl large, with a prominent concave subsutural tabulation. Angulation bearing 12 weak nodes that are elongated axially. Sutural collar broad, flat topped. Surface sculptured by alternating rounded primary and secondary ribs that become broader toward the base. Aperture elongate, outer lip broken. Base constricted into a short anterior canal. Inner lip smooth, parietal callus very thin; columellar segment thick, bounded by an impressed line. Siphonal fasciole sculptured by five spiral ribs and fine growth lines. Base of columella with an incipient umbilicus.

373-855 O—70——7

Height (almost complete) 35.5 mm, width 18.3 mm.

Types: Holotype, U.S. Natl. Mus. 650161; paratype, USNM 650146.

Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south 350 feet west of NE cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

Calicantharus woodfordi is a finely sculptured, strongly angulate species readily separable from other Tertiary species of this genus. It is stouter and more strongly noded than *C. posoensis* (Anderson and Martin), with which it occurs in the upper part of the Olcese Sand. The delicate spiral ribbing resembles that of the California Pliocene species *C. humerosus* (Gabb), but the two can be distinguished by the noded angulation of *C. woodfordi.*

The paratype (pl. 10, fig. 6) illustrates variation in spire height and overall elongation of some individuals. The deformed shell was originally more slender than indicated by the figure, the photograph having been taken perpendicular to the plane of crushing.

Occurrence: Lower part of the Olcese Sand, USGS loc. M1698 cf. Upper part of Olcese Sand, USGS loc. M1597. Round Mountain Silt, USGS loc. M1605.

Calicantharus cf. C. kettlemanensis (Arnold)

Plate 11, figure 30

An incomplete specimen of *Calicantharus* with sculpture preserved only on the final quarter-turn of the body whorl is comparable to the Pliocene species *C. kettlemanensis* (Arnold, 1909, p. 69–70, pl. 15, fig. 4; pl. 21, figs. 1, 1a) originally described from the Jacalitos Formation and the Etchegoin Formation on the west side of the San Joaquin Valley. The varix on the nonapertural side of the body whorl is a resting stage that has been emphasized by selective exfoliation of shell material. It is indicative of a crenulated outer apertural lip, collared suture, and well-developed posterior siphonal notch, features that are characteristic of Pliocene species of *Calicantharus*. The arrangement of nodes and details of spiral sculpture are similar to some of the inflated, strongly noded specimens of *C. kettlemanensis.*

There are no undoubted records of *Calicantharus kettlemanensis* in pre-Pliocene rocks.

Occurrence: Lower part of Round Mountain Silt, USGS loc. 6063.

Family BUCCINIDAE

Genus MACRON H. and A. Adams, 1853

Type (by subsequent designation Cossmann, 1901): *Pseudoliva kellettii* A. Adams [= *M. aethiops* (Reeve) fide Keen, 1958a, p. 404]. Holocene, outer coast of Baja California and Gulf of California.

Macron aethiops (Reeve)

Plate 11, figures 25–27

Buccinum aethiops Reeve, 1847, Conchologia iconica, v. 3, pl. 13, fig. 108.

Macron aethiops (Reeve), Keen, 1958, Sea shells of tropical West America, p. 404, fig. 556.

Pseudoliva kellettii A. Adams, 1854, Zool. Soc. London Proc. for 1853, p. 185.

Macron kellettii (A. Adams), Tyron, 1881, Manual of conchology, v. 3, p. 214, pl. 82, fig. 477.

Macron aethiops (Reeve) variety *kellettii* (A. Adams), Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 650, pl. 28, fig. 8.

Specimens identified as *Macron aethiops* (Reeve) are distinguished from the middle Miocene species *M. merriami* Arnold (1907, p. 529, pl. 41, figs. 4, 4a) by their strongly inflated body whorl, broad apical angle, and broadly rounded posterior tabulation of the body whorl. In profile the shell is conical rather than elliptical, and the sides of the body whorl are more nearly flat than convex.

The California Miocene specimens are conspecific with a weakly sculptured form of *Macron aethiops* in U.S. National Museum collections from Cedros Island and San Quintin on the outer coast of Baja California, USNM localities 265240 and 34510. This is the form that Grant and Gale (1931, p. 650, pl. 28, fig. 8) figured as *M. aethiops* var. *kellettii* (A. Adams) from Scammons Lagoon, Baja California. Theirs is a more angular specimen than the Holocene and Miocene specimens mentioned above, yet it seems to fall well within the broad range of variation of this species. Typical *M. aethiops* has spiral sculpture on the upper part of the body whorl and on the spire (Grant and Gale, 1931, p. 650). The doubtfully reported occurrence of "*M. aethiops kelletti*" at Catalina Island, Calif. (Cooper in Dall, 1921, p. 89) was later regarded as erroneous (Burch, 1945, no. 50, p. 11).

Macron aethiops has not been reported from beds older than Pliocene in California. Pleistocene specimens are recorded from the western part of the Los Angeles basin by Woodring and others (1946, p. 75), Cooper (1894), Arnold (1903), and Grant and Gale (1931).

An early Miocene buccinid from the Isidro Formation in Baja California, "*Macron*" *hartmanni* Hertlein and Jordan (1927, p. 629–630, pl. 18, fig. 2; pl. 21, fig. 5), has been considered ancestral to the living *M. aethiops* by Grant and Gale (1931, p. 650). The deeply channeled suture and unique posterior extension of the aperture of that species suggest assignment to the early and middle Miocene genus *Nicema* Woodring (1964, p. 268) or possibly *Triumphis*. In any event, it is separable from the middle Miocene to

Holocene *M. aethiops* by its sharply angulated tabulation, convex body-whorl profile, and finer more numerous spiral grooves on the body whorl.

Occurrence: Lower part of Olcese Sand, SU loc. BR101; UCLA loc. MB1400.

Genus TRIUMPHIS Gray, 1857

Type (by monotypy): *Buccinum distortum* Wood. Holocene, Costa Rica to Ecuador.

Triumphis? n. sp.

Plate 11, figure 23, 24

Relatively small, low spired, thick shelled. Spire, dome shaped. Body whorl very large, tabulate posteriorly. Posterior collar set off by constricted area bearing two closely spaced spiral grooves. Surface nearly smooth, sculptured by faint, widely spaced microscopic spiral grooves and numerous axial striae. Base of body whorl with six strong, spiral cords, two of which are split by fine medial grooves. Aperture elongate, posterior part constricted into a narrow slot-like canal.

Height (incomplete) 18 mm, width (nearly complete) 13.3 mm.

Figured specimen: California Univ., Los Angeles 45768.
Locality: UCLA MB1400, "Top of Py[ramid Hill] Sand, Poso Creek." Matrix and other species from this locality suggest the material is from the lower part of the Olcese Sand exposed on the south side of Poso Creek, near the center of sec. 9, T. 28 S., R. 29 E., Woody quadrangle.

Triumphis? n. sp. is represented by two specimens from the lower part of the marine Miocene sequence on Poso Creek. They are in a collection which contains specimens of the similar buccinid *Macron aethiops*, from which they can be readily distinguished by the sharply tabulate, spirally sculptured collar on the body whorl and the elongate posterior canal. This species is similar to *Nicema hartmanni* (Hertlein and Jordan, 1927, p. 629–630, pl. 18, fig. 2; pl. 21, fig. 5) from the lower Miocene of Baja California, Mexico, but differs from that species by its well-developed sutural collar and narrow, extremely long posterior canal.

If correctly assigned to *Triumphis*, the Miocene species from the Olcese Sand is the first Tertiary occurrence of this heretofore monotypic, tropical genus. The figured specimen has been compared with Holocene specimens of *T. distorta* from near Paita, Peru (USNM 368541). Broad similarities between the two suggest generic affinity, but the Holocene specimens do not have the sharp sutural collar of *T.* ? n. sp. Assignment to *Triumphis* is qualified because of the incomplete condition of the fossil specimens, particularly of the aperture.

Occurrence: Lower part of Olcese Sand, UCLA loc. MB1400.

Genus MOLOPOPHORUS Gabb, 1869

Type (by monotypy): *Bullia (Molopophorus) striata* Gabb. Tejon Formation, upper Eocene, California.

Molopophorus anglonanus (Anderson)

Plate 11, figures 1–4

Bullia (Molopophorus) anglonana Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 205, pl. 16, figs. 74–76.
Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100.
Molopophorus anglonana (Anderson), Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 470, pl. 90, figs. 14–16, 18, 23.
Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 97–98, pl. 13, figs. 1, 2, 4, 5 7 10 14–16.
Hanna and Hertlein 1943, California Div. Mines Bull. 118, p. 174, fig. 64–14.
Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 37–38, pl. 3, figs. 1, 4.
?*Molopophorus*, cf. *M. anglonana* (Anderson), Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 38, pl. 3, fig. 5.
Molopophorus anglonanus (Anderson), Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, p. C106, fig. 4L.

Original description.—Shell moderate in size, 1 inch in length, ¾ inch in width; spire moderately elevated; aperture broad, lip simple, notched above; columella crusted, whorls angulated, bearing tubercular, or spinose nodes above, and on lower part of body whorl; surface ornamented with lines of growth, and with revolving lines, strongest on the lower portion of the body whorl. The anterior notch is deep and bordered by 2 strong folds which extend upward, revolving obliquely around the columella, forming a wide canal, shown only in figure 74 [Anderson, 1905].

Lectotype: California Acad. Sci. 91 (selected by Weaver, 1942, p. 470–471).
Locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse (probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quad.). Upper part of the Olcese Sand, middle Miocene.

Molopophorus anglonanus is one of the more characteristic ornate gastropods occurring in the Kern River Miocene. Its lowest stratigraphic occurrence is in the Round Mountain Silt. As far as is known, this is the highest occurrence of the genus in the California Tertiary. The lowest stratigraphic occurrence of the genus is in the type Meganos Formation (Clark and Woodford, 1927, p. 117) of early Tertiary age.

Specimens of a stout, weakly sculptured *Molopophorus* from the Astoria Formation of southwestern Washington that have been identified as *M. anglonanus* by Etherington (1931, pl. 13, figs. 1, 2, 4, 5, 7, 10, 14) differ in some respects from topotype specimens from the Kern River district. They have a smooth to weakly noded subsutural collar that is generally weaker than on the topotypes and a more weakly noded body whorl angulation. Two of Etherington's specimens (1931, pl. 13, figs. 2, 14) are very close to the Kern River specimens. His other hypotypes have finer axial nodes that occur near the middle of the body whorl rather than on the lower part. These specimens suggest a broader range of variation within *M. anglonanus* in the Astoria Formation of southwestern Washington.

Weaver (1942, p. 471) suggested that *Molopophorus matthewi* Etherington (1931), also from the Astoria Formation of Southwestern Washington, is more closely related to other species than to *M. anglonanus*. Moore (1963, p. 38) suggested that it might best be treated as a distinct species rather than a subspecies of *M. anglonanus*, a practice followed herein. Specimens of *M. matthewi* have been collected from only one locality in California, USGS M3605 in the Temblor Formation of the Griswold Hills in San Benito County.

An abraded specimen from the Astoria Formation in Oregon identified by Moore as *Molopophorus* cf. *M. anglonana* (1963, pl. 3, fig. 5) has a weakly noded angulation and sutural collar, possibly the result of abrasion. The spire is considerably higher than on specimens of *M. anglonanus*.

Despite its wide geographic range during the Miocene, *Molopophorus anglonanus* is definitely known from only four limited areas along the Pacific coast. It is noteworthy that the California occurrences are limited to the east side of the San Andreas fault.

Distribution and stratigraphic occurrence: Astoria Formation, Montesano quadrangle, southwestern Washington (Etherington, 1931); near Astoria, Oreg. (Moore, 1963); Yaquina Head, Lincoln County, Oreg. (Moore, 1963, cf.). Empire Formation of Diller (1903), near Cape Blanco, Oreg. (USGS loc. M2142, cf.). Gould Shale Member of the Monterey Shale, Temblor Range, Kern County, Calif. (USGS loc. M3283).

Range: Lower Miocene to middle Miocene.

Localities: Lower part of Jewett Sand, USGS M1591. Upper part of Olcese Sand, USGS 6890, M1597, M1599–M1602, M1693; UCMP B1586, B1587, B1593–B1600, B1603, B1615, B1616, B1621, B1623, B1624, 1642. Round Mountain Silt, USGS M1604, M1605.

Genus ANTILLOPHOS Woodring, 1928

Type (by original designation): *Cancellaria candei* d'Orbigny. Holocene, North Carolina to Cuba and eastern Gulf of Mexico.

Antillophos posunculensis (Anderson and Martin)

Plate 11, figures 6, 8–11, 13, 28

Pleurotoma (Clathurella) dumblei Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 204–205, pl. 15, figs. 60, 61.
Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100. [Not *Pleurotoma (Drillia) dumblei* Harris, 1895, Philadelphia Acad. Nat. Sci. Proc., p. 59, pl. 5, fig. 2].
Amphissa posunculensis Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 72–73, pl. 7, figs. 11a, b.
Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 171.
"Amphissa" posunculensis Anderson and Martin, Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 36.
Nassa chehalisensis Weaver, 1916, Washington Univ. (Seattle) Pubs. Geology, v. 1, no. 1, p. 46–47, pl. 5, figs. 69, 70.
Tritiaria (Antillophos) dumblei var. *chehalisensis* (Weaver), Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 100–101, pl. 12, figs. 6, 21, 22.
Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 463, pl. 89, figs. 23, 24, 29, 30.
Antillophos dumbleana chehalisensis (Weaver), Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 37.
Phos dumbleana Anderson in Hanna, 1924, California Acad. Sci. Proc., ser. 4, v. 13, p. 183
Phos (Antillophos) dumbleana Anderson in Hanna, Keen, 1943, San Diego Soc. Nat. History Trans. v. 10, no. 2, p. 37.
Cancellaria posunculensis Anderson and Martin, Hanna and Hertlein, 1943, California Div. Mines Bull. 118, p. 172, fig. 63–5.
?*Cancellaria posunculensis* Anderson and Martin, Lutz, 1951, California Univ., Dept. Geol. Sci. Bull., v. 28, no. 13, p. 392, pl. 18, fig. 12.

Supplementary description of Kern River specimens.—Shell of medium size, high spired, surface finely cancellate. Spire consisting of five to six whorls, tapering uniformly toward nucleus. Nuclear whorls sculptured by numerous fine axial and spiral threads. Penultimate whorl with closely spaced axial ribs of variable strength crossed by evenly spaced spiral ribs forming nodose intersections. Interspaces occupied by secondary spirals of variable strength, some nodose. Sutures incised. Body whorl with an occasional varix and generally strong spiral ribs that become relatively stronger near base. Axial ribs less regularly spaced and generally weaker than spiral ones. Larger specimens with broad shoulder near posterior one-quarter line of body whorl. Outer lip with internal lirae that usually do not reach the edge of outer lip; within the aperture they break up into elongate nodes. Inner lip encrusted by thin callus, base set off by well-developed fold above which there are a shallow groove and a weaker fold. Base of columella reflected to left. Siphonal fasciole sculptured by about four spiral ribs and bounded by the basal columellar fold below and a strongly raised rib above in large specimens.

Types: Holotype, California Acad. Sci. 153; paratype, CAS 154.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

Type of *Pleurotoma dumblei* Anderson: California Acad. Sci. 66.

Type locality: In the vicinity of Barker's Ranch (headquarters formerly near the center of sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle). This and other newly described species were collected "chiefly north of the river" (Anderson, 1905, p. 187).

Type of *Nassa chehalisensis* Weaver: California Acad. Sci. 564.

Type locality: Washington University (Seattle) 230, cut in North River branch of Chicago, Milwaukee and St. Paul and Pacific Railway in sec. 27, T. 17 N., R. 8 W., Grays Harbor County, Wash. Astoria Formation, middle Miocene.

The types of *Antillophos posunculensis* are poorly preserved, decorticated specimens that do not clearly show sculptural detail or apertural characteristics. Yet the whorl proportions and small remaining areas of shell material on the penultimate whorls clearly indicate that they are identical to "*Pleurotoma*" *dumblei* Anderson, a homonym that was renamed *Phos dumbleana* Hanna (1924). Both types are from the same stratigraphic interval and geographic area. It is of some interest that whereas *A. posunculensis* was included in Anderson and Martin's faunal list (1914, p. 41–44), the earlier "*P.*" *dumblei* was not. The apparently shorter anterior canals of the types of *A. posunculensis* are within the relatively broad range of variation defined by the abundant specimens of this taxon from the upper part of the Olcese Sand and the Round Mountain Silt. The absence of a siphonal fasciole on the paratype (Anderson and Martin, 1914, pl. 7, fig. 11b) is due to decortication; this specimen closely resembles internal molds of *A. posunculensis* from the Olcese Sand.

Antillophos posunculensis first appears in the lower Miocene of California, where it is known from a single specimen collected from the lower part of the Jewett Sand northwest of Pyramid Hill (USGS loc. M1699). It is one of the most widespread middle Miocene mollusks on the Pacific coast and occurs at several localities from western Washington to southern California. The only recorded upper Miocene occurrence of this species is from well cores of the Santa Margarita Formation at Fruitvale oil field west of Bakersfield, Calif. (Gale in Preston, 1931, p. 16).

This species differs from the type of *Antillophos*, *A. candei* (d'Orbigny), by the absence of spiral ridges on the inner wall of the aperture. In this characteristic it resembles the Recent eastern Pacific *A. veraguensis* (Hinds), an evenly reticulate species that Woodring (1964, p. 265) regards as a descendant from the same ancestral stock as *A. candei*. Perhaps the absence of ridges on the columellar and parietal walls of the Miocene and Holocene eastern Pacific species and their varices are evidence of an endemic eastern Pacific subgeneric group. In any event the modern *A. veraguensis* seems closely related to *A. posunculensis*.

Among the Holocene eastern Pacific species that are customarily grouped under *Phos* in a rather broad usage of that genus (Strong and Lowe, 1936; Keen, 1958a), only *A. veraguensis* has axial sculpture (Strong and Lowe, 1936, pl. 22, figs. 2, 8, 11) as delicate as *A. posunculensis*. Woodring (1928, p. 260) observed that none of the Holocene *Phos*-like species from the Panamic molluscan province closely resemble the type species *P. senticosus*. Strong and Lowe (1936, p. 316) doubted the assignment of "*Nassa*" *chehalisensis* Weaver to *Phos*. They suggested that it appeared to be closer to *Nassarius* of the *N. perpinguis* group. It lacks the angulated whorls and strong basal sulcus on the body whorl of the type species of *Phos*, *P. senticosus* (Linné), a Holocene Western Pacific and Indo-Pacific species figured by Kira (1962, pl. 27, fig. 10).

"*Nassa*" *chehalisensis* was described from the Astoria Formation of the Montesano quadrangle, southwestern Washington. It has been variously regarded as a variety or subspecies of *Phos dumbleana* Hanna (Etherington, 1931; Weaver, 1942; Moore, 1963). Differences between it and the California Miocene specimens, according to Etherington and Weaver, are the shorter, stouter shell, broader apical angle, and shorter columella. Comparison of variation in apical angle and spire height of Kern River specimens with sizeable collections of "*Nassa*" *chehalisensis* from USGS localities M1495 and M1518, in the same part of the Astoria Formation as Weaver's type locality but about 6–7 miles to the east, indicates no appreciable differences in these characteristics. The Washington specimens tend to develop somewhat stronger, more uniformly spaced axial ribs and a papillose surface. Yet there are some individuals with sculpture as delicate as the Kern River specimens, clearly indicating morphologic overlap of these widely separated populations.

One specimen is known from the Astoria Formation in Oregon—USGS locality 18907 at Yaquina Head, Newport County, Oreg. (Moore, 1963, p. 37).

Distribution and stratigraphic occurrence: Middle Miocene: Astoria Formation — Montesano quadrangle, southwestern Washington (Etherington, 1931); Yaquina Head, Lincoln County, Oreg. (Moore, 1963). Temblor Formation—Reef Ridge, Calif. (Stewart, 1946); La Panza Range (Loel and Corey, 1932, p. 173) [possibly a typographical error as this species is not recorded in the adjoining "Kern River" column]. Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (Repenning and Vedder, 1961). Middle part of Altimira Shale Member of Monterey Shale (Woodring and others, 1946). Topanga Formation: San Joaquin Hills (Vedder, unpub. data, 1958); Santa Ana Mountains (Vedder and Woodring, unpub. data, 1953). Upper Miocene: Santa Margarita Formation, Fruitvale oil field (Gale in Preston, 1931).

Range: Lower Miocene to upper Miocene.

Localities: Jewett Sand, USGS M1699. Upper part of Olcese Sand, USGS 6624, 6890, M1596, M1597, cf. M1598, M1600–M1602, M1697; UCMP B1586, B1587, B1593, B1595, B1596, B1598–B1600, ?B1601, B1603, B1614, B1621–B1624, B1753. Round Mountain Silt, USGS 3886, 6063, 6065, 6067, 6612, 6621–6623, 6641, M1603–M1605, M1608–M1610, M1612, M1613, M1696, M2480; UCMP B1618, B1619, B1625, B1638, cf. B1678.

Antillophos woodringi Addicott, n. sp.

Plate 11, figures 7, 12, 14, 19, 22

Small, moderately thick shelled. Nuclear whorls smooth to the beginning of third whorl, at which point fine protractive axial riblets crossed by four spiral threads originate. Early whorls of spire angulated near posterior one-quarter line, surface smooth above angulation. Three evenly spaced primary spirals on lower three-quarters of whorls. Penultimate whorl with nine broad axial ribs that are nodose at intersection with primary spiral ribs. One or two secondary spiral threads occupy interspaces on later whorls of the spire. Suture wavy, bordered above by a spiral cord of secondary strength. Body whorl with nine primary spiral cords and 10 axial ribs. Usually two or three secondary threads occupy space between primary spiral ribs. Aperture elongate, outer lip not thickened, lirate within but lirae do not reach the edge of lip. Inner lip with narrow callus, prominent fold at base, above which there is another fold of secondary strength. Siphonal fasciole broad, flat, bearing four spiral cords. Anterior canal moderately well developed, slightly inclined to left.

Length (almost complete) 11.6 mm, width 5.5 mm.

Type: U.S. Natl. Mus. 650165.

Type locality: USGS M1597, in an abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

This species is represented by several specimens from the type locality in the upper part of the Olcese Sand. The strength of the subsutural angulation is variable. On one specimen it is reflected by only an accentuated primary spiral cord. Axial ribs on the body whorl range from 10 to 14 in number. The basic developmental pattern of primary sculpture on the holotype, however, is repeated on the other more finely sculptured specimens. As with the extremely abundant *Antillophos chehalisensis* with which it occurs, there are denticles or folds on the upper part of the columellar lip.

Antillophos woodringi is lower spired and stouter and possesses a more clearly differentiated pattern of primary and secondary spiral sculpture than "*Phos*" *articulatus* Hinds (Strong and Lowe, 1936, pl. 22, fig. 6), a similar species from the Panamic molluscan province of the eastern Pacific Ocean.

A similar form occurs in the middle Miocene Saltos Shale Member of the Monterey Shale of Hill, Carlson, and Dibblee (1958) in the Caliente Range of eastern San Luis Obispo County (J. G. Vedder, written commun. December 1967).

Occurrence: Basal part of Jewett Sand, USGS loc. M1591?. Upper part of Olcese Sand, USGS loc. M1597.

Family NASSARIIDAE

Genus NASSARIUS Duméril, 1806

Type (by monotypy): *Buccinum mutabile* Linné. Holocene, Mediterranean.

The status of Duméril's names is a perplexing problem to taxonomists. As with *Nassarius*, as discussed by Woodring (1928, p. 264–265; 1964, p. 270), it is a question of whether Dumeril proposed *Nassarius* as a substitute name for *Nassa* Lamarck, 1799, a homonym of *Nassa* Röding, 1798, or as an entirely new name. In following the first possibility, there is the further problem of whether the name on Duméril's list was an emendation of *Nassa* Lamarck or *Nassa* Röding. The alternative approach, and the one most recently followed by Woodring (1957, p. 85; 1964, p. 270), makes *Buccinum arcularia* Linné the type species. *Buccinum arcularia* has a heavy parietal callus that flows outward onto the body whorl and a well-defined posterior notch in the aperture. This differentiates it from *B. mutabile* and the species that are here grouped under *Nassarius*.

Subgenus CATILON Addicott, 1965

Type (by original designation): *Nassa arnoldi* Anderson. Middle Miocene, California to Washington.

Nassarius (Catilon) arnoldi (Anderson)

Plate 12, figures 3, 4, 7, 12–15

Nassa arnoldi Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 204, pl. 16, figs. 70, 71.

Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100.

Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 43.

Nassarius (*Hima*) *arnoldi* (Anderson), Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 99, pl. 12, figs. 15, 19.

Nassarius (Uzita) arnoldi (Anderson), Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 679.

Nassarius arnoldi (Anderson), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 461, pl. 89, fig. 14.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, C106, fig. 4f.

Uzita? arnoldi (Anderson), Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 39, pl. 5, figs. 14, 16–20.

Nassarius (Catilon) arnoldi (Anderson), Addicott, 1965, U.S. Geol. Survey Prof. Paper 503–B, p. 12–13, pl. 3, figs. 1–3, 10, 15.

Original description.—Shell small, acutely ovate; spire moderately elevated, bearing five whorls; aperture circular, outer lip always bordered by a thickened varix; columella short, bearing only a slight, or no sulcus; surface ornamented by spiral and longitudinal ridges forming a reticulation as in the young of *N. perpinguis* Hds.

Types: Holotype lost during the 1906 San Francisco fire; neotype (designated by Addicott, 1965b), U.S. Natl. Mus. 648577.

Type locality: In the vicinity of Barker's Ranch [headquarters formerly near the center of sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle]. This and other newly described species were collected "chiefly north of the river" (Anderson, 1905, p. 187). The neotype is from USGS loc. M1597 (in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle), which is within Anderson's generalized description of the original type locality. Upper part of Olcese Sand, middle Miocene.

Nassarius arnoldi is one of the more useful mollusks in stratigraphic correlation of Miocene formations of the Pacific coast. It is of widespread occurrence from western Washington to the southern part of California and is restricted in stratigraphic distribution to strata that are classified as middle Miocene according to the megafossil chronology of Weaver and others (1944, chart). Accordingly, *N. arnoldi* is one of the very few molluscan indices to the "Temblor Stage" of California. The only undoubted early Miocene occurrence of *Nassarius* in California is on Santa Rosa Island off southern California, where a single specimen of *N. churchi* (Hertlein, 1928, p. 156, pl. 22, fig. 2) is recorded from the Vaqueros Formation. Hertlein's minute species differs from *N. arnoldi* by its distinctive sculpture, which consists of both fewer spiral threads and coarse axial folds. Moreover, the holotype of *N. churchi* has an "apparently smooth" inner lip (Hertlein, 1928, p. 156).

Nassarius antiselli (Anderson and Martin, 1914, p. 76–77, pl. 7, fig. 16), a somewhat similar species that has been doubtfully assigned to *Catilon* (Addicott, 1965b), can be differentiated from *N. arnoldi* by its fewer, strongly papillose spiral ribs and weak basal furrow.

Characteristic morphologic features of this small nassariid are its sharply delimited aperture, margined by a well-defined callus on the parietal-columellar side and an outer lip that is coarsely denticulate within and varixed externally. Varices are apt to occur at earlier stages of growth. The stout body whorl is sculptured by 10–13 spiral cords that are generally of much weaker strength than the variable axial sculpture.

Specimens of *Nassarius arnoldi* from the vicinity of the type locality are characteristically small, have a short conical spire, and do not show much sculptural variation. At other localities, however, there is a considerable amount of variation in sculpture and spire height. Spiral ribbing predominates on a few specimens (pl. 12, fig. 7); on others, axial ribbing is equal to or much stronger than the spiral cords. Some of the larger specimens differ considerably from typical specimens of *N. arnoldi* by having a relatively high spire with moderately convex whorls. These high-spired individuals are clearly intergradational with the small, stout form characteristic of this species. An extreme example is shown on plate 12, figure 13.

This species has been mistakenly identified from the upper Miocene Modelo Formation of the eastern Ventura basin (Daviess in Oakeshott, 1958). Specimens in the collection from UCLA locality 2018 labeled *N. arnoldi* are of a relatively large species that seems to be intermediate between *N. arnoldi* and *N. stocki* Kanakoff, an early Pliocene species.

Distribution and stratigraphic occurrence: Clallam(?) Formation, Clallam County, Wash. (Arnold and Hannibal, 1913). Uppermost part of Lincoln Formation of Weaver (1912) or lowermost part of Astoria Formation, Grays Harbor County, Wash. (Addicott, 1965b). Astoria Formation—Grays Harbor County, Wash. (Etherington, 1931; Weaver, 1942); Astoria, Oreg. (Arnold and Hannibal, 1913); Cape Lookout, Oreg. (Addicott in Mangum, 1967, cf.); Lincoln County and Coos County, Oreg. (Moore, 1963). Monterey Shale, Point Reyes Peninsula and western Napa County, Calif. (Weaver, 1949). Monterey Group, western Contra Costa County (Weaver, 1949). Monterey Formation, Monterey Peninsula (Arnold and Hannibal, 1913). Temblor Formation—La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932); Reef Ridge (Stewart, 1946). Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967). Unnamed Miocene sandstone, San Rafael Mountains (Vedder and others, 1967).

Range: Middle Miocene.

Localities: Middle part of Olcese Sand, USGS M1698?. Upper part of Olcese Sand, USGS 6619, M1597, M1601, M1602; UCMP B1596, B1598, B1600, B1603, B1614, ?B1616, ?B1621, B1624, B1641. Round Mountain Silt, USGS 3886, 6063–6065, 6067, 6068, 6621–6623, M1604, M1608–M1610, ?M1611, M1612, M1613, M2480; UCMP B1618, B1620, B1625, B1637, B1638.

Subgenus PHRONTIS H. and A. Adams, 1853

Type (by subsequent designation, Cossmann, 1901): *Nassa tiarula* Kiener. Holocene, Philippine Islands and Solomon Islands (Tryon, 1882).

Miocene species included in this subgenus seem to be related to Panamic-Pacific nassariids included in *Arcularia* by Keen (1958a). Figures of *Buccinum* *gibbulosum* Linné, the type of *Arcularia*, show an enormous parietal callus that envelops the apertural side of the body whorl and much of the spire, whereas the callus of *Nassa tiarula*, the type of *Phrontis*, is much more restricted and does not extend upward onto the spire. The outer lip of *Phrontis* is externally thickened by a varix and the sculpture is usually dominated by axial folds that are strongest posteriorly. Species assigned to *Catilon* (Addicott, 1965b), a somewhat similar subgenus, differ by their reticulate sculpture, nontabulate sutures, and narrow, sharply margined parietal-columellar callus. A species formerly included in *Catilon*, *Nassarius smooti* Addicott, is here reassigned to *Phrontis*.

Nassarius (Phrontis) smooti Addicott

Plate 12, figures 8–11

Nassarius (Catilon) smooti Addicott, 1965, U.S. Geol. Survey Prof. Paper 503–B, p. 13, pl. 3, figs. 7–9.

Type: U.S. Natl. Mus. 648578.

Type locality: USGS M1597, in an abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of SW. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

This species is placed in *Phrontis* rather than *Catilon* (Addicott, 1965b, p. 13) because of its subtabulate coronate sutures and thick parietal callus that is apt to roll out a variable, but relatively short, distance onto the body whorl. These features, in addition to the body whorl sculpture of coarse axial folds, permit immediate discrimination from the somewhat similar *N. arnoldi* with which it occurs. Variation in spiral sculpture is shown by the development of secondary spirals on an incomplete topotype.

Nassarius smooti is rare in the upper part of the Olcese Sand, there being only three specimens in collections from the type locality. Poorly preserved external molds from the upper part of the Round Mountain Silt (USGS loc. 6609) are doubtfully identified as *Nassarius* cf. *N. smooti*. They have a comparable number of spiral ribs but finer and more numerous axial ribs (pl. 12, fig. 2).

Occurrence: Upper part of Olcese Sand, USGS loc. M1597, cf. M1602. Upper part of Round Mountain Silt, USGS loc. 6609 cf.

Nassarius (Phrontis) harrellensis Addicott, n. sp.

Plate 12, figures 5, 6

Small, stout, with a large, nearly smooth body whorl. Spire of five whorls including a smooth nucleoconch of about two whorls. Later whorls with prominent axial folds crossed by five to six flat spiral cords that become obsolete on penultimate whorl. Base of penultinate whorl with a strong spiral groove. Upper part of body whorl smooth, lower part with four spiral ribs. Aperture subovate; outer lip thickened externally by a narrow varix, nonlirate within. Inner lip with a thick parietal callus extending outward onto the body whorl. Siphonal fasciole sculptured by six spiral cords and set off posteriorly by a well-developed spiral fossa.

Height 11.8 mm, width 6.7 mm.

Type: U.S. Natl. Mus. 650173.

Type locality: USGS 3886, bluffs on north side of Kern River a mile below power-development station (probably N½ sec. 1, T. 29 S., R. 29 E.). Lower part of Round Mountain Silt, middle Miocene.

A fairly well preserved specimen is available for description. Its smooth body whorl and subdued spiral sculpture distinguish this species from *Nassarius smooti*, which it otherwise resembles rather closely. An apparent difference between these species is the nonlirate interior of the aperture of *N. harrellensis*, but the narrow roughened zone on the holotype does not preclude the presence of marginal denticles.

The possibility that *Nassarius harrellensis* is a smooth form of *N. smooti* must be considered. The relationship of *N. insculptus* (Carpenter) and *N. eupleura* (Dall) may have some bearing on this problem. *Nassarius insculptus* is a relatively smooth form with axial sculpture restricted to the spire, whereas in *N. insculptus* forma *eupleura* (Dall) axial ribs continue onto the body whorl. Demond (1952, p. 314) observed intergradation of these two forms in collections of Recent material. *N. harrellensis* is provisionally considered a separate species because it is not linked to *N. smooti* by intermediate forms. In fact, there is no suggestion of diminution of spiral sculpture on the body whorl of available specimens of *N. smooti*.

Occurrence: Lower part of Round Mountain Silt, USGS loc. 3886.

Nassarius (Phrontis) ocoyanus (Anderson and Martin)

Plate 12, figures 17–19

Nassa ocoyana Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 75–76, pl. 7, fig. 17.

Nassarius ocoyana (Anderson and Martin), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Nassarius ocoyanus (Anderson and Martin), Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

Addicott, 1965, U.S. Geol. Survey Prof. Paper 503–B, p. 16–17, pl. 3, figs. 19, 26–28.

? *Nassa blakei* Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 76, pl. 7, figs. 15a, b.

? *Nassarius blakei* (Anderson and Martin), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

Type: California Acad. Sci. 163.

Type locality: CAS 64, in bottom of small canyon about 1¼ miles due north of Barker's ranch house. Upper part of Olcese Sand, middle Miocene.

Type of "*Nassa*" *blakei:* California Acad. Sci. 180.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

This slender, distinctively turreted species occurs at a few localities in the upper part of the Olcese Sand and lower part of the Round Mountain Silt. It is characterized by coarse axial sculpture on the spire and a slender, smooth-sided body whorl with axial nodes at the top and two spiral cords near the base. The outer lip is thickened by a varix and there are weak denticles within on one well-preserved specimen. There is sufficient variation in the height of the spire of recently collected specimens from the Round Mountain Silt (locs. B1637 and B1638) to suggest the possibility that *N. blakei* (Anderson and Martin, 1914, p. 76, pl. 7, figs. 15a, 15b) is a low-spired form of this species (Addicott, 1965b).

Distribution and stratigraphic occurrence: Temblor Formation, La Panza Range, eastern San Luis Obispo County (Anderson and Martin, 1914; Loel and Corey, 1932); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee and others (1958), Caliente Range (Addicott, 1965b).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, CAS 65?. Lower part of Round Mountain Silt, USGS M1612; UCMP B1637, B1638, cf. B1639.

Nassarius (Phrontis?) posoensis Addicott, n. sp.

Plate 12, figures 1, 2

Shell small, later whorls becoming smooth, sutures tabulate. Nucleus of two smooth whorls, later whorls sculptured by about 12 smooth axial ribs that become obsolete on the penultimate or body whorl. Whorls of the spire with a spiral groove near the anterior and posterior margins. Upper part of body whorl marked by closely spaced retractive axial growth lamellae that form a finely noded subsutural collar above the anterior spiral groove. Below the midline occurs a series of about eight spiral grooves that become stronger and more crowded toward the base. Aperture subcircular, outer lip rather thin, with a poorly defined external thickening that may represent a varix. Parietal callus very thin, extending outward onto parietal wall, edge indistinct. Columellar callus bearing weak denticles near base.

Height (almost complete) 10.5 mm, width 7 mm.

Type: U.S. Natl. Mus. 650168.

Type locality: USGS M1593, cut on road to abandoned well location, a few hundred feet northwest of center sec. 9, T. 28 S., R. 29 E., Woody quadrangle. Lower part of the Olcese Sand, middle Miocene.

Nassarius posoensis is represented by two external molds from the type locality in the lower part of the Olcese Sand. The holotype is a finely detailed specimen quite unlike any of the Holocene eastern Pacific Ocean species included in this subgeneric group [*Arcularia* of Keen (1958a)].

There is a certain similarity to *Nassarius harrellensis* (pl. 12, figs. 5, 6), a species from the lower part of the overlying Round Mountain Silt. The callus of that species is much thicker and it lacks the fine axial sculpture and subsutural collar of *N. posoensis.* The Olcese Sand species is a more slender, seemingly more delicate shell.

Assignment to *Phrontis* is considered doubtful because the presence of a definite varix on the outer lip of the aperture and denticles within cannot be established from the material at hand. The thin parietal callus is another bothersome characteristic, but variation in this feature has been observed on *N. smooti.*

Occurrence: Lower part of Olcese Sand, USGS loc. M1593.

Family FUSINIDAE

Genus PRISCOFUSUS Conrad, 1865

Type (by subsequent designation, Cossmann, 1901): *Fusus geniculus* Conrad. Astoria, Oreg. Astoria Formation, Miocene.

Priscofusus geniculus (Conrad)

Plate 12, figures 21, 22, 26, 28–30

Fusus geniculus Conrad, 1849, U.S. Exploring Exped., Geology, v. 10, app, 1 p. 728, atlas pl. 20, fig. 3.

Fusinus (Priscofusus) geniculus (Conrad), Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 482, pl. 92, fig. 10.

Priscofusus geniculus (Conrad), Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 40–41, pl. 6, figs. 13, 15–18.

Priscofusus aff. *P. geniculus* (Conrad), Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, p. 104.

Undetermined species. Conrad, 1849, U.S. Exploring Exped., Geology, v. 10, atlas pl. 20, figs. 10, 11, 11a.

Priscofusus oregonensis Conrad, 1865, Am. Jour. Conchology, v. 1, p. 150 [new name for his undetermined species, 1849, pl. 20, figs. 10, 11, 11a].

Lectotype: U.S. Natl. Mus. 3552 (designated by Moore, 1963).

Type locality: Astoria, Oreg. Astoria Formation, Miocene.

Lectotype of *Priscofusus oregonensis* Conrad: U.S. Natl. Mus. 3517 [Conrad's "undetermined species" (1849, pl. 20, fig. 10)] (designated by Moore, 1963, p. 40).

Type locality: Astoria, Oreg. Astoria Formation, Miocene.

Two forms of *Priscofusus geniculus* are recognized in the collections from the basal marine conglomeratic sandstone of the Jewett Sand: a typical form corresponding to the lectotype (Moore, 1963, pl. 6, fig. 17) characterized by strongly protruding nodes at the periphery of the whorls and a form with narrow axial ribs that is identical to the lectotype of *P. oregonensis* (Conrad) (Moore, 1963, pl. 6, fig. 16). At first these forms seemed specifically distinct, but further study of other specimens showed that the strength and spacing of axial ribs is variable and seems to be connected by intermediate forms.

Specimens of *Priscofusus geniculus* from the Jewett Sand (pl. 12, figs. 21, 22) are much larger than the lectotype (pl. 12, fig. 29) and have coarser spiral sculpture. There are clearly defined primary, secondary, and tertiary spirals below the angulation on one specimen. The axial folds culminate in nodes at the spiral cord on the angulation and on two or three primaries below. Above the angulation, the spiral ribbing is uniformly fine and much subdued. Another slight difference is the lack of the hooked nodes that are characteristically developed on the whorl angulation of the Oregon specimens (Moore, 1963, p. 40). By comparison with type material, these seem to be minor, infrasubspecific differences; consequently, the earlier identification of these specimens as *Priscofusus* aff. *P. geniculus* (Addicott, 1965a) is herein amended.

The axially ribbed form (pl. 12, figs. 26, 28) is very close to the lectotype of "*Priscofusus oregonensis* Conrad" (refigured on pl. 12, fig. 30). The axial ribs are narrower, longer, and more closely spaced than on typical *P. geniculus*. Furthermore, the spiral ribs are not differentiated into coarse primaries with alternating secondary and teritary ribs below the middle of the whorls. Consequently, the axial ribs are very little enlarged at the intersection with spiral ribs.

The only specimens of the axially ribbed form of *Priscofusus geniculus* from the Kern River area are poorly preserved and slightly crushed. Several areas of gypsum-encrusted sand grains could not be removed from the very delicate shell material without damage to the specimen. Although the photographs of these specimens are poor, sufficient area has been exposed to indicate that they are distinct from other species of *Priscofusus* from the middle and upper Tertiary of the Pacific coast of North America. This form resembles somewhat *P. hecoxae* (Arnold, 1908, p. 371–372, pl. 33, fig. 8), a species characteristic of the uppermost (Oligocene) part of the San Lorenzo Formation and the lowermost part of the Vaqueros Sandstone of Cummings, Touring, and Brabb (1962) (Oligocene or early Miocene) of the Santa Cruz Mountains, Calif. However, *P. hecoxae* has very strongly angulated whorls, fewer and more strongly noded axial ribs, and more uniform spiral sculpture. A specimen from the San Ramon Sandstone of Contra Costa County, Calif. figured by Clark (1918, pl. 22, fig. 7) as *Fusinus (Priscofusus) hecoxi* Arnold differs from specimens of *P. hecoxae* from the Santa Cruz Mountains collected by Earl Brabb (USGS loc. M810, M823) and seems to be an unnamed species. Clark is reported to have later decided that the specimen from the San Ramon Sandstone was a distinct species (Tegland, 1933, p. 129).

Priscofusus coli (Dall), a Pliocene species from the Empire Formation near Coos Bay, Oreg., can be distinguished from *P. geniculus* by its much stronger, more widely spaced axial ribs and concave subsutural slope.

Distribution and stratigraphic occurrence: Middle Miocene: Clallam Formation, Clallam County, Wash. (Arnold and Hannibal, 1913); Astoria Formation, coastal Oregon (Conrad, 1849; Arnold and Hannibal, 1913; Moore, 1963).

Range: Lower Miocene to middle Miocene.

Localities: Lower part of Jewett Sand, USGS M1590?, M1591.

Priscofusus medialis (Conrad)

Plate 12, figures 20, 23–25, 27

Cerithium mediale Conrad, 1849, U.S. Exploring Exped., Geology, v. 10, app. 1, p. 728, atlas pl. 20, figs. 1, 1a.

Fusinus (Priscofusus) medialis (Conrad), Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 483, pl. 93, fig. 7.

Priscofusus medialis (Conrad), Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 41–42, pl. 5, figs. 6, 7; pl. 6, figs. 1–7, 9; pl. 7, fig. 10.

Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, p. 104.

Fusus corpulentus Conrad, 1949, U.S. Exploring Exped., Geology, v. 10, app. 1, p. 728, atlas pl. 20, fig. 4.

Fusinus (Priscofusus) corpulentus (Conrad), Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 482, pl. 92, fig. 1.

Fusinus (Priscofusus) sp. indet. Dall, 1909, U.S. Geol. Survey Prof. Paper 59, p. 40–41 [not figured].

Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 483–484, pl. 92, figs. 5, 6 [not fig. 3 (Moore, 1963, p. 41)].

Turris lincolnensis Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 88–89, pl. 6, fig. 8.

Fusinus (Priscofusus) lincolnensis (Anderson and Martin), Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 487, pl. 93, figs. 8, 9.

Siphonalia, n. sp.? Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 96.

Lectotype: U.S. Natl. Mus. 3532 (designated by Moore, 1963, p. 41).

Type locality: Astoria, Ore. Astoria Formation, Miocene.

Lectotype of *Fusus corpulentus:* U.S. Natl. Mus. 3551 (designated by Moore, 1963, p. 41).

Type locality: Astoria, Oreg. Astoria Formation, middle Miocene.

Type of *Turris lincolnensis* Anderson and Martin: California Acad. Sci. 211.

Type locality: CAS 36, on the coast 5 miles north of Yaquina Bay, Oreg. Astoria Formation, middle Miocene.

Specimens of *Fusinus (Priscofusus)* sp. indet. Dall: USNM 561973, 561974 [a third specimen, USNM 3544, is not a *Priscofusus* according to Moore (1963, p. 41)].

Locality: Astoria, Oreg. Astoria Formation Miocene.

Priscofusus medialis is one of the most abundant gastropods in the basal marine conglomeratic sandstone of the Miocene Series of the Kern River district. It is limited in occurrence to the Jewett Sand and Freeman Silt. The only other reported occurrence in California is from doubtfully identified material in the lower member of the Temblor Formation at Reef Ridge on the west side of San Joaquin Valley (Stewart, 1946, table 2, as *P. lincolnensis?*). It is an apparently abundant and characteristic species in the Astoria Formation of Oregon. Because of poorly illustrated type material, this species has been more commonly known by one of its synonyms, *P. lincolnensis* (Anderson and Martin, 1914, p. 88–89, pl. 6, fig. 8). Recent study of the molluscan fauna of the Astoria Formation by Moore (1963) has cleared up uncertainty as to the recognition of this important species as well as many of the other early names of Conrad which have been obscured by poorly known type material.

Although most specimens are relatively high spired, there is considerable variation in spire height. Most specimens are somewhat deformed, giving rise to considerable variation in the curvature of the anterior canal as well as extremely broad body whorls on certain individuals. The anterior canal is moderately long, open, and gently recurved to the left. Practically all of the specimens from the Kern River district differ from the holotype by having very strong nodes on the spire, immediately above the suture rather than near the middle of the whorl. A specimen of *P. medialis* from the Astoria Formation figured by Moore (1963, pl. 6, fig. 5), however, has rather strong nodes near the base of the penultimate whorl. These nodes suggest a range of variation which can accommodate the California specimens.

Priscofusus medialis can be easily distinguished from most of the other named species of *Priscofusus* by the presence of well-developed rounded nodes. *P. hecoxae* (Arnold) from the San Lorenzo Formation and Vaqueros Formation of the Santa Cruz Mountains, Calif., and *P. chehalisensis* (Weaver) from the Lincoln Creek Formation of southwestern Washington, both of which occur in older strata, have similar sculpture. This similarity suggests a possible ancestral relationship to *P. medialis*. They can be separated from the Kern River specimens, however, by their extremely slender, high-spired shells and the medial location of nodes that are much more widely spaced than on *P. medialis*.

Distribution and stratigraphic occurrence: Middle Miocene: Astoria Formation—Astoria, Oreg. (Conrad, 1849; Arnold and Hannibal, 1913). Lincoln County, Oreg. (Anderson and Martin, 1914; Vokes and others, 1949; Snavely and Vokes, 1949; Moore, 1963). Coos County, Oreg. (Moore, 1963). Temblor Formation, Reef Ridge, Kings County, Calif. (Stewart, 1946?).

Range: Lower to middle Miocene.

Localities: Lower part of Jewett Sand, USGS M1590, M1591; UCMP B1665, B1669. Upper part of Freeman-Jewett Silt of Matthews (1955), UCR 1306.

Family MITRIDAE

Genus MITRA Lamarck, 1798

Type (by tautonymy, see MacNeil, 1960, p. 91–92): *Mitra mitra* Linné. Holocene, Indo-Pacific.

Details of the question of authorship of the genus *mitra* are discussed by MacNeil (1960) and by Coan (1966).

Subgenus ATRIMITRA Dall, 1918

Type (by original designation): *Mitra idae* Melvill. Holocene, Farallon Islands to Cortez Bank.

Mitra (Atrimitra) andersoni Addicott, n. sp.

Plate 13, figures 11, 13, 16, 18

Shell of medium size, thick, with punctate spire and smooth body whorl. Spire consists of five or more whorls. Penultimate whorl sculptured by seven rows of rectangular pits that disappear on final half turn. Pits have a vertically oriented long axis. Pits separated by indistinct axial threads on earlier whorls, which give a predominantly channeled aspect. Axial threads become as wide as pits on penultimate whorl. Penultimate and body whorls weakly shouldered; sutures channeled, somewhat wavy. Body whorl virtually smooth but with indistinct spiral sculpture near base and random axial lines of growth, some of which are collected into roughened resting stages near aperture. Aperture narrow, elongate. Outer lip culminating in a thin edge, inner lip with well-developed callus armed with four columellar plaits and a weak ridge at base. Siphonal fasciole broad, roughened by several ridges and channels due to irregular rate of growth. Anterior canal broad and short.

Length (nearly complete) 49 mm, width 19 mm.

Type: U.S. Natl. Mus. 650183.

Type locality: USGS 6641, north side of Kern River in first deep gulch east of bridge crossing river, three-fourths of a mile below mouth of canyon. About half a mile northeast of Kern River and half a mile southwest of sediment-granite contact (near N¼ cor. sec. 1, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle). Lower part of Round Mountain Silt, middle Miocene.

An additional specimen of *Mitra andersoni* is in the collections at the University of California. It is larger and somewhat better preserved than the holotype but consists of only the body whorl. The base of the body whorl is sculptured by about 20–25 fine, microscopically punctate spiral grooves. Although accurate locality data for this specimen are lacking, the matrix and associated species in the collection from UCMP locality 2714 suggest that the material was collected from near the top of the Olcese Sand, probably in the vicinity of Barker's Ranch but on the north side of the river. This is the same stratigraphic interval and general location as the type area of Anderson's "B" zone (1911).

Mitra andersoni is related to a group of eastern Pacific Ocean species, including *M. idae* Melvill, *M. orientalis* Wood, and *M. montereyi* Berry that have punctate spiral sculpture (Sphon, 1961, p. 33). It seems to be most closely related to *M. orientalis* Gray (figured by Tryon, 1882, p. 121, pl. 36, fig. 67, as *M. maura* Swainson) but appears to have somewhat finer spiral sculpture than the South American species. From *M. idae*, which some consider to be a North American analog of *M. orientalis* (Burch, 1945, no. 49, p. 30), this species differs by its coarser, more strongly and regularly punctate spiral sculpture. The columellar lip bears four spiral plaits, below which the margin continues in a straight line rather than curving abruptly to the left as on specimens of *M. idae.*

Reference to *Atrimitra* rather than *Strigatella* is based upon the close similarity to the type species of the former, *M. idae.* The type of *Strigatella*, *M. litterata* Lamarck, is a stout, very low spired species with well-defined spiral grooves on the body whorl.

As far as can be determined, this is the first reported occurrence of the genus *Mitra* in strata of Miocene age along the west coast. A few specimens of a large *Mitra* that seems to be similar to *M. andersoni* have been collected from the Saltos Shale Member of the Monterey Shale of Hill, Carlson, and Dibblee (1958) USGS loc. M3292 and M3338 in the Caliente Range of eastern San Luis Obispo County, Calif., by J. G. Vedder.

Occurrence: Upper part of Olcese Sand, UCMP loc. 2714. Lower part of Round Mountain Silt, USNM loc. 6641.

Family VOLUTIDAE

Genus PSEPHAEA Crosse, 1871

Type (by monotypy): *Voluta concinna* Broderip. Holocene, Japan.

Subgenus MIOPLEIONA Dall, 1907

Type (by original designation): *Rostellaria indurata* Conrad. Miocene, western coastal Oregon, Wash.

Psephaea (Miopleiona) weaveri (Tegland)

Plate 13, figures 15, 17, 19

Miopleiona indurata (Conrad), Dall, 1909, U.S. Geol. Survey Prof. Paper 59, p. 35 [in part], pl. 18, fig. 6 [not pl. 18, fig. 5].

Miopleiona weaveri Tegland, 1933, California Univ., Dept. Geol. Sci. Bull., v. 23, no. 3, p. 127–128, pl. 11, figs. 1–5.

Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 492–493, pl. 94, figs. 6, 10, 11.

Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, p. 104.

?*Miopleiona scowensis* Durham, 1943, California Univ., Dept. Geol. Sci. Bull., v. 27, no. 5, p. 177–178, pl. 17, fig. 15.

?*Miopleiona* sp. Clark, 1918, California Univ., Dept. Geology Bull., v. 11, no. 2, p. 184, pl. 23, fig. 13.

Description of figured specimen.—Large, thin shelled. Spire incomplete, whorls evenly convex, sutures channeled. Penultimate whorl sculptured by 14 protractive axial ribs that tend to disappear at top of whorls. Numerous very fine spiral ribs on spire become extremely faint to obsolete on body whorl. Body whorl almost smooth, axial and spiral ribs discernible on upper part. Aperture elongate and narrow, largely concealed by matrix.

Type: California Univ. Mus. Paleontology 32243.

Type locality: UCMP 681, Restoration Point, Kitsap County, Wash. Blakeley Formation of Weaver (1912), upper Oligocene.

Type of *Miopleiona scowensis* UCMP 35419.

Type locality: UCMP A3696, along beach on Marrowstone Island, south of UCMP A3675. NW¼NE¼ sec. 32, T. 30 N., R. 1 E., Jefferson County, Wash. Marrowstone Shale, Oligocene.

Figured specimen of *Miopleiona* sp. (Clark, 1918): California Univ. Mus. Paleontology 11244.

Locality: UCMP 1165, on first ridge north of Sobrante Ridge in road pass; five-eighths of a mile due east of source of west fork of Bear Creek, 125 feet above road on west side; altitude 825 feet; Contra Costa County, long 122°12'20'' W., lat 37°65'17'' N.

Psephaea weaveri is represented by two specimens from the basal marine strata at Pyramid Hill. Heretofore this species was recognized only from Weaver's (1912) Blakeley Formation of Washington. The better of the two specimens (pl. 13, figs. 15, 17) differs slightly from specimens figured by Tegland (1933, pl. 11, figs. 1–5) by having somewhat finer spiral sculpture on the spire and by lacking well-defined spiral sculpture on the body whorl. This is considered to be an infrasubspecific difference in view of the range of variation of spiral sculpture on a closely related species—*P. indurata* Conrad from the Astoria Formation of coastal Oregon. *P. indurata* normally lacks any spiral sculpture but some well-preserved specimens figured by Moore (1963, pl. 7, figs. 7, 9) have very fine spiral ribbing. *Psephaea indurata* differs from *P. weaveri* by having more numerous axial ribs that are strongly developed on all whorls and abruptly twisted posteriorly to form a subsutural tabulation. The Pliocene species *P. oregonensis* from the Purisima Formation of coastal central California and the Empire Formation of Oregon has a short, rapidly tapering spire and relatively strong, sinuous axial ribs which are well developed on the body whorl.

Another poorly known California occurrence of the genus in rocks of probable early Miocene age is from the San Ramon Sandstone, from which Clark (1918) reported *Miopleiona* sp. (p. 184, pl. 23, fig. 13) and *Miopleiona indurata* (p. 185). *Miopleiona* sp. is represented by an incomplete specimen consisting of part of the penultimate whorl and body whorl. The shell material is missing, yet there are faint traces of spiral sculpture near the suture on the penultimate whorl.

The use of *Psephaea* rather than *Fulgoraria* for this species is based on the discussion of generic characters by Moore (1963, p. 42–43). Her conclusion that *Psephaea* can be differentiated from *Fulgoraria*, a genus to which comparable modern Japanese species have been assigned by Kira (1962, p. 82–83, pl. 32), is based upon the greater number of columellar plaits and differences in the outer apertural lip of the type of *Fulgoraria*.

Psephaea scowensis (Durham) from the Marrowstone Shale of Durham (1944) of the Olympic Peninsula, Wash., was originally differentiated from *P. weaveri* by its lack of a concave segment of the whorl profile immediately below the suture that occurs on the holotype of *P. weaveri*. Examination of one of Tegland's paratypes (1933, pl. 11, figs. 3, 4; UCMP 32248) indicates that the concave segment is a variable characteristic not developed on all specimens. In other respects, the fragmentary holotype of *P. scowensis* seems to be inseparable from *P. weaveri* and is therefore provisionally included in the synonymy of that species.

Distribution and stratigraphic occurrence: Upper Oligocene: Marrowstone Shale of Durham (1944), northern Olympic Peninsula, Wash.; type Lincoln Formation of Weaver (1912), Wash. (Durham, 1944, doubtfully identified). Blakeley Formation of Weaver (1912), Restoration Point, Wash. (Tegland, 1933; Durham, 1944). Lower Miocene: ?San Ramon Sandstone, Contra Costa County, Calif. (Clark, 1918, as *Miopleiona* sp.).
Range: Upper Oligocene (?) to lower Miocene.
Locality: Lower part of Jewett Sand, USGS M1591.

Psephaea (Miopleiona) cf. P. (M.) indurata (Conrad)

Plate 13, figures 6, 8

A fragment of an external mold of a large *Psephaea* is in the Miocene stratigraphic collections at the University of California, Riverside. The specimen was cored from a depth of 4,657 feet in the Shell Oil "Edison" 2–1, sec. 33, T. 29 S., R. 29 E., about a mile north of Edison, Calif. The core is from the lower part of the Freeman-Jewett Silt of Matthews (1955), which is of early Miocene (lower Saucesian Stage) age (Beck, 1952).

A latex cast of the specimen (pl. 13, fig. 8) indicates sharp, rather closely spaced axial ribs that have the twist just below the suture characteristic of *Psephaea indurata*. There is also a network of very fine spiral threads such as are sometimes found on specimens of *P. indurata* (Moore, 1963, p. 43). Although more numerous and much more closely spaced than on *P. weaveri*, the axial ribs seem intermediate between that species and the high-built, closely packed ribs of *P. indurata*. At any event, there is a closer similarity to *P. indurata*, and for the time being the specimen is tentatively compared with that species.

Loel and Corey's *Miopleiona* sp. (1932, p. 96, 241; UCMP 12136) from their "upper zone" of the Vaqueros Formation [Monterey Group of Wagner and Schilling (1923)] in the eastern San Emigdio Mountains, Calif. (pl. 13, fig. 6), seems to be the same as the Kern River specimen. It, too, is represented by an incomplete external mold with strong, closely spaced axial ribs that are strongly recurved just below the suture. Fine spiral threads also occur in the interspaces.

Occurrence: Shell Oil "Edison" 2–1, 4,657 feet, near Edison, Kern County, Calif. Freeman-Jewitt Silt of Matthews (1955).

Family CANCELLARIIDAE

Genus CANCELLARIA Lamarck, 1799

Type (by monotypy): *Voluta reticulata* Linné. Holocene, Southeastern United States and West Indies (Warmke and Abbott, 1961).

Cancellaria is represented by more species, 17, than any other gastropod genus in the Kern River Miocene. Whereas only one species occurs in assemblages from the lower Miocene Jewett Sand, by middle Miocene time the genus was flourishing with 16 species occurring in the upper part of the Olcese Sand and lower part of the Round Mountain Silt. Fifteen of the species are placed in seven named subgenera; the other two are not classified subgenerically. More than half of the Kern River cancellariids are included in the subgenus *Euclia*.

The strong representation of cancellariids in the Kern River middle Miocene is comparable to the number of species reported from a Miocene formation in Columbia by Stevenson (in Marks, 1949). Cancellariids are abundantly represented in the modern fauna of the tropical eastern Pacific Ocean. Keen (1958a) lists 34 species from the Panamic-Pacific faunal province, which extends from the Gulf of California to Peru. The diversification of this characteristically warm-water genus in middle Miocene strata of the Kern River area is therefore one of the important reasons for interpreting subtropical to tropical marine environment during during deposition of the upper part of the Olcese Sand and the Round Mountain Silt.

The sudden flood of species and appearance of many subgeneric units in the upper part of the Olcese Sand and the lower part of the Round Mountain Silt is also of potential chronologic significance as a hallmark of the Middle Miocene "Temblor Stage" of the Pacific coast megafaunal chronology of Weaver and others (1944). In California, for example, only three cancellariids are reported from strata assigned to the lower Miocene "Vaqueros Stage:" *Cancellaria condoni* Anderson (Repenning and Vedder, 1961); *C. dalliana* Anderson (Loel and Corey, 1932); and *C. galei* n. sp. A similar ratio of late Oligocene or early Miocene species to middle Miocene species occurs in Oregon and Washington. One species has been recorded from the Yaquina Formation of northwestern Oregon, *Cancellaria* n. sp.? Addicott (1966), whereas seven have been reported from the middle Miocene Astoria Formation (Etherington, 1931; Moore, 1963).

An attempt is made to group species into the subgenera used by Marks (1949) and Keen (1958a) for tropical species of Miocene and Holocene age, respectively. Wherever possible, the well-established Recent subgeneric names from the Panamic molluscan province of the eastern Pacific Ocean have been utilized. As in many other intricately sculptured genera, subgeneric classification poses an extremely difficult problem, and the end result may be more artificial than real. Species recognition is no less a problem, although many of the cancellariids are represented by populations that are sufficiently abundant to study individual variation, thereby permitting fairly confident definition of species. Others are represented by only a few specimens and consequently are less well defined in terms of variation. The greatest problem of species recognition occurs in the subgenus *Euclia*, which includes more than half of the Kern River cancellariids. The species *Cancellaria condoni*, *C. circumspinosa*, *C. dalliana* *C. simplex*, and *C. joaquinensis*, for example, might seem to form an intergradational species complex, with *C. condoni* at one extreme and *C. joaquinensis* at the other, because differences between adjacent species in the grouping seem rather fine. But whereas *C. dalliana* and *C. simplex* are sometimes difficult to differentiate, *C. condoni* and *C. simplex* are clearly distinct and separable. Similar comparisons can be made between other adjecent and once or twice removed species in this apparent series. Possibly we could be dealing with hybrid populations, but this is difficult to determine when working with fossils. The species of Anderson (1905) and Anderson and Martin (1914) seem, for the most part, to be valid, although recognition of some is hampered by the loss of certain types during the San Francisco earthquake and fire of 1906, and differentiation of *C. condoni* from *C. dalliana* was made difficult by an unfortunate mixing of specimens figured in the 1914 report.

The restricted stratigraphic occurrence of many species of *Cancellaria* is of particular interest, inasmuch as California Miocene mollusks are characteristically much longer ranging. Distinctive species such as *Cancellaria sanjosei*, *C. keenae*, *C. dalli*, and *C. posunculensis* occur abundantly at only a few localities that define a limited stratigraphic interval.

Subgenus EUCLIA H. and A. Adams, 1854

Type (by subsequent designation, Cossmann, 1899): *Cancellaria cassidiformis* Sowerby. Holocene, Gulf of California to Peru.

Recognition of *Euclia* as a tropical American cancellariid subgenus dates from Olsson's definitive discussion (1932, p. 157–158) of its typology. It was originally described as a low-spired, smooth taxon by H. and A. Adams (1858, p. 277), who included four species but failed to designate a type. Cossmann's subsequent designation of one of these as the type (1899) fixed *Euclia* as a strongly sculptured, spinose taxon. He, however, placed *Euclia* in the synonymy of *Cancellaria* s. s. Olsson included one California species in *Euclia*, *C. tritonidea* Gabb. Subsequently, Moore (1963, p. 45) assigned five Miocene species to this subgenus: *C. condoni* Anderson, *C. dalliana* Anderson, *C. oregonensis* Conrad, *C. pacifica* Anderson, and *C. simplex* Anderson.

About half of the Kern River cancellariids are assigned to *Euclia*. Species such as *C. vetusta*, *C. pacifica*, and *C. joaquinensis* fit rather comfortably in this subgenus. Others included in *Euclia*, such as *C. condoni*, *C. dalliana*, and *C. oregonensis*, and analogous tropical Miocene and Holocene species (Marks, 1949; Keen, 1958a; Olsson, 1964), are less clearly related to the type on account of their angular, turreted spire and strong axial sculpture. The apparent morphologic continuum between the high-spired, axially sculptured species such as *C. condoni* and robust, low-spired forms such as *C. vetusta* that closely resemble the type of *Euclia* suggests that *Euclia* does indeed embrace a wide assortment of species. Nearly all of the Kern River species are spinose. Their sculpture varies, however, from predominately axial in some forms to spiral in others and the shell itself from rotund to slender and turreted.

Key to Miocene species of Euclia *from the Kern River area*

1. Spire consisting of several shouldered whorls, noded or with axial ribs ---------------- 2
   Spire, dome shaped, smooth -- *Cancellaria joaquinensis*
2. Body whorl sculptured by axial ribs, moderately to strongly shouldered ----------- 3
   Body whorl with only spiral sculpture, convex or with a faint shoulder ---------- *C. nevadensis*

Key to Miocene species of Euclia *from the Kern River area*—Con.

3. Spiral sculpture of primary cords........... 4
   Spiral sculpture of primary and secondary cords................................ 5
4. Subsutural shoulder moderately inclined, bearing blunt spines.............. *C. condoni*
   Subsutural shoulder almost horizontal, bearing sharp spines.............. *C. circumspinosa*
5. Body whorl sculptured by alternating primary and secondary ribs; shoulder relatively narrow................................ 6
   Upper part of body whorl sculptured by groups of two or more secondary ribs alternating with primaries; shoulder broad, moderately inclined.............. *C. dalliana*
6. Spiral sculpture sharp, emphasized by deep interspaces............................ 7
   Spiral sculpture subdued, interspaces shallow. 8
7. Axial ribs weakly developed on shoulder of body whorl; spiral sculpture of closely spaced primary and secondary ribs... *C. ocoyana*
   Axial ribs strongly developed on shoulder of body whorl; spiral sculpture of relatively coarse primary and secondary cords. *C. oregonensis*
8. Body whorl compressed; shoulder weakly noded, narrow...................... *C. pacifica*
   Body whorl broad; shoulder usually strongly noded, much broader.............. *C. simplex*

Cancellaria (Euclia) condoni Anderson

Plate 13, figures 1–5, 10; plate 14, figure 10

Cancellaria condoni Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 200 [in part], pl. 15, fig. 49 [not pl. 15, fig. 50 (=*Cancellaria ramonensis* Clark, 1918)].
Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 86, pl. 8, figs. 8a, b, c, d.
Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 506, pl. 96, figs. 5, 6.
Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 36.
Cancellaria dalliana condoni (Anderson), Loel and Corey, 1932, California Univ., Dept.. Geol. Sci. Bull., v. 22, no. 3, p. 171.
Cancellaria (Euclia) oregonensis Conrad, Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 45 [in part], pl. 9, fig. 22 [not figs. 15–17, 19–21, 23].
Cancellaria vestusta [*vetusta*] Gabb, Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 29, figs. 16, 17.

Original description.—Shell of moderate size, 1–1½ inches in length, ½–¾ inch wide; spire high; whorls angular, slightly sloping above; surface ornamented with strong revolving lines, with wide interspaces, crossed by strong varical ridges forming tubercular nodes on the upper angle of the whorls; inner lip crusted, bearing 2 spiral folds on the columella.

Supplementary description.—Shell of small to medium size. Spire short, consisting of about four strongly tabulate whorls. Profile of penultimate whorl defines a right angle, surface sculptured by about 11 slightly retractive axial ribs that become obsolete above angulation and five spiral ribs of lesser strength below angulation. Body whorl large with very gently sloping profile above the angulation and a nearly vertical segment below. Sculptured by about 11 very strong axial varices that form spines with excavated bases at angulation. Spiral sculpture more subdued, in larger specimens both primary and secondary cords present. Aperture alongate-ovate, inner lip incrusted with a heavy callus that spreads across parietal wall. Columellar wall vertical. Umbilicus subperforate, bordered by a strong, broadly spiraling siphonal fasciole.

Lectotype: California Acad. Sci. 67 (designated as "type" by Clark (1918, p. 186).

Type locality: In the vicinity of Barker's Ranch [headquarters formerly near the center of sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle]. This and other newly described species were collected "chiefly north of the river" (Anderson, 1905, p. 187).

Cancellaria condoni is represented by only a few specimens in collections from the Kern River district. Some workers (Loel and Corey, 1932, p. 171, 239) have considered *C. condoni* to be a variant of *C. dalliana* of Anderson (1905, pl. 15, figs. 39–42). It has been relatively easy, however, to separate the few adult and intermediate size specimens of *C. condoni* from the extremely abundant specimens of *C. dalliana* in several large collections from the upper part of the Olcese Sand near the type locality of these species. On the penultimate whorl of *C. condoni*, the angulation occurs near the top of the whorl and approaches a right angle; on *C. dalliana* the angulation is obtuse and near the midpoint of the whorl. The segment of the body whorl above the angulation of *C. condoni* is much less strongly inclined than on *C. dalliana*. The aperture of *Cancellaria condoni* has a nearly vertical columellar lip,which on larger specimens is bordered by a strong callus. On *C. dalliana* the basal segment of the columella is reflected to the left. Other features by which *C. condoni* can be differentiated from *C. dalliana* are the large siphonal fasciole, the less spinose angulation, and the lack of very fine secondary spiral sculpture on the upper half of the body whorl. Juvenile specimens (less than about 10 mm) present the greatest difficulty in distinguishing these species because the strong subsutural slope of *C. dalliana* is not clearly developed until the later stages of growth.

Strongly sculptured cancellariids that bear some resemblance to both *Cancellaria condoni* and *C. dalliana* (pl. 14, figs. 1, 2, 6, 7, 16) are here included in a newly named species, *C. circumspinosa.* This species has strong spiral cords similar to cords on *C. condoni* but markedly fewer in number. Its greater subsutural slope, strongly spinose whorl angulation, broad body whorl, and weak siphonal fasciole permit discrimination from *C. condoni.*

Recently *Cancellaria condoni* has been included, with *C. dalliana*, in the synonymy of *C. oregonensis* Conrad (Moore, 1963, p. 45), a poorly known species long considered to be a *Trichotropis* (Dall, 1909, p. 77–78; Weaver, 1942, p. 388). The holotype of *C. oregonensis* Conrad is an incomplete external mold. A latex cast of the holotype (Moore, 1963, pl. 9, fig. 16) seems closer to *C. dalliana* than to *C. condoni.* Because other specimens of *C. oregonensis* Conrad from the Astoria Formation figured by Moore (1963, pl. 9, figs. 15, 17, 19, 23) appear to differ significantly from both *C. dalliana* and *C. condoni*, Conrad's species is here considered separate and distinct.

Specimens figured by Clark (1929, pl. 29, figs. 16, 17) as *Cancellaria vetusta* Gabb are rephotographs of two of Anderson and Martin's figures of *C. condoni* (1914, pl. 8, figs. 8b and 8c).

Specimens tentatively identified as *Cancellaria condoni* by Arnold (1907, pl. 40, fig. 9 [refigured by Eldridge and Arnold, 1907, pl. 27, fig. 9]) and Woodring and others (1946, pl. 28, fig. 8) are closer to *C. oregonensis* (Conrad) than to *C. condoni.* Both have a less strongly tabulate profile than *C. condoni* and axial ribs that continue posteriorly from the angulation to the suture. Furthermore, the spiral ribbing of these specimens does not change across the angulation, as in *C. condoni.*

Cancellariids from the upper Miocene Modelo Formation of the eastern Ventura basin that were identified as *Cancellaria condoni* by Daviess (in Oakeshott, 1958; UCLA loc. 2018) are misidentified specimens of *C. hemphilli* Dall, a late Miocene to Pliocene species.

Distribution and stratigraphic occurrence: Lower Miocene: Painted Rock Sandstone Member of Vaqueros Formation of Hill, Carlson, and Dibblee (1958), Caliente Range (Repenning and Vedder, 1961). Middle Miocene: middle faunal zone of Monterey Group, western Contra Costa County (Merriam in Lawson, 1914); Temblor Formation, La Panza Range (Anderson and Martin, 1914); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (Repenning and Vedder, 1961); Topanga Formation—Santa Monica Mountains (Grant in Soper, 1938; Susuki, 1951), San Joaquin Hills (Vedder, unpub. data, 1958, Santa Ana Mountains (Vedder and Woodring, unpub. data), 1953, cf. San Onofre Breccia, northwestern Peninsular Range (Woodford, 1925, cf.).

Range: Lower Miocene to middle Miocene.

Localities: Middle part of Olcese Sand, USGS M1698?. Upper part of Olcese Sand, USGS M1597, cf. M1599, M1600, cf. M1601, M1602; UCMP B1600, B1601, cf B1622, B1624, cf. B1641, ?M1698. Round Mountain Silt, USGS 6068, 6622, 6623, ?M1604, cf. M1608; UCMP B1618.

Cancellaria (Euclia) dalliana Anderson

Plate 13, figures 7, 9, 12, 14; plate 14, figures 3, 11

Cancellaria dalliana Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 199, pl. 15, figs. 39, 40–42.

Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, pl. 8, figs. 1b, c, d [not fig. 1a].

Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 29, figs. 6–9, 12 [not fig. 5].

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 171.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 36.

Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, p. 106, fig. 4h.

Original description.—Shell of moderate size, fusiform; spire high and angular; whorls angular and spinose; columella thickly crusted within in old specimens; surface marked with strong varical ridges and lines, the ridges rising in thin edges on the upper surface of the body whorl. The lower part of the body whorl is ornamented with strong revolving lines with wide interspaces in which there are usually 1–3 secondary lines. The canal notch is not shown.

Supplementary description.—Small to medium, spinose, with variable spiral sculpture. Spire of about four whorls, the lowest of which has a spinose angulation near the midpoint. Spiral sculpture relatively finer above angulation than below on penultimate whorl. Subsutural slope of body whorl gently concave, sculptured by fine, closely spaced spiral cords and occasional varical ridges near aperture. Below shoulder, sets of as many as eight secondary spirals alternate with primary spirals, secondaries becoming relatively fewer in number and primaries relatively stronger toward base. Axial sculpture consists of nine to 12 folds that become spinose at angulation and are somewhat nodose at intersection with primary spirals below. In larger specimens, axials become varicose near aperture. Aperture slightly greater than one-half length of shell, columellar and parietal walls encrusted with heavy callus. Lower part of columellar wall reflected to left. Siphonal fasciole nearly obscured by callus. Columellar plaits usually not visible in apertural view.

Types: Syntypes probably lost in San Francisco fire of 1906.

Type locality: In the vicinity of Barker's Ranch [headquarters formerly near the center of sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle]. This and other newly described species were collected "chiefly north of the river" (Anderson, 1905, p. 187).

Neotype: California Acad. Sci. 199, here designated with approval of A. M. Keen (oral commun., 1967). Previous neotype designation of Keen and Bentson (1944, p. 138) of CAS 198 here rejected because of nonconformance with rules of zoological nomenclature (Internat. Comm. Zool. Nomenclature, 1961).

Neotype locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586; near center of NW¼SE¼ sec. 32, T. 28 S., 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

Anderson's type material (1905, pl. 15, figs. 39–42) was lost or destroyed during the 1906 San Francisco earthquake and fire. Subsequently Anderson and Martin (1914, p. 86, pl. 8, figs. 1a–d) figured additional specimens of *Cancellaria dalliana* "to illustrate its variation and to point out more clearly the characters by which it may be distinguished from the new species of *Cancellaria* that are here described." Four additional specimens of *C. condoni* were figured at that time, but a syntype that survived the 1906 holocaust was not. Clark (1918, p. 186–187) subsequently recognized that one of Anderson and Martin's figures of *C. dalliana* (1914, pl. 8, fig. 1a) and one of the original syntypes of *C. condoni* (Anderson, 1905 pl. 15, fig. 50) represented a distinct species, which he named *C. ramonensis* on the basis of material from the San Ramon Sandstone of Contra Costa County. These two figures are so similar (the earlier one is a line drawing) that it seems possible they are one and the same specimen. In any event, both figures are distinct from Anderson's original concept of *C. dalliana.* Apparently Clark's realization that these specimens were of a different species than other figured specimens of *C. dalliana* and *C. condoni* has gone unnoticed by subsequent workers, for later Keen and Bentson (1955, p. 138) designated one of these misidentified specimens (Anderson and Martin, 1914, pl. 8, fig. 8a) as the neotype of *C. dalliana.* As noted by Moore (1963, p. 45), their neotype is identical to *C. oregonensis* Conrad. Accordingly, the neotype designation has the effect of making *C. dalliana* a synonym of *C. oregonensis*, yet Anderson's original figures (1905) and three of the four specimens subsequently figured by Anderson and Martin (1914) are of a uniquely sculptured species that is clearly distinct from *C. oregonensis.* Accordingly, Keen and Bentson's neotype designation (1944) is here rejected, because it does not meet the criteria for designation of neotypes as set forth in the International Code of Zoological Nomenclature (Internat. Comm. Zool. Nomenclature, 1961, art. 75b). An alternative neotype that adequately characterizes this abundant, distinctively sculptured species from the upper part of the Olcese Sand (Anderson and Martin, 1914, pl. 8, fig. 8b) is designated with the approval of A. M. Keen (oral commun. 1967). (See also discussion under *Cancellaria (Euclia) oregonensis* Conrad.)

What are here considered typical specimens of *Cancellaria dalliana* from the general type area on the north side of the Kern River near the [former] headquarters of Barker's Ranch are clearly distinct from other cancellariids in the Kern River district. Unique characters are the strongly spinose angulation, the long, concave slope above the angulation sculptured by very fine spiral cords, and the characteristic alternation of groups of secondary spiral cords and individual primary cords below the angulation. These features are fairly well illustrated by one of the two original specimens of *C. dalliana* figured by Anderson (1905, pl. 15, figs. 39, 40). The distinctive intercalation of several secondary spirals between primaries on the body whorl described by Anderson (1905, p. 199) clearly fixes the original concept of *C. dalliana* and permits ready discrimination from the similar species *C. condoni* and *C. circumspinosa.*

Loel and Corey's figured specimens of *Cancellaria dalliana* (1932, pl. 47, figs. 12, 13) do not represent this species. Both are so poorly preserved that identification at the species level must be considered doubtful. One specimen (pl. 47, fig. 12), a cast of an apparently deformed fragmentary external mold, has strong axial ribs that continue across the angulation from suture to suture. This specimen seems to be closer to *C. oregonensis* Conrad than to any other species. A second specimen is herein doubtfully identified as *C. nevadensis* Anderson and Martin.

Young specimens of *Cancellaria dalliana* are difficult to distinguish from *C. condoni.* The critical size is about 10 mm, a point in growth above which specimens of *C. dalliana* ordinarily develop characteristic secondary spirals and differentiation of the subsutural slope becomes apparent. Adult specimens of *C. dalliana* are very abundant at localities near the top of the Olcese Sand. Features by which this species can be differentiated from adult specimens of the less abundant *C. condoni* are the spinose whorls, moderate subsutural slope, unique body-whorl sculpture, and less elongate shell.

Records of this species listed below are of specimens originally identified as *C. dalliana.* Although it is assumed that they correspond to Anderson's original description and figures (1905), it is entirely possible that other species such as *C. condoni* may be represented because of the variable concepts of *C. dalliana.*

A late Miocene record of *Cancellaria dalliana* from the Modelo Formation of the eastern Ventura basin (Daviess in Oakeshott, 1958) is a misidentification. Specimens in the stratigraphic collection from UCLA locality 2018 from Gorman Canyon, Los Angeles County, Calif., labeled *C. dalliana* are identical to *C. ocoyana* Addicott, n. sp.

Distribution and stratigraphic occurrence: Middle Miocene: Monterey Shale, western Napa County (Weaver, 1949), Monterey Group, western Contra Costa County (Weaver, 1949); Oursan Sandstone, Alameda County (Hall, 1958); Temblor Formation—Reef Ridge (Adegoke, 1967), La Panza Range (Anderson and Martin, 1914, Loel and Corey, 1932); Topanga Formation—Santa Monica Mountains (Grant in Soper, 1938; Woodring in Hoots, 1931; Susuki, 1951), San Joaquin Hills (Vedder, unpub. data, 1958 cf.).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS 6623, 6624, cf. M1596–M1598, ?M1604; UCMP B1586, B1587, B1593, B1598, B1599, cf. B1623.

Cancellaria (Euclia) circumspinosa Addicott, n. sp.

Plate 14, figures 1, 2, 6, 7, 16

Small, moderately low spired with a gently sloping subsutural tabulation. Protoconch smooth for one and a half whorls. Spire turreted, sculpture predominately axial, whorl angulation near posterior quarter line. Body whorl large, spinose, base constricted into slender neck. Subsutural shelf sculptured by about seven very fine spiral threads and indistinct axial ridges. Below angulation, spiral sculpture consists of prominent, widely spaced cords that become nodose at intersection with axial ridges. One, occasionally two, secondary spiral threads occur between spinose angulation and adjacent spiral cord. Primary spirals weaken and secondary threads are regularly developed near base of body whorl interspaces. Inner apertural lip thinly callused. Columella with two moderately inclined folds. Anterior canal short, inclined to the left.

Height 18.8 mm, width (almost complete) 11.5 mm.

Type: U.S. Natl Mus. 650187.

Type locality: USGS M1608, Olcese Boy Scout Camp, at base of bluff on south bank of Kern River, 3,200 feet south, 1,100 feet west of NE. cor. sec. 1, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene.

This is a strongly sculptured cancellariid characterized by very spinose whorls, strong primary spiral cords, and a few weak secondary spiral threads. In profile, *Cancellaria circumspinosa* is similar to *C. dalliana* but its subsutural slope is somewhat shorter and less strongly inclined. The spiral sculpture of coarse primary ribs is distinct from *C. dalliana.* From specimens of *C. oregonensis* that were originally figured as *C. condoni* Anderson (1905, pl. 15, fig. 50) and *C. dalliana* Anderson (Anderson and Martin, 1914, pl. 8, fig. 1a) and later transferred to *C. ramonensis* Clark (1918), *C. circumspinosa* differs by its more strongly sloping subsutural profile, extremely spinose angulation, fewer axial ribs that become obsolete above the angulation, and slender body whorl.

Cancellaria condoni has a similar profile to *C. circumspinosa* but the sculpture is coarser, the angulation more spinose, and the spiral ribs fewer in number on the penultimate and body whorls.

Occurrence: Upper part of Olcese Sand, USGS locs. M1596 cf., M1601, M1602, M1693; UCMP locs. B1596?, cf. B1603, B1624, B1753. Round Mountain Silt, USGS locs. 3886, 6623, M1608, M1612; UCMP loc. B1618.

Cancellaria (Euclia) ocoyana Addicott, n. sp.

Plate 14, figures 4, 5, 8, 9; plate 16, figure 20

Of medium size, stout, with a moderately high, turreted spire consisting of five whorls including nucleoconch. Penultimate whorl strongly shouldered, sculptured by about 12 slightly retractive axial ribs that become weak above angulation. Body whorl convex below spinose angulation, subsutural slope gently concave. Sculptured by fine, evenly spaced spiral cords above angulation and closely spaced alternating primary and secondary spirals below. Axial ribs prominent and regularly spaced on first part of body whorl, but weaken and become more randomly spaced on final part. They become weak above spinose angulation and disappear before reaching suture. Aperture broken on type, on other specimens greater than half height of shell. Outer lip thin, columellar lip encrusted by thick callus that spreads outward onto parietal wall, the distal part descending almost vertically to base of columella. Columellar plaits narrow, nearly concealed from view in apertural orientation.

Height (almost complete) 26.5 mm, width (incomplete) 17.5 mm (holotype).

Type: California Univ. Mus. Paleontology 33484.

Type locality: UCMP B1618, mouth of first gully on north side of Kern River east of section line fence, SW¼SW¼ sec. 34, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene.

This species is most closely allied to *Cancellaria wynoocheensis* Weaver (1916, p. 50–51, pl. 4, figs. 51–54) and *C. oregonensis* Conrad from the Astoria Formation in Oregon and Washington. Its stout body whorl and sharp subsutural tabulation are similar to the northern species. The sculpture is close to that of *C. wynoocheensis*, but the broader, more inclined subsutural slope, spinose angulation, and coarser, more widely spaced axial sculpture permit discrimination from the species from Washington.

Cancellaria ocoyana can be differentiated from *C. condoni* by the less strongly tabulate whorls, regularly alternating primary and secondary spiral ribs, and the gently convex profile of the stout body whorl. *C.*

dalliana has a different pattern of spiral sculpture and a very long, strongly inclined subsutural slope.

Two immature specimens from the upper part of the Olcese Sand (USGS loc. M1597 and UCMP loc. B1598) have early growth stages that lack axial sculpture. On these specimens (pl. 14, figs. 8, 9; pl. 16, fig. 20) the appearance of axial sculpture is delayed until development of the fourth whorl, at which point the characteristic alternating primary and secondary sculpture also appears.

Distribution and stratigraphic occurrences: Middle Miocene: Topanga Formation, central Santa Monica Mountains, Calif. (USGS loc. M1075). Upper Miocene: Modelo Formation of Oakeshott (1958), eastern Ventura basin (UCLA loc. 2018).

Range: Middle Miocene.

Localities: Lower part of Olcese Sand, USGS M1593; UCMP B1646. Middle part of Olcese Sand, USGS M1698 cf. Upper part of Olcese Sand, UCMP B1598, cf. B1599. Lower part of Round Mountain Silt, USGS M1608, M1612, cf. M1613.

Cancellaria (Euclia) oregonensis Conrad

Plate 14, figure 12; plate 16, figure 23

Unnamed figure. Conrad, 1849, U.S. Exploring Exped., Geology, v. 10, Atlas, pl. 20, fig. 8.

Cancellaria? oregonensis Conrad, 1865, Am. Jour. Conchology, v. 1, p. 151.

Cancellaria oregonensis Conrad, Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 45 [in part], pl. 9, figs. 15–17, 19–21, 23 [not fig. 22].

Trichotropis oregonensis (Conrad), Dall, 1909, U.S. Geol. Survey Prof. Paper 59, p. 77–78.

Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 388, pl. 76, fig. 13.

Cancellaria condoni Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 200 [in part], pl. 15, fig. 50 [not fig. 49].

?*Cancellaria* cf. *C. condoni* Anderson, Arnold, 1907, U.S. Natl. Mus. Proc., v. 32, no. 1545, p. 541, pl. 40, fig. 9.

Eldridge and Arnold, 1907, U.S. Geol. Survey Bull. 309, pl. 27, fig. 9.

Woodring, W. P., Bramlette, M. N., and Kew, W. S. W., 1946, U.S. Geol. Survey Prof. Paper 207, pl. 28, fig. 8.

Cancellaria dalliana Anderson, Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 86 [in part], pl. 8, fig. 1a; [not figs. 1b, c, d].

Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 29, fig. 5 [not figs. 6–9, 12].

Cancellaria ramonensis Clark, 1918, California Univ., Dept. Geology Bull., v. 11, no. 2, p. 186–187, pl. 23, fig. 7.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 36.

Cancellaria andersoni Clark, 1918, California Univ., Dept. Geology Bull., v. 11, no. 2, pl. 23, fig. 4.

Type: U.S. Natl. Museum 3554.

Type locality: Astoria, Oreg. Astoria Formation, Miocene.

Type of *Cancellaria ramonensis* Clark: California Univ. Mus. Paleontology 11237.

Type locality: UCMP 1131, half a mile southwest of town of Walnut Creek in creek bed about 100 yards to east of Oakland and Antioch bridge, altitude 150 feet, Contra Costa County, Calif.

Type of *Cancellaria andersoni* Clark: California Univ. Mus. Paleontology 11235.

Type locality: UCMP loc. 1309, on Santa Fe Railroad 1¼ mile northeast of Muir Station, altitude 150 feet, Contra Costa County, Calif.

A poorly preserved specimen from the upper part of the Olcese Sand is identified as *Cancellaria oregonensis* on the basis of its sculpture, tabulate subsutural slope, and stout, convex body whorl. The spiral and axial sculpture are closely comparable to specimens from the Astoria Formation of northwestern Oregon in collections at the U.S. National Museum.

Two other figured specimens also seem to belong here. Clark (1918, p. 186–187) first noted that specimens from the Kern River area originally identified as *C. condoni* (Anderson, 1905, pl. 15, fig. 50) and *C. dalliana* (Anderson and Martin, 1914, pl. 8, fig. 1a) represented still a different species which he named *C. ramonensis*. The former specimen is doubtfully included in the synonymy of *C. oregonensis* because it seems to be an immature specimen. It appears to be similar to a latex cast of the holotype of *C. oregonensis* figured by Moore (1963, pl. 9, fig. 16), but because the specimen was lost in the 1906 San Francisco fire, the relationship cannot be carefully evaluated. The relatively larger specimen figured as *C. dalliana* by Anderson and Martin (1914) is clearly referable to *C. oregonensis* because of its stout body whorl and gently convex subsutural shelf sculptured by strong axial ribs. This is the specimen that Keen and Bentson (1944) designated as the neotype of *C. dalliana*, an action that is herein rejected (p. 109).

There is some confusion surrounding Clark's *Cancellaria ramonensis* from the San Ramon Sandstone of Contra Costa County, Calif. This name does not appear on Clark's checklist (1918, p. 80). It seems possible that Clark intended to name the species *C. andersoni*, as suggested by a dedicatory comment 1918, (p. 186), but upon learning that this name was preoccupied in *Cancellaria*, he substituted *C. ramonensis* in the systematic description but not on one of the plate descriptions (pl. 13, fig. 4) or on the checklist. Clark's statement in Keen and Bentson (1944, p. 138) that the specimen figured as *C. andersoni* is actually *C. sobrantensis* seems doubtful, as the specimens are not at all similar. The figure of *C. sobrantensis* indicates that the type material is missing from the University of California type collections. The holotype of *C. ramonensis* appears to be an immature specimen that has rather closely spaced, strong spiral ribs. The early whorls are similar to those of the specimen figured as *C. andersoni* Clark (1918, pl. 23, fig. 4). *C. andersoni* has sculpture similar to *C. oregonensis;*

therefore, both names are included in the synonymy of that species.

C. oregonensis has a less strongly tabulate, stouter body whorl than *Cancellaria condoni* in addition to alternating primary and secondary spiral ribs and coarse axial ribs that are well developed above the angulation. *C. ocoyana* is more spinose, has a more strongly inclined subsutural slope, and much finer spiral sculpture. The spiral sculpture of the closely related cancellariid from the Astoria Formation of Washington, *C. wynoocheensis* Weaver, is much finer than that of *C. oregonensis*.

Problems of recognition of this species resulted from the poorly illustrated fragmentary type specimen, an incomplete external mold. The proper generic placement of *Cancellaria oregonensis* was obscured for many years following Dall's diagnosis (1909, p. 77–78) of this specimen as a *Trichotropis*. It was identified as a cancellariid and documented by adequate figures by Moore (1963, p. 45, pl. 9, figs. 15–17, 19, 23).

An incomplete cast of a cancellariid figured as *Cancellaria* cf. *C. condoni* by Woodring and others (1946, pl. 40, fig. 9) from the middle Miocene part of the Altamira Shale Member of the Monterey Shale is very close to *C. oregonensis*, the principal difference being its more slender and somewhat higher spire. A poorly preserved specimen figured by Arnold (1907, pl. 40, fig. 9) as *Cancellaria* cf. *C. condoni* is referred to *C. oregonensis* with less certainty, although the sculpture is fairly similar.

Cancellaria vetusta Gabb (Stewart, 1927, p. 412–413, pl. 31, figs. 1, 1a) may belong here. The strength and pattern of spiral sculpture on the body whorl is similar to that of *C. oregonensis*, as are the strong axial ribs that persist from suture to suture on the penultimate whorl. What seems to be an important difference is the fairly long, concave subsutural slope of the body whorl on Stewart's lectotype. The possibility that this is the species that Clark (1918) figured as *C. ramonensis* and *C. andersoni* was recognized by Stewart.

Distribution and stratigraphic occurrence: Lower Miocene(?): San Ramon Sandstone, Contra Costa County, Calif. (Clark, 1918; Weaver, 1953). Middle Miocene: Astoria Formation—southwestern Washington and coastal Oregon (Moore, 1963); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range, Calif. (J. G. Vedder, written commun., December 1967); Topanga Formation, Santa Monica Mountains (Arnold, 1907; Eldridge and Arnold, 1907); Altamira Shale Member of Monterey Shale, Palos Verdes Hills (Woodring and others, 1946).

Range: Lower Miocene(?) to middle Miocene.

Localities: Lower part of Olcese Sand, USGS M1593. Upper part of Olcese Sand, UCMP B1641; CAS 65.

Cancellaria (Euclia) simplex Anderson

Plate 14, figures 13–15, 17–21, 24, 25, 27

Cancellaria simplex Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 200, pl. 15, figs. 51, 52.
Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.
Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 36.
Cancellaria (Euclia) simplex Anderson, Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 29, figs. 15, 19.
?*Cancellaria pacifica* Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 199 [in part], pl. 15, fig. 45, [not figs. 43, 44].
Cancellaria vetusta Gabb, Arnold, 1909, U.S. Geol. Survey Bull. 396, p. 124, pl. 9, fig. 6.
Arnold and Anderson, 1910, U.S. Geol. Survey Bull. 398, pl. 31, fig. 6.

Original description.—Shell moderate in size, simple and inconspicuously marked, resembling *C. pacifica*, but having a less elevated spire, and generally shorter whorls. The spiral lines and longitudinal ridges are both more reduced and the width of the shell is greater. The inner lip is well crusted. The length of the largest shell found is nearly 2 inches.

Supplementary description.—Medium to large, stout, low spired. Spire of about four whorls. Penultimate whorl with nodose angulation near midpoint. Body whorl large, with prominent tabulation above posterior one-quarter line. Profile concave above angulation, broadly convex below. Spiral sculpture of rounded primary and secondary cords separated by narrow interspaces. Axial sculpture usually restricted to nodes on angulation but on some specimens, weak rib segments of variable length continue downward and disappear above angulation, although in many specimens they may persist anteriorly toward the poorly defined basal angulation. Aperture large, subovate, about two-thirds length of shell. Inner lip encrusted with thick callus that spreads outward across body whorl and reaches upward to angulation. Columella straight; anterior canal short, open. Siphonal fasciole obscured by callus.

Syntypes: California Acad. Sci. 78, 79.

Type locality: In the vicinity of Barker's Ranch [headquarters formerly near the center of sec. 5, T. 29 S., R. 29 E., Bakesfield quadrangle]. This and other newly described species were collected "chiefly north of the river" (Anderson, 1905, p. 187).

In profile *Cancellaria simplex* is intermediate between the high-spired *C. dalliana* and *C. joaquinensis*, which has a smooth, domelike spire. The sculpture of *C. simplex* differs considerably from that of *C. dalliana*, which it most closely resembles. The spiral ribbing of *C. simplex* is subdued and, where best developed, consists of flattened, closely spaced cords that alternate in strength. The profile of the spire of *C. simplex* is convex on the earliest whorls but becomes subtabulate on the final whorl. On *C. dalliana*, the profile of early whorls is strongly tabulate.

Cancellaria pacifica, a species with which Anderson (1905, p. 200) compared *C. simplex*, is a relatively slender, more strongly sculptured cancellariid with a moderately high, tabulate whorl profile. Although belonging to the same subgenus, it seems less closely related to this species than *C. dalliana* and *C. joaquinensis*.

There is considerable variation in the development of axial sculpture and relative height of the spire in *Cancellaria simplex*. On a weakly sculptured form (pl. 14, fig. 15) only the body whorl is noded, the earlier whorls being evenly convex and sculptured only by fine spiral threads. On most specimens, however, axial sculpture is prominent on the penultimate whorl. The syntypes, and most of the specimens from USGS locality M1597, which is in the general area from which Anderson's original material (1905) was collected, have a moderately high spire and, except for the nodes on the body whorl, very weak axial sculpture. These specimens grade into others that have a relatively low spire, a much larger body whorl with a vertical profile below the angulation, and stronger axial sculpture. These are figured as "strongly sculptured form" (pl. 14, figs. 19, 20, 27). These specimens bear considerable resemblance to *C. vetusta* but can be easily distinguished from that species by their broader axial folds and much finer, more subdued spiral sculpture.

Distribution and stratigraphic occurrence: Temblor Formation, Coalinga district (Arnold, 1909 [as *Cancellaria vetusta*]; Woodring and others, 1940), La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932); Topanga Formation, Santa Monica Mountains (Grant in Soper, 1938; USGS loc. M1075).

Range: Middle Miocene.

Localities: Lower part of Olcese Sand, USGS M1593?. Middle part of Olcese Sand, USGS M1698. Upper part of Olcese Sand, USGS 6613 cf., 6624, 6890, M1597–M1599, M1601, M1602, M1693, M1698; UCMP B1586, B1587, B1598, B1599, B1603, cf. B1615, B1616, B1622, B1624. Round Mountain Silt, USGS M1605, cf. M1606, M1612.

Cancellaria (Euclia) joaquinensis Anderson

Plate 14, figures 22, 23, 26; plate 15, figures 4, 5

Cancellaria joaquinensis Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 199, pl. 15, figs. 46–48.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 171.

Original description.—Shell of moderate size, stout, and ovate; 1 inch or more in length and nearly as broad; spire medium or low, sloping evenly without conspicuous angles; shell thick; inner lip crusted; surface ornamented chiefly by revolving lines and interspaces, with finer secondary lines within; varical ridges weak, but forming on the upper angle of the body whorl a single circle of nodes.

Type: California Acad. Sci. 74.

Type locality: In the vicinity of Barker's Ranch [headquarters formerly near the center of sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle]. This and other newly described species were collected "chiefly north of the river" (Anderson, 1905, p. 187).

This globose species is distinguished from *Cancellaria simplex* Anderson by its convex, domelike profile above the crown of spines encircling the upper part of the body whorl. The spiral sculpture of alternating primary and secondary cords is similar to that of *C. lickana*, but the noded body whorl, lack of a subsutural angulation, extensive parietal callus, and faint posterior apertural notch all permit ready discrimination from that species. The parietal callus covers more of the body whorl than in other species of *Cancellaria* from this area. In many specimens it spreads upward to the suture, and on some specimens (pl. 15, fig. 4) across part of the penultimate whorl. The callus is not as thick as on *C. lickana*, and there is no abnormal thickening of shell material at the juncture of the parietal wall and outer apertural lip.

Among Holocene cancellariids, a moderately large species from the Panamic molluscan province of western North and South America, *Cancellaria cassidiformis* Sowerby (Tryon, 1885, pl. 1, fig. 1), is perhaps closest to this species. It differs from *C. joaquinensis* by having a spinose spire, a more strongly sculptured body whorl, and a narrower wash of callus on the body whorl.

The late Miocene *Cancellaria pabloensis* Clark (1915, p. 503, pl. 68, figs. 9, 11) from the San Pablo Group of Contra Costa and Napa Counties seems to be a direct descendant of this species. Clark's type specimens have a somewhat higher spire in addition to an elongation of the body whorl nodes parallel to the growth lines. On *C. joaquinensis* the nodes are circular in cross section, and the tips are pointed or elongate parallel to the spiral sculpture.

Distribution and stratigraphic occurrence: Middle Miocene: Temblor Formation, La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967). Upper Miocene: Santa Margarita Formation, Fruitvale oil field, Kern County (Gale in Preston, 1931).

Range: Middle Miocene and upper Miocene.

Localities: Upper part of Olcese Sand, USGS 6890, M1597, ?M1598, M1599, M1601, M1602, cf. M1693; UCMP B1594, B1598–B1600, B1622, B1624, B1626, ?B1641, cf. B1753.

Cancellaria (Euclia) pacifica Anderson

Plate 15, figures 14–16, 28, 29

Cancellaria pacifica Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 199 [in part], pl. 15, figs. 43, 44 [not fig. 45, probably *Cancellaria simplex* Anderson].

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 36.

?*Cancellaria andersoni* Arnold, 1909, U.S. Geol. Survey Bull. 396, p. 60–61 [not including synonymy], pl. 9, fig. 5.

Arnold and Anderson, 1910, U.S. Geol. Survey Bull. 398, pl. 31, fig. 5.

Original description.—Shell moderate in size, ¾–1½ inches in length, width ½ as great; spire moderately elevated; mouth oval in outline; whorls angulated, bearing small nodes on the upper angles; surface ornamented with revolving lines, heavier and lighter lines occurring alternately on the body whorl, crossed by vertical ridges.

Height 21.7 mm., width 13.1 mm.

Types: Type material destroyed by fire, San Francisco, Calif., 1906.

Neotype: U.S. Natl. Mus. 650205 (here designated).

Neotype locality: USGS M1600, *Tivela* biostrome on east side of gully trending southeasterly through sec. 33, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle, 650 feet south, 100 feet east of NW. cor. sec. 33. Near the top of Olcese Sand, middle Miocene.

Type of *Cancellaria andersoni* Arnold: U.S. Natl. Mus. 165607.

Type locality: USGS 4631, *Turritella ocoyana* bed in SE¼-NE¼ sec. 16, T. 19 S., R. 15 E., 10 miles north of Coalinga, Calif., Vaqueros Formation of Arnold (1909), middle Miocene.

This rather small cancellariid occurs in a few collections from the Kern River district. The neotype is from a locality in the uppermost part of the Olcese Sand that is within the stratigraphic interval from which Anderson (1905) obtained the original material. It and many other specimens appear to fit Anderson's description and figures (1905, p. 199, pl. 15, figs. 43, 44) of a moderately low spired specimen with cancellate sculpture and a short tabulate area above the nodose angulation. A stout, apparently smaller specimen figured as *C. pacifica* (Anderson, 1905, pl. 15, fig. 45) seems to be a juvenile *C. simplex* and is herein tentatively referred to that species.

Moore's view (1963, p. 45) that this species might be a synonym of *Cancellaria oregonensis* Conrad seems less likely than possible relationship to *C. birchi* or to *C. nevadensis*. The axial sculpture on the body whorl is a variable characteristic but is of sufficient strength to permit differentiation from a somewhat similar species, *C. nevadensis* which has fine spiral sculpture but only weak axial ribs or faint nodes restricted to the spire. From *C. birchi* n. sp., an abundant slender species in the lowermost part of the Round Mountain Silt, *C. pacifica* differs by having a very weakly recurved columella, a relatively short spire, and a much larger adult size. In the absence of clearly intermediate forms, these species are considered separate and distinct.

Arnold's *Cancellaria andersoni* (1909, p. 60–61, pl. 9, fig. 5) is closer to this species than to any of the other California Miocene species treated herein. Features that differ from specimens figured as *C. pacifica* are the virtually smooth body whorl and thickening of the parietal callus posteriorly. The proportions of the shell and sculpture of the spire are close to those of *C. pacifica*. The poor preservation of the body whorl leaves some doubt as to its original sculpture. In view of these considerations, Arnold's holotype is doubtfully included as a synonym of *C. pacifica*.

Cancellaria balboae Pilsbry (Keen, 1958a, p. 439, fig. 692) seems to be a modern analog of *C. pacifica*. The Holocene tropical species is from Panama Bay, where it has been dredged from depths of 10–20 fathoms.

Distribution and stratigraphic occurrence: Middle Miocene: Temblor Formation, La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932). Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967). Upper Miocene: Santa Margarita Formation, Fruitvale oil field, Kern County (Gale in Preston, 1931, cf.).

Range: Middle Miocene. Doubtfully recorded from the upper Miocene.

Localities: Upper part of Olcese Sand, USGS M1600. Round Mountain Silt, USGS 6063, cf. 6623, M1605, M1608, M1696, cf. M2480.

Cancellaria (Euclia?) nevadensis Anderson and Martin

Plate 15, figures 6–8, 17

Cancellaria nevadensis Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 85, pl. 8, figs. 5a–d.

Cancellaria nevadaensis Anderson and Martin, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Cancellaria n. sp. Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 29, fig. 14.

?*Cancellaria dalliana* Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 239 [in part], pl. 47, fig. 13 [not fig. 12].

Supplementary description.—Small, with short to moderately high spire of about four whorls. Earliest whorls usually sharply angulated above midpoint, sculptured by well-defined spiral cords and axial folds. Penultimate whorl with alternating primary and secondary spiral cords, axial sculpture usually obsolete, angulation faint. Body whorl globose, angulation either obsolete or marked by an enlarged primary spiral, which retains vestiges of axial ribs as indistinct nodes on some specimens. Spiral sculpture not clearly differentiated into primary and secondary cords; numerous very fine axial lines of growth form a faintly reticulate surface. Aperture elongate-ovate, inner lip with an oblique plication between primary columellar folds near margin of thin columellar callus. Outer lip bearing fine, elongate denticles in large specimens.

Type: California Acad. Sci. 190.

Type locality: CAS 68, north bank of Kern River about three-fourths of a mile west of power station [probably in NE¼ sec. 1, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle]. Lower part of Round Mountain Silt, middle Miocene.

Figured specimen of *Cancellaria* n. sp. Clark (1929) "not detected" in search by Keen and Bentson (1944, p. 141), locality unknown.

Cancellaria nevadensis is a distinctive slender species that is distinguished from other cancellariids of the Kern River area by its fine spiral sculpture. Axial sculpture usually becomes obsolete on the penultimate whorl, although traces may persist to the body whorl as faint nodes on the angulation.

Some of the more strongly tabulate specimens resemble *Cancellaria pacifica* in profile, but the obsolete or greatly subdued axial sculpture of *C. nevadensis* and its fine spiral sculpture permit ready differentiation.

The range of variation recognized for this species is probably as great as in any of the cancellariids from the Kern River area. One extreme is represented by the holotype (Anderson and Martin, 1914, pl. 8, fig. 5a), a high-spired specimen with prominent axial sculpture on the spire. The other morphologic extreme is a relatively low spired form with weak axial sculpture on the early whorls of the spire. The body whorl varies from evenly convex (pl. 15, figs. 7, 8) to weakly tabulate. The subsutural angulation near the posterior quarter-line may bear weak nodes or an enlarged spiral cord. The subsutural slope varies from convex to slightly concave (pl. 15, fig. 6).

A specimen figured as *Cancellaria dalliana* Anderson by Loel and Corey (1932, pl. 47, fig. 13) may belong here. It has relatively fine sculpture and a weak angulation on whorls of the spire.

A late Miocene record of this species from the Modelo Formation in the eastern Ventura basin (Daviess in Oakeshott, 1958) is regarded as doubtful. Specimens resembling *Cancellaria nevadensis* were not found in the Daviess collection (UCLA loc. 2018).

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation, La Panza Range (Loel and Corey, 1932). Middle Miocene: Monterey Shale, western Napa County (Weaver, 1949); Temblor Formation, La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932). Upper Miocene: Santa Margarita Formation, Fruitvale oil field, Kern County (Gale in Preston, 1931) [*Cancellaria* cf. *C. nevadensis*].

Range: Lower Miocene(?) to upper Miocene(?).

Localities: Upper part of Olcese Sand, USGS M1597, M1598, M1600, M1602; UCMP B1601, cf. B1614, B1616. Round Mountain Silt, USGS 3886, 6065, 6622, 6641, M1608, M1613; UCMP B1588, B1638.

Subgenus **PYRUCLIA** Olsson, 1932

Type (by original designation): *Cancellaria solida* Sowerby. Pliocene, Ecuador (Olsson, 1964) to Holocene, Gulf of California to Peru (Keen, 1958a).

Cancellaria (Pyruclia) lickana Anderson and Martin

Plate 15, figures 1–3, 9, 10

Purpura lima Martyn, Anderson, California Acad. Sci. Proc., ser. 3, v. 2, p. 202, pl. 15, figs. 62, 63.

?*Thais* (*Nucella*) *lima* Martyn, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173.

Cancellaria andersoni Arnold, 1909, U.S. Geol. Survey Bull. 396, p. 60–61 [in part], [not pl. 9, fig. 5].

Cancellaria lickana Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 84–85, pl. 8, figs. 6a–d.

Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 29, figs. 11, 22 (as *Cancellaria lichana*).

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 171.

To Anderson and Martin's description (1914, p. 84–85) can be added that this species has a very short, pointed spire worn smooth in practically every specimen examined. Larger specimens characteristically develop a shoulder below the suture in the last quarter revolution of the body whorl and a mound of parietal callus adjacent to the poorly defined posterior canal. There is a strong siphonal fasciole. The umbilicus is nearly obscured by the thick columellar callus.

Type: California Acad. Sci. 186.

Type locality: CAS 64, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586; near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

Cancellaria lickana occurs in several collections from the upper part of the Olcese Sand, although it is not abundantly represented at any locality. This species is clearly distinct from other cancellariids from the Kern River Miocene. Characteristic features are the large, spirally sculptured body whorl, pointed spire, subsutural shelf on final quarter-turn of the body whorl, and the mound of parietal callus near the top of the broad aperture.

Anderson's figures of *Purpura lima* Martyn (1905 pl. 15, figs. 62, 63) almost certainly represent the cancellariid which was later named *Cancellaria lickana* by Anderson and Martin (1914). They do not substantiate Arnold's placement (1909, p. 60–61) of *P. lima*

Martyn (Anderson, 1905) in the synonymy of his newly named *C. andersoni*, whose type specimen is from the Coalinga district on the west side of the San Joaquin Valley. Although the hypotype of Anderson's *P. lima* is lost, the figures clearly show no axial sculpture other than fine lines of growth.

This species is assigned to *Pyruclia* on the basis of a close degree of similarity with the type species, *Cancellaria solida*, and other late Tertiary species from South America figured by Olsson (1964, pl. 21, figs. 1–4). Principal differences between these species and *C. lickana* are their nearly obsolete body whorl sculpture and somewhat stronger columellar folds. Some specimens of *C. lickana* have an inward refraction of the basal part of the columella (pl. 15, fig. 9) but this seems to be a variable characteristic. There is a degree of similarity to the western Pacific subgenus *Merica* (type: *C. asperilla* Lamarck) but the parietal columellar callus of *C. lickana* is much heavier and lacks the finely papillose ornamentation of the basal part of the columellar lip. An earlier classification of this species as *Cancellaria* s.s. (Addicott and Vedder, 1963, p. C65) can be disregarded.

The holotype of Arnold's *Cancellaria andersoni* (1909, p. 60–61, pl. 9, fig. 5) is a slender, much higher spired specimen with prominent axial ribbing on the spire albeit a virtually smooth body whorl. It resembles *C. lickana* chiefly by having a much thickened parietal callus posteriorly. Arnold's specimen most closely resembles what is herein identified as *C. pacifica* Anderson (p. 114) and is tentatively included in the synonymy of that species. Anderson and Martin (1914, p. 85) noted the differences between Arnold's holotype and their *C. lickana* but believed that the resemblance of *P. lima* Martyn (Anderson, 1905) to this species was only superficial. The apparent absence of cancellariid plaits from Anderson's specimen is not unusual because the columellar plicae of *C. lickana* are not always visible in apertural view. Two of the specimens figured on plate 15 have apertures clogged with matrix, as did Anderson's specimen (1905, pl. 15, fig. 62). The plaits are visible on a specimen with a broken apertural lip (pl. 15, fig. 3) that has been rotated from normal apertural orientation.

Distribution and stratigraphic occurrence: Middle Miocene: Temblor Formation, Reef Ridge (Stewart, 1946?); Topanga Formation, Santa Ana Mountains (Vedder and Woodring, unpub. data, 1953, cf.). Upper Miocene: Santa Margarita Formation, Fruitvale oil field, Kern County (Gale in Preston, 1931).

Range: Middle Miocene to upper Miocene.

Localities: Upper part of Olcese Sand, USGS M1599, M1601, M1602, M1693; UCMP B1599, B1600, B1624.

Subgenus COPTOSTOMA Cossmann, 1899

Type (by original designation): *Cancellaria quadrata* Sowerby. Eocene, Europe.

Cancellaria (Coptostoma) posunculensis Anderson and Martin

Plate 15, figures 22, 24–26

Cancellaria posunculensis Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 86, pl. 8, figs. 7a–c.
Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.
?Lutz, 1951, California Univ., Dept. Geol. Sci. Bull., v. 28, no. 13, p. 392 [not pl. 18, fig. 8].

Type: California Acad. Sci. 202.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

Cancellaria posunculensis can be readily distinguished from other Miocene cancellariids in the Kern River district by the combination of finely reticulate sculpture and the slender, evenly convex body whorl. The species with which *C. posunculensis* is most apt to be confused is *Antillophos posunculensis* (Anderson and Martin), which has almost identical ornamentation but a relatively shorter aperture and body whorl as well as a nonplicate columella. On many specimens the columellar plaits terminate well within the aperture and are not visible in the normal apertural orientation. Immature specimens resemble *C. barkeri* superficially but can be distinguished by the postnuclear development of sinuous fine axial ribs superimposed upon spiral ribs that are much narrower than those of *C. barkeri.*

This species appears to have many characteristics in common with the type of *Coptostoma*, *C. quadrata* Sowerby (Cossmann, 1899, pl. 2, figs. 8, 9), notably the fine sculptural pattern and slender, nonangulated spire. The base of the body whorl of *Cancellaria posunculensis*, however, is more constricted anteriorly and the basal part of its columella is straight rather than curved inward. *Coptostoma* has not previously been reported from the west coast of North America.

C. posunculensis also resembles the type of *Aphera*, *C. tessellata* Sowerby (Tryon, 1885, pl. 4, figs. 58–60), in details of sculpture but lacks the thick parietal-columellar callus of that species and has a strong constriction above the base of the body whorl.

A poorly preserved specimen devoid of original shell material from the Sobrante Sandstone in the Hayward quadrangle, California, identified as *Cancellaria posunculensis* by Lutz (1951, p. 392, pl. 18, fig. 12) probably is *Antillophos posunculensis* (Anderson and Martin). The anterior canal is much shorter than on specimens of *C. posunculensis*, and the proportions of the body whorl are different. Columellar plaits are not present on the specimen from the Sobrante Sandstone.

Distribution and stratigraphic occurrence: Sobrante Sandstone, Alameda County (Lutz, 1951?); Temblor Formation—Reef Ridge (Stewart, 1946?), La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932); San Onofre Breccia, northwestern Peninsular Range (Woodford, 1925).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597, M1599, M1601, M1602; UCMP B1599, B1601, B1616, B1624, B1641.

Subgenus?

Cancellaria dalli (Anderson and Martin)

Plate 15, figures 11–13, 23, 27

Fossarus dalli Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 70, pl. 7, figs. 13a, b.

Fossarius dalli Anderson and Martin, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Fossarus barkeri Anderson in Hanna, 1924, California Acad. Sci. Proc., ser. 4, v. 13, no. 10, p. 165–166.

Cancellari barkeri (Anderson in Hanna), Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 36.

Type: California Acad. Sci. 148.

Type locality: CAS 64, in bottom of small canyon about 1¼ miles due north of Barker's ranchhouse. Upper part of Olcese Sand, middle Miocene.

This small obconic species is sculptured by deeply channeled spiral grooves. Axial sculpture ordinarily is missing, although on a few specimens there are irregularly spaced faint wrinkles. The parietal callus spreads outward onto the body whorl but is variable in thickness. There are two sharp, steeply inclined axial folds on the columella and the outer lip bears many fine denticles within.

Anderson in Hanna (1924, p. 165) proposed *Fossarus barkeri* as a new name for this species on the assumption that it was congeneric with *Trichotropis dalli* Whitfield (1894), which was transferred to *Fossarus* by Martin (1904, p. 240). Richard E. Petit (written commun., Aug. 14, 1965) has kindly pointed out that Whitfield's species does not belong in the Fossariidae as that family is presently understood. Rather, it seems to be an *Iselica*, a genus placed in the Pyramidellidae by Keen (1963, p. 89). Thus the name *dalli* is not preoccupied in the genus *Fossarus* and is available for the Kern River cancellariid. Petit also pointed out the close degree of similarity of *C. dalli* to the New Zealand Tertiary taxon *Pristimerica* (type: *P. dolioides* Finlay and Marwick, 1937, p. 82, pl. 11, figs. 2, 3), a rotund cancellariid with strong spiral sculpture.

Cancellaria dalli is known from only a few localities in a limited stratigraphic interval including the upper part of the Olcese Sand and the lower part of the Round Mountain Silt. It has not been reported from localities outside of the Kern River area.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597, M1602; UCMP loc. B1598, B1614, B1621. Round Mountain Silt, USGS loc. 3886, 6623, M1608; UCMP loc. B1638.

Subgenus CRAWFORDINA Dall, 1919

Type (by monotypy): *Cancellaria crawfordiana* Dall. Pliocene to Holocene, northeastern Pacific Ocean. Holocene range: Alaska to San Diego, Calif.

Cancellaria (Crawfordina) kernensis Addicott, n. sp.

Plate 15, figures 18–21

Small, low spired. Spire consisting of about three rapidly enlarging convex whorls. Penultimate whorl sculptured by 16 broad axial folds crossed by seven raised spiral cords separated by wide interspaces. Suture distinct, impressed. Body whorl large, cancellate. Intersections of subdued axial folds with relatively strong spiral ribbing nodose. Spiral cords more closely spaced than axial ribs, which form rectangular interspaces excepting between highest four spirals, which are relatively widely spaced. Aperture lens shaped, outer lip thin, faintly lirate within. Inner lip encrusted with thin callus deposit. Columella straight, bearing two sharp folds. An oblique plait occurs between the folds near the edge of callus. Umbilicus nearly obscured by a columellar callus. Anterior canal short, not markedly constricted. Siphonal fasciole poorly developed, bearing four fine spiral cords.

Height 13.4 mm, width 7.8 mm.

Type: U.S. Natl. Mus. 650207.

Type locality: USGS M1608, at base of bluff on south bank of Kern River at Olcese Boy Scout Camp, 3,200 feet south, 1,100 feet west of NE. cor. sec. 1, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene.

This species is closely allied to the Pliocene to Holocene *Cancellaria crawfordiana* Dall (1891, p. 182, pl. 6, fig. 1) from California. It is represented by two specimens from the east side of the southern San Joaquin Valley that seem to be clearly distinct from other Miocene species from the Pacific coast. It differs from *C. siletzensis* Anderson in Hanna (1924, p. 159) from the Astoria Formation of Lincoln County, Oreg. by its relatively slender profile, a greater number of axial ribs that are much weaker than the spiral cords, and no secondary spiral sculpture.

Another northern species from the Astoria Formation of Washington, *Cancellaria weaveri* Etherington (1931, p. 108–109, pl. 14, figs. 1, 3, 17) is somewhat similar to *C. kernensis* but much larger. It differs from *C. kernensis* by its more convex whorls and finely reticulate sculpture. The well-developed siphonal fasciole at the base of the body whorl of *C. weaveri* is bordered posteriorly by a strong constriction and the base of the columella is curved inward, whereas on *C. kernensis* it is straight.

Although there are only two known specimens of this species, a considerable degree of variation in sculpture is apparent. The specimen from a core of the Santa Margarita Sandstone in CWOD Alford 1, sec. 35, T. 27 S., R. 27 E., about 10 miles north of Bakersfield, has finer, more subdued axial folds than occur on the holotype. Axial sculpture on this specimen is developed only on the body whorl. The Santa Margarita Sandstone in this well is of late Miocene age, as it overlies approximately 500 feet of undifferentiated Round Mountain Silt and Fruitvale Shale of Miller and Bloom (1937) of Relizian to early Mohnian and late Luisian age (Kleinpell in Addicott, 1956, pl. 6).

Range: Middle Miocene to upper Miocene.

Localities: Round Mountain Silt, USGS M1608. Santa Margarita Sandstone CAS 28790.

Subgenus BARKERIA Addicott n. subgen.

Type: *Cancellaria sanjosei* Anderson and Martin. Miocene, California and Washington.

Small, cylindrical, with turreted spire. Whorls of spire broadly tabulate. Body whorl cylindrical, sculptured by relatively weak, flat-topped spiral cords that alternate in strength. Aperture subquadrate, with thick deposit of callus extending horizontally from posterior edge of outer lip backward onto parietal wall and then descending vertically toward anterior canal. Siphonal fasciole well developed, partly concealed by columellar callus. Columella armed with two sharp spiral plaits.

The distinctive inverted L-shaped columellar-parietal callus and the cylindrical, turreted shell of *Barkeria* are unique among fossil and Holocene cancellariids of the eastern Pacific Ocean. The type, *Cancellaria sanjosei* Anderson and Martin (1914, p. 87, pl. 6, figs. 2a, 2b), has been recognized from several localities in California and one locality in Washington, all of middle Miocene age. *Cancellaria urumacoensis* Hodson (1931, p. 45, pl. 18, figs. 2, 3), a turreted middle Miocene species from Venezuela, may also belong in this subgenus.

Cancellaria (Barkeria) sanjosei Anderson and Martin

Plate 16, figures 5, 11, 21, 22

Cancellaria sanjosei Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 87, pl. 6, figs. 2a, b.

Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 507 [in part], pl. 96, fig. 8.

Cancellaria sanjoseensis Anderson and Martin, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Type: California Acad. Sci. 207.

Type locality: CAS 126, in bed of small creek near center sec. 34, T. 28 S., R. 15 E., La Panza Range, San Luis Obispo County, Calif. "Lower Miocene" [probably middle Miocene].

Cancellaria sanjosei is known from localities in the upper part of the Round Mountain Silt near the mouth of Cottonwood Creek (USGS 6608, M1605, UCMP B1588) in the Kern River area. Specimens from these localities compare favorably with type material from San Luis Obispo County although traces of spiral sculpture are preserved on only a few of them. Preservation of material from this locality is generally poor; details of finer sculpture on other gastropods from M1605 usually are not discernible because of partial replacement of coating of original shell material by gypsum.

There is considerable variation in spire height and whorl tabulation in specimens from the Round Mountain Silt locality. Morphologic end points are a slender, high-spired form with strongly tabulate whorls (pl. 16, fig. 5) and an inflated, low-spired form with a weakly tabulate body whorl (pl. 16, figs. 21, 22). The low-spired form most closely resembles the holotype of *Cancellaria sanjosei*. The smooth tabulate profile and heavy, inverted L-shaped apertural callus are unique characters of this species.

Distribution and stratigraphic occurrence: Astoria Formation, Grays Harbor basin, southwestern Washington (Weaver, 1942); Sobrante Sandstone, Contra Costa County, Calif. (Weaver, 1953); Temblor Formation, La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932); Saltos Shale Member of the Monterey Shale of Hill, Carlson, and Dibblee, (1958), Caliente Range (J. G. Vedder, oral commun., January 1966).

Range: Middle Miocene.

Localities: Upper part of Round Mountain Silt, USGS 6608, M1605; UCMP B1588.

Subgenus NARONA H. and A. Adams, 1854

Type (by subsequent designation, Jousseaume, 1887): *Cancellaria clavatula* Sowerby. Holocene, west coast of Mexico to Peru.

Cancellaria (Narona) birchi Addicott, n. sp.

Plate 16, figures 12–16

Small, rugose, moderately high spired. Later whorls of spire sculptured by axial folds and a pair of finer spiral cords. Secondary spirals appear in interspaces on penultimate whorl. Body whorl slender, angulated near posterior one-quarter line, profile gently convex above, more strongly convex below. Axial sculpture of about 10 folds, some of which are varicose and relatively larger than others. Axials well developed above angulation but tend to disappear near basal constriction of body whorl. Spiral sculpture of two or three closely spaced cords above angulation and alternating primary and secondary cords with wide interspaces below. Spiral cord on angulation is swollen and nodose at intersection with axial ribs. Aperture elongate ovate. Outer lip thin, with four or five rounded denticles within. Inner lip encrusted with narrow callus. Anterior canal fairly short, moderately recurved to left. Well-developed siphonal fasciole.

Height 11.9 mm, width 6.3 mm.

Type: California Univ. Mus. Paleontology 33859.

Type locality: UCMP B1637, bottom of east fork of gully in SW¼ sec. 6, T. 29 S., R. 30 E., 1,350 feet east, 1,250 feet north from SW. cor. sec. 6, Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene.

Cancellaria birchi n. sp. is extremely abundant at localities in the lower part of the Round Mountain Silt immediately west and southwest of the mouth of Kern River Gorge. As far as is known, it is limited to a restricted stratigraphic interval near the base of the Round Mountain Silt. It is a small, slender species seldom attaining more than 15 mm in height. The height of the spire is somewhat variable, as is the number and strength of secondary spiral cords on some specimens.

The Holocene Panamic-Pacific *Cancellaria jayana* Keen (1958b, p. 249–250, pl. 30, fig. 5) from Panama Bay resembles *C. birchi* but has coarser spiral sculpture, a well-developed siphonal fasciole, and a broader parietal callus.

This species is most likely to be confused with *Cancellaria pacifica* Anderson, which occurs in the same stratigraphic interval. Differentiation from that species is based upon the strongly recurved anterior canal, relatively high spire, small adult size, slender profile, and denticulate inner apertural lip.

Immature specimens of *Cancellaria condoni* and *C. dalliana* have much different sculpture than *C. birchi*. The subsutural tabulation on juveniles of those species is flat or concave and relatively smooth, the angulation spinose, and the axial ribs slender and limited to the area below the angulation.

Occurrence: Lower part of Round Mountain Silt, USGS locs. 6063, 6066, M1603, M1608–M1610, M1612, M1613; UCMP locs. B1637, B1638.

Subgenus?

Cancellaria keenae Addicott, n. sp.

Plate 16, figures 1–4, 18, 19

Small, rugose, fusiform, high spired. Whorls convex, suture deeply impressed, wavy. Body whorl sculptured by eight raised axial folds or varices separated by interspaces about twice as wide. Spiral sculpture of about 15 rounded primary cords which alternate with secondary spirals on lower three-quarters of body whorl. Spiral cords on upper one-quarter of body whorl relatively fine and closely spaced. Aperture subovate, anterior canal short. Inner lip with nine elongate plicae. Columella encrusted with thin deposit of callus.

Height (almost complete) 14.7 mm, width 7.5 mm.

Type: California Univ., Los Angeles 45771.

Type locality: UCLA AC-2-34, lower part of Round Mountain Silt, Kern River [presumably from same stratigraphic interval and geographic area as USGS locs. M1608, M1612, and M1613, which are on the south side of Kern River in sec. 1, T. 29 S., R. 29 E., and sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle].

This species bears considerable resemblance to Holocene species of *Trigonostoma* from the Panamic-Pacific molluscan province, *T. funiculatum* (Hinds) (Keen, 1958a, p. 442, fig. 709) and *T. campbelli* Shasky (1961, p. 20, pl. 4, fig. 5), and to a Neogene species from the Esmeralda Formation, *T. thisbe* Olsson (1964, p. 126–127, pl. 22, fig. 6). Differentiation from them, and from *Trigonostoma*, is based upon the lack of an open umbilicus. Although variable, the whorl profile is not coronate, as in the Panamic species.

The change in spiral ribbing near the top of the body whorl from alternating primary and secondary cords below to fine spirals above is reflected as a faint angulation on one specimen (pl. 16, fig. 18). On the other specimens, the convex profile is unbroken.

Selection of a poorly located specimen as holotype is necessitated by the inferior preservation of the only other two specimens known to have been collected. The matrix on the type specimen and species associated with it suggests that the specimen was collected from sandy siltstones near the base of the Round Mountain Silt near the mouth of Kern River Gorge.

Occurrence: Lower part of Round Mountain Silt, USGS locs. 6065, 6623; UCMP loc. B1638; UCLA loc. AC-2-34.

Subgenus?

Cancellaria galei Addicott, n. sp.

Plate 16, figures 6–10

Of medium size, whorls acutely tabulate. Maximum diameter of whorls at angulation; shoulder slightly concave, sloping downward toward suture from periphery. Body whorl sculptured by 11–15 widely spaced, slightly retractive axial folds that become subdued on shoulder and tend to disappear below basal angulation. Spiral sculpture of relatively fine, alternating primary and secondary cords below tabulation and fine, indistinct spirals between tabulation and suture. Suture canaliculate, wavy. Aperture triangular, outer lip thin.

Height (nearly complete) 26.8 mm, width 17.5 mm.

Types: Holotype, U.S. Natl. Mus. 650214; paratype, USNM 650213.

Type locality: USGS M1590, fossil quarry in small gully on south side of prominent ridge trending southwestward through SE¼ sec. 15, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle. Basal part of Jewett Sand, lower Miocene.

Cancellaria galei n. sp. is represented by several crushed specimens from the basal marine sandstone of early Miocene age on the south flank of Pyramid Hill. It has not been found in collections from middle Miocene formations in the Kern River district. Although rather poorly preserved, the specimens clearly differ from other Miocene cancellariids in having downward-sloping shoulders and a trigonal aperture. The triangular-shaped aperture and acutely tabulate whorl profile suggest close relationships to *Trigonostoma*, a tropical genus represented by many species in the Panamic-Pacific molluscan province. It differs from *Trigonostoma*, however, by lacking an open umbilicus.

Were it not for the concave, inward-sloping shoulder, this species would closely resemble *Cancellaria oregonensis* Conrad and would be referable to the subgenus *Euclia*.

Occurrence: Basal part of Jewett Sand, USGS locs. M1590, M1591; UCMP loc. B1665.

Family OLIVIDAE

Genus OLIVA Bruguière, 1789

Type (by absolute tautonomy): *Voluta oliva* Linné. Holocene, Mauritius (Olsson and Harbison, 1953).

Oliva (Oliva) californica Anderson

Plate 16, figures 17, 26–30

Oliva californica Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 201, pl. 15, figs. 54–55.

Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 28, figs. 3, 4.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173, 239, pl. 47, figs. 4a, b.

Oliva futheyana Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 201, pl. 15, fig. 53.

Oliva simondsi Trask, 1922, California Univ., Dept. Geol. Sci. Bull., v. 13, no. 5, pl. 8, figs. 5a, b.

Original description.—Shell moderate in size, 1–1½ inches long, width more than half as great, ovate, narrowing below; spire low and rounded; aperture narrow, inner lip somewhat crusted; columella bearing 2 principal spiral plications, with finer lines both above and below; suture impressed and sharply defined on adolescent and mature shells; surface marked only by lines of growth.

Syntypes: California Acad. Sci. 76, 77.

Type locality: In the vicinity of Barker's Ranch [headquarters formerly near the center of sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle]. This and other newly described species were collected "chiefly north of the river" (Anderson, 1905, p. 187).

Type of *Oliva futheyana* Anderson: Lost or destroyed in San Francisco fire, 1906.

Type of *Oliva simondsi* Trask: California Univ. Mus. Paleontology 12394.

Type locality: UCMP 171, 222 mm east and 29 mm south from the northwest corner of Concord quadrangle, Contra Costa County, Calif. (Trask, 1922). Briones Sandstone, upper Miocene.

Large samples of specimens of *Oliva californica* Anderson from localities near the top of the Olcese Sand illustrate a broad range of variation in profile of this species. As a general rule, the older, thick-shelled specimens tend to have a broader apical angle and a strongly shouldered body whorl. In some specimens this may be a result of abrasion or wearing down of what was once a more acute spire. It is possible, however, to take specimens of intermediate size from a locality and trace a gradation from a relatively high spired individual with a relatively slender profile to a low-spired individual with a shouldered body whorl.

Loel and Corey (1932, p. 239) first recognized the slender form, originally named *Oliva futheyana* Anderson (1905, p. 201, pl. 15, fig. 53), as a variant of *O. californica*. *O. futheyana* was originally described as being similar to *O. californica* but "narrower, and having a more elevated spire and more graceful outline" (Anderson, 1905, p. 201). Attempts to separate these forms in some of the larger collections from the upper part of the Olcese Sand were so difficult that it seemed clear they represent a single, variable population. Keen's observations (1958a, p. 420–422) indicated there is considerable difficulty in differentiating some Holocene species of *Oliva* from the Panamic molluscan province, particularly when dealing with young specimens. The present treatment does not reflect the level of refinement in species discrimination among Holocene Panamic Olivas where color patterns are recognized as specific traits and are utilized in species discrimination.

In general, the smaller size range of *O. californica* includes mostly slender, nonshouldered specimens, whereas the adult specimens are almost exclusively broad and shouldered to varying degrees. Anderson's original line drawings (1905, pl. 15, figs. 53–55) have similar height-width ratios and do not clearly bring out the differences described from the type material. No attempt is made to record the occurrences of the slender form, as it is present in most of the collections.

Oliva californica resembles, very closely, the Pleistocene species *O. davisae* Durham (1950, p. 103, pl. 26, figs. 3, 5) from Santa Ynez Bay and Magdalena Bay, Baja California. The living *O. incrassata*, a thick-shelled, shouldered species ranging from Magdalena Bay south to Peru, is close to *O. davisae* but, according to Durham (1950, p. 103), has a higher spire and a weaker shoulder. Differentiation of *O. californica* from the Gulf of California Pleistocene species can be made on the greater number of primary spiral plaits near the base of the columella, four on *O. davisae*, as compared with only two on *O. californica*.

A stubby, very thick shelled specimen with an extremely broad apical angle of about 145° (pl. 16, fig. 25) is doubtfully treated as an undescribed species but may be no more than an extreme variant of *Oliva californica*.

Oliva simondsi Trask (1922, p. 159, pl. 8, figs. 5a, b) from the upper Miocene Briones Sandstone of Contra Costa County, Calif., is a synonym of *O. californica*. The holotype is a poorly preserved, somewhat deformed, weakly shouldered specimen similar to some of the more slender specimens of *O. californica* from the Kern River district. There are two primary spiral plaits near the base of the columella, as on *O. californica*.

The presence of *Oliva*, whose living species are restricted to the Panamic molluscan province of the western coast of Central America, is suggestive of subtropical to tropical marine climate in the central California region during deposition of the Briones Sandstone. This and a record of *O. spicata* (Bolten) from the Castaic Formation of Crowell (1955) (Stanton, 1966, p. 34, pl. 7, fig. 13) are the highest stratigraphic occurences of this genus in Tertiary strata of California.

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation—northern Santa Lucia Range, La Panza Range, San Emigdio Mountains, Ventura basin, Santa Ana Mountains (Loel and Corey, 1932); Painted Rock Sandstone Member of Vaqueros Formation of Hill, Carlson, and Dibblee (1958), Caliente Range (Repenning and Vedder, 1961). Middle Miocene: Monterey Shale, western Napa County (Weaver, 1949); Temblor Formation—Cantua Creek (Anderson, 1908), Anticline Ridge (Woodring and others, 1940), Reef Ridge (Stewart, 1946), La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (Repenning and Vedder, 1961); "Vaqueros or Temblor," northern Tejon Hills (Clark in Merriam, 1916); Vaqueros Sandstone of Hoots (1930), northern Tejon Hills (Addicott, 1965a); Topanga Formation—Santa Monica Mountains (Woodring in Hoots, 1931; Susuki, 1951), Santa Ana Mountains (Vedder and Woodring, unpub. data, 1953). Upper Miocene: Briones Sandstone, western Contra Costa County (Trask, 1922; Weaver, 1949).

Range: Lower Miocene to upper Miocene.

Localities: Basal part of Jewett Sand, UCMP B1660 cf. Middle part of Olcese Sand, USGS M1698. Upper part of Olcese Sand, USGS 6624, 6628, 6890, M1597–M1602, M1693, cf. M1697, M1698; UCMP B1586, B1587, B1593, B1594, B1596, B1599–B1601, B1616, B1622, B1623, B1629, B1640, B1753. Round Mountain Silt, USGS 6074?, M1612, M1613, M1696; UCMP 2713, B1613.

Oliva (Oliva) n. sp.?

Plate 16, figure 25

Of moderately large size, very thick shelled. Spire low, describing angle of about 145°. Suture deeply excavated. Body whorl strongly shouldered. Outer lip of aperture relatively straight.

Height 26.4 mm, width, 20.5 mm.

Figured specimen: California Univ. Mus. Paleontology 33871.

Locality: UCMP B1587, uppermost fossiliferous ledge in SE-facing river bluff in SW¼SE¼ sec. 32, T. 28 S., R. 29 E., Bakersfield quadrangle. Upper part of Olcese Sand, middle Miocene.

This stout, low-spired *Oliva* may prove to be a form of *O. californica*, but in the absence of intermediate forms linking it with the variable Miocene species, it is tentatively considered as new. The body whorl is more strongly shouldered than on specimens of *O. californica* and the outer apertural lip is much straighter. Poor preservation prevents determination of the number and arrangement of plaits on the columella. Only one specimen has been collected.

Occurrence: Upper part of Olcese Sand, UCMP loc. B1587.

Genus OLIVELLA Swainson, 1831

Type (by subsequent designation, Dall, 1909, p. 31): *Oliva* (*purpurata* Swainson=*O. dama* Wood). Holocene, head of the Gulf of California to Mazatlan, Mexico (Keen, 1958a).

Olivella (Olivella) ischnon Keen

Plate 17, figures 9, 13

Astyris pedroana Conrad, Anderson and Martin, 1914, California Acad. Sci. Proc., ser 4, v. 4, p. 42.

Olivella pedroana Conrad, Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 43.

Olivella pedroana var. *subpedroana* Loel and Corey, 1932, p. 173 [in part] [not p. 240, pl. 46, figs. 8a, b, 9a, b].

Olivella ischnon Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 50, pl. 4, figs. 3, 4.

Original description.—Shell relatively small and slender; spire high, about three-fourths the length of the aperture; sutural channel deep and wide; columellar folds weak, five in number, near anterior end of inner lip.

Supplementary description.—Small, slender, with a high spire of about four whorls. Sutures deeply channeled, fronted by very thin wall of shell material projecting upward from lower whorl. Parietal callus faint, in most specimens terminates posteriorly at or near the top of body whorl. Columellar lip of aperture with plicate basal pad bounded posteriorly by fairly deep spiral groove. Basal pad sculptured by basal fold, which is usually separated from overlying set of three of four plicae by a relatively broad channel. Columellar pad overlain by three or more very faint plicae on some specimens.

Type: Stanford Univ. Paleontology type colln. 7542.

Type locality: SU 2641, side of gully approximately 250 feet north of mouth of small gully, 1,000 feet south, 600 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle. Collected from 120-foot stratigraphic interval in uppermost part of Olcese Sand stratigraphically above USGS loc. M1597. Middle Miocene.

There is some variation in spire height and number of columellar plaits in specimens of *Olivella ischnon* Keen. Usually there are five plaits on the basal columellar pad but there may be as few as three. The lowest plait usually is stronger than the other four, which occur in couplets on some specimens. The number of plaits on *O. ischnon* is similar to that of *O. quadriplicata* Clark (1918, p. 185, pl. 19, figs. 10, 17) from the lower Miocene(?) San Ramon Sandstone of Contra Costa County, Calif., but the spire is uniformily much more elevated and acute. In profile, *O. ischnon* resembles *O. gracilis* (Broderip and Sowerby), a tropical Pliocene to Holocene species living in the Panamic molluscan province from the Gulf of California to Peru. The pillar structure of *O. gracilis* appears to lack the strong demarcation of the basal pad of *O. ischnon*, as indicated by a Holocene specimen from Ecuador figured by Olsson (1956, pl. 11, figs. 5, 5a).

Although most specimens of *Olivella ischnon* do not have the deeply excavated parietal wall within the aperture nor the clear-cut truncation inward of the columellar plicae, the presence of these features in a few specimens indicates assignment of the species to *Olivella* s.s.

Olivella pedroana subpedroana Loel and Corey (1932, p. 240, pl. 46, figs. 8a, 8b, 9a, 9b), a slender species from the lower Miocene Vaqueros Formation, is comparable to *O. ischnon* in all respects except the shape of the aperture, which is very narrow in both the holotype and paratype. Its narrow, slotlike aperture contrasts markedly with the triangular-shaped aperture of *O. ischnon.* Loel and Corey's record (1932, p. 173) of this subspecies from their "Temblor Horizon" of the Kern River area presumably is of *O. ischnon.*

Distribution and stratigraphic occurrence: Buttonbed Sandstone Member of Temblor Formation of Heikkila and MacLeod (1951), northern Temblor Range (USGS loc. M2632); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967); Topanga Formation, San Joaquin Hills (Vedder, unpub. data, 1958).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597, cf. M1600, M1601, M1602; UCMP B1586, B1588, B1598. Lower part of Round Mountain Silt, USGS 6063?, ?6064, cf. 6065, M1613, M2480; UCMP B1637.

Olivella sp.

An incomplete specimen of a moderately low spired *Olivella* with several sharp columellar plications has been collected from the basal conglomeratic sandstone of the Jewett Sand. It is similar in gross morphology to a specimen of *O. santana* Loel and Corey (1932, pl. 46, figs. 11a, 11b) but apparently has a more plicate columella. *O. ischnon* from the Olcese Sand and Round Mountain Silt is a much more slender species.

Occurrence: Basal part of Jewett Sand, USGS loc. M1591.

Family CONIDAE

Genus CONUS Linné, 1758

Type (by subsequent designation, Children, 1823): *Conus marmoreus* Linné. Holocene, Indo Pacific.

Subgenus CHELYCONUS Mörch, 1852

Type (by subsequent designation, Cossmann, 1896): *Conus testudinarius* Martini. Holocene, West Indies and west coast of Africa.

Conus (Chelyconus) owenianus Anderson

Plate 17, figures 1–8, 32, 37

Conus oweniana Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 201–202, pl. 15, figs. 58, 59.
Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 29, figs. 20, 21.
Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.
Conus owenianus Anderson, Arnold, 1909, U.S. Geol. Survey Bull. 396, p. 124, pl. 9, fig. 3.
Arnold and Anderson, 1910, U.S. Geol. Survey Bull. 398, pl. 31, fig. 3.
Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.
Woodring, Bramlette, and Kew, 1946, U.S. Geol. Survey Prof. Paper 207, pl. 28, figs. 14, 15.
Conus owenianus Arnold, Hanna and Hertlein, 1943, California Div. Mines Bull. 118, p. 172, fig. 63–10.
?*Conus* n. sp. Arnold, 1906, U.S. Geol. Survey Prof. Paper 47, p. 84.
Conus juanensis Wiedey, 1928, San Diego Soc. Nat. History Trans., v. 5, no. 10, p. 123–124, pl. 9, fig. 3.
Conus oweniana (Anderson) var. *ynezanus* Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 237, pl. 47, figs. 1a, b.

Original description.—Shell small, conical; spire moderate, conical; whorls flattened, or concave above; suture impressed on young shells; aperture narrow, and straight; surface marked by distinct, fine revolving lines.

Supplementary description.—Of medium size, profile varying from broad and low spired to slender and high spired. Spire consists of about five whorls, profile flat to gently concave, sculptured by microscopic growth lines with an evenly rounded, shallow antispiral sinus and much fainter spiral striae. Nucleoconch erect, consisting of three smooth, bulbous whorls with deeply impressed sutures. Body whorl sharply angulated to rounded. Segment of body whorl above angulation gently concave to flat. Regularly spaced light-brown bands preserved on most specimens, with interspaces about four times as wide. Profile regularly conic; a few specimens have a concave segment above the anterior canal. Base with six or more spiral grooves, the lower of which become indistinct but are bordered anteriorly by a rather strong spiral ridge that bears nodes on a few well-preserved specimens. Aperture narrow, outer lip very thin, inner lip encrusted by a thin wash of callus.

Syntypes: California Acad. Sci. 64, 65.

Type locality: In the vicinity of Barker's Ranch [headquarters formerly near the center of sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle]. This and other newly described species were collected "chiefly north of the river" (Anderson, 1905, p. 187).

Type of *Conus juanensis* Wiedey: San Diego Soc. Nat. History 16.

Type locality: SDSNH and SU 432, east side of first ridge west of Syncline Hill, 2 miles west of Simmler, San Luis Obispo County, Calif. Temblor Formation, middle Miocene.

Type of *Conus oweniana* var. *ynezanus* Loel and Corey: California Univ. Mus. Paleontology 31577.

Type locality: UCMP A602, west of Nojoqui Creek about 2½ miles southwest of Buellton, Santa Barbara County, Calif. Vaqueros Formation, lower Miocene.

Conus owenianus Anderson is abundant in the uppermost part of the Olcese Sand and in the lower sandy part of the Round Mountain Silt near the mouth of the Kern River. A wide range of variation is indicated by a large suite of specimens from USGS localities M1608, M1612, and M1613 in that area. Two forms seem to be recognizable in collections at hand. One is a stout, low-spired form with a sharp angulation at the top of the body whorl and, in most specimens, a slightly concave profile immediately above the base of the shell (pl. 17, figs. 5, 37); the profile of the spire is gently concave. This form is abundant at locality M1608. The other is a slender, moderately high spired form with a rounded angulation and a flat to slightly convex spire profile (pl. 17, figs. 6, 7). Both the stout and the slender forms of *C. owenianus* are represented in most of the larger collections that have been examined. Although one form predominates over the other in certain collections, for example, the stout form in M1608 and the slender form in M1613, many of the larger collections contain specimens that strongly suggest an intergradational relationship between these morphologic extremes. Another variable characteristic that does not seem to be clearly related to either the stout or the slender form is the sculpture at the base of the body whorl. A few specimens have a set of six or more fairly strong spiral grooves on this part of the body whorl. On others, all but the uppermost grooves are obsolete but are replaced by strong spiral ridges which bear widely spaced nodes on a few well-preserved specimens. Some specimens have no indication of ridges or grooves on the lower part of the body whorl.

In the context of species discrimination among modern eastern Pacific Ocean *Conus* (Keen, 1958a; Hill, 1959; Emerson and Old, 1962; Hanna, 1962), it seems possible that several species might be represented in the material herein included under *C. owenianus*. Yet in the absence of well-preserved color patterns, the chief criterion by which many of the Panamic species of *Conus* are differentiated, it is not possible to achieve such a fine degree of discrimination. The widespread use of color markings in species level identifications of eastern Pacific *Conus* is emphasized in Hanna's key to West American species (1962, p. 12–13).

Specimens of *Conus vittatus* Bruguière in U.S. National Museum collections from the Gulf of California show a considerable degree of similarity to the slender form of *C. owenianus*. The variable color markings are almost identical to the color banding preserved on some specimens of the California Miocene species, and the range of variation in the height of the spire is similar. The living species does attain a considerably larger adult size than *C. owenianus*. The stout form of *C. owenianus* resembles the Holocene *C. orion* Broderip (Hanna, 1962; pl. 7, figs. 1, 2, 16), a species that has been included as a synonym of *C. vittatus* by many workers. The modern analog of *C. owenianus* is restricted to the tropical Panamic molluscan province ranging from Santa Ynez Bay on the west coast of the Gulf of California southward to Ecuador (Emerson and Old, 1962).

Conus owenianus belongs to a group of smooth, relatively low spired species included in the subgenus *Chelyconus*. Although one member of this subgenus, *C. californicus* Hinds, ranges as far north as the central California coast (Hanna, 1962), the others are mainly tropical in their modern distribution. They range no farther north than Magdalena Bay on the outer coast of southern Baja California.

Conus juanensis Wiedey (1928, p. 123–124, pl. 9, fig. 3), originally believed to be closely similar to *C. owenianus* but differing from it by lack of "prominent spiral sculpture" and a somewhat higher spire, seems to fall within the range of variation of *C. owenianus*. It should be noted that Wiedey (1928, p. 124) suggested that this conclusion might be reached upon comparison with topotype material from the Kern River district. The characteristic spiral color banding on the body whorl of *C. owenianus* is not discernible on all specimens, and, as previously noted, the height of the spire is subject to much variation.

Conus owenianus var. *ynezanus* Loel and Corey is a slender form of *C. owenianus* with a somewhat concave body-whorl profile. Specimens closely approaching this form are in collections from the Round Mountain Silt. The pattern of spiral sculpture is barely discernible on the holotype.

Distribution and stratigraphic occurrence: Lower Miocene: Painted Rock Sandstone Member of Vaqueros Formation of Hill, Carlson, and Dibblee (1958), Caliente Range (Repenning and Vedder, 1961); Vaqueros Formation—Caliente Range (Eaton and others, 1941), western Santa Ynez Mountains (Loel and Corey, 1932). Middle Miocene: Temblor Formation—Cantua Creek (Anderson, 1908), Anticline Ridge (Arnold, 1909; Arnold and Anderson, 1910; Woodring and others, 1940), La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932), Caliente Range (Eaton and others, 1941); Buttonbed Sandstone Member of Temblor Formation, northern Temblor Range (Heikkila and MacLeod, 1951); Saltos Shale Member of Monterey Shale, of Hill, Carlson, and Dibblee, (1958) Caliente Range (Repenning and Vedder, 1961); "Vaqueros Formation" [Olcese Sand], northern Tejon Hills (Clark in Merriam, 1916; Addicott, 1965a); Topanga Formation—Santa Monica Mountains (Woodring in Hoots, 1931; Susuki, 1951), San Joaquin Hills (Vedder, unpub. data, 1958), Santa Ana Mountains (Vedder and Woodring, unpub. data, 1953).

Localities: Middle part of Olcese Sand, USGS M1698?. Upper part of Olcese Sand, USGS M1598, M1600, M1693; UCMP B1600, cf. B1616, B1622, B1623. Round Mountain Silt, USGS 3886, 6063–6066, ?6611–6613, 6622, 6623, 6641, ?13361, M1603–M1606, M1608, M1610, M1612, M1613, M1696, M2480; UCMP B1618, B1619, ?B1625, cf. B1633, B1637, B1638.

Subgenus LITHOCONUS Mörch, 1852

Type (by subsequent designation, Cossmann, 1889): *Conus millepunctatus* Lamarck. Holocene, Indo-Pacific.

Conus (Lithoconus) hayesi Arnold

Plate 16, figure 24

Conus hayesi Arnold, 1909, U.S. Geol. Survey Bull, 396, p. 62–63, pl. 6, fig. 3.

Arnold and Anderson, 1910, U.S. Geol. Survey Bull, 398, pl. 28, fig. 3.

Type: U.S. Natl. Mus. 165566.

Type locality: "Reef bed" on Wagon Wheel Mountain, sec. 36, T. 25 S., R. 18 E., Emigrant Hill quadrangle "Vaqueros Sandstone" [Escudo Sandstone of Vancouvering and Allen, 1943], middle Miocene.

Although incomplete, the specimen from near the top of the Round Mountain Silt is better preserved than Arnold's holotype. It has a rounded shoulder above which the body-whorl profile is gently concave. Features that indicate specific identity with the holotype from the Escudo Sandstone of Vancouvering and Allen (1943) near Devil's Den on the west side of San Joaquin Valley are the subsutural carina of the spire and faint spiral sculpture above the shoulder of the body whorl.

Conus hayesi appears to be limited to strata of middle Miocene age in California. It is closely related to the very large *C. fergusoni* Sowerby, a Pliocene to Holocene species that ranges from the outer coast of southern Baja California southward to Peru as noted by Arnold (1909) and Hanna (1962).

Distribution and stratigraphic occurrence: "Vaqueros Formation" [Escudo Formation of Vancouvering and Allen, 1943], Devil's Den area (Arnold, 1909; Arnold and Anderson, 1910); Temblor Formation, La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932); Saltos Shale Member of Monterey Shale of Hill, Carlson, Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967); Topanga Formation—Santa Monica Mountains (Susuki, 1951, cf.), Santa Ana Mountains (English, 1926; Vedder and Woodring, unpub. data, 1953, cf.).

Range: Middle Miocene.

Locality: Upper part of Round Mountain Silt, USGS 6611.

Family TEREBRIDAE

Genus TEREBRA Bruguière, 1789

Type (by monotypy, Lamarck, 1799): *Buccinum subulatum* Linné. Holocene, Indo-Pacific.

Subgenus TEREBRA

Terebra (Terebra) cooperi Anderson

Plate 17, figures 21, 27, 31, 33–35

Terebra cooperi Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 203, pl. 16, figs. 66, 67.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

?*Terebra* (subgenus=?) *cooperi* Anderson, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 236 [not pl. 47, fig. 6].

Original description.—Shell of moderate size, tapering regularly; length 1½–2 inches, width of body whorl ½ inch or less; aperture narrow and elongated, with simple outer lip; surface ornamented with slightly sinuous vertical ribs or lines closely set on the whorls; inner lip only slightly crusted; columella with a narrow oblique fold on the outer side; the upper ⅓ of the whorls bearing a constricted band, not clearly shown in the figures.

Supplementary description.—Large, thick, tapering more rapidly in early stages of growth. Spire high, delicately pointed, sculptured by closely spaced axial ribs that are relatively straight on earlier whorls but become slightly arcuate below subsutural band on later whorls. Penultimate and body whorl usually lack axial ribs, although closely spaced axial lines of growth are usually visible. Spiral sculpture microscopic, usually obsolete or abraded. Broad subsutural collar defined by faint spiral groove on earlier whorls is usually obsolete on body whorl. Earliest sutures strongly tabulate, later ones less so. Body whorl large, relatively smooth with well-rounded basal angulation. Aperture subquadrate, bearing a single basal fold within corresponding to lower edge of siphonal fasciole. Upper edge of fasciole bounded by a sharp ridge. Columella slightly twisted to left.

Type: California Acad. Sci. 72.

Type locality: In the vicinity of Barker's Ranch [headquarters formerly near the center of sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle]. This and other newly described species were collected "chiefly north of the river" (Anderson, 1905, p. 187).

This species is represented by a few specimens in collections from the upper part of the Olcese Sand and overlying fine-grained strata included in the Round Mountain Silt. It is a large, turreted species with weak axial sculpture, a broad but poorly defined subsutural band, and a relatively high body whorl.

Terebra cooperi is similar to the tropical eastern Pacific *T. strigata* Sowerby, a large species that ranges from the Gulf of California southward to Panama (Keen, 1958a, p. 489). The Holocene species differs from *T. cooperi* by its more strongly delimited subsutral collar which, on later whorls, becomes progressively broader and tends to occupy nearly half of the final whorls.

Immature specimens are difficult to distinguish from other species of *Terebra* from the Olcese Sand and Round Mountain Silt. In general they can be differentiated from *T. stirtoni* n. sp. by their more numerous, straighter axial ribs as well as by the weekly defined subsutural band.

A slender species represented by much smaller specimens than *Terebra cooperi*, *Terebra* n. sp., resembles immature growth stages of *T. cooperi*. Were it not for the narrow subsutural collar clearly defined by a fairly deep groove, the slender outline, and closely spaced axial ribs, this species might be considered a slender variant of *T. cooperi*.

A short, stout form of *Terebra cooperi* (pl. 17, fig. 35) occurs at a locality in the upper part of the Olcese Sand (USGS M1600). As far as is known, *T. cooperi* is restricted to beds considered to be of middle Miocene age based on megafossil evidence. Occurrences from three localities in the La Panza Range of eastern San Luis Obispo County reported by Loel and Corey (1932, p. 111) are considered doubtful because their figured specimen (pl. 47, fig. 6), although not sufficiently well preserved to be specifically identified, has areas of discernible sculpture that suggest it is not properly identified as *T. cooperi*. The subsutural callus on this specimen is narrower and bordered by a more deeply incised line than on *T. cooperi* and the axial ribs on the body whorl are much stronger and more closely spaced than on the Kern River specimens.

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation, La Panza Range (Loel and Corey, 1932?). Middle Miocene: Monterey Shale, western Napa County (Weaver, 1949); Temblor Formation, La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December, 1967); "Vaqueros Formation" [Olcese Sand], northern Tejon Hills (Clark in Merriam, 1916; Addicott, 1965a); Topanga Formation, Santa Monica Mountains (Grant in Soper, 1938; Susuki, 1951).

Range: Middle Miocene (early Miocene occurrences of Loel and Corey, 1932, are doubtful).

Localities: Upper part of Olcese Sand, USGS 6890, M1597, cf. M1598, M1600; UCMP B1587, ?B1588, B1600, B1622. Round Mountain Silt, USGS 6064?, ?6074, M1605, M1610, cf. M1612, M1613; UCMP B1638.

Terebra (Terebra) n. sp.

Plate 17, figures 18, 19, 30

Small with a rapid apical tapering in posterior half of spire. Early whorls sculptured by strong, nearly straight axial ribs and a narrow subsutural collar set off by a fairly strong groove. Body whorl sculptured by very fine spiral striae and a poorly defined subsutural collar. Base of the body whorl evenly rounded. Outer apertural lip thin, evenly rounded; columella nearly vertical, anterior canal twisted slightly to the left. Siphonal fasciole set off above by a sharply raised ridge.

Height 18.9 mm, width 4.7 mm.

Figured specimen: U.S. Natl. Mus. 650233.

Locality: USGS M1597, in an abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

This new species is represented by a few small, possibly immature specimens from the upper part of the Olcese Sand. It differs from immature growth stages of the somewhat similar *Terebra cooperi* by its very slender shell, nontabulate sutures, a narrower and more clearly defined subsutural collar and, in some specimens, very closely spaced axial ribs. Most of these differences are readily discernible on comparable growth stages of each species.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Subgenus FUSOTEREBRA Sacco, 1891

Type (by original designation): *Fusus terebrina* Bonelli, Tortonian (Miocene), Italy.

Terebra (Fusoterebra?) adelaidana Addicott, n. sp.

Plate 17, figures 16, 17

Of medium size, slender, with strongly wrinkled axial sculpture. Spire consisting of about 10 whorls. Axial sculpture of about 14 ribs with larger but indistinctly bordered interspaces. Axial ribs gently inclined in an anterior direction and more or less continuous from one whorl to the next although at least one new rib is added to each successive whorl. Spiral sculpture lacking. Axial ribs slightly recurved in an apertural direction immediately below the suture on the body whorl. Base of body whorl with a distinct angulation marked by slight local antispiral sinus on axial ribs. Columellar lip vertical, encrusted by narrow callus. Siphonal fasciole poorly defined, bearing four microscopic grooves.

Height 16.4 mm, width 4.9 mm.

Type: U.S. Natl. Mus. 650232.

Type locality: USGS M1597, in an abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

This unique terebrid does not seem to have a modern analog in the Recent fauna of the eastern Pacific Ocean. It is similar in some respects and may be related subgenerically to *Terebra isopleura* Pilsbry and Lowe (1932; pl. 1, fig. 6), a Holocene species from the northern part of the Panamic molluscan province which has been doubtfully assigned to the subgenus *Microtrypetes* by Keen (1958a, p. 489). It differs from *T. isopleura* as well as from the type of *Microtrypetes (T. iola* Pilsbry and Lowe) by having a narrower, rather long anterior canal and lacking spiral sculpture.

The subgenus *Fusoterebra* Sacco (1891, p. 59), is based upon *Terebra terebrina* (Bonelli), a longitudinally ribbed species with a moderately long anterior canal. Cossmann's figure (1896, pl. 4, fig. 14) of *T. terebrina* is similar to *T. adelaidana.* It differs principally in the more closely spaced, nearly vertical axial ribs. It is possible, however, that Cossmann's figure of the Tortonian species may not be characteristic because all but one of Sacco's figures of *T. terebrina* and varieties (1891a, pl. 2, figs. 70–75) show one or more spiral rows of nodes on the crests of the axial ribs.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597. Lower part of Round Mountain Silt, USGS loc. M1613.

Subgenus STRIOTEREBRUM Sacco, 1891

Type (by original designation): *Terebra basteroti* Nyst. Miocene, Italy and France (Cossmann, 1896, p. 50).

Terebra (Strioterebrum) stirtoni Addicott, n. sp.

Plate 17, figures 11, 12, 20

Moderately large, thick shelled, with a well-defined subsutural collar. Spire evenly tapered, whorls short, suture subtabulate. Axial sculpture of vertical ribs near apex that become arcuate and less regularly spaced on later whorls. Spiral sculpture of very fine to microscopic striae discernible on well-preserved specimens. Subsutural collar bounded below by deeply incised spiral groove. Body whorl with subdued axial sculpture, base strongly angulated. Aperture subquadrate, inner lip with thick callus. Anterior canal twisted to left. Siphonal fasciole set off by sharp ridge. Columella with strong basal fold and weak fold above.

Height (almost complete) 26mm, width 7.8 mm.

Type: U.S. Natl. Mus. 650330.

Type locality: USGS M1613, east side of gully about 25 feet above base and 20 feet stratigraphically above M1612, 1,300 feet north, 1,450 feet east of SW. cor. sec. 6, T. 29 S., R. 30 E., Oil Center quadrangle. Lower part of Round Mountain Silt, middle Miocene.

Terebra stirtoni n. sp. is known from a few localities in the upper part of the Olcese Sand and the lower, sandy part of the overlying Round Mountain Silt. It can be readily distinguished from *T. cooperi*, with which it is usually found, by its less strongly tapered shell, strong subsutural collar, well-developed axial sculpture on later whorls, shorter whorl height, and strong basal angulation. Although several large specimens (maximum height 47 mm) are in the collections, none are sufficiently well preserved to designate as holotype. The relatively small specimen selected as the type of *T. stirtoni* is representative of the sculpture and profile of the larger specimens.

Specimens in the U.S. National Museum collections labeled *Terebra fluctuosa* Berry from Santa Maria Bay, Baja California (USNM 267750), are similar to *T. stirtoni.* The modern analog differs chiefly by its more sinuous axial ribbing of the body whorl. In other respects it is closely similar to the middle Miocene species.

Immature specimens of *Terebra stirtoni* (less than 10 mm in height) are abundant at a few localities. They are more coarsely ribbed and have a weaker subsutural collar than the adult specimens figured on plate 17.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597. Round Mountain Silt, USGS locs. 3886, 6065, 6622, 6623, cf. M1603, M1605, M1608, M1610, M1612, M1613, M2480; UCMP locs. B1588, B1638.

Terebra (Strioterebrum) n. sp.?

Plate 17, figures 14, 15

Small, with narrow, well-defined subsutural collar bordered below by a weak groove. Spiral sculpture relatively coarse. Axial sculpture of prominent, slightly curved ribs on whorls of spire, weakening on final half turn of body whorl.

Height 7.6 mm, width 2.4 mm.

Figured specimen: U.S. Natl. Mus. 650230.

Locality: USGS M1597, in an abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

The few small specimens of this spirally sculptured terebrid may represent an undescribed species, but in the absence of more material and larger specimens, the relationship to other species cannot be satisfactorily determined. The coarse spiral sculpture and rather fine, closely spaced axial ribs permit separation from *Terebra stirtoni* n. sp., the species it most closely resembles.

Specimens in U.S. National Museum collections from localities in the Gulf of California (USNM 267839, 268708) arranged under the heading "*Terebra (Strioterebrum) diomeda* B[erry]" are similar to this species. They are comparably small and slender but are more coarsely sculptured.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Genus HASTULA H. and A. Adams, 1853

Type (by subsequent designation, Cossmann, 1896, p. 53): *Buccinum strigilatum* Linné. Holocene, Indo-Pacific.

Hastula gnomon Keen

Plate 17, figures 23–26

Hastula gnomon Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 47, pl. 4, fig. 11.

Types: Holotype, Stanford Univ. paleontology type colln. 7536; paratypes, California Univ. Mus. Paleontology 33311, 33312, 35675, 35676.

Type locality: SU 2121, in small gully close to terrace contact near center of SW¼ sec. 6, T. 29 S., R. 30 E., Caliente quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

This small species can be distinguished from immature specimens of *Terebra*, with which it occurs, by the weak axial ribs that become obsolete on the lower part of the penultimate whorl and body whorl. A further difference is the lack of a subsutural collar.

Hastula is a tropical genus. The only species described from the eastern Pacific area in addition to *H. gnomon* is *H. luctuosa* Hinds, a Holocene species ranging from Carmen Island, Gulf of California, Mexico (Emerson and Puffer, 1957) to Panama (Keen, 1958a). This slender Holocene species attains a much larger size than *H. gnomon.* Other differences are the larger sutural angle of *H. luctuosa* and its greater number of axial ribs, which are more strongly developed on the later whorls.

Distribution and stratigraphic occurrence: Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range, Calif. (J. G. Vedder, written commun., December 1967).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS 6890. Lower part of Round Mountain Silt, USGS 6641, M1613, M1696; UCMP 2713, B1611.

Family TURRIDAE
Subfamily TURRINAE

Genus POLYSTIRA Woodring, 1928

Type (by original designation): *Pleurotoma albida* Perry. Holocene, West Indies and Florida; Pliocene, Florida (Fargo in Olsson and Harbison, 1953, p. 368).

Bartsch (1934, p. 8) maintained that Woodring's original designation of *Pleurotoma albida* Perry could not be used as the type of *Polystira*, because the name was originally proposed for a New Zealand turrid that differed from the Caribbean species upon which Woodring based his new genus. According to Powell (1964, p. 315), however, the original Indo-Pacific record of *P. albida* is erroneous, the species being restricted to the Caribbean. Holocene West American species of this genus have been placed in *Pleuroliria* Gregorio by Keen (1958a, p. 476), a genus that Woodring (1928, p. 145–146) differentiated from *Polystira* by its weak peripheral keel and protoconch of four whorls. Powell (1964) considered *Pleuroliria* to be ancestral to *Polystira* and lists its stratigraphic occurrences as Eocene and Oligocene.

Polystira englishi Addicott n. sp.

Plate 17, figures 28, 29, 36, 38, 39

Moderately large, stout. Spire consisting of 4½ whorls angulated above midpoint by a strong keel edged by two fine threads. Two spiral cords occur below the angulation, a third between the suture and the angulation. Later whorls with secondary and tertiary spiral threads and fine to microscopic axial lines of growth that form a finely reticulate microsculpture. Body whorl slightly convex in profile, strongly constricted below, keel reduced in prominence. Suture narrowly subtabulate. Spiral sculpture of a single spiral cord above the flat-topped, finely bicarinate "keel" and three below. Exterior roughened by irregularly spaced axial growth lines on final half turn. Inner lip of aperture encrusted by a thin callus. Anterior canal moderately long and straight. Columella umbilicate, siphonal fasciole well developed.

Length (incomplete) 59.5 mm, width 21.5 mm (holotype).

Types: Holotype, California Acad. Sci. 12938; paratype, CAS 12937.

Type locality: CAS 2064 [= CAS 65], west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably in NE¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle].

The type material of *Polystira englishi* is from near the top of the Olcese Sand. A smaller specimen from the collections at the University of California, Berkeley (pl. 17, figs. 28, 29), is referable to this species, although the carina is not as strongly developed as in the larger specimens. Although precise locality data for this specimen are lacking (UCMP loc. 2716 "Miocene of Kern River"), its joint occurrence with *Hastula gnomon. Cancellaria nevadanus*, *Cylichna loismartinæ*, *Nassarius arnoldi*, and "*Mactra sectoris*" in light-grayish-brown silty, very fine sand matrix suggests that the collection was made from the basal, sandy part of the Round Mountain Silt. This part of the Round Mountain Silt is well exposed and most fossiliferous about a mile west of the mouth of Kern River Gorge, in sec. 1, T. 29 S. R. 29 E., and in sec. 6, T. 29 S., R. 30 E.

Polystira englishi resembles specimens of *P. oxytropis* (Sowerby), a Holocene inner sublittoral species ranging from the Gulf of California to Colombia (Keen, 1958a, p. 477) but has a much weaker carina. The living species is adjudged sufficiently similar to be considered a modern analog. The genus has not previously been reported from the Pacific coast Tertiary.

Occurrence: Upper part of Olcese Sand, CAS loc. 2064 (loc. 65). ?Lower part of Round Mountain Silt, UCMP loc. 2716.

Genus XENUROTURRIS Iredale, 1929

Type (by original designation): *Xenuroturris legitima* Iredale=*Pleurotoma cingulifera* Lamarck (Powell, 1964, p. 321–322). Holocene, tropical Indian Ocean and Pacific Ocean.

Xenuroturris antiselli (Anderson and Martin)

Plate 19, figures 3, 15

Drillia antiselli Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 93, pl. 7, figs. 2a, b.

?*Clathrodrillia (Moniliopsis) antiselli* (Anderson and Martin), Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 113, pl. 14, figs. 16, 18, 19.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Thesbia antiselli (Anderson and Martin), Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 538, pl. 99, fig. 10, [?figs. 8, 9].

"*Thesbia*" *antiselli* (Anderson and Martin), Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 47–48, pl. 10, figs. 6, 12, 13, 15.

Types: Holotype, California Acad. Sci. 226; cotype, CAS 227.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

This species is referred to *Xenuroturris*, a Holocene Indo-Pacific and Japanese genus not previously reported from the eastern Pacific, because of the strong resemblance to the Holocene *X. cingulifera* (Lamarck) (Kira, 1962, pl. 35, fig. 9), the type of *Xenuroturris*. The eastern Pacific genus which comes closest to accommodating *X. antiselli* is *Gemmula*. The principal features by which the Miocene species is excluded from that genus are its short anterior canal and nonbeaded posterior sinus band.

Moore (1963, p. 48) has shown that previous assignment of this species to *Thesbia* is incorrect because of basic differences in sculpture and configuration of the posterior sinus. Moore's specimens of "*T.*" *antiselli* from the Astoria Formation (1963, pl. 10, figs. 6, 12, 13, 15) have fewer spiral ribs than the California Miocene specimens, but variation within the latter group is such that inclusion of the Astoria turrids in this species seems warranted.

Xenuroturris antiselli is represented by scattered specimens in collections from the upper part of the Olcese Sand and the lower part of the Round Mountain Silt. There is considerable variation in spiral sculpture. Usually two spiral cords occur below the medial keel, although on some specimens, secondary spirals are intercalated.

Specimens from the Astoria Formation of southwestern Washington identified as "*Clathrodrillia*" *antiselli* by Etherington (1931, p. 112, pl. 14, figs. 16. 18, 19) have a relatively convex whorl profile and lack the well-defined, keeled angulation characteristic of this species. In view of these differences, they are considered doubtful occurrances of *Xenuroturris antiselli.*

Distribution and stratigraphic occurrence: Astoria Formation, southwestern Washington (Etherington, 1931?), coastal Oregon (Moore, 1963); Temblor Formation, La Panza Range (Anderson and Martin, 1914); Loel and Corey, 1932); Topanga Formation, Santa Monica Mountains (Grant in Soper, 1938).

Range: Lower Miocene(?) to Middle Miocene.

Localities: Basal part of Jewett Sand, USGS loc. M1591?. Upper part of Olcese Sand, USGS M1597. Lower part of Round Mountain Silt, USGS M2480.

Subfamily TURRICULINAE

Genus TURRICULA Schumacher, 1817

Type (by monotypy): *Turricula flammea* Schumacher. Recent, East Indies.

Turricula ochsneri (Anderson and Martin)

Plate 18, figures 1–3, 6, 12, 13

Drillia (aff.) *torosa* [Carpenter], Arnold, 1960, U.S. Geol. Survey Prof. Paper 47, p. 84.

Drillia ochsneri Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 5, p. 90–91, pl. 6, figs. 9a, b, c.

Turricula ochsneri (Anderson and Martin), Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 488.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 174.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

Turricula cf. *ochsneri* (Anderson and Martin), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 238.

Turricula oschneri (Anderson and Martin), Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 27, figs. 5, 6 [reproductions of *Drillia wilsoni* Anderson and Martin (1914, pl. 6, figs. 10c, b, respectively)]; pl. 28, fig. 7.

Drillia wilsoni Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 5, p. 91, pl. 6, figs. 10a, b, c.

Turricula wilsoni (Anderson and Martin), Clark, 1929, Stratigraphy and faunal horizons of the Coast Ranges of California, pl. 27, fig. 7.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 174.

Turricula libya Dall, 1919, U.S. Natl. Mus. Proc., v. 56, no. 2288, p. 2–3, pl. 2, fig. 5.

Turrricula (*Turricula*) *libya* Dall, Keen, 1958, Sea shells of tropical west America, marine mollusks from Lower California to Colombia, p. 474, fig. 899.

Type: California Acad. Sci. 215.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchouse [probably same as UCMP B1586, near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

Type of *Drillia wilsoni:* California Acad. Sci. 218.

Type locality: CAS 126, in bed of small creek near center of sec. 34, T. 28 S., R. 15 E., "lower Miocene" [probably middle Miocene], La Panza Range, San Luis Obispo County, Calif.

Type of *Turricula libya:* U.S. Natl. Mus. 96576.

Type locality: U.S. Bureau of Fisheries Station 2830, off Cape San Lucas, Baja California, in 66 fathoms.

Turricula ochsneri includes a relatively small group of specimens from the lower part of the Round Mountain Silt characterized by nodose, strongly angulated whorls. Two fairly distinct forms are recognized. The more common is the strongly noded form (pl. 18, figs. 3, 12, 13) characterized by a short, strongly concave subsutural profile. The relatively scarce weakly noded form (pl. 18, figs. 1, 2, 6) has a long, gently concave subsutural slope and a more elongate, less turreted spire. The strongly noded form is angulated at the midpoint of the whorl or slightly above and has a prominent concave subsutural slope. The weekly noded form is angulated well below the midpoint. The surface of better preserved specimens of the strongly noded form is virtually smooth, whereas the other form has rather fine spiral cords on the lower part of the body whorl similar to Anderson and Martin's figures (1914, pl. 6, figs. 9a, 9b, 9c). These differences are considered of infrasubspecific rank because the two forms appear to intergrade in collections from USGS locality M1613 in the lower part of the Round Mountain Silt. There is also a remarkably similar variation in whorl profile and elongation of the spire in a closely related species, *T. piercei* (Arnold), which occurs with *T. ochsneri.*

As Grant and Gale (1931, p. 488) have observed, the differences between *Turricula ochsneri* and *T. wilsoni*, a species described from the middle Miocene strata of eastern San Luis Obispo County, do not seem to warrant recognition as separate species. Perhaps the latter could be recognized as a slender, coarsely noded form of *T. ochsneri.* Grant and Gale's belief (1931) that *T. ochsneri* is intergradational with *T. piercei* is not indicated by collections containing large representations of both species.

The Holocene analog of *Turricula ochsneri* has been considered to be *T. libya* Dall by Addicott and Vedder (1963, p. C65). Subsequent comparison of Dall's holotype (USNM 96576) and three topotypes (USNM 537873) with *T. ochsneri* indicate that the principal difference between them is the somewhat deeper posterior sinus of *T. libya.* The apex of the sinus also occurs somewhat lower on the body whorl of *T. libya.* These differences are so slight that it seems advisable to include Dall's species (1919, p. 2–3, pl. 2, fig. 5) as a synonym. Modern records of this species are from the Cape Lucas region of Baja California to Mazatlan in depths of 20–66 fathoms (Keen, 1958a, p. 474).

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation—San Emigdio Mountains(?), Ventura basin (cf.) (Loel and Corey, 1932); Painted Rock Sandstone Member of Vaqueros Formation of Hill, Carlson, and Dibblee (1958), Caliente Range (Repenning and Vedder, 1961). Middle Miocene: Temblor Formation, La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (Repenning and Vedder, 1961); Topanga Formation—Santa Monica Mountains Susuki, 1951), Santa Ana Mountains (Vedder and Woodring, unpub. data, 1953, cf.); San Onofre Breccia, northwestern Peninsula Range (Woodford, 1925). Upper Miocene: Santa Margarita Formation, Fruitvale Oil Field (Gale in Preston, 1931). Holocene: Cape San Lucas to Mazatlan (Keen, 1958a).

Range: Lower Miocene to Holocene.

Localities: Middle part of Olcese Sand, USGS M1698 cf. Upper part of Olcese Sand, UCMP B1623. Round Mountain Silt, USGS 3886, 6063, cf. 6065, 6623, 6641, M1608, M1609, M1612, M1613; UCMP B1618 cf., B1638.

Turricula piercei (Arnold)

Plate 18, figures 4, 5, 7–9

Pleurotoma (Bathytoma) piercei Arnold, 1909, U.S. Geol. Survey Bull. 396, p. 61–62, pl. 9, fig. 7.
Arnold and Anderson, 1910, U.S. Geol. Survey Bull. 398, pl. 31, fig. 7.
Bathytoma piercei Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 42.
Turricula (Antiplanes) piercei (Arnold), Loel and Corey, 1932, California Univ., Dept. Geol. Sci., v. 22, no. 3, p. 174.
Turricula piercei (Arnold), Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 488.
Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 174.
Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.
"Clavatula" cf. *"C." labiata* (Gabb), Woodring, 1946, U.S. Geol. Survey Prof. Paper 207, pl. 28, fig. 9.

Original description.—Shell averaging about 50 mm in length, turriculated, fusiform. Whorls probably about six (type décolleté) moderately prominently angulated about middle of whorl; posterior surface slightly concave, anterior surface prominently convex; the convexity of the posterior portion of the body whorl is most pronounced just back of the angle; body whorl regularly rounded below. Surface of whorls faintly spirally sculptured below; lines of growth are also visible in well-preserved specimens. Suture impressed, distinct. Aperture and canal imperfect but believed to be similar to *B. carpenteriana.*

Supplementary description based on Kern River material.—Of medium size, slender, surface smooth. Spire consists of about five whorls not including protoconch. Protoconch of between two and three whorls, defective or abraded in available specimens. Uppermost whorls of spire with eight or nine nodes that define a knobby angulation just above anterior suture. Faint groove on upper part of earlier whorls forms weak subsutural band on many specimens. Microscopic spiral sculpture of fine cords best developed above angulation on spire, coarser spirals on lower part of body whorl starting at about basal angulation and becoming relatively coarser toward base. Axial sculpture of microscopic lines of growth defining a moderately deep U-shaped sinus, with apex slightly below midpoint of concave subsutural slope. Aperture narrow, outer lip thin. Canal of moderate length slightly inclined to left. Columella covered by thin callus.

Type: U.S. Natl. Mus. 165578.

Type locality: USGS 4631, *Turritella ocoyana* bed in SE¼ NE¼ sec. 16, T. 19 S., R. 15 E., 10 miles north of Coalinga. Near top of so-called Vaqueros Formation, middle Miocene.

The type of *Turricula piercei* is a large, incomplete specimen from middle Miocene strata north of Coalinga, Calif. The shell material has been recrystallized and eroded somewhat. These changes make comparison of details of sculpture of well-preserved Kern River material with the holotype dfficulty, yet the gross similarities suggest that the material is conspecific with Arnold's species. The earliest whorls are invariably noded and this may have led Grant and Gale (1931, p. 488) to consider *T. piercei* as a probable weakly noded variant of *T. ochsneri* (Anderson and Martin). Although some difficulty might be encountered in recognizing juvenile specimens of these species, the adults are clearly separable from each other in the collections on the basis of the slender profile and smooth later whorls of *T. piercei.* On immature specimens or on early whorls of *T. piercei*, the nodes are relatively much weaker and less elongate than on comparable specimens of *T. ochsneri.* As with *T. ochsneri*, there is a strongly noded form on which nodes may persist onto the penultimate whorl. The body whorl, however, is much more slender than on *T. ochsneri.* Adult specimens of *T. piercei* vary considerably in spire height and in the position of the angulation on the penultimate whorl.

Distribution and stratigraphic occurrence: "Vaqueros Formation," Coalinga anticline (Arnold, 1909; Arnold and Anderson, 1910); Temblor Formation-Anticline Ridge (Woodring and others, 1940), La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932).

Range: Middle Miocene.

Localities: Middle part of Olcese Sand, USGS M1698?. Upper part of Olcese Sand, USGS 6624, cf. M1597, M1598; UCMP B1586, B1593, B1594, B1600, B1614–B1616, B1640. Round Mountain Silt, USGS 3886, 6064, cf. 6065, 6066, 6621–6623, 6641, M1604, cf. M1606, M1608–M1610, M1612, M1613; UCMP B1611, cf. B1618, B1638.

Turricula? buwaldana (Anderson and Martin)

Plate 18, figures 10, 11, 14, 18, 19; plate 19, figure 4

Drillia buwaldana Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 92, pl. 7, figs. 3a, 3b, 3c.
Clathrodrillia buwaldana (Anderson and Martin), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.
?*Clathrodrillia* cf. *buwaldana* (Anderson and Martin), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, No. 3, p. 238, pl. 46, figs. 6a, 6b, 7a, 7b.
Turricula buwaldana (Anderson and Martin), Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

Type: California Acad. Sci. 223.

Type locality: CAS 68, on north bank of Kern River about three-fourths of a mile west of power station [probably in NE¼ sec. 1, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle]. Lower part of Round Mountain Silt, middle Miocene.

Tentative assignment of this species to *Turricula* is based on the relatively long anterior canal, poorly developed posterior fasciole, and strong degree of similarity to other Miocene species herein assigned to this genus. *Clathrodrillia* or *Crassispira*, genera with which this species may seem to be more closely allied, differ by having a varix behind the aperture. The subsutural band described by Anderson and Martin (1914, p. 92) is present on less than half of the individuals examined during this study.

"*Pseudomelatoma*" *torosa* (Carpenter), a Pleistocene and Holocene species that ranges from Monterey, Calif., to Scammons Lagoon, Baja California (Palmer, 1958, p. 233), is closely related to this species. Principal differences between the two are the more numerous, relatively weaker axial nodes of the Miocene species and the more pronounced constriction at the base of its body whorl. Late Pleistocene specimens of "*P.*" *torosa* from San Nicolas Island, Calif. (USGS loc. 21653), exhibit a fairly broad range of variation from stout, strongly noded individuals to slender ones with elongate axial nodes. The configuration of the turrid notch, which is closer to that of *T. buwaldana* than to the type of *Pseudomelatoma*, *P. penicillata* (Carpenter), in addition to the aforementioned similarities of the slender form, suggests generic affinity with *Turricula? buwaldana*. According to unpublished notes at the U.S. National Museum, Paul Bartsch intended to place "P." *torosa*, *Turricula libya* Dall, and *T. renaudi* in a new genus which he considered most closely related to *Pseudomelatoma*.

The subsutural band described by Anderson and Martin (1914, p. 92) is not developed on many of the individuals examined during this study. Where present, it is often on smaller specimens and is usually defined by a broad groove or a raised spiral cord as in *Crassispira*. As on some specimens of *Turricula ochsneri*, the axial ribs of this species tend to become obsolete on the body whorl of larger specimens. Spiral sculpture occurring on the lower part of the body whorl of small specimens also tends to become obscure on adult individuals. A characteristic property of better preserved specimens is the yellow hue of the outermost shell layer, a feature that permits ready discrimination of some of the badly worn individuals from the somewhat similar *T. piercei* with which it occurs.

Two small specimens from the Vaqueros Formation figured as *Clathrodrillia* cf. *buwaldana* by Loel and Corey (1932, pl. 46, figs. 6a, 6b, 7a, 7b) are considered doubtful identifications. One specimen is too poorly preserved to permit confident specific identification; the other has axial ribs that are continuous from suture to suture on the spire. Specimens of *T. buwaldana* of comparable size have a concave subsutural segment devoid of axial ribbing. It seems probable that these specimens represent a different species.

Distribution and stratigraphic occurrence: Middle Miocene: Topanga Formation, Santa Monica Mountains (Grant in Soper, 1938, cf.; Susuki, 1951).

Range: Middle Miocene (early Miocene record of Loel and Corey, 1932, probably is of another species).

Localities: Upper part of Olcese Sand, USGS M1597, cf. M1599, M1602; UCMP B1624. Round Mountain Silt, USGS 3886, 6063, cf. 6065, 6067, 6622, 6623, M1608, M1612, M1613, cf. M2480; UCMP B1637, B1638.

Genus KNEFASTIA Dall, 1919

Type (by original designation): *Pleurotoma olivacea* Sowerby. Holocene, Gulf of California to Ecuador (Keen, 1958a, p. 446).

Knefastia garcesana Addicott, n. sp.

Plate 18, figure 24

Large, strongly turreted, consisting of more than five whorls. Lower part of penultimate whorl sculptured by an estimated seven retractive axial folds that are strongest at angulation. Spiral sculpture of about five cords below angulation. Profile strongly concave above angulation, slightly convex below. Suture appressed, with faint collar below. Body whorl with more subdued axial ribs that do not extend to basal constriction. About 18 spiral cords occur between angulation and base of columella. Anterior canal moderately long, stout.

Height (nearly complete) 60 mm, width 25 mm.

Type latex cast of an external mold): U.S. Natl. Mus. 650255.

Type locality: USGS M1607, higher of two concretionary sandstone ledges approximately 30 feet below contact with boulder gravels of the Kern River Formation (of Anderson, 1911; Brooks, 1952), 1,650 feet north, 650 feet east of SW. cor. sec. 11, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle. Round Mountain Silt, middle Miocene.

Knefastia garcesana is represented by an incomplete external mold from near the top of the Round Mountain Silt. Only one other species of *Knefastia* has been reported from the California Miocene, *K.* cf. *K. funiculata* (Valenciennes) (Woodring and others, 1946, p. 27, pl. 28, fig. 13). That specimen differs from *K. garcesana* by its subsutural callus, the greater number of nodes, and less pronounced angulation. There is an unreported occurrence of *Knefastia* in the Topanga Formation of the San Joaquin Hills, Orange County, Calif. (J. G. Vedder, written commun., December 1967).

The Kern River species is most closely related to several specimens in a U.S. National Museum collection from station 2822 in 21 fathoms off Baja California (USNM 96648) that bear a manuscript name of

Bartsch. The modern specimens are similar in profile and spiral ribbing of the whorls but are generally smaller and more slender than *Knefastia garcesana.*

Occurrence: Near top of Round Mountatin Silt, USGS loc. M1607.

Genus MEGASURCULA Casey, 1904

Type (by subsequent designation, Stewart, 1927): *Pleurotoma carpenteriana* Gabb. Pliocene to Holocene, northeastern Pacific Ocean. Holocene range—Bodega Bay, Calif. to Cedros Island, Mexico.

Megasurcula condonana (Anderson and Martin)

Plate 19, figures 8, 17, 18

Bathytoma condonana Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 89–90, pl. 7, fig. 8.

Megasurcula condonana (Anderson and Martin), Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 530, pl. 98, fig. 4 [not figs. 10, 12].

Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 48, pl. 9, figs. 11–14, 18.

Type: California Acad. Sci. 214.

Type locality: CAS 39, along coast, 4 miles north of Yaquina Bay, Oreg. Astoria Formation, middle Miocene.

Megasurcula condonana is fairly abundant in the basal marine conglomeratic sandstone at Pyramid Hill. Although specimens are generally poorly preserved, the characteristic stout biconic profile and 11–12 strong nodes encircling the body whorl compare favorably with morphologic features of specimens from the Astoria Formation north of the mouth of Yaquina Bay, Oreg., in the collections of the U.S. Geological Survey at Menlo Park, Calif. The Kern River specimens differ somewhat by having a uniformly lower spire with sutures riding up higher onto preceding whorls so that only the nodes on the body whorl are exposed. These differences seem to fall within the range of variation of specimens figured by Moore (1963, pl. 9, figs. 11, 14, 18).

The species with which *Megasurcula condonana* might be most easily confused, *M. howei* Hanna and Hertlein, is a slender, high-spired form [which is] uniformly biconic in profile. Excepting one joint occurrence at locality M1698 in the upper part of the Olcese Sand, these two species have mutually exclusive stragraphic ranges in the Kern River area.

Pseudotoma condonana, a minute specimen from the Astoria Formation of Grays Harbor County, Wash. (Etherington, 1931, p. 110–111, pl. 14, fig. 20), is not this species and very likely not *Megasurcula.* The specimen is closer to *Calicantharus.* It has a subsutural band and much coarser, more irregular axial and spiral sculpture than *Megasurcula.*

Distribution and stratigraphic occurrence: Astoria Formation, coastal Oregon (Anderson and Martin, 1914; Moore, 1963).

Range: Lower Miocene to middle Miocene.

Localities: Basal part of Jewett Sand, USGS M1591; UCMP B1665. Lower part of Olcese Sand, USGS M1694. Middle part of Olcese Sand, USGS M1698.

Megasurcula howei Hanna and Hertlein

Plate 18, figures 17, 21–23

?*Pleurotoma (Dolichotoma)* n. sp. Arnold, 1907, U.S. Geol. Survey Prof. Paper 47, p. 84.

Pseudotoma n. sp. (?) Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 110, pl. 14, fig. 33.

?*Turris*, n. sp. (large), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 174.

Megasurcula howei Hanna and Hertlein, 1938, Jour. Paleontology, v. 12, no. 1, p. 107, pl. 21, figs. 10, 12, 13.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.

Addicott, 1965, U.S. Geol. Survey Prof. Paper 525–C, p. C106, fig. 4j.

Megasurcula etheringtoni Weaver, 1943, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 530–531, pl. 98, fig. 13.

Megasurcula keepi (Arnold), Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 496–497, [in part].

Type: California Acad. Sci. 7082.

Type locality: CAS 64, in bottom of small canyon about 1¼ miles due north of Barker's ranchhouse. Upper part of Olcese Sand, middle Miocene.

Type of *Megasurcula etheringtoni* Weaver [= *Pseudotoma* n. sp. (?) Etherington]: California Univ. Mus. Paleontology 32038.

Type locality: UCMP A373 [=Washington Univ. loc. 425], in Rock Creek, 1,200 feet downstream from falls and just below old damsite in sec. 7, T. 16 N., R. 5 W., Malone quadrangle, Washington. Astoria Formation, middle Miocene.

This high-spired, biconic species is abundant in the uppermost part of the Olcese Sand and lowermost Round Mountain Silt. It differs from *Megasurcula condonana* (Anderson and Martin) by having a smoothly conic spire and relatively narrower body whorl. When the body whorl angulation is used as a point of reference, in nonapertural view, the upper cone of *M. howei* is relatively higher than the lower cone, whereas the reverse is true in specimens of the stout-shelled *M. condonana.* Further differences are the more acute sutural angle and the concave profile of *M. condonana.*

Megasurcula etheringtoni Weaver, a new name for the specimen figured by Etherington (1931, pl. 14, fig. 33) as *Pseudotoma* n. sp. (?), from the Astoria Formation of southwestern Washington, is a synonym of *M. howei.*

As noted by Hanna and Hertlein (1938, p. 107), the diagnosis of *Megasurcula keepi* by Grant and Gale (1931, p. 496–497) describes *M. howei* rather than *M. keepi.* Possibly the reported occurrence of *M. keepi* in the Kern River district by Anderson and Martin (1914) and Loel and Corey (1932) refer at least in large part to *M. howei* because *M. keepi* is extremely rare in the older collections from the Kern River Miocene at the California Academy of Sciences, University of California, and the U.S. National Museum. Only a few scattered specimens referable to *M. keepi* have been found in these collections. The principal difference between these species is the exposed circle of nodes on the whorls of the spire of *M. keepi*. On specimens of *M. howei*, the upper edge of the body whorl usually conceals the spinose angulation of the penultimate whorl. At one locality (USGS loc. M1597), however, many of the specimens have a nodose penultimate whorl (pl. 18, fig. 17). Where the sculpture of *M. howei* approaches that of *M. keepi*, the species can usually be differentiated by the comparatively greater concavity of the subsutural slope on whorls of the spire of *M. keepi* in addition to the completely exposed nodes on the early whorls.

Distribution and stratigraphic occurrence: Astoria Formation, southwestern Washington (Etherington, 1931).

Range: Middle Miocene.

Localities: Lower part of Olcese Sand, USGS M1593. Middle part of Olcese Sand, USGS M1698. Upper part of Olcese Sand, USGS 6890, M1586, M1597, M1599–M1602, cf. M1693; UCMP B1586, cf. B1587, B1593, B1594, B1596–B1601, ?B1615, B1616, B1622, B1624, ?B1640, B1641, B1753. Round Mountain Silt, USGS 3886, 6622, 6623, M1604, ?M1610, M1612, M1613, M2480; UCMP B1625, B1632, B1638.

Megasurcula keepi (Arnold)

Plate 18, figures 15, 16, 20

Pleurotoma (Bathytoma) keepi Arnold, 1907, U.S. Natl. Mus. Proc., v. 32, No. 1545, p. 529, pl. 46, fig. 5.

Pleurotoma (Dolichotoma) keepi Arnold, Eldridge and Arnold, 1907, U.S. Geol. Survey Bull. 309, p. 258, pl. 33, fig. 5.

Bathytoma keepi Arnold, Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 42.

Surculites (Megasurcula) keepi (Arnold), Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 496–497 [in part].

Turris keepi (Arnold), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 174.

Type: U.S. Natl. Mus. 164993.

Type locality: Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, Calif. Topanga Formation, middle Miocene.

A few specimens from the upper part of the Olcese Sand and the Round Mountain Silt are referable to this species on the basis of a clearly exposed, nodose angulation on the whorls of the spire. *Megasurcula keepi* is a high-spired species that differs from *M. howei* by its nodose, turreted spire. As figured by Arnold (1907, pl. 46, fig. 5), individual whorls of the spire have concave subsutural slopes that terminate in a nodose angulation near the lower one-quarter line of the whorl. *Megasurcula howei*, a species which, prior to its description by Hanna and Hertlein (1938, p. 107, pl. 21, figs. 10, 12, 13), was apparently identified as *M. keepi* by most workers, has a lower, smoothly conical spire. One some specimens of *M. howei*, however, the nodes of the penultimate whorl may be partly visible. Identifications of *M. keepi* by early workers in the Kern River area (Anderson and Martin, 1914; Loel and Corey, 1932) probably were of *M. howei*. This conclusion is based on the scarcity of specimens of *M. keepi* in the earlier collections on which these papers were based. Grant and Gale's diagnosis of *M. keepi* (1931, p. 496–497) is applicable to *M. howei*, as first noted by Hanna and Hertlein (1938).

Distribution and stratigraphic occurrence: Monterey Shale, western Napa County (Weaver, 1949); Hambre Sandstone of Monterey Group, Contra Costa County (Weaver, 1949); Temblor Formation—La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932), Reef Ridge (Stewart, 1946, cf.); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967); Topanga Formation—Santa Monica Mountains (Arnold, 1907; Susuki, 1951), Santa Ana Mountains (Vedder and Woodring, unpub. data, 1953, cf.).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, CAS 65, Round Mountain Silt, USGS 6622, 6623, cf. M1605, M1606.

Megasurcula wynoocheensis (Weaver)

Plate 19, figures 1, 2, 14

Turris wynootcheensis Weaver, 1912, Washington Geol. Survey Bull. 15, p. 70–71, pl. 9, figs. 87–89, 94.

Turris wynoocheensis Weaver, Weaver, 1916, Washington Univ. (Seattle) Pubs. Geology, v. 1, p. 52–53, pl. 5, fig. 65.

Pseudotoma wynoocheensis (Weaver), Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 110, pl. 14, figs. 25, 29.

Surculites (Megasurcula) wynootcheensis (Weaver), Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 500, pl. 25, fig. 2.

Megasurcula wynoocheensis (Weaver), Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 527, pl. 98, figs. 2, 8.

Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 49, pl. 9, figs. 9, 10; pl. 10, figs. 3, 5, 8, 14.

Lectotype: California Acad. Sci. 533 (designated by Moore, 1963).

Type locality: Cut on old Chehalis Logging Co. road, 1 mile west of Montesano, in sec. 6, T. 17 N., R. 7 W., Montesano quadrangle, Washington. Astoria Formation, middle Miocene.

Megasurcula wynoocheensis has not been previously reported from California. Specimens from the Round Mountain Silt compare favorably with the low-spired, less strongly tabulate form selected as the lectotype by Moore (1963, p. 49, pl. 10, figs. 5, 14). Specimens from the Astoria Formation of Oregon (Moore, 1963) are also referable to this stout, fairly short form. Weaver's original figures (1912, pl. 9, figs. 87–89, 94) indicate that *M. wynoocheensis* is a slender, high-spired turrid with a strongly concave whorl profile and sutures riding high upon the vertical segment of preceeding whorls. These features are well illustrated by specimens from a locality (UCMP 9069 and UW 473) about 3 miles northwest of the Weaver's original locality (pl. 19, fig. 1). In a later publication, Weaver (1942, p. 527, pl. 98, fig. 8) refigured a low-spired specimen of *M. wynoocheensis* from UCMP locality 9069 as "topotype." This individual is similar to the Oregon and California specimens. It is within the context of this variation that the Kern River specimens are referred to *M. wynoocheensis.*

Some of the confusion over the type locality of this species may be laid to Etherington's statement (1931, p. 110) that "UC loc. 9069 [is] the type locality of Weaver's type." According to Etherington, Weaver collected better material from this locality subsequent to his original description of the species. The stout, low-spired variant of *Megasurcula wynoocheensis* can be differentiated from the similar *M. condonana* by the fact that the nodose angulation is exposed on the whorls of the spire. This angulation results in a turreted rather than smoothly conic profile.

Distribution and stratigraphic occurrence: Clallam Formation, northern Olympic Peninsula, (Tegland, 1929). Astoria Formation, southwestern Washington (Weaver, 1912; Etherington, 1931; Grant and Gale, 1931; Addicott, 1966), Coastal Oregon (Moore, 1963).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1601. Round Mountain Silt, USGS 3886, M1604; UCMP B1618, B1638.

Subfamily CLAVINAE

Genus CRASSISPIRA Swainson, 1840

Type (by subsequent designation, Hermannsen, 1847): *Pleurotoma bottae* Valenciennes in Kiener. Holocene, Gulf of California, Mexico (Keen, 1958a, p. 458).

Crassispira olcesensis Addicott, n. sp.

Plate 19, figures 20, 21

Small, thick, dark-brownish yellow. Whorl profile nearly flat. Suture strongly appressed with indistinctly bordered collar below. Body whorl slender, slightly convex. Sutural collar sculptured by fine spiral cord near top of fasciolar band and several microscopic threads above. Axial sculpture of 19 slender, slightly sinuous, protractive axial ribs extending from midpoint of fasciolar band downward nearly to base of whorl. Axial ribs and microscopic growth lines crossed by 20–25 spiral threads with larger interspaces that contain a minute secondary thread on upper part of body whorl. Aperture narrow, lower part not markedly constricted into anterior canal. Anal notch deep, rounded, opening slightly constricted, outer lip thin, nearly straight below anal notch. Inner lip arcuate above, slightly recurved to right below.

Height (almost complete) 14.9 mm, width 5.7 mm.

Type: U.S. Natl. Mus. 650264.

Type locality: USGS M1608, base of bluff on south side of Kern River at Olcese Boy Scout Camp, 3,200 feet south, 1,100 feet west of NE. cor. sec. 1, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle. Lower part of the Round Mountain Silt, middle Miocene.

The holotype is a worn yet very distinctive specimen from near the base of the Round Mountain Silt. Another specimen doubtfully referred to this species has been collected from the upper part of the Olcese Sand. It is similar to a light-brown species described from the lower Pleistocene of the Los Angeles basin, California, by Berry (1940, p. 152, 153, pl. 2, fig. 1) as *Clavus (Crassispira) zizyphus.* These species can be distinguished by details of sculpture on the subsutural collar. On *Crassispira olcesensis the* spiral sculpture is much weaker and lacks the nodes that occur on the collar of *C. zizyphus.* In other details of form and sculpture, the species are closely similar. A paratype of *C. zizyphus* deposited in the U.S. National Museum (522571) is closer to a reddish brown than to Berry's original color description (1940, p. 152) of a "a warm light brown," which seems to fit the residual light-brownish-yellow coloration of *C. olcesensis.*

Occurrence: Upper part of Olcese Sand, UCMP loc. B1598?. Lower part of Round Mountain Silt, USGS loc. M1608.

Genus OPHIODERMELLA Bartsch, 1944

Type (by original designation): *Surcula ophioderma* Dall (= *Pleurotoma inermis* Hinds). Bolinas Bay, Calif., to Ballenas Lagoon, Baja California (Burch, 1946, no. 62, p. 10).

Ophiodermella temblorensis (Anderson and Martin)

Plate 17, figure 22; plate 19, figures 5–7, 9–13, 16

Drillia temblorensis Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 91–92, pl. 7, figs. 5a, b.

Clathrodrillia temblorensis (Anderson and Martin), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Types: Holotype, California Acad. Sci. 221; paratype, CAS 222.

Type locality: CAS 64, in bottom of small canyon about 1¼ miles due north of Barker's ranchhouse. Upper part of Olcese Sand, middle Miocene.

As herein construed, *Ophiodermella temblorensis* is one of the most variable turrids of the Kern River Miocene. Two principal forms can be segregated: a spirally sculptured form (pl. 17, fig. 22; pl. 19, figs. 9, 16) and a reticulate form (pl. 19, figs. 5, 6, 10–13). The form with strong spiral sculpture is typified by Anderson and Martin's holotype (1914, pl. 7, figs. 5a, 5b). It has convex to very weakly angulated whorls that are sculptured by strong spiral cords. Axial sculpture is subdued or obsolete on the later whorls. The reticulate form includes individuals with strongly angulated whorls with finely reticulate sculpture on the concave subsutural slope and coarser spiral sculpture below. The strength of spiral sculpture is variable in both forms. A unique specimen with fine spiral sculpture and angulated whorls (pl. 19, fig. 7) may represent a third form of this species.

All the forms are represented in the collection from USGS locality M1597 near the top of the Olcese Sand. They are clearly linked by intermediate forms. Even in smaller collections, it is difficult to satisfactorily separate the two principal forms of this species.

Distribution and stratigraphic occurrence: Astoria Formation, Coos Bay, Oreg. (USGS loc. 1S2S4); Monterey Shale, western Napa County and Contra Costa County (Weaver, 1949); Temblor Formation, Reef Ridge (Stewart, 1946).

Range: Middle Miocene.

Localities: Lower part of Olcese Sand, UCMP B1676. Upper part of Olcese Sand, USGS M1597, M1600–M1602; UCMP B1586, B1589, B1753. Round Mountain Silt, USGS 6065, 6068, M1608, M1610, M1612, M1613, M2480; UCMP B1638.

Ophiodermella electilis (Keen)

Moniliopsis electilis Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 49, pl. 4, fig. 15.

Type: Stanford Univ. paleontology type colln. 7540.

Type locality: SU 2121, in small gully close to terrace contact near center SW¼ sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

This species is known only from the holotype, a small specimen that has uniformily reticulate sculpture on the body whorl and spire. There is a considerable degree of similarity to the reticulate form of *Ophiodermella temblorensis*, which has been collected from the same locality. The axial sculpture on *O. electilis* is much coarser and more widely spaced than on *O. temblorensis*, and its spiral ribbing is of uniform strength on the body whorl, whereas *O. temblorensis* has one or more coarse spiral cords below the angulation on the body whorl.

Occurrence: Lower part of Round Mountain Silt, SU loc. 2121.

Subfamily MANGELIINAE

Genus MANGELIA Risso, 1826

Type (by subsequent designation, Hermannsen, 1852): *Mangelia striolata* Risso = *Murex attenuatus* Montagu = *Pleurotoma villiersi* Michaud (Powell, 1966). Holocene and "subfossil" in the Mediterranean area (Grant and Gale, 1931, p. 585)

Subgenus NOTOCYTHARELLA Hertlein and Strong, 1955

Type (by original designation): *Cytharella niobe* Dall. Holocene, Panama.

Mangelia (Notocytharella) kernensis (Anderson and Martin)

Plate 19, figures 24–26, 30, 31

Mangelia kernensis Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 94–95, pl. 7, figs. 6a, b.

Mangelia (Cacodaphnella?) kernensis (Anderson and Martin), Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 47–48, pl. 4, fig. 21.

Clathrodrillia (Moniliopsis) kernensis (Anderson and Martin), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Pseudotomella kernensis (Anderson and Martin), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173.

?*Pseudomelatoma kernensis* (Anderson and Martin), Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 112, pl. 14, fig. 32.

Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 536–537, pl. 99, figs. 5, 6.

Types: Holotype, California Acad. Sci. 233; paratype, CAS 233a.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586—near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

The sculpture of the spire is dominated by protractive axial ribs that tend to be continuous from one whorl to the next but are only weakly developed across the fasciolar band. These ribs vary in strength and spacing to the extent that a coarsely ribbed form (pl. 19, figs. 25, 26, 30, 31) and a finely ribbed form (pl. 19, fig. 24) can be recognized. On the body whorl of mature individuals the axial sculpture is greatly subdued or obsolete. Spiral ribbing is relatively stronger on the later whorls and may or may not include fine secondary threads.

Placement in the subgenus *Notocytharella* is based upon the fine reticulate sculpture of the third whorl of the protoconch (Keen, 1943, pl. 4, fig. 21) and on general sculptural features. The axial ribs of *Mangelia kernensis* usually are not continuous from suture to suture as on the type of *Notocytharella* (Hertlein and Strong, 1955, p. 232). The Miocene species does not seem to have a modern analog among the living eastern Pacific species of this subgenus figured by Keen (1958a, figs. 888–891).

Two species listed by Loel and Corey (1932) from the Kern River middle Miocene—*Pseudotomella kernensis* (Anderson and Martin) and *Clathrodrillia kernensis* (Anderson and Martin)—probably represent this species because Anderson and Martin (1914) used the specific name *kernensis* for only one turrid.

Distribution and stratigraphic occurrence: Astoria Formation, southwestern Washington (Etherington, 1931).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597, M1601, M1602; UCMP B1586, B1593, B1598, B1600, cf. B1601, cf. B1603, B1616, B1624. Round Mountain Silt, USGS 6068, M1604, M1608–M1610, M1612; UCMP B1637, B1638.

Mangelia (Notocytharella?) hartensis Addicott, n. sp.

Plate 19, figure 22

Small, moderately high spired. Whorls evenly rounded, sculptured by closely spaced axial and spiral ribs that form a noded surface on the spire and upper part of the body whorl. Spiral ribs differentiated into relatively fine cords in the upper one-third of each whorl and coarser ones below. Axial ribs slightly protractive but recurve as they cross the subsutural set of finer spiral cords. Axials obscure below the midpoint of the body whorl. Aperture elongate-ovate. Anterior canal short, columella encrusted with thin callus.

Height (incomplete) 4.3 mm, width 1.9 mm.

Type: U.S. Natl. Mus. 650265.

Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 N., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

This species is characterized by evenly developed spiral and axial ribs that produce a fairly uniform nodose surface on the spire and upper part of the body whorl. It differs from the much more abundant *Mangelia kernensis* by its narrow interspaces between spiral ribs and the absence of secondary spirals. Another difference from most of the specimens of *M. kernensis* is the absence of a distinct angulation on the whorls of the spire of *M. hartensis.*

The sculpture of *Mangelia hartensis* is similar to that of the Pleistocene and Holocene *M. interfossa* Carpenter (Palmer, 1958, pl. 27, figs. 5, 6), which ranges from northern Vancouver Island, British Columbia to Catalina Island, Calif. The Miocene species can be differentiated, however, by the set of fine, closely spaced spiral cords in the upper one-third of the later whorls and the more closely spaced axial ribs.

This species is named for Hart Memorial Park, a short distance downstream from the type locality on the Kern River.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Subgenus AGATHOTOMA Cossmann, 1899

Type (by monotypy) *Pleurotoma angusta* (Jan.): Miocene and Pliocene, southern Europe.

Mangelia (Agathotoma) howei Anderson and Martin

Plate 19, figure 23

Mangilia howei Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 95, pl. 7, fig. 7.

Mangila howei Anderson and Martin, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Type: California Acad. Sci. 234.

Type locality: CAS 68, north bank of Kern River, about three-fourths of a mile west of the powerplant and about 3 miles east of Rio Bravo ranchhouse. Lower part of Round Mountain Silt, middle Miocene.

This poorly known species is represented by a few badly worn specimens from three localities in the Kern River area. It is characterized by a few strong axial folds that ascend the spire in more or less continuous ridges. The specimen from the lower part of the Round Mountain Silt (pl. 19, fig. 23) illustrates these strong axials but is too worn to show other details of sculpture. Other species of *Mangelia* from the Kern River area have much finer, more numerous axial ribs.

Occurrence: Upper part of Olcese Sand, USGS loc. 6065?. Lower part of Round Mountain Silt, USGS 1613?, M2480.

Genus GLYPHOSTOMA Gabb, 1872

Type (by monotypy): *Glyphostoma dentiferum* Gabb. Miocene, West Indies.

Glyphostoma carinata Addicott, n. sp.

Plate 19, figures 19, 33–36

Small, thick; whorls of spire angulate near midpoint, flat above and slightly convex below. Penultimate whorl sculptured by 10 broad axial folds that are strongest below angulation; very fine secondary axials occur between the axial folds. Spiral ribs above the angulation much finer and more closely spaced. Body whorl large, angulation near posterior one-quarter line. Aperture narrow, outer lip thickened externally by varix. Posterior canal "U"-shaped, opening constricted. Anterior canal short, not markedly set off from aperture. Columellar lip faintly denticulate, encrusted with callus; outer lip denticulate within.

Length (nearly complete) 8.4 mm, width 4.1 mm.

Types: Holotype, California Univ. Mus. Paleontology 37098; paratype, UCMP 37099.

Type locality: UCMP B1586, on east side of southward-trending gully. Next to the lowest of six fossiliferous beds, in NE¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle. Near top of Olcese Sand, middle Miocene.

Glyphostoma carinata is represented by three specimens from the upper part of the Olcese Sand. It is the first record of this genus in pre-Pliocene strata of the Pacific coast. *G. conradiana* Gabb (Grant and Gale, 1931, p. 606–607, pl. 26, fig. 11), a fairly common Pliocene to Holocene species, differs from *G. carinata* by its more subdued and much finer sculpture.

This species is assigned to *Glyphostoma* on the basis of the denticulate outer lip of the aperture, a feature more strongly developed in the paratype than on the holotype. Grant and Gale (1931, p. 607) noted that the Recent species *G. canfieldi* (Dall) does not always have denticles within the outer lip. Specimens of *G. canfieldi* in USGS collections from the late Pleistocene of California are fairly close to *G. carinata*. They differ principally in their smaller size, finer axial sculpture, and slender, more high spired profile.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597; UCMP loc. B1586.

Order TECTIBRANCHIA
Family ACTEONIDAE

Genus ACTEON Montfort, 1810

Type (by original designation): *Voluta tornatilis* Gmelin. Holocene, Europe.

Acteon boulderanus Etherington

Plate 19, figures 27–29, 32

Acteon bouldcrana Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 113, pl. 14, fig. 9.
Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 542-543, pl. 99, fig. 37.
Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 42, pl. 4, fig. 22.

Type: California Univ. Mus. Paleontology 32057.
Type locality: UCMP A–373, on Rock Creek about 1,200 feet downstream from the falls and just below old damsite in sec. 7, T. 16 N., R 5 W, Malone quadrangle, Grays Harbor County, Wash.

Specimens of *Acteon boulderanus* from Miocene strata in the Kern River area are somewhat variable in spire height and degree of convexity of whorls of the spire. They compare closely with the type and with specimens from near the type locality in the Astoria Formation of southwestern Washington.

Acteon boulderanus differs from the Holocene *A. traski* (Stearns), a species that ranges from Catalina Island, southern California, to Panama (Burch, 1945, no. 47, p. 9), by its stouter, lower spired shell. A variant of the Holocene species in U.S. National Museum collections, *A. traski* forma *magdalensis* Bartsch (USNM 217833) is similar to *A. boulderanus* but has a higher spire and relatively larger penultimate whorl.

Distribution and stratigraphic occurrence: Middle Miocene: Astoria Formation, southwestern Washington (Etherington, 1931); Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range, Calif. (J. G. Vedder, written commun., December 1967); Temblor Formation, Reef Ridge, (Stewart, 1946, cf.). Upper Miocene: Castaic Formation of Crowell (1955), eastern Ventura basin (Stanton, 1966, cf.).

Range: Middle Miocene to upper Miocene (?).
Localities: Upper part of Olcese Sand, USGS M1597 cf., M1600, M1602; UCMP B1600.

Subgenus RICTAXIS Dall, 1871

Type (by original designation): *Tornatella punctocoelatus* (Carpenter). Holocene, southeastern Alaska to Magdalena Bay, Baja California (Burch, 1945, no. 47, p. 9).

Acteon (Rictaxis) weaveri Addicott, n. sp.

Plate 20, figure 9

Shell small, relatively slender. Spire short, whorls convex, sutures impressed. Body whorl sculptured by about 26 rounded spiral cords separated by narrow, fairly deep interspaces. Axial sculpture of evenly spaced, fine threads limited to the spiral grooves. Aperture narrow; inner lip long and straight, with an obscure columellar fold.

Height 5.1 mm, width 2.4 mm.

Type: U.S. Natl. Mus. 650282.
Type locality: USGS M2601, bottom of southwestward-trending gully, 1,350 feet south, 600 feet west of NE. cor. sec. 35, T. 28 S., R. 29 W., Rio Bravo Ranch quadrangle, lower part of Round Mountain Silt, middle Miocene.

This species differs from small specimens of *Acteon boulderanus* (Etherington) by its slender, lens-shaped outline, very short spire, and obscure columellar fold.

Acteon weaveri is similar to the type species of *Rictaxis*, *A. punctocaelatus* (Carpenter) (USNM 14914) but differs by its more slender shell and much weaker columellar plait.

Occurrence: Lower part of Round Mountain Silt, USGS loc. M2601.

Genus BULLINA Férussac, 1821

Type (by subsequent designation, Pilsbry, 1893, p. 175): *Bulla scabra* Gmelin. Living, Indo-Pacific.

Bullina sp.

Plate 7, figure 20

A small, fragile *Bullina* is represented by several specimens from USGS locality M1612 near the base of the Round Mountain Silt. Because of their minute size and delicate shells, it has been difficult to obtain photographs suitable for figuring in this report. The globular shells range from 1 to 2 mm in length. The body whorl is sculptured by finely incised spiral grooves that are microscopically punctate. The inner lip is somewhat thickened by callus. There is an obscure columellar fold that is not clearly visible in apertural orientation.

Bullina sp. differs from immature specimens of *Aceton boulderanus*, a somewhat similar Miocene acetonid that occurs in the Kern River area, by its bent apex and relatively broad initial whorl. The shell of immature specimens of *A. boulderanus* seems to be noticeably thicker than that of the minute *Bullina*.

This minute species seems to be the first record of the genus along the eastern margin of the Pacific Ocean.

The Holocene distribution of *Bullina* includes the western Pacific Ocean from Australia to Japan and the Indian Ocean.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597. Lower part of Round Mountain Silt, USGS loc. M1612.

Family BULLIDAE

Genus BULLA Linné, 1758

Type (by subsequent designation, Montfort, 1810): *Bullus ampulla* Linné. Holocene, Indo-Pacific.

Bulla cantuaensis Anderson and Martin

Plate 20, figures 34, 35

Bulla sp. Anderson, 1908, California Acad. Sci. Proc., ser. 4, v. 3, p. 19.

Bulla cantuaënsis Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 95–96, pl. 5, figs. 3a, b.
Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 36.

Scaphander jugularis Conrad, Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 235 [in part], pl. 46, figs. 2a, 2b [not figs. 1a, 1b].

Types: Holotype, California Acad. Sci. 235; paratype, CAS 236.

Type locality: One mile north of Cantua Creek in sec. 28, T. 17 S., R. 14 E., Coalinga quadrangle (Keen and Bentson, 1944), western Fresno County, Calif. "Temblor beds," middle Miocene.

Bulla cantuaensis was collected from the lower part of the Round Mountain Silt by Keen (1943, p. 36). Her specimen (pl. 20, figs. 34, 35) differs from Holocene species of *Bulla* from the eastern Pacific Ocean by its less strongly convex, more elongate inner apertural margin. It has a much thicker and more elongate shell than the Holocene *B. gouldiana*, an inner sublittoral species that ranges from southern California to Ecuador (Keen, 1958a, p. 496). The shell of *B. cantuaensis* is of comparable thickness to specimens of *B. punctulata*, in the collections of the U.S. National Museum, a warm-water species that ranges from Magdalena Bay, Baja California, southward to Peru (Keen, 1958a, p. 496).

Loel and Corey (1932, pl. 46, figs. 2a, b) figured a *Bulla* from the Vaqueros Formation of the La Panza Range, San Luis Obispo County, Calif., as *Scaphander jugularis*. This specimen is doubtfully referred to *B. cantuaensis* because of imperfect preservation.

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation, La Panza Range (Loel and Corey, 1932 [*Scaphander jugularis*, in part]): Painted Rock Sandstone Member of Vaqueros Formation of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967). Middle Miocene: Temblor Formation, Cantua Creek and west of Coalinga (Anderson, 1908: Anderson and Martin, 1914): Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range (J. G. Vedder, written commun., December 1967); Topanga Formation—Santa Monica Mountains (Susuki, 1951), San Joaquin Hills (Vedder, unpub. data, 1958); Altamira Shale Member of Monterey Shale, Palos Verdes Hills (Woodring and others, 1946, cf.).

Range: Lower Miocene to middle Miocene.

Locality: Lower part of Round Mountain Silt, SU 2121.

Family AKERIDAE

Genus HAMINOEA Turton and Kingston in Carrington, 1830

Type (by monotypy): *Bulla hydatis* Linné. Holocene, west coast of France to the Mediterranean.

Haminoea virescens Sowerby

Plate 20, figures 27, 28

Bulla virescens Sowerby, 1833, Genera of Recent shells, pt. 39, fig. 2.
Adams, 1850, Thesaurus Conchyliorum, v. 2, p. 579, pl. 124, fig. 83.

Haminea virescens (Sowerby), Pilsbry, 1893, Tryon manual of conchology, v. 15, p. 360, pl. 40, fig. 5; pl. 43, fig. 19.
Kobelt, 1896, Martini and Chemnitz, Neues Systematische Conchylien-Cabinet * * * v. 1, pt. 9, p. 106, pl. 15, fig. 16.
Bradshaw, 1895, Nautilus, v. 8, p. 101, pl. 2, fig. 15.
Arnold, 1903, California Acad. Sci. Mem., v. 3, p. 194(?), pl. 8, fig. 18.

Haminoea virescens Burch, 1945, Distributional list of west American marine mollusks from San Diego to the Polar Sea, Conchological Club, Southern California, v. 1, pt. 2, minutes no. 48, p. 4, pl. 3, figs. 3, 4, 5.

Haminoea vesicula Gould, Morris, 1964. A field guide to shells, pl. 30, fig. 33.

Type: Presumed to be in the British Museum (Grant and Gale, 1931).

Type locality: Pitcairn Island, Holocene.

A specimen in the collections of the California Academy of Sciences is referable to this species. It is somewhat larger than late Pleistocene and Holocene specimens from southern California with which it has been compared. The broad sulcus encircling the anterior part of the shell is characteristic of this species and differentiates it from the similar Holocene species *Haminoea strongi* Baker and Hanna (1927, p. 130–131, pl. 4, fig. 2) from the Gulf of California. Because the type locality of *H. virescens* is Pitcairn Island, Grant and Gale (1931, p. 458–460) abandoned that name in favor of *H. cymbiformis* Carpenter, a name generally considered to be based upon an immature specimen. Nevertheless, Pacific coast malacologists seem to recognize *H. virescens* as a valid species in the Holocene fauna, a practice followed herein.

This is the first occurrence of *Haminoea* in the Tertiary of California. Miocene and Pliocene records from the European Tertiary are listed by Cossmann (1895, p. 92).

Distribution and stratigraphic occurrence: Pleistocene: "Upper San Pedro series," San Pedro (Arnold, 1903); lower San Pedro fauna, Nob Hill cut, San Pedro (Oldroyd, 1924); Palos Verdes Sand, Newport Bay (Kanakoff and Emerson, 1959);

unnamed formation, Point Loma (Webb, 1937). Holocene: Puget Sound to Puerto Libertad, Mexico (Burch, 1945).

Range: Middle Miocene to Holocene.

Locality: Upper part of Olcese Sand, CAS 2147.

Family SCAPHANDRIDAE

Genus SCAPHANDER Montfort, 1810

Type (by original designation): *Bulla lignaria* Linné. Holocene, eastern North Atlantic to Mediterranean Sea.

Scaphander jugularis (Conrad)

Plate 20, figures 8, 29–31, 36, 37

Bulla jugularis Conrad, 1855, U.S. 33d Cong., 1st ses., House Ex. Doc. 129, p. 19.

Conrad, 1857, U.S. 33d Cong., 2d sess., Senate Ex. Doc. 78, Appendix art. 2, p. 328, pl. 7, figs. 62, 62a, b.

Scaphander jugularis (Conrad) Anderson, 1905, California Acad. Sci. Proc., ser. 3, v. 2, p. 201, pl. 15, figs. 56, 57.

Anderson, 1911, California Acad. Sci. Proc., ser. 4, v. 3, p. 100.

Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 43.

Grant and Gale, 1931, San Diego Soc. Nat. History Mem., v. 1, p. 452.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173, 235; pl. 46, figs. 1a, b [not figs. 2a, b].

Scaphander cf. *jugularis* (Conrad), Bremner, 1932, Santa Barbara Mus. Nat. History, Occasional Paper no. 1, pl. 2, fig. 3.

Neotype: California Acad. Sci. 60 (here designated).

Neotype locality: In the vicinity of Barker's Ranch [headquarters formerly near the center of sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle]. This and other newly described species were collected "chiefly north of the river" (Anderson, 1905, p. 187).

As far as can be determined, Conrad's original description of this species was based on drawings made in the field. Although the description and drawing (Conrad, 1857, p. 328, pl. 7, figs. 62, 62a, b) are clearly of internal molds and consequently do not satisfactorily represent this taxon, there is little doubt that the species that has subsequently been recognized as *Scaphander jugularis* is identical to the incomplete material upon which Conrad based his name. Although *S. jugularis* cannot be conclusively recognized from the original description and the original figures depict an exaggerated sulcus encircling the posterior part of the shell, the name is well established and should be retained in the interest of stability of nomenclature.

Scaphander jugularis is perhaps best illustrated by the line drawings in Anderson (1905, pl. 15, figs. 56, 57). One of those specimens (CAS 60) is selected as neotype, although it was collected from somewhat higher stratigraphic position in the upper part of the Olcese Sand on Kern River about 5 miles south of Blake's original locality (1855, p. 170) on Poso [Ocoya] Creek.

Two different species have been figured by Loel and Corey (1932, pl. 46, figs. 1a, b, 2a, b) as *Scaphander jugularis*. Figures 1a and b are of *S. jugularis;* the other two are of a *Bulla*, probably *B. cantuaensis* Anderson and Martin.

A stout, barrel-shaped *Scaphander* from the Astoria Formation of southwestern Washington originally identified as *S. jugularis* by Etherington (1931, p. 114, pl. 14, figs. 7, 27) lacks the characteristic flat or slightly concave posterior segment of the more slender California Miocene species. This unique species has been named *S. doliaris* Addicott (1966, p. 642–643, pl. 77, figs. 6, 7).

Distribution and stratigraphic occurrence: Lower Miocene: Vaqueros Formation—La Panza Range, western Santa Ynez Range, Ventura basin, Channel Islands, and San Joaquin Hills (Loel and Corey, 1932). Middle Miocene: Monterey Shale—western Napa County and western Contra Costa County (Weaver, 1949); Temblor Formation-Monocline Ridge (Zimmerman, 1944, cf.), Reef Ridge (Stewart, 1946,?), La Panza Range (Anderson and Martin, 1914; Loel and Corey, 1932), Caliente Range (Eaton and others, 1941); Topanga Formation—Santa Monica Mountains (Susuki, 1951), San Joaquin Hills (Vedder, unpub. data, 1958).

Range: Lower Miocene to middle Miocene.

Localities: Lower part of Jewett Sand: USGS 6639 cf. Upper part of Olcese Sand, USGS M1596, M1600, M1693, M1697; UCMP B1595, B1596, B1600, B1601, B1614, B1622, B1623, B1753. Lower part of Round Mountain Silt, USGS 6613, M1608.

Family ACTEOCINIDAE

Genus CYLICHNA Lovén, 1846

Type (by subsequent designation, Herrmannsen, 1852, p. 42): *Bulla cylindracea.* Pennant. Holocene, European seas.

Cylichna? loismartinae Keen

Plate 20, figures 7, 17, 26

Cylichna? loismartinae Keen, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 44, pl. 4, figs. 16, 18.

Types: Holotype, Stanford Univ. paleontology type colln. 7532; paratypes, California Univ. Mus. Paleontology 33321, 33322, 35671.

Type locality: SU 2121, in small gully close to terrace contact near center SW¼ sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

This species is characterized by a stout profile, rounded posterior extremity, and posterior narrowing of the aperture. On some of the larger specimens, the oblique columellar fold carries a microscopic groove. The circular apical depression bordered by an indistinct ridge (pl. 20, fig. 17) affords a simple means of discrimination from *Cylichna temblorensis*, which has an umbilicate, subtruncate apex. Mature specimens can be readily differentiated by the more slender, posteriorly truncate profile of *C. temblorensis*.

Occurrence: Lower part of Round Mountain Silt, USGS locs. M1609, ?M1611, M1612; UCMP loc. B1637.

Cylichna temblorensis Keen

Plate 20, figures 10, 11, 18, 25

?*Cylicha*, n. sp.? Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

Cylichna temblorensis Keen, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 44–45, pl. 4, figs. 13, 14.

?*Cylichna petrosa* (Conrad), Etherington, 1931, California Univ., Dept. Geol. Sci. Bull., v. 20, no. 5, p. 114, pl. 14, fig. 13.

Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 172.

?*Haminoea petrosa* (Conrad), Weaver, 1942, Washington Univ. (Seattle) Pubs. Geology, v. 5, p. 549–550 [in part], pl. 100, figs. 16–19 [not fig. 23].

?*Cylichna* sp. Moore, 1963, U.S. Geol. Survey Prof. Paper 419, p. 50, pl. 8, figs. 8, 9.

Types: Holotype, Stanford Univ. paleontology type colln. 7533; paratypes, California Univ. Mus. Paleontology 33353, 33354, 33355, 35677.

Type locality: SU 2121, in small gully close to terrace contact near center SW¼ sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

This species resembles the Pleistocene and Holocene *Cylichna attonsa* Carpenter (Palmer, (1958, p. 242–243, pl. 25, figs. 17, 18), but the living species is much larger, has a more strongly truncate posterior, and lacks the posterior elevation of the apertural lip. The holotype of *C. attonsa* is nearly twice the size of adult specimens of *C. temblorensis*.

A species identified as "*Cylichna* aff. *alba* (Brown) new species?" by Loel and Corey (1932, p. 235–236, pl. 46, figs. 3a, b, 4a, b, 5a, c) from the Vaqueros Formation in the Coast Ranges from Monterey County to Santa Barbara County is less cylindrical in profile and less strongly truncated anteriorly than *C. temblorensis*. According to Loel and Corey (1932, p. 236), it is much larger than the "*Cylichna* which occurs in the Temblor horizon (not *C. petrosa* [Conrad])." Their Temblor species (Loel and Corey, 1932, p. 172) is listed from the Santa Monica Mountains and questionably from the Kern River district. It may represent *C. temblorensis*.

Cylichna ramonensis Clark (1918, p. 188, pl. 20, fig. 7) from the San Ramon Sandstone of Contra Costa County, Calif., is comparable in size to *C. temblorensis*, but the aperture has a posterior flare which extends above the apex of the shell.

Cylichnina petrosa (Conrad, 1849, p. 727, pl. 19, fig. 8) from the Miocene Astoria Formation of Oregon is a larger, much stouter species with stronger spiral sculpture. Confusion of this species with his *Bullina petrosa* (Conrad, 1848, p. 433, fig. 11), a more slender species known only from the unsatisfactory original line drawing, has resulted in two distinct species being treated as one. The slender species was treated as a nomen dubium by Moore (1963, p. 50) because the type specimen is lost, and the original figure and description are too poor for identification. It is possible that Etherington's *Cylichna petrosa* (1931, p. 114, pl. 14, fig. 13), Weaver's *Haminoea petrosa* (1942, pl. 100, figs. 16, 17, not fig. 23), and Moore's *Cylichna* sp. (1963, p. 50, pl. 8, figs. 8, 9) represent Conrad's "*Bullina*" *petrosa* (1848). Their specimens have height: width ratios similar to those of *C. temblorensis;* however, the preservation is too poor to permit unequivocal assignment to the Kern River species.

Distribution and stratigraphic occurrence: Saltos Shale Member of Monterey Shale of Hill, Carlson, and Dibblee (1958), Caliente Range, Calif. (J. G. Vedder, written commun. December 1967).

Range: Middle Miocene.

Localities: Upper part of Olcese Sand, USGS M1597, M1599, M1600, M1602; UCMP B1586, B1598–B1601. Round Mountain Silt, USGS 6065, 6623, M1604, M1608, M1611–M1613, ?M2480; UCMP B1637, B1638.

Genus SULCORETUSA Burch, 1945

Type of *Sulcularia* Dall, 1921 [not *Sulcularia* Rafinesque, 1831] by original designation: *Bulla sulcata* d'Orbigny. Holocene, Florida and West Indies.

Burch (1945, no. 47, p. 16) proposed *Sulcoretusa* as a substitute name for *Sulcularia* Dall, a homonym.

Sulcoretusa? israelskyi Addicott, n. sp.

Plate 20, figures 14–16, 33

Small, cylindrical, with poorly defined medial flatening on larger specimens. Profile tapering more or less uniformly toward apex from point of greatest diameter near base. Apical pit broad and fairly deep. Body whorl sculptured by very fine axial striae. Sculpture of earlier whorls and immature specimens consisting of spiral grooves defining broad flat-topped cords that tend to be split by much finer spiral grooves. Aperture as long as the shell, posterior two-thirds extremely narrow. Outer lip with faint sulcus near anterior one-third line, broadly rounded below. Basal part of columella thickened, smooth.

Height 2.7 mm, width 1.2 mm.

Types: Holotype, U.S. Natl. Mus. 650290; paratypes, USNM 650287, 650288.

Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE cor. sec. 5, T. 29 N., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

Sulcoretusa? *israelskyi* is represented by several minute specimens from the type locality. It has much weaker axial sculpture, a more acutely rounded posterior apertural lip, and a more strongly tapered profile than the Holocene Pacific coast species *S. xystrum* (Dall, 1919), figured by Oldroyd (1927, v. 2, pl. 2, fig. 10), and *S. montereyensis* (Smith and Gordon, 1948, pl. 3, fig. 11). The Miocene specimens from Kern River differ also by having a faint medial sulcus. Smith and Gordon (1948, p. 217) note that *S. xystrum* has faint spiral grooves between axial threads on the exterior. The description of sculpture of the Holocene *S. carpenteri* Hanley from Mazatlan, Mexico (Strong in Burch, 1945, Minutes no. 47, p. 17) seems even closer to that of the California middle Miocene species.

The generic assignment of this species is queried because it has only a very weak medical constriction and its axial sculpture is weak or missing on some specimens. Whereas spiral sculpture is predominant on the early whorls of this species, axial sculpture similar to described species of *Sulcoretusa* tends to replace it on the body whorl of some mature specimens. Another characteristic that suggests reference to *Sulcoretusa* is the extremely narrow posterior part of the aperture.

If assignment to *Sulcoretusa* is correct, this is the earliest Tertiary occurrence of the genus along the Pacific coast of North America. Woodring (1928, p. 123) described a middle Miocene species from Jamaica. Keen (1958a, p. 499) recognizes three species of *Sulcoretusa* from the Panamic molluscan province.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597. Lower part of Round Mountain Silt, USGS loc. M1508.

Genus VOLVULELLA Newton, 1891

Type of *Volvula* Adams 1850, a homonym of *Volvula* Gistle 1848, for which *Volvulella* Newton 1891 was proposed as a substitute name (by subsequent designation, Bucquoy, Dautzenberg, and Dollfus, 1886): *Volvula rostrata* A. Adams. Holocene, Australia.

Volvulella gluma Keen

Plate 20, figures 3, 4

Volvulella gluma Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 54–55, pl. 4, fig. 10.

Types: Holotype, Stanford Univ. paleontology type colln. 7550; paratype, California Univ. Mus. Paleontology 33335.

Type locality: SU 2641, side of gully approximately 250 feet north of mouth of small gully 1,000 feet south, 600 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Bakersfield quadrangle. Collected from 120-foot stratigraphic interval in uppermost part of Olcese Sand stratigraphically above USGS loc. M1597. Middle Miocene.

Volvulella gluma differs from the similar Holocene *V. cylindrica* (Carpenter, 1864), figured by Palmer (1958, pl. 25, figs. 1, 2), by having a more acutely tapering posterior outline that culminates in a moderately well developed spine. The columellar callus and spiral sculpture of *V. gluma* seem stronger than on the modern species. The short spine indicated by Palmer's figures of the holotype (1958, pl. 25, figs. 1, 2) is not characteristic of *V. cylindrica*, judging by spinose specimens in collections of the U.S. National Museum.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597; UCMP locs. B1586, B1598. Lower part of Round Mountain Silt, USGS locs. 6623, M1608, M1611, M1613; UCMP loc. B1637.

Volvulella joaquinensis Addicott, n. sp.

Plate 20, figure 2

Of medium size, slender, cylindrical. Aperture narrow; outer lip thin. Columellar lip smooth, gently inclined. Surface sculptured by closely spaced very fine grooves near anterior and posterior extremities. Apex imperforate.

Length 5.3 mm, width 2 mm.

Type: California Univ. Mus. Paleontology 37101.

Type locality: UCMP B1638, east side of gully 20 feet stratigraphically above B1637, 1,300 feet north, 1,450 feet east of SW cor. sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene.

This species is represented by one individual from the lower part of the Round Mountain Silt. It differs from *Volvulella gluma* by having a cylindrical rather than lens-shaped profile, a fairly blunt apex, and a less strongly thickened columella.

Volvulella joaquinensis is similar to a Holocene specimen in the collections of the U.S. National Museum from the head of Concepcion Bay, Baja California, bearing a Bartsch manuscript name (USNM 267574). The spiral sculpture and morphology of the apical part of the two species is closely comparable, yet the columella of the Holocene species is relatively shorter and is more strongly reflected toward the left.

Occurrence: Lower part of Round Mountain Silt, UCMP loc. B1638.

Family PYRAMIDELLIDAE

Genus PYRAMIDELLA Lamarck, 1799

Type (by monotypy). *Trochus dolabratus* Linné 1767. Holocene, Bahamas and the West Indies (Warmke and Abbott, 1961).

Subgenus LONGCHAEUS Mörch, 1875

Type (by subsequent designation, Dall and Bartsch, 1909): *Pyramidella punctata* Schubert and Wagner. Holocene, Polynesia and Indian Ocean.

Pyramidella (Longchaeus) cooperi Anderson and Martin

Plate 21, figures 1–3

Pyramidella cooperi Anderson and Martin, 1914, California Acad. Sci. Proc., ser, 4, v. 4, p. 66, pl. 7, figs. 18a, b.
Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173.
Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 37.
Pyramidellida (Longchaeus) cooperi (Anderson and Martin), Bartsch, 1917, U.S. Natl. Museum Proc., v. 52, no. 2193, p. 637–638, pl. 42, fig. 3.

Type: California Acad. Sci. 136.

Type locality: CAS 65, west bank of small canyon 1¼ miles northeast of Barker's ranchhouse [probably same as UCMP B1586—near center of NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle]. Upper part of Olcese Sand, middle Miocene.

Pyramidella cooperi is abundant in collections from the lower part of the Round Mountain Silt near the mouth of Kern River Canyon. It differs from known Pleistocene and Holocene species of the northeastern Pacific Ocean area by its broad and deeply channeled sutures. There is a well-defined spiral ridge within the excavated basal part of the later whorls. Spiral microsculpture is developed on the base of the body whorl; axial and subdued spiral microsculpture are developed on the flat part of the body whorl and on the whorl of the spire.

Occurrence: Upper part of Olcese Sand, USGS locs. M1597, M1599; UCMP locs. B1598, B1600. Lower part of Round Mountain Silt, USGS locs. 6063, 6065, 6622, M1604, M1608, M1609, M1611–M1613, M2480; UCMP locs. B1637, B1638.

Subgenus SYRNOLA A. Adams, 1860

Type (by monotypy): *Syrnola gracillima* A. Adams, Holocene, Japan.

Pyramidella (Syrnola) ochsneri (Anderson and Martin)

Plate 21, figures 4–6

Eulimella ochsneri Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 66, pl. 7, figs. 23a, b
Pyramidella (Syrnola) ochsneri (Anderson and Martin), Bartsch, 1917, U.S. Natl. Mus. Proc., v. 52, no. 2183, p. 639.
Pyramidella (Eulimella) ochsneri (Anderson and Martin), Loel and Corey, 1932, California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 173.
Syrnola scandix Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 50–51, pl. 4, figs. 24, 29, ?30.

Type: California Acad. Sci. 138.

Type locality: CAS 64, in bottom of small canyon about 1¼ miles due north of Barker's ranchhouse. Upper part of Olcese Sand, middle Miocene.

Types of *Syrnola scandix* Keen: Holotype, Stanford Univ. paleontology type colln. 7544; paratypes, SUPTC 7544a, 7544b.

Type locality: SU 2121, in small gully close to terrace contact near center SW¼ sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

Pyramidella ochsneri is characterized by deeply incised sutures, a relatively flat whorl profile, and faint spiral ribs discernible on the body whorls of some of the larger specimens. On well-preserved specimens, a microsculpture of closely spaced axial and spiral grooves is discernible. *Syrnola scandix* Keen (1943, p. 50–51, pl. 5, figs. 24, 29) is based upon smaller specimens from a locality that is stratigraphically higher than the type locality of *P. ochsneri*. The holotypes have similar whorl profiles, sutures, and similar whorl proportions. The less strongly channeled sutures of the smaller specimen of *S. scandix* (Keen, pl. 4, fig. 24) are here regarded as a normal characteristic of immature specimens. The smallest of Keen's specimens of *S. scandix* (1943, pl. 4, fig. 30) seems to have relatively higher and possibly more convex whorls than the other specimens. It may represent another species and is therefore included as a doubtful specimen of *P. ochsneri*.

Occurrence: Upper part of Olcese Sand, USGS locs. M1597, M1599, M1602. Lower part of Round Mountain Silt, USGS locs. M1602 cf., M1612; UCMP locs. B1637, cf. B1638.

Genus ODOSTOMIA Fleming, 1813

Type (by subsequent designation, Gray, 1847): *Turbo plicatus* Montagu. Holocene, Europe.

Subgenus CHRYSALLIDA Carpenter, 1856

Type (by monotypy): *Chemnitzia communis* C. B. Adams. Living, Panama Bay and Tobago.

Palmer (1958, p. 244–245) discusses the typology of this taxon.

Odostomia (Chrysallida?) sequoiana Addicott n. sp.

Plate 20, figure 12; plate 21, figures 8, 9, 19

Small, thick, surface smooth and polished. Spire conical, moderately high. Nuclear whorls submerged. Whorls slightly convex, base angulated, sutures impressed. Sculptured by strong spiral groove near base above which are one or two weaker grooves. Faint, closely spaced axial sculpture discernible on upper part of later whorls. Body whorl large, periphery broadly angulated. Base of body whorl broadly rounded, sculptured with two or more spiral grooves below the angulation. Aperture subrhomboidal. Inner lip sharp, bordered by elongate umbilical chink. Columellar fold not visible in apertural view on some specimens.

Height 3.0 mm, width 1.4 mm.

Types: Holotype, U.S. Natl. Mus. 650302; paratypes, USNM 650300, 650301.

Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

Odostomia sequoiana is represented by several specimens from the type locality in the upper part of the Olcese Sand. It bears some resemblance to certain living eastern Pacific Ocean species assigned to the subgenus *Chrysallida* by Dall and Bartsch (1909) but lacks the clearly defined axial ribs of the type species. However, species with extremely faint traces of axial sculpture such as *O. deceptrix* Dall and Bartsch and *O. sanctorum* Dall and Bartsch (1909, p. 167, pl. 18, fig. 1) have been included in this subgenus. *Odostomia sequoiana* resembles fairly closely the minute *O. sanctorum* (USNM 46499) from the west coast of Baja California but has a much thicker, opaque shell and stronger spiral sculpture. Subgeneric affinity with the modern taxon is thereby suggested.

The sculpture of this species is variable. Some specimens have extremely weak spiral sculpture that becomes obsolete on the later whorls (pl. 20, fig. 12).

Occurrence: Upper part of Olcese Sand, USGS loc. M1597; UCMP loc. B1598.

Odostomia (Chrysallida?) n. sp.

Plate 21, figure 47

Small, stout, surface polished. Spire consisting of three convex whorls with subtabulate sutures. Nuclear whorls inclined to axis of shell, submerged. Penultimate whorl sculptured by about eight closely spaced, weak spiral grooves that are strongest on lower part of whorl. Axial sculpture of very fine slightly retractive ribs that become dominant sculptural features on body whorl. Body whorl large, broadly rounded, summit subtabulate. Well-defined spiral plait occurs at juncture of parietal and columellar walls.

Height (incomplete) 2.9 mm, width (incomplete) 1.6 mm.

Figured specimen: U.S. Natl. Mus. 650328.
Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

Odostomia n. sp.? differs from *O. sequoiana* by its more numerous, relatively subdued spiral grooves, subtabulate whorl profile, and broadly rounded body whorl.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Subgenus BESLA Dall and Bartsch, 1904

Type (by original designation): *Chrysallida convexa* Carpenter. Holocene, Gulf of California.

Odostomia (Besla) rotundomontana (Keen)

Plate 21, figures 29–31

Chrysallida rotundomontana Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 43–44, pl. 4, fig. 28.
Type: Stanford Univ. paleontology type colln. 7531.
Type locality: SU 2121, in small gully close to terrace contact near center SW¼ sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

Placement of this beautifully sculptured *Odostomia* in *Besla* is suggested by close similarity to the type species *O. convexa* Carpenter (Dall and Bartsch, 1909, p. 135–136, pl. 13, fig. 4; Brann, 1966, pl. 45, fig. 514) from the Holocene fauna of the Gulf of California. It lacks the evenly papillose sculpture characteristic of most of the eastern Pacific Ocean species of *Chrysallida* (Dall and Bartsch, 1909, p. 137–169), to which it was originally assigned. The Kern River species has a larger apical angle and broader, more protractive axial ribs.

The protractive axial ribs of this species vary from straight to sinuous. On the holotype and a few other specimens, the intersection of the two anterior spiral cords with the axial ribs is nodose. Further variation occurs in the convexity of the whorls of the spire and the number of axial ribs.

There is a considerable sculptural similarity to *Turbonilla (Tragula) greenhornensis* n. sp., but the two species can be readily separated by the greater number of whorls, the very slender angulated profile, and the lack of spiral plait within the aperture of the *T. greenhornensis*.

Occurrence: Lower part of Round Mountain Silt, USGS locs. 6067, 6623, cf. M1609, M1610, M1612, M1613; UCMP locs. B1637, B1638.

Subgenus MENESTHO Möller, 1842

Type (by monotypy): *Turbo albulus* Fabricius. Holocene, Labrador to Greenland (Tryon, 1886, v. 8, p. 344).

Odostomia (Menestho) repenningi Addicott, n. sp.

Plate 21, figures 22, 32

Small, elongate ovate. Nuclear whorls submerged. Whorls of spire convex, sculptured by four strong spiral cords with narrower interspaces. A fifth, very weak spiral cord appears just below suture on later whorls. Body whorl large, well rounded, sculptured by five strong spiral cords. Secondary spiral cord below suture, three relatively weak flattened cords on the upper part of base of body whorl. Numerous closely spaced microscopic retractive growth striae on body whorl. Aperture subovate, basal and columellar lips meet in approximate right angle. Obscure, umbilical slit on some specimens.

Height 2.8 mm, width 1.4 mm.

Types: Holotype, U.S. Natl. Mus. 650314; paratype, USNM 650313.

Type locality: USGS loc. M1597, in an abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west from NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

The strong, rounded spiral cords of *Odostomia repenningi* and the rounded, fairly high spired profile differ markedly from the known species assigned to the subgenus *Menestho* from the eastern Pacific ocean. Several minute specimens are in the collections from the type locality.

This species is similar to *Odostomia farma* Dall and Bartsch (1909, p. 188, pl. 20, figs. 1, 1a) in overall proportions and size, but its stronger spiral ribs and nonpitted, deeper interspaces are clearly distinct from the Holocene southern California species. Several minute specimens are in the collections from the type locality.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Subgenus EVALEA A. Adams, 1860

Type (by subsequent designation, Verrill and Bush, 1900): *Evalea elegans* A. Adams. Holocene, Japan.

Odostomia (Evalea) andersoni Bartsch

Plate 21, figures 11, 12, 21, 25

Eulimella californica Anderson and Martin, 1914, California Acad. Sci. Proc., ser. 4, v. 4, p. 67, pl. 7, figs. 19a, b, c. [Not *Odostomia (Evalea) californica* Dall and Bartsch, 1909].

Odostomia (Evalea) andersoni Bartsch, 1917, U.S. Natl. Mus. Proc., v. 52, no. 2193, p. 667.

Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 49–50, pl. 4, figs. 17, 23.

Type: California Acad. Sci. 141.

Type locality: CAS 64, in bottom of small canyon about 1¼ miles due north of Barker's ranchhouse. Upper part of Olcese Sand, middle Miocene.

This slender species is similar to *Odostomia nemo* Dall and Bartsch (1909, p. 198–199, pl. 22, fig. 8), a living species that ranges from Santa Monica, Calif. southward to Todos Santos Bay, Baja California. The modern species differs, however, by having a nearly flat whorl profile with a broadly rounded basal angulation. The resultant profile differs from the more convex, less distinctly angulated whorls of *O. andersoni.*

Occurrence: Upper part of Olcese Sand, USGS locs. M1597, M1602; UCMP locs. B1698, B1600. Lower part of Round Mountain Silt, USGS locs. M1612; UCMP locs. B1612, B1637.

Odostomia (Evalea) aff. O. (E.) donilla Dall and Bartsch

Plate 21, figure 33

A small *Odostomia* from the upper part of the Olcese Sand (USGS loc. M1597) is similar to material in the type lot of *O. donilla* Dall and Bartsch (1909, p. 208, pl. 24, fig. 3). The Holocene specimens from the Californian molluscan province differ, however, by their greater apical angle, which is manifested by a comparatively stouter shell.

The shell consists of four broadly convex postnuclear whorls separated by well-defined sutures. The body whorl is large, its periphery angulated, and its base broadly rounded. The surface is sculptured by microscopic spiral grooves and obscure axial growth striae. The subovate aperture has a stout columellar lip armed with a fairly strong plication at the juncture with the partial wall.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Odostomia (Evalea) sp.

Plate 21, figure 28

A small, stout *Odostomia* with an abraded exterior is in the collections from USGS locality M1597 in the upper part of the Olcese Sand. It has a large, convex body whorl, a small umbilical chink, and a reflected columellar lip. There are a few widely spaced spiral grooves preserved on the body whorl. These grooves suggest subgeneric allocation to *Evalea.*

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Odostomia (Evalea?) n. sp.

Plate 21, figure 27

Small, with narrow spire of four whorls, including partly submerged nuclear whorl. Body whorl rounded, larger than spire, with obscure angulation near posterior one-third line.

Height 3.3 mm, width 1.6 mm.

Figured specimen: U.S. Natl. Mus. 650316.

Locality: USGS 1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

This small, worn *Odostomia* seems distinct from other species in the Kern River area. It is distinguished from the abundant *O. andersoni* with which it occurs by its more convex whorls, proportionately larger body whorl, and smooth anterior whorl profile.

Although there is no evidence of spiral groove characteristic of the subgenus *Evalea*, this species is tentatively included in this subgenus because of general similarity to other species so grouped. The surface of the figured specimen shows signs of considerable abrasion.

With only one poorly preserved specimen available for study, it is difficult to make meaningful comparisons with known species of *Odostomia* from the northeastern Pacific Ocean. There does appear to be considerable similarity to *O. tenuis* Carpenter (Dall and Bartsch, 1909, p. 197–198, pl. 22, fig. 3), a smaller species from the Panamic molluscan province near Mazatlan, Mexico.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Genus TURBONILLA Risso, 1826

Type (by subsequent designation Hermannsen, 1852); *Turbon costulata* R[isso]. Fossil, Saint Jean (Palmer, 1958, p. 251).

Subgenus CHEMNITZIA d'Orbigny, 1840

Type (by monotypy): *Melania campanellae* Philippi. Holocene, Sicily.

Turbonilla (Chemnitzia) n. sp.

Plate 21, figure 44

Small, thick shelled, elongate-conical, glossy white. Surface of whorls abraded, sculptured by heavy vertical axial ribs separated by interspaces of about equal width. Penultimate whorl with 16 axial ribs. Sutures subtabulate, deeply impressed. Base of body whorl smooth, evenly rounded. Aperture subquadrate, periphery broken, with strong spiral fold below insertion of collumellar lip.

Height (almost complete) 4.4 mm, width 1.8 mm.

Figured specimen: U.S. Natl. Mus. 650325.
Locality: USGS 1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

This thick-shelled, coarsely ribbed species seems to be distinct from the known fossil and Holocene species from the northeastern Pacific Ocean. It differs from Holocene species of *Chemnitzia* in the U.S. National Museum collections by its broad apical angle and coarse axial ribbing. One abraded specimen has been found in collections from the uper part of the Olcese Sand.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Turbonilla (Chemnitzia) hannai Addicott, n. sp.

Plate 21, figures 38–40

Small, slender, elongate-conical. Surface dull white, smooth. Nuclear whorls oriented at nearly 90° to axis of shell, slightly submerged in first of seven postnuclear whorls. Whorl profile nearly flat, angulated near base. Sutures strongly impressed. Sculptured by broad, fairly strong axial ribs that are not clearly set off from narrower interspaces. Axial ribs terminate just above smooth basal angulation. Body whorl with about 16 axial ribs, base smooth. Aperture subquadrate, inner and outer lips straight, converging slightly toward apex. Basal lip rounded, somewhat reflected.

Height 4.2 mm, width 1 mm.

Types: Holotype, U.S. Natl. Mus. 650324; paratype, California Univ. Mus. Paleontology 32140.
Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

Turbonilla hannai is represented by several specimens from the type locality. It differs from the other species from the Kern River district assigned to *Chemnitzia* by having a slender, conical spire and rather strongly angulated whorls. These features, in addition to the relatively few broad axial ribs, seem to be unique among Holocene species of *Chemnitzia* from the northeastern Pacific Ocean.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Turbonilla (Chemnitzia?) n. sp.

Plate 21, figure 18

Small, very slender. Surface smooth. Nuclear whorls encrusted, slightly submerged, oriented at right angles to axis of spire. Postnuclear whorls eight, gently rounded, sculptured by strong, slightly protractive axial ribs separated by narrow interspaces. Penultimate whorl with 13 axial ribs, body whorl with about 14. Axial ribs somewhat broader in lower half of each whorl. Sutures strongly constricted. Base of body whorl rounded. Aperture subquadrate, inner lip vertical, slightly reflected. Basal part of outer lip produced anteriorly near juncture with inner lip.

Height 4.2 mm, width 0.9 mm.

Figured specimen: U.S. Natl. Mus. 650311.
Locality: USGS 1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

Placement of this species in *Chemnitzia* is considered probable but uncertain because of the worn condition of the exterior of the only available specimen. A few interspaces have very faint pockmarks that seem to have been produced by abrasion but could possibly represent faint spiral sculpture.

Turbonilla n. sp. seems distinct from the known fossil and living species of this subgenus from the eastern Pacific Ocean. To a certain degree it resembles *T. amortajadensis* Baker and others (1928, p. 209, pl. 11, fig. 2), but can be readily distinguished from this larger Holocene species from the Gulf of California by its less rapidly tapering spire, narrow interspaces between axial ribs, and less convex whorls.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Subgenus PYRGISCUS Philippi, 1841

Type (by subsequent designation, Arnold, 1903): *Melania rufa* Philippi. Holocene, Europe.

Turbonilla (Pyrgiscus) bravoensis Keen

Plate 21, figures 34–36

Turbonilla (*Pyrgiscus*) *bravoensis* Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 51–52, pl. 4, figs. 20, 26, 27.

Type: Stanford Univ. paleontology type colln. 7546.

Type locality: SU 2121, in small gully close to terrace contact near center SW¼ sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene (probably same as USGS M1612 and UCMP B1637).

Turbonilla bravoensis is characterized by spiral rows of slotlike perforations in the interspaces between the strong axial ribs. The slots number from five to nine per whorl. On some individuals they are evenly spaced; on others they are widely spaced near the sutures but closely spaced and narrower near the center of the whorls.

Turbonilla bravoensis has been compared (Keen, 1943) with *T. virgo* (Carpenter, 1864) figured by Dall and Bartsch (1909, pl. 8, figs. 4, 4a), a Holocene species known only from the type locality at Santa Barbara. The holotype of *T. virgo* has 21 axial ribs, whereas the count on *T. bravoensis* is substantially lower, 14–16. Comparison of topotype material of the Kern River Miocene species with the holotype of *T. virgo* indicates that the best means of distinguishing between the two is the presence of spiral sculpture on the base of *T. bravoensis*. Contrary to the original illustration (Dall and Bartsch, 1909, pl. 8, fig. 4), the holotype of *T. virgo* has a smooth base.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597; UCMP locs. B1586 cf., B1598. Lower part of Round Mountain Silt, USGS locs. M1612; UCMP B1637.

Turbonilla (Pyrgiscus) hormigacuesta Addicott, n. sp.

Plate 21, figures 37, 43

Moderately small, very slender. Nuclear whorls poorly preserved, oriented at right angles to spire and partly submerged in the first of nine postnuclear whorls. Whorl profile nearly flat, point of maximum width just above base of whorls. Sculptured by strong, somewhat protractive axial ribs, of which there are 22 on the body whorl. The broad interspaces contain seven revolving rows of perforations. Sutures deeply impressed. Base of body whorl sculptured by three or more spiral grooves. Aperture subovate. Outer lip fairly straight, basal lip rounded. Inner lip straight, slightly reflected.

Height 4.4 mm, width 0.9 mm. (holotype)

Types: Holotype, U.S. Natl. Mus. 650322; paratype, USMN 650321.

Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

This species differs from *Turbonilla bravoensis*, with which it occurs, by its extremely slender shell. The sculpture and height-width ratio bear considerable similarity to *T. ayamana* Hertlein and Strong (1951, p. 96, pl. 6, fig. 14), a Holocene species from western Central America, but the axial ribs of the Holocene species are retractive, whereas those of *T. hormigacuesta* are mainly vertical. The combination of a very narrow apical angle and a few deeply excavated spiral pits seem to distinguish this species from other Holocene turbonillas assigned to *Pyrgiscus*.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Turbonilla (Pyrgiscus) n. sp.

Plate 21, figures 23, 24

Small, elongate-conical. Nuclear whorls set at right angles to axis of spire, slightly submerged. Postnuclear whorls five, profile almost straight. Posterior whorls sculptured by about 16 slender, vertically oriented axial ribs separated by nearly equal interspaces. Axial ribs become obsolete on penultimate whorl and are poorly developed in lower third of earlier whorls. Spiral sculpture of six evenly spaced spiral grooves on whorls of spire, eight on body whorl. Sutures deeply impressed. Aperture subovate. Basal and inner lips reflected outwards. Thin callus on parietal wall.

Height 3.4 mm, width 1.0 mm.

Figured specimen: U.S. Natl. Mus. 650315.

Locality: USGS loc. 1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

This species differs markedly from other turbonillas of the Kern River Miocene by the absence of axial sculpture on the final whorls. It does not closely resemble any of the known Holocene northeastern Pacific species included in *Pyrgiscus*.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597.

Subgenus PYRGOLAMPROS Sacco, 1892

Type (by original designation): *Pyrgolampros mioperplicatulus* Sacco. Tortonian, Montegibbio, Italy.

Turbonilla (Pyrgolampros) mariposa Keen

Plate 21, figures 17, 26, 40, 42

Turbonilla (Pyrgolampros) mariposa Keen, 1943, San Diego Soc. Nat. History Trans., v. 10, no. 2, p. 52, pl. 4, figs. 19, 25.

Type: Stanford Univ. Paleontology type colln. 7547.

Type locality SU 2121, small gully close to terrace contact near center of SW¼ sec. 6, T. 29 S., R. 30 E., Caliente quadrangle. Lower part of Round Mountain Silt, middle Miocene.

Most specimens collected from near the type locality of *Turbonilla mariposa* in the lower part of the Round Mountain Silt lack clearly defined microscopic spiral sculpture. The rib count, general proportions, and size, however, are comparable to Keen's original figures and description (1943). On some of the well-preserved specimens, the spiral sculpture consists of extremely faint, microscopic striae. There is considerable variation in the strength of axial ribbing on specimens identified herein as *T. mariposa*; on some individuals the axial sculpture weakens or becomes obsolete on the final whorl.

A small, abraded specimen identified as *Turbonilla* cf. *T. mariposa* (pl. 21, fig. 20) has a relatively larger body whorl than topotypes of *T. mariposa.* Microscopic spiral striae occur on the body whorl of this specimen, but the magnification of the photograph is insufficient to show them.

Occurrence: Upper part of Olcese Sand, USGS loc. M1597; UCMP loc. B1601 cf. Lower part of Round Mountain Silt, USGS loc. M1612; UCMP locs. B1637, cf. B1638.

Subgenus PTYCHEULIMELLA Sacco, 1892

Type (by subsequent designation, Dall and Bartsch, 1904): *Tornatella pyramidata* Deshayes. Tertiary, Europe.

Turbonilla (Ptycheulimella) edisonensis Addicott, n. sp.

Plate 21, figure 7

Small, thin, highly polished. Nuclear whorls partly immersed in first of six postnuclear whorls. Sutures strongly impressed. Whorl profile nearly flat. Surface smooth, with faint, irregular axial lines of growth and very finely microscopic spiral striae. Aperture broadly oval shaped. Outer lip extremely thin, inner lip curved.

Height 3.2 mm, width 0.4 mm.

Type: U.S. Natl. Mus. 650299.

Type locality: USGS loc. M1613, east side of gully 20 feet stratigraphically above M1612, 1,300 feet north, 1,450 feet east of SW. cor. sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle. Lower part of Round Mountain Silt, middle Miocene.

Turbonilla edisonensis is the first Tertiary species of *Ptycheulimella* to be described from western North America. It is slenderer and has more strongly impressed sutures than the Holocene northeastern Pacific Ocean species of this subgenus.

Occurrence: Lower part of Round Mountain Silt, USGS loc. M1613.

Subgenus TRAGULA Monterosato, 1884

Type (by original designation): *Odostomia fenestrata* Forbes. Holocene, Europe.

Turbonilla (Tragula) greenhornensis Addicott, n. sp.

Plate 21, figures 45, 46

Small, elongate-conical. Nuclear whorls submerged, only slightly tilted. Postnuclear whorls six, profile flat, base broadly angulate. Whorls sculptured by about 14 strongly protractive axial ribs with narrower interspaces. Spiral sculpture of two strong cords in lower one-third of each whorl. Sutures deeply impressed, bordered posteriorly by a very weak spiral cord. Base of body whorl smooth, with one narrow groove near edge. Aperture ovate, inner lip curved.

Height 3.4 mm, width 1.1 mm.

Types: Holotype, U.S. Natl. Mus. 650326; paratype, USNM 650327.

Type locality: USGS M1597, in abandoned roadbed at mouth of small gully, 1,300 feet south, 350 feet west of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle. Upper part of Olcese Sand, middle Miocene.

This species is placed in the subgenus *Tragula* because of the close degree of similarity to the type species, *Turbonilla (Tragula) fenestrata* (Forbes) (Pilsbry, 1886, pl. 74, figs. 58, 60, 61), from European seas. This subgenus has not previously been reported from the eastern Pacific Ocean.

There is a very close resemblance between this species and *Odostomia rotundomontana.* The two species can be differentiated, however, by the greater number of whorls and much smaller apical angle of *Turbonilla greenhornensis.*

Occurrence: Upper part of Olcese Sand, USGS locs. M1597, M1602.

FOSSIL LOCALITIES

[The following are original descriptions taken from the locality registers. Formational nomenclature and age assignments added in brackets are those of the present author. Localities are shown in figure 3.]

USGS localities (Washington, D.C. register)

Locality	*Description of locality, collector, and date collected*
3886	Bluffs of Kern River, 1 mile below power station on north side of river. Collected by G. H. Eldridge, 1903.
6063	North bank of Kern River, 11 miles northeast of Bakersfield, from 100 to 500 ft southwest from bridge across river 1 mile below mouth of granite canyon; from the water's edge to 30 ft up on bluff. From lowest Miocene beds exposed [lower part of the Round Mountain Silt, middle Miocene]. Collected by Robert Anderson, September 1910.
6064	North of Kern River, 11 miles northeast of Bakersfield, an eighth of a mile northward from bridge 1 mile below mouth of Kern Canyon; in gully about 70 ft above level of river. Lower beds of Miocene, just above lowest beds exposed [lower part of the Round Mountain Silt, middle Miocene]. Collected by Robert Anderson, September, 1910.
6065	North of Kern River about 10 miles northeast of Bakersfield. Along flume at edge of hills, at center of first big reentrant bend of border of river terrace about 1 mile northeast of Rio Bravo Ranch [lower part of the Round Mountain Silt, middle Miocene]. Collected by Robert Anderson, September 1910.

USGS localities (Washington, D.C. register)—Con.

Locality	*Description of locality, collector, and date collected*
6066----	Southeast side of Kern River about 11 miles northeast of Bakersfield. About a quarter of a mile downstream from bridge, 1 mile below mouth of the granite canyon of Kern River. Thirty feet above stream in low bluff. Lower part of Miocene [lower part of the Round Mountain Silt, middle Miocene]. Collected by Robert Anderson, September 1910.
6067----	South bank of Kern River at Barker's Ranch, 8 miles miles northeast of Bakersfield. At water's edge 500 ft east of old ranchhouse half a mile north of Ant Hill. Clayey sand in upper part of lower Miocene [lower part of the Round Mountain Silt, middle Miocene]. Collected by Robert Anderson, September 1910.
6068----	South bank of Kern River at Barker's Ranch, 8 miles northeast of Bakersfield. About 30 ft above river in low bluff 600 ft east of old ranchhouse half a mile north of Ant Hill. Soft yellow sand in lower part of Miocene [lower part of the Round Mountain Silt, middle Miocene]. Collected by Robert Anderson, September 1910.
6608----	South side of Kern River, about 11 miles east of Bakersfield. West side of Cottonwood Creek, about a third of a mile west of road along the creek and 1 mile upstream from junction of that road with Kern River road. Near top of lower Miocene [Round Mountain Silt, middle Miocene]. Collected by J. D. Northrop, Sept. 27, 1911.
6609----	North side of Kern River, about 8 miles northeast of Bakersfield. In gulch on south side of easternmost 860-ft hill about 1 mile north of Kern River. In NE¼SW¼ sec. 25, T. 28 S., R. 28 E., near top of lower Miocene [near the top of the Round Mountain Silt, middle Miocene]. Collected by J. D. Northrop, Oct. 3, 1911.
6610----	South side of Kern River, about 11 miles east of Bakersfield. Crest of 1,000-ft. hill southwest a third of a mile from junction of road up Cottonwood Creek with that of Kern River. Almost at top of lower Miocene [Round Mountain Silt, middle Miocene]. Collected by J. D. Northrop, Sept. 25, 1911.
6611----	Ten miles N. 75° E. of Bakersfield and about 1 mile southeast of Rio Bravo Ranch. General collection in gullies draining southwest from crest of 1,100-ft ridge trending northwest-southeast and lying due south of junction of Kern River and Cottonwood Creek. Near SE cor. sec. 11, T. 29 S., R. 29 E. In upper part of lower Miocene [near top of the Round Mountain Silt, middle Miocene]. Collected by A. T. Schwennessen, Oct. 19, 1911.
6612----	Ten miles N. 75° E. of Bakersfield and 1 mile southeast of Rio Bravo Ranch. In northernmost gulch draining southwest from 1,100-ft ridge trending northwest-southeast and lying due south of junction of Kern River and Cottonwood Creek. Near SE, cor. sec. 11, T. 29 S., R. 29 E. Near top of lower Miocene [near top of Round Mountain Silt, middle Miocene]. Collected by J. D. Northrop, Sept. 27, 1911. Same as loc. 6611.
6613----	South bank of Kern River, 8 miles N. 60° E. of Bakersfield. About 300 yds east of old buildings of Barker's Ranch, along abandoned irrigation ditch. In upper part of lower Miocene (see loc. 6067, 6068) [lower part of the Round Mountain Silt, middle Miocene]. Collected by R. W. Pack and J. D. Northrop, Sept. 19, 1911.
6619----	North side of Kern River about 9 miles N. 60° E. of Bakersfield. In SE¼ sec. 32, T. 28 S., R. 29 E., in prominent bluffs above cabin. Upper middle part of lower Miocene [upper part of the Olcese Sand, middle Miocene]. Collected by A. T. Schwennessen, Sept. 27, 1911.
6621----	Ten miles northeast of Bakersfield, on north bank of Kern River 1¼ miles northwest of Rio Bravo Ranch, where river makes a right-angied turn from north to west. In first small gully after leaving flat, about 15 ft above base of bank. Upper middle part of lower Miocene [lower part of the Round Mountain Silt, middle Miocene]. Collected by A. T. Schwennessen, Sept. 27, 1911.
6622----	North bank of Kern River, 10–11 miles northeast of Bakersfield. Float rock at base of bluff below where fossils were collected at loc. 6623. Middle part of lower Miocene. These fossils are unquestionably from beds in the cliffs at whose foot they lie, and are from same horizon as those of loc. 6623 [lower part of the Round Mountain Silt, middle Miocene]. Collected by R. W. Pack, J. D. Northrop, October 1911.
6623----	North bank of Kern River, 10–11 miles northeast of Bakersfield. In bluffs above irrigation ditch about 1¼ miles northeast of Rio Bravo Ranch and three-fourths of a mile below the bridge, three-fourths of a mile below mouth of Canyon. Approximately same as loc. 6065. Middle part of lower Miocene [lower part of the Round Mountain, Silt, middle Miocene]. Collected by R.W. Pack, A. T. Schwennessen, Sept. 19, 1911.
6624----	Ten miles northeast of Bakersfield and 2½ miles northwest of Rio Bravo Ranch. In the S½ sec. 28, and N½ sec. 32, T. 28 S., R. 29 E., in bed of large arroyo that drains due south through those sections. Middle part of lower Miocene [upper part of the Olcese Sand, middle Miocene]. Collected by J. D. Northrop, A. T. Schwennessen, Sept. 20, 1911.
6625----	Eleven miles northeast of Bakersfield. About half a mile east of Cottonwood Creek on south side of gully joining that creek about a quarter of a mile above crossroads at its junction with Kern River [Round Mountain Silt, middle Miocene]. In middle part of lower Miocene. Collected by J. D. Northrop, Sept. 27, 1911.
6627----	Twelve miles N. 30° E. of Bakersfield. In center W½ sec. 36, T. 27 S., R. 28 E. In small arroyo tributary to Adobe Canyon from west. About 1 mile above its mouth. In first arroyo upstream from 1,070-ft hill. Middle part of lower Miocene [lower part of the Olcese Sand, middle Miocene]. Collected by R. W. Pack, Sept. 2, 1911, and A. T. Schwennessen, Aug. 31, 1911.

USGS localities (Washington, D.C. register)—Continued

Locality	*Description of locality, collector, and date collected*
6628	About one-fourth of a mile south of cabin in small valley 2½ miles almost due east of Round Mountain [near top of Olcese Sand, middle Miocene]. Collected by R. W. Pack, Aug. 26, 1911.
6638	Between Kern River and Poso Creek in northwest corner Caliente quadrangle about 13 miles northeast of Bakersfield. Southwest slope of Pyramid Mountain. In hard sandstone reefs just north of old road running east and west. In lower part of lower Miocene [lower part of the Jewett Sand, lower Miocene]. Collected by J. D. Northrop, R. W. Pack, Sept. 15, 1911.
6639	Twelve miles N. 45° E. of Bakersfield. North end of ridge running north from Pyramid Hill. From 1,500-ft hill and crest of ridge north of it in sec. 10, T. 28 S., R. 29 E., just north of Caliente quadrangle. From massive sandstone overlying clays that form base of Miocene [lower part of the Jewett Sand, lower Miocene]. Collected by R. W. Pack, Aug. 24, 1911.
6641	North side of Kern River about 11 miles northeast of Bakersfield. In first deep gulch east of bridge crossing river three-fourths of a mile below mouth of canyon. About half a mile northeast of Kern River and half a mile southwest of granitic contact. Lower part of lower Miocene [lower part of Round Mountain Silt, middle Miocene]. Collected by J. D. Northrop, Sept. 16, 1911.
6890	North side of Kern River 1 mile northeast of the Barker's ranchhouse, about 12 miles east and a little north of Bakersfield [upper part of the Olcese Sand, middle Miocene]. From California Academy of Science (CAS loc. 65), May 1914.
13361	First small canyon north of Sharktooth Hill. SE¼ NW¼ sec. 25, T. 28 S., R. 28 E., M.D.B.&M., 2,100 ft N. 10° W. of 643 hill. Bakersfield quadrangle. Temblor Formation [upper part of the Round Mountain Silt, middle Miocene]. Collected by K. E. Lohman, July 13, 1934.

USGS Cenozoic localities (Menlo Park register)

Locality	*Description of locality, collector, and date collected*
M1590	In small gully on south side of prominent ridge trending southwesterly through SE¼ sec. 15, T. 28 S., R. 29 E., 1,450 ft N., 1,500 ft W. of SE. cor. sec. 15, Rio Bravo Ranch quadrangle (1954 ed.). Collected from large fossil quarry in basal marine stratum west of Pyramid Hill. Basal part of the Jewett Sand. Collected by W. O. Addicott, 1962.
M1591	On north side of westerly-trending gully in NW¼ sec. 14, T. 28 S., R. 29 E., 2,150 ft N., 500 ft E. of SW. cor. sec. 14, Rio Bravo Ranch quadrangle (1954 ed.). Basal marine conglomeratic sandstone on southwest flank of Pyramid Hill. Basal part of the Jewett Sand, same as UCMP B1665. Collected by W. O. Addicott, 1962–64.
M1592	700 ft S., 950 ft W. of NE. cor. sec. 23, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). Basal marine sandstone overlying nonmarine Walker Formation southeast of Pyramid Hill. Basal part of the Jewett Sand, same as UCMP B1662. Collected by W. O. Addicott, 1962.

USGS Cenozoic localities (Menlo Park register)—Continued

Locality	*Description of locality, collector, and date collected*
M1593	A few hundred feet northwest of center of sec. 9, T. 28 S., R. 29 E., in cut on access road to well location where road crosses north shoulder of hill, Woody quadrangle (1952 ed.). Concretionary stratum in bluish-gray very fine grained sandstone. Lower part of the Olcese Sand, same as UCMP B1676. Collected by W. O. Addicott, 1962, 1964.
M1594	Roadcut on northwest side of canyon trending northeasterly through N½ sec. 12, T. 28 S., R. 28 E., in SE¼NW¼ sec. 12, Woody quadrangle (1952 ed.). Uppermost, coarse to very coarse, crossbedded sand in the Olcese Sand overlain by Round Mountain Silt. Same as UCMP B1629. Collected by W. O. Addicott, 1962.
M1595	West bank of large gully 550 ft S., 3,000 ft E., of NW. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle (1954 ed.). Upper part of the Olcese Sand. Collected by W. O. Addicott, 1962.
M1596	Pelecypod biostrome on east side of southerly-trending canyon, 1,400 ft N., 100 ft W. of SE. cor. sec. 24, T. 28 S., R. 28 E., Oil Center quadrangle (1954 ed.). Near the top of the Olcese Sand, same as UCMP loc. 1603. Collected by W. O. Addicott, 1962.
M1597	In NE¼ sec. 5, T. 29 S., R. 29 E., 1,300 ft S., 350 ft W. from NE. cor. sec. 5, Oil Center quadrangle (1954 ed.). Upper part of the Olcese Sand, same as UCMP B1598. Collected by W. O. Addicott, 1962, 1963.
M1598	Opposite mouth of second gully south of the forks on east side of large southerly-trending canyon, 700 ft N., 1,400 ft W., of SE. cor. sec. 28, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). Near the top of the Olcese Sand, same as UCMP B1615. Collected by W. O. Addicott, 1962.
M1599	Bottom of southeasterly-trending gully 900 ft S., 150 ft E. of NW. cor. sec. 33, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). Near the top of the Olcese Sand, 17 ft stratigraphically below M1600. Same as UCMP B1599. Collected by W. O. Addicott, 1962.
M1600	*Tivela* bed on east side of gully trending southeasterly through sec. 33, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). 650 ft S., 100 ft E. of NW. cor. sec. 33, near the top of the Olcese Sand, 17 ft stratigraphically above loc. M1599. Same as UCMP B1600. Collected by W. O. Addicott, 1962.
M1601	On northwest bank of stream running south-southwesterly through SE¼ sec. 31, T. 28 S., R. 29 E., Oil Center quadrangle (1954 ed.). 1,700 ft N., 400 ft W. of SE. cor. sec. 31. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1962.
M1602	On west bank of Ely fork of gully in SW¼SW¼ sec. 32, T. 28 S., R. 29 E., Oil Center quadrangle (1954 ed.); 700 ft N., 300 ft E. of SW. cor. sec. 32. Near the top of the Olcese Sand, probably same stratigraphic position as M1601. Collected by W. O. Addicott, 1962.
M1603	Cut on east side of Rancheria Road, 2,000 ft S., 1,900 ft E. of NW. cor. sec. 35, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). Round Mountain Silt. Collected by W. O. Addicott, 1962.

USGS Cenozoic localities (Menlo Park register)—Continued

Locality	*Description of locality, collector, and date collected*
M1604	Near mouth of southerly-trending gully immediately north of Kern River, 900 ft N. of SE. cor. sec. 33, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). Round Mountain Silt. Collected by W. O. Addicott, 1962.
M1605	*Turritella* bed west of Cottonwood Creek, 1,050 ft S., 2,500 ft E. of NW. cor. sec. 13, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). At the top of the diatomaceous part of the Round Mountain Silt, same as UCMP B1588. Collected by W. O. Addicott, 1962, 1965.
M1606	On northeast side of southwesterly-trending gully 200 ft N. of SE. cor. sec. 11, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). Uppermost part of the Round Mountain Silt, 52 ft stratigraphically below the Bena Formation of Dibblee and others (1965). Same as UCMP B1678. Collected by W. O. Addicott, 1962.
M1607	Approximately 30 ft below contact with Kern River Formation, 1,650 ft N., 650 ft E. of SW. cor. sec. 11, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). Near the top of the Round Mountain Silt, approximately 30 ft stratigraphically below the base of the Santa Margarita Formation. Same as UCMP B1633. Collected by W. O. Addicott, 1962.
M1608	Olcese Boy Scout Camp on south bank of Kern River, at base of bluff 3,200 ft S., 1,100 ft W. of NE. cor. sec. 1, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1962.
M1609	Olcese Boy Scout Camp on south bank of Kern River, 3,200 ft S., 1,100 ft W. of NE. cor. sec. 1, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). Lower part of the Round Mountain Silt, 26 ft stratigraphically above loc. M1608. Collected by W. O. Addicott, 1962.
M1610	Olcese Boy Scout Camp on south bank of Kern River, 3,200 ft S., 1,100 ft W. of NE. cor. sec. 1, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). Lower part of the Round Mountain Silt, 37 ft stratigraphically above loc. M1608. Collected by W. O. Addicott, 1962.
M1611	Bottom of gully 1,150 ft. N, 2,050 ft E. of SW. cor. sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle (1954 ed.). Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1962.
M1612	Bottom of east fork of gully in SW¼ sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle (1954 ed.)., 1,250 ft N., 1,350 ft E. of SW. cor. sec. 6. Lower part of the Round Mountain Silt, same as UCMP B1637. Collected by W. O. Addicott, 1962, 1963.
M1613	East side of gully 20 ft stratigraphically above M1612, 1,300 ft N., 1,450 ft E. of SW. cor. sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle (1954 ed.). Lower part of the Round Mountain Silt, same as UCMP B1638. Collected by W. O. Addicott, 1962. 1963.
M1614	West bank of stream 1,450 ft N., 750 ft W. of SE. cor. sec. 31, T. 28 S., R. 29 E., Oil Center quadrangle (1954 ed.). Near the top of the Olcese Sand. Collected by W. O. Addicott, 1962.
M1692	Bottom of gully trending south-southwesterly through center of sec. 31, T. 28 S., R. 29 E., 1,750 ft S., 2,900 ft E. of NW. cor. sec. 31, Oil Center quadrangle (1954 ed.). Near the top of the Olcese Sand. Collected by W. O. Addicott, 1963.
M1693	Calcareous fine to very fine grained sandstone concretions in north bank of northwesterly-trending gully, 50 ft N., 1,550 ft W. of SE. cor. sec. 30, T. 28 S., R. 29 E. Oil Center quadrangle (1954 ed.). Upper part of the Olcese Sand. Collected by W. O. Addicott, 1963.
M1694	Collected from weak ledge of concretionary silty, very fine grained sandstone approximately 70 ft stratigraphically below M1593 on south side of west-southwesterly trending summit of hill near center of sec. 9, T. 28 S., R. 29 E., 2,400 ft southerly and 1,800 ft easterly from NW. cor. sec. 9, Woody quadrangle (1952 ed.). Same as H. G. Schenck's (1931) "Aturia" locality. Lower part of the Olcese Sand. Collected by W. O. Addicott, 1963.
M1695	Bottom of major gully trending northwest through SW¼ sec. 6, 1,000 ft N. and 1,150 ft E. of SW. cor. sec. 6, T. 29 S., R. 30 E., Rio Bravo quadrangle (1954 ed.). Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1963.
M1696	From lens of silty very fine sand in siltstone section. In bottom of gully trending northwesterly through SW¼ sec. 6, T. 29 S., R. 30 E., 350 ft N. and 900 ft E. of SW. cor. sec. 6, Rio Bravo Ranch quadrangle (1954 ed.). Lower part of the Round Mountain Silt, stratigraphically above M1695. Collected by W. O. Addicott, 1963.
M1697	Near top of southerly-trending cliff, 2,550 ft E. and 650 ft N. of SW. cor. sec. 32, T. 28 S., R. 29 E., Oil Center quadrangle (1954 ed.). From fine to very fine grained calcareous sandstone ledge. Upper part of the Olcese Sand. Collection from same stratum as UCMP B1587 and B1597. Collected by W. O. Addicott, 1963.
M1698	350 ft south of bridge across Poso Creek, near base of cliff on south side of creek, 150 ft S., 50 ft E. of NW. cor. sec. 7, T. 28 S., R. 29 E., Woody quadrangle (1952 ed.). Probably the same as Blake's Ocoya Creek locality collected in August 1853. Olcese Sand. Collected by W. O. Addicott, 1963, 1967.
M1699	Top of southerly of two knobs on narrow ridge trending northerly through center of sec. 10, T. 28 S., R. 29 E., 2,300 ft S., 2,100 ft E. of NW. cor. sec. 10, Woody quadrangle (1952 ed.). Near the base of the Jewett Sand, stratigraphically above loc. M1700. Collected by W. O. Addicott, 1963.
M1700	2,300 ft S., and 2,000 ft E. of NW. cor. sec. 10, T. 28 S., R. 29 E., Woody quadrangle (1952 ed.). Basal marine conglomeratic sandstone of the Jewett Sand. Collected by W. O. Addicott, 1963.
M2460	2,200 ft S., 650 ft W. of NE. cor. sec. 15, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). About 100 ft stratigraphically above the base of the Jewett Sand. Collected by W. O. Addicott, 1963.

USGS Cenozoic localities (Menlo Park register)—Continued

Locality	*Description of locality, collector, and date collected*
M2480	1,300 ft N., 1,450 ft E. of SW. cor. sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle (1954 ed.); 35–40 ft stratigraphically above M1613. Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1962.
M2601	In bottom of gully about 1,800 ft southwest of basement sediment contact, 1,350 ft S., 500 ft W. of NE. cor. sec. 36, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle (1954 ed.). Lower part of the Round Mountain Silt. Collected by W. O. Addicot 1954.

California University Museum of Paleontology (Berkeley) localities (UCMP)

Locality	*Description of locality, collector, and date collected*
2713	Temblor locality 1. Caliente quadrangle, Miocene [presumably from the Round Mountain Silt near Kern River].
2714	Temblor locality 2. Caliente quadrangle, Miocene [Upper part of the Olcese Sand(?), middle Miocene].
2716	Temblor locality 4. Caliente quadrangle, Miocene.
B1586	Next to lowest of six fossiliferous strata on east side of north-south trending gully, NW¼SE¼ sec. 32, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Gray calcareous silty very fine grained sandstone, 4–6 in. thick. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1953, 1954.
B1587	Uppermost fossiliferous ledge in southeast-facing cliff, SW¼SE¼ sec. 32, T. 28 S., R. 29 E., Bakersfield quadrangle (1906 ed.). Gray calcareous fine to very fine grained sandstone ledge, 1–3 ft thick. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1953, 1954.
B1588	On east slope of hill facing Cottonwood Creek at about 1,000-ft contour, NE¼NW¼ sec. 13, T. 29 S., R. 29 E., Caliente quadrangle (1914 ed.). *Turritella ocoyana* bed in orangish-tan-weathering gypsiferous silty very fine sand. At the top of the diatomaceous part of the Round Mountain Silt. Collected by W. O. Addicott, 1953, 1954.
B1592	Near mouth of a quarter-mile-long east-trending gully immediately northeast of Sharktooth Hill, SE¼NW¼ sec. 25, T. 28 S., R. 28 E., Bakersfield quadrangle (1906 ed.). Faded-red-weathering unconsolidated lenticular silt 3–4 in. thick. At the top of the diatomaceous part of the Round Mountain Silt. Collected by W. O. Addicott, 1953, 1954.
B1593	East side of hill 933, NE¼NW¼ sec. 32, T. 28 S., R. 29 E., Bakersfield quadrangle (1906 ed.). Light-gray silty calcareous sandstone forming prominent bench in slope. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1953, 1954.
B1594	East side of hill 933, NE¼NW¼ sec. 32, T. 28 S., R. 29 E., Bakersfield quadrangle (1906 ed.). Brown-weathering lenticular very fine sand about 13 ft stratigraphically below B1593. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1953, 1954.

California University Museum of Paleontology (Berkeley) localities (UCMP)—Continued

Locality	*Description of locality, collector, and date collected*
B1595	East side of hill 933, NE¼NW¼ sec. 32, T. 28 S., R. 29 E., Bakersfield quadrangle (1906 ed.). Gray calcareous platy very fine grained sandstone 40 ft stratigraphically below B1593. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1953, 1954.
B1596	North side of short northwest-trending gully 125 yds upstream from mouth and 20 ft above bed. Just north of south line of sec. 30, T. 28 S., R. 29 E. (in SW¼SE¼), Bakersfield quadrangle (1906 ed.). Gray calcareous silty very fine grained sandstone ledge. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1953, 1954.
B1597	Float collection from uppermost ledge on south side of hill 728 (Bakersfield quadrangle), 200 ft S., 100 ft W. of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle (1950 ed.). Fine- to medium-grained sandstone cropping out in a 6- to 12-in. ledge traceable for a quarter of a mile. Upper part of the Olcese Sand; same bed as B1587. Collected by W. O. Addicott, 1953, 1954.
B1598	At mouth of short Y-shaped gully approximately 200 yds north of abandoned sand and gravel plant, 1,200 ft S., 300 ft W. of NE. cor. sec. 5, T. 29 S., R. 29 E., Oil Center quadrangle (1950 ed.). Gray clean fine to very fine sand. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1953, 1954.
B1599	In second southeast-trending gully due east of hill 933 (Bakersfield quadrangle), NW¼NW¼ sec. 33, T. 28, S., R. 29 E., Caliente quadrangle (1914 ed.). Gray tuffaceous poorly sorted fine-grained sandstone 3–4 in. thick. Upper part of the Olcese Sand, approximately 80 ft stratigraphically below the base of the Round Mountain Silt. Collected by W. O. Addicott, 1953, 1954.
B1600	In second southeast-trending gully due east of hill 933 (Bakersfield quadrangle), NW¼NW¼ sec. 33, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). *Tivela-Polinices* bed reddish-brown weathering micaceous medium to coarse gravelly sand. Upper part of the Olcese Sand, 17 ft stratigraphically above B1599. Collected by W. O. Addicott, 1953, 1954.
B1601	In second southeast-trending gully due east of hill 933 (Bakersfield quadrangle), NW¼NW¼ sec. 33, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Limonitic stained poorly sorted very fine grained sandstone ledge 6–8 in. thick. Upper part of the Olcese Sand, 21 ft stratigraphically above B1600. Collected by W. O. Addicott, 1953, 1954.
B1602	South side of Sharktooth Hill in head of south-trending gully, N½SW¼ sec. 25, T. 28 S., R. 28 E., Bakersfield quadrangle (1906 ed.). Orangish-brown-weathering calcareous silty sandstone ledge. Upper part of the Round Mountain Silt stratigraphically above the tooth and bone bed and about 30 ft stratigraphically below the Santa Margarita Formation of Dibblee and others (1965). Same as Anderson's (1911) "C zone" megafossil locality. Collected by W. O. Addicott, 1953, 1954.

California University Museum of Paleontology (Berkeley) localities (UCMP)—Continued

Locality	*Description of locality, collector, and date collected*
B1603	Lower of two fossiliferous strata in east bank of north-south-trending gully east of gypsum mining operations, NE¼SE¼ sec. 24, T. 28 S., R. 29 E., Bakersfield quadrangle (1906 ed.). Pelecypod biostrome in orangish-brown-weathering gypsiferous very fine sand 1–4 ft thick. Upper part of the Olcese Sand about 80 ft stratigraphically below top of the formation. Collected by W. O. Addicott, 1953, 1954.
B1605	West flank of northernmost knob on north-south ridge and 25 ft below top, SW¼NW¼ sec. 10, T. 28 S., R. 29 E., Woody quadrangle (1952 ed.). Calcareous very coarse grained conglomeratic sandstone about 5 ft thick. Basal part of the Jewett Sand. Collected by W. O. Addicott, 1954.
B1606	West flank of north-south-trending ridge 1,000 ft south of B1605, 1,000 ft west of center of sec. 10, T. 28 S., R. 29 E., Woody quadrangle (1952 ed.). Float collection from basal 95 ft of the Jewett Sand. This locality and B1605 probably are equivalent to Loel and Corey's (1932, p. 97) "northwest of Pyramid Hill" locality. Collected by W. O. Addicott, 1954.
B1607	In roadcut 500 ft. east of bend in Poso Creek road, SE¼SE¼ sec. 2, T. 28 S., R. 28 E., Woody quadrangle (1952 ed.). Gray calcareous silty very fine grained sandstone 6 in. thick. Lower part of the Round Mountain Silt about 15–20 ft stratigraphically above the top of the Olcese Sand. Collected by W. O. Addicott, 1954.
B1608	South side of Kern River in cut on east side of road leading to bridge built in 1952, NE¼ sec. 11, T. 29 S., R. 29 E., Caliente quadrangle (1914 ed.). Lenses of mollusks in dark-gray micaceous silty shale. Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1954.
B1609	Top of northwest-trending flat-topped hill west of gravel plant on Cottonwood Creek, NE¼SW¼ sec. 12, T. 29 S., R. 29 E., Caliente quadrangle (1914 ed.). Float collection from tan sandy silt soil. Top of the diatomaceous part of the Round Mountain Silt; same stratigraphic position as B1588. Collected by W. O. Addicott, 1954.
B1611	About 25 ft below and south of highest point on northwest-trending ridge, SW¼NW¼ sec. 8, T. 29 S., R. 30 E., Caliente quadrangle (1914 ed.). Light-gray calcareous very fine grained sandstone. Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1954.
B1612	In roadcut near top of cliff above mouth of southeast-trending gully, near center of SW¼ sec. 6, T. 29 S., R. 30 E., Caliente quadrangle (1914 ed.). Thin fossiliferous lens in grayish-tan-weathering massive siltstone. Lower part of the Round Mountain Silt, 160 ft stratigraphically above B1638. Collected by W. O. Addicott, 1954.
B1613	At "Y" in north fork of southeast-trending gully west of P.G.&E. private road, SW¼SE¼ sec. 26, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Fossiliferous lenses at base of grayish-tan limonitic mottled sandy siltstone 19 ft thick. Round Mountain Silt. Collected by W. O. Addicott, 1954.
B1614	Near top of first gully southeast of "Y" in large north-south canyon, NE¼SE¼ sec. 28, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Collection from three *Tivela* beds in 20-ft. interval of fine to very coarse gravely sand. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1954.
B1615	Opposite mouth of second gully on east side of major north-south canyon south of the forks, SW¼SE¼ sec. 28, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Orangish-brown-weathering silty fine to very fine sand 5 ft above floor of canyon. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1954.
B1616	West side of canyon 300 ft downstream from B1615, SW¼SE¼ sec. 28, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Same stratum and lithology as B1615. Upper part of the Olcese Sand, middle Miocene. Collected by W. O. Addicott, 1954.
B1617	Near top of 125-ft cliff cut by old river meander and 3 ft below river terrace gravel contact, center of NW¼ sec. 1, T. 29 S., R. 29 E., Caliente quadrangle (1914 ed.). Collection from thin lens in light-gray massive gypsiferous siltstone. Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1954.
B1618	Mouth of first gully on north side of Kern River and east of section line fence, SW¼SW¼ sec. 34, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Gray-to chocolate-brown-weathering shaly silt and very fine sand. Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1954.
B1619	North bank of Kern River, a third of a mile downstream from B1618, SW¼SE¼ sec. 33, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1954.
B1620	Mouth of north-south-trending gully north of abandoned bridge across Kern River, NE¼NE¼ sec. 1, T. 29 S., R. 29 E., Caliente quadrangle (1914 ed.). Thin fossiliferous lenses in white to light-tan siltstone. Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1954.
B1621	In landslide or slump in north fork of west-trending gully emptying into east fork of major north-south canyon, SW¼NW¼ sec. 27, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Light-brown-weathering silty very fine sand 1 ft thick. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1954.

California University Museum of Paleontology (Berkeley) localities (UCMP)—Continued

Locality	*Description of locality, collector, and date collected*
B1622	Near top of landslide or slump halfway up east bank of major north-south canyon half a mile north of Kern River, SW¼NE¼ sec. 33, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Orangish-brown-weathering very fine grained sandstone 6–8 in. thick. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1954.
B1623	In landslide on east wall of major north-south canyon 200 yds south of B1622 and 75 ft above canyon floor, east of center of sec. 33, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Upper part of the Olcese Sand. Collected by W. O. Addicott, 1954.
B1624	Slump block on east side of major north-south canyon near intersection of canyon floor and 600-ft topographic contour, W½NE¼ sec. 33, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Collection from orangish-brown-weathering crossbedded fine sand 5–8 in. thick about 15 ft above canyon floor. Upper part of the Olcese Sand. Collected by W. O. Addicott, 1954.
B1625	Top of northwest-trending ridge between the 1,300- and 1,400-ft topographic contours, SW¼SE¼ sec. 22, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Gray calcareous sandy siltstone concretions near top of a 25-ft siltstone. Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1954.
B1626	In small north-south-trending gully south of flat-topped hill in NE¼ sec. 31, T. 28 S., R. 29 E., Bakersfield quadrangle (1906 ed.). Gray calcareous silty very fine grained sandstone ledge. Upper part of the Olcese Sand, probably same stratigraphic position as B1596. Collected by W. O. Addicott, 1954.
B1629	Roadcut on northwest side of canyon, SE¼NW¼ sec. 12. T. 28 S., R. 28 E., Woody quadrangle (1952 ed.). Brown-weathering crossbedded coarse to very coarse gravelly sand 4–6 ft thick, overlain by grayish-tan-weathering siltstone of the Round Mountain Silt. Top of the Olcese Sand. Collected by W. O. Addicott, 1954.
B1630	Head of second north-south gully east of B1607, SE¼SE¼ sec. 2, T. 28 S., R. 28 E., Woody quadrangle (1952 ed.). Lower part of the Round Mountain Silt, 15–20 ft stratigraphically above Olcese Sand contact. Same stratigraphic position and lithology as B1607. Collected by W. O. Addicott, 1954.
B1633	Center of SW¼ sec. 11, T. 29 S., R. 29 E., Caliente quadrangle (1914 ed.). Gray calcareous siltstone ledge about 30 ft stratigraphically below base of Santa Margarita Formation. Upper part of the Round Mountain Silt. Collected by W. O. Addicott, 1954.
B1636	Just below head of northeast-trending canyon, center of SW¼ sec. 12, T. 29 S., R. 29 E., Caliente quadrangle (1914 ed.). *Turritella ocoyana* bed in orangish-tan-weathering gypsiferous concretionary sandy siltstone 1½ ft thick. Upper part of the Round Mountain Silt above the diatomaceous part of the formation. Collected by W. O. Addicott, 1954.

California University Museum of Paleontology (Berkeley) localities (UCMP)—Continued

Locality	*Description of locality, collector, and date collected*
B1637	East bank of east fork of northwest-trending gully 4 ft above floor, center of SW¼ sec. 6, T. 29 S., R. 30 E., Caliente quadrangle (1914 ed.). Fossiliferous lenses at top and bottom of 1½-ft platy very fine grained sandstone. Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1954.
B1638	Center of SW¼ sec. 6, T. 29 S., R. 30 E., Caliente quadrangle (1914 ed.). Very abundant small mollusks in 6-in. thick orangish-brown-weathering sand. Lower part of the Round Mountain Silt, 20 ft stratigraphically above B1637. Collected by W. O. Addicott, 1954.
B1639	SW¼SE¼ sec. 26, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). *Neverita* bed in tan-weathering fine to very fine grained calcareous sandstone 2½ ft thick. Round Mountain Silt, 31 ft stratigraphically below B1613. Collected by W. O. Addicott, 1954.
B1640	About 50 ft above canyon floor on west side of canyon south of bend in deep north-south-trending canyon at point on map where 600-ft contour crosses canyon floor, near W¼ cor. of NE¼ sec. 33, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Gray medium to very coarse poorly sorted sand 3–4 ft thick. Upper part of the Olcese Sand, 60 ft stratigraphically below Round Mountain Silt contact. Collected by W. O. Addicott, 1954.
B1641	Near W¼ cor. of NE¼ sec. 33, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Gray calcareous concretionary sandstone 1½ ft thick. Upper part of the Olcese Sand, 27 ft stratigraphically below Round Mountain Silt contact and 38 ft above loc. B1640. Collected by W. O. Addicott, 1954.
B1642	Near W¼ cor. of NE¼ sec. 33, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Gray calcareous sandy siltstone 6–12 in. thick. Upper part of the Olcese Sand, 27 ft stratigraphically above B1641. Same stratigraphic position as B1622 and B1623 Collected by W. O. Addicott, 1954.
B1643	At "Y" in north-south-trending gully east of gypsum mine in NE¼NE¼ sec. 24, T. 28 S., R. 28 E., Bakersfield quadrangle (1906 ed.). *Ostrea* bed in brown-weathering crossbedded pebbly fine to medium sand 2 ft thick. Upper part of the Olcese Sand, 71 ft stratigraphically below Round Mountain Silt contact. Collected by W. O. Addicott, 1954.
B1645	Roadcut at first gully southwest of Shell Oil Co. "Bell" 1, NE¼SE¼ sec. 12, T. 28 S., R. 28 E., Woody quadrangle (1952 ed.). Tan-weathering gypsiferous sandy siltstone 4 in. thick. Lower part of the Round Mountain Silt. Collected by W. O. Addicott, 1954.
B1646	In bottom of southwest-trending tributary of Borel Canyon midway between first and second gullies southeast of powerline maintenance road on southwest side of canyon. Calcareous concretions at base of light-gray massive silty very fine grained sandstone. Lower part of the Olcese Sand. Collected by W. O. Addicott, 1954.

California University Museum of Paleontology (Berkeley) localities (UCMP)—Continued

Locality	*Description of locality, collector, and date collected*
B1660	South side of west flank of Pyramid Hill at 1,900-ft topographic contour above "6" in 2161 on Caliente quadrangle, NE¼SW¼ sec. 14, T. 28 S., R. 29 E. Molluscan bed in gritty silty very fine grained sandstone 6–12 ft thick. About 40 ft stratigraphically above base of Jewett Sand. Collected by W. O. Addicott, 1954.
B1662	Top of knoll above bend in little-used dirt road a quarter of a mile southwest of intersection with Rancheria Road, NE¼NE¼ sec. 23, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Poorly sorted, calcareous sandstone. Basal part of the Jewett Sand. Collected by W. O. Addicott, 1954.
B1664	North side of first major east-west canyon east of section line fence, SW¼NW¼ sec. 14, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Calcareous, clayey coarse-grained sandstone. Base of the Jewett Sand. Collected by W. O. Addicott, 1954.
B1665	In SW¼NW¼ sec. 14, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Lithology similar to B1664 but sandstone is finer grained and platy; 7 ft stratigraphically above locality B1664. Collected by W. O. Addicott, 1954.
B1666	In SW¼NW¼ sec. 14, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Orangish-tan-weathering calcareous concretionary very fine sand 3½ ft thick. Lower part of the Jewett Sand, 200 ft stratigraphically above base of the formation. Collected by W. O. Addicott, 1954.
B1667	Southeast slope of Pyramid Hill on west side of road near intersection of road with 1,900-ft topographic contour, near center of W½ of SE¼ sec. 14, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Poorly exposed concretionary calcareous very fine grained sandstone. A few feet above the base of the Jewett Sand. Collected by W. O. Addicott, 1954.
B1668	In SW¼NW¼ sec. 14, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Lenticular calcareous locally clayey granuliferous sandstone. Base of the Jewett Sand. Collected by W. O. Addicott, 1954.
B1674	Float from basal part of the Jewett Sand, about 500 ft south of 1,550-ft hill in NE¼NW¼ sec. 4, T. 28. S., R. 29 E., Woody quadrangle (1952 ed.). Collected by W. O. Addicott, 1954.
B1676	Cut in northeast shoulder of hill along road leading to well location, SE¼NW¼ sec. 9, T. 28 S., R. 29 E., Woody quadrangle (1952 ed.). Bluish-gray concretionary very fine grained sandstone. Lower part of the Olcese Sand. Collected by W. O. Addicott, 1954.
B1677	South side of hill just east of old well location, SE¼ NW¼ sec. 9, T. 28. S., R. 29 E., Woody quadrangle (1952 ed.). Lower part of the Olcese Sand, same stratigraphic position as B1676. Collected by W. O. Addicott, 1954.
B1678	Near head of southwest-trending gully, SE¼SE¼ sec. 11, T. 29 S., R. 29 E., Caliente quadrangle (1914 ed.). One-foot ledge of calcareous abundantly fossiliferous very fine grained sandstone. Upper part of the Round Mountain Silt, 52 ft stratigraphically below base of Bena Formation of Dibblee, Bruer, Hackel, and Warne (1965). Collected by W. O. Addicott, 1954.
B1753	In NW¼NW¼ sec. 33, T. 28 S., R. 29 E., Caliente quadrangle (1914 ed.). Gray calcareous, clayey siltstone. Upper part of the Olcese Sand 14 ft stratigraphically above locality B1600. Collected by W. O. Addicott, 1954.

Los Angeles County Museum, invertebrate paleontology locality (LACMIP)

Locality	*Description of locality*
456	Myra Keen locality. 600 ft N., 700 ft E. of SW. cor. sec. 6, T. 29 S., R. 29 E., Rio Bravo Ranch quadrangle. Round Mountain Silt.
462	Pyramid Hill-2. 200 ft N., 500 ft E. of SW. cor. sec. 14, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle. Pyramid Hill Formation [basal part of Jewett Sand, lower Miocene].
463	Barker's Ranch. 750 ft S., 70 ft E. of NW. cor. sec. 33, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle. Upper part of the Olcese Sand. Collected by J. A. Sutherland, 1966.

California Academy of Sciences localities (CAS)

Locality	*Description of locality*
64	Kern County, Calif. In the bed of a small gulch about 1¼ miles north [east added in pencil] of Barker's ranchhouse. Kern River. [Near the top of the Olcese Sand, middle Miocene; a notation by Anderson that localities 63–65 are from the same zone appears in the register].
65	Kern County, Calif. This locality occupies an area nearly half a mile square in hills just north of the Kern River and northeast of Barker's ranchhouse. The materials represent one horizon and have been included into one locality for that reason [upper part of Olcese Sand, middle Miocene].
68	Kern County, Calif. In the banks of the first big canyon or creek west of the power plant on the north side of Kern River about 3 or 4 miles northeast of the Rio Bravo ranchhouse. This is nearly 4 miles due south of Pyramid Hills. Lower Miocene.
69	Kern County, Calif. On the south and west slopes of Pyramid Hills which is 4 or 5 miles due north of the power plant in Kern River and about 15 miles northeast of Bakersfield.
2064	Same as CAS locality 65.
2147	*Scaphander jugularis* Conrad. Lower Miocene, Kern River. Collected by F. M. Anderson.
28790	C.C.M.O. [C.W.O.D.] Co. "Alford" 1, sec. 35, T. 27 S., R. 27 E., Kern County, Calif. Depth, 1795–1800 ft. Santa Margarita Formation. Collected by O. F. Kotick.
28909	Superior Oil Co. Crome Community 1. Sec. 36, T. 29 S., R. 28 E., Kern County, Calif. Foraminifera slides from strata 3,900–5,008 ft. Collected by O. F. Kotick, June, 1937.
37468	Fossil mollusks from Pyramid Hill, south side of west flank about 1 mile west of crest, Kern County, Calif. Temblor, Miocene. Found with abundant Miocene. Near center SE¼ sec. 15, T. 28 S., R. 29 E., south side of spur at head of gully; outcrop of sandstone can be seen from Pyramid Road. Collected by R. C. Bishop.

Stanford University localities (SU)

Locality	*Description of locality*
2121	California, Kern County, Caliente quadrangle. Near center of SW¼ sec. 6, T. 29 S., R. 30 E., in small gully close to terrace contact. Stratigraphic horizon: lowermost part of Round Mountain Silt. Collected by D. C. Birch, 1938; R. T. White, 1939; L. T. Martin and E. A. Watson, 1940; A. M. Keen, 1939.
2641	California, Kern County, Bakersfield or Caliente quadrangles. In sec. 5, T. 29 S., R. 29 E., 1,000 ft S., 600 ft W. of NE. cor. sec. 5, on the side of a gully, approximately 250 ft north of where a small gully flows onto the alluvium of Kern River. Stratigraphic horizon: basal Round Mountain Silt or uppermost Olcese Sand. Collected by R. T. White.

Stanford University general specimen numbers (SU)

Locality	*Description of locality*
26854	California, Kern County, Woody quadrangle. 2,000 ft N., 1,700 ft E. of SW. cor. sec. 9, T. 28 S., R. 29 E. "Upper part of the Freeman Silt" (Galliher's *Aturia* locality) [lower part of the Olcese Sand]. Field locality BR101. Collected by R. T. White.
29501	California, Kern County, Caliente quadrangle. In bottom of small southward-flowing gully, 3,000 ft S., 1,600 ft W. of NE. cor. sec. 32, T. 32 S., R. 29 E. Top of the Olcese Sand. Field locality BR26. Collected by R. T. White.

California University, Los Angeles localities (UCLA)

Locality	*Description of locality*
3456	On west side of south-trending ridge stratigraphically above UCLA 2669, 1,700 ft N., 1,600 ft W. of SE. cor. sec. 32, T. 28 S., R. 29 E., Rio Bravo Ranch quadrangle. Upper part of Olcese Sand.
AC-2-34	Lower part of the Round Mountain Silt, Kern River [presumably from same stratigraphic interval and geographic area as USGS localities M1608, M1612, and M1613, which are on the south side of Kern River in sec. 1, T. 29S., R.29 E., and sec. 6, T. 29 S., R. 30 E., Rio Bravo Ranch quadrangle]. Collected by Alex Clark, 1934.
AC-8-34	Upper part of the Olcese Sand, Kern River. Collected by Alex Clark, 1934.
AC-13-34	Lower part of the Round Mountain Silt, Kern River [presumably from same stratigraphic interval and geographic area as USGS localities M1608, M1612, and M1613]. Collected by Alex Clark, 1934.
AC-14-34	Lower part of the Round Mountain Silt, Kern River. Collected by Alex Clark, 1934.
MB-1400	"Top of Py[ramid Hill] Sand, Poso Creek." Matrix and other specimens from this locality suggest the material is from the lower part of the Olcese Sand exposed on the south side of Poso Creek, near the center of sec. 9, T. 28 S., R. 29 E., Woody quadrangle. Collected by Max Birkhauser, 1928 or 1929.
WR-163	"One and a half miles northwest of Pyramid Hill, 'Vaqueros'." Probably same as UCR locality 1154, 2,045 ft N., 2,195 ft E. of NW. cor. sec. 15, T. 28 S., R. 29 E. (field No. WR-163-K9), which contains index species of the "Vaqueros Stage." Collected by W. W. Rand.

California University, Riverside localities (UCR)

Locality	*Description of locality*
1199	Mobil Oil Co. [General Petroleum Corp.] "Seale" 5-10, sec. 5, T. 30 S., R. 29 E., depth 3,891 ft. Olcese Sand. Field No. PR-489. Collected by Philip W. Reinhart.
1301	Shell Oil Co. "Edison" 2-1, sec. 33, T. 29 S., R. 29 E., depth 5,138 ft. Upper part of the Vedder Sand.
1305	Shell Oil Co. "Edison" 2-1, depth 4,657 ft. Freeman-Jewett Silt of Matthews (1955).
1306	Shell Oil Company "Edison" 2-1, sec. 33, T. 29 S., R. 29 E., depth 4,385 ft. Freeman-Jewett Silt of Matthews (1955).
PR604	L. and B. Producing Co. "Jewett" 1, sec. 19, T. 28 S., R. 29 E. Vedder Sand. Collected by P. W. Reinhart.
PR605	L. and B. Producing Co. "Jewett" 1, sec. 19, T. 28 S., R. 29 E. Vedder Sand. Collected by P. W. Reinhart.

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[Italic page numbers indicate both major references and descriptions]

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PLATES 1–21

PLATE 1

FIGURES 1, 9, 24. *Diodora (Diodora)* n. sp. (p. 40).
Length 45 mm, width 25 mm, height 15 mm. UCMP 10064. Float block from basal part of the Jewett Sand, early Miocene. UCMP loc. B1674. Figs. 1 and 9 are a rubber cast.

2, 3, 5–7. *Tegula (Omphalius) laevis* Addicott, n. sp. (p. 41).
Upper part of the Olcese Sand, middle Miocene.
2. Paratype. Height 18.7 mm, width 18.2 mm. USNM 650042. USGS Cenozoic loc. M1598.
3, 5, 6. Holotype. Height 12.6 mm, width 17.2 mm. USNM 650043. USGS Cenozoic loc. M1602.
7. Height 15 mm, width 16.2 mm. USNM 650044. USGS Cenozoic loc. M1602.

4. *Calliostoma* sp. B. (p. 42).
Height 9.7 mm, width 9.5 mm. USNM 650335. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.

8. *Diodora*? n. sp. (p. 40).
Length 18 mm, width 11.5 mm, height 3.5 mm. UCMP 11031. Near the base of the Jewett Sand, early Miocene. UCMP loc. B1605.

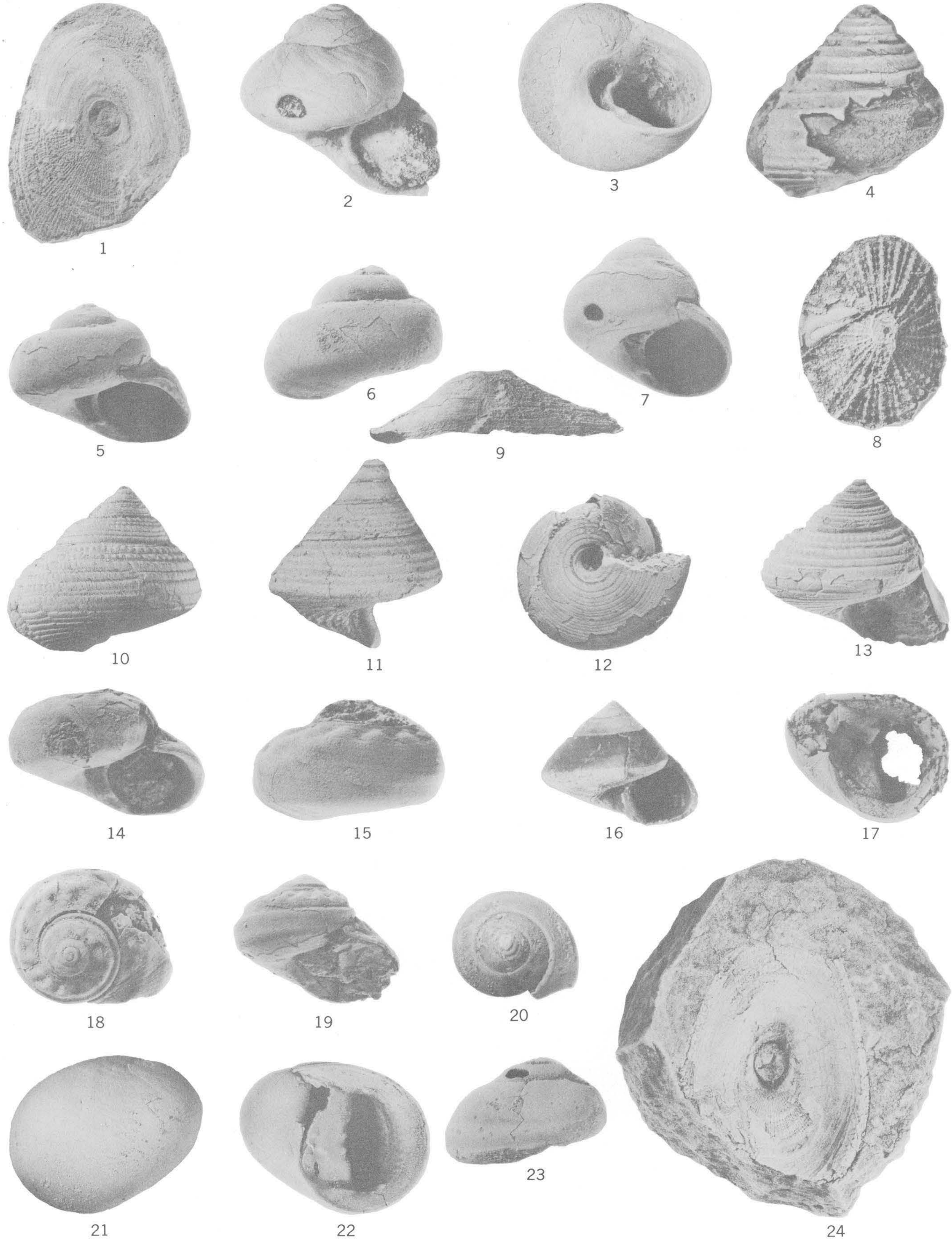
10, 13. *Calliostoma carsoni* Addicott, n. sp. (p. 42).
Holotype. Height 16.7 mm, width 17.5 mm. UCLA 45763. Upper part of the Olcese Sand, middle Miocene. UCLA loc. 3456.

11. *Calliostoma* sp. A (p. 43).
Height 9.3 mm, width 8.1 mm. CAS 12930. Lower part of the Jewett Sand, early Miocene. CAS loc. 37468.

12, 16, 20. *Gibbula* (*Tumulus*?) *baileyi* Addicott, n. sp. (p. 42).
Lower part of the Round Mountain Silt, middle Miocene. USGS loc. 6065.
12. Paratype. Height 4.9 mm, width 6.4 mm. USNM 650047.
16. Holotype. Height 4.8 mm, width 6 mm. USNM 650048.
20. Height 4.2 mm, width 4.7 mm. USNM 650049.

14, 15, 18, 19, 23. *Tegula* (*Omphalius*) *dalli arnoldi* Addicott, n. sp. (p. 41).
Upper part of the Olcese Sand, middle Miocene.
14, 15. Paratype. Height 10.8 mm, width 14.5 mm. UCMP 11062. UCMP loc. B1599.
18, 19. Holotype. Height 12.3 mm, width 15.7 mm. USNM 650045. USGS Cenozoic loc. M1599.
23. Width 12.8 mm. USNM 650046. USGS Cenozoic loc. M1600.

17, 21, 22. *Nerita* (*Theliostyla*?) *joaquinensis* Addicott, n. sp. (p. 45).
Lower part of the Round Mountain Silt, middle Miocene.
17. Paratype. Height 9.8 mm, width 12.1 mm. USNM 650050. USGS Cenozoic loc. M1640.
21, 22. Holotype. Height 12.5 mm, width 13.9 mm. USNM 650051. USGS Cenozoic loc. M1613.



DIODORA, *TEGULA*, *CALLIOSTOMA*, *GIBBULA*, and *NERITA*

PLATE 2

FIGURE 1. *Astraea* (*Pomaulax*) n. sp. (p. 43).
Height 25 mm, width 24 mm. UCMP 11064. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1616.

2, 3, 6–9. *Astraea* (*Pomaulax*) *biangulata* (Gabb) (p. 44).
2, 3, 7–9. Upper part of the Olcese Sand or lower part of the Round Mountain Silt, middle Miocene. UCMP loc. 2713.
2, 9. Width 29.5. UCMP 11333.
3, 7. Height 34 mm, width 31 mm. UCMP 12147.
8. Height 19.7 mm, width 21 mm. UCMP 12148.
6. Width 27.5 mm. UCMP 12149. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1615.

4, 5, 10. *Vitrinella* (*Vitrinellops*) *lens* (Keen) (p. 46).
4, 10. Height 0.6 mm, width 1.5 mm. USNM 650052. Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1612.
5. Width 1.3 mm. USNM 650053. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

11–14. *Turritella moodyi* Merriam (p. 46).
Lower part of the Round Mountain Silt, middle Miocene.
11. Height 19.9 mm, width 5.4 mm. UCMP 12150. UCMP loc. B1637.
12. Height 25 mm, width 7.6 mm. USNM 650054. USGS Cenozoic loc. M1604.
13. Height 19.6 mm, width 6.3 mm. USNM 650055. USGS Cenozoic loc. M1604.
14. Height 12.4 mm, width 5 mm. USNM 650056. USGS Cenozoic loc. M1609.

15. *Turritella oregonensis* (Conrad) (p. 51).
Height 14.1 mm, width 6 mm. USNM 650057. Unnamed middle Miocene formation, Coos Bay, Oreg. USGS loc. 18284.

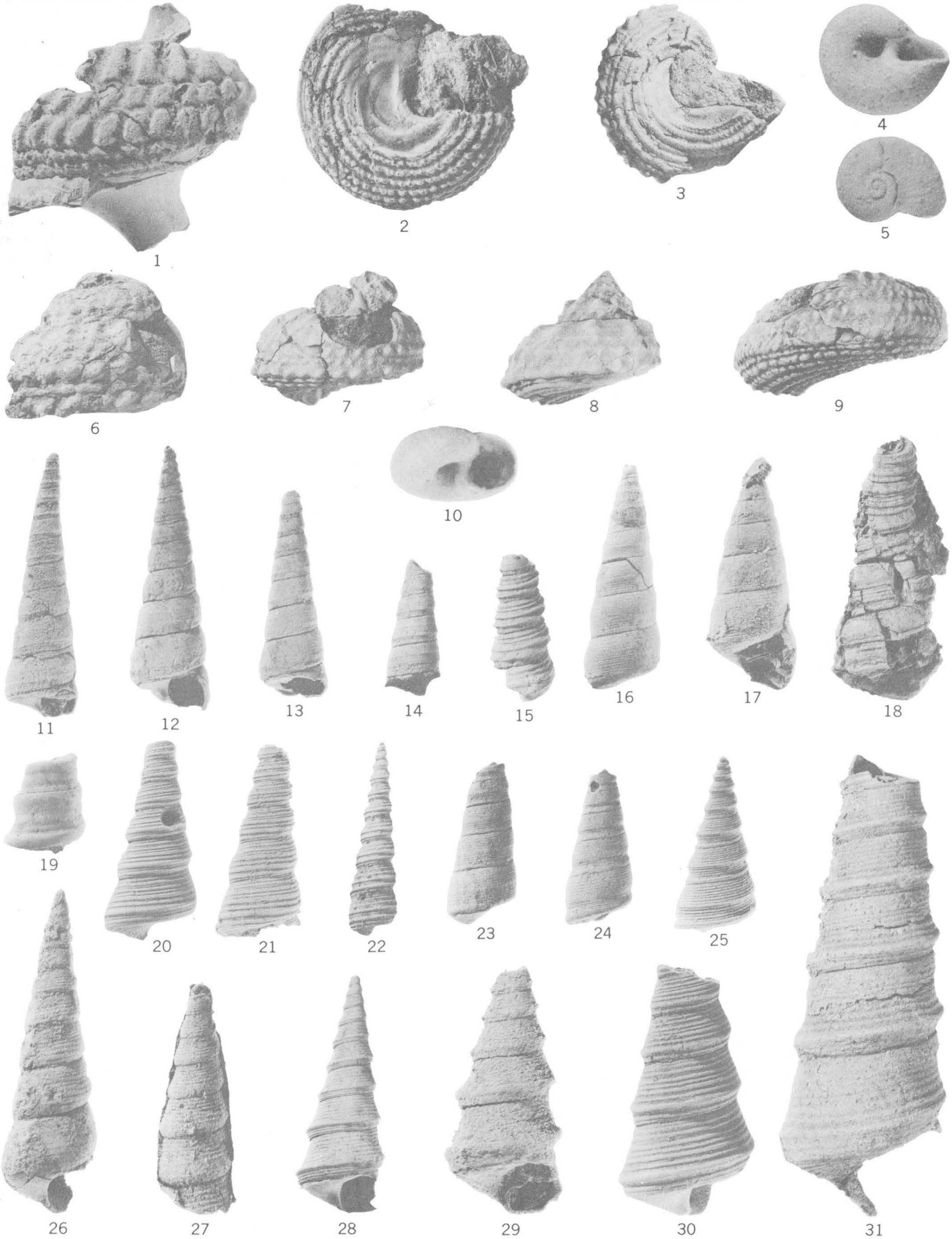
16, 17, 23–25. *Turritella kernensis* Addicott, n. sp. (p. 47).
Upper part of the Olcese Sand, middle Miocene.
16. Paratype. Height 29 mm, width 9.6 mm. USNM 650058. USGS Cenozoic loc. M1597.
17. Height 28.5 mm, width 11.4 mm. UCMP 12548. UCMP loc. B1614.
23. Holotype. Height 20.7 mm, width 8.5 mm. USNM 650059. USGS Cenozoic loc. M1598.
24. Height 15 mm, width 6.1 mm. USNM 650060. USGS Cenozoic loc. M1597.
25. Paratype. Height 8.4 mm, width 3.9 mm. USNM 650061. USGS Cenozoic loc. M1597.

18. *Turritella* (*Torcula*) *inezana pervulgata* Merriam (p. 48).
Height 58 mm, width 19.5 mm (specimen crushed). UCR 1301. Upper part of the Vedder Sand, Shell Oil Co. "Edison" 2–1, 5,138 ft. UCR loc. 1301.

19. *Turritella* (*Torcula*?) cf. *T.* (*T.*?) *padronesensis* Grant and Eaton (p. 49).
Height 18.2 mm, width 15.2 mm. UCMP 12549. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1616.

20–22, 26–28. *Turritella ocoyana* Conrad (p. 49).
20–22, 27, 28. Upper part of the Olcese Sand, middle Miocene.
20. Height 19.3 mm, width 8.6 mm. UCMP 12550. UCMP loc. B1598.
21. Height 12.3 mm, width 5.2 mm. USNM 650062. USGS Cenozoic loc. M1597.
22. Immature specimen. Height 7.3 mm, width 1.9 mm. USNM 650063. USGS Cenozoic loc. M1597.
27. Topotype. Height 29.5 mm, width 10 mm. USNM 650064. USGS Cenozoic loc. M1689.
28. Height 44 mm, width 16.9 mm. USNM 650065. USGS Cenozoic loc. M1597.
26. Height 63 mm, width 18.5 mm. UCMP 14980. Upper part of the Round Mountain Silt, middle Miocene. UCMP loc. B1588.

29–31. *Turritella ocoyana* forma *topangensis* Merriam (p. 51).
29. Height 31.5 mm, width 15.4 mm. USNM 650066. Upper part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1605.
30, 31. Upper part of the Olcese Sand, middle Miocene.
30. Height 24.7 mm, width 13.2 mm. UCMP 14993. UCMP loc. B1598.
31. Height 88 mm, width 32 mm. USNM 650067. USGS loc. 6628.



ASTRAEA, *VITRINELLA*, and *TURRITELLA*

PLATE 3

FIGURES 1, 2, 22. *Lacuna carpenteri* Anderson and Martin (p. 45).
Upper part of the Olcese Sand, middle Miocene.
1, 2. Height 6.8 mm, width 4.2 mm. USNM 650068. USGS Cenozoic loc. M1600.
22. Height 4.9 mm, width 3.9 mm. UCMP 14994. UCMP loc. B1600.

3, 8–12. *Batillaria ocoyana.* (Anderson and Martin) (p. 53).
Upper part of the Olcese Sand, middle Miocene.
3. Lirate form. Height 16.9 mm, width 7.5 mm. USNM 650069. USGS Cenozoic loc. M1597.
8. Beaded form. Height 14.3 mm, width 6.7 mm. UCMP 14995. UCMP loc. B1600.
9, 10. Beaded form. Height 16 mm, width 7.7 mm. USNM 650070. USGS Cenozoic loc. M1602.
11, 12. Lirate form. Height 20.7 mm, width 9.1 mm. USNM 649170. USGS Cenozoic loc. M1602.

4–7, 13, 14. *Bittium topangensis* (Arnold) (p. 52).
Upper part of the Olcese Sand, middle Miocene.
4,5. Height 17.1 mm, width 6.6 mm. USNM 650071. USGS Cenozoic loc. M1600.
6, 7. Height 13.2 mm, width 5.2 mm. UCMP 15423. UCMP loc. B1600.
13, 14. Height 20.8 mm, width 7.3 mm. USNM 650072. USGS Cenozoic loc. M1599.

15, 16, 34–37. *Epitonium (Cirsotrema) clallamense* Durham (p. 54).
Basal part of the Jewett Sand, early Miocene.
15, 35, 36. Height 31 mm, width 15 mm. UCMP 36533. UCMP loc. B1665.
16. Width 11 mm. UCMP 15428.. UCMP loc. B1665.
34. Height 15 mm, width 7.6 mm. USNM 650073. USGS Cenozoic loc. M1590.
37. Height 22.6 mm, width 12.3 mm. USNM 650074. USGS Cenozoic loc. M1591.

17, 18. *Epitonium (Nitidiscala) tedfordi* Addicott, n. sp. (p. 55).
Upper part of the Olcese Sand, middle Miocene.
17. Holotype. Height 7.8 mm, width 2.8 mm. USNM 650075. USGS Cenozoic loc. M1597.
18. Height 4.4 mm, width 2.1 mm. USNM 650076. USGS Cenozoic loc. M1602.

19. *Epitonium (Gyroscala) barkerianum* Addicott, n. sp. (p. 55).
Height 4.9 mm, width 2.5 mm. USNM 650077. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

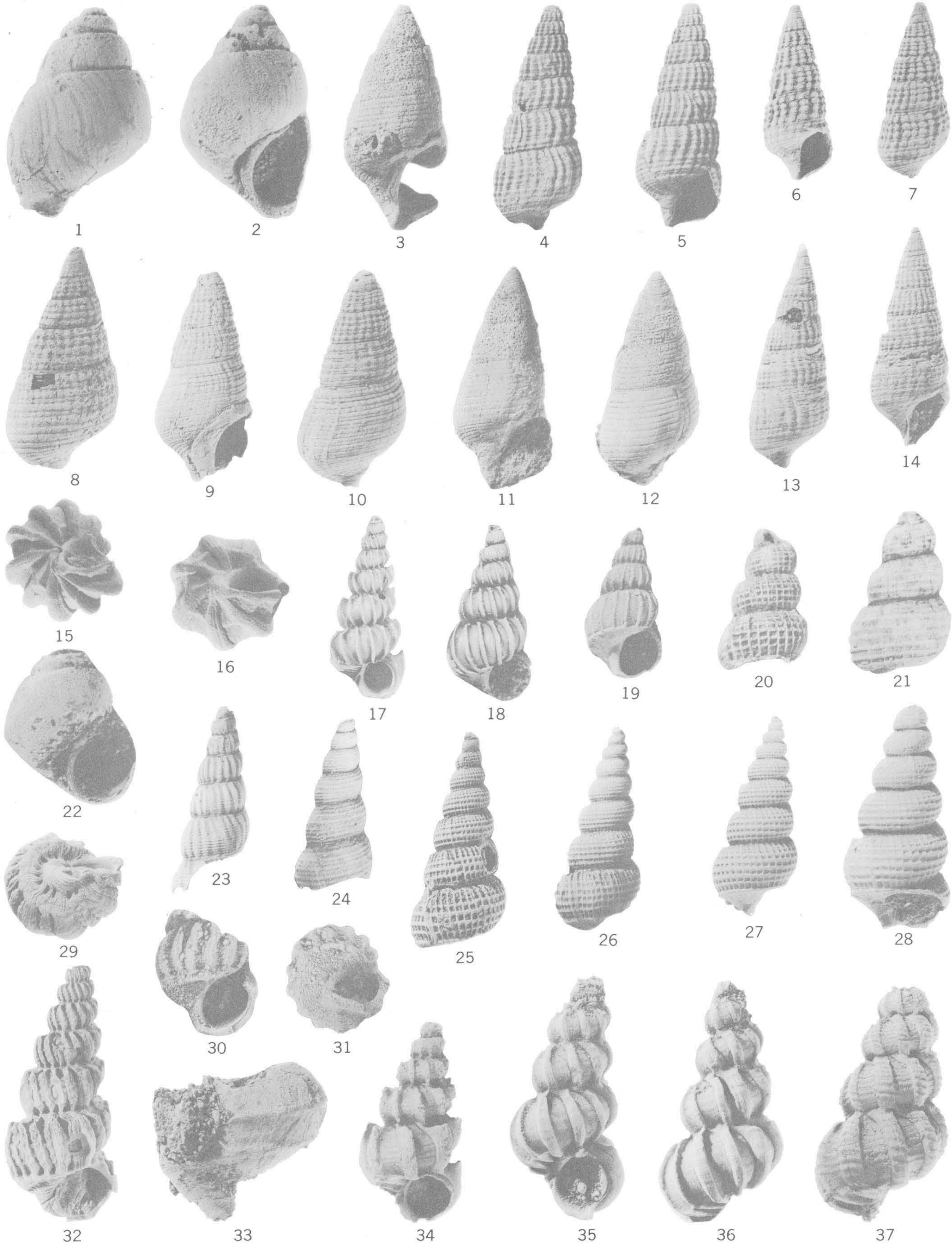
20, 25–28. *Scalina whitei* (Keen) (p. 57).
Lower part of the Round Mountain Silt, middle Miocene.
20. Immature specimen. Height 3 mm, width 1.7 mm. USNM 650078. USGS Cenozoic loc. M1613.
25. Height 13.3 mm, width 5.9 mm. UCMP 15430. UCMP loc. B1638.
26. Height 19 mm, width 7.8 mm. USNM 650079. USGS Cenozoic loc. M1613.
27. Height 14.6 mm, width 5.6 mm. USNM 650080. USGS Cenozoic loc. M1612.
28. Height 16.6 mm, width 7.9 mm. USNM 650081. USGS Cenozoic loc. M1612.

21, 24. *Scalina durhami* (Keen) (p. 56).
Lower part of the Round Mountain Silt, middle Miocene.
21. Immature specimen. Height 3.3 mm, width 1.7 mm. USNM 650082. USGS Cenozoic loc. M1613.
24. Height 8.6 mm, width 4.1 mm. USNM 650083. USGS Cenozoic loc. M1611.

23, 30, 31. *Opalia (Rugatiscala) williamsoni* (Anderson and Martin) (p. 56).
23. Height 12.4 mm, width 4.9 mm. UCMP 15447. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1599.
30, 31. Width 3.2 mm. UCMP 15448. Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1637.

29, 32. *Epitonium (Cirsotrema) posoense* Anderson and Martin (p. 55).
Height 24.5 mm, width 10.5 mm. UCLA 45764. Lower part of the Round Mountain Silt, middle Miocene. UCLA loc. AC–14–34.

33. *Trichotropis* sp. (p. 59).
Width 33.5 mm. USNM 650084. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1590.



LACUNA, *BATILLARIA*, *BITTIUM*, *EPITONIUM*, *SCALINA*, *OPALIA*, and *TRICHOTROPIS*

PLATE 4

FIGURES 1, 4, 18. *Calyptraea coreyi* Addicott, n. sp. (p. 60).
Basal part of the Jewett Sand, early Miocene.
1, 4. Holotype. Height 26 mm, width 37.5 mm. USNM 650085. USGS Cenozoic loc. M1591.
18. Paratype. Height 21 mm, width 34 mm. UCMP 15452. UCMP loc. B1665.

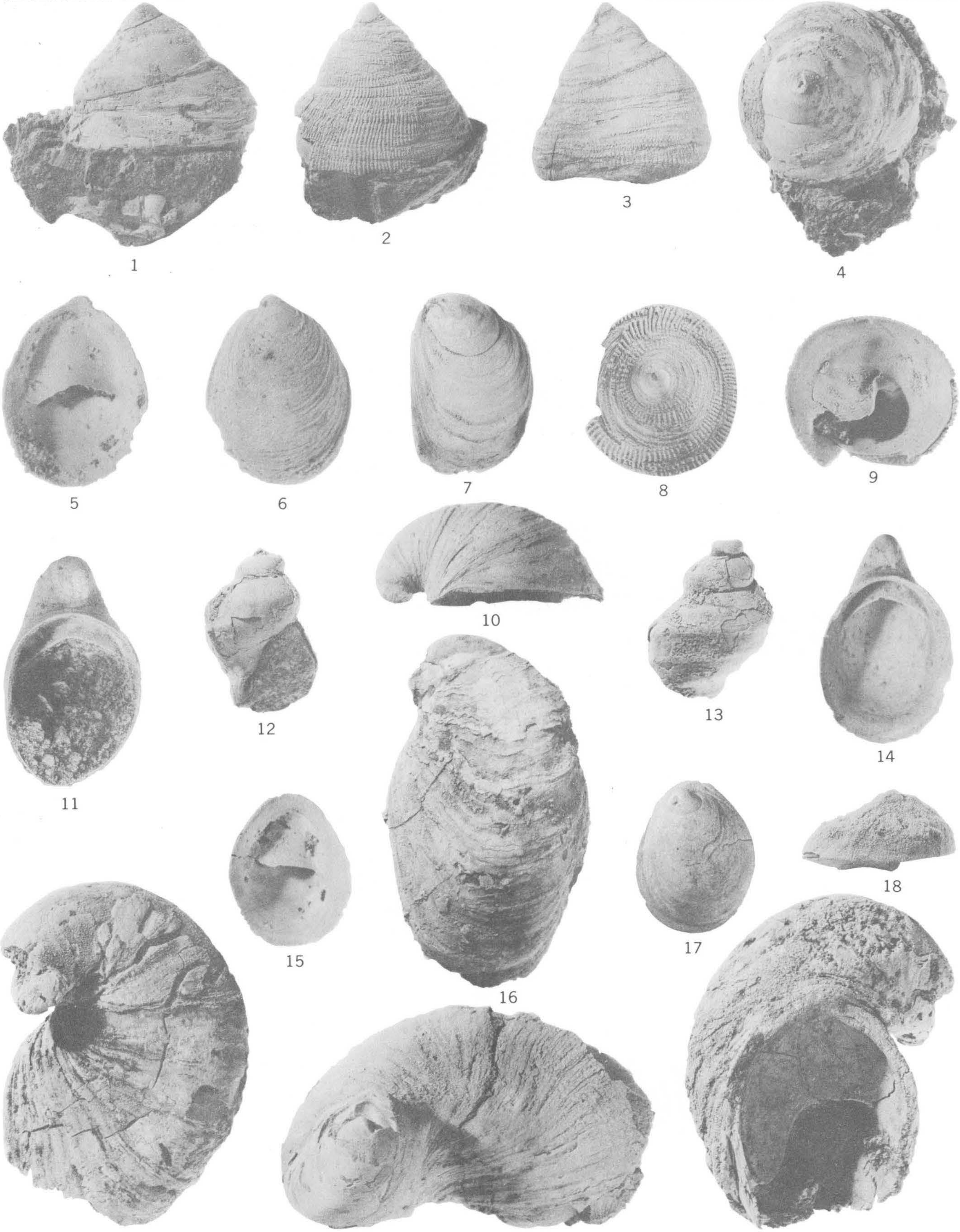
2, 3, 8, 9. *Calyptraea filosa* (Gabb) (p. 60).
Lower part of the Round Mountain Silt, middle Miocene.
2. Height 25 mm, width 22 mm. USNM 650086. USGS Cenozoic loc. M1604.
3. Height 21.9 mm, width 24.4 mm. USNM 650087. USGS loc. 6623.
8, 9. Height 12.6 mm, width 7 mm. UCMP 15453. UCMP loc. B1683.

5–7, 15, 17. *Crepidula bractea* Addicott, n. sp. (p. 62).
Upper part of the Olcese Sand, middle Miocene.
5, 6. Holotype. Length 5.9 mm, width 4.5 mm. USNM 650088. USGS Cenozoic loc. M1597.
7. Paratype. Length 17.7 mm, width 11.3 mm, height 2.3 mm. CAS 12931. CAS loc. 2064.
15, 17. Length 4.7 mm, width 3.7 mm, height 1 mm. UCMP 15455. UCMP loc. B1598.

10, 11, 14. *Crepidula rostralis* (Conrad) (p. 64).
10, 11. Length 28.5 mm, width 17 mm, height 12.8 mm. USNM 650089. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1600.
14. Immature specimen. Length 9.6 mm, width 6.2 mm, height 3.2 mm. USNM 650090. Upper part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1608.

12, 13. *Trichotropis tricarinata* Addicott, n. sp. (p. 59).
Height 31 mm, width 22.3 mm. USNM 650091. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1590.

16, 19–21. *Crepidula princeps* Conrad (p. 63).
Basal part of the Jewett Sand, early Miocene.
16. Length 66.5 mm, width 39 mm, height 26.5 mm. USNM 650092. USGS Cenozoic loc. M1591.
19, 21. Length 64 mm, width 52 mm, height 26.5 mm. USNM 650093. USGS Cenozoic loc. M1590.
20. Length 72 mm, width 55 mm, height 38 mm. USNM 650094. USGS Cenozoic loc. M1591.



CALYPTRAEA, *CREPIDULA*, and *TRICHOTROPIS*

PLATE 5

FIGURES 1, 2, 20. *Natica (Natica) teglandae* Hanna and Hertlein (p. 65).

1, 2. Height 19.2 mm, width 18.3 mm. USNM 650095. Round Mountain Silt, middle Miocene, USGS Cenozoic loc. M1608.

20. Height 16.1 mm, width 15.3 mm. UCMP 15456. Round Mountain Silt, middle Miocene. UCMP loc. B1618.

3, 4. *Natica (Naticarius?) posuncula* Hanna and Hertlein (p. 66).

Height 19.1 mm, width 18 mm. USNM 650096. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

5, 6, 8, 9, 13. *Crucibulum (Dispotaea) papulum* Addicott, n. sp. (p. 62).

Lower part of the Round Mountain Silt, middle Miocene.

5. Paratype. Height 13 mm, diameter 13.9 mm. USNM 650097. USGS loc. 6623.

6. Holotype. Height 9 mm, diameter 11.5 mm. USNM 650098. USGS loc. 6623.

8, 9, 13. Height 9.7 mm, diameter 10.5 mm. UCMP 15457. UCMP loc. B1638.

7. *Crepidula praerupta* Conrad (p. 64).

Height 19.5 mm, diameter 35 mm. USNM 650099. Astoria Formation, Montesano quadrangle, southwestern Washington. USGS Cenozoic loc. M1518.

10, 16. *Crepidula rostralis* (Conrad) (p. 64).

Upper part of the Olcese Sand, middle Miocene.

10. Height 11 mm, diameter 21.1 mm. UCMP 15458. UCMP loc. B1601.

16. Height 7.3 mm, diameter 12.7 mm. UCMP 15460. UCMP loc. B1598.

11, 12, 15. *Crucibulum* cf. *C. scutellatum* (Wood) (p. 62).

Height 19.8 mm, diameter 21.5 mm. UCMP 15463. Upper part of the Round Mountain Silt, middle Miocene. UCMP loc. B1588.

14. *Natica* sp. operculum. (p. 66).

Diameter 15.5 mm. USNM 950100. Round Mountain Silt, middle Miocene. USGS loc. 6065.

17, 18, 21. *Polinices victoriana* Clark and Arnold (p. 67).

Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

17. Height 20 mm, width 17.2 mm. USNM 650101.

18. Height 18 mm, width 27.5 mm. USNM 650102.

21. Height 23.4 mm, width 21 mm. USNM 650103.

19, 25. *Neverita (Glossaulax) alta* Arnold (p. 69).

Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

19. Height 16.3 mm, width 14.5 mm. USNM 650104.

25. Height 45.5 mm, width 41.5 mm. USNM 650105.

22–24. *Neverita (Glossaulax) andersoni* (Clark) (p. 67).

Upper part of the Olcese Sand, middle Miocene.

22. Height 38.5 mm, width 42 mm. UCMP 36557. UCMP loc. B1593.

23. Height 19 mm, width 20.9 mm. UCMP 15466. UCMP loc. B1598.

24. Height 25 mm, width 28 mm. USNM 650106. USGS Cenozoic loc. M1597.

NATICA, *CRUCIBULUM*, *CREPIDULA*, *POLINICES*, and *NEVERITA*

PLATE 6

FIGURES 1, 9. *Neverita (Glossaulax)* n. sp.? (p. 70).
Lower part of the Round Mountain Silt, middle Miocene.
1. Height 30.5 mm, width 26.5 mm. USNM 650107. USGS loc. 6622.
9. Height 18.8 mm, width 16.2 mm. UCMP 15492. UCMP loc. B1638.

2–4. *Mediargo mathewsoni* (Gabb) (p. 72).
Basal part of the Jewett Sand, early Miocene.
2. Height 49 mm, width 33.5 mm. USNM 650108. USGS Cenozoic loc. M1591.
3, 4. Height 30 mm, width 21.7 mm. UCMP 15497. UCMP loc. B1665.

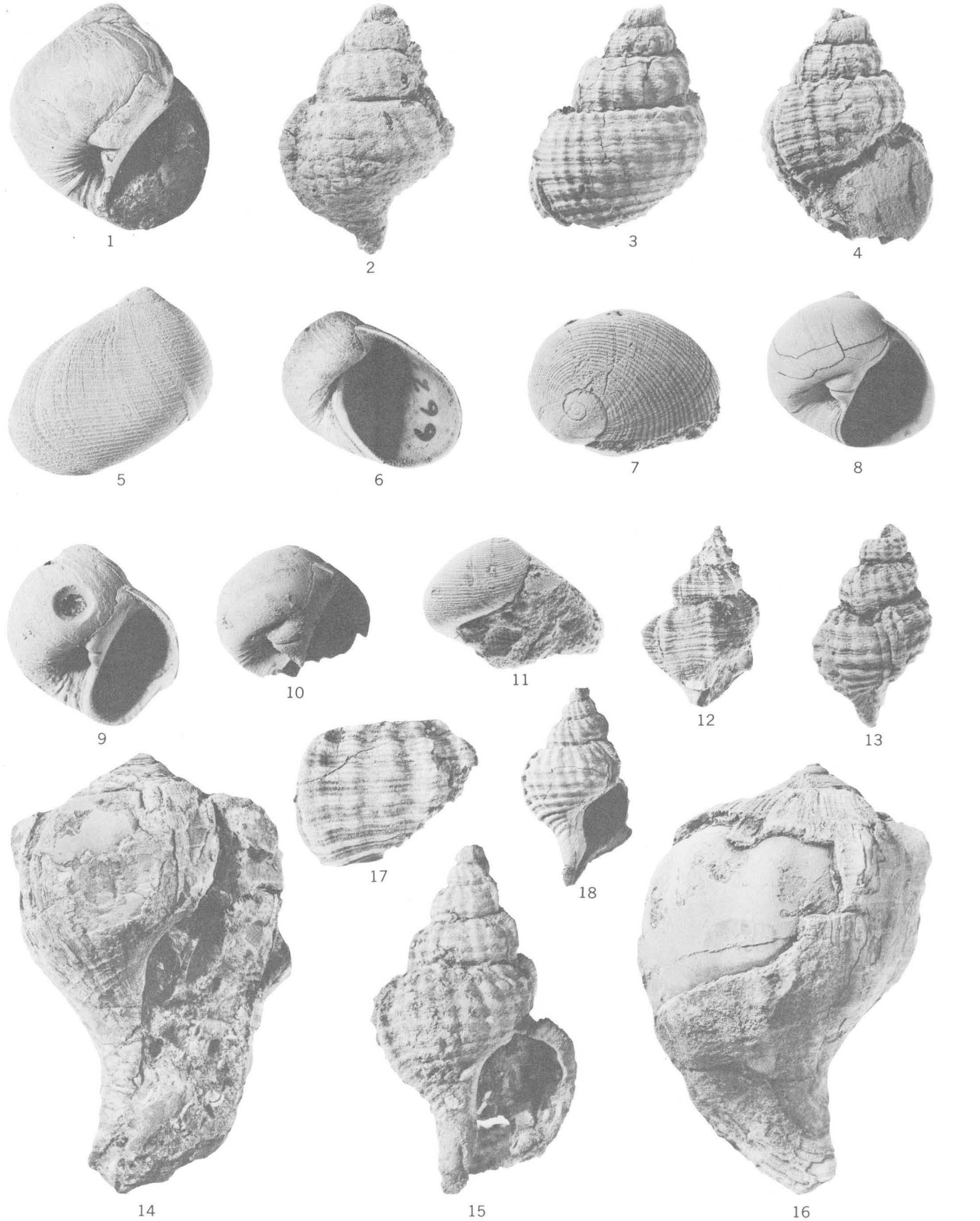
13, 15, 17, 18. *Mediargo dilleri* (Anderson and Martin) (p. 72).
13, 15, 17, 18. Upper part of the Olcese Sand, middle Miocene.
13. Height 15.6 mm, width 9.1 mm. USNM 650109. USGS Cenozoic loc. M1602.
15. Height 67.5 mm, width 40 mm. LACMIP 1157. LACMIP loc. 463.
17. Diameter of fragment 26 mm. UCMP 37113. UCMP loc. B1622.
18. Height 39.5 mm, width 22 mm. CAS 12942. CAS loc. 65.

5–7, 11. *Sinum scopulosum* Conrad (p. 70).
5, 6. Round Mountain Silt, middle Miocene.
5. Height 18.3 mm, width 18.9 mm. USNM 650110. USGS loc 6622.
6. Height 12.2 mm, width 13 mm. USNM 650111. USGS loc 6623.
7, 11. Height 9.9 mm, width 11.8 mm. USNM 650112. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1602.

8, 10. *Neverita (Glossaulax) jamesae* Moore (p. 70).
8. Height 22.7 mm, width 20.6 mm. UCMP 15498. Round Mountain Silt, middle Miocene. UCMP loc. 2713.
10. Height 20.4 mm, width 16.5 mm. UCMP 15500. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1624.

12. *Cymatium* n. sp. (p. 72).
Height 37 mm, width 25.5 mm. CAS 12932. Upper part of the Olcese Sand, middle Miocene. CAS loc. 2064.

14, 16. *Ficus (Trophosycon) kerniana* (Cooper) (p. 73).
Height 86 mm, width 55 mm. UCMP 15543. Basal part of the Jewett Sand, early Miocene. UCMP loc. B1660.



NEVERITA, *MEDIARGO*, *SINUM*, *CYMATIUM*, and *FICUS*

PLATE 7

FIGURES 1, 2. *Ocenebra gabbiana* (Anderson) (p. 79).
Height 53 mm, width 37.5 mm. USNM 650113. Upper part of the Olcese Sand, middle Miocene. USGS loc. 6624.

3–5, 8, 14, 17. *Ficus (Trophosycon) kerniana* (Cooper) (p. 73).
3, 8, 14, 17. Upper part of the Olcese Sand, middle Miocene.
3. Height 45.5 mm, width 34.5 mm. UCMP 15546. UCMP loc. B1598.
8. Height 35.5 mm, width 24.3 mm. USNM 650115. USGS Cenozoic loc. M1601.
14. Height 35.5 mm, width 26.5 mm. UCMP 15919. UCMP loc. B1597.
17. Height 57.5 mm, width 44 mm. UCMP 15988. UCMP loc. B1600.
4. Height 43.5 mm, width 37 mm. UCMP 30121. Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1638.
5. Height 29 mm, width 21.5 mm. USNM 650116. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.

6, 7, 10. *Forreria cancellaroides* Arnold (p. 77).
6, 7. Height 25.5 mm, width 16.2 mm. USNM 650114. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
10. Height 32 mm, width 27.5 mm, slightly crushed. UCMP 15544. Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1612.

9, 12, 13, 16. *Forreria emersoni* Addicott, n. sp. (p. 78).
Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.
9. Height 23.5 mm, width 15.7 mm. USNM 650117.
12, 13. Holotype. Height 29 mm, width 22.2 mm. USNM 650118.
16. Height 25 mm, width 15 mm. USNM 650119.

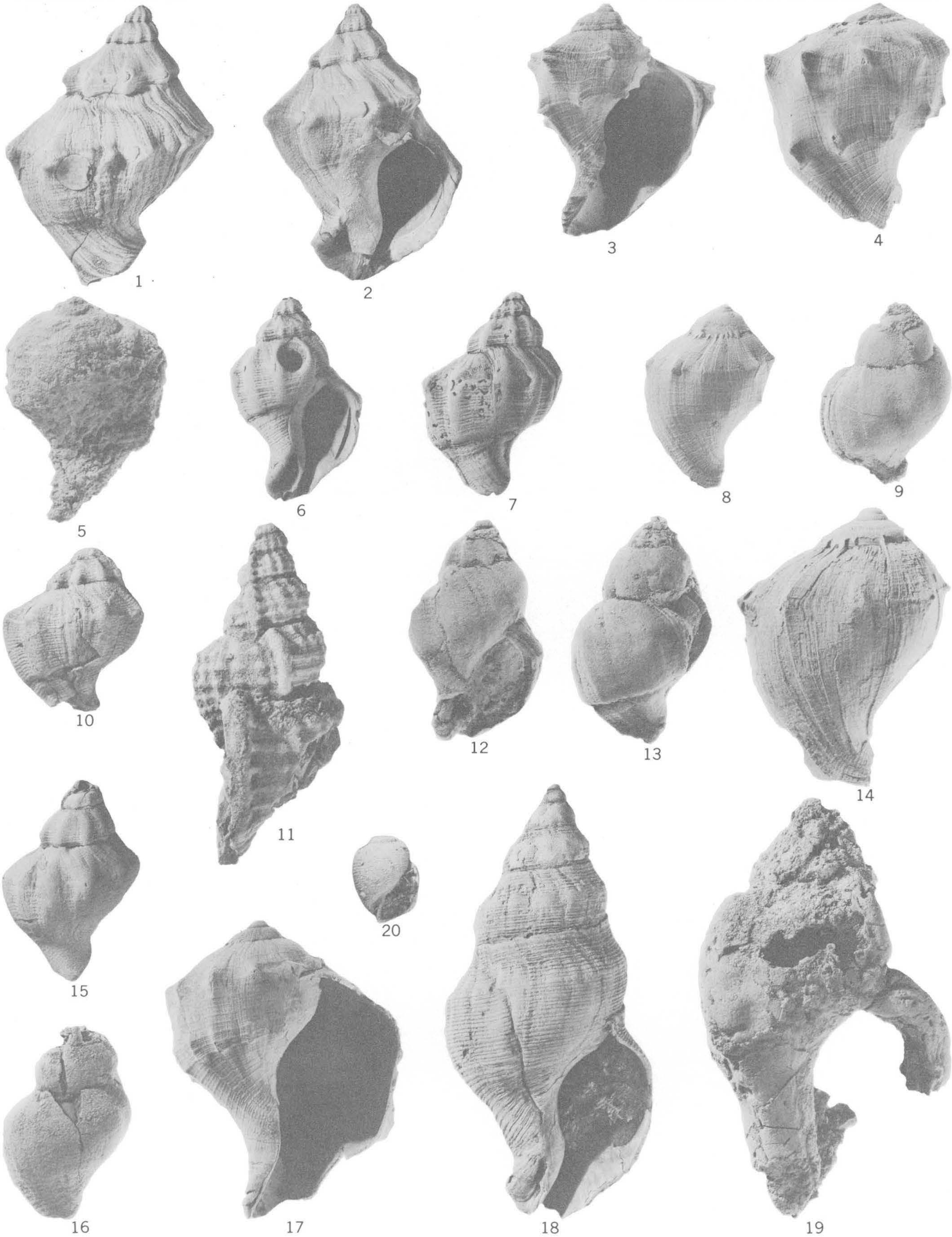
11. *Mediargo dilleri* (Anderson and Martin) (p. 72).
Height 67.5 mm, width 40 mm. LACMIP 1157. Upper part of the Olcese Sand, middle Miocene. LACMIP loc. 463.

15. *Ocenebra wilkesana* (Anderson) (p. 78).
Height 38.5 mm, width 25.5 mm. UCMP 30122. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1599.

18. *Calicantharus kernensis* (Anderson and Martin) (p. 92).
Height 84 mm, width 39 mm. LACMIP 1158. Upper part of the Olcese Sand, middle Miocene. LACMIP loc 463.

19. *Ceratostoma*? aff. *C. perponderosum* (Dall) (p. 76).
Height 83 mm, width 47 mm. USNM 650120. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.

20. *Bullina* sp. (p. 137).
Height 1.7 mm, width 1.2 mm. USNM 650336. Lower part of the Round Mountain Silt. USGS Cenozoic loc. M1612.



OCENEBRA, FICUS, FORRERIA, MEDIARGO, CALICANTHARUS, CERATOSTOMA, and *BULLINA*

PLATE 8

FIGURES 1, 2. *Ocenebra* cf. *O. wilkesana* (Anderson) (p. 78).
Height 22.7 mm, width 14.5 mm. USNM 650121. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.

3. *Ocenebra topangensis* Arnold (p. 81).
Height 21.1 mm, width 15.7 mm. USNM 650122. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.

4, 5, 9, 10. *Ocenebra trophonoides* (Anderson and Martin) (p. 79).
Upper part of the Olcese Sand, middle Miocene.
4, 5. Height 27mm, width 18.5 mm. UCMP 15992. UCMP loc. B1621.
9, 10. Height 24.3 mm, width 14.4 mm. UCMP 15993. UCMP loc. B1599.

6–8. *Ocenebra clarki* Addicott, n. sp. (p. 80).
Upper part of the Olcese Sand, middle Miocene.
6, 7. Holotype. Height 29.5 mm, width 15 mm. UCLA 45765. UCLA loc. AC 8–34.
8. Height 25.5 mm, width 13.6 mm. UCMP 30822. UCMP loc. B1599.

11. *Ocenebra wilkesana* (Anderson) (p. 78).
Height 29 mm, width 26.5 mm. USNM 650123. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1599.

12, 13, 22–27. *Trophon (Austrotrophon) kernensis* Anderson (p. 81).
12, 13, 22, 24, 25. Upper part of the Olcese Sand, middle Miocene.
12, 13. Height 25 mm, width 17 mm. USNM 650124. USGS Cenozoic loc. M1599.
22. Height 27.5 mm, width 20.7 mm. USNM 650125. USGS Cenozoic loc. M1597.
24, 25. Height 55.5 mm, width 43 mm. UCMP 36561. UCMP loc. B1600.
23, 26, 27. Lower part of the Round Mountain Silt, middle Miocene.
23. Height 28.5 mm, width 22.3 mm. UCMP 30823. UCMP loc. B1619.
26, 27. Height 57.5 mm, width 41 mm. USNM 650126. USGS loc. 6621.

14–16. *Trophon (Austrotrophon) kernensis medialis* Addicott, n. subsp. (83).
Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.
14, 15. Holotype. Height 23.5 mm, width 15.7 mm. USNM 650127.
16. Height 32.5 mm, width 23.5 mm. USNM 650128.

17. *Typhis (Talityphis) lampada* Keen (p. 83).
Height 22.4 mm, width 18.1 mm. USNM 650129. Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1613.

18, 19. *Ocenebra milicentana* (Loel and Corey) (p. 80).
Height 23.7 mm, width 15.1 mm. USNM 650130. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.

20, 21. *Ocenebra* sp. (p. 81).
Height 27.5 mm, width 23.4 mm. CAS 12933. Basal part of the Jewett Sand, early Miocene. CAS loc. 37468.

OCENEBRA, *TROPHON*, and *TYPHIS*

PLATE 9

FIGURES 1–4, 19. *Thais (Nucella) packi* Clark (p. 84).

Basal part of the Jewett Sand, early Miocene.

1. Height 24.2 mm, width 15.5 mm. USNM 649167. USGS Cenozoic loc. M1591.
2, 3. Height 17.8 mm, width 13.6 mm. UCMP 32127. UCMP loc. B1665.
4. Height 19.7 mm, width 15.1 mm. USNM 650131. USGS Cenozoic loc. M1591.
19. Height 13.7 mm, width 11.9 mm. USNM 650132. USGS Cenozoic loc. M1591.

5, 18. *Typhis (Talityphis) lampada* Keen (p. 83).

Lower part of the Round Mountain Silt, middle Miocene.

5. Height 27 mm, width 20.7 mm. UCLA 45766. UCLA loc. AC–13–34.
18. Height 22.4 mm, width 18.1 mm. USNM 650133. USGS Cenozoic loc. M1613.

6, 7. *Thais (Thaisella) blakei* (Anderson and Martin) (p. 85).

Height 20.5 mm, width 11.2 mm. CAS 12934. Upper part of the Olcese Sand, middle Miocene. CAS loc. 65.

8, 16, 17. *Mitrella (Columbellopsis) alta* Addicott, n. sp. (p. 87).

Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

8. Height 6.1 mm, width 2.4 mm. USNM 650134.
16, 17. Holotype. Height 5.3 mm, width 2.2 mm. USNM 650135.

9, 10, 21, 22. *Mitrella anchuela* Keen (p. 87).

Lower part of the Round Mountain Silt, middle Miocene.

9. Height 6.8 mm, width 3.4 mm. USNM 650136. USGS Cenozoic loc. M2601.
10. Height 6.5 mm, width 3.3 mm. USNM 650137. USGS loc. 6623.
21. Height 5.1 mm, width 2.8 mm. UCMP 32255. UCMP loc. B1638.
22. Height 4.7 mm, width 2.5 mm. USNM 650138. USGS Cenozoic loc. M1612.

11, 12. *Anachis (Costoanachis) watsonae* Keen (p. 86).

Lower part of the Round Mountain Silt, middle Miocene.

11. Height 11.4 mm, width 5.4 mm. USNM 650139. USGS loc. 6065.
12. Height 12.1 mm, width 5.7 mm. USNM 650140. USGS Cenozoic loc. M1612.

13, 23–25, 27, 28. *Bruclarkia barkeriana* (Cooper) (p. 88).

13. Height 7.4 mm, width 3.9 mm, an immature specimen. UCMP 32774. Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1638.

23–25, 27, 28. Upper part of the Olcese Sand, middle Miocene.

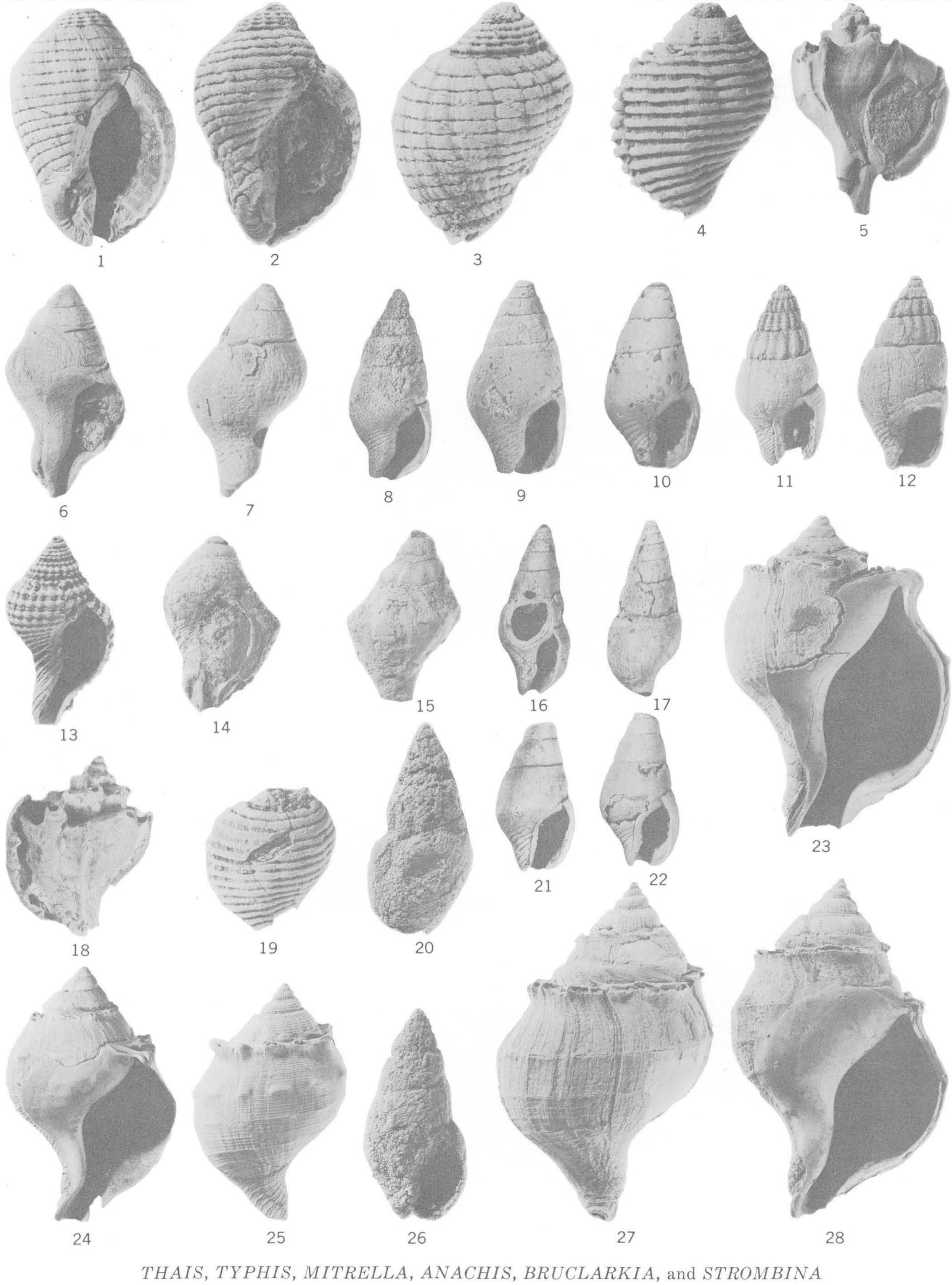
23. Height 62.5 mm, width 43 mm. UCMP 32775. UCMP loc. B1587.
24. Height 48.5 mm, width 30.5 mm. USNM 166584. USGS loc. 6890.
25. Height 46 mm, width 29 mm. UCMP 32776. UCMP loc. B1598.
27, 28. Height 66.5 mm, width 42 mm. UCMP 36555. UCMP loc. B1600.

14, 15. *Thais (Thaisella) edmondi* (Arnold) (p. 85).

14. Weakly noded form. Height 23 mm, width 15.3 mm. USNM 650141. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1601.
15. Height 16.4 mm, width 10.3 mm. UCLA 45767. Lower part of the Round Mountain Silt, middle Miocene. UCLA loc. AC–13–34.

20, 26. *Strombina* sp. (p. 86).

Height 13.4 mm, width 6.5 mm. USNM 650142. Upper part of the Round Mountain silt, middle Miocene USGS Cenozoic loc. M1605.



THAIS, TYPHIS, MITRELLA, ANACHIS, BRUCLARKIA, and *STROMBINA*

PLATE 10

FIGURES 1, 2, 5, 9. *Bruclarkia barkeriana* forma *santacruzana* (Arnold) (p. 88)
Upper part of the Olcese Sand, middle Miocene.
1, 2. Height 35 mm, width 21.3 mm. UCMP 32806. UCMP loc. B1603.
5. Body whorl slightly crushed. Height 46 mm, width 28.5 mm. UCMP 36556. UCMP loc. B1598.
9. Height 42 mm, width 24.2 mm. USNM 650143. USGS Cenozoic loc. M1597.

3, 7, 10. *Bruclarkia barkeriana* (Cooper) (p. 88).
Weakly sculptured form.
3, 7. Height 46 mm, width 33 mm. UCMP 32807. Lower part of the Olcese Sand, middle Miocene. UCMP loc. B1646.
10. Height 38.5 mm, width 27.5 mm. USNM 650144. Lower part of the Saltos Shale Member of the Monterey Shale, middle Miocene, Caliente Range, San Luis Obispo County. USGS Cenozoic loc. M2898.

4, 14–16. *Bruclarkia oregonensis* (Conrad) (p. 90).
4. Height 43 mm, width 27 mm. UCMP 32832. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1593.
14. Height 34.5 mm, width 22 mm. USNM 650145, a rubber mold. Lower part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1593.
15, 16. Unnamed middle Miocene formation, Coos Bay, Oreg. USGS loc. 18284.
15. Height 31 mm, width 24.5 mm. USNM 650147.
16. Height 31 mm, width 21.9 mm. USNM 650148.

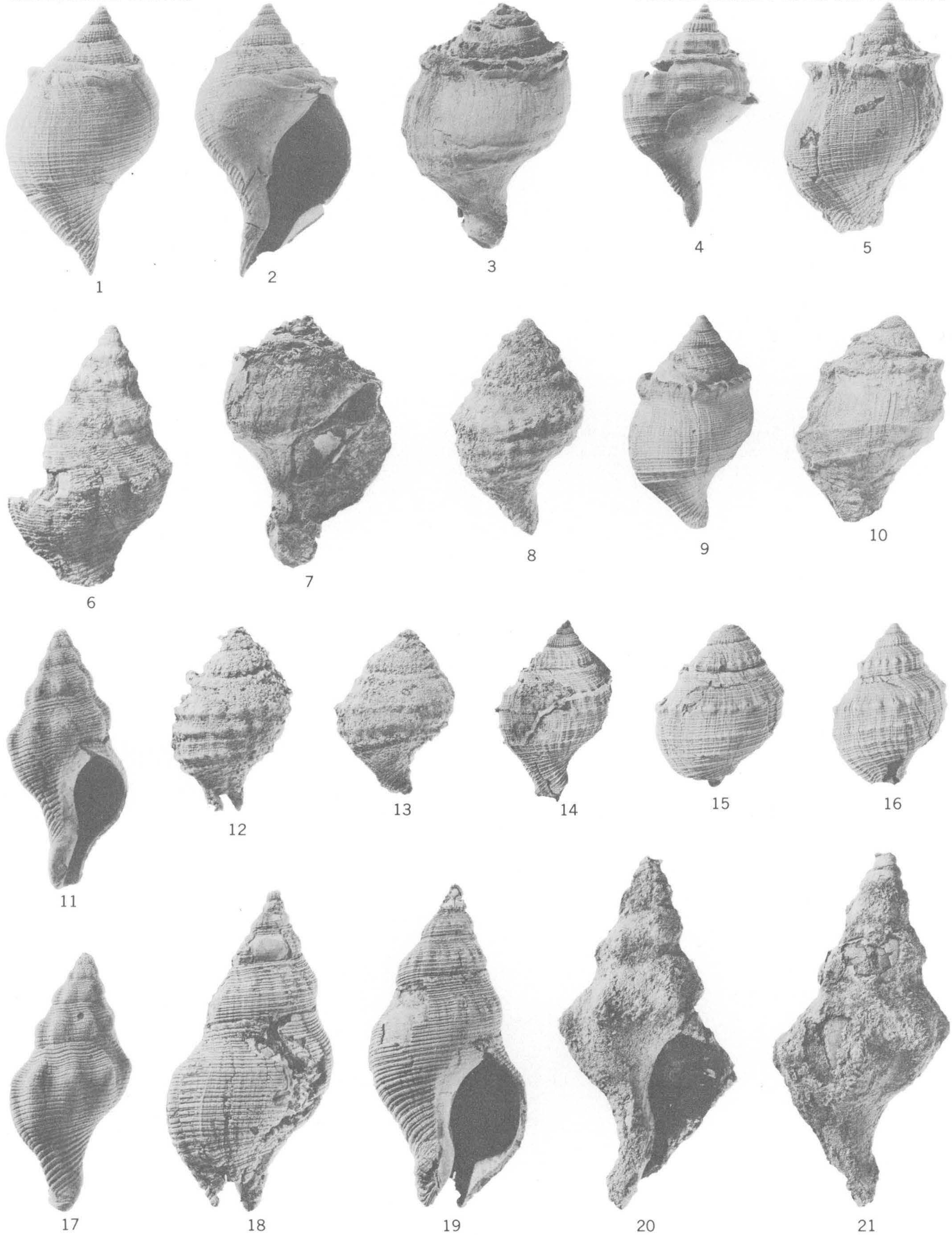
6. *Calicantharus woodfordi* Addicott, n. sp. (p. 93).
Paratype. Height 51 mm, width 28.5 mm. USNM 650146. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

8, 12, 13. *Bruclarkia yaquinana* (Anderson and Martin) (p. 90).
Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.
8. Height 32.5 mm width 27 mm. USNM 650149.
12. Height 35.5 mm width 23.5 mm. USNM 650150.
13. Height 31.5 mm width 23.4 mm. USNM 650151.

11, 17. *Kelletia lorata* Addicott n. sp. (p. 91).
Holotype. Height 33.5 mm width 15 mm. UCMP 32834. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1598.

18, 19. *Calicantharus kernensis* (Anderson and Martin) (p. 92).
Height 63 mm, width 30.5 mm. UCMP 32839. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1623.

20, 21. *Kelletia posoensis* (Anderson and Martin) (p. 92).
Height 68 mm, width 35 mm. USNM 650152. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.



BRUCLARKIA, *CALICANTHARUS*, and *KELLETIA*

PLATE 11

FIGURES 1–4. *Molopophorus anglonanus* (Anderson) (p. 95).
Upper part of the Olcese Sand, middle Miocene.
1. Height 33 mm, width 21 mm. UCMP 36562. UCMP loc. B1598.
2, 3. Height 22.7 mm, width 14.5 mm. UCMP 32851. UCMP loc. B1598.
4. Height 21.3 mm. width 13.7 mm. USNM 650153. USGS Cenozoic loc. M1597.

5, 20, 21. *Calicantharus rancherianus* Addicott, n. sp. (p. 93).
Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.
5. Height 27 mm, width 14.7 mm. USNM 650154.
20. Height 25.5 mm, width 13.1 mm, USNM 650155.
21. Holotype. Height 22.5 mm, width 11.4 mm. USNM 650156.

6, 8–11, 13, 28. *Antillophos posunculensis* (Anderson and Martin) (p. 96).
6. Height 23.3 mm, width 10.9 mm. USNM 650157. Astoria Formation, middle Miocene, Grays Harbor County, Wash. USGS Cenozoic loc. M1495.
8, 11. Upper part of the Olcese Sand, middle Miocene.
8. Height 18.4 mm, width 8 mm. UCMP 32852. UCMP loc. B1598.
11. Height 12 mm, width 5.6 mm. USNM 650158. USGS Cenozoic loc. M1597.
9, 10, 13, 28. Lower part of the Round Mountain Silt, middle Miocene.
9, 10. Height 19.6 mm, width 8 mm. USNM 650159. USGS Cenozoic loc. M1604.
13. Height 6.9 mm, width 3.4 mm. UCMP 33014. UCMP loc. B1637.
28. Height 27.5 mm, width 11.7 mm. USNM 650163. USGS Cenozoic loc. M1613.

7, 12, 14, 19, 22. *Antillophos woodringi* Addicott, n. sp. (p. 98).
Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
7. Height 16 mm, width 8 mm. USNM 650164.
12, 19. Holotype. Height 11.6 mm, width 5.5 mm. USNM 650165.
14. Height 4.3 mm, width 2.4 mm. USNM 650166.
22. Height 5.5 mm, width 2.7 mm. USNM 650167.

15, 16. *Morula (Morunella) granti* Addicott, n. sp. (p. 86).
Holotype. Height 10.5 mm, width 4.9 mm. USNM 650160. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

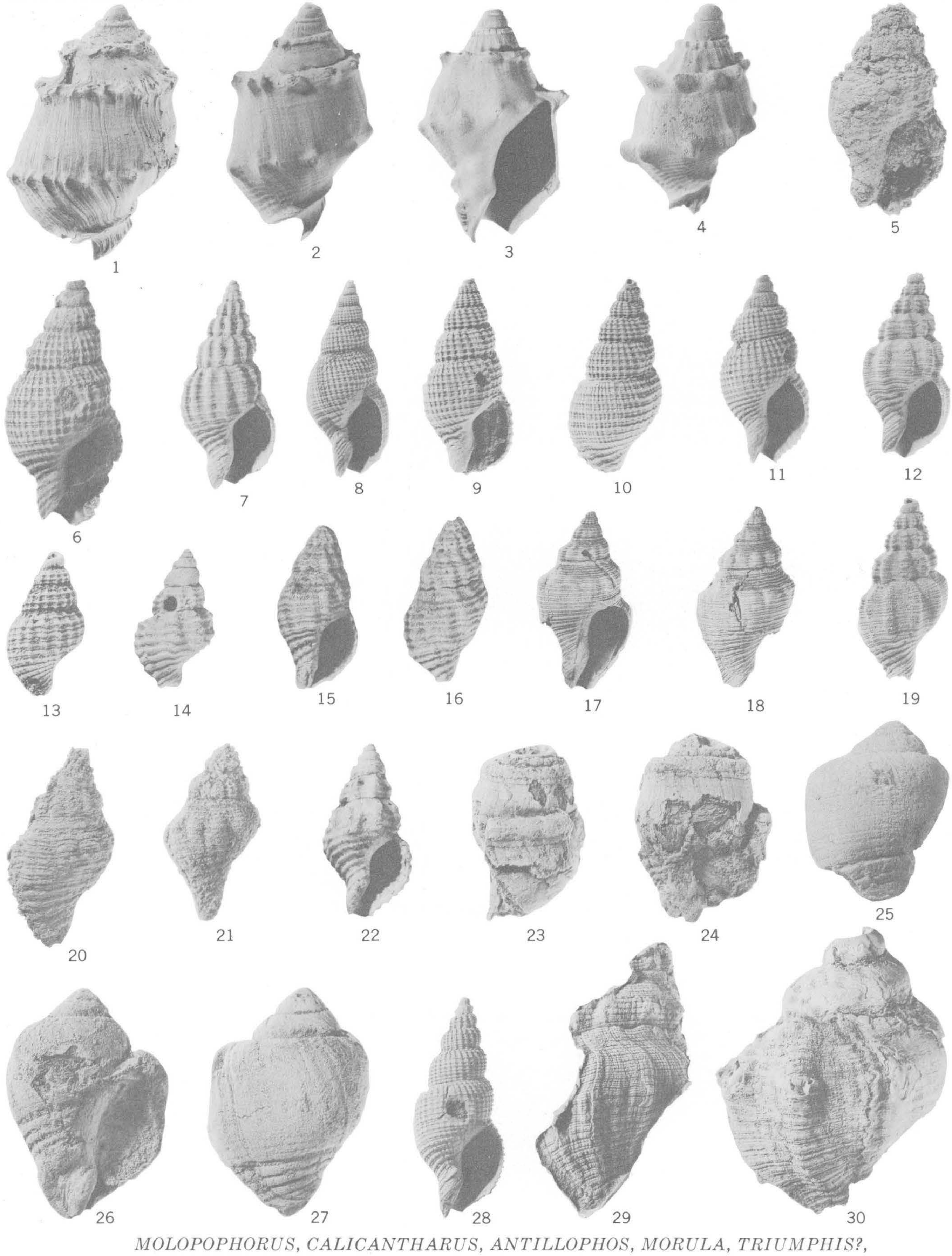
17, 18. *Calicantharus woodfordi* Addicott, n. sp. (p. 93).
Holotype. Height 35.5 mm, width 18.3 mm. USNM 650161. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

23, 24. *Triumphis*? n. sp. (p. 95).
Height 18 mm, width 13.3 mm. UCLA 45768. Lower part of the Olcese Sand, middle Miocene. UCLA loc. MB1400.

25–27. *Macron aethiops* (Reeve) (p. 94).
Lower part of the Olcese Sand, middle Miocene.
25. Height 23.7 mm, width 18.9 mm. SUPTC 9940. SU general specimen 26854.
26, 27. Height 21.8 mm, width 15 mm. UCLA 45769. UCLA loc. MB1400.

29. *Kelletia* cf. *K. posoensis* (Anderson and Martin) (p. 92).
Height 52.5 mm, width 30 mm. UCLA 45770, a rubber cast. Lower part of the Jewett Sand, early Miocene. UCLA loc. WR163.

30. *Calicantharus* cf. *C. kettlemanensis* (Arnold) (p. 94).
Height 58.5 mm, width 46 mm. USNM 650162. Lower part of the Round Mountain Silt, middle Miocene. USGS loc. 6063.



MOLOPOPHORUS, *CALICANTHARUS*, *ANTILLOPHOS*, *MORULA*, *TRIUMPHIS?*, *MACRON*, and *KELLETIA*

PLATE 12

FIGURE 1. *Nassarius* (*Phrontis?*) *posoensis* Addicott, n. sp. (p. 101).
Holotype. Height 10.5 mm, width 7 mm. USNM 650168, a rubber cast. Lower part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1593.

2. *Nassarius* (*Phrontis*) cf. *N.* (*P.*) *smooti* Addicott (p. 100).
Height 13.5 mm, width 8.5 mm. USNM 650169, a rubber cast. Round Mountain Silt, middle Miocene.

3, 4, 7, 12–15. *Nassarius* (*Catilon*) *arnoldi* (Anderson) (p. 98).
3, 4, 13, 14, Lower part of the Round Mountain Silt, middle Miocene.
3, 4. Height 7 mm, width 4.5 mm. USNM 648575. USGS Cenozoic loc. M1604.
13. High spired form. Height 7.5 mm, width 4.2 mm. USNM 650170. USGS Cenozoic loc. M1608.
14. Height 10.2 mm, width 6.1 mm. USNM 650171. USGS loc. 3886.
7, 12, 15. Upper part of the Olcese Sand, middle Miocene.
7. Height 6.9 mm, width 4.3 mm. USNM 650172. USGS Cenozoic loc. M1597.
12. Neotype. Height 7.2 mm, width 4.6 mm. USNM 648577. USGS Cenozoic loc. M1597.
15. Height 7 mm, width 4.5 mm. UCMP 33016. UCMP loc. B1598.

5, 6. *Nassarius* (*Phrontis*) *harrellensis* Addicott, n. sp. (p. 100).
Holotype. Height 11.8 mm, width 6.7 mm. USNM 650173. Lower part of the Round Mountain Silt, middle Miocene. USGS loc. 3886.

8–11. *Nassarius* (*Phrontis*) *smooti* Addicott (p. 100).
Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
8, 9. Holotype. Height 7.3 mm, width 4.2 mm. USNM 648578.
10. Height 8.9 mm, width 5.3 mm. USNM 648579.
11. Height 5.8, width 4.3. USNM 650174.

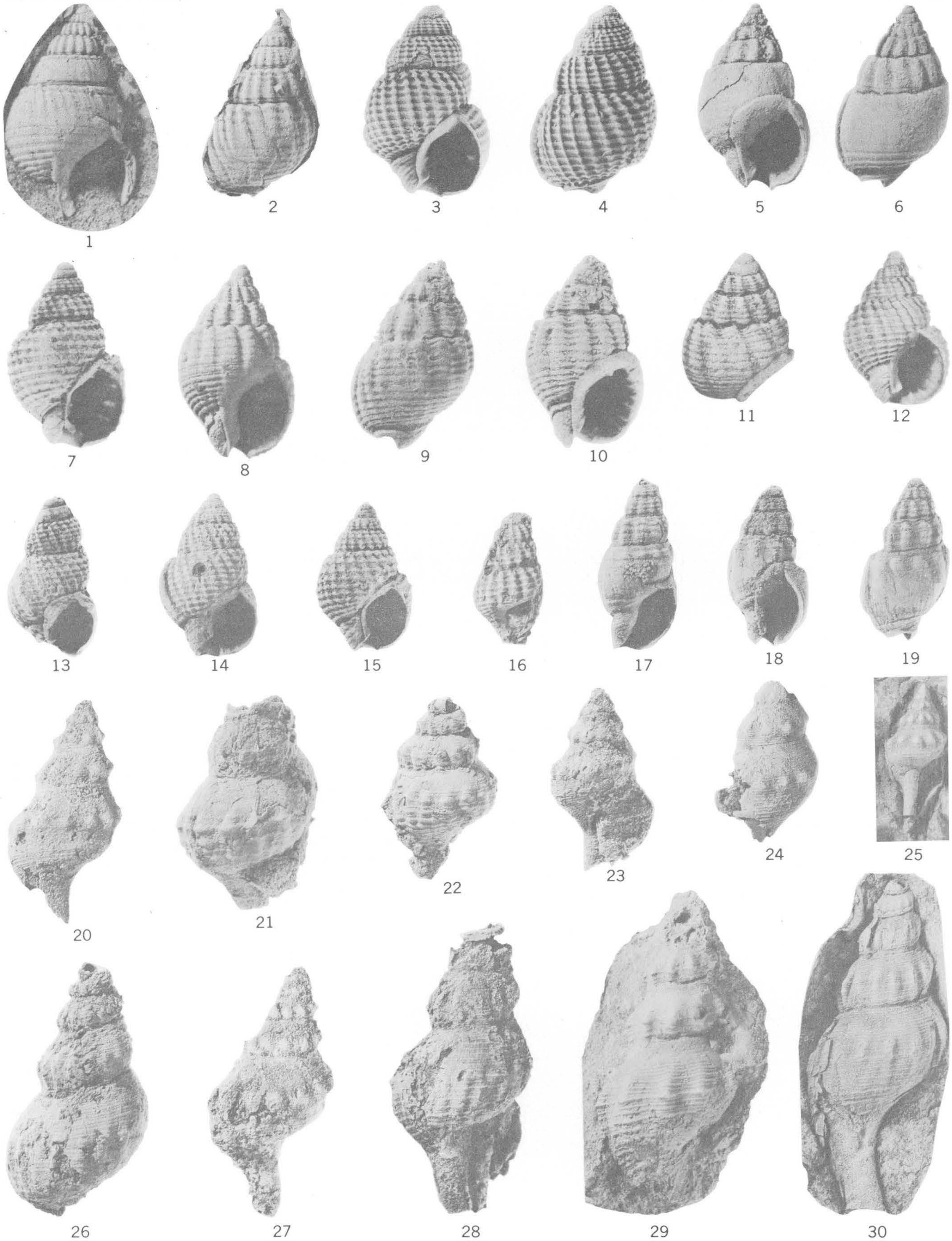
16. Undetermined gastropod.
Height 8.5 mm, width 4.5 mm. UCR 1199. Olcese Sand of Matthews (1955), middle Miocene. Mobil Oil Co. [General Petroleum] well "Seale" 5–10, sec. 5, T. 30 S., R. 29 E., 3,891 ft. UCR loc. 1199.

17–19. *Nassarius* (*Phrontis*) *ocoyanus* (Anderson and Martin) (p. 100).
Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1637.
17. Height 10.5 mm, width 4.9 mm. UCMP 15082.
18, 19. Height 10.2 mm, width 5 mm. UCMP 15081.

20, 23–25, 27. *Priscofusus medialis* (Conrad) (p. 102).
20, 23, 24, 27. Basal part of the Jewett Sand, early Miocene.
20. Height 42 mm, width 20.1 mm. USNM 650175. USGS Cenozoic loc. M1591.
23. Height 35.5 mm, width 20.8 mm. UCMP 33017. UCMP loc. B1665.
24. Height 21.4 mm, width 12.6 mm. USNM 650176. USGS Cenozoic loc. M1590.
27. Height 48.5 mm, width 24.2 mm, slightly crushed. USNM 650177. USGS Cenozoic loc. M1591.
25. Height 24.2 mm, width 11.9 mm. UCR 1306. Freeman-Jewett Silt of Matthews (1955), Shell Oil Co. well "Edison" 2–1, 4,385 ft. UCR loc. 1306.

21, 22, 29. *Priscofusus geniculus* (Conrad) (p. 101).
21, 22. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M. 1591.
21. Height 42.5 mm, width 30.5 mm, slightly crushed. USNM 650178.
22. Height 36.5 mm, width 24.5 mm, slightly crushed. USNM 650179.
29. Height 18 mm, width 9 mm. USNM 3552. Astoria Formation, middle Miocene. Astoria, Oreg.

26, 28, 30. *Priscofusus geniculus* (Conrad) axial ribbed form (p. 101).
26, 28. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.
26. Height 49.5 mm, width 28 mm, slightly crushed. USNM 650180.
28. Height 55 mm, width 30 mm, slightly crushed. USNM 650181.
30. Height 42 mm. USNM 3517, a rubber cast. Astoria Formation, middle Miocene. Astoria,. Oreg.



NASSARIUS and *PRISCOFUSUS*

PLATE 13

FIGURES 1–5, 10. *Cancellaria* (*Euclia*) *condoni* Anderson (p. 107).

1, 2. Height 15.1 mm, width 9.5 mm. UCMP 33019. Lower part of the Round Mountain Silt, middle Miocene UCMP loc. B1618.

3–5, 10. Upper part of the Olcese Sand, middle Miocene.

3, 4. Height 20.9 mm, width 12.2 mm. USNM 650182. USGS Cenozoic loc. M1597.

5, 10. Height 42.5 mm, width 26 mm. UCMP 33349. UCMP loc. B1600.

7, 9, 12, 14. *Cancellaria* (*Euclia*) *dalliana* Anderson (p. 108).

Upper part of the Olcese Sand, middle Miocene.

7. Height 26 mm. width 24.6 mm. UCMP 36558. UCMP loc. B1598.

9, 12. Height 40 mm, width 27 mm. UCMP 33375. UCMP loc. B1587.

14. Height 15.6 mm, width 9.7 mm. UCMP 33476. UCMP loc. B1598.

6, 8. *Psephaea* (*Miopleiona*) cf. *P.* (*M.*) *indurata* (Conrad) (p. 105).

6. Height 52 mm, width 20.5 mm. UCMP 12136, a rubber cast. Monterey Group of Wagner and Schilling (1923), early Miocene. UCMP loc. 3229.

8. Height 37.5 mm, width 29 mm. UCR 1305, a rubber cast. Freeman-Jewett Silt of Matthews (1955), early Miocene. Shell Oil Co. "Edison" 2–1, sec. 33, T. 29 S., R. 29 E., 4,657 ft. UCR loc. 1305.

11, 13, 16, 18. *Mitra* (*Atrimitra*) *andersoni* Addicott, n. sp. (p. 103).

11, 13. Holotype. Height 49 mm, width 19 mm. USNM 650183. Lower part of the Round Mountain Silt, Middle Miocene. USGS loc. 6641.

16, 18. Height 39.5 mm, width 22.2 mm. UCMP 33479. Upper part of the Olcese (?) Sand, middle Miocene. UCMP loc. 2714.

15, 17. *Psephaea* (*Miopleiona*) *weaveri* (Tegland) (p. 104).

Height 101 mm, width 42 mm. USNM 650184, slightly crushed. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.

19. *Psephaea* (*Miopleiona*) cf. *P.* (*M.*) *weaveri* (Tegland) (p. 104).

Height 73 mm, width 29.5 mm, crushed. USNM 650185. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.

CANCELLARIA, *PSEPHAEA*, and *MITRA*

PLATE 14

FIGURES 1, 2, 6, 7, 16. *Cancellaria* (*Euclia*) *circumspinosa* Addicott, n. sp. (p. 110).

1, 6, 7. Lower part of the Round Mountain Silt, middle Miocene.

1. Height 16.6 mm, width 11.9 mm. USNM 650186. USGS loc. 3886.

6, 7. Holotype. Height 18.8 mm, width 11.5 mm. USNM 650187. USGS Cenozoic loc. M1608.

2, 16. Upper part of the Olcese Sand, middle Miocene.

2. Height 27.5 mm, width 20.8 mm. UCMP 33480. UCMP loc .B1601.

16. Height 9.3 mm, width 5.8 mm. UCMP 33481. UCMP loc. B1624.

3, 11. *Cancellaria* (*Euclia*) *dalliana* Anderson (p. 108).

Upper part of the Olcese Sand, middle Miocene.

3. Height 19.5 mm, width 14.3 mm. USNM 650188. USGS Cenozoic loc. M1597.

11. Height 11 mm, width 6.7 mm. UCMP 33483. UCMP loc. B1598.

4, 5, 8, 9. *Cancellaria (Euclia) ocoyona* Addicott, n. sp. (p. 110).

4. Height 18.3 mm, width 16.7 mm. USNM 650189, a rubber mold. Lower part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1593.

5. Holotype. Height 26.5 mm, width 17.5 mm. UCMP 33484. Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1618.

8, 9. Height 11.7 mm, width 7.5 mm. UCMP 33485. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1598.

10. *Cancellaria* (*Euclia*) *condoni* Anderson (p. 107).

Height 11.2 mm, width 6.9 mm. USNM 650190. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

12. *Cancellaria* (*Euclia*) *oregonensis* Conrad (p. 111).

Height 17.9 mm, width 13.2 mm. UCMP 33577. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1641.

13–15, 17, 18, 24, 25. *Cancellaria* (*Euclia*) *simplex* Anderson (p. 112).

Upper part of the Olcese Sand, middle Miocene.

13, 14. Height 24.6 mm, width 16.9 mm. USNM 650191. USGS Cenozoic loc. M1597.

15. Height 23.8 mm, width 16.8 mm. USNM 650192. USGS Cenozoic loc. M1597.

17. Height 26.5 mm, width 18.4 mm. USNM 166593. USGS loc. 6890.

18. Height 20 mm, width 12.5 mm. UCMP 33711. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1624.

24, 25. Height 47.5 mm, width 34.5 mm. CAS 12935. CAS loc. 65.

19, 20, 27. *Cancellaria* (*Euclia*) *simplex* Anderson strongly sculptured form (p. 112).

19, 27. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1602.

19. Height 24.4 mm, width 17.5 mm. USNM 650193.

27. Height 43 mm, width 26 mm. USNM 650194.

20. Height 17.4 mm, width 12.2 mm. USNM 650195. Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1608.

21. *Cancellaria* (*Euclia*) *simplex* Anderson weakly sculptured form (p. 112).

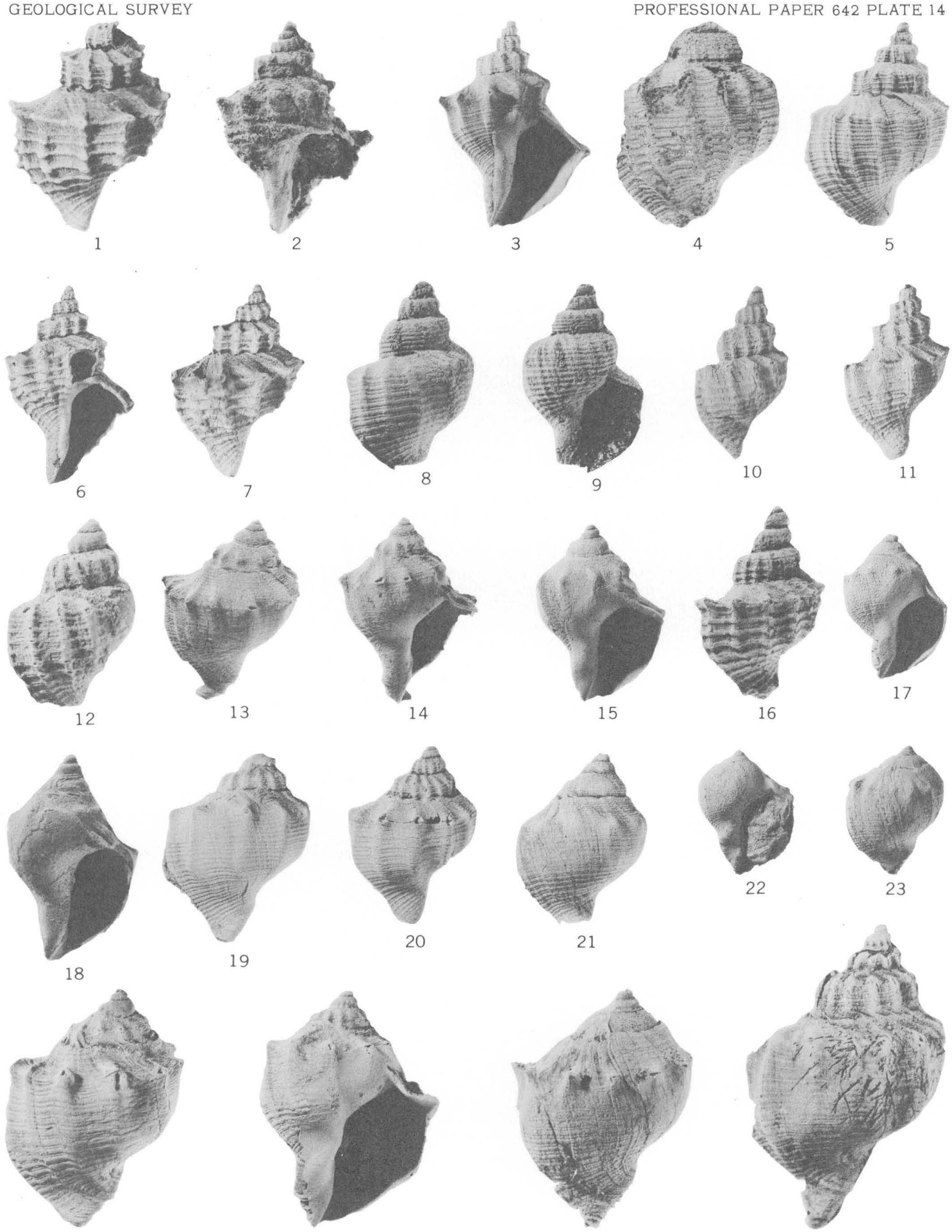
Height 22.6 mm, width 17.7 mm. USNM 650196. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1602.

22, 23, 26. *Cancellaria* (*Euclia*) *joaquinensis* Anderson (p. 113).

Upper part of the Olcese Sand, middle Miocene.

22, 23. Height 24.1 mm, width 18.3 mm. USNM 650197. USGS Cenozoic loc. M1601.

26. Height 31.5 mm, width 28.5 mm. UCMP 33731. UCMP loc. B1622.



CANCELLARIA

PLATE 15

FIGURES 1–3, 9, 10. *Cancellaria (Pyruclia) lickana* Anderson and Martin (p. 115).
Upper part of the Olcese Sand, middle Miocene.
1, 2. Height 19.5 mm, width 16 mm. USNM 650198. USGS Cenozoic loc. M1599.
3. Height 15.6 mm, width 10.9 mm. UCMP 33735. UCMP loc. B1600.
9, 10. Height 23.4 mm, width 16 mm. USNM 650199. USGS Cenozoic loc. M1602.

4, 5. *Cancellaria (Euclia) joaquinensis* Anderson (p. 113).
Upper part of the Olcese Sand, middle Miocene.
4. Height 25.5 mm, width 19.4 mm. UCMP 33738. UCMP loc. B1597.
5. Height 23.3 mm, width 20.4 mm. UCMP 33760. UCMP loc. B1624.

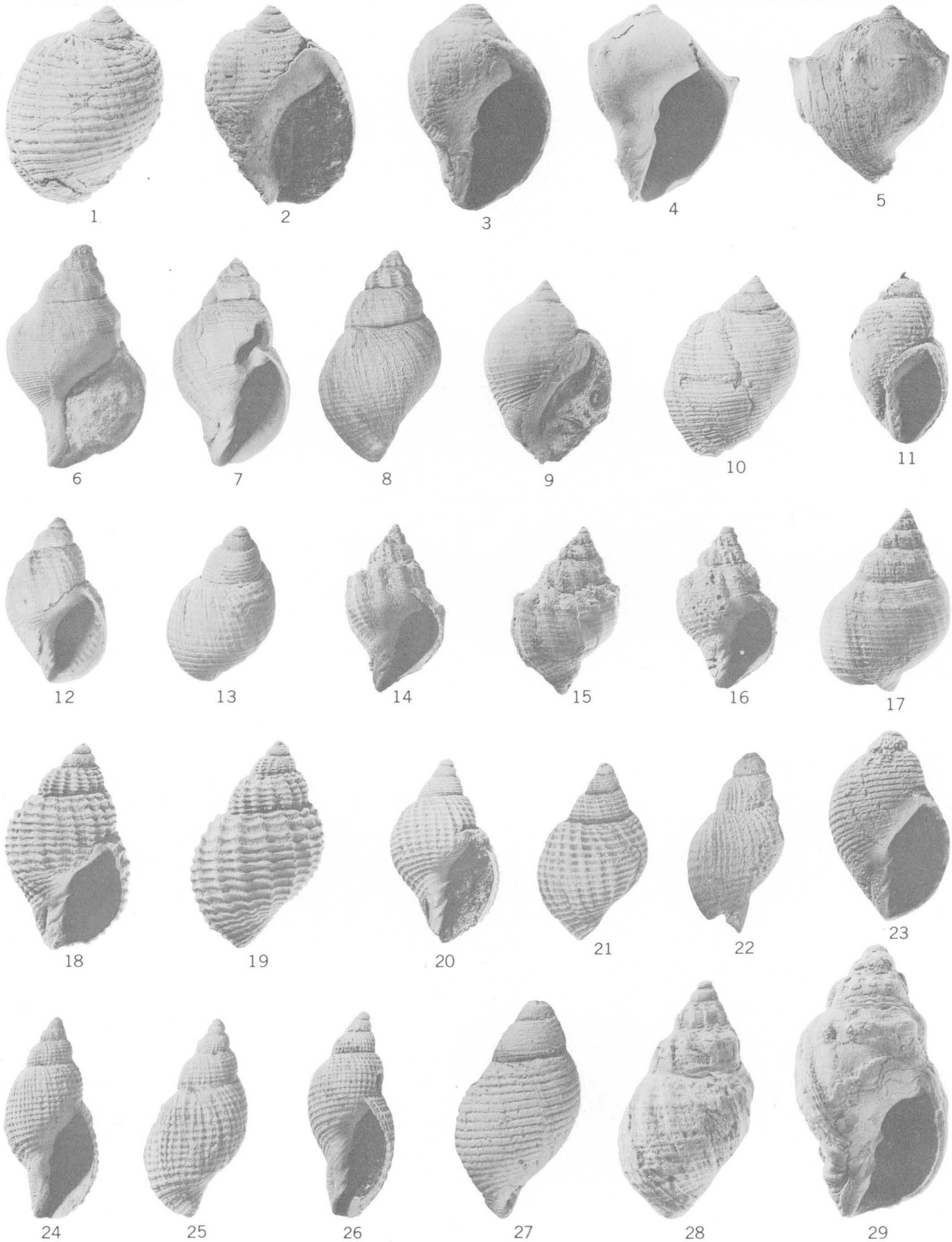
6–8, 17. *Cancellaria (Euclia?) nevadensis* Anderson and Martin (p. 114).
Lower part of the Round Mountain Silt, middle Miocene.
6. Height 30 mm, width 18.1 mm. USNM 650200. USGS loc. 6641.
7, 8. Height 13.5 mm, width 7.4 mm. USNM 650201. USGS Cenozoic loc. M1608.
17. Height 17.5 mm, width 11.5 mm. UCMP 33795. UCMP loc. B1611.

11–13, 23, 27. *Cancellaria dalli* Anderson and Martin (p. 117).
11. Height 12.6 mm, width 7.3 mm. USNM 650202. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
12, 13, 23, 27. Lower part of the Round Mountain Silt, middle Miocene.
12, 13. Height 7.9 mm, width 4.5 mm. USNM 650203. USGS Cenozoic loc. M1613.
23. Height 5.9 mm, width 3.7 mm. USNM 650204. USGS Cenozoic loc. M2601.
27. Height 8.8 mm, width 4.2 mm. UCMP 33803. UCMP loc. B1638.

14–16, 28, 29. *Cancellaria (Euclia) pacifica* Anderson (p. 114).
14, 15, 28, 29. Upper part of the Olcese Sand, middle Miocene.
14, 15. Neotype. Height 21.7 mm, width 13.1 mm. USNM 650205. USGS Cenozoic loc. M1600.
28. Height 23.3 mm, width 12.3 mm. UCMP 33804. UCMP loc. B1600.
29. Height 26.5 mm, width 14.5 mm. UCMP 33805. UCMP loc. B1622.
16. Height 10.3 mm, width 6.4 mm. USNM 650206. Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1608.

18–21. *Cancellaria (Crawfordina) kernensis* Addicott n. sp. (p. 117).
18, 19. Holotype. Height 13.4 mm, width 7.8 mm. USNM 650207. Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1608.
20, 21. Height 11.5 mm, width 7 mm. CAS 12936. CWOD "Alford" 1, sec. 35, T. 27 S., R. 27 E. Santa Margarita Formation, late Miocene. CAS loc. 28790.

22, 24–26. *Cancellaria (Coptostoma) posunculensis* Anderson and Martin (p. 116).
Upper part of the Olcese Sand, middle Miocene.
22. Height 6.4 mm, width 3.2 mm. UCMP 33811. UCMP loc. B1624.
24, 25. Height 15.2 mm, width 7.5 mm. USNM 650208. USGS Cenozoic loc. M1597.
26. Height 13.1 mm, width 6.1 mm. UCMP 33829. UCMP loc. B1598.



CANCELLARIA

PLATE 16

FIGURES 1–4, 18, 19. *Cancellaria keenae* Addicott, n. sp. (p. 119).
Lower part of the Round Mountain Silt, middle Miocene.
1, 2. Holotype. Height 14.7 mm, width 7.5 mm. UCLA 45771. UCLA loc. AC–2–34.
3, 4. Height 16 mm, width 7.5 mm. UCMP 33840. UCMP loc. B1638.
18, 19. Height 9.8 mm, with 6.3 mm. USNM 650209. USGS loc. 6065.

5, 11, 21, 22. *Cancellaria* (*Barkeria*) *sanjosei* Anderson and Martin (p. 118).
Upper part of the Round Mountain Silt, middle Miocene.
5. Height 21.3 mm, width 10.9 mm. USNM 650210. USGS Cenozoic loc. M1605.
11. Height 24.1 mm, width 13.6 mm. UCMP 33847. UCMP loc. B1588.
21, 22. Height 16.4 mm, width 11.4 mm. USNM 650211. USGS Cenozoic loc. M1605.

6–10. *Cancellaria galei* Addicott, n. sp. (p. 119).
Basal part of the Jewett Sand, early Miocene.
6. Height 38 mm, width 27.5 mm.USNM 650212. USGS Cenozoic loc. M1591.
7. Paratype. Height 39 mm, width 31 mm. USNM 650213. USGS Cenozoic loc. M1591.
8, 9. Holotype. Height 26.8 mm, width 17.5 mm. USNM 650214. USGS Cenozoic loc. M1590.
10. Rubber cast of external mold of holotype.

12–16. *Cancellaria* (*Narona*) *birchi* Addicott, n. sp. (p. 118).
Lower part of the Round Mountain Silt, middle Miocene.
12. Height 11.5 mm, width 6.3 mm. USNM 650215. USGS Cenozoic loc. M1613.
13, 14. Holotype. Height 11.9 mm, width 6.3 mm. UCMP 33859. UCMP loc. B1637.
15, 16. Height 9.7 mm, width 4.6 mm. USNM 650216. USGS Cenozioc loc. M1613.

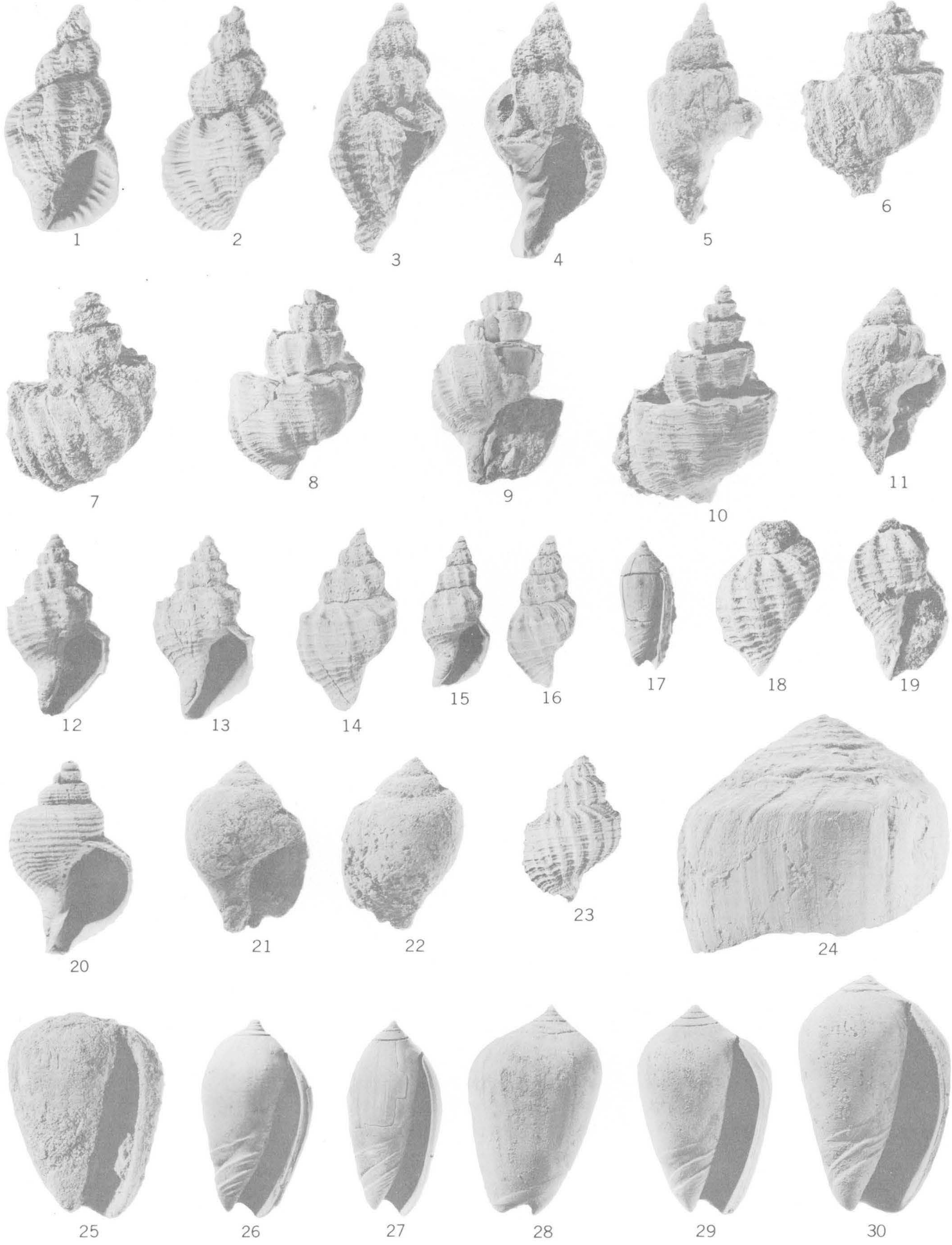
17, 26–30. *Oliva* (*Oliva*) *californica* Anderson (p. 120).
17, 27. Slender form. Lower part of the Round Mountain Silt, middle Miocene.
17. Height 17 mm, width 6.8 mm. USNM 650217. USGS Cenozoic loc. M1613.
27. Height 26 mm, width 12.8 mm. UCMP 15507. UCMP loc. 2713.
26, 28–30. Upper part of the Olcese Sand, middle Miocene.
26. Height 18.2 mm, width 10.5 mm. USNM 650218. USGS Cenozoic loc. M1597.
28, 29. Height 27 mm, width 17.3 mm. UCMP 36560. UCMP loc. B1600.
30. Height 22.6 mm, width 14.7 mm. UCMP 33861. UCMP loc. B1600.

20. *Cancellaria* (*Euclia*) *ocoyana* Addicott, n. sp. (p. 110).
Height 9.2 mm, width 6 mm. USNM 650219. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

23. *Cancellaria* (*Euclia*) *oregonensis* Conrad (p. 111).
Height 27 mm, width 19 mm. USNM 563213. Unnamed middle Miocene formation, Coos Bay, Oreg. USGS loc. 18284.

24. *Conus* (*Lithoconus*) *hayesi* Arnold (p. 124).
Height 62 mm, width 47 mm. USNM 650220. Upper part of the Round Mountain Silt, middle Miocene. USGS loc. 6611.

25. *Oliva* (*Oliva*) n. sp.? (p. 121).
Height 26.5 mm, width 20.2 mm. UCMP 33871. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1587.



CANCELLARIA, *OLIVA*, and *CONUS*

PLATE 17

FIGURES 1–8, 32, 37. *Conus (Chelyconus) owenianus* Anderson (p. 122).
1, 5–8, 32, 37. Lower part of the Round Mountain Silt, middle Miocene.
1. Height 26.5 mm, width 14.3 mm. USNM 650221. USGS Cenozoic loc. M1612.
5. Stout form. Height 19.3 mm, width 13.3 mm. USNM 650222. USGS loc. 6622.
6. Slender form. Height 22 mm, width 10.9 mm. UCMP 36932. UCMP loc. B1637.
7. Slender form. Height 24.7 mm, width 11.6 mm. USNM 650223. USGS Cenozoic loc. M1618.
8. Height 15.9 mm, width 9 mm. USNM 650224. USGS Cenozoic loc. M1612.
32. Height 7.2 mm, width 3.1 mm. UCMP 36933. UCMP loc. B1637.
37. Stout form. Height 20 mm, width 14 mm. USNM 650225. USGS Cenozoic loc. M1608.
2–4. Height 23.8 mm, width 13.2 mm. UCMP 36934. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1600.

9, 13. *Olivella (Olivella) ischnon* Keen (p. 121).
Upper part of the Olcese Sand, middle Miocene.
9. Height 10 mm, width 3.9 mm. UCMP 36935. UCMP loc. B1598.
13. Height 7.2 mm, width 3.1 mm. USNM 650227. USGS Cenozoic loc. M1597.

10. *Olivella* sp. (p. 121).
Height 16.4 mm, width 7.6 mm. USNM 650226. Basal part of the Jewett Sand, early Miocene. USGS Cenozoic loc. M1591.

11, 12, 20. *Terebra (Strioterebrum) stirtoni* Addicott, n. sp. (p. 126).
Upper part of the Olcese Sand, middle Miocene.
11. Height 12.6 mm, width 3.9 mm. USNM 650228. USGS Cenozoic loc. M1597.
12. Height 13.3 mm, width 3.8 mm. USNM 650229. USGS Cenozoic loc. M1597.
20. Holotype. Height 26 mm, width 7.8 mm. USNM 650330. USGS loc. M1613.

14, 15. *Terebra (Strioterebrum)* n. sp.? (p. 127).
Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
14. Height 7.6 mm, width 2.4 mm. USNM 650230.
15. Height 6.0 mm, width 2.1 mm. USNM 650231.

16, 17. *Terebra (Fusoterebra?) adelaidana* Addicott, n. sp. (p. 126).
Holotype. Height 16.4 mm, width 4.9 mm. USNM 650232. Upper part of the Olcese Sand, middle Miocene USGS Cenozoic loc. M1597.

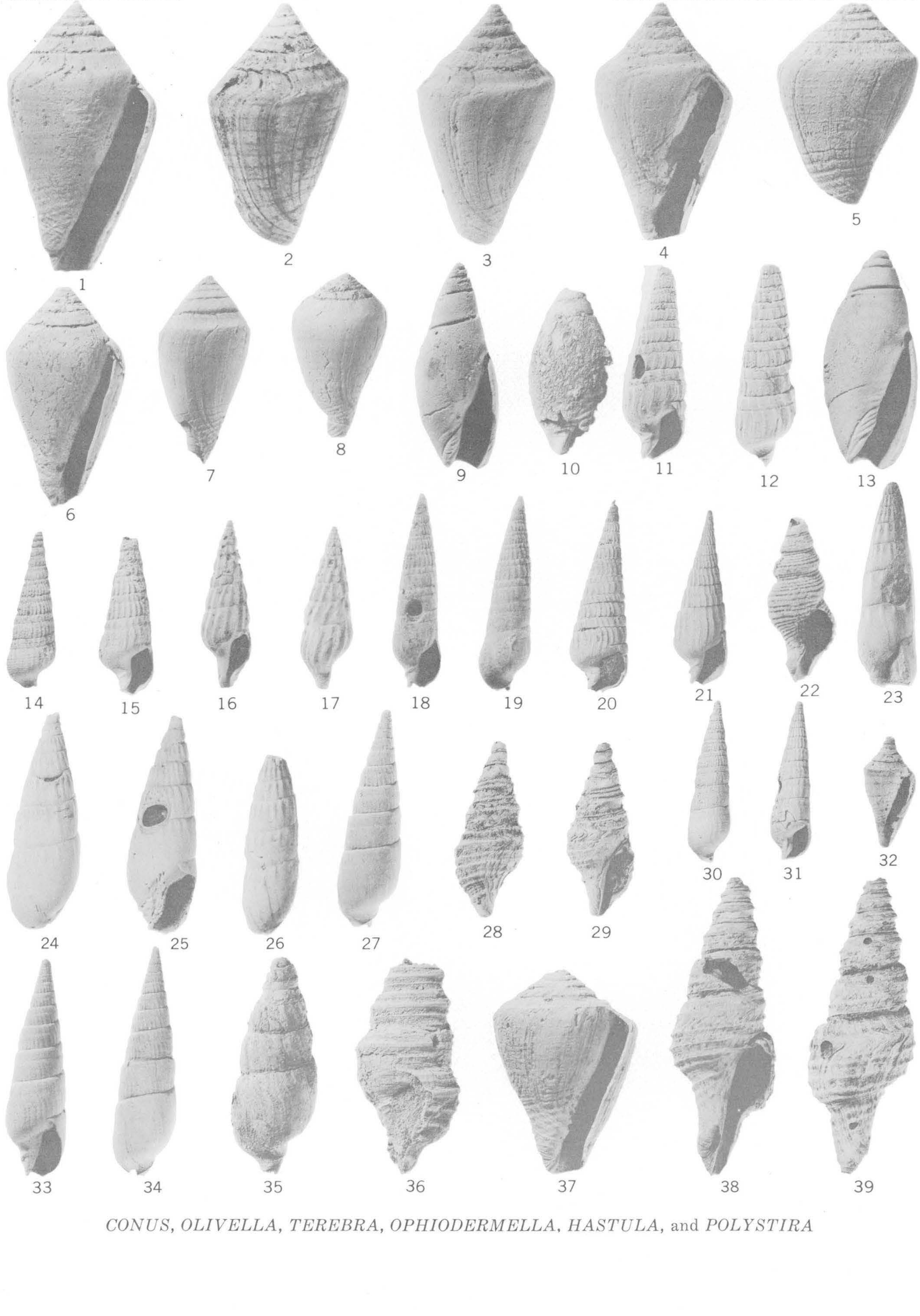
18, 19, 30. *Terebra (Terebra)* n. sp. (p. 125).
Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
18, 19. Height 18.9 mm, width 4.7 mm. USNM 650233.
30. Height 16.4 mm, width 2.7 mm. USNM 650234.

21, 27, 31, 33–35. *Terebra (Terebra) cooperi* Anderson (p. 124).
21, 27, 31, 33, 34. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
21. Height 24.1 mm, width 7.4 mm. USNM 650235.
27, 33. Height 42.5 mm, width 11.6 mm. USNM 650236.
31. Height 11.4 mm, width 2.5 mm. USNM 650237.
34. Height 44.5 mm, width 12.4 mm. USNM 650238.
35. Stout form. Height 21 mm, width 7.9 mm. USNM 650239. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1600.

22. *Ophiodermella temblorensis* (Anderson and Martin) (p. 134).
Height 12.8 mm, width 5 mm. UCMP 36937. Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1638.

23–26. *Hastula gnomon* Keen (p. 127).
Lower part of the Round Mountain Silt, middle Miocene.
23. Height 15.8 mm, width 4.5 mm. USNM 650240. USGS loc. 6641.
24, 25. Height 14.2 mm, width 4.4 mm. USNM 650241. USGS Cenozoic loc. M1613.
26. Height 13.8 mm, width 4.1 mm. UCMP 36938. UCMP loc. 2716.

28, 29, 36, 38, 39. *Polystira englishi* Addicott, n. sp. (p. 127).
28, 29, 38, 39. Upper part of the Olcese Sand, middle Miocene. CAS loc. 2064.
28, 29. Paratype. Height 24 mm, width 9.4 mm. CAS 12937.
38, 39. Holotype. Height 59.5 mm, width 21.5 mm. CAS 12938.
36. Height 28 mm, width 14.7 mm. UCMP 36939. Lower part of the Round Mountain Silt, middle Miocene UCMP loc. 2716.



CONUS, *OLIVELLA*, *TEREBRA*, *OPHIODERMELLA*, *HASTULA*, and *POLYSTIRA*

PLATE 18

FIGURES 1–3, 6, 12, 13. *Turricula ochsneri* (Anderson and Martin) (p. 129).
Lower part of the Round Mountain Silt, middle Miocene.
1, 2. Weakly noded form. USGS Cenozoic loc. M1613.
1. Height 36.5 mm, width 13.7 mm. USNM 650242.
2. Height 33.5 mm, width 12.8 mm. USNM 650243.
3. Strongly noded form. Height 32 mm, width 12.5 mm. USNM 650244. USGS Cenozoic loc. M1613.
6. Weakly noded form. Height 28.5 mm, width 16.1 mm. USNM 650245. USGS loc. 6641.
12, 13. Strongly noded form. Height 26.5 mm, width 16.6 mm. UCMP 36940. UCMP loc. B1637.

4, 5, 7–9. *Turricula piercei* (Arnold) (p. 130).
4, 5. Height 33.5 mm, width 12.5 mm. UCMP 37091. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1586.
7–9. Lower part of the Round Mountain Silt, middle Miocene.
7. Height 26 mm, width 9.6 mm. USNM 650246. USGS loc. 6624.
8. Height 24.1 mm, width 9.1 mm. USNM 650247. USGS loc. 6063.
9. Height 22.8 mm, width 8 mm. UCMP 37092. UCMP loc. B1638.

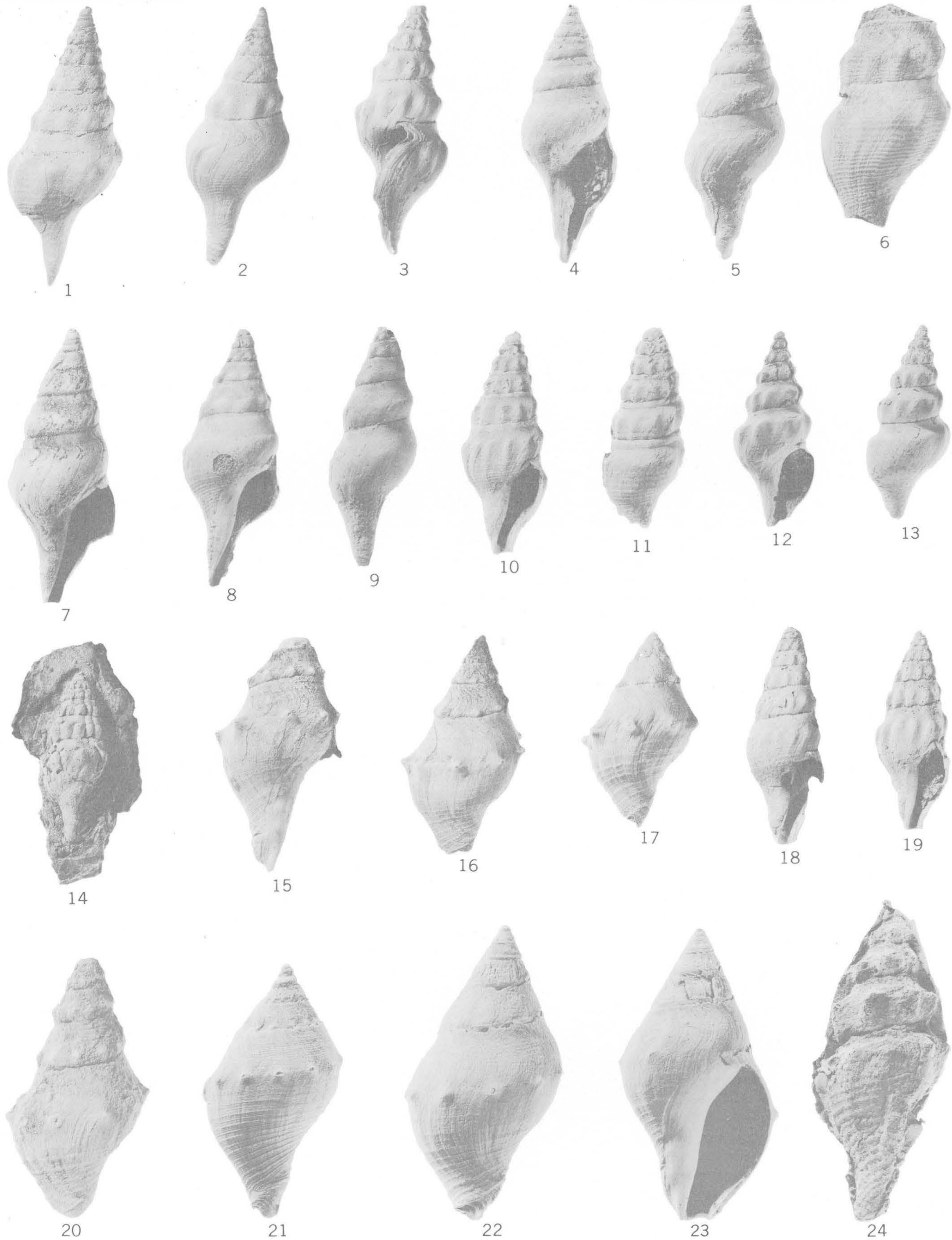
10, 11, 18, 19. *Turricula? buwaldana* (Anderson and Martin) (p. 130).
10, 18, 19. Lower part of the Round Mountain Silt, middle Miocene.
10. Height 17.1 mm, width 6.4 mm. USNM 650248. USGS loc. 3886.
18. Height 20.3 mm, width 7 mm. USNM 650249. USGS Cenozoic loc. M1613.
19. Height 15.2 mm, width 5.5 mm. USNM 650250. USGS Cenozoic loc. M1608.
11. Height 19 mm, width 7.5 mm. USNM 650251. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1602.

14. *Turricula?* cf. *T. buwaldana* (Anderson and Martin) (p. 130).
Height 31.5 mm, width 12.6 mm. CAS 12941. Superior Oil Co. Crome Community well 1, sec. 36, T. 29 S., R. 28 E. 4,949–5,957 ft. Edison Shale of Cushman and Goudkoff (1938), middle Miocene. CAS loc. 28909.

15, 16, 20. *Megasurcula keepi* (Arnold) (p. 133).
Lower part of the Round Mountain Silt, middle Miocene.
15. Height 44 mm, width 23.3 mm. CAS 12939. CAS loc. 68.
16. Height 42 mm, width 23.3 mm. USNM 650252. USGS loc. 6623.
20. Height 34.5 mm, width 18.8 mm. USNM 650253. USGS loc. 6622.

17, 21–23. *Megasurcula howei* Hanna and Hertlein (p. 132).
Upper part of the Olcese Sand, middle Miocene.
17. Height 36 mm, width 23.6 mm. USNM 650254. USGS Cenozoic loc. M1597.
21. Height 24.2 mm, width 12.3 mm. UCMP 37093. UCMP loc. B1593.
22, 23. Height 28.5 mm, width 19.4 mm. UCMP 36560. UCMP loc. B1597.

24. *Knefastia garcesana* Addicott, n. sp. (p. 131).
Holotype. Height 60 mm, width 25 mm. USNM 650255, a rubber cast. Upper part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1607.



TURRICULA, TURRICULA?, MEGASURCULA, and *KNEFASTIA*

PLATE 19

FIGURES 1, 2, 14. *Megasurcula wynoocheensis* (Weaver) (p. 133).
1. Height 43 mm, width 21.4 mm. USNM 650256. Upper part of the Astoria Formation, middle Miocene, Wynoochee Valley quad., southwestern Washington. USGS Cenozoic loc. M1539.
2. Height 20.5 mm, width 11.3 mm. UCMP 37094. Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1618.
14. Height 35 mm, width 15.6 mm. UCMP 15906. Upper part of the Olcese Sand or Round Mountain Silt. UCMP loc. 2713.

3, 15. *Xenuroturris antiselli* (Anderson and Martin) (p. 128).
3. Height 10.7 mm, width 5.6 mm. SUPTC 9942. Top of the Olcese Sand. SU general specimen no. 29501.
15. Height 12.5 mm, width 6 mm. USNM 650257. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

4. *Turricula? buwaldana* (Anderson and Martin) (p. 130).
Height 16.5 mm, width 6.1 mm. USNM 650258. Lower part of the Round Nountain Silt, middle Miocene. USGS loc. 3886.

5–7, 9–13, 16. *Ophiodermella temblorensis* (Anderson and Martin) (p. 134).
5–7, 9–11, 16. Upper part of the Olcese Sand, middle Miocene.
5. Reticulate form. Height 15 mm, width 6.1 mm. USNM 650259. USGS Cenozoic loc. M1597.
6. Reticulate form. Height 4.4 mm, width 1.6 mm. USNM 650260. USGS Cenozoic loc. M1597.
7. Spirally sculptured form. Height 15.1 mm, width 6.4 mm. USNM 650261. USGS Cenozoic loc. M1597.
9. Spirally sculptured form. Height 17.3 mm, width 6.4 mm. USNM 650262. USGS Cenozoic loc. M1597.
10, 11. Reticulate form. Height 14.5 mm, width 5.6 mm. UCMP 37095. UCMP loc. B1598.
16. Spirally sculptured form. Height 12.8 mm, width 5 mm. UCMP 36937. UCMP loc. B1624.
12, 13. Reticulate form. Height 9.5 mm, width 4.1 mm. UCMP 37096. UCMP loc. B1638.

8, 17, 18. *Megasurcula condonana* (Anderson and Martin) (p. 132).
Basal part of the Jewett Sand, early Miocene.
8. Height 20 mm, width 13 mm. CAS 12940. CAS loc. 37468.
17, 18. Height 32 mm, width 18.3 mm. USNM 650263. USGS Cenozoic loc. M1590.

19, 33–36. *Glyphostoma carinata* Addicott, n. sp. (p.136).
Upper part of the Olcese Sand, middle Miocene.
19. Height 4.7 mm, width 2.2 mm. UCMP 37097. UCMP loc. B1598.
33, 34. Holotype. Height 8.4 mm, width 4.1 mm. UCMP 37098. UCMP loc. B1586.
35, 36. Paratype. Height 9.1 mm, width 4.2 mm. UCMP 37099. UCMP loc. B1586.

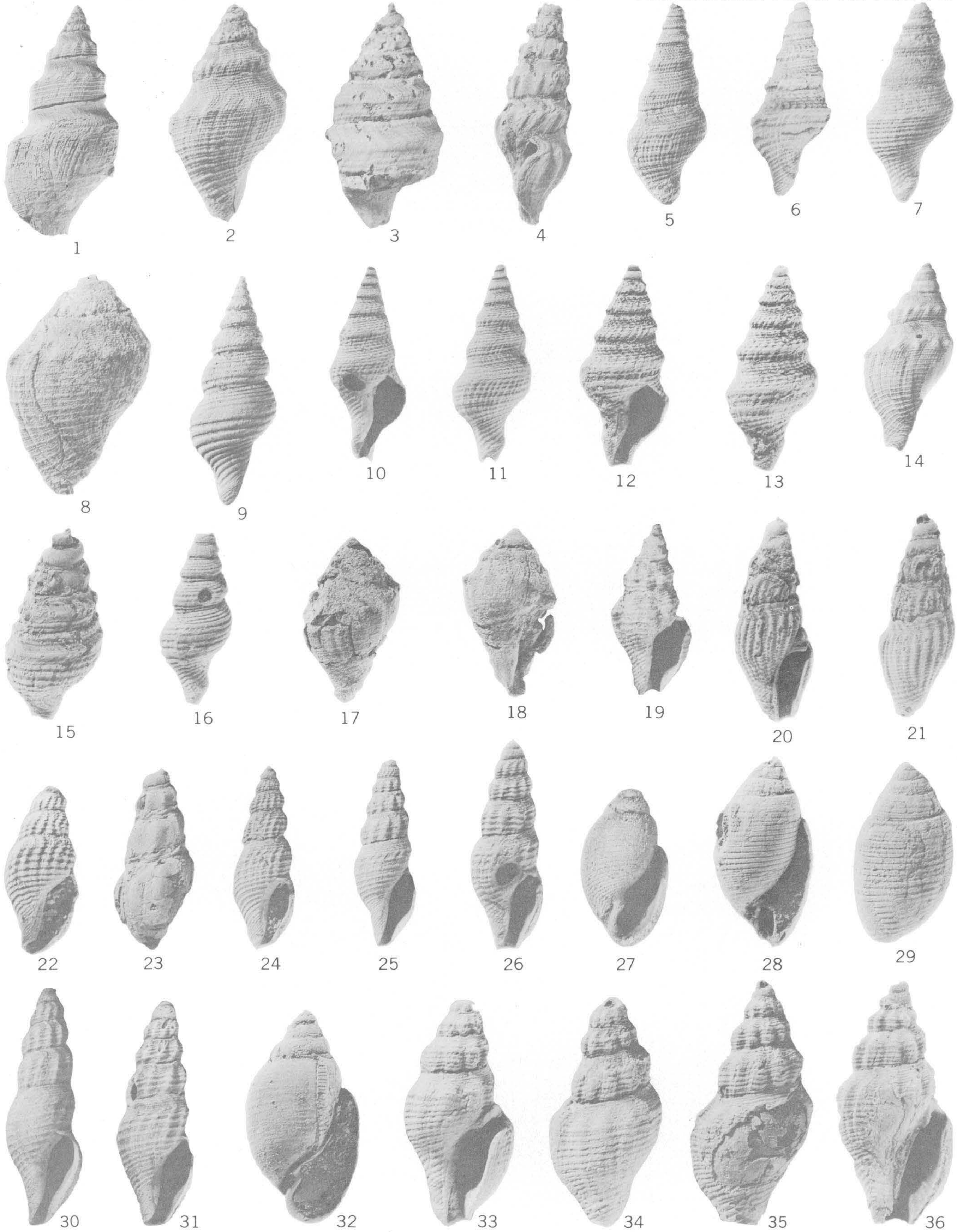
20, 21. *Crassispira olcesensis* Addicott, n. sp. (p. 134).
Holotype. Height 14.9 mm, width 5.7 mm. USNM 650264. Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1608.

22. *Mangelia* (*Notocytharella?*) *hartensis* Addicott, n. sp. (p. 136).
Height 4.3 mm, width 1.9 mm. USNM 650265. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

23. *Mangelia* (*Agathotoma*) *howei* Anderson and Martin (p. 136).
Height 6.7 mm, width 2.7 mm. USNM 650266. Lower part of the Round Mountain Silt, middle Miocene USGS Cenozoic loc. M2480.

24–26, 30, 31. *Mangelia* (*Notocytharella*) *kernensis* (Anderson and Martin) (p. 135).
Upper part of the Olcese Sand, middle Miocene.
24. Finely ribbed form. Height 6.6 mm, width 2.3 mm. USNM 650267. USGS Cenozoic loc. M1597.
25, 26, 30, 31. Coarsely ribbed form.
25. Height 6.9 mm, width 2.3 mm. USNM 650268. USGS Cenozoic loc. M1597.
26. Height 6.4 mm, width 2.3 mm. UCMP 37100. UCMP loc. B1598.
30. Height 6.3 mm, width 2.1 mm. USNM 650269. USGS Cenozoic loc. M1597.
31. Height 5.9 mm, width 2 mm. USNM 650270. USGS Cenozoic loc. M1597.

27–29, 32. *Acteon boulderanus* Etherington (p. 137).
Upper part of the Olcese Sand, middle Miocene.
27. Height 3.1 mm, width 1.4 mm. USNM 650271. USGS Cenozoic loc. M1597.
28, 29. Height 11.9 mm, width 5.1 mm. USNM 650272. USGS Cenozoic loc. M1602.
32. Height 13.5 mm, width 7 mm. USNM 650273. USGS Cenozoic loc. M1600.



MEGASURCULA, *XENUROTURRIS*, *TURRICULA?*, *OPHIODERMELLA*, *CRASSISPIRA*, *GLYPHOSTOMA*, *MANGELIA*, and *ACTEON*

PLATE 20

FIGURES 1, 32. *Balcis conchita* Keen (p. 57).
Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1612.
1. Height 4.6 mm, width 1.5 mm. USNM 650274.
32. Height 5.3 mm, width 1.4 mm. USNM 650275.

2. *Volvulella joaquinensis* Addicott, n. sp. (p. 141).
Holotype. Height 5.3 mm, width 2 mm. UCMP 37101. Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1637.

3, 4. *Volvulella gluma* Keen (p. 141).
Upper part of the Olcese Sand, middle Miocene.
3. Height 5.3 mm, width 2 mm. UCMP 37102. UCMP loc. B1598.
4. Height 4.7 mm, width 2 mm. USNM 650276. USGS Cenozoic loc. M1597.

5, 6. *Eulima gabbiana* (Anderson and Martin) (p. 57).
5. Height 4.1 mm, width 1.1 mm. UCMP 37103. Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1637.
6. Height 5.2 mm, width 1.3 mm. USNM 650277. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

7, 17, 26. *Cylichna*? *loismartinae* Keen (p. 139).
Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1637.
7. Height 3.4 mm, width 1.8 mm. UCMP 37104.
17. Height 2.2 mm, width 1.1 mm. UCMP 37106.
26. Height 3.1 mm, width 1.6 mm. UCMP 37105.

8, 29–31, 36, 37. *Scaphander jugularis* (Conrad) (p. 139).
Upper part of the Olcese Sand, middle Miocene.
8. Immature specimen. Height 4.3 mm, width 2.4 mm. USNM 650278. USGS Cenozoic loc. M1597.
29, 30. Height 33 mm, width 22.2 mm. USNM 650279. USGS Cenozoic loc. M1693.
31, 36. Height 28.5 mm, width 17 mm. USNM 650280. USGS Cenozoic loc. M1600.
37. Height 22.8 mm, width 13 mm. USNM 650281. USGS Cenozoic loc. M1600.

9. *Acteon* (*Rictaxis*) *weaveri* Addicott, n. sp. (p. 137).
Holotype. Height 5.1 mm, width 2.4 mm. USNM 650282. Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M2601.

10, 11, 18, 25. *Cylichna temblorensis* Keen (p. 140).
10, 18, 25. Lower part of the Round Mountain Silt, middle Miocene.
10. Height 5.1 mm, width 2.1 mm. UCMP 37107. UCMP loc. B1637.
18. Height 4.2 mm, width 1.8 mm. UCMP 37108. UCMP loc. B1637.
25. Height 6.3 mm, width 2.4 mm. USNM 650283. USGS Cenozoic loc. M1604.
11. Height 5 mm, width 1.9 mm. USNM 650284. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1599.

12. *Odostomia* (*Chrysallida*?) *sequoiana* Addicott, n. sp. (p. 142).
Height 5.2 mm, width 2.4 mm. USNM 650285. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

13. *Balcis petrolia* Addicott, n. sp. (p. 58).
Height 5.6 mm, width 1.7 mm. USNM 650286. Lower part of the Round Mountain Silt, middle Miocene. USGS loc. 6623.

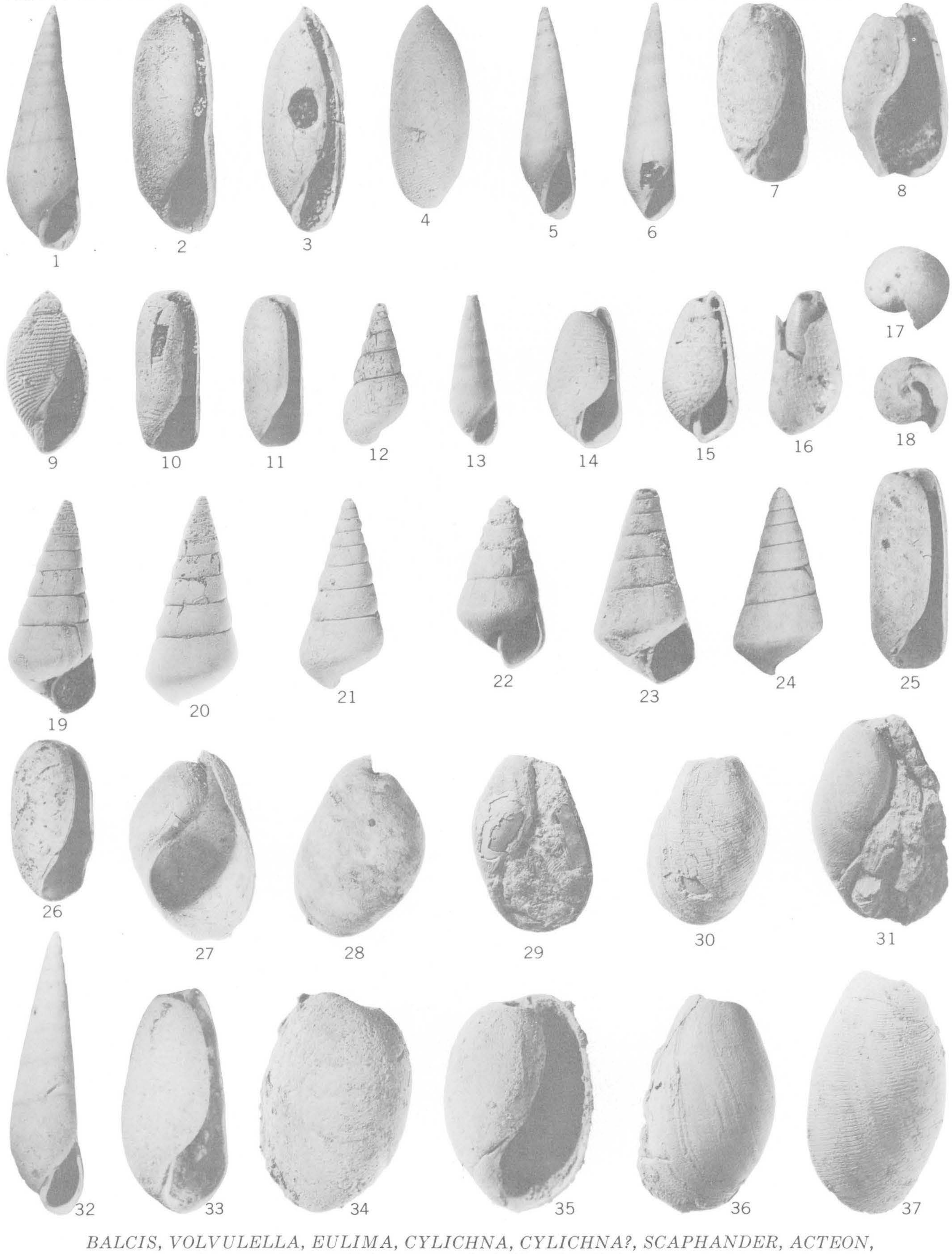
14–16, 33. *Sulcoretusa*? *israelskyi* Addicott, n. sp. (p. 140).
Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
14. Paratype. Height 1.9 mm, width 1 mm. USNM 650287.
15. Paratype. Height 2 mm, width 1 mm. USNM 650288.
16. Height 2.9 mm, width 1.4 mm. USNM 650289.
33. Holotype. Height 2.8 mm, width 1.4 mm. USNM 650290.

19–21. *Niso cottonwoodensis* Addicott, n. sp. (p. 59).
19, 20. Holotype. Height 13.5 mm, width 5.6 mm. USNM 650291. Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1640.
21. Height 6.1 mm, width 2.6 mm. USNM 650292. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

22–24. *Niso antiselli* Anderson and Martin (p. 58).
Lower part of the Round Mountain Silt, middle Miocene.
22. Height 8 mm, width 4.3 mm. USNM 650293. USGS loc. 6065.
23. Height 6.2 mm, width 3.2 mm. USNM 650294. USGS Cenozoic loc. M2601.
24. Height 6 mm, width 2.9 mm. USNM 650295. USGS Cenozoic loc. M1612.

27, 28. *Haminoea virescens* (Sowerby) (p. 138).
Height 17.8 mm, width 11.9 mm. CAS 12943. Upper part of the Olcese Sand, middle Miocene. CAS loc. 2147.

34, 35. *Bulla cantuaensis* Anderson and Martin (p. 138).
Height 21 mm, width 13.7 mm. SUPTC 9941. Lower part of the Round Mountain Silt, middle Miocene. SU loc. 2121.



BALCIS, VOLVULELLA, EULIMA, CYLICHNA, CYLICHNA?, SCAPHANDER, ACTEON, ODOSTOMIA, SULCORETUSA? NISO, HAMINOEA, and *BULLA*

PLATE 21

FIGURES 1–3. *Pyramidella* (*Longchaeus*) *cooperi* Anderson and Martin (p. 142).
Lower part of the Round Mountain Silt, middle Miocene.
1, 2. Height 13.4 mm, width 4.9 mm. UCMP 37109. UCMP loc. B1638.
3. Height 8.7 mm, width 3.9 mm. USNM 650296. USGS Cenozoic loc. M1612.

4–6. *Pyramidella* (*Syrnola*) *ochsneri* (Anderson and Martin) (p. 142).
4, 5. Upper part of the Olcese Sand, middle Miocene.
4. Height 6.3 mm, width 2.4 mm. USNM 650297. USGS Cenozoic loc. M1602.
5. Height 7.2 mm, width 2.7 mm. USNM 650298. USGS Cenozoic loc. M1597.
6. Height 3.4 mm, width 0.9 mm. UCMP 37110. Lower part of the Round Mountain Silt, middle Miocene. UCMP loc. B1637.

7. *Turbonilla* (*Ptycheulimella*) *edisonensis* Addicott, n. sp. (p. 147).
Holotype. Height 3.2 mm, width 0.4 mm. USNM 650299. Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1613.

8, 9, 19. *Odostomia* (*Chrysallida?*) *sequoiana* Addicott, n. sp. (p. 142).
Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
8. Paratype. Height 5.1 mm, width 2.3 mm. USNM 650300.
9. Paratype. Height 3.8 mm, width 1.8 mm. USNM 650301.
19. Holotype. Height 3.0 mm, width 1.4 mm. USNM 650302.

10. *Balcis* cf. *B. oldroydi* Bartsch (p. 58).
Height 3.2 mm, width 1.5 mm. USNM 650303. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

11, 12, 21, 25. *Odostomia* (*Evalea*) *andersoni* Bartsch (p. 144).
11, 12, 25. Upper part of the Olcese Sand, middle Miocene.
11. Height 4.5 mm, width 1.8 mm. USNM 650304. USGS Cenozoic loc. M1597.
12. Height 4 mm, width 1.8 mm. USNM 650305. USGS Cenozoic loc. M1597.
25. Height 4.3 mm, width 1.6 mm. UCMP 37111. UCMP loc. B1598.
21. Height 1.8 mm, width 0.9 mm. USNM 650306. Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1612.

13–15. *Balcis lutzi* Addicott, n. sp. (p. 58).
Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
13. Paratype. Height 4.5 mm, width 1.5 mm. USNM 650307.
14. Paratype. Height 5.6 mm, width 2.0 mm. USNM 650308.
15. Holotype. Height 5.5 mm, width 1.7 mm. USNM 650309.

16. *Balcis petrolia* Addicott, n. sp. (p. 58).
Holotype. Height 6.4 mm, width 2 mm. UCMP 37112. Upper part of the Olcese Sand, middle Miocene. UCMP loc. B1600.

17, 26, 41, 42. *Turbonilla* (*Pyrgolampros*) *mariposa* Keen (p. 146).
17. Height 3.7 mm, width 0.9 mm. USNM 650310. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
26, 41, 42. Lower part of the Round Mountain Silt, middle Miocene. USGS Cenozoic loc. M1612.
26. Height 3.2 mm, width 0.9 mm. USNM 650332.
41. Height 2.6 mm, width 0.8 mm. USNM 650333.
42. Height 3.5 mm, width 1 mm. USNM 650334.

18. *Turbonilla* (*Chemnitzia?*) n. sp. (p. 145).
Height 4.2 mm, width 0.9 mm. USNM 650311. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

20. *Turbonilla* cf. *T. mariposa* Keen (p. 147).
Height 3.5 mm, width 1.3 mm. USNM 650312. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

22, 32. *Odostomia* (*Menestho*) *repenningi* Addicott, n. sp. (p. 143).
Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
22. Paratype. Height 2.2 mm, width 1.1 mm. USNM 650313.
32. Holotype. Height 2.8 mm, width 1.4 mm. USNM 650314.

PLATE 21—Continued

FIGURES 23, 24. *Turbonilla* (*Pyrgiscus*) n. sp. (p. 146).
Height 3.4 mm, width 1 mm. USNM 650315. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

27. *Odostomia* (*Evalea*?) n. sp.? (p. 144).
Height 3.3 mm, width 1.6 mm. USNM 650316. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

28. *Odostomia* (*Evalea*) sp. (p. 144).
Height 2.4 mm, width 1.4 mm. USNM 650317. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

29–31. *Odostomia* (*Besla*) *rotundomontana* (Keen) (p. 143).
Lower part of the Round Mountain Silt, middle Miocene.
29. Height 2.6 mm, width 1.4 mm. USNM 650318. USGS Cenozoic loc. M1613.
30. Height 4.3 mm, width 2 mm. UCMP 37115. UCMP loc. B1638.
31. Height 2.5 mm, width 1.2 mm. UCMP 37116. UCMP loc. B1637.

33. *Odostomia* (*Evalea*) aff. *O.* (*E.*) *donilla* Dall and Bartsch (p. 144).
Height 2.6 mm, width 1.4 mm. USNM 650319. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

34–36. *Turbonilla* (*Pyrgiscus*) *bravoensis* Keen (p. 146).
Lower part of the Round Mountain Silt, middle Miocene.
34. Height 3.8 mm, width 1 mm. USNM 650320. USGS Cenozoic loc. M1612.
35. Height 2.5 mm, width 1.2 mm. UCMP 37117. UCMP loc. B1637.
36. Height 4.4 mm, width 1.2 mm. UCMP 37118. UCMP loc. B1637.

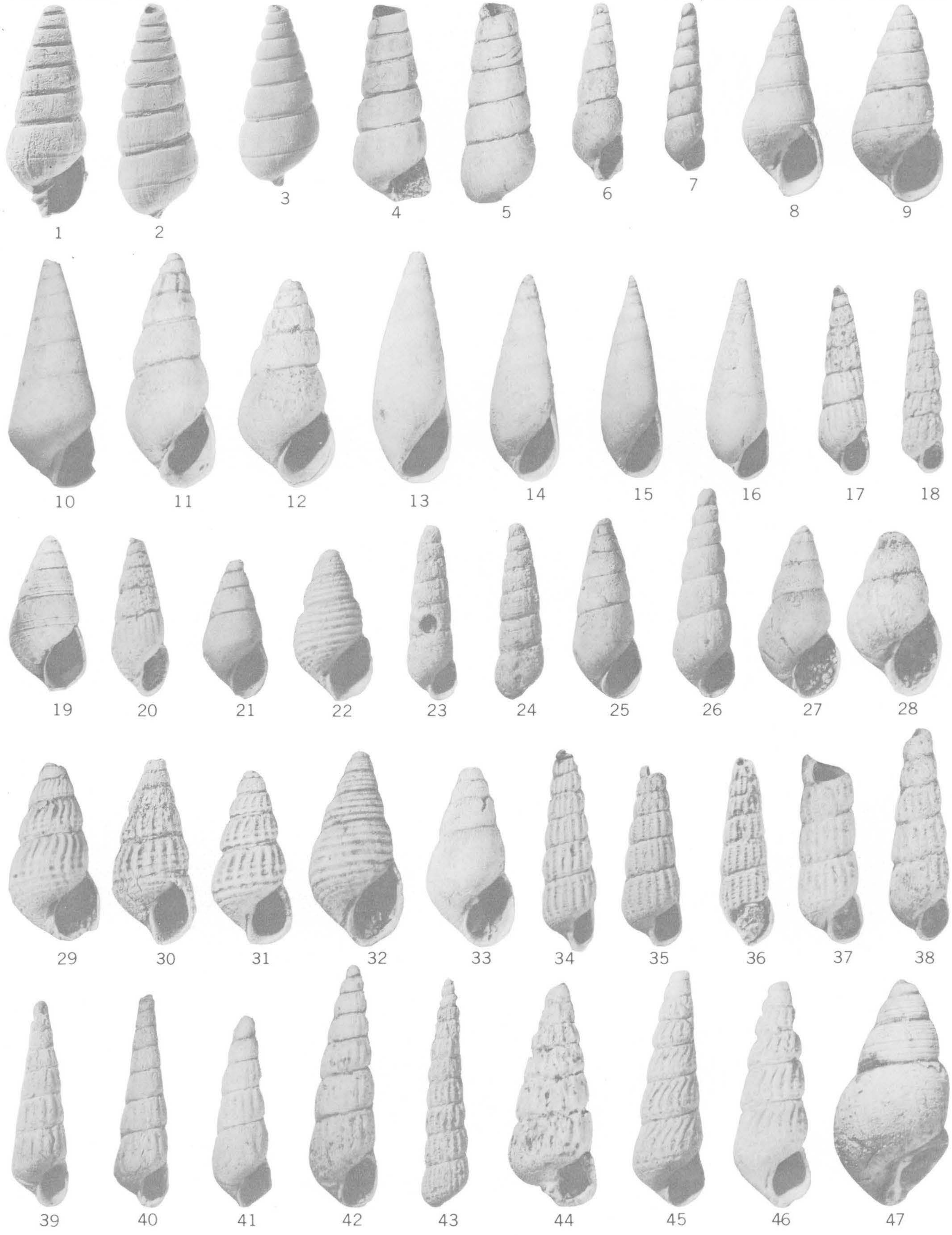
37, 43. *Turbonilla* (*Pyrgiscus*) *hormigacuesta* Addicott, n. sp. (p. 146).
Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
37. Paratype. Height 3 mm, width 1 mm. USNM 650321.
43. Holotype. Height 4.4 mm, width 0.9 mm. USNM 650322.

38–40. *Turbonilla* (*Chemnitzia*) *hannai* Addicott, n. sp. (p. 145).
Upper part of the Olcese Sand, middle Miocene.
38. Height 4.1 mm, width 1.2 mm. USNM 650323. USGS Cenozoic loc. M1597.
39. Paratype. Height 4 mm, width 1.1 mm. UCMP 32140. UCMP loc. B1598.
40. Holotype. Height 4 mm, width 1.1 mm. USNM 650324. USGS Cenozoic loc. M1597.

44. *Turbonilla* (*Chemnitzia*) n. sp. (p. 145).
Height 4.4 mm, width 1.8 mm. USNM 650325. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.

45, 46. *Turbonilla* (*Tragula*) *greenhornensis* Addicott, n. sp. (p. 147).
Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.
45. Holotype. Height 3.4 mm, width 1.1 mm. USNM 650326.
46. Paratype. Height 3 mm, width 1.1 mm. USNM 650327.

47. *Odostomia* (*Chrysallida*?) n. sp.? (p. 143).
Height 2.9 mm, width 1.6 mm. USNM 650328. Upper part of the Olcese Sand, middle Miocene. USGS Cenozoic loc. M1597.



PYRAMIDELLA, TURBONILLA, ODOSTOMIA, and *BALCIS*