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PALEONTOLOGY OF THE EOCENE BATEQUE FORMATION, BAJA CALIFORNIA SUR, MEXICO

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Paleontology of the Eocene Bateque Formation, Baja California Sur, Mexico

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ABSTRACT. This study is the first detailed account of marine Eocene macrosized invertebrate fossils from Baja California Sur, Mexico. The fossils, which are locally richly abundant, are from exposures of the middle lower Eocene ("Capay Stage") to upper middle Eocene ("Tejon Stage") Bateque Formation along the Pacific coast from the eastern Laguna San Ignacio area to the San Juanico area about 105 km to the south.

Ninety-nine species were found and are one red alga, one green? alga, five large benthic foraminifers, traces of one demosponge?, one calcareous sponge, one spongiomorph? organism, one helioporid octocoral, one gorgonian, eight colonial corals, four solitary corals, two bryozoans, one polychaete worm, one scaphopod, 37 gastropods, 23 bivalves, two nautiloids, two crabs, and three types of cidaroid echinoids (based on spines), as well as two cassiduloid? and two spatangoid echinoids.

Ten of the macrofossils are new species that have already been named. Eleven other new species are described and named: one gorgonian, *Parisis batequensis* new species; three colonial corals, *Stylosmilia ameliae* new species, *Colpophyllia nicholasi* new species, and *Montastrea laurae* new species; one solitary coral, *Antillia batequensis* new species; one polychaete worm, *Serpula batequensis* new species; one gastropod, *Bernaya* (*Protocypraea*) *grovesi* new species; one bivalve, *Lima kennedyi* new species; two crabs, *Ranina berglundi* new species and *Lophoranina bishopi* new species; and a spatangoid echinoid, *Eupatagus batequensis* new species.

Only 300 m of the formation is exposed, and these deposits grade upward from offshore, to braid delta, to coral reef(?), to shallow marine, and to offshore. Most of the macrofossils are in the shallow-marine deposits in scattered lenses of channel-lag, very short-distance storm accumulations. A large benthic foraminifer-pectinid bivalve-oysterid community is present in a thin muddy interval within quieter water offshore deposits overlying the shallow-marine deposits.

Overlying the Bateque Formation at one locality is a thin interval of diatomite assignable to the late middle Eocene CP14a to CP14b Zones. This diatomite is most likely part of another formation.

The Bateque Formation macrofossil fauna is indicative of warm-water conditions. Many of the taxa show influence of Old World Tethyan warm-water faunal elements. Most of the Bateque Formation macrofossils are known elsewhere in Pacific coast lower Eocene strata, primarily in California. Some Bateque Formation genera are new to the Pacific coast during the early Eocene. A few are Mesozoic relicts. A few other macrofossils have been previously reported from the Pacific coast but have their earliest or their latest occurrence in the Bateque. The Bateque Formation early Eocene occurrence of the gastropod *Platyoptera,* the bivalve *Nayadina* (*Exputens*), and the crab *Ranina* is the earliest anywhere in the world, and the early Eocene occurrence of the gastropod genera *Amauropsis* and *Gyrodes*? is the latest anywhere in the world.

RESUMEN. Este estudio es el primer relato detallado de macrofósiles invertebrados marinos del Eoceno de Baja California Sur, México. Los fósiles, localmente muy abundantes, se hallan en afloramientos ascendiendo del Eoceno inferior medio ("Capay Stage") al Eoceno superior medio ("Tejon Stage") en la Formación Bateque, ubicada por la costa del Pacifico entre la proximidad del lado oriental de la Laguna San Ignacio y la proximidad de San Juanico, cubriendo una distancia de approximadamente 105 km.

Noventa y cinco especies halladas incluyen una alga rhodophyta, una alga? chlorophyta, cinco foraminiferas benthicas grandes, vestigios de una demoporifera, una porifera calcarea, un organismo "spongiomorph?", un octocoral helioporido, un gorgonio, ocho corales coloniales, cuartro corales soliatrios, dos bryozoas, un "polychaete worm," un escafópodo, 37 gasterópodos, 23 pelecípodos, dos cefalópodos, dos cangrejos, tres tipos de "cidaroid" equinoides (basados en espinas), así como dos equinoides "cassiduloid" y dos equinoides "spatangoid."

Diez de los macrofósiles son nuevas especies ya nombradas. Once especies nuevas son describidas y nombradas: un gorgonio, *Parisis batequensis* nueva especie; tres corales coloniales, *Stylosmilia ameliae* nueva especie, *Colpophyllia nicholasi* nueva especie, y *Montastrea laurae* nueva especie; un coral solitario *Antillia batequensis* nueva especie; un "polychaete worm" *Serpula batequensis* nueva especie; un gasterópodo *Bernaya* (*Protocypraea*) *grovesi* nueva especie, un pelecípodo *Lima kennedyi* nueva especie; dos cangrejos *Ranina berglundi* nueva especie y *Lophoranina bishopi* nueva especie, y un equinoide "spatangoid" *Eupatagus batequensis* nueva especie.

Solamente 300 m de la formación está expuesta, y los depósitos se cambian ascendiendo de costafuera a delta a arrecife(?) de coral a marino de poca profundidad a costafuera. Los demás de los macrofósiles se hallan en los depósitos marinos de poca profundidad en bolsas lenticulares dispersas depositadas con poca trasladación durante tormentas y acumuladas en canales. Una comunidad de foraminiferas benthicas grandes, pelecípodos "pectinid," y ostras se halla en un intervalo lodoso delgado dentro los depósitos costafueras que cubren a los depósitos marinos de poca profundidad.

En una localidad la Formación Bateque esta cubierta con un intervalo delgado de tierra diátomacea asignable al Eoceno medio (Zonas CP14a a CP14b). Esta tierra diátomacea es probablemente una parte de otra formación.

La fauna macrofósil el la Formación Bateque es indicativa de condiciónes marinas de aguas cálidas. Mucha de las taxa muestra una influencia de elementos faunales del Mar Tethys con sus aguas cálidas. La mayor parte de los macrofósiles de la Formación Bateque son conocidos en depósitos del Eoceno inferior en otras areas de la costa Pacífica, principalmente en California Alta. Algunos géneros de la Formación Bateque se introducieron a la costa Pacífica durante el Eoceno inferior. Algunos son reliquias del Mesozoico. Algunos otros macrofósiles previamente conocidos en la costa Pacífica aparecen con su primaro o último suceso en la Formación Bateque. Los sucesos del gasterópodo *Platyoptera,* el pelecípodo *Nayadina* (*Exputens*), y el cangrejo *Ranina* son los primeros en el mundo; y los suscesos de los gasterópodos *Amauropsis* y *Gyrodes*? son los últimos en el mundo.

INTRODUCTION

Givens (1974), Givens and Kennedy (1979), and Squires (1984, 1987, 1988b) have provided detailed knowledge of southern California Eocene molluscan faunas. These faunas contain many Old World Tethyan or Tethyan-affinity, warm-water taxa that immigrated to California during the early Eocene (Squires, 1987). A route of migration that paralleled the Pacific coast of Baja California, Mexico, has been implied or suggested by a number of workers, but documentation has been lacking because early Eocene faunas were unknown from this area.

In 1987, while doing reconnaissance field work in Baja California Sur, the junior author discovered some rich deposits of macrofossils near the middle of the Bateque Formation. He shared his find with the senior author who recognized that they were of early Eocene age. Since 1988, we have been making trips into the area to collect these fossils and to search throughout the formation for other localities.

The main purpose of this paper is to document the Eocene macrofossils of the Bateque Formation as well as to describe the stratigraphy, depositional environments, and geologic age of each main part of the formation. Depositional environments will be discussed in a preliminary manner, based on reconnaissance field studies. More detailed work is needed to delineate subenvironments.

This study documents the southern California early Eocene macrofossil fauna in Baja California Sur. Except for a few species that are known only from the Bateque Formation, the geographic distribution of all the molluscan species and a few corals mentioned in this report are extended from southern California to Baja California Sur.

PREVIOUS WORK

Mina (1956, 1957) described and mapped the Bateque Formation. He did not designate a type section. Durham and Allison (1960) mentioned the Bateque Formation in their analysis of the biogeography of peninsular Baja California. Sorensen (1982) worked on the sedimentary petrology and small benthic foraminifers of the formation. McLean et al. (1985) mapped the geology at a scale of 1:125,000. McLean et al. (1987) reported on the distribution and general lithology of the formation, and McLean and Barron (1988) reported the presence of a diatomite. The first macropaleontologic work in the study area was done by Squires and Demetrion (1989, 1990a, 1990b) and Squires (1990a, 1990b, 1990c). Carreño and Cronin (1991) reported on ostracodes from the Bateque Formation.

MACROFOSSILS

Ninety-nine species, 63 percent of which are mollusks and 14 percent are cnidarians, were identified from the Bateque Formation in the study area. The flora and fauna consist of one red alga, one green? alga, five large benthic foraminifers, traces of one demosponge?, one calcareous sponge, one spongiomorph? organism, one helioporid octocoral, one gorgonian, eight colonial corals, four solitary corals, two bryozoans, one polychaete worm, one scaphopod, 37 gastropods, 23 bivalves, two nautiloids, two crabs, and three types of cidaroid echinoids (based on spines) as well as two cassiduloid? and two spatangoid echinoids. Ten of these species are new species that have already been named. They are as follows: one calcareous sponge, *Elasmostoma bajaensis* Squires and Demetrion, 1989; three gastropods, *Velates batequensis* Squires and Demetrion, 1990a, *Tenagodus bajaensis* Squires, 1990a, and *Platyoptera pacifica* Squires and Demetrion, 1990a; and six bivalves, *Batequeus mezquitalensis* Squires and Demetrion, 1990b, *Spondylus batequensis* Squires and Demetrion, 1990b, *Pycnodonte (Phygraea) pacifica* Squires and Demetrion, 1990b, *Pycnodonte (Pegma) bajaensis* Squires and Demetrion, 1990b, *Cubitostrea mezquitalensis* Squires and Demetrion, 1990b, and *Fimbria pacifica* Squires, 1990c. The bivalve genus *Batequeus* Squires and Demetrion, 1990b, and the bivalve subgenus *Pegma* Squires and Demetrion, 1990b, are also new taxa that have already been named.

Eleven other Bateque Formation species are new and described herein. They are as follows: one gorgonian, *Parisis batequensis* new species; three colonial corals, *Stylosmilia ameliae* new species, *Colpophyllia nicholasi* new species, and *Montastrea laurae* new species; one solitary coral, *Antillia batequensis* new species; one polychaete worm, *Serpula batequensis* new species; one gastropod, *Bernaya (Protocypraea) grovesi* new species; one bivalve, *Lima kennedyi* new species; two crabs, *Ranina berglundi* new species and *Lophoranina bishopi* new species; and a spatangoid echinoid, *Eupatagus batequensis* new species.

Other macroinvertebrates that are too poorly preserved for generic determination include some solitary corals, some encrusting bryozoans, and crab fragments.

STRATIGRAPHY AND DEPOSITIONAL ENVIRONMENTS

INTRODUCTION

The Bateque Formation of Mina (1956, 1957) crops out along the Pacific side of Baja California Sur, Mexico, from the north end and east side of Laguna San Ignacio area to the San Juanico area about 105 km to the south (Fig. 1). Isolated outcrops are located in the northern end, whereas continuous exposures are in the cliff faces of large mesas that border the coastal plain on the east side of Laguna San Ignacio to the village of Batequi de San Juan. Although there is extensive slope wash in this area, there are excellent outcrops in a few of the canyons that incise these mesas. Isolated outcrops are in major arroyos between Batequi de San Juan and the San Juanico area. Most of the coastal exposures are difficult to reach because of poor roads that are modified by drifting sands or flooded by maximum

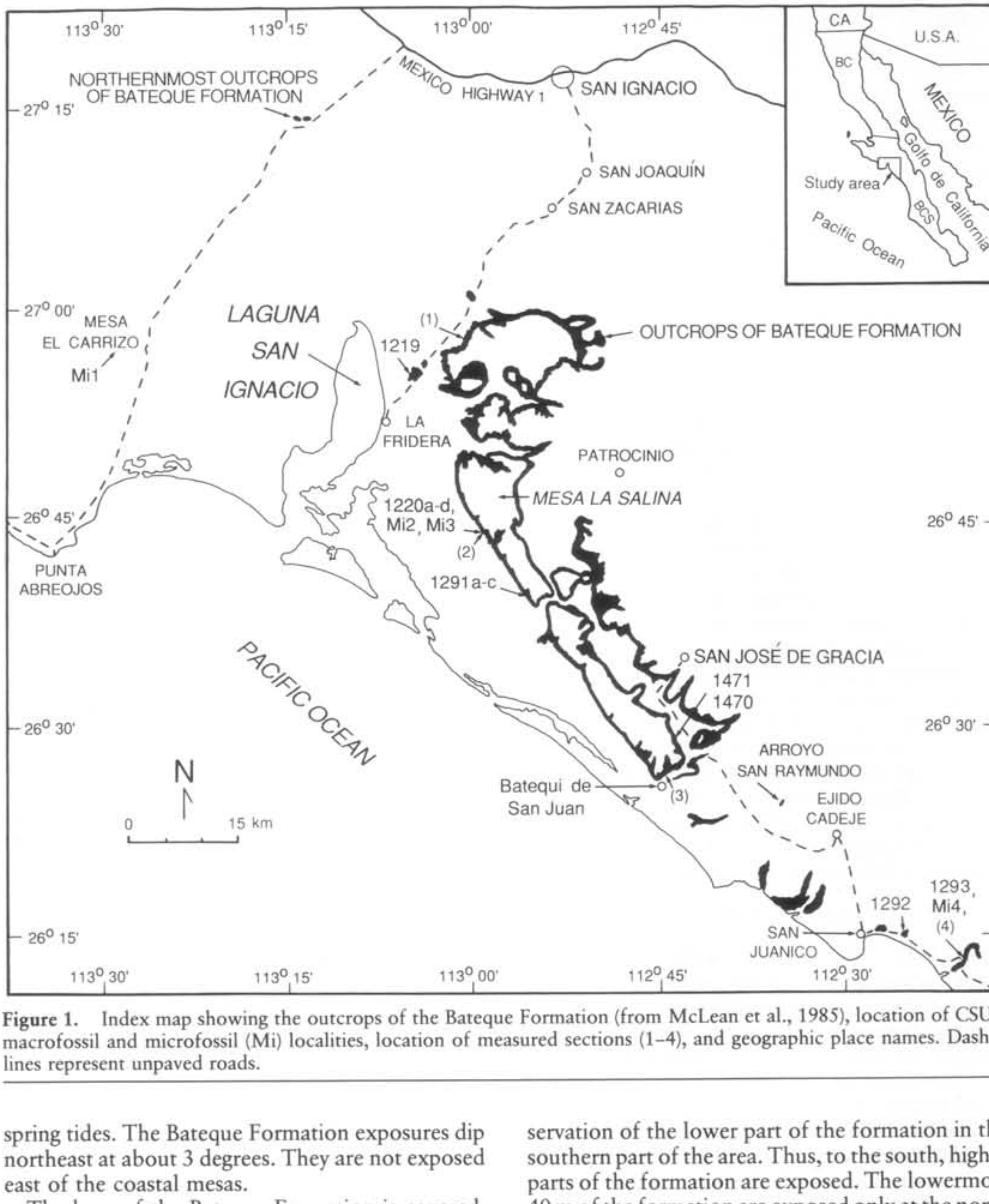

Figure 1. Index map showing the outcrops of the Bateque Formation (from McLean et al., 1985), location of CSUN macrofossil and microfossil (Mi) localities, location of measured sections (1–4), and geographic place names. Dashed lines represent unpaved roads.

spring tides. The Bateque Formation exposures dip northeast at about 3 degrees. They are not exposed east of the coastal mesas.

The base of the Bateque Formation is covered, and the formation is unconformably overlain by sedimentary and volcanic rocks that range in age from late middle Eocene to Holocene. The distribution of these overlying units is discussed in McLean and Barron (1988). Erosion has removed the upper part of the Bateque Formation in the northern part of the area. A combination of the regional dip of the formation and slope wash prevents observation of the lower part of the formation in the southern part of the area. Thus, to the south, higher parts of the formation are exposed. The lowermost 40 m of the formation are exposed only at the north end of Laguna San Ignacio and along its east side. The overlying 200 m are exposed along the coastal cliffs area, and the upper 70 m are exposed in the southern part of the area between the vicinity of Batequi de San Juan and the vicinity of San Juanico (Fig. 1).

The exposed Bateque Formation is 300 m thick, as compiled from four sections measured with a

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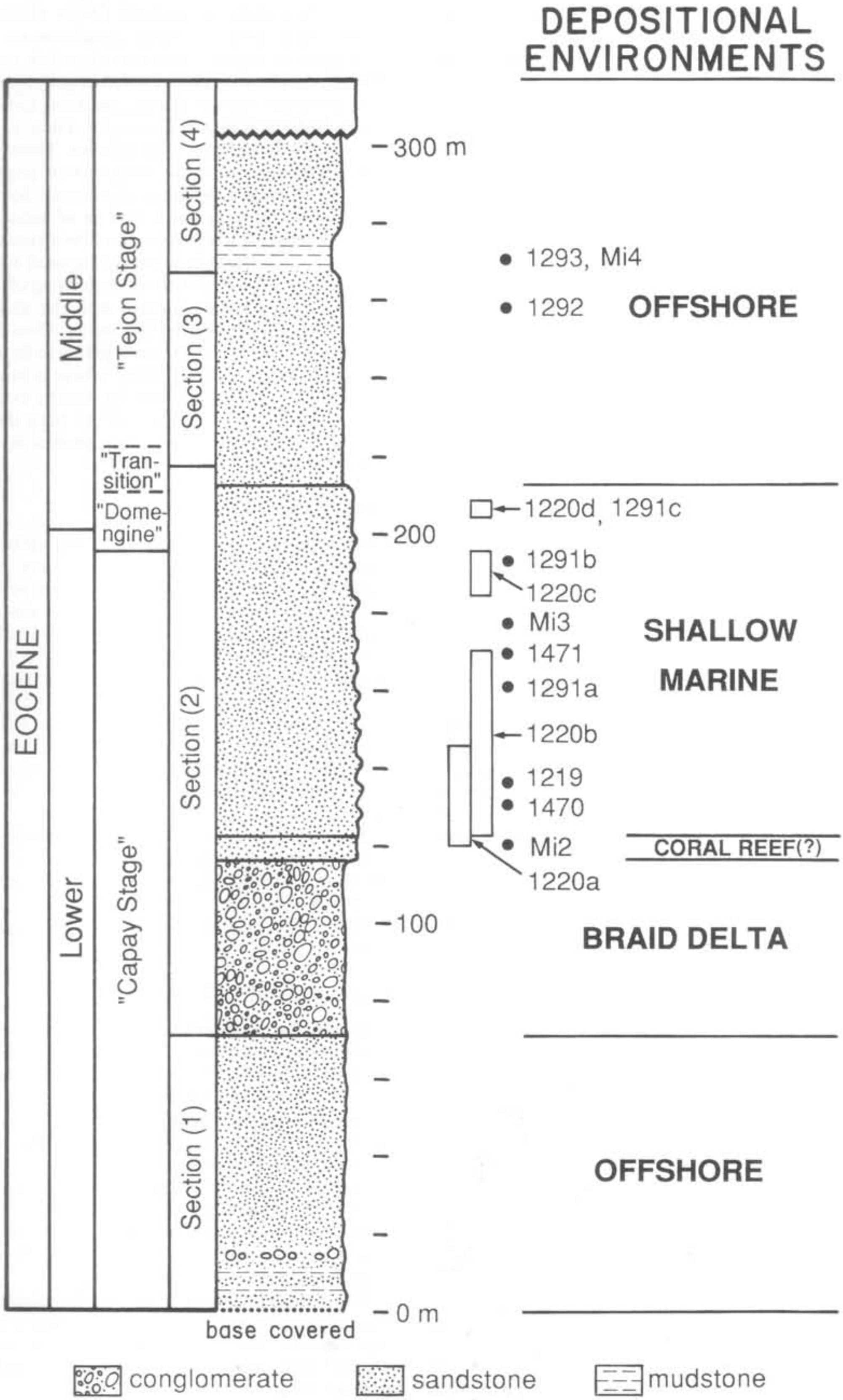
Figure 2. Composite columnar section of the Bateque Formation showing Pacific coast of North America provincial molluscan stages (from Squires, 1987), stratigraphic position of measured sections, position of CSUN macrofossil and microfossil (Mi) localities, and depositional environments.


DEPOSITIONAL ENVIRONMENTS
EOCENE
Middle
Lower
"Tejon Stage"
"Tran-sition"
"Dome-ngine"
"Capay Stage"
Section (4)
Section (3)
Section (2)
Section (1)
300 m
200
100
0 m
base covered
1293, Mi4
1292
OFFSHORE
1220d, 1291c
1291b
1220c
Mi3
1471
1291a
1220b
1219
1470
Mi2
1220a
SHALLOW MARINE
CORAL REEF(?)
BRAID DELTA
OFFSHORE
conglomerate
sandstone
mudstone

Jacob's staff. Locations of sections are shown in Figure 1. A composite columnar section is shown in Figure 2. Rock types are bioturbated, yellow, very fine-grained sandstones (79%), pebble conglomerates (15%), fossil-bearing lenses of sandstone (5%), and mudstones/siltstones (1%). Deposits grade vertically upward from offshore, to braid delta, to coral reef?, to shallow marine, to offshore (Fig. 2).

OFFSHORE DEPOSITS IN LOWER PART OF FORMATION

The offshore deposits in the lower part are 70 m thick. The lowermost 15 m of these deposits consists mostly of silty mudstone interbedded with parallel-laminated, fine-grained sandstone. Rip-up clasts, flame structures, convoluted bedding, and thickening-upward cycles of beds are present as well as a 1-m-thick bed of matrix-supported, disorganized, well-rounded pebble to cobble, volcanic porphyry and quartzite conglomerate. This conglomerate bed crops out in small hills about 17 km south of the junction of Mexico Highway 1 and the dirt road to Punta Abreojos and along the east side of Laguna San Ignacio, about 32 km south of the town of San Ignacio along the main dirt road from the town to La Fridera fish camp (Fig. 1).

Overlying the lowermost 15 m is a 55-m-thick, yellow, bioturbated, very fine-grained sandstone with some intervals of parallel-laminated, very fine-grained sandstone. Locally, there are horizontal burrows of *Thalassinodes*. In the upper half of this section there is only bioturbated sandstone.

The sandstone in the lower 70 m of the Bateque Formation resembles that in the upper part of the informally proposed Ballenas formation (Sorensen, 1982) that reportedly underlies the Bateque Formation. The Ballenas formation crops out in the Punta Abreojos area on the west side of Laguna San Ignacio and is best exposed at Rancho Carrizo Mesa. The Ballenas formation outcrops dip northeast at about 14 degrees, whereas the Bateque Formation outcrops are nearly horizontal. The Ballenas/Bateque formational contact is unconformable. The contact lies below the modern sediments of Laguna San Ignacio.

Sorensen (1982) interpreted the Ballenas formation as inner to mid-bathyal turbidites, approximately correlative to the mid-portion of the continental slope. We interpret the lowermost 15 m of the Bateque Formation as the last turbidite in a basin where shallowing was taking place. The Bateque Formation turbidites were probably deposited in offshore, shelf-like depths rather than bathyal depths, because the overlying, mostly bioturbated sandstone that they grade into resembles deposits described by Reineck and Singh (1980:fig. 566) from the modern offshore zone of Sapelo Island, Georgia.

BRAID-DELTA DEPOSITS

Overlying the offshore deposits in the lower part of the Bateque Formation are braid-delta deposits that are 45 m thick (Fig. 2). Outcrops were found only in the vicinity of localities CSUN 1220a and 1220b and consist of pebble conglomerate with subangular to angular clasts that show fair sorting. Most of the clasts consist of volcanic porphyry, but there are some clasts of granite, quartzite, and fossil wood. Bedding is poorly developed. Locally, there are cross beds and some flat pebbles. There are a few channels that contain a fining-upward sequence of small to large pebble conglomerates. Some of the channels have as much as 2 m of incisement into the underlying deposits. The lower contact of the braid-delta deposits is poorly exposed and appears to be gradational with the underlying offshore sandstone. The upper contact with the shallow-marine unit is erosional. The entire 45-m-thick, pebble-conglomerate unit is interpreted to be a lobe of a gravelly delta that formed where a braided-fluvial system prograded into the marine environment. This type of delta, which has been defined as a braid delta, was previously classified as a fan delta (McPherson et al., 1987).

CORAL REEF(?) DEPOSITS

Overlying the braid-delta lobe in the vicinity of localities CSUN 1220b and 1220c is a very poorly exposed, 7-m-thick interval that consists of laminated?, very fine-grained sandstone containing radially oriented or massive large growths of colonial reef corals. Some of the corals are up to 1 m in height and appear to be in situ. It is interpreted that they grew on the top and/or sides of a shoal caused by the underlying lobe of the braid delta. A similar relationship between a fan delta and a 1.5-m-high coral reef of middle Eocene age in northeastern Spain was described by Taberner and Bosence (1985).

Because of the poor exposures of the coral-reef(?) deposits in the Bateque Formation, positive determination as to whether or not the reef corals actually constructed a coral reef cannot be ascertained. Consequently, the term "coral reef" is queried.

SHALLOW-MARINE DEPOSITS

Overlying the coral-reef(?) deposits are 90-m-thick shallow-marine deposits (Fig. 2) that are extensively exposed along the cliffs facing the Pacific Ocean and consist of bioturbated and parallel-laminated, yellow, very fine-grained sandstone (75%) with many interbedded lenses (25%) filled with abundant macrofossils. Most of the fossils described in this report were collected from this part of the Bateque Formation. The parallel-laminated beds are not as abundant as the bioturbated beds and, locally, the two lithologies alternate. Also, locally, there are fairly high-angle cross beds.

The bioturbated sandstone contains more vertical burrows in the lower half of the shallow-marine deposits. Also, in the lower half near locality CSUN 1220c, an angular unconformity extends for at least 100 m.

The fossiliferous lenses range in thickness from 20 to 50 cm and range in lateral extent from a few meters to several hundred meters. Some show incisement into the underlying bioturbated sandstone. Most lenses are vertically separated by only a few meters of very fine-grained sandstone barren of macrofossils or with only rare fragments. Fossils in the lenses are very abundant and form poorly sorted coquinas. Specimens range in size from 1-mm-diameter benthic miliolid foraminifers to 50-cm-long pieces of colonial corals. Specimens in some of the lenses show normal grading. One lens contains miliolid foraminifers in parallel laminae.

Fossils are fragmental to complete. Fossil-hash concentrations are uncommon. Complete specimens of large benthic foraminifers are abundant. Complete, three-dimensionally preserved specimens of calcareous sponges are common. Complete specimens and growth series of the gastropods *Velates perversus* and *V. batequensis* are common. Growth series of the gastropod *Gyrodes*? sp. are also common. Articulated specimens of the bivalves *Pinna* sp., *Nayadina (Exputens) batequensis, Spondylus batequensis,* and *Lima kennedyi* new species are uncommon. Complete spatangoids are uncommon. Fossils show little or no evidence of abrasion, an indication of minimal post-mortem transport.

Some specimens have delicate parts. Examples are a thin and delicate winged outer lip of the gastropod *Platyoptera pacifica,* patches of small spines adhering to the tests of the spatangoid *Schizaster,* and thin epitheca in all specimens of the solitary coral *Antillia batequensis* new species.

Lenses in the upper half of the shallow-marine deposits are thinner, less laterally extensive, and flat-bottomed or with indistinct tops and bottoms and have fewer fossils and more articulated bivalves. There is also a vertical succession of fossil types within the interval. Those in the lower few meters are characterized by algae and abundant colonial corals. In the overlying 40 m or so, the gastropods *Velates perversus* and *Gyrodes*? sp. are common, as are spatangoid echinoids and the large benthic foraminifer *Pseudophragmina clarki.* Toward the top of the shallow-marine deposits, the bivalve *Pycnodonte* (*Phygraea*) *pacifica* and the gastropod *Turritella andersoni lawsoni* predominate. These *Turritella* commonly show bimodal-preferred orientation, an indication of wave action.

The macrofossils in the lenses are interpreted as storm-bed deposits in channels in a shallow-marine environment adjacent to coral reef(?)-inhabited shoal areas. Each shoal would have been a local source of macrofossils, and distance of post-mortem transport would have been short. This is consistent with the unabraded fossils, the articulated bivalves, the growth series of gastropods, and the retention of delicate parts. It is important to note that certain fossils in the channels would normally occur as fragments because their flexible and erect skeletons were joined by horny connective parts. These are the gorgonian *Parisis* and the cheilostome bryozoan *Cellaria.*

The bioturbated to massive very fine-grained sandstone that surrounds the storm beds is interpreted as fairweather deposits in which much biogenic reworking took place. An environment in which shell-filled storm beds are interbedded with fairweather, bioturbated beds would be between fairweather wave base and maximum storm base. This environment would correlate to the inner shelf zone as defined by Bottjer and Jablonski (1988). The term "shelf" cannot be applied to the Bateque Formation with any degree of certainty because whether or not a true shelf was present is not known. In the case of the Bateque Formation, it would be more appropriate to substitute the term "shelf-like depths" for the term "shelf."

The fossils in the channels also suggest nearby reef conditions, especially the algae and colonial corals. Modern *Archeolithothamnium* red algae live in shallow waters, and modern dasycladacean green algae live just below low tide to about a 30-m depth (Wray, 1977). Species of the colonial coral genera *Stylophora, Goniopora, Colophyllia,* and *Montastrea* are common as reef builders (Wood, 1983). They are hermatypic corals (Wells, 1956), and these types of corals are restricted to shallow waters by the light requirements of their symbiotic algae (Oliver and Coates, 1987:162) and flourish in depths less than 50 m (Britton and Morton, 1989:275). Many modern octocorals, including *Heliopora,* are also associated with symbiotic algae (Bayer, 1956; Wood, 1983). The gastropod genus *Velates* has been found associated with inner reef facies in middle Eocene strata of northeastern Spain (Taberner and Bosence, 1985). The bivalve *Nayadina* (*Exputens*) *batequensis* was a byssate epifaunal nestler or, possibly, a byssate fissure dweller (Squires, 1990b), and it could have lived in crevices within reefs. The Bateque Formation bivalves *Barbatia* spp., *Spondylus batequensis,* and *Lima kennedyi* new species could also have been reef dwellers. Today, species of these bivalves are part of a reef community in the northern Gulf of Mexico (Britton and Morton, 1989). The crab genus *Ranina* lives today in depths between 20 and 50 m (Sakai, 1976).

Other fossils in the storm beds also indicate shallow-marine depths. Nearly all the mollusks in the storm beds, with the exception of species only found in the Bateque Formation, have been reported as having lived in depths between about 15 and 60 m in other Eocene formations on the Pacific coast of North America (Squires, 1984, 1987, 1988b).

The upper 20 m of the shallow-marine deposits were deposited in slightly deeper waters that were becoming more offshore because the physical sedimentary structures become less pronounced and coral reef(?)-dwelling organisms are replaced by the gastropod *Turritella andersoni lawsoni* and articulated specimens of the bivalve *Pycnodonte* (*Phygraea*) *pacifica.* This particular subspecies of *Turritella* has been reported as an indigenous faunal element of an offshore community in the Eocene

Llajas Formation, Simi Valley, southern California (Squires, 1981, 1984).

OFFSHORE DEPOSITS IN UPPER PART OF FORMATION

Overlying the shallow-marine deposits are offshore deposits that are 90 m thick (Fig. 2). They crop out primarily in the southern part of the area and consist mostly of bioturbated, yellow, very fine-grained sandstone. There are some laminated beds, scattered shell fragments, some oblique burrows, and some low-angle discordances that extend laterally for several hundred meters and may be related to channelling. Locally, at locality CSUN 1293 in the southeasternmost part of the study area (Fig. 1), there is a 9-m-thick interval of reddish gray mudstone with abundant remains of the large benthic foraminifers *Lepidocyclina* sp. and *Pseudophragmina advena* and the bivalves *Batequeus mezquitalensis* and *Cubitostrea mezquitalensis*. The large benthic foraminifers are complete and have growth series. Rare, thin beds of large benthic foraminifer coquina are present. The bivalves are articulated and show growth series.

The 90-m-thick, bioturbated, very fine-grained sandstone upsection from the shallow-marine storm-bed interval is interpreted as having been deposited offshore (Fig. 2) in depths between normal storm wave base and maximum storm base. Biogenic reworking is extensive, and only a few fossil fragments were moved into this environment during maximum storms. This part of the Bateque Formation strongly resembles the offshore strata just below the braid delta and would correlate to the middle "shelf" as defined by Bottjer and Jablonski (1988). This environment prevailed to the top of the Bateque Formation except for the 9-m-thick mudstone at locality CSUN 1293. The large benthic foraminifers, except those in the rare maximum storm-influenced coquinas, and the bivalves are in situ and represent a paleocommunity that lived in fairly quiet waters no deeper than 100 m (Squires and Demetrion, 1990b).

The vertical sequence of offshore, to braid delta, to coral reef(?), to shallow marine, to offshore deposits for the Bateque Formation (Fig. 2) is herein recognized for the first time. Sorensen (1982) reported that the entire formation was massive-bedded and deposited by sheet flow, high-concentration turbidites into bathyal depths. He did find mollusks and echinoids but concluded that they had been transported. Sorensen did not report the braid-delta conglomerate, the overlying coral-reef(?) deposits, and the well-bedded storm beds in the shallow-marine deposits. McLean et al. (1985, 1987) cited Sorensen's (1982) paleoenvironmental interpretations.

DIATOMITE OVERLYING THE BATEQUE FORMATION

In the southeastern part of the study area in Arroyo San Raymundo (Fig. 1), a small exposure of an 8-m-thick sequence grades upward from brown, thin-bedded, well-indurated, fish-scale-bearing mudstone, interbedded with porcellaneous beds, into white unaltered diatomite that strongly resembles the Miocene Monterey Formation of California. The lateral extent of the exposure is only about 50 m because of cover by modern stream alluvium. The base of the sequence is in sharp contact with an underlying 2-m-thick exposure of bioturbated, yellow, very fine-grained sandstone, and the contact between the sandstone and diatomite appears to be an erosional surface with channelling and truncated beds. The lower part of the diatomite sequence also contains two sedimentary dikes consisting of the mudstone and impure diatomite. These dikes extend upward from the contact with the yellow sandstone but they do not pierce the contact. The mudstone and porcellaneous beds are draped over a possible paleo-high in the underlying sandstone. The mudstone and porcellaneous beds on both sides of the paleo-high show pinch outs as they approach it.

McLean and Barron (1988), who did not discuss any field relations regarding the diatomite, included it within the Bateque Formation because the ages are similar. The late middle Eocene CP14a to CP14b age they obtained from diatoms in the unit is about the same to slightly younger than for the mudstone at locality CSUN 1293 in the upper part of the Bateque Formation (see "Age and Correlation"). Diatom samples collected by the authors from the diatomite yielded the same age range (R. Arends, pers. comm., 1990) reported by McLean and Barron (1988).

McLean and Barron (1988) also included the diatomite in the Bateque Formation because they concluded, as did Sorensen (1982), that the entire Bateque Formation was deposited by turbidity currents and sediment-gravity flows in waters between the shelf break and the base of the continental slope.

McLean and Baron (1988) also mentioned another diatomite locality in the northern part of the field area. They included this diatomite within the Bateque Formation, but they lacked an age date for it and did not discuss the field relations.

We are reluctant to include any diatomite beds within the Bateque Formation because a positive relationship to the Bateque Formation cannot be proven at this time. From what was observed at Arroyo San Raymundo, the field relations are ambiguous and more detailed study is needed.

The Arroyo San Raymundo diatomite shares characteristics of the upper Oligocene San Gregorio Formation that McLean et al. (1985, 1987) described, and that McLean and Barron (1988) reported as cropping out in upper Arroyo San Raymundo in an unconformable relationship with the Bateque Formation. The San Gregorio Formation contains brown porcellaneous shale with fish scales, nontectonic folds, and white diatomite that resembles the Miocene Monterey Formation of California. The so-called Bateque Formation diatomite

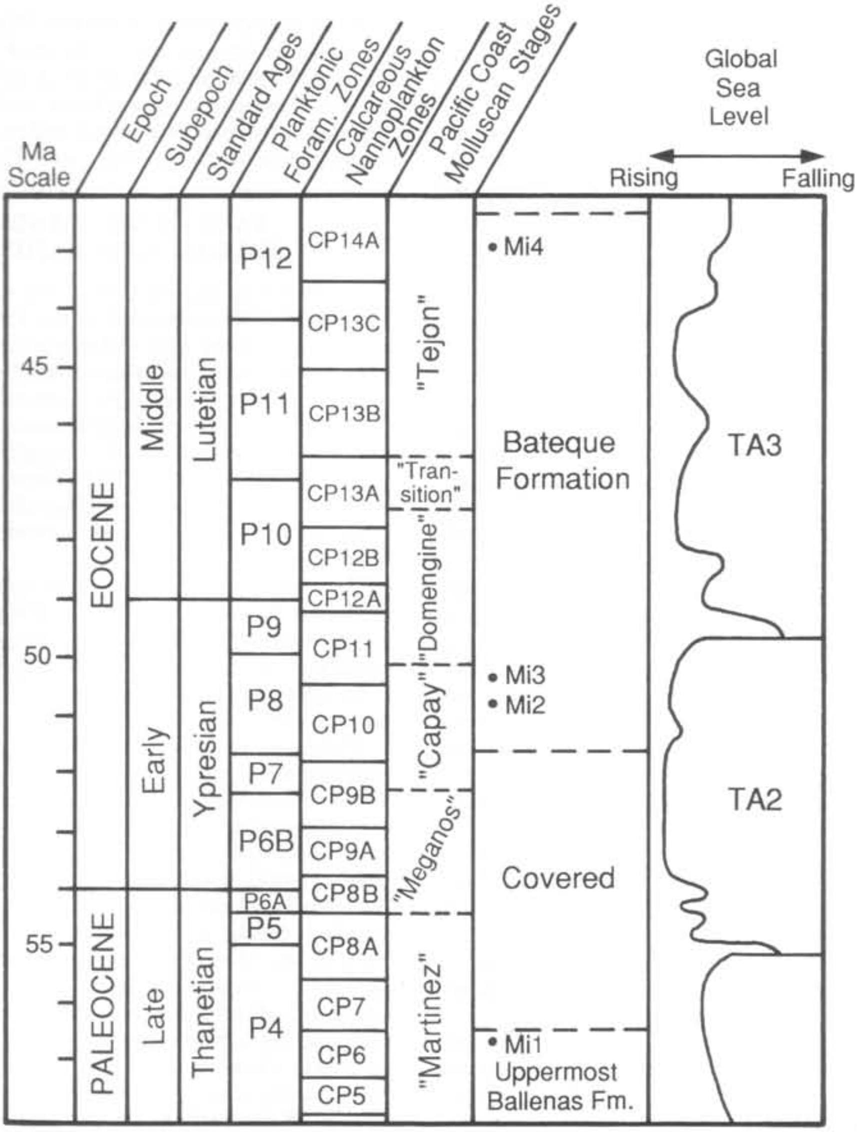


Figure 3. Correlation of the Bateque Formation and uppermost Ballenas formation with millions of year scale (Ma), epochs, subepochs, standard ages, planktonic foraminifera zones, calcareous nannoplankton zones, global sea-level changes (all from Haq et al., 1987), and Pacific coast provincial molluscan stages (from Saul, 1983). Geologic age results of four microfossil (Mi) samples are also plotted.

may be the, heretofore, upper middle Eocene unrecognized basal part of the San Gregorio Formation.

AGE AND CORRELATION

Sorensen (1982) reported that the Bateque Formation overlies the Ballenas formation. Based on small-sized benthic foraminifers, he reported the age of the Ballenas formation to be early to early late Paleocene. A microfossil sample (Mi1) collected by us at the top of the Ballenas formation at Rancho Carrizo Mesa (Figs. 1, 3) yielded the following species of calcareous nannofossils: *Fasciculithus tympaniformis* Hay and Mohler, *Discoaster mohleri* Bukry and Percival, and *Coccolithus pelagicus* (Wallich). M. Filewicz (pers. comm., 1990) assigned them to the upper Paleocene *Discoaster mohleri* (CP6) Zone of Okada and Bukry (1980).

The Bateque Formation ranges in age from middle early Eocene to late middle Eocene (Fig. 3) based on calcareous nannofossils, planktonic foraminifers, and mollusks. An early Eocene age for most of the Bateque Formation ranging into the middle Eocene near the top is also what Sorensen (1982) found using small benthic foraminifers. McLean et al. (1985, 1987) iterated Sorensen (1982).

Macrofossils are lacking in the offshore and braid-delta deposits in the lower 115 m of the Bateque Formation. The only microfossil sin this interval are some rare and poorly preserved calcareous nannofossils that are not zone diagnostic but do indicate an early to early middle Eocene age (M. Filewicz, pers. comm., 1988).

Planktonic foraminifers from microfossil locality Mi2 (Fig. 1) at the base of the shallow-marine deposits (Fig. 2) indicate a middle early Eocene age ("Capay" age) (Figs. 2, 3) based on overlap of *Acarinina nitida* (Martin) and *Morozovella aragonensis* (Nuttall) (equivalent to the *Globorotalia formosa formosa* Zone of Stainforth et al., 1975, and the P8? Zone of Blow, 1979) (R. Fulwider, pers. comm., 1988).

Planktonic foraminifers from microfossil locality Mi3 (Fig. 1) near the middle of the shallow-marine deposits (Fig. 2) also indicate an early Eocene age (Figs. 2, 3) based on the presence of *M. aragonensis* and *M. aragonensis caucasica* (Glaessner) (equivalent to *Globorotalia aragonensis* or *G. pentacamerata* Zones of Stainforth et al., 1975, and the P8 or P9 Zone of Blow, 1979) (R. Fulwider, pers. comm., 1988). The P8 Zone ("Capay" age) interpretation is favored here because of the upsection presence of the gastropod *Turritella andersoni* s.s., which is diagnostic of the "Capay Stage." This gastropod was found at localities CSUN 1291a and 1291b, in the upper part of the shallow-marine deposits. This species is known elsewhere on the Pacific coast only from the middle lower Eocene "Capay Stage" (Givens, 1974; Squires, 1987, 1988b, 1988c).

Turritella andersoni lawsoni was found at localities CSUN 1220c (upper part), 1220d, and 1291c, near the top of the shallow-marine deposits. This subspecies is known elsewhere on the Pacific coast only from the upper lower through lower middle Eocene "Domengine Stage" (Givens, 1974; Squires, 1984).

Most of the other mollusks in the shallow-marine and overlying offshore deposits range from the "Capay Stage" through the "Domengine Stage." Calcareous nannofossils from these deposits are very rare and poorly preserved and generally indicate an undifferentiated Paleogene age (M. Filewicz, pers. comm., 1988).

Calcareous nannofossils from locality CSUN 1293 (= microfossil locality Mi4) (Fig. 1) in the mudstone interval of the offshore deposits near the top of the Bateque Formation (Figs. 2, 3) indicate the middle Eocene *Discoaster bifax* CP14a Subzone of Okada and Bukry (1980) based on the presence of *Reticulofenestra umbilica* (Levin) and *Chiasmolithus solitus* (Bramlette and Sullivan) (M. Filewicz, pers. comm., 1989). Mollusks at this locality are not stage diagnostic. This subzone is equivalent to the middle Eocene part of the molluscan "Tejon Stage."

Beal (1948) assigned all Paleocene and Eocene strata of peninsular Baja California to Heim's (1922) Tepetate Formation, whose type section is about 200 km south of the study area at Rancho Tepetate, east of Bahia Magdalena, Baja California Sur. Mina (1956, 1957) mainly restricted the Tepetate Formation to its type section area but did include the outcrops in the vicinity of locality CSUN 1293 (in the southeasternmost part of the study area) in the Tepetate Formation. McLean et al. (1985) suggested that these particular rocks be included in the Bateque Formation. We concur and restrict the Bateque Formation to the study area (Fig. 1).

PALEOCLIMATE AND PALEOBIOGEOGRAPHY

As reviewed by Squires (1987), the early Eocene was the peak warm interval of the Cenozoic, and tropical conditions were widespread until a worldwide cooling trend began in the late Eocene. Macrofossils within the Bateque Formation strongly support the presence of tropical waters. Living species of *Archaeolithamnium*, a coralline red alga, are restricted to tropical and subtropical marine waters (Wray, 1977:68). Living dasycladacean green algae occur most commonly in tropical and subtropical waters (Wray, 1977:106).

The calcareous nannofossils at locality CSUN 1293 near the top of the Bateque Formation show a greater diversity than that in age-equivalent assemblages in California, which suggests warmer (tropical?) paleotemperatures (M. Filewicz, pers. comm., 1989).

The extinct large benthic foraminifer genus *Pseudophragmina* is indicative of tropical to subtropical waters (Vaughan, 1945:70). Living calcareous sponges, similar to the extinct *Elasmostoma*, are most commonly found in shallow tropical waters (Rigby, 1987). The living octocoral *Heliopora* is associated with coral reefs (Wood, 1983). The living colonial corals *Stylophora, Goniopora, Colpophyllia*, and *Montastrea* are all hermatypic and indicative of tropical waters (Wells, 1956; Wood, 1983). Nearly all the molluscan species have been reported from tropical to subtropical paleoenvironments elsewhere on the Pacific coast of North America (Squires, 1984, 1987, 1988b). Only one species of the crab *Ranina* is now living and is confined to the warm waters of the tropical Indo-Pacific region (Rathbun, 1919). Only five species of *Eupatagus* are known today, and all are in the tropical Indo–West Pacific (Kier, 1984).

The widespread warm-water conditions that prevailed during the Eocene caused latitudinal gradients in the marine faunas to be slight (Addicott, 1970). Paleolatitude determination for Baja California Sur during deposition of the Bateque Formation, therefore, must rely heavily on paleomagnetic data. As reviewed by Flynn et al. (1989), workers have maintained that the Baja California peninsula has been tectonically translated northward by 10–15 degrees since the Late Cretaceous. As to the question of the timing of this northward translation, the paleomagnetic data have been inconsistent and contradictory. For example, Morris et al. (1986) concluded that the translation was entirely post-Miocene, but the work by Flynn et al. (1989) indicated that there has been no significant post–early Eocene northward translation of

Baja California and that the early Eocene paleolatitude of the Baja California peninsula was almost the same as its present latitude.

The early Eocene ("Capay Stage") was a time of major influx of Old World Tethyan macroinvertebrates into the Pacific coast of North America via a seaway through Central America (Clark and Vokes, 1936; Givens, 1979; Squires, 1984, 1987). Arrival of the Tethyan mollusks in California during the early Eocene was also coincident with a major global sea-level rise (Squires, 1987) that is equivalent to the TA2 cycle of Haq et al. (1987) (Fig. 3). Many of the species used to document the timing of this influx of immigrants into California are the same ones present in the lower Eocene ("Capay Stage") part of the Bateque Formation. One of the most important of these is the neretid gastropod *Velates perversus,* which emigrated westwardly from Pakistan into the Pacific coast of North America during the early Eocene (Squires, 1987). Other Bateque Formation mollusk genera that have been recognized as Tethyan or Tethyan affinity (Clark and Vokes, 1936; Squires, 1984, 1987, 1990b; Givens, 1989) and that accompanied *V. perversus* into Pacific coast waters include species of *Paraseraphs, Eocypraea, Ectinochilus, Pachycrommium, Galeodea, Clavilithes, Lyrischapa, Barbatia,* and *Nayadina* (*Exputens*).

Several of the macrofossils from the lower Eocene ("Capay Stage") part of the Bateque Formation are new to the Pacific coast of North America. These include species of the sponge *Elasmostoma,* the cnidarians *Heliopora*?, *Parisis, Heterocoenia*?, *Stylosmilia, Antillia,* and *Montastrea,* the bryozoan *Stomatopora,* the gastropods *Tenagodus, Platyoptera,* and *Cypraedia,* the bivalve *Pycnodonte* (*Phygraea*), the crab *Lophoranina,* possibly the cassiduloid echinoid *Echinolampas,* and possibly the spatangoid echinoid *Eupatagus.* The sponge *Elasmostoma* and the corals *Stylosmilia* and *Heterocoenia*? were previously only known from Mesozoic strata, primarily in western Europe. For the gastropod *Platyoptera* and possibly the gorgonian *Parisis,* this is the earliest occurrence anywhere in the world.

A few of the Bateque Formation macrofossils have been previously reported from the Pacific coast but have their earliest record in the lower Eocene ("Capay Stage") part of the Bateque Formation. These genera are the large benthic foraminifer *Lepidocyclina,* the bryozoan *Cellaria,* the bivalve *Nayadina* (*Exputens*), the crab *Ranina,* and possibly the bivalves *Barbatia* (*Acar*?) and *Lima* as well as possibly the spatangoid echinoid *Eupatagus.* For *Nayadina* (*Exputens*) and *Ranina,* this is the earliest occurrence anywhere in the world.

A few of the Bateque Formation macrofossils have been previously reported from the Pacific coast but have their latest occurrence in the lower Eocene ("Capay Stage") part of the Bateque Formation. These molluscan genera are the gastropods *Bernaya* (*Protocypraea*), *Amauropsis,* and *Gyrodes*?. For the latter two, this is the latest record anywhere in the world.

The bivalve genus *Cubitostrea* appeared on the Pacific coast during the upper middle Eocene ("Tejon Stage") part of the Bateque Formation.

The bivalve genera *Batequeus* and *Pycnodonte* (*Pegma*) are known only from the Bateque Formation.

SYSTEMATIC MATERIALS AND METHODS

Systematic arrangement for the kingdom categories is from Margulis and Schwartz (1982). Systematic arrangement of the generic and higher taxonomic categories follows that of Wray (1977) for the algae, Loeblich and Tappan (1988) for the large benthic foraminifers, Laubenfels (1955) for the sponges, Bayer (1956) for the octocorals, Wells (1956) for the scleractinian corals, Bassler (1953) for the bryozoans, Clark (1969) for the polychaete worm, Palmer (1974) for the scaphopod, generally Wenz (1938–1944) for the gastropods, Bieler (1988) for the gastropod *Architectonica,* Cox et al. (1969) and Vokes (1980) for the bivalves, Kummel (1964) for the cephalopods, Glaessner (1969) for the brachyurans, and Fischer (1966) for the echinoids.

The original reference is given for each species or subspecies. Synonymies and primary type material for most of the positively identified species/subspecies of the Bateque Formation can be found in Squires (1984, 1987, 1988b). For those few taxa that are not included therein, primary type material is given herein, and reference is made to a source in which a synoymy is available.

Molluscan stage range and geographic distribution are given for each positively identified species or subspecies, with most of the data derived from Squires (1984, 1987, 1988b). For those few taxa that are not included herein, literature sources are given under "Remarks" in this present report.

The molluscan stages are those of Clark and Vokes (1936), who informally proposed five molluscan provincial Eocene stages for the Pacific coast of North America: "Meganos," "Capay," "Domengine," "Transition," and "Tejon." They recognized two faunal zones in their "Capay Stage." Givens (1974) showed that the upper faunal zone of the "Capay" should be assigned to the "Domengine Stage," and he restricted the use of "Capay Stage" to the lower faunal zone. The "Capay Stage" is used herein. Saul (1983) and Squires (1984, 1987, 1988b) regarded the restricted "Capay Stage" of Givens (1974) as middle lower Eocene.

Local occurrence and remarks are given for the species. Terms used to denote specimen abundance are defined as follows (number of specimens in parentheses): rare (1–4), uncommon (5–9), common (10–29), and abundant (30 or more).

New stage ranges or new geographic extensions that are the result of this present study also are mentioned under "Remarks."

Abbreviations used for catalog and/or locality numbers are as follows:

CAS: California Academy of Sciences, San Francisco.
CSUN: California State University, Northridge.
IGM: Instituto de Geología, Universidad Nacional Autónoma de México, Mexico City.
LACMIP: Natural History Museum of Los Angeles County, Invertebrate Paleontology Section.
SDNHM: San Diego Natural History Museum.
USNM: United States National Museum of Natural History.

The type specimens are deposited at IGM; plaster casts of the primary type material from the Bateque Formation have also been deposited at LACMIP.

SYSTEMATICS

Kingdom Protoctista

Division Rhodophyta

Class Rhodophyceae

Order Cryptonemiales

Family Corallinaceae (Lamouroux) Harvey, 1849

Genus *Archaeolithothamnium* Rothpletz, 1891

Archaeolithothamnium sp.

Figure 4

LOCAL OCCURRENCE. Localities CSUN 1220 a, 1220b, 1471.

REMARKS. Specimens of this red alga are common at localities 1220a and 1220b. They are rare at locality 1471. Most specimens occur as aggregates (rhodoliths) of crustose lumps up to 5.5 cm across. Some specimens show sporangia arranged in loose rows, a distinctive feature of this genus (Wray, 1977:60). One specimen at locality 1471 encrusts the octocoral *Heliopora*? sp.

Division Chlorophyta

Class Chlorophyceae

Order Dasycladales

Family Dasycladaceae Stizenberger, 1860

Dascyladaceae, indet.

Figure 5

LOCAL OCCURRENCE. Localities CSUN 1220a, 1220b, 1291a, 1470.

REMARKS. Specimens of this green alga are abundant at 1220a, 1220b, and 1291a and form an integral part of the lithology of rocks at these localities. At locality 1470, they are common. All specimens are disarticulated fragments of variable shapes. Lensoidal and polygonal shapes are the most common. Some fragments are up to 4 mm long, and many have closely spaced pits on the exterior. These pits have been subdued by weathering. In some hand specimens, the fragments show concentration and sorting.

Phylum Protista

Class Rhizopodea

Order Foraminiferida

Family Lepidocyclinidae Scheffen, 1932

Genus *Lepidocyclina* Gümbel, 1870

Lepidocyclina sp.

Figures 6, 7

LOCAL OCCURRENCE. Locality CSUN 1293.

REMARKS. Specimens are extremely abundant and form a "pavement" on the weathered mudstone outcrops at this locality. Tests show a growth series up to 21 mm in diameter, and many of the tests are of large size. They have a granular exterior, and a few have a small central boss. Internally, they have four-sided to six-sided equatorial chambers. In each chamber, the chamber wall that is nearer the periphery of the test is convex outward.

Unfortunately, the proloculus area in every specimen that was thin-sectioned has been obliterated by diagenesis. Identification as to species is not possible.

Lepidocyclina sp. from the Bateque Formation resembles *L. ocalana* Cushman (1920:71–72, pl. 28, figs. 3, 4; pl. 29, figs. 1–3) from the upper Eocene Ocala Limestone, northern Florida. The Bateque Formation specimens differ in the following features: less inflated central boss area and both sides of test similar rather than dissimilar.

Lepidocyclina has not been reported previously from the Eocene of the Pacific coast of North America any farther north than Chiapas, Mexico, where Vaughan (1924) reported *L.* (*Polylepidina*) *chiapasensis* Vaughan (1924:808–809, pl. 30, figs. 1–3) from Eocene strata and *L.* (*P.*) *adkinsi* Vaughan (1924:809–810, pl. 31, figs. 1–5) from upper Eocene strata. *Lepidocyclina* sp. from the Bateque Formation differs from *L.* (*P.*) *chiapasensis* in having a much larger test and a less inflated central boss area, and the Bateque Formation species differs from *L.* (*P.*) *adkinsi* in having a larger test and a less pronounced granular exterior.

Schenck and Childs (1942) reported *Lepidocyclina* from upper Oligocene deposits in California.

Family Nummulitidae de Blainville, 1827

Genus *Operculina* d'Orbigny, 1826

Operculina sp., aff. *O. cookei* Cushman, 1921a

Figure 8

[*Operculina cookei* Cushman, 1921a:127–128, pl. 18, figs. 1, 2.]

LOCAL OCCURRENCE. Locality CSUN 1293.

REMARKS. Specimens are uncommon. The planispiral and flattened tests are up to 9 mm in length. They resemble *O. cookei* Cushman, 1921a, from the upper Eocene Ocala Limestone of Georgia. The Bateque Formation specimens differ in having pustules along the sutures rather than having continuous ridges along the sutures.

There are only a few other Eocene occurrences of *Operculina* from the Pacific coast of North America. *Operculina cushmani* Cole (1927:23, pl. 2, fig. 13) is known from the middle Eocene "Domengine Stage" part of the Llajas Formation, Simi Valley, southern California (Cushman and McMasters, 1936:513, pl. 75, figs. 18–20). *Operculina cushmani* is also known from the lower Paleogene lower Lodo Formation, Media Agua Creek, south-central California (Mallory, 1959:185, pl. 15, fig. 11). The Bateque Formation specimens have less distinct sutures and no raised central boss area. The type locality of *O. cushmani* is on the eastern coast of Mexico at Guayabal (Cole, 1927), which is half way between the cities of Tampico and Veracruz, Mexico.

Operculina sp. is known from the upper Eocene Keasey Formation, southwestern Washington (Durham, 1937:367, fig. 1). The Bateque Formation specimens differ in having pustules along the sutures and fewer sutures.

Givens (1974:table 1) listed *Operculina*? sp. from a locality in middle Eocene "Domengine Stage" strata in the Pine Mountain area, southern California.

Although Woodring (1930) reported *Operculina* cf. *ocalana* Cushman from Eocene limestone deposits, Santa Barbara County, southern California, Cole (1958:411) reassigned these specimens to genus *Operculinoides*.

Family Discocyclinidae Vaughan and Cole, 1940

Genus *Actinocyclina* Gümbel, 1870

Actinocyclina sp., aff. *A. aster* Woodring, 1930

Figure 9

[*Actinocyclina aster* Woodring, 1930:152–155, pl. 14, figs. 3–6; pl. 16, figs. 1–4; pl. 17, figs. 1, 2.]

LOCAL DISTRIBUTION. Locality CSUN 1220b.

REMARKS. Specimens are rare, as much as 4 mm in diameter, and discoidal in outline, and most have seven very narrow rays or ridges emanating from a central raised boss. These rays are papillate and extend to the periphery. One specimen has eight narrow rays because one ray is bifurcated.

The Bateque Formation specimens resemble the narrow-rayed forms of *A. aster* Woodring, 1930, from the lower? Eocene Sierra Blanca Limestone, Santa Barbara County, southern California. Ellis and Messina (1967:unnumbered plates, figs. 1–26) also illustrated *A. aster*. The rays in the Bateque Formation specimens are narrower and show no tendency for having thick rays or as many as 13 rays that can occur in *A. aster*.

Genus *Pseudophragmina* Douvillé, 1923

Pseudophragmina clarki (Cushman, 1920)

Figures 10, 11

Orthophragmina clarki Cushman, 1920:41–42, pl. 7, figs. 4, 5.

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Florida, Peru?, Mexico through southwestern Oregon.

LOCAL OCCURRENCE. Localities CSUN 1219, 1220a, 1220b, 1220c, 1291a, 1291b, 1470?, 1471.

REMARKS. Specimens are extremely abundant, especially at localities 1219, 1220a, 1220b, and 1220c. Specimens are up to 7 mm in diameter and have pustules on the exterior, and most show a well-developed central boss.

Cole (1958:419) regarded *Orthophragmina peruviana* Cushman (1922:138–139, pl. 24, fig. 3) to be a synonym of *P. clarki*. If this is correct, then *P. clarki* also occurs in Peru.

Pseudophragmina advena (Cushman, 1921b)

Figures 12, 13

Orthophragmina advena Cushman, 1921b:139, pl. 22, figs. 1–5.

PRIMARY TYPE MATERIAL. Holotype, USNM 328252, from the St. Maurice Formation, Natchitoches, Louisiana, Eocene.

MOLLUSCAN STAGE RANGE. "Capay" through middle Eocene part of "Tejon."

GEOGRAPHIC DISTRIBUTION. Gulf Coast of the United States, Jamaica, Cuba, Baja California Sur, Mexico, through Santa Ynez Range, southern California.

LOCAL OCCURRENCE. Localities CSUN 1293, 1471.

REMARKS. Specimens are abundant, as much as 12 mm in diameter, lensoidal, and smooth exteriorly. Internally, the annuli are much more closely spaced than in *P. clarki*, and the radial walls of the equatorial chambers are not as well developed as those in *P. clarki.*

For the rather involved synonymy and geographic distribution of this species, see Cole (1969:25–26), who regarded *P. perkinsi* (Vaughan, 1928) from Jamaica, *P. compacta* Cole and Gravell, 1952, from Cuba, and *P. cloptoni* (Vaughan, 1929) from Baja California Sur to be synonyms.

The Bateque Formation specimens are like *P. cloptoni* (Vaughan, 1929:14–15, pl. 15, figs. 1–6) from the Tepetate Formation east of Bahia Magdalena, Baja California Sur. Neither the Bateque Formation specimens nor *P. cloptoni* from the Tepetate Formation show the deep umbonal depression than can be associated with *P. advena*. Cole (1969), however, noted that *P. advena* has variable shape and is the same as *P. cloptoni* based on identical internal structures.

Based on its presence in the Bateque Formation, the molluscan stage range of this species can now be reported as "Capay" through the middle Eocene part of the "Tejon."

Kingdom Animalia

Phylum Porifera

Class Demospongea

Order Hadromerida

Family Clionidae Gray, 1867

Clionidae?, indet.

Figure 14

LOCAL OCCURENCE. Localities CSUN 1220b, 1220c, 1471.

REMARKS. Boreholes probably related to the burrowing sponge *Cliona* were found in a few of the larger specimens of *Velates perversus* and *Eocernia hannibali* (Fig. 83) at locality 1220b and on some of the specimens of *Pycnodonte* (*Phygraea*) *pacifica* at localities 1220c and 1471.

Class Calcarea

Order Lithonida

Family Elasmostomatidae de Laubenfels, 1955

Genus *Elasmostoma* Fromentel, 1860

Elasmostoma bajaensis Squires and Demetrion, 1989

Figures 15, 16

Elasmostoma bajaensis Squires and Demetrion, 1989:440–442, figs. 1–9.

PRIMARY TYPE MATERIAL. Holotype, LACMIP 7982; paratypes, LACMIP 7983, 7984, and 7985; all from locality CSUN 1220a.

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Locality CSUN 1220a.

REMARKS. Specimens are abundant. They are three-dimensional and many are complete. Others are unabraded fragments formed during weathering of the exposures. Most specimens are ear-shaped, and they form a growth series ranging from 9 to 45 mm in diameter. Three of these specimens have small buds where juveniles are attached. One colonial specimen, consisting of four specimens, is 70 mm in diameter and 20 mm in depth.

Before its discovery in the Bateque Formation, *Elasmostoma* was previously only known from Jurassic and Cretaceous strata of western Europe (Squires and Demetrion, 1989).

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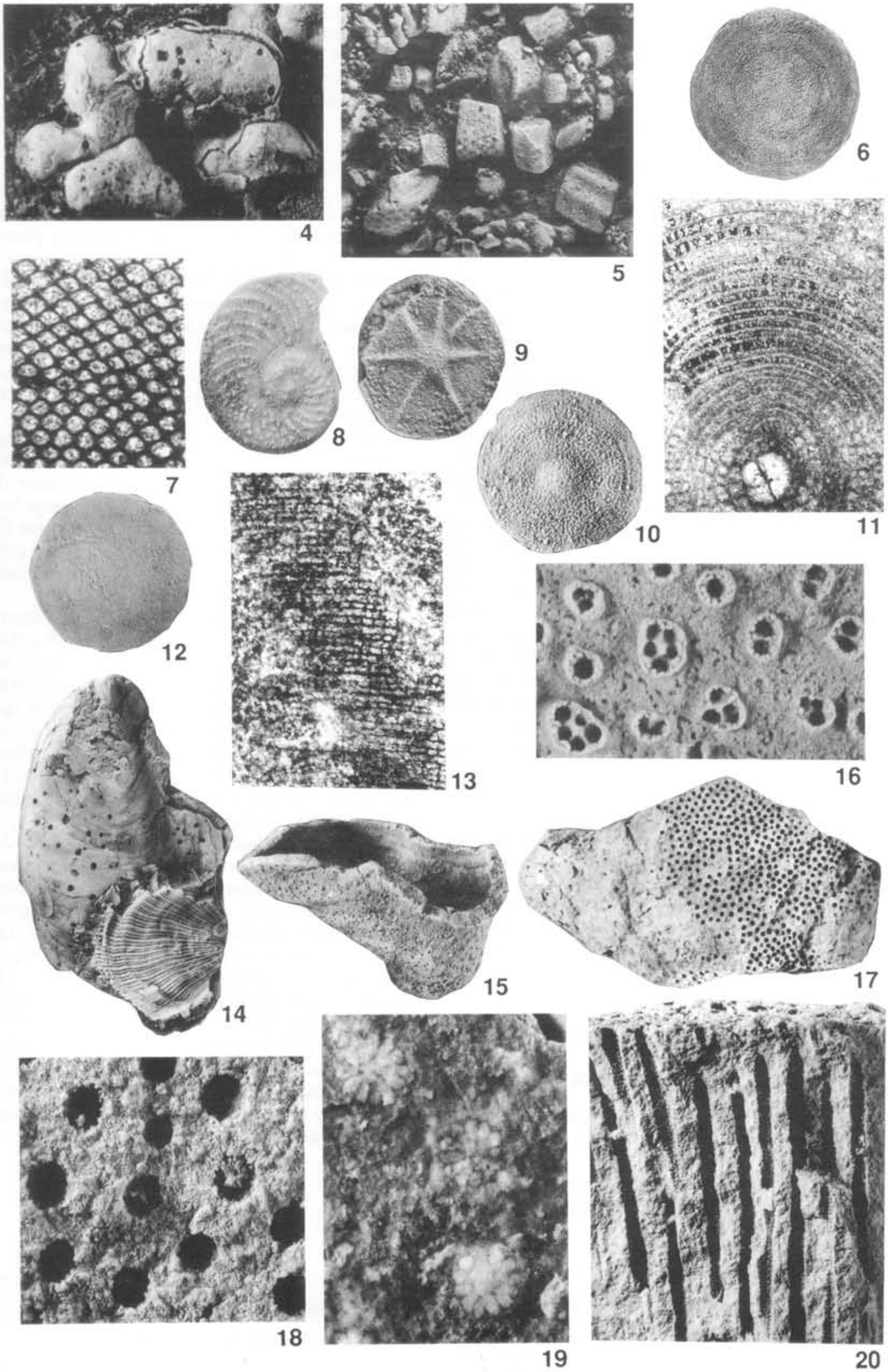
Figures 4–20. Bateque Formation calcareous algae, large benthic foraminifera, sponges, and a spongiomorph? organism. **Figs. 4, 5.** Calcareous algae. **4.** *Archeolithothamnium* sp., ×1.74, width of field 29 mm, hypotype, IGM 5120, loc. CSUN 1220b. **5.** Dasycladaceae, indet., ×3.2, width of field 16 mm, hypotype, IGM 5121, loc. CSUN 1220b. **Figs. 6–13.** Large benthic foraminifera. **6, 7.** *Lepidocyclina* sp., loc. CSUN 1293. **6.** Test exterior, ×1.2, diameter 21 mm, hypotype, IGM 5122. **7.** Part of equatorial section, ×27, width of field 1 mm, hypotype, IGM 5123. **8.** *Operculina* sp., aff. *O. cookei* Cushman, 1921a, test exterior, ×3.1, height 9 mm, width 6 mm, hypotype, IGM 5124, loc. CSUN 1293. **9.** *Actinocyclina* sp., aff. *A. aster* Woodring, 1930, test exterior, ×5.6, diameter 4.5 mm, hypotype, IGM 5125, loc. CSUN 1220b. **10, 11.** *Pseudophragmina clarki* (Cushman, 1920), loc. CSUN 1220b. **10.** Test exterior, ×4.3, diameter 6 mm, hypotype, IGM 5126. **11.** Equatorial section, ×33, width of field 1.5 mm, hypotype, IGM 5127. **12, 13.** *Pseudophragmina advena* (Cushman, 1921b), loc. CSUN 1293. **12.** Test exterior, ×3, diameter 8.3, hypotype, IGM 5128. **13.** Part of equatorial section, ×50, width of field 1 mm, hypotype, IGM 5129. **Figs. 14–16.** Sponges. **14.** Clinoidae?, indet., in left valve of *Pycnodonte* (*Phygraea*) *pacifica*, ×0.9, height of valve 67 mm, width 41 mm, hypotype, IGM 5130, loc. CSUN 1471. **15, 16.** *Elasmostoma bajaensis* Squires and Demetrion, 1989, loc. CSUN 1220a. **15.** Side view, ×1.1, height 25 mm, maximum width 31 mm, paratype, LACMIP 7983. **16.** Part of ostia-bearing wall, ×9, width of field 5.8 mm, paratype, LACMIP 7984. **Figs. 17–20.** Spongiomorph organism. Spongiomorphidae?, hypotype, IGM 5131, loc. CSUN 1220a. **17.** Dorsal view of entire colony, ×0.4, length 14 cm. **18.** Part of dorsal surface near center of colony, ×4.3, width of field 11 mm. **19.** Underside of small chip removed from upper right area of colony, ×8.3, width of field 4 mm. **20.** Part of lateral view, ×2, width of field 22 mm.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Phylum Cnidaria

Class Hydrozoa

Order Spongiomorphida

Family Spongiomorphidae Frech, 1890

Spongiomorphidae?, indet.

Figures 17–20

LOCAL OCCURRENCE. Locality CSUN 1220a.

REMARKS. Two specimens were found, one colony about 15 cm in length and 4.5 cm in thickness, and another only a sliver (4 cm thick) of a colony. The larger specimen shows the best preservation. It consists of coenosteum surrounding circular gastropores(?), openings about 1 mm in diameter and spaced about 1.5–2.5 mm apart. The walls of the gastropores(?) consist of 12 stellate columns (pseudosepta). The gastropores(?), which are flush with the external surface, extend vertically all the way through the 4.5-cm-thick colonial structure. They do not vary in diameter throughout their vertical extent. Most of the gastropores(?) are hollow and have a beaded appearance along the walls. This beaded appearance is similar to that of the surrounding coenosteum. About 10 percent of the gastropores(?) are completely filled with calcareous material consisting of six rods grouped starwise as a vertical, tubular structure encircling a central rod. Each of the six rods are bilobate due to a slit that extends toward the central rod. A few structures consist of 10 rods encircling a central one.

In transverse view, the Bateque Formation specimens resemble the spongiomorph *Heptastylis stromatoporoides* [Frech (1890); Hill and Wells, 1956: 88, fig. 74 2a–c; Chudinova, 1962:232, fig. 12a–c] from Triassic strata of Europe. The Bateque Formation specimens differ significantly in lacking the horizontal laminae of *Heptastylis*.

It is interesting to note that the empty, minutely stellate gastropores(?) of the Bateque Formation spongiomorph(?) specimens resemble those seen in the Bateque Formation specimens of the octocoral *Heliopora*? sp.

Class Anthozoa

Order Coenothecalia

Family Heliporidae Moseley, 1876

Genus *Heliopora* de Blainville, 1830

Heliopora? sp.

Figures 21, 22

LOCAL OCCURRENCE. Locality CSUN 1471.

REMARKS. Specimens are rare, and they appear to be distal parts of colonies or incrustations. Specimens consist of finely porous coenosteum surrounding circular autozooid pits about 1.25 mm in diameter and about 1–2 mm apart (measured from wall to wall). The walls of the autozooid pits show about 24 minute columns (pseudosepta). The pits are nearly filled with calcareous sediment.

Heliopora? sp. from the Bateque Formation is only the third occurrence of this genus in North America. *Heliopora mexicanae* Frost and Langenheim (1974:311–312, pl. 123, figs. 1–3; Perrilliat, 1989:93, fig. 32c) is known from middle Eocene strata of Chiapas, Mexico. The Bateque Formation specimens differ in having twice as many pseudosepta per autozooid pit.

Heliopora bennetti Wells (1934:155–156, pl. 2, figs. 1, 2) is known from upper? Eocene strata of Cuba and is more similar to the Bateque Formation species. The Bateque Formation species differs in having pseudosepta that do not project halfway to the center of the autozooids and autozooids that are larger and more widely spaced.

The genus *Heliopora* is queried for the Bateque Formation specimens and also should be queried for the Chiapas and Cuban species, because they do not possess the distinctive tubular openings found within the autozooids of *Heliopora coerulae* (Pallas) (Wood, 1983:214), the type species of *Heliopora*. The Bateque Formation, Chiapas, and Cuban species may belong to a new genus.

Heliopora? sp. from the Bateque Formation closely resembles *H. edwardsana* Stoliczka (1873: 185–186, pl. 11, fig. 11, 11a, 11b) from the Ootatoor Group of southern India. Sastry et al. (1968) assigned the Ootatoor Group to the lower upper Cretaecous (Cenomanian Stage). The Bateque Formation specimens differ in having more pseudosepta (24 rather than 18) and more closely spaced autozooids (1–2 mm apart rather than 4–5 mm apart).

According to Montanaro-Gallitelli (1956), *Heliopora* is confined to the Recent. It is evident, therefore, that all fossil species of *Heliopora* should be reviewed to determine their generic placement. Several Cretaceous specimens have been reported from Europe and southern India (Stoliczka, 1873; Felix, 1914b), and one probable Cretaceous species has been reported from central Texas (Wells, 1932, 1934). A few Eocene species have been reported from Europe (Wells, 1934). Woodring (1957:21) included *Heliopora* sp. in a checklist of corals from the middle to upper Eocene Gatuncillo Formation in the Panama Canal Zone. He did not give any repository numbers nor did he figure or describe the specimen(s).

Order Gorgonacea

Family Parisididae Aurivillius, 1931

Genus *Parisis* Verrill, 1864

***Parisis batequensis* new species**

Figures 23–25

DIAGNOSIS. A *Parisis* with straight-sided internode stems and pointed condyles.

COMPARISON. The geologic record of the gorgonian octocoral *Parisis* is very poorly known, and there is much uncertainty about which fossil species actually belong to the genus. A literature search revealed only one species of fossil gorgonian octocoral that shares many of the characteristics of the new species. It is species *Melitodes? hamiltoni* (Thomson, 1908:99, pl. 14, fig. 1) from middle Oligocene strata in New Zealand. Squires (1958:29, pl. 2, figs. 1–7) also discussed *M.? hamiltoni.* The new species differs in having more straight-sided stems and a more pointed central apex on the condyles.

According to Bayer (1956), *Melitodes* is now classified as *Melithaea,* a genus characterized by axial internodes that are very porous. The morphology of Thomson's (1908) species from New Zealand is like *Parisis* rather than like *Melithaea,* and we believe that *Melithaea? hamiltoni* should be placed in genus *Parisis.*

Parisis batequensis new species resembles *Isis* sp. 1 of Duncan (1880:109, pl. 28, figs. 9, 10) from Miocene strata in western India. The new species differs in having condyles with a central pointed tip (rather than flat-topped) and in the absences of any transverse ribs perpendicular to the radial ribs. Future work may show that *Isis* sp. 1 belongs to family Parisididae.

DESCRIPTION. Solid, nearly circular calcareous internode stems, straight-sided, up to 30 mm long and up to 18 mm in diameter, longitudinally marked by closely spaced single or double ribs that spiral about the axis. Some ribs bifurcate, and some rarely have a single groove that is much wider than the other grooves. Raised condyles branch off from some stems. Condyles with a central small pointed tip, bearing simple or frilled radial ribs that extend to periphery and align with corresponding longitudinal ribs. A few radial ribs bifurcate at the periphery.

PRIMARY TYPE MATERIAL. Holotype, IGM 5133 (= LACMIP plastoholotype 8845); paratypes, IGM 5134–5135 (= LACMIP plastoparatypes 8846–8847); all from locality CSUN 1220b.

TYPE LOCALITY. Locality CSUN 1220b.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Specimens are common and consist of only the calcareous segments of a colony that had joints (nodes) of spiculiferous horny material. According to Bayer (1956:200), the geologic range of the gorgoian octocoral genus *Parisis* is Tertiary to Recent. The Bateque Formation new species is the first record of *Parisis* from the Pacific coast of North America, and it may be the earliest known species of *Parisis.*

ETYMOLOGY. The new species is named after the Bateque Formation.

Order Scleractinia

Family Astrocoeniidae Koby, 1890

Genus *Astrocoenia* Milne-Edwards and Haime, 1848

Astrocoenia dilloni Durham, 1942

Figure 26

Astrocoenia dilloni Durham, 1942:505, pl. 44, fig. 3.

PRIMARY TYPE MATERIAL. Holotype, CAS 7724, locality CAS 30677A.

MOLLUSCAN STAGE RANGE. "Capay" and "Domengine?."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through central California.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1471.

REMARKS. Specimens are abundant, well preserved, and fragmentary. Calices are as much as 4 mm in diameter and are much larger than those in the holotype, which has calices as much as 2.5 mm in diameter. Like the holotype, the Bateque Formation specimens have 10 major septa that reach the sunken styliform columella and minor septa that do not reach the columella.

The holotype is from the south side of the headwaters of Media Aqua Creek, Kern County, south-central California. Determination of the formation and geologic age of the Eocene strata at the type locality of *A. dilloni* need refinement. Strata at about the same stratigraphic horizon (Durham, 1942), however, do contain the gastropod *Campanile dilloni* Hanna and Hertlein (1949:393, pl. 77, figs. 2, 4), whose molluscan stage range is "Capay" and possibly "Domengine" (Squires and Advocate, 1986: 853).

The presence of *Astrocoenia dilloni* in the Bateque Formation is the second known occurrence of this species.

Family Pocilloporidae Gray, 1842

Genus *Stylophora* Schweigger, 1819

Stylophora chaneyi Durham, 1942

Figure 27

Stylophora chaneyi Durham, 1942:509, pl. 44, fig. 8.

PRIMARY TYPE MATERIAL. Holotype, CAS 7723, locality CAS 30667.

MOLLUSCAN STAGE RANGE. "Capay" and "Domengine?."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through central California.

LOCAL OCCURENCE. Locality CSUN 1220b.

REMARKS. Specimens are abundant and fragmentary, laterally compressed ramose branches. Preservation is fair. Like the holotype, calices are about 0.5 mm in diameter with six major septa that reach the styliform columella and minor septa that do not reach the columella. The calices are 0.2–0.5 mm from each other and separated by solid coenenchymal material.

The holotype is from the same area as the holotype of *Astrocoenia dilloni* and is, therefore, "Capay" and possibly "Domengine."

The presence of *Stylophora chaneyi* in the Bateque Formation is the second known occurrence of this species.

Family Stylinidae d'Orbigny, 1851

Genus *Heterocoenia* *Milne-Edwards, 1848*

Heterocoenia? sp.

Figure 28

LOCAL OCCURRENCE. Locality CSUN 1220a.

REMARKS. Only one specimen was found. It is a poorly preserved fragment that is about 5 cm in height and 4 cm in width. Only the longitudinal view of this plocoid corallum is observable. It shows separate corallites united by dissepiments and coenosteum that resemble *Heterocoenia.*

Wells (1956) reported that *Heterocoenia* is known from Cretaceous strata in Europe, North America, and Japan. If the Bateque Formation specimen is *Heterocoenia,* it would be the first record of the genus from the Pacific coast of North America, and it would extend the geologic range of the genus into the early Eocene.

Genus *Stylosmilia* Milne-Edwards, 1848

***Stylosmilia ameliae* new species**

Figures 29, 30

DIAGNOSIS. A *Stylosmilia* with widely spaced, thick-walled corallites having 12 primary septa.

COMPARISON. The new species has been compared with all of the species of *Stylosmilia* listed in Felix (1914a:14–15). Nearly all of these are illustrated in Fromentel (1873). Additional comparisons were made with other species illustrated in Becker (1875), Tomes (1885), Koby (1896), and Geyer (1954). All of the previously described species of *Stylosmilia* are from Europe and occur in strata within the Middle Jurassic to Early Cretaceous age range that has been reported (Geyer, 1954; Wells, 1956) for this genus. Most of the species are not comparable to the new species because they have more septa and/or their corallites are more closely spaced.

The new species is most similar to *S. suevica* Becker (1875:139, pl. 39, fig. 1a, b; Vaughan and Wells, 1943:pl. 9, fig. 5; Wells, 1956:fig. 266, 7a, b) from the Upper Jurassic strata of Germany. The new species differs in having smaller diameter corallites (2–3 mm rather than 3.5–4 mm).

DESCRIPTION. Phaceloid colony, with parallel or nearly parallel laterally free corallites spaced up to 5 mm apart. Corallites about 2–3 mm in diameter, up to 80 mm in length, and with walls up to 0.5 mm thick. Branching common. Exterior finely granulate with numerous very closely spaced ribs. About 12 primary septa, all joining to the strong styliform columella.

PRIMARY TYPE MATERIAL. Holotype, IGM 5139 (= LACMIP plastoholotype 8848).

TYPE LOCALITY. Locality CSUN 1220a.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Localities CSUN 1220a, 1471?.

REMARKS. Only one corallum (holotype, IGM 5139) was found at locality 1220a. This corallum is 120 mm in diameter. At locality 1471, a lens 50 cm thick and 3 m in lateral extent was found to consist of abundant fragments of what appears to be *Stylosmilia ameliae* new species.

The Bateque Formation specimen of *Stylosmilia* extends the geologic range of this genus into the early Eocene and extends the geographic range into North America.

ETYMOLOGY. The new species is named after Amelia Z. Demetrion.

Family Actinacididae Vaughan and Wells, 1943

Genus *Actinacis* d'Orbigny, 1849

Actinacis? sp.

Figures 31, 32

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Specimens are common and occur as coralla as much as 30 cm in length and 15 cm in height. In side views of the Bateque Formation specimens, this colonial coral is characterized by massive growth with an extensive and finely laminated coenosteum. The laminae are about 1 mm thick, undulatory, and superficially resemble stromatolites. The coenosteum has a beaded look. Along the dorsal surface of the colony are corallites up to 1.5 mm in diameter, possessing definite calicular margins, and are separated (on the average) by 1 mm of reticulated coenosteum. On unweathered surfaces, the corallites have raised rims and a projecting trabecular columella. There are 24 septa. They are short and their distal ends bifurcate. The septa extend into the spongy columella, which fills most of the corallite interior.

These Bateque Formation colonial corals have the extensive coenosteum and trabecular columella of actinacid corals. They seem to be an intermediate form between the actinacid *Dendraraea,* reported by Wells (1956) from the Jurassic and Cretaceous, Eurasia and South America, and the actinacid *Actinacis,* reported by Wells (1956) from the Middle Cretaceous through Oligocene, Eurasia, Africa, North America, South America, and the West Indies. Future work may show that the Bateque Formation specimens belong to a new genus of actinacids.

Family Poritidae Gray, 1842

Genus *Goniopora* Blainville, 1830

Goniopora sp., cf. *G. vaughani* Nomland, 1916

Figures 33–35

[*Goniopora vaughani* Nomland, 1916:68–69, pl. 3, figs. 18, 19.]

LOCAL OCCURRENCE. Locality CSUN 1471.

REMARKS. Specimens are common and each consists of a small mass on a cylindrical stalk with concentric growth layers very obvious on the ventral surface of the corallum. The specimens are badly weathered, and positive specific identification cannot be made. They resemble *Goniopora vaughani* Nomland, 1916, from Eocene strata north of Del Mar, San Diego County, southern California. The holotype is the only known specimen of this species, and it is badly weathered. It is an encrusting form that encompasses both sides of an oyster fragment.

Like the holotype of *G. vaughani,* the Bateque Formation specimens have crowded corallites about 3 mm in diameter with numerous (20–24) septa and a spongy columella that is projecting in some corallites. The septa in the Bateque Formation specimens do not appear to be fused as in *G. vaughani,* but the fusion characteristic in *G. vaughani* may be a function of deep weathering.

Family Faviidae Gregory, 1900

Genus *Colpophyllia* Milne-Edwards, 1848

***Colpophyllia nicholasi* new species**

Figure 36

DIAGNOSIS. Meandroid colony, fairly deep valleys tend to be short and monocentric, collines moderately continuous to discontinuous.

COMPARISON. The new species has been compared with all the Paleogene species descriptions of *Colpophyllia,* a genus whose geologic range is Eocene to Recent (Wells, 1956). There are only two previously described Eocene species. *Colpophyllia reagani* Durham (1942:96, pl. 16, fig. 5; pl. 17, fig. 2) from the lower Eocene Crescent Formation, northwestern Washington, is the only other species of *Colpophyllia* from the Paleogene of the Pacific coast of North America. The new species differs in the following features: shorter and more circular valleys, more discontinuous collines, about 18–24 septa to the centimeter rather than 12–18, and septal faces not granulate.

The other Eocene species is *C. wellsi* (Durham *in* Clark and Durham, 1946:81, pl. 26, figs. 1, 4–6) from Eocene strata, Columbia. The new species differs in having many more septa per centimeter and shorter valleys.

Woodring (1957:21) included *Colpophyllia* sp. in a checklist of corals from the middle to upper Eocene Gatuncillo Formation in the Panama Canal Zone. He did not give any repository numbers nor did he figure or describe the specimen(s).

The new species somewhat resembles *Colpophyllia willoughbiensis* (Vaughan, 1919:422–423, pl. 104, figs. 2, 2a; pl. 105; Frost and Langenheim, 1974:248–251, pl. 88, figs. 1–6; pl. 89, figs. 1–7) from Oligocene strata, Chiapas, Mexico, as well as Antigua and Puerto Rico. The specimen illustrated by Frost and Langenheim (1974:pl. 89, fig. 2) is most similar to the Bateque Formation specimens. The Bateque Formation specimens differ from *C. willoughbiensis* in the following features: collines more discontinuous, collines tend to be more subcircular, and colline crests more rounded.

DESCRIPTION. Massive corallum, meandroid to submeandroid. Fairly long to short valleys, mostly subcircular, depressions about 2–4 mm deep. Some valleys tend to be monocentric. Collines moderately continuous and sinuous to discontinuous. Colline crests rounded to narrow, some with a deposit formed by fusion of septa. About 18–24 septa to the centimeter. Sides of collines slope from 45 degrees to near vertical. Columella deep in fossa, very small, trabecular, and can be plate-like between corallites. No paliform lobes observed.

PRIMARY TYPE MATERIAL. Holotype, IGM 5143 (= LACMIP plastoholotype 8849).

TYPE LOCALITY. Locality CSUN 1220a.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Locality CSUN 1220a.

REMARKS. Specimens are rare and are as much as 14 cm in diameter and 3 cm thick.

ETYMOLOGY. The new species is named after Nicholas A. Demetrion.

Genus *Montastrea* Blainville, 1830

Montastrea laurae new species

Figures 37, 38

DIAGNOSIS. A *Montastrea* with 14 primary septa and with only slightly raised, widely spaced corallites (about 2 mm apart) joined by some prominent distant costae.

COMPARISON. *Montastrea* has very complicated taxonomic history and has been known by at least 13 synonyms (Wells, 1956). Two of the more commonly used names in old literature are *Orbicella* Dana and *Phyllocoenia* Milne-Edwards and Haime. Because the geologic range of *Montastrea* is Late Jurassic to Recent with cosmopolitan distribution (Wells, 1956), there are numerous species. This is a genus that needs to have its species reviewed in a monographic treatment.

We have endeavored to compare *M. laurae* new species with all Western Hemisphere Cretaceous through Eocene species and with many other Cretaceous and early Tertiary species from elsewhere in the world. The reader is referred to Felix (1891), Vaughan (1919), Wells (1933), and Frost and Langenheim (1974) for descriptions and illustrations of many of the Western Hemisphere fossil species. Most of the species are not comparable to the new species because their corallites are more closely spaced than in *M. laurae* new species. Only one species possesses low-relief corallites of the same size and same spacing (with smooth coenosteum in between) as in the new species. It is *Montastrea imperatoris* (Vaughan, 1919:378, pl. 86, figs. 2–5) from the upper Oligocene Emperador Limestone, Panama Canal Zone, Panama. The new species differs in the following features: about 14 primary septa rather than 6, 14 secondary septa rather than 6, no tertiary septa, slightly larger corallites, and no tendency for corallites to project several millimeters upward.

The only other Eocene species of *Montastrea* from the Western Hemisphere is *M. antilliana* Wells (1945:9, pl. 2, fig. 14; Frost and Langenheim, 1974: 261–262, pl. 94, figs. 3–5) from middle Eocene strata in Chiapas, Mexico, and Barbados. Its corallites are smaller and more closely spaced than those of the new species.

DESCRIPTION. Colonial, plocoid, massive, corallites circular in transverse section, 3–4 mm in diameter and about 2–3 mm apart (measured from wall to wall). Corallite wall distinct and slightly raised. Septothecate. Fourteen primary septa and 14 secondary septa. Primary septa reach the columella; secondary septa usually do not. Corallites separated by extensive and smooth coenosteum but joined by some prominent distant costae (1–2 mm in length), which correspond to the primary septa. Some secondary septa project a short distance. Spongy trabecular columella, formed by fusion of inner edges of the primary septa.

PRIMARY TYPE MATERIAL. Holotype, IGM 5144 (= LACMIP plastoholotype 8850); locality CSUN 1220a.

TYPE LOCALITY. Locality CSUN 1220a.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Localities CSUN 1220a, 1220b.

REMARKS. Specimens are common, but not are large-boulder size and could not be collected. One specimen at locality 1220b, for example, measures 1 m in diameter.

The new species is the only early Eocene occurrence of *Montastrea,* and it is the first known occurrence of this genus from the Pacific coast of North America.

ETYMOLOGY. The new species is named after Laura C. Demetrion.

Family Mussidae Ortamnn, 1890

Genus *Antillia* Duncan, 1863

Antillia batequensis new species

Figures 39–42

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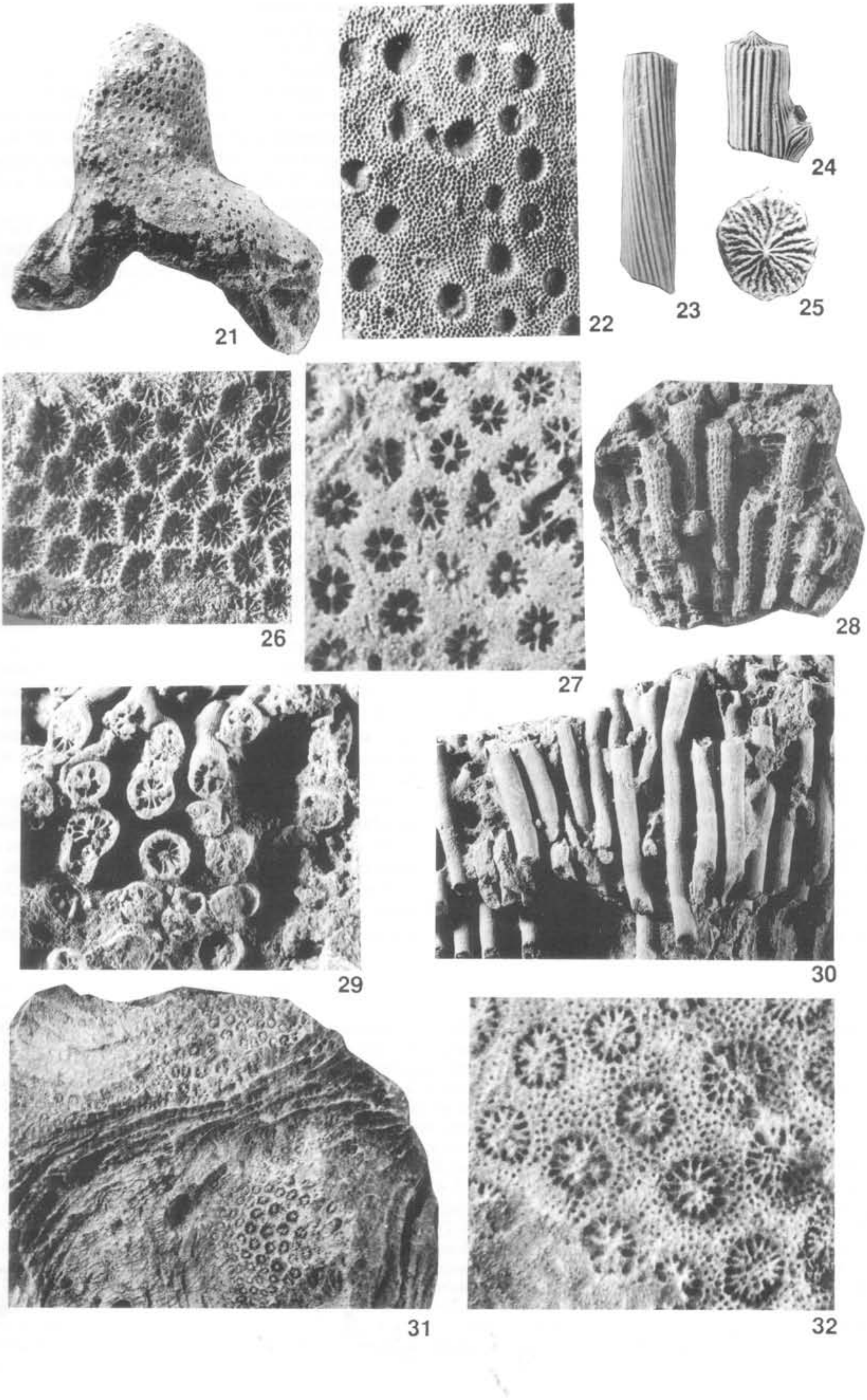
Figures 21–32. Bateque Formation octocorals and scleractinian corals. **Figs. 21–25.** Octocorals. **21, 22.** *Heliopora*? sp., hypotype, IGM 5132, loc. CSUN 1471. **21.** Lateral view of entire colony, ×0.8, height 60 mm, width 65 mm. **22.** Part of lateral surface along upper right side of colony, ×4.25, width of field 9 mm. **23–25.** *Parisis batequensis* new species, loc. CSUN 1220b. **23.** Lateral view of internode stem, ×1.7, height 24 mm, diameter 6 mm, holotype, IGM 5133. **24.** Lateral view of internode stem, ×2.4, 9.5 mm, maximum diameter 6 mm, paratype, IGM 5134. **25.** Dorsal view of internode stem, ×3.8, diameter 5 mm, paratype, IGM 5135. **Figs. 26–32.** Scleractinian corals. **26.** *Astrocoenia dilloni* Durham, 1942, dorsal view of part of colony, ×2.4, width of field 21 mm, hypotype, IGM 5136, loc. CSUN 1220b. **27.** *Stylophora chaneyi* Durham, 1942, dorsal view of part of colony, ×10, width of field 5 mm, hypotype, IGM 5137, loc. CSUN 1220b. **28.** *Heterocoenia*? sp., lateral view of part of colony, ×2, width of field 20 mm, hypotype, IGM 5138, loc. CSUN 1220a. **29, 30.** *Stylosmilia ameliae* new species, holotype, IGM 5139, loc. CSUN 1220a. **29.** Dorsal view of part of colony, ×1.9, width of field 30 mm. **30.** Lateral view of part of colony, ×1, width of field 64 mm. **31, 32.** *Actinacis*? sp., hypotype, IGM 5140, loc. CSUN 1220b. **31.** Side view of part of colony, ×1, width of field 68 mm. **32.** Dorsal view of upper left center part of colony shown in previous illustration, ×6.4, width of field 10 mm.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DIAGNOSIS. A cylindrical-shaped *Antillia* with a flat, wide base.

COMPARISON. The new species has been compared with all the species descriptions of *Antillia,* a genus whose geologic range is Eocene to Miocene (Wells, 1956). There are only two other Eocene species. One is *A. clarki* Durham (*in* Clark and Durham, 1946:74, pl. 25, figs. 4, 6, 7; Frost and Langenheim, 1974:293–294, pl. 113, figs. 1–6, 13–15) from apparently middle Eocene strata in Colombia and lower upper Eocene strata in Chiapas, Mexico (Frost and Langenheim, 1974). The new species differs in having taller sides and a flat base rather than a rounded base.

The other Eocene species is *Antillia hadleyi* (Wells, 1934:153–154, pl. 2, figs. 3, 4) from upper? Eocene strata in Cuba. Woodring (1957:21) also reported *A.* cf. *A. hadleyi* from the middle to upper Eocene Gatuncillo Formation in the Panama Canal Zone. The new species differs in having an epitheca and a cylindrical shape rather than a conical shape.

Nearly all of the younger Tertiary species of *Antillia* are not comparable to the new species because they have a corallum with a rounded or pointed base. Only three specie have a flat base. One is *A. ponderosa* (Milne-Edwards and Haime, 1857–1860) from Miocene strata in the Dominican Republic, West Indies. Duncan (1863:433, 441–442, pl. 161, figs. 6a, b) also discussed this species. The second species is *A. plana* Duncan (1864a:300, pl. 18, fig. 5; 1880:84, pl. 23, fig. 5) from Miocene strata in western India. The third species is *A. granti* (Archiac and Haime, 1853:191, pl. 12, figs. 5a, b), also from Miocene strata in western India. The new species, however, differs from these three Miocene species in having a tall cylindrical shape rather than a short, wide discoidal shape.

Although the corallum of *A. dentata* Duncan (1864b:29–30, pl. 3, fig. 2a–c; Wells, 1956:fig. 318 4a–b) from Miocene strata in the Dominican Republic, West Indies, has a pointed base, it should be mentioned that it does resemble the new species in terms of the tall straight sides of the corallum.

DESCRIPTION. Solitary, cupolate, cylindrical (the walls approach straight-sided), up to 34 mm in height and 30 mm in diameter. Shallow calyx, trabecular columella, 24 primary septa, and 48 secondary septa. Septa thickest at periphery and thinning toward center of calyx. Very thin membraniform epitheca extending only 80–90 percent of the way to the top of the corallite where granulate costae are exposed. Wide, flat base (can be depressed) with a small, pointed apex in center.

PRIMARY TYPE MATERIAL. Holotype, IGM 5145 (= LACMIP plastoholotype 8851); paratypes, IGM 5146–5147 = (LACMIP plastoparatypes 8852–8853); all from locality CSUN 1291a.

TYPE LOCALITY. Locality CSUN 1291a.

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, to San Diego County, southern California.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1291a.

REMARKS. A single scar of where a corallite base was once attached was found at locality 1220b. Specimens are uncommon at locality 1291a, where they range in height from 20 to 34 mm. This species can be very short or quite tall in the mature stage. Most have a flat base with a central apex, but in one specimen (paratype, IGM 5147) the apex seems to have encrusted an echinoid spine.

Four specimens of the new species were found in the collections of the middle Eocene Ardath Shale (locality SDNHM 3296) in San Diego, southern California. Three are very short (about 10 mm in height and 25 m in diameter), but one is fairly tall (23 mm in height and 29 mm in diameter).

Antillia batequensis new species extends the geographic distribution of this genus into the Pacific coast region of North America. The new species is probably the earliest representative of the genus.

It is pertinent to note, as did Duncan (1864b:28, 1865:186), the remarkable similarity between the predominantly Miocene mussid *Antillia* and the

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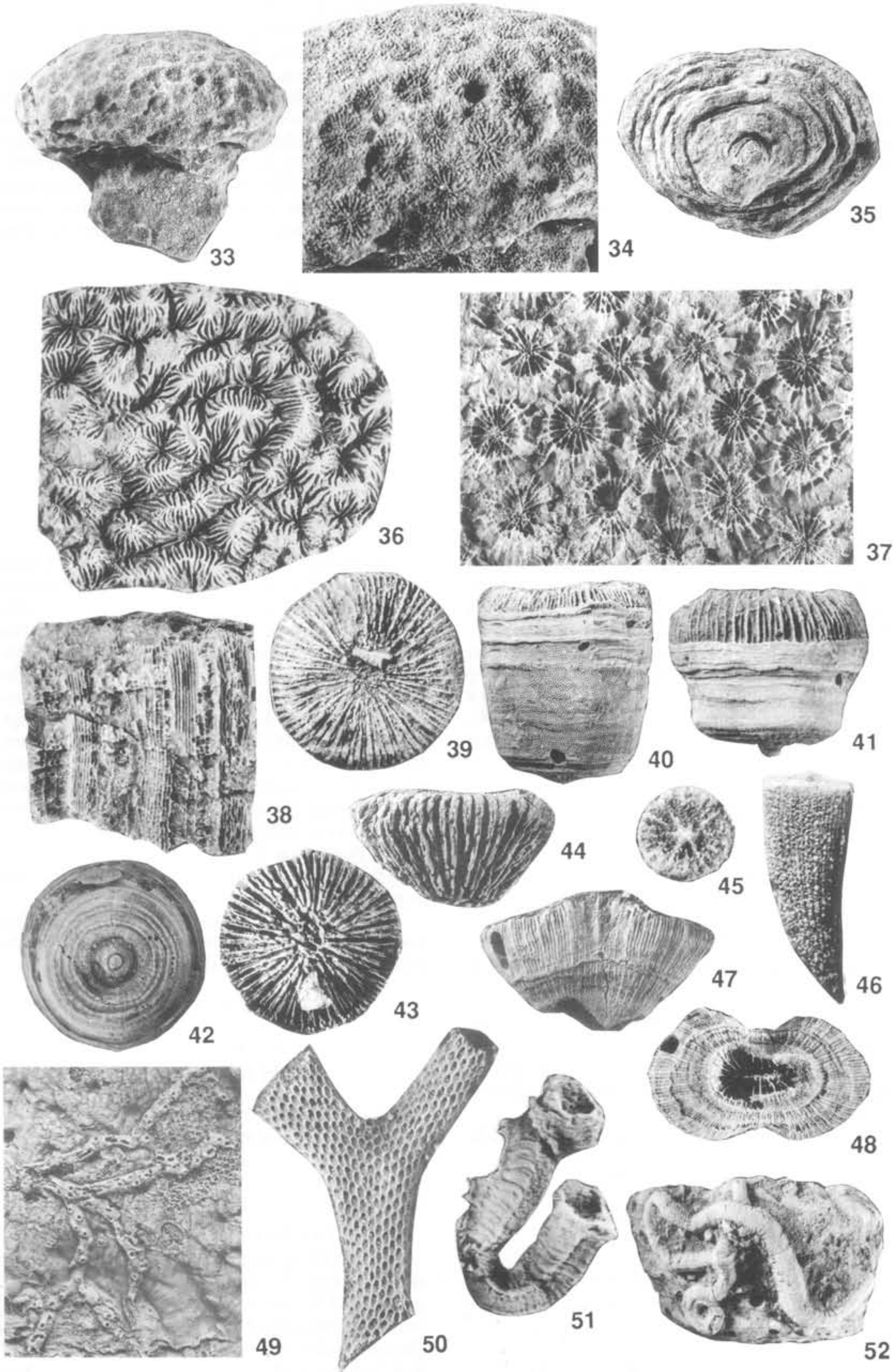
Figures 33–52. Bateque Formation scleractinian corals, bryozoans, and polychaete worm. **Figs. 33–48.** Scleractinian corals. **33–35.** *Goniopora* sp., cf. *C. vaughani* Nomland, 1916, loc. CSUN 1471. **33, 34.** Hypotype, IGM 5141. **33.** Lateral view of entire colony, ×1.4, height 25 mm, maximum diameter 31 mm. **34.** Part of lateral surface at center of colony, ×3.1, width of field 15 mm. **35.** Ventral surface, ×1.1, maximum diameter 38 mm, hypotype, IGM 5142. **36.** *Colpophyllia nicholasi* new species, dorsal view of part of colony, ×1.4, width of field 40 mm, holotype, IGM 5143, loc. CSUN 1220a. **37, 38.** *Montastrea laurae* new species, holotype, IGM 5144, loc. CSUN 1220a. **37.** Dorsal view of part of colony, ×2.6, width of field 27 mm. **38.** Lateral view, ×1.3. **39–42.** *Antillia batequensis* new species, loc. CSUN 1291a. **39.** Dorsal view, ×1, diameter 31 mm, holotype, IGM 5145. **40.** Lateral view, ×0.9, height 36 mm, width 30 mm, paratype, IGM 5146. **41, 42.** Paratype, IGM 5147. **41.** Lateral view, ×1.1, height 25 mm, diameter 29 mm. **42.** Ventral view, ×1. **43, 44.** *Stephanocyathus*? sp., hypotype, IGM 5148, loc. CSUN 1220b. **43.** Dorsal view, ×1, diameter 28 mm. **44.** Lateral view, ×1.5, height 12 mm. **45, 46.** *Turbinolia dickersoni* Nomland, 1916, ×5.2, hypotype, IGM 5149, loc. CSUN 1220b. **45.** Dorsal view, diameter 2.8 mm. **46.** Lateral view, height 7 mm. **47, 48.** *Placotrochus*? sp., ×1.4, hypotype, IGM 5150, loc. CSUN 1220b. **47.** Lateral view, height 16 mm, diameter 27 mm. **48.** Ventral view. **Figs. 49, 50.** Polychaete worm. **49.** *Stomatopora* sp., dorsal view, ×4.3, width of field 13 mm, hypotype, IGM 5151, loc. CSUN 1220b. **50.** *Cellaria* sp., lateral view, ×4.6, height 12 mm, hypotype, IGM 5152, loc. CSUN 1220b. **Figs. 51, 52.** *Serpula batequensis* new species. **51.** Lateral view of part of colony, ×3.3, maximum diameter 3 mm, holotype, IGM 5153, loc. CSUN 1470. **52.** Dorsal view, ×1.8, maximum diameter 3 mm, paratype, IGM 5154, loc. CSUN 1470.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Mesozoic montlivaltiid *Montlivaltia.* Duncan (1864b:21), in fact, listed *Montlivaltia* as a subgenus of *Antillia.* Prior to Duncan's (1864b) naming of *Antillia,* species of this genus were assigned by earlier workers to *Montlivaltia.* The only distinguishing character is that *Antillia* has a spongy columella, whereas *Montlivaltia* either has no columella or a rudimentary one (Milne-Edwards and Haime, 1850–1854:xxv, 133, pl. 26, figs. 5, 5a, b; Wells, 1956). With future study, it may be found that these two genera are part of an evolutionary sequence.

ETYMOLOGY. The new species is named after the Bateque Formation.

Family Caryophyllidae Gray, 1847

Genus *Stephanocyathus* Seguenza, 1864

Stephanocyathus? sp.

Figures 43, 44

LOCAL OCCURRENCE. Localities CSUN 1220b, 1220c, 1291.

REMARKS. Specimens are common at each locality. Preservation of the free, solitary corallites is as internal molds, and no calices are exposed. Specimens, which are as much as 28 mm in diameter, are patellate and show a trabecular columella. They resemble the genus *Stephanocyathus,* which has a geologic range of Eocene to Recent (Wells, 1956). Better preservation is needed to confirm the generic identification.

Genus *Turbinolia* Lamarck, 1816

Turbinolia dickersoni Nomland, 1916

Figures 45, 46

Turbinolia dickersoni Nomland, 1916:61, pl. 3, figs. 5–8.

MOLLUSCAN STAGE RANGE. Upper Paleocene through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through central California.

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. A single specimen was found.

Family Flabellidae Bourne, 1905

Genus *Placotrochus* Milne-Edwards, 1848

Placotrochus? sp.

Figures 47, 48

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. A single specimen was found. Preservation of the free, solitary corallite is good except for the calice area, which is mostly covered by well-indurated matrix. The specimen, which is 27 mm in diameter, is compressed flabellate and shows a thin lamellar columella (only exposed at the base of the corallite on the Bateque specimen). The specimen resembles *Placotrochus,* which has a geologic range of Eocene to Recent (Wells, 1956). Better preservation is needed to confirm the generic identification.

Phylum Bryozoa

Order Cyclostomata

Family Diastoporidae Gregory, 1899

Genus *Stomatopora* Bronn, 1825

Stomatopora sp.

Figure 49

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Only a single specimen was found, and it encrusts a valve of the bivalve *Pycnodonte (Pegma) bajaensis.* The adnate zooarium of this bryozoan is composed of irregularly branching subtubular lines with slightly raised zooecia. The zooarium very closely resembles *Stomatopora granulata* (Milne-Edwards, 1838:205, pl. 16, figs. 3, 3a; Canu, 1909:34–35, pl. 12, fig. 15; Osburn, 1953:619–620, pl. 65, figs. 1, 2) whose geologic range is Early Cretaceous (Gregory, 1896:47; Canu, 1909) through Recent (Osburn, 1953) with fossil occurrences in Europe, Russian and Australia (Canu, 1909). Today, it is widely distributed in the Northern Hemisphere, including southern California (Osburn, 1953).

The Bateque Formation specimen is the first known record of the genus *Stomatopora* in the Paleogene of North America.

Order Cheilostomata

Family Cellaridae Hincks, 1880

Genus *Cellaria* Solander, 1786

Cellaria sp.

Figure 50

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Specimens are locally very abundant and constitute the major lithologic component of the rock. They are unworn, hollow, straight, and branching cylindrical segments of zooaria that had chitinous joints. They resemble the posterior view (but not the anterior view) of *Cellaria bifaciata*

Canu and Bassler (1920:274, pl. 40, figs. 14–17) from the upper Eocene Castle Hayne Limestone, North Carolina and South Carolina.

The geologic range of *Cellaria* is Eocene to Recent (Bassler, 1953:177). The Bateque Formation specimens represent the first record of this genus from the Paleogene of North America.

Phylum Annelida

Order Sedentaria

Family Serpulidae Burmeister, 1837

Genus *Serpula* Linné, 1758

Serpula batequensis new species

Figures 51, 52

DIAGNOSIS. Entirely encrusting, calcareous, solitary or colonial, planispiral juvenile tube, irregularly coiled adult tube, tendency for flange to develop along one edge of mature tube. One to three (rarely) longitudinal ribs along length of the tube. Aperture rimmed by thick deposit.

COMPARISON. The geologic range of *Serpula* is Silurian to Recent (Howell, 1962). A review of available literature revealed that the Tertiary fossil record of *Serpula* and other serpulid worm tubes is very poorly known, especially for the Pacific coast of North America. *Serpula batequenesis* new species is the first reported species of this genus from either the Paleocene or Eocene of the Pacific coast of North America. The only other Paleogene species from this area is *Serpula* sp. Clark and Arnold (1923:175, pl. 39, fig. 4), based on a fragmentary specimen from upper Oligocene rocks, Vancouver Island, British Columbia. The new species differs in having much smaller tubes that are not parallel to one another.

The new species most resembles *Serpula (Tetraserpula) quinquangularis* Goldfuss (1831:230, pl. 68, fig. 8b) from Jurassic strata of Germany. Parsch (1956:224, pl. 19, fig. 9; pl. 20, fig. 13; pl. 21, fig. 25) also illustrated this species. The new species differs in the following features: juvenile tube more planispiral, mature tube does not taper, and longitudinal ribs not as prominent.

DESCRIPTION. Encrusting, calcareous tube, solitary or colonial. Juvenile tube of about two tightly coiled planispiral whorls. Mature tube irregularly coiled but usually in loops, tube flat on encrusting side, convex on upper side. Tube always adhering to substrate, tendency for flange to develop along outside edge of the loops. One to three (rare) longitudinal ribs along length of tube. Longitudinal ribs somewhat noded at intersections with prominent growth lines. Tube subrectangular in cross section. Aperture rimmed by thick calcareous deposits. Tubes up to 3 mm in diameter.

PRIMARY TYPE MATERIAL. Holotype, IGM 5153 (= LACMIP plastoholotype 8854), locality CSUN 1470; paratype, IGM 5154 (= LACMIP plastoparatype 8855), locality CSUN 1291a

TYPE LOCALITY. Locality CSUN 1470.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Localities CSUN 1291a, 1470, 1471.

REMARKS. The holotype, IGM 5153, is one specimen in a colony of about 30 intergrown specimens that measures 50 mm in diameter. One solitary tube (paratype, IGM 5154) (Fig. 52) encrusts a specimen of *Antillia batequensis* new species at locality 1291a.

ETYMOLOGY. The new species is named after the Bateque Formation.

Phylum Mollusca

Class Scaphopoda

Order Dentalioida

Family Dentaliidae Gray, 1834

Genus *Dentalium* Linné, 1758

Dentalium stentor Anderson and Hanna, 1925

Figure 53

Dentalium stentor Anderson and Hanna, 1925:145, pl. 13, fig. 17.

MOLLUSCAN STAGE RANGE. "Domengine" through "Tejon."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through southern San Joaquin Valley, California.

LOCAL OCCURRENCE. Locality CSUN 1291c.

REMARKS. A single, fairly large (45 mm in height) specimen was found. Sculpture consists of longitudinal ribs uniform in size, except near the tapered end where some of the longitudinal ribs alternate with finer ribs. According to Anderson and Hanna (1925), uniform rib size is the norm for this species.

Class Gastropoda

Order Archaeogastropoda

Family Turbinidae Rafinesque, 1815

Genus *Arene* H. and A. Adams, 1854

Arene mcleani Squires, 1988b

Figure 54

Arene mcleani Squires, 1988b:9–10, figs. 9–11.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through northern Lockwood Valley, Los Angeles County, southern California.

LOCAL OCCURRENCE. Locality CSUN 1291a.

REMARKS. Specimens are uncommon, and only one is well preserved. This specimen differs slightly from the published photographs of this species in that it shows one extra costate spiral rib on the shoulder of the body whorl. This variation, which is also present in at least one topotype specimen of *A. mcleani,* corresponds to the case where the rare third spiral rib posterior to the bicostate spiral ribs has become costate itself. The presence of this extra spiral rib was noted in the original description of this species.

Family Neritidae Rafinesque, 1815

Genus *Velates* Montfort, 1810

Velates perversus (Gmelin, 1791)

Figures 55, 56

Nerita perversa Gmelin, 1791:3686.

MOLLUSCAN STAGE RANGE. In Europe and India, Thanetian (upper Paleocene) up to Bartonian (upper middle Eocene). On the Pacific coast of North America, "Capay" and possibly "Domengine."

GEOGRAPHIC DISTRIBUTION. Pakistan, India, Myanmar, Tibet, Middle East, northern Africa, western Europe, Florida, Panama?, and Baja California Sur, Mexico, through central California.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1291a, 1470, 1471.

REMARKS. Specimens are abundant, especially at locality 1220b. In one slab of rock that measures 90 mm in diameter, 17 specimens were found. All specimens show fair preservation. At locality 1220b they form a growth series ranging from 4 to 90 mm in height, and at locality 1470 they form a growth series ranging from 6 to 40 mm in height (i.e., height is parallel to axis of coiling).

As discussed in Woods and Saul (1986:648), the age of the only reported "Domengine Stage" beds that *V. perversus* has been found in is not well known. As suggested by them, these beds, which are in Big Tar Canyon, Kings County, central California, may actually belong to the "Capay Stage."

The species was first noted in the Bateque Formation by Squires and Demetrion (1990a). Previously, *V. perversus* had been reported (Beal, 1948: 50) from the Tepetate Formation farther south in Baja California Sur, Mexico.

Velates batequensis Squires and Demetrion, 1990a

Figure 57

Velates batequensis Squires and Demetrion, 1990a: 99–100, figs. 1–5.

PRIMARY TYPE MATERIAL. Holotype, IGM 5051 (= LACMIP plastoholotype 8052); paratypes, IGM 5052–5054 (= LACMIP plastoparatypes 8053–8055); all from locality CSUN 1220b.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Specimens are abundant and well preserved. They form a growth series ranging from 4 to 48 mm in height.

Order Mesogastropoda

Family Turritellidae Woodward, 1851

Genus *Turritella* Lamarck, 1799

Turritella andersoni s.s. Dickerson, 1916

Figure 58

Turritella andersoni Dickerson, 1916:501–502, pl. 42, fig. 9a, b.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through southwestern Oregon.

LOCAL OCCURRENCE. Localities CSUN 1291a, 1291b.

REMARKS. Specimens are rare at locality 1291a and common at 1291b. At both localities, most specimens are upper spire fragments and show the diagnostic whorl profile that is broadly concave medially between a pair of broadly spaced primary spiral ribs. The anterior rib is stronger. The posterior rib has small nodes. There are secondary ribs between the two primaries, and there is a secondary rib between the posterior primary and the suture.

At locality 1291b, there are also a few specimens that are intermediate between *T. andersoni* s.s. and *T. andersoni lawsoni.* This locality must be at or very near the boundary between the "Capay Stage" (to which *T. andersoni* s.s. is confined) and the "Domengine Stage" (to which *T. andersoni lawsoni* is confined).

Turritella andersoni lawsoni Dickerson, 1916

Figure 59

Turritella lawsoni Dickerson, 1916:502, pl. 42, fig. 10a, b.

MOLLUSCAN STAGE RANGE. "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio, Baja California Sur, Mexico, through central California.

LOCAL OCCURRENCE. Locality CSUN 1220c (uppermost part), 1220d, 1291c.

REMARKS. Specimens are abundant at all localities. At 1220c and 1220d, they form several beds about 15 cm thick that consist of closely packed large individuals showing bimodal preferred orientation. At both localities, many of the specimens are internal molds. Specimens at locality 1291c are the best preserved.

Most specimens are upper spire fragments, but a few are almost complete individuals. All show a whorl profile that has a strong anterior primary spiral rib with many secondary and tertiary spiral ribs posteriorly. The more complete individuals show the gradual weakening of sculpture with increasing whorl size and the incipient development of overhanging of the whorls with increasing whorl size. Both features are diagnostic of this subspecies.

Turritella sp., ? *T. merriami* Dickerson, 1913

Figure 60

[*Turritella merriami* Dickerson, 1913:284–285, pl. 13, fig. 6a–6c.]

LOCAL OCCURRENCE. Locality CSUN 1291b.

REMARKS. Specimens are rare, and they are well-preserved, small fragments of juveniles (15 mm in height or less). They show a posterior tabulation that gradually develops with increasing whorl size.

Two known Paleogene subspecies of *Turritella* from the Pacific coast of North America have a posterior tabulation in the juvenile stage. These are *T. merriami* s.s. and *T. merriami brevitabulata* Merriam and Turner (1937:105, pl. 6, figs. 1, 2). They are virtually indistinguishable as juveniles. In the adult stage, the posterior tabulation develops into a flange on *T. merriami,* whereas in *T. merriami brevitabulata* it does not. The juvenile Bateque Formation specimens are questionably assigned to *T. merriami* because, with increasing whorl size, there is a tendency for the posterior tabulation to develop more strongly.

Turritella merriami is known from the Whitaker Peak area, Los Angeles County, to southwestern Oregon (Squires, 1987). If the Bateque Formation specimens are *T. merriami,* they would extend the geographic distribution of this species southward into the eastern Laguna San Ignacio area, Baja California Sur, Mexico.

Turritella buwaldana Dickerson, 1916

Figure 61

Turritella buwaldana Dickerson, 1916:500–501, pl. 42, fig. 7a, b.

MOLLUSCAN STAGE RANGE. Upper "Meganos?," "Capay" through "Tejon."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio, Baja California Sur, Mexico, through southwestern Oregon.

LOCAL OCCURRENCE. Localities CSUN 1220b?, 1291b.

REMARKS. Specimens are rare. They show the diagnostic flat-sided whorls with three primary spiral ribs (minutely noded) and two slightly weaker posterior spiral ribs (minutely noded). Tertiary ribs are in the interspaces.

Turritella uvasana subsp., ? *T. uvasana applinae* Hanna, 1927

Figure 62

[*Turritella applini* Hanna, 1927:307, pl. 49, figs. 1, 4.]

LOCAL OCCURRENCE. Locality CSUN 1291c.

REMARKS. A single specimen was found. Its fragmentary condition prevents positive identification as to subspecies. *Turritella uvasana applinae* is known from San Diego to the Pine Mountain area, southern California (Squires, 1987). If the Bateque Formation specimen is *T. uvasana applinae,* it would extend the geographic distribution of this species southward into the eastern San Ignacio area, Baja California Sur, Mexico.

Turritella uvasana subsp.

Figure 63

LOCAL OCCURRENCE. Localities CSUN 1220b, 1470.

REMARKS. Several small specimens were found at each locality. They have convex whorls and primary spirals of nearly uniform strength. They probably are apical parts of once larger specimens. Preservation is not good enough to allow subspecific identification.

Family Siliquariidae Anton, 1838

Genus *Tenagodus* Guettard, 1770

Tenagodus bajaensis Squires, 1990a

Figure 64

Tenagodus bajaensis Squires, 1990a:298, figs. 6–8.

PRIMARY TYPE MATERIAL. Holotype, IGM 5102 (= LACMIP plastoholotype 8089); paratype, IGM 5103 (= LACMIP plastoparatype 8090); all from locality CSUN 1291a.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Locality CSUN 1291a.

REMARKS. Three solitary specimens were found. They show the longitudinal slit that is diagnostic of this genus. The Bateque Formation specimens represent the only known representatives of the genus *Tenagodus* from the Pacific coast of North America (Squires, 1990a).

Family Campanilidae Douvillé, 1904

Genus *Campanile* Fischer, 1884

Campanile sp.

Figure 65

LOCAL OCCURRENCE. Locality CSUN 1220a.

REMARKS. A single poorly preserved specimen was found. Although it is 190 mm in height, it is only the upper spire part of the shell. Shell material is missing from the apertural side, and the abapertural side has been damaged by boring organisms (sponges?). Widely spaced nodes are present just anterior to the suture.

There are only two other reported species of *Campanile* from the Eocene of the Pacific coast of North America. They are *C. dilloni* (Hanna and Hertlein, 1949:392–394, pl. 77, figs. 2, 4) and *Campanile* new species? Squires (1987:31–32, figs. 32, 33) from lower Eocene strata of south-central and southern California. Poor preservation prevents comparison of the Bateque Formation specimen with these two species.

Family Epitoniidae Lamarck, 1822

Genus *Acrilla* H. Adams, 1860

***Acrilla* new species?**

Figure 66

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. A single specimen was found. Other than having its abapertural side buried in matrix and its apertural side slightly worn in places, the shell is generally well preserved. There are seven to eight spiral ribs on each whorl, and they are equal in prominence to the axial ribs. Anterior to the prominent basal keel are about five to six weak spiral ribs that become weaker posteriorly.

This species does not match any known Paleogene fossil species from the Pacific coast of North America. It most closely resembles *Acrilla procerus* Zinsmeister (1983:1291, fig. 2G, H) from the upper Paleocene Santa Susana Formation in Simi Valley, Ventura County, southern California, and from the upper Paleocene Sepultura Formation in northern Baja California (Paredes-Mejia, 1989:185–186, pl. 3, figs. 25, 26). The Bateque specimen differs in the

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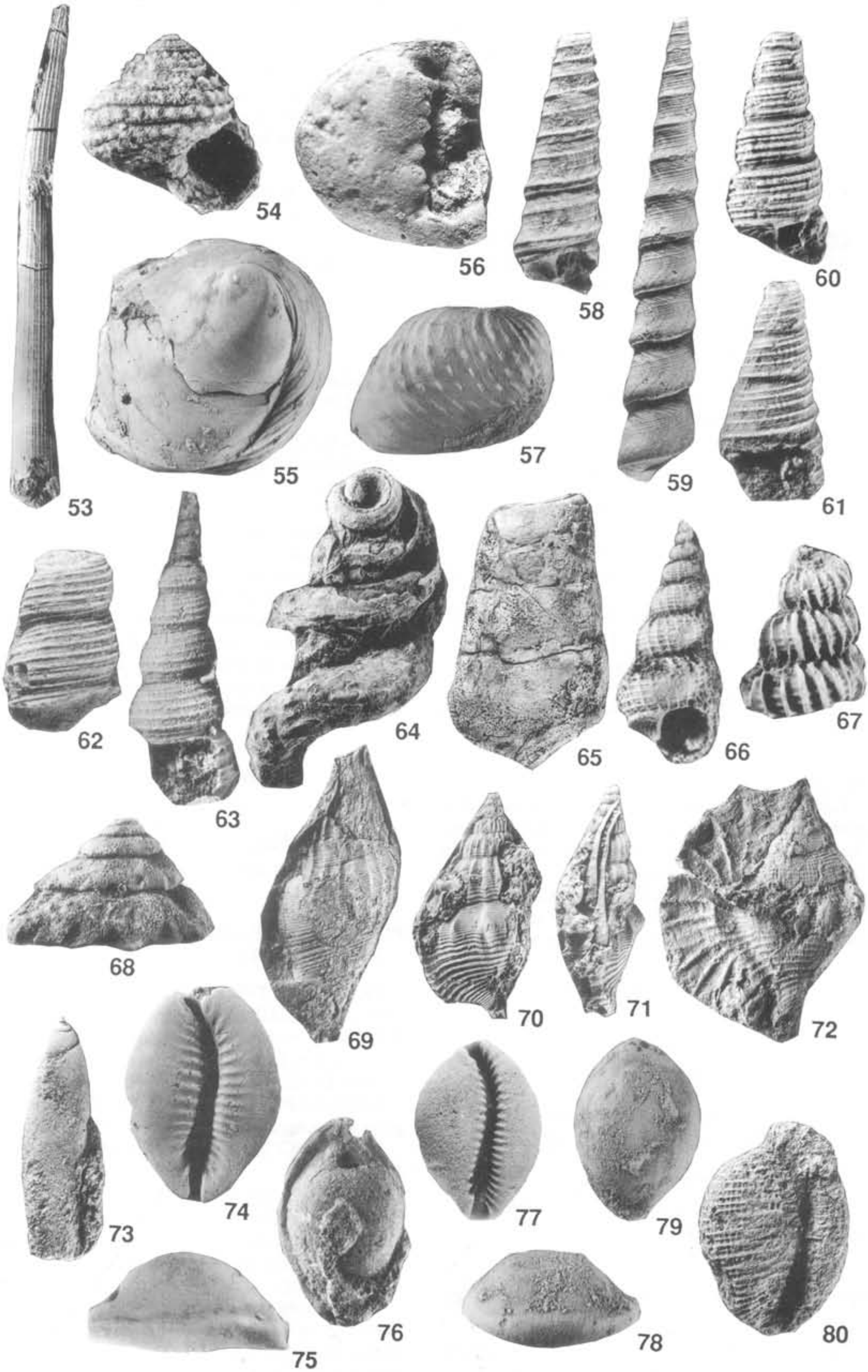
Figures 53–80. Bateque Formation scaphopod and gastropods. **Fig. 53.** Scaphopod. *Dentalium stentor* Anderson and Hanna, 1925, lateral view, ×1.7, length 48 mm, hypotype, IGM 5155, loc. CSUN 1291c. **Figs. 54–80.** Gastropods. **54.** *Arene mcleani* Squires, 1988, apertural view, ×4.5, height 6.5 mm, width 7 mm, hypotype, IGM 5156, loc. CSUN 1291a. **55, 56.** *Velates perversus* (Gmelin, 1791). **55.** Abapertural view showing spiral surface, ×0.7, height 58 mm, hypotype, IGM 5157, loc. CSUN 1291a. **56.** Apertural view, ×1.8, outer lip missing, height 19 mm, hypotype, IGM 5158, loc. CSUN 1220b. **57.** *Velates batequensis* Squires and Demetrion, 1990a, abapertural view, ×1.7, height 14 mm, width 14.5 mm, holotype, IGM 5051, loc. CSUN 1220b. **58.** *Turritella andersoni* s.s. Dickerson, 1916, apertural view, ×2.5, height 17 mm, width 6 mm, hypotype, IGM 5159, loc. CSUN 1291b. **59.** *Turritella andersoni lawsoni* Dickerson, 1916, abapertural view, ×1.3, height 57 mm, width 10 mm, hypotype, IGM 5160, loc. CSUN 1291c. **60.** *Turritella* sp., ? *T. merriami* Dickerson, 1913, apertural view, ×3.1, height 12 mm, width 5 mm, hypotype, IGM 5161, loc. CSUN 1291b. **61.** *Turritella buwaldana* Dickerson, 1916, apertural view, ×3.9, height 9 mm, width 4.5 mm, hypotype, IGM 5162, loc. CSUN 1291b. **62.** *Turritella uvasana* subsp., ? *T. uvasana applinae* Hanna, 1927, abapertural view, ×3.3, height 9 mm, width 7 mm, hypotype, IGM 5163, loc. CSUN 1291c. **63.** *Turritella uvasana* subsp., apertural view, ×5, height 10 mm, width 4 mm, hypotype, IGM 5164, loc. CSUN 1220b. **64.** *Tenagodus bajaensis* Squires, 1990a, lateral view, ×0.9, height 57 mm, width 27 mm, paratype, IGM 5103, loc. CSUN 1291a. **65.** *Campanile* sp., abapertural view, ×0.2, height 190 mm, width 110 mm, hypotype, IGM 5165, loc. CSUN 1220a. **66.** *Acrilla* n. sp.?, apertural view, ×6.5, height 6.2 mm, width 2.5 mm, hypotype, IGM 5166, loc. CSUN 1220b. **67.** *Epitonium* sp., part of spire, ×5.6, height 5 mm, width 4 mm, hypotype, IGM 5167, loc. CSUN 1220b. **68.** *Xenophora stocki* Dickerson, 1916, lateral view, ×2.8, height 8 mm, width 15 mm, hypotype, IGM 5168, loc. CSUN 1220b. **69.** *Ectinochilus* sp., cf. *E.* (*Macilentos*) *macilentus* (White, 1889), abapertural view, ×2, height 24 mm, width 11 mm, hypotype, IGM 5169, loc. CSUN 1293. **70, 71.** *Ectinochilus* (*Cowlitzia*) sp., aff. *E.* (*C.*) *canalifera* (Gabb, 1864), ×1.5, height 24 mm, width 12 mm, hypotype, IGM 5170, loc. CSUN 1293. **70.** Abapertural view. **71.** Outer lip view. **72.** *Platyoptera pacifica* Squires and Demetrion, 1990a, latex peel of external mold, abapertural view, ×1.1, height 40 mm, width (includes winged outer lip) 33 mm, holotype, IGM 5055, loc. CSUN 1220b. **73.** *Paraseraphs erraticus* (Cooper, 1894), apertural view, anterior area missing, ×1.1, height 36 mm, width 12 mm, hypotype, IGM 5171, loc. CSUN 1220b. **74–76.** *Bernaya* (*Protocypraea*) *grovesi* new species, ×2.1, height 16.5 mm, width 12 mm, holotype, IGM 5172, loc. CSUN 1220b. **74.** Ventral view. **75.** Right lateral view. **76.** Dorsal view, ×2, height 17 mm, width 10 mm, paratype, IGM 5173. **77–79.** *Eocypraea*? sp., ×3.1, height 9.3 mm, width 6.5 mm, hypotype, IGM 5174, loc. CSUN 1220b. **77.** Ventral view. **78.** Right lateral view. **79.** Dorsal view. **80.** *Cypraedia* sp., apertural view, ×1.8, height 20 mm, width 14 mm, hypotype, IGM 5057, loc. CSUN 1220b.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following features: less elongate, less prominent spiral ribs, and five to six rather than nine spiral ribs anterior to the basal keel. It may be a new species.

Genus *Epitonium* Röding, 1798

Epitonium sp.

Figure 67

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. A single specimen was found. The sculpture is well preserved and shows approximately 20 well-developed lamellar costae (= varices of some authors) and about four to five fairly weak spiral ribs with about three tertiary spiral ribs in the interspaces. Spiral ribbing is obsolete on the whorl posterior. Because the entire anterior portion of the shell is missing, the specimen cannot be assigned to a subgenus.

Family Xenophoridae Philippi, 1853

Genus *Xenophora* Fischer von Waldheim, 1807

Xenophora stocki Dickerson, 1916

Figure 68

Xenophora stocki Dickerson, 1916:502–503, pl. 37, fig. 4a, b.

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through northern Lockwood Valley, Ventura County, southern California.

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Specimens are rare, are internal molds, and range in height from 9 to 45 mm.

Family Strombidae Rafinesque, 1815

Genus *Ectinochilus* Cossmann, 1889

Subgenus *Macilentos* Clark and Palmer, 1923

Ectinochilus sp., cf. *E.* (*Macilentos*) *macilentus* (White, 1889)

Figure 69

[*Rimella macilenta* White, 1889:19, pl. 3, figs. 10–12.]

LOCAL OCCURRENCE. Localities CSUN 1220b, 1293.

REMARKS. Specimens are rare and poorly preserved. *Ectinochilus* (*M.*) *macilentus* is known from San Diego, southern California, to central California (Squires, 1988b). If the Bateque specimens are *E.* (*M.*) *macilentus,* they would extend the geographic distribution of this species southward into Baja California Sur, Mexico.

Subgenus *Cowlitzia* Clark and Palmer, 1923

Ectinochilus (*Cowlitzia*) sp., aff. *E.* (*C.*) *canalifera* (Gabb, 1864)

Figures 70, 71

[*Rostellaria canalifer* Gabb, 1864:123–124, pl. 29, fig. 228.]

LOCAL OCCURRENCE. Locality CSUN 1470.

REMARKS. Specimens are rare and show good preservation only on their abapertural sides. The specimens have affinity to *E.* (*C.*) *canalifera* known from "Tejon Stage" strata at San Diego, southern California, and the Tehachapi Mountains, Kern County, south-central California (Clark and Palmer, 1923; Hanna, 1927; Givens, 1974). The Bateque Formation specimens differ from *E.* (*C.*) *canalifera* in the following features: spiral ribs not as wide, spiral ribs not as prominent in area of nodes on body whorl, and spiral ribs more closely spaced in area of nodes on body whorl.

Genus *Platyoptera* Conrad, 1854

Platyoptera pacifica Squires and Demetrion, 1990a

Figure 72

Platyoptera pacifica Squires and Demetrion, 1990a: 100–102, figs. 2.6, 2.7.

PRIMARY TYPE MATERIAL. Holotype, IGM 5055 (= LACMIP plastoholotype 8056); paratype, IGM 5056 (= LACMIP plastoholotype 8057); all from locality CSUN 1220b.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Locality CSUN 1220b, 1470?.

REMARKS. Specimens are uncommon and are internal molds. In one of these (Fig. 72), the associated external mold shows the complete abapertural view of the specimen, including the extended outer lip wing.

This species is the earliest record for the genus anywhere in the world and the first record of this genus from the Pacific coast of North America (Squires and Demetrion, 1990a).

Family Seraphsidae Jung, 1974

Genus *Paraseraphs* Jung, 1974

Paraseraphs erraticus (Cooper, 1894)

Figure 73

Tornatina erratica Cooper, 1894:47, pl. 2, fig. 35.

MOLLUSCAN STAGE RANGE. "Capay" through "Transition."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through central California.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1470.

REMARKS. Specimens are uncommon and are internal molds.

Family Cypraeidae Gray, 1824

Genus *Bernaya* Jousseaume, 1884

Subgenus *Protocypraea* Schilder, 1927

***Bernaya (Protocypraea) grovesi* new species**

Figures 74–76

DIAGNOSIS. Small shell for genus, prominent callus around shell margin, denticulation strong, outer lip with 16 teeth, inner lip with 12 teeth, small pit in spire area.

COMPARISON. Groves (1990) reviewed and illustrated all the North American species of *Bernaya (Protocypraea)*, a subgenus whose geologic range is Early Cretaceous to Recent. All the previously known North American species are Late Cretaceous in age and are not comparable to the new species because they have much weaker denticulation.

No previously described Cenozoic species of *B. (Protocypraea)* are known from the Pacific coast of North America (Groves, 1990). Of the few species of the subgenus known from the Eocene of western Europe, the new species is most similar to *B. malandaini* (Chédeville, 1904:103–104, figs. 3, 3 bis; Cossmann and Pissarro, 1910–1913:pl. 33, fig. 162-22) from middle Eocene (lower Lutetian) strata of the Paris Basin, France. The new species differs from the Paris Basin species in the following features: smaller shell, callosity along margin much better developed, fossula area more separated from inner lip teeth, 17 outer lip teeth rather than 20–21, 12 inner lip teeth rather than about 18, and better development of pit in spire area.

DESCRIPTION. Small shell (17 mm in height), moderately pyriform, maximum diameter in center of shell, base flattened with a small concavity near anterior end. Spire covered, spire area coincident with a small pit. Aperture fairly sinuous, posterior canal curved left, anterior and posterior canals deep, denticulation strong with smooth interstices, outer lip with 16 teeth, inner lip with 12 teeth. Fossula smooth and concave. Outer lip callus prominent and associated with a dorsal ring. Inner lip callus present. Holotype height 17 mm, width 12 mm.

PRIMARY TYPE MATERIAL. Holotype, IGM 5172 (= LACMIP plastoholotype 8856); paratype, IGM 5173 (= LACMIP plastoparatype 8857); all from locality CSUN 1220b.

TYPE LOCALITY. Locality CSUN 1220b.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. locality CSUN 1220b.

REMARKS. Two specimens were found. Both are about the same size and are well preserved. The small pit in the spire area is accentuated by weathering.

The new species is the first record of *Bernaya (Protocypraea)* in the Cenozoic of the Pacific coast of North America.

ETYMOLOGY. The new species is named after Lindsey T. Groves.

Family Ovulidae Fleming, 1828

Genus *Eocypraea* Cossmann, 1903

Eocypraea? sp.

Figures 77–79

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. A single juvenile? specimen (10 mm in height) was found.

Family Pediculariidae H. and A. Adams, 1854

Genus *Cypraedia* Swainson, 1840

Cypraedia sp.

Figure 80

Cypraedia sp. Squires and Demetrion, 1990a:102, figs. 2.8–2.10.

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. A single internal mold represents the only record of this genus from the Pacific coast of North America (Squires and Demetrion, 1990a).

Family Naticidae Forbes, 1838

Genus *Amauropsis* Mörch *in* Rink, 1857

Amauropsis sp.

Figure 81

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Specimens are rare. The best specimen (Fig. 81) shows most of the features that Marincovich (1977) listed as diagnostic of the genus; namely, a distinctly channelled suture, slit-like umbilicus, and elongate proportions. No fine spiral sculpture, however, was seen, but its lack is probably due to poor preservation. The Bateque Formation specimens show variation in relative height of the spire. The figured specimen shows a relatively low-spired example.

The Bateque Formation specimens are the youngest occurrences of *Amauropsis* from the Pacific coast of North America. Previously, the only known Paleogene species of this genus in this area were *A. martinezensis* Dickerson (1914a:142, pl. 13, Fig. 4a, b; Marincovich, 1977:221–222, pl. 17, figs. 5–7, 9–10, not 8 *fide* Zinsmeister, 1983) and *A. meierensis* Zinsmeister (1983:1292–1293, fig. 2L, M) from upper Paleocene strata of California. Paredes-Mejia (1989) also reported *A. martinezensis* from Paleocene strata of northern Baja California.

More Bateque Formation specimens are needed to determine specific identification. It may be that it is a new species.

Genus *Gyrodes* Conrad, 1860

Gyrodes? sp.

Figure 82

LOCAL OCCURRENCE. Localities CSUN 1220b, 1291a, 1470.

REMARKS. Specimens are abundant and are internal molds. Many are large (up to 60 mm in height).

The preservation does not allow for positive generic or specific identification, but the specimens resemble *Gyrodes abyssinus* (Morton, 1834:49, pl. 13, fig. 13) known from Upper Cretaceous (Maastrichtian) strata of the Atlantic and Gulf Coastal Plains (Sohl, 1960:121). Like the Bateque Formation specimens, *G. abyssinus* is medium- to large-sized, has a globular body whorl with a moderately tabular shoulder, and has a wide umbilicus (see Sohl, 1960:pl. 17, figs. 26, 29, 30, 33).

The genus *Gyrodes* is predominantly of later Cretaceous age, but *G.* (*G.* ?) *robustus* Waring, 1917, is known from Paleocene (Selandian) strata of southern California (Popenoe et al., 1987).

Genus *Eocernina* Gardner and Bowles, 1934

Eocernina hannibali (Dickerson, 1914b)

Figure 83

Natica hannibali Dickerson, 1914b:119, pl. 12, fig. 5a, b.

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through northwestern Washington.

LOCAL OCCURRENCE. Locality CSUN 1220b, 1291a.

REMARKS. Specimens are common. At locality 1291a, they represent a growth series from 20 to 55 mm in height. At locality 1220b, one of the specimens is very large (90 mm in height).

Genus *Pachycrommium* Woodring, 1928

Pachycrommium clarki (Stewart, 1927)

Figure 84

Amaurellina (*Euspirocrommium*) *clarki* Stewart, 1927:336–339, pl. 26, figs. 8, 9 [new name, in part, for *Amauropsis alveata* (Conrad, 1855), preoccupied and misidentified].

MOLLUSCAN STAGE RANGE. "Capay" through "Tejon."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through northwestern Washington.

LOCAL OCCURRENCE. Localities CSUN 1229b, 1291a.

REMARKS. Specimens are uncommon. At locality 1220b, they represent a partial growth series from 13 to 45 mm in height.

Family Cassidae Swainson, 1832

Genus *Galeodea* Link, 1807

Galeodea sp.

Figure 85

LOCAL OCCURRENCE. Localities CSUN 1220b, 1470.

REMARKS. Specimens are rare and poorly preserved. There are either fragments of the shell or internal molds. All specimens are too fragmentary to allow identification as to species.

Family Bursidae Thiele, 1925

Genus *Olequahia* Stewart, 1927

Olequahia domenginica (Vokes, 1939)

Figure 86

Ranella domenginica Vokes, 1939:147–148, pl. 19, figs. 6, 20.

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through central California.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1470.

REMARKS. Specimens are rare and are internal molds.

Order Neogastropoda

Family Fasciolariide Gray, 1853

Genus *Clavilithes* Swainson, 1840

Clavilithes tabulatus (Dickerson, 1913)

Figure 87

Clavella tabulata Dickerson, 1913:283, pl. 12, fig. 7.

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through central California.

LOCAL OCCURRENCE. Localities CSUN 1291a, 1470.

REMARKS. Specimens are rare and are either partial specimens or internal molds.

Family Olividae Latreille, 1825

Genus *Olivella* Swainson, 1831

? *Olivella mathewsonii* Gabb, 1864

Figure 88

[*Olivella mathewsonii* Gabb, 1864:100, pl. 18, fig. 53.]

LOCAL OCCURRENCE. Localities CSUN 1220b, 1470.

REMARKS. Specimens are uncommon, are poorly preserved, and do not clearly show the anterior inner lip area that is necessary for positive identification. *Olivella mathewsonii* is known from Simi Valley, Los Angeles County, southern California, to northwestern Washington (Squires, 1988b). If the Bateque Formation specimens are *O. mathewsonii,* they would extend the geographic distribution of this species southward into Baja California Sur, Mexico.

Family Harpidae Bronn, 1849

Genus *Eocithara* P. Fischer, 1883

Eocithara sp.

Figure 89

LOCAL OCCURRENCE. Locality CSUN 1220c.

REMARKS. A single internal mold was found, but it shows evidence of thin collabral costae on the body whorl.

Family Volutidae Rafinesque, 1815

Genus *Lyria* Gray, 1847

Lyria andersoni Waring, 1917

Figure 90

Lyria andersoni Waring, 1917:97, pl. 15, fig. 12.

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through southwestern Oregon.

LOCAL OCCURRENCE. Locality CSUN 1291a.

REMARKS. A single specimen was found.

Genus *Lyrischapa* Aldrich, 1911

Lyrischapa lajollaensis (Hanna, 1927)

Figure 91

Pejonia lajollaensis Hanna, 1927:320, pl. 52, figs. 1, 2.

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through Pine Mountain area, Ventura County, southern California.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1470.

REMARKS. Specimens are rare and are either fragmentary or internal molds.

Family Conidae Rafinesque, 1815

Genus *Conus* Linné, 1758

Conus caleocius Vokes, 1939

Figure 92

Conus caleocius Vokes, 1939:127–129, pl. 18, figs. 1, 7.

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through central California.

LOCAL OCCURRENCE. Locality CSUN 1291c.

REMARKS. A single specimen was found.

Subclass Heterobranchia

Order Architectonicoidea

Family Architectonicidae Gray, 1850

Genus *Architectonica* Röding, 1798

Subgenus *Stellaxis* Dall, 1892

Architectonica (*Stellaxis*) *cognata* Gabb, 1864

Figure 93

Architectonica cognata Gabb, 1864:117, pl. 20, figs. 72, 72a, 72c [not figs. 72d and 72e as stated].

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through southwestern Oregon.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1291b.

REMARKS. Specimens are rare. They are poorly preserved shells that are smooth except for the prominent keel and a prominent sutural cord. These two cords produce the diagnostic double-keel feature of this species.

Subclass Euthyneura

Order Cephalaspidea

Family Cylichnidae A. Adams, 1850

Genus *Cylichnina* Monterosato, 1884

Cylichnina tantilla (Anderson and Hanna, 1925)

Figure 94

Cylichnella tantilla Anderson and Hanna, 1925: 140, pl. 7, figs. 4, 8, 9.

MOLLUSCAN STAGE RANGE. "Capay" through "Tejon."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through western Washington.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1470.

REMARKS. Specimens are common at locality 1220b. One hand specimen of rock from this locality contained eight specimens. Specimens are rare at locality 1470.

Genus *Scaphander* Montfort, 1810

Scaphander? sp.

Figure 95

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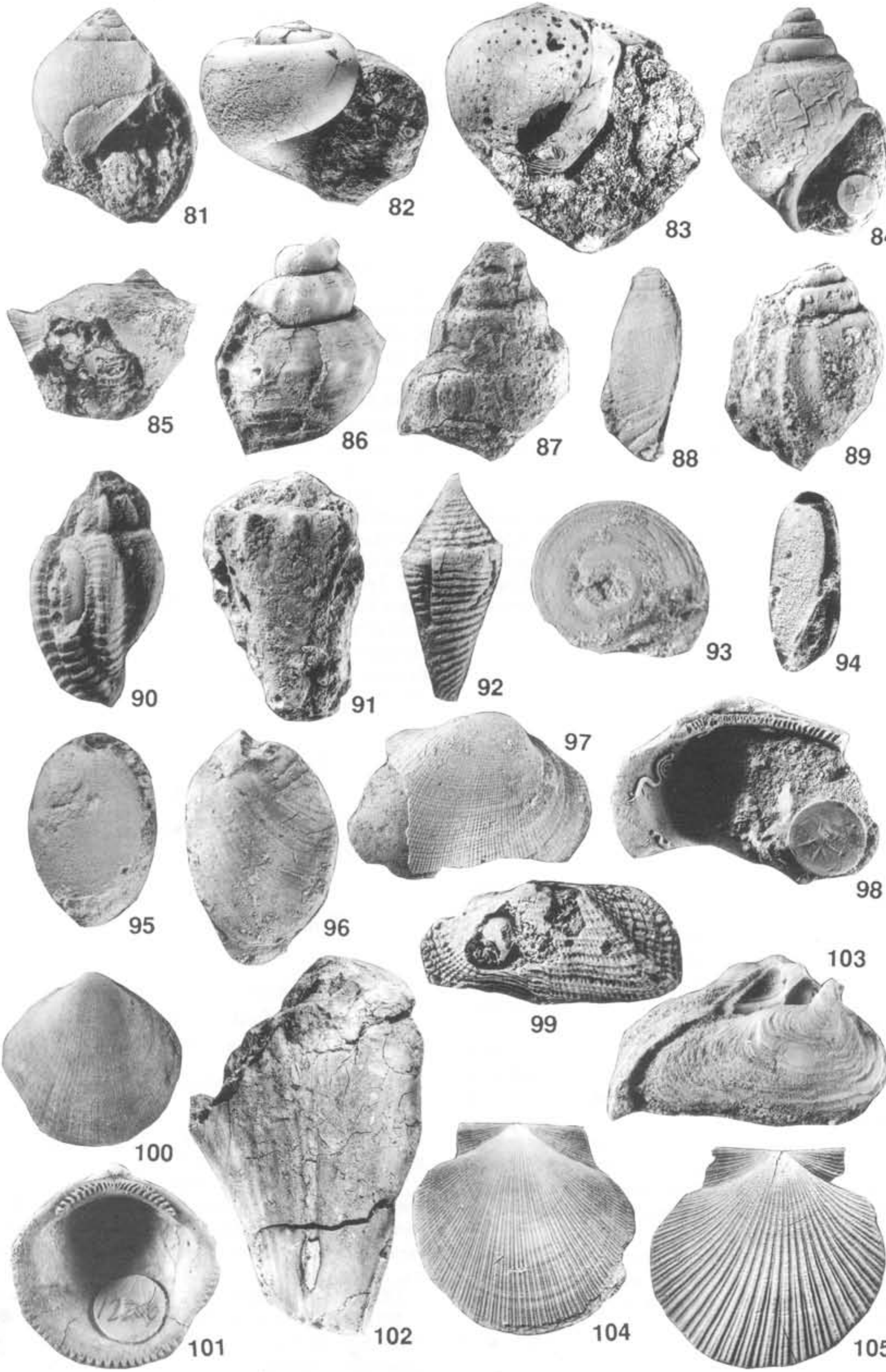
Figures 81–105. Bateque Formation gastropods and bivalves. **Figs. 81–96.** Gastropods. **81.** *Amauropsis* sp., apertural view, ×1.7, height 20 mm, width 15 mm, hypotype, IGM 5175, loc. CSUN 1220b. **82.** *Gyrodes*? sp., apertural view, ×0.6, height 45 mm, width 50 mm, hypotype, IGM 5176, loc. CSUN 1220b. **83.** *Eocernina hannibali* (Dickerson, 1914), apertural view, ×0.5, height 85 mm, width 85 mm, hypotype, IGM 5177, loc. CSUN 1220b. **84.** *Pachycrommium clarki* (Stewart, 1927), apertural view, ×1, height 37 mm, width 26.5 mm, hypotype, IGM 5178, loc. CSUN 1291a. **85.** *Galeodea* sp., abapertural view, anterior part missing, ×1.6, height 12 mm, width 15 mm, hypotype, IGM 5179, loc. CSUN 1220b. **86.** *Olequahia domenginica* (Vokes, 1939), internal mold, abapertural view, ×1.2, height 30 mm, width 22 mm, hypotype, IGM 5180, loc. CSUN 1470. **87.** *Clavilithes tabulatus* (Dickerson, 1913), abapertural view, spire area, ×1, height 35 mm, width 30 mm, hypotype, IGM 5181, loc. CSUN 1291a. **88.** ?*Olivella mathewsonii* Gabb, 1864, abapertural view, ×4.4, height 7 mm, width 2.5 mm, hypotype, IGM 5182, loc. CSUN 1470. **89.** *Eocithara* sp., abapertural view, ×1.6, height 21 mm, width 18 mm, hypotype, IGM 5183, loc. CSUN 1220c. **90.** *Lyria andersoni* Waring, 1917, left lateral view, ×3.7, height 10 mm, width 7 mm, hypotype, IGM 5184, loc. CSUN 1291a. **91.** *Lyriscapha lajollaensis* (Hanna, 1927), left lateral view, ×1.3, height 32 mm, width 19.5 mm, hypotype, IGM 5185, loc. CSUN 1220b. **92.** *Conus caleocius* Vokes, 1939, abapertural view, ×4.1, height 9 mm, width 3.5 mm, hypotype, IGM 5186, loc. CSUN 1291c. **93.** *Architectonica* (*Stellaxis*) *cognata* Gabb, 1864, dorsal view, ×4, diameter 7 mm, hypotype, IGM 5187, loc. CSUN 1220b. **94.** *Cylichnina tantilla* (Anderson and Hanna, 1925), apertural view, ×3.2, height 9 mm, width 3.5 mm, hypotype, IGM 5188, loc. CSUN 1220b. **95.** *Scaphander*? sp. abapertural view, ×2.4, height 13 mm, width 10 mm, hypotype, IGM 5189, loc. CSUN 1470. **96.** *Megistostoma gabbianum* (Stoliczka, 1868), internal mold, dorsal view, ×0.7, height 50.5 mm, width 32 mm, hypotype, IGM 5190, loc. CSUN 1293. **Figs. 97–105.** Bivalves. **97, 98.** *Barbatia* (*Barbatia*?) sp., right valve, length 23 mm, height 16 mm, hypotype, IGM 5191, loc. CSUN 1220b. **97.** ×1.7. **98.** ×1.8. **99.** *Barbatia* (*Acar*?) sp., left valve, ×1.3, length 32 mm, height 15 mm, hypotype, IGM 5192, loc. CSUN 1220a. **100, 101.** *Glycymeris* (*Glycymerita*) *sagittata* (Gabb, 1864), right? valve, length 18.5 mm, height 18 mm, hypotype, IGM 5193, loc. CSUN 1220b. **100.** ×1.5. **101.** ×1.8. **102.** *Pinna llajasensis* Squires, 1983, internal mold of right valve of an articulated specimen, anterior end missing, ×0.4, length 130 mm, height 83 mm, hypotype, IGM 5194, loc. CSUN 1220d. **103.** *Nayadina* (*Exputens*) *batequensis* Squires, 1990b, left valve, ×2, length 19 mm, height 11 mm, paratype, IGM 5113, loc. CSUN 1220b. **104, 105.** *Batequeus mezquitalensis* Squires and Demetrion, 1990b, loc. CSUN 1293. **104.** Left valve, ×0.9, length 38 mm, height 36.5 mm, holotype, IGM 5058. **105.** Right valve, ×0.90, length 40 mm, height 38 mm, paratype, IGM 5050.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LOCAL OCCURRENCE. Locality CSUN 1470.
REMARKS. Only a single poorly preserved specimen was found.

Family Philinidae Gray, 1850

Genus *Megistostoma* Gabb, 1864

Megistostoma gabbianum (Stoliczka, 1868)

Figure 96

Bullaea gabbiana Stoliczka, 1868:434 [new name for *Megistostoma striata* Gabb, 1864, preoccupied.]

MOLLUSCAN STAGE RANGE. "Domengine" through middle part of "Tejon."
GEOGRAPHIC DISTRIBUTION. San Juanico area, Baja California Sur, Mexico, through southwestern Oregon.
LOCAL OCCURRENCE. Locality CSUN 1293.
REMARKS. A single internal mold was found. The presence of *M. gabbianum* at locality CSUN 1293 extends the molluscan range of this species into the middle Eocene part of the "Tejon Stage." Previously, the upper range limit had been known to be "Transition Stage" (Squires, 1984).

Class Bivalvia

Order Arcoida

Family Arcidae Lamarck, 1809

Genus *Barbatia* Gray, 1842

Barbatia (*Barbatia*?) sp.

Figures 97, 98

LOCAL OCCURRENCE. Localities CSUN 1220a, 1220b.
REMARKS. Specimens are rare and fragmentary. They have the shape and external ornamentation of *Barbatia* s.s. The best-preserved specimen (Figs. 97, 98) also has the convergent hinge teeth similar to those in *Barbatia* s.s., but the figured specimen has a very narrow cardinal area with only a single ligamental groove. In *Barbatia* s.s., the cardinal area is fairly wide and there are several ligamental grooves.

The steep inclination and narrowness of the cardinal area in the Bateque specimens approach that seen in *B.* (*Acar*), but *Acar* has a different shape, coarser external ornamentation, and a prominent posterior umbonal carina.

More Bateque Formation specimens are needed to resolve the question as to which subgenus this arcid belongs. It may prove to be a new subgenus.

Subgenus *Acar* Gray, 1857

Barbatia (*Acar*?) sp.

Figure 99

LOCAL OCCURRENCE. Localities CSUN 1220a, 1220b.
REMARKS. Specimens are rare and are either fragments of shell or are somewhat weathered. The specimens have the shape and external ornamentation of *Barbatia* (*Acar*). The best-preserved specimen also has hinge teeth (inaccessible for photography) and a fairly narrow cardinal area (with at least two ligamental grooves) that seem to be similar to those in *Acar*. Better preservation is needed to positively assign these specimens to subgenus *Acar*. *Acar* has a geologic range of early Paleocene to Recent (Newell, 1969). If the Bateque specimens do belong to a species of *Acar*, this species would be the earliest one known from the Pacific coast of North America. The only other Paleogene *Acar* species from this area is *B.* (*A.*) *reinharti* Effinger (1938:367, pl. 45, figs. 3, 4; pl. 46, figs. 1, 2) from the upper Eocene Gries Ranch beds, southwestern Washington (Squires, 1989).

The Bateque Formation specimens resemble *B.* (*A.*) *aspera* (Conrad, 1854:pl. 14, fig. 5), the only reported species of *Acar* from the Paleogene of the southeastern United States. This species is from middle through upper Eocene strata in Mississippi and Texas (Palmer and Brann, 1965:44). The Bateque Formation specimens differ from *B.* (*A.*) *aspera* in the following features: anterior end more elongate and umbo more medially located. The Bateque Formation specimens may represent a new species.

Family Glycymerididae Newton, 1922

Genus *Glycymeris* da Costa, 1778

Subgenus *Glycymerita* Finley and Marwick, 1937

Glycymeris (*Glycymerita*) *sagittata* (Gabb, 1864)

Figures 100, 101

Axinaea (*Limopsis*?) *sagittata* Gabb, 1864:197–198, pl. 31, figs. 267, 267a.

MOLLUSCAN STAGE RANGE. "Capay" through "Tejon," Oligocene?.
GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through Gulf of Alaska (Marincovich, 1988) and far eastern Soviet Union (Devyatilova and Volobueva, 1981).
LOCAL OCCURRENCE. Locality CSUN 1220b.
REMARKS. A single specimen was found. Although its exterior is weathered, the interior is excellently preserved and shows the diagnostic 12 well-defined teeth on each side of the hinge. In the medial area, the teeth are smaller. The ligamental

area is well defined and contains five inverted V-shaped ridges.

Order Mytiloida

Family Pinnidae Leach, 1819

Genus *Pinna* Linné, 1758

Pinna llajasensis Squires, 1983

Figure 102

Pinna llajasensis Squires, 1983:359–360, fig. 2L.

MOLLUSCAN STAGE RANGE. "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through central California.

LOCAL OCCURRENCE. Locality CSUN 1220d and float in vicinity of locality CSUN 1470.

REMARKS. A single large, articulated specimen was found at CSUN locality 1220d. Articulated specimens are common in float in the vicinity of CSUN locality 1470. The float material, which is at the base of the approximately 100-m-high cliff in this area, must have come from higher in the section than at locality 1470. The relatively unfossiliferous very fine-grained sandstone matrix surrounding the specimens is identical to that at locality 1220d.

Order Pterioida

Family Malleidae Lamarck, 1819

Genus *Nayadina* Munier-Chalmas, 1864

Subgenus *Exputens* Clark, 1934

Nayadina (*Exputens*) *batequensis* Squires, 1990b.

Figure 103

Nayadina (*Exputens*) *batequensis* Squires, 1990b: 308–309, figs. 3–25.

PRIMARY TYPE MATERIAL. Holotype, IGM 5108 (= LACMIP plastoholotype 8294); paratypes, IGM 5109–5119 (= LACMIP plastoparatypes 8295–8305); all from locality CSUN 1220b.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1471.

REMARKS. Specimens are abundant. There are equal numbers of left and right valves and a few articulated specimens at both localities.

This species is highly variable in shape, and seven variants have been recognized (Squires, 1990b). Specimens at locality 1471 are much larger than those at locality 1220b. With increasing size, the triangular shape that is the most common variant of this species becomes more elongate anteriorly and posteriorly.

Nayadina (*Exputens*) is confined to Eocene deposits of North America, and *N.* (*E.*) *batequensis* is the earliest known species of this subgenus (Squires and Demetrion, 1990b).

Family Pectinidae Rafinesque, 1815

Genus *Batequeus* Squires and Demetrion, 1990b

Batequeus mezquitalensis Squires and Demetrion, 1990b

Figures 104, 105

Batequeus mezquitalensis Squires and Demetrion, 1990b:383, 385, figs. 2.1–2.5.

PRIMARY TYPE MATERIAL. Holotype, IGM 5058 (= LACMIP plastoholotype 8061); paratypes, IGM 5059–5060 (= LACMIP plastoparatypes 8062–8063); all from locality CSUN 1293.

MOLLUSCAN STAGE RANGE. Middle Eocene part of "Tejon."

GEOGRAPHIC DISTRIBUTION. San Juanico area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Locality CSUN 1293.

REMARKS. Specimens are abundant, with about equal numbers of left and right valves. Some are articulated. *Batequeus* is known only from the Bateque Formation.

Family Plicatulidae Watson, 1930

Genus *Plicatula* Lamark, 1801

Plicatula sp., aff. *P. filamentosa* Conrad, 1833

Figures 106, 107

[*Plicatula filamentosa* Conrad, 1833:38; Harris, 1919:18, pl. 2, figs. 3–8.]

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Specimens are rare. They closely resemble *P. filamentosa* Conrad, 1833, from middle Eocene strata, southeastern United States. The only difference is that the Bateque specimens show only the faintest hint of any secondary radial ribs. In most specimens of *P. filamentosa*, these secondary ribs are scaly and impart a beaded look. In some slightly weathered? specimens, however, collected by the senior author from the Gosport Sand in Alabama, the scaly ribs are very subdued, and these specimens are virtually indistinguishable from the Bateque specimens. More Bateque material is needed to resolve whether or not the *Plicatula* specimens represent a new species.

Plicatula juncalensis Squires (1987:57–58, figs. 95, 96), the only other reported species of *Plicatula* from the Eocene of the Pacific coast of North America, is from "Capay Stage" strata in the Whitaker Peak area, Los Angeles County, southern California. The Bateque Formation specimens differ from *P. juncalensis* in the following features: fewer, wider, and more lamellose ribs and no secondary radial ribs.

Plicatula sp.

Figure 108

LOCAL OCCURRENCE. Localities CSUN 1291a, 1293, 1471?.

REMARKS. Specimens are uncommon and poorly preserved as fragments, internal molds, and shell interiors. Several are articulated.

Plicatula sp. from the Bateque Formation differs from specimens of *P.* sp., aff. *P. filamentosa* from the formation in the following features: more numerous primary radial ribs (possibly 30 rather than approximately 15) and much narrower radial ribs.

Family Spondylidae Gray, 1826

Genus *Spondylus* Linné, 1758

Spondylus batequensis Squires and Demetrion, 1990b

Figure 109

Spondylus batequensis Squires and Demetrion, 1990b:385–386, figs. 2.6–2.12.

PRIMARY TYPE MATERIAL. Holotype, IGM 5061 (= LACMIP plastoholotype 8064); paratypes, IGM 5062–5066 (= LACMIP plastoparatypes 8065–8069); all from locality CSUN 1220b.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Localities CSUN 1220a, 1220b, 1220c, 1471.

REMARKS. Specimens are abundant at localities 1220a and 1220b, and several specimens at these localities were found articulated. A few specimens at locality 1220b are attached to valves of *Pycnodonte* (*Phygraea*) *pacifica*. Specimens are rare at the other localities.

Family Anomiidae Rafinesque, 1815

Genus *Anomia* Linné, 1758

Anomia? sp.

Figure 110

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. A single, weathered left valve was found. The interior of the delicate specimen is filled with well-cemented matrix, and it is not possible to positively identify the specimen as to genus.

Family Limidae Rafinesque, 1815

Genus *Lima* Bruguière

Lima kennedyi new species

Figures 111, 112

DIAGNOSIS. Approximately 47 spinose narrow radial ribs with very closely spaced oblique ribbing in the interspaces; radial ribs become much wider and lamellose in mature individuals.

COMPARISON. A review of fossil *Lima* from the Pacific coast of North America is much needed. *Lima*, whose geologic range is Jurassic to Recent (Cox et al., 1969), may have been present in this area since the Late Cretaceous. A few Late Cretaceous species from southern California (Gabb, 1864, 1869; Packard, 1922; Sundberg, 1979) and a few late middle Eocene or Oligocene species from western Washington and vicinity (Weaver, 1943) have been placed in genus *Lima*, but none of these species has both the relatively well-differentiated auricles and scaly radial ribs diagnostic of *Lima*. A thorough review of these species is needed to understand their proper generic assignments. Until this study is done, it can only be tentatively stated that *Lima kennedyi* new species is the earliest occurrence of *Lima* from the Pacific coast of North America.

In the Paleogene record of the Atlantic and Gulf coasts of North America, only *Lima vicksburgiana* Dall (1898:765, pl. 35, fig. 20) from upper Eocene strata of Florida belongs to *Lima* s.s. (Palmer and Brann, 1965). The new species differs in having 47 rather than 35 primary radial ribs.

Eocene species of *Lima* are best represented in strata of the Paris Basin, France. Comparison with these revealed that the new species is most similar to *Lima rara* Deshayes (1860:pl. 78, figs. 9–11; Cossmann and Pissarro, 1904–1906:pl. 40, fig. 129-2) from middle Eocene (Lutetian) strata of the Paris Basin. The new species differs from *L. rara* in having approximately 47 primary radial ribs rather than about 35, and primary radial ribs more widely spaced and less strongly spinose.

DESCRIPTION. Medium-sized shell for genus, moderately thin, obliquely oval, valves slightly convex. Slight posterior gape adjacent to hinge line. Anterior auricle small. Posterior auricle twice as large, with three or four radial riblets, and a thickened posterior margin that is obliquely truncate. Approximately 47 narrow primary radial ribs, spinose (except in umbo area), with spinosity becoming stronger ventrally. Interspaces about two times as wide as primary radial ribs except anteriorly and posteriorly, where spacing can be variable. Interspaces with closely spaced fine ribs that obliquely intersect the radial ribs; on anterior half of valve these fine ribs point anteriorly and on posterior half of valve they point in the opposite direction. In mature individuals, nearly all primary radial ribs grade into thick lamellose costae that become more strongly spinose (commonly with two rows of spines) near shell venter. Growth lines very closely spaced. Hinge not seen. Holotype height 32 mm, length 25 mm.

PRIMARY TYPE MATERIAL. Holotype, IGM 5198 (= LACMIP plastoholotype 8858); paratype, IGM 5199 (= LACMIP plastoparatype 8859); all from locality CSUN 1220b.

TYPE LOCALITY. Locality CSUN 1220b.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Eight specimens were found. They are all single valves except one articulated specimen which is embedded in very hard matrix. They represent a growth series.

Pending a review of Pacific coast of North America fossil *Lima*, *L. kennedyi* new species is the earliest record of *Lima* from this area.

ETYMOLOGY. The new species is named after George L. Kennedy who has made valuable contributions in the study of Cenozoic mollusks.

Family Gryphaeidae Vyalov, 1936

Genus *Pycnodonte* Fischer de Waladheim, 1835

Subgenus *Phygraea* Vyalov, 1936

Pycnodonte (*Phygraea*) *pacifica* Squires and Demetrion, 1990b

Figure 113

Pycnodonte (*Phygraea*) *pacifica* Squires and Demetrion, 1990b:386, figs. 3.1–3.4.

PRIMARY TYPE MATERIAL. Holotype, IGM 5067 (= LACMIP plastoholotype 8070); paratype, IGM 5068 (= LACMIP plastoparatype 8071); all from locality CSUN 1220c.

MOLLUSCAN STAGE RANGE. "Capay" through middle Eocene part of "Tejon."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area through San Juanico area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1220c, 1220d, 1291b, 1293, 1470, 1471.

REMARKS. Specimens are common at locality 1220c, where they occur as large individuals (some articulated) or in concentrations of single valves. At the other localities, specimens are uncommon.

This species is the first report of the subgenus *Phygraea* on the Pacific coast of North America.

Subgenus *Pegma* Squires and Demetrion, 1990b

Pycnodonte (*Pegma*) *bajaensis* Squires and Demetrion, 1990b

Figure 114

Pycnodonte (*Pegma*) *bajaensis* Squires and Demetrion, 1990b:388, figs. 3.5–3.12.

PRIMARY TYPE MATERIAL. Holotype, IGM 5069 (= LACMIP plastoholotype 8072); paratypes, IGM 5070–5072 (= LACMIP plastoparatypes 8073–8075); all from locality CSUN 1220b.

MOLLUSCAN STAGE RANGE. "Capay" through middle Eocene part of "Tejon."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area through San Juanico area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1470, 1471, 1292, 1293.

REMARKS. Specimens are abundant at locality 1220b, where they occur as disarticulated valves that represent a growth series. Most of these valves are unattached right valves. Shell and coral debris commonly form the substrate for attachment of the left valves. A few specimens, however, have a trough-like attachment scar that resembles the outline of a mangrove root (Squires and Demetrion, 1990b:fig. 3.5). At the other localities, specimens are rare to uncommon.

The subgenus *Pegma* is known only from the Bateque Formation.

Family Ostreidae Rafinesque, 1815

Genus *Cubitostrea* Sacco, 1897

Cubitostrea mezquitalensis Squires and Demetrion, 1990b

Figures 115, 116

Cubitostrea mezquitalensis Squires and Demetrion, 1990b:388–390, figs. 4.1–4.9.

PRIMARY TYPE MATERIAL. Holotype, IGM 5073 (= LACMIP plastoholotype 8076); paratypes, IGM 5074–5075 and 5105–5107 (= LACMIP plastoparatypes 8077–8078 and 8276–8278); all from locality CSUN 1293.

MOLLUSCAN STAGE RANGE. Middle Eocene part of "Tejon."

GEOGRAPHIC DISTRIBUTION. San Juanico area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Locality CSUN 1293.

REMARKS. Specimens are very abundant and well preserved with nearly equal numbers of left and right valves. Many specimens are articulated.

Cubitostrea meszquitalensis is the only species of this genus known from the Pacific coast of North America.

Order Veneroida

Family Fimbriidae Nicol, 1950

Genus *Fimbria* Megerle von Mühlfeld, 1811

Fimbria pacifica Squires, 1990c

Figure 117

Fimbria pacifica Squires, 1990c:554–555, figs. 3.1–3.3.

PRIMARY TYPE MATERIAL. Holotype, IGM 5104 (= LACMIP plastoholotype 8097), locality CSUN 1220b; paratype, LACMIP 7519, locality CSUN 830.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through southern California.

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. This species is known only from single valves, which are rare.

Family Carditidae Fleming, 1820

Genus *Glyptoactis* Stewart, 1930

Subgenus Claibornicardia Stenzel and Krause, 1957

Glyptoactis (*Claibornicardia*) *domenginica* (Vokes, 1939)

Figure 118

Venericardia (*Glyptoactis*?) *domenginica* Vokes, 1939:66, pl. 5, figs. 7–9.

MOLLUSCAN STAGE RANGE. "Capay" through "Transition."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through Mt. Diablo, northern California.

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Specimens are uncommon and are single valves.

Family Crassatellidae Férussac

Genus *Crassatella* Lamarck, 1799

Crassatella sp.

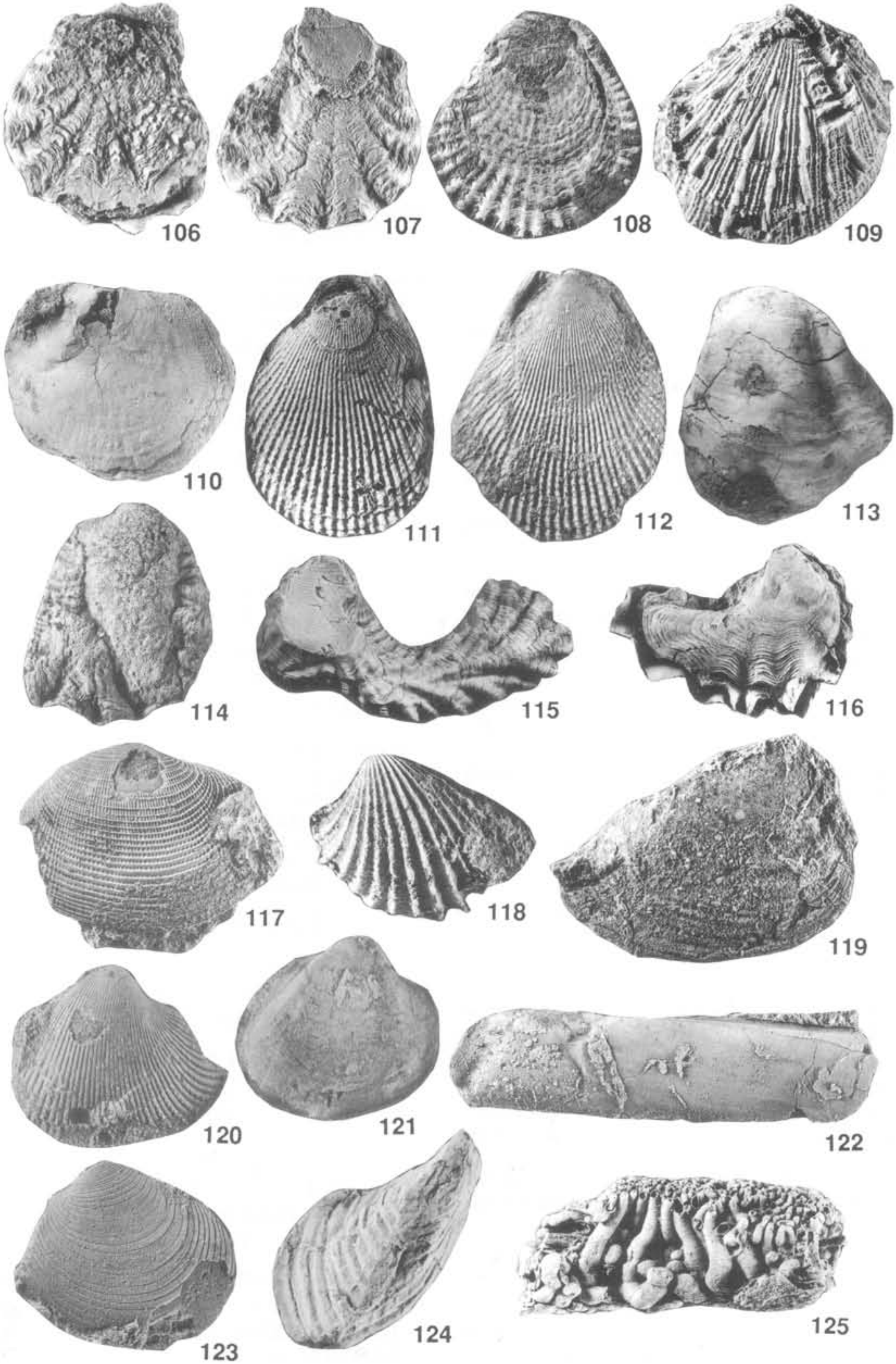
Figure 119

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. A single specimen was found, and it is an internal mold of an articulated individual.

→

Figures 106–125. Bateque bivalves. **Figs. 106, 107.** *Plicatula* sp., aff. *P. filamentosa,* Conrad, 1833, ×2.1, length 15 mm, height 16 mm, hypotype, IGM 5195, loc. CSUN 1220b. **106.** Left valve. **107.** Right valve. **Fig. 108.** *Plicatula* sp., interior of left? valve, ×1.8, length 20 mm, height 20 mm, hypotype, IGM 5196, loc. CSUN 1293. **Fig. 109.** *Spondylus batequensis* Squires and Demetrion, 1990b, right valve, ×1.8, length 19 mm, height 21 mm, holotype, IGM 5061, loc. CSUN 1220b. **Fig. 110.** *Anomia*? sp. left valve, ×1.4, length 25.5 mm, height 21 mm, hypotype, IGM 5197, loc. CSUN 1220b. **Figs. 111, 112.** *Lima kennedyi* new species, loc. CSUN 1220b. **111.** Left valve, ×1.2, length 25 mm, height 36 mm, paratype, IGM 5199. **112.** Right valve, ×1.4, length 31 mm, height 33 mm, holotype, IGM 5198. **Fig. 113.** *Pycnodonte* (*Phygraea*) *pacifica* Squires and Demetrion, 1990b, left valve, ×0.5, length 72 mm, height 80 mm, holotype, IGM 5067, loc. CSUN 1220c. **Fig. 114.** *Pycnodonte* (*Pegma bajaensis* Squires and Demetrion, 1990b, right valve, ×1.4, length 22 mm, height 26 mm, holotype, IGM 5069, loc. CSUN 1220b. **Figs. 115, 116.** *Cubitostrea mezquitalensis* Squires and Demetrion, 1990b, loc. CSUN 1293. **115.** Left valve, ×0.6, length 79 mm, height 39 mm, holotype, IGM 5073. **116.** Right valve of an articulated specimen, ×0.8, length 39 mm, height 30 mm, paratype, IGM 5075. **Fig. 117.** *Fimbria pacifica* Squires, 1990c, right valve, ×1.1, length 47 mm, height 32 mm, holotype, IGM 5104, loc. CSUN 1220b. **Fig. 118.** *Glyptoactis* (*Claibornicardia*) *domenginica* (Vokes, 1939), left valve, ×2, length 17 mm, height 13 mm, hypotype, IGM 5200, loc. CSUN 1220b. **Fig. 119.** *Crassatella* sp., internal mold of right valve, ×0.7, length 69 mm, height 50 mm, hypotype, IGM 5201, loc. CSUN 1220b. **Fig. 120.** *Acanthocardia* (*Agnocardia*) sp., aff. *A.* (*A.*) *sorrentoensis* (Hanna, 1927), partial left? valve, ×2.6, length 13 mm, height 11 mm, hypotype, IGM 5904, loc. CSUN 1220b. **Fig. 121.** *Nemocardium linteum* (Conrad, 1855), internal mold of left valve, ×1.5, length 22 mm, height 19 mm, hypotype, IGM 5905, loc. CSUN 1293. **Fig. 122.** *Solena* (*Eosolen*) *novacularis* (Anderson and Hanna, 1928), internal mold of left valve of an articulated specimen, ×0.9, length 75 mm, height 18 mm, hypotype, IGM 5906, loc. CSUN 1470. **Fig. 123.** *Pitar* (*Lamelliconcha*) *joaquinensis* Vokes, 1939, left valve, ×1.5, length 20 mm, height 18 mm, hypotype, IGM 5907, loc. CSUN 1470. **Fig. 124.** *Pholadomya* sp., cf. *P.* (*Bucardiomya*) *givensi* Zinsmeister, 1978, internal mold of crushed right valve, ×1.5, length 14 mm, height 28.2 mm, hypotype, IGM 5908, loc. CSUN 1293. **Fig. 125.** Teredinidae, indet., side view of colony, ×1.3, length of colony 40 mm, height of colony 16.5 mm, hypotype, IGM 5909, loc. CSUN 1220b.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Family Cardiidae Lamarck, 1809

Genus *Acanthocardia* Gray, 1851

Subgenus *Agnocardia* Stewart, 1930

Acanthocardia (*Agnocardia*) sp., Aff. *A.* (*A.*) *sorrentoensis* (Hanna, 1927)

Figure 120

[*Cardium sorrentoensis* Hanna, 1927:285, pl. 41, figs. 10, 12, 14.]

LOCAL OCCURRENCE. Localities CSUN 1220b, 1293.

REMARKS. Specimens are uncommon at locality 1220b and rare at 1293. Preservation is poor, and a few specimens are internal molds. A few specimens are articulated.

The specimens closely resemble *A.* (*A.*) *sorrentoensis* (Hanna, 1927) from "Domengine Stage" strata, San Diego area, southern California. Stewart (1930:265) assigned Hanna's species to the genus and subgenus *Acanthocardia* (*Agnocardia*). The Bateque Formation specimens, like *A.* (*A.*) *sorrentoensis,* have numerous flat-topped radial ribs with chevron-shaped spines. Ribs with fairly strong chevron-shaped spines usually alternate with ribs that have much weaker chevron-shaped spines. The Bateque Formation specimens differ from *A.* (*A.*) *sorrentoensis* in the following features: more closely spaced ribs and a less inflated umbo area.

Genus *Nemocardium* Meek, 1876

Nemocardium linteum (Conrad, 1855)

Figure 121

Cardium linteum Conrad, 1855:3, 9; 1857:pl. 2, fig. 1.

MOLLUSCAN STAGE RANGE. "Martinez" through "Tejon."

GEOGRAPHIC DISTRIBUTION. San Juanico area, Baja California Sur, Mexico, through southwestern Oregon.

LOCAL OCCURRENCE. Locality CSUN 1293.

REMARKS. A single internal mold was found.

Family Solenidae Lamarck, 1809

Genus *Solena* Mörch, 1853

Subgenus *Eosolen* Stewart, 1930

Solena (*Eosolen*) *novacularis* (Anderson and Hanna, 1928)

Figure 122

Solen novacula Anderson and Hanna, 1928:147, pl. 6, fig. 9.

MOLLUSCAN STAGE RANGE. "Capay" through "Tejon."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through southwestern Oregon.

LOCAL OCCURRENCE. Locality CSUN 1470.

REMARKS. Specimens are uncommon and are internal molds of articulated individuals.

Family Veneridae Rafinesque, 1815

Genus *Pitar* Römer, 1857

Subgenus *Lamelliconcha* Dall, 1802

Pitar (*Lamelliconcha*) *joaquinensis* Vokes, 1939

Figure 123

Pitar (*Lamelliconcha*) *joaquinensis* Vokes, 1939: 85–86, pl. 13, figs. 9–12.

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through central California.

LOCAL OCCURRENCE. Locality CSUN 1470.

REMARKS. A single valve was found.

Order Pholadomyoida

Family Pholadomyidae Gray, 1847

Genus *Pholadomya* G.B. Sowerby, 1823

Subgenus *Bucardiomya* Rollier *in* Cossmann, 1912

Figure 124

Pholadomya sp., cf. *P.* (*Bucardiomya*) *givensi* Zinsmeister, 1978

Figure 124

[*Pholadomya* (*Bucardiomya*) *givensi* Zinsmeister, 1978:235, fig. 1.]

LOCAL OCCURRENCE. Locality CSUN 1293.

REMARKS. Specimens are uncommon and are crushed internal molds of incomplete individuals.

Poor preservation prevents positive identification as to species.

Pholadomya (*B.*) *givensi* is known only from "Capay Stage" strata in the Whitaker Peak and Pine Mountain areas, southern California (Squires, 1987). If this species is present in the upper part of the Bateque Formation, then the molluscan stage range of the species would be expanded to the middle Eocene part of the "Tejon Stage," and its geographic distribution would be expanded southward to the San Juanico area, Baja California Sur, Mexico.

Order Myoida

Family Teredinidae Rafinesque, 1815

Teredinidae, indet.

Figure 125

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Several clusters and several individuals of calcareous-lined burrows were found. One cluster is in fossil wood.

Class Cephalopoda

Order Nautilida

Family Hercoglossidae Spath, 1927

Genus *Hercoglossa* Conrad, 1866

Hercoglossa? sp.

Figure 126

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Two internal molds were found, one 62 mm in diameter (Fig. 126) and the other, more poorly preserved, is 100 mm in diameter.

The lateral-lobe and lateral-saddle sutural pattern of the Bateque specimens is intermediate between that of the genus *Cimomia* and a primitive *Hercoglossa.* To distinguish these two transitional genera, it is necessary to compare the entire sutural pattern. Unfortunately, the ventral and dorsal parts of the sutural pattern are not well preserved or not observable on the Bateque Formation specimens. In addition, the position of the siphuncle cannot be determined.

The Bateque Formation specimens resemble *Cimomia tenuicosta* Glenister et al. (1956:495–496, pl. 53, figs. 1–9) from uppermost Cretaceous strata in Western Australia. The Bateque specimens also resemble *Hercoglossa peruviana* Berry (1923:427–431, figs. 1, 2) from upper Eocene strata in Peru.

Family Aturiidae Hyatt, 1894

Genus *Aturia* Bronn, 1838

Aturia myrlae Hanna, 1927

Figure 127

Aturia myrli Hanna, 1927:331, pl. 57, figs. 1, 6.

MOLLUSCAN STAGE RANGE. "Capay" through "Domengine."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico, through central California.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1470.

REMARKS. Two internal molds of partial specimens were found, both about 70 mm in diameter.

Squires (1988c) summarized published reports that indicated *A. myrlae* may be the same as *A. alabamensis* (Morton, 1834:33, pl. 18, fig. 3), which may have had worldwide distribution during the Eocene.

Phylum Arthropoda

Class Malacostraca

Order Decapoda

Family Raninidae de Haan, 1841

Genus *Ranina* Lamarck, 1801

***Ranina berglundi* new species**

Figures 128, 129

DIAGNOSIS. A *Ranina* s.s. with a wide fronto-orbital margin, two equally spaced wide and strong anterolateral spines (outermost one serrate), and wide spacing between all spines.

COMPARISON. The new species has been compared with all the species descriptions of *Ranina*, a genus whose geologic range is Eocene through Recent with Eocene specimens only known with certainty from North America (Glaessner, 1969).

In the Eocene record of the Atlantic and Gulf coasts of North America, the only two reported species of *Ranina* actually belong to *Lophoranina.* These are *Ranina porifera* Woodward (1866:591–592, pl. 26, fig. 18) and *R. georgiana* Rathbun (1935: 97–98, pl. 21, figs. 7, 8).

In the Eocene record of the Pacific coast of North America, there are only two previously reported species of *Ranina. Ranina americana* Withers (1924:125, pl. 4, figs 1–3) from the upper Eocene Hoko River Formation in northwestern Washington (R. E. Berglund, pers. comm., 1989). Rathbun (1926:91–92, pl 23, figs. 1–4) also discussed this species. The new species differs from *R. americana* in the following features: wider spacing between all spines, wider fronto-orbital margin, stronger and wider anterolateral spines, and outermost anterolateral spine serrate on anterior edge.

The other Pacific coast Eocene species is *R. tejoniana* Rathbun (1926:70–91, pl. 22, figs. 1, 2) from Eocene strata, southern San Joaquin Valley, central California. The new species has a more tapering carapace and more widely spaced spines.

DESCRIPTION. Moderate-sized raninid with ovate, moderately convex carapace, very broad in proportion to its length. Widest along anterior one-fifth at outermost anterolateral spine area. Carapace maximum width (including outermost anterolateral spines) equals total length. Carapace width (excluding outermost anterolateral spines) 80 percent of total length. Lateral borders curve inward, posterior margin very narrow. Surface with small pits, sparse on anterior middle part, closer posteriorly and toward lateral and anterior borders. Posterolaterally, pits in transverse rows of about 10.

Rostrum trifid, small, and pointed. Fronto-orbital margin curved with three spines on each side. First (innermost) fronto-orbital spine small, outward-pointing, and separated from wider second spine by a short furrow. Second fronto-orbital spine separated from forward-pointing and more prominent third spine by a very short and narrow furrow. Length of fronto-orbital area about 60 percent of width of carapace (excluding outermost anterolateral spines). Two anterolateral spines, equally spaced. First anterolateral spine forward-pointing, about equal in size to outermost fronto-orbital spine but more pointed. Second (outermost) anterolateral spine widest and strongest of all spines, extended at a 45-degree angle to a blunt point, with four serrations on anterior edge of spine (the middle two the strongest). Posteriorly to second anterolateral spine, a fine raised rim extends around the carapace. Holotype 39 mm in width (including outermost anterolateral spines), 38 mm in length.

PRIMARY TYPE MATERIAL. Holotype, IGM 5913 (= LACMIP plastoholotype 8860); paratype, IGM 5914 (= LACMIP plastoparatype 8861); all from locality CSUN 1220b.

TYPE LOCALITY. Locality CSUN 1220b.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Locality CSUN 1220b.

REMARKS. Four specimens were found, two of which are incomplete. The early Eocene *Ranina berglundi* new species is the earliest report of *Ranina,* not only in North America but in the world.

ETYMOLOGY. The new species is named after Ross E. Berglund who has made valuable contributions in the study of Paleogene decapods from Washington and Oregon.

Genus *Lophoranina* Fabiani, 1910

Lophoranina bishopi new species

Figure 130

DIAGNOSIS. A *Lophoranina* with four species in fronto-orbital area and two nonbifurcating anterolateral spines.

COMPARISON. The new species has been compared with all the species descriptions of *Lophoranina,* a genus whose geologic range is Eocene to Oligocene (Glaessner, 1969). These species are described in Vía Boada (1969:119–122). Most of the Eocene species are from the Mediterranean region. Except for one of these, they are not comparable to the new species because their spines are weaker than the new species. The one that is most similiar to the new species is *L. straeleni* Vía Boada (1959: 366–367, text fig. 7; 1969:115–119, text fig. 13, pl. 7, fig. 1a–c; pl. 8, fig. 1) from middle Eocene (Lutetian Stage) strata of Spain and Italy (Vía Boada, 1969). Bishop and Whitmore (1986:fig. 2G, H) also reported *L.* cf. *straeleni* Vía Boada from the middle Eocene Santee Formation in South Carolina. The new species differs from *L. straeleni* in the following features: one extra spine in fronto-orbital area, outermost anterolateral spine not bifurcated, frontal area more distinctly set off from rest of frontal-orbital area, and sides of carapace straighter.

DESCRIPTION. Moderately large-sized lophoraninid with ovate, convex carapace. Widest about halfway between outermost anterolateral spine and posterior margin. Surface with closely spaced parallel transverse granulated ridges. Granules form rows along ridge crests.

Rostrum pointed. Fronto-orbital area with four spines on side. First (innermost) fronto-orbital spine of moderate size, forward-pointing, and separated from about equal-sized second spine by a short but fairly wide furrow. Forward-pointing, second fronto-orbital spine separated from flattish third spine by a very short and narrow furrow. Fourth spine very forward-pointing. Length of fronto-orbital area about 73 percent of width of carapace measured along line connecting outermost anterolateral spines. Two anterolateral spines, approximately equally spaced. Both forward-pointing and about equal in size to outermost, fronto-orbital spine. Posteriorly to outermost anterolateral spine, a fine, raised rim extends around the sides of the carapace. Holotype, 40.5 mm maximum in width, 43 mm in length (incomplete).

PRIMARY TYPE MATERIAL. Holotype, IGM 5915 (= LACMIP plastoholotype 8862).

TYPE LOCALITY. Locality CSUN 1220b.

MOLLUSCAN STAGE RANGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Localities CSUN 1291b, 1470.

REMARKS. Two partial carapaces were found, one a large fragment (Fig. 130) with the central and left anterior margin areas poorly preserved, the second a small fragment.

Lophoranina bishopi new species is the first occurrence of this genus from the Pacific coast of North America.

ETYMOLOGY. The species is named after Gale A. Bishop, who has made valuable contributions to the study of Cretaceous and early Tertiary crabs.

Phylum Echinodermata

Class Echinoidea

Order Cidaroida

Cidaroida, indet. spine A

Figure 131

LOCAL OCCURRENCE. Localities CSUN 1220b, 1471.

REMARKS. Specimens of these primary spines are common at locality 1220b and uncommon at locality 1471. Some are small fragments, but others are nearly complete and up to 26 mm in length. This type of spine is solid, slightly tapering, and cylindrical, with 9–15 longitudinal rows of spinules. Toward the base of the spine, there is a progressive transition from a smooth neck, to a very finely striated collar, to a milled ring, to a smooth base, and then to a rim that is hollowed out.

Cidaroida, indet. spine B

Figures 132, 133

LOCAL OCCURRENCE. Locality CSUN 1293.

REMARKS. Specimens of these primary spines are common. Most are small fragments, but a few are nearly complete and up to 39 mm in length (Fig. 132). None shows the spine tip. This type of spine is solid, flattened throughout its length, very gradually tapering, minutely striated, slightly curved, and elliptical in cross section. Toward the base of the spine there is no neck, but a very minutely striated collar is well developed and passes into a milled ring. The base of the spine has about 10 crenulations at its terminus.

Cidaroida, indet. spine C

Figure 134

LOCAL OCCURRENCE. Locality CSUN 1293.

REMARKS. Specimens of these primary spines are common. Most are small fragments, but a few are up to 28 mm in length. These spines are very similar to cidaroid spine B. The only difference is that cidaroid spine C has fine serrations along the flattened margin. These serrated spines resemble some of the types of primary spines known from the Eocene cidaroid genus *Porocidaris.*

Order Cassiduloida

Family Echinolampadidae Gray, 1851

Genus *Echinolampas* Gray, 1825

Echinolampas? sp. A

Figures 135, 136

LOCAL OCCURRENCE. Locality CSUN 1470.

REMARKS. Only one incomplete specimen was found. It shows most of the aboral surface. The posterior region is missing, and the oral surface is mostly obliterated. The specimen has an inflated test with a monobasal apical system, four large genital pores, unequal poriferous zones on the medium-length open petals, wide interporiferous zones, single pores in the ambulacral plates beyond the petals, and numerous inflated small tubercles in deep scrobicules. Preservation of the specimen is too incomplete to allow positive identification as to genus.

The specimen is similar to the *E. oviformis* (Gmelin, 1789:3187; Kier, 1962:107–108, pl. 30, figs. 1–4, text fig. 90; 1966:fig. 393 1a-b). *Echinolampas ociformis,* which is the type species of *Echinolampas,* is found today in the Indian Ocean.

The geologic range of *Echinolampas* is Eocene to Recent (Kier, 1966). If the Bateque specimen does belong to *Echinolampas,* it would be the first report from the Pacific coast of North America.

Echinolampas? sp. B

Figure 137

LOCAL OCCURRENCE. Locality CSUN 1470.

REMARKS. Only a single small-sized, inflated, and circular specimen (maximum diameter 12 mm) was found. The specimen shows most of the aboral surface fairly well, but the oral surface is obliterated. The posterior region is missing. There is a monobasal apical system, a tendency for unequal poriferous zones on the long open petals, wide interporiferous zones, single pores in the ambulacral plates beyond the petals, and numerous small tubercles in deep scrobicules. Preservation of the specimen is too poor, however, to allow positive identification as to genus.

The main part of the test of *Echinolampas?* sp. B generally resembles *E. appendiculata* Emmons (1858:307, figs. 240, 241; Clark and Twitchell, 1915: 149–150, pl. 68, fig. 2a, b; Cooke, 1959:56, pl. 22, figs. 5, 6) from upper Eocene beds in North Carolina (Cooke, 1959). One major difference is that *E.?* sp. B lacks genital pores and *E. appendiculata* has four. The posterior region of *E.?* sp. B is missing so it could not be compared to the distinctly pointed posterior region of *E. appendiculata.*

The geologic range of *Echinolampas* is Eocene to Recent (Kier, 1966). *Echinolampas?* sp. B, along with *Echinolampas?* sp. A, may be the first occurrences of this genus from the Pacific coast of North America.

Order Spatangoida

Family Schizasteridae Lambert, 1905

Genus *Schizaster* L. Agassiz, 1836

Subgenus *Paraster* Pomel, 1869

Schizaster (*Paraster*) sp., aff. *S. lecontei* Merriam, 1899

Figures 138–141

[*Schizaster lecontei* Merriam, 1899:164–165, pl. 21, fig. 1, 1a.]

LOCAL OCCURRENCE. Localities CSUN 1220b, 1291a, 1291b, 1470, 1471.

REMARKS. Specimens are common at localities 1220b and 1471 and rare elsewhere. At locality 1220b, specimens range in length from 16.5 mm to 55 mm. A few of these specimens have extensive patches of small spines adhering to the test.

Crushing has affected all of the specimens to varying degrees. Many are incomplete due to crushing and/or weathering. No single specimen is complete, and no specimen shows the ventral surface. One specimen (Fig. 138) shows both the peripetalous fasciole and the lateral fasciole. This same specimen also has the most inflated test, and it seems to be the least affected by crushing. Another specimen (Figs. 139–141) shows a keel extending posteriorly in interambulacrum V from the apical system.

The specimens resemble *S. lecontei* from upper Paleocene strata, northern California. Kew (1920: 151–152, pl. 41, fig. 3a–d) also discussed this species. The Bateque Formation specimens differ in the following features: larger size, more inflated test, narrower? anteriorlateral ambulacra (II and IV), and anterior ambulacrum III does not show distinct ambulacral plates. The differences in test inflatedness may be due to crushing, and the ambulacral differences may be due to weathering or to the fact that most workers previously have only described and figured internal molds of *S. lecontei.*

In terms of test inflatedness, the Bateque Formation specimens resemble *S. diabloensis* Kew (1920:150–151, pl. 41, fig. 5a–c) from upper Paleocene through "Domengine Stage" strata, southern and central California (Squires, 1984).

Only two Bateque Formation specimens show the apical system. One specimen (Fig. 138) has two genital pores that are slightly posterior of the center of the test. The other specimen has four genital pores. The apical system of these two specimens is very similar to that in *S.* (*Paraster*) *tatei* McNamara and Philip (1980:51–52, fig. 2A–E) from lower upper Eocene strata, South Australia. Although Fischer (1966:569) reported that *Paraster* has four genital pores, McNamara and Philip (1980) showed that the number of genital pores is of little taxonomic significance in the Schizasteridae.

Although they could not be photographed effectively, the pore pairs in ambulacrum IV of the the Bateque specimens are oblique and arranged in double rows.

Family Brissidae Gray, 1855

Genus *Eupatagus* L. Agassiz, 1847

Eupatagus batequensis new species

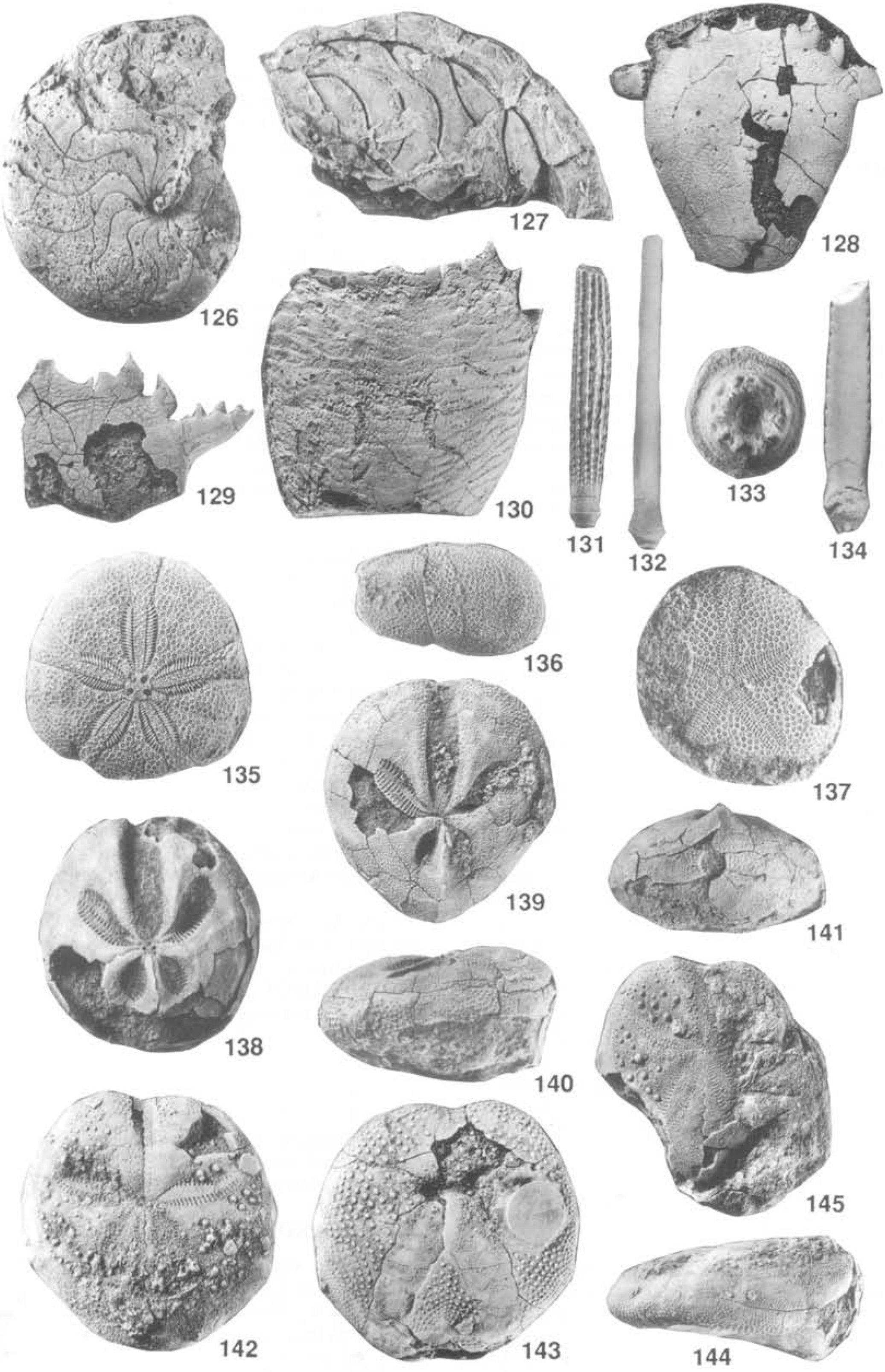
Figures 142–145

DIAGNOSIS. An *Eupatagus* with a circular-shaped aboral surface, elevated posteriorly, greatest height posterior at sharply inflated plastron, anterior ambulacra curved anteriorly, no tubercles on aboral interambulacrum 5.

COMPARISON. *Eupatagus* has complicated

→

Figures 126–145. Bateque Formation cephalopods, crabs, and echinoids. **Figs. 126, 127.** Cephalopods. **126.** *Hercoglossa?* sp., internal mold, lateral view, ×0.8, maximum diameter 62 mm, hypotype, IGM 5910, loc. CSUN 1220b. **127.** *Aturia myrlae* Hanna, 1927, internal mold of partial specimen, lateral view, ×1, maximum diameter 29 mm, hypotype, IGM 5911, loc. CSUN 1220b. **Figs. 128–130.** Crabs. **128, 129.** *Ranina berglundi* new species, loc. CSUN 1220b. **128.** Dorsal view, ×1.1, length 37 mm, maximum width (excluding spines) 30 mm, holotype, IGM 5912. **129.** Dorsal view of right anterior area, ×2.1, length 12 mm, width 17.5 mm, paratype, IGM 5913. **130.** *Lophoranina bishopi* new species, dorsal view, posterior area missing, ×1, length 43 mm, width 40 mm, holotype, IGM 5914, loc. CSUN 1291b. **Figs. 131–145.** Echinoids. **131.** Cidaroida, indet. spine A, lateral view, ×1.7, length 24 mm, diameter 3 mm, hypotype, IGM 5915, loc. CSUN 1220b. **132, 133.** Cidaroida, indet. spine B, hypotype, IGM 5916, loc. CSUN 1293. **132.** Lateral view, ×1.2, length 39.5 mm, diameter, 4.5 mm. **133.** Basal view, ×4.4, diameter 4.5 mm. **134.** Cidaroida, indet. spine C, lateral view, ×2.1, length 19 mm, width 3.5 mm, hypotype, IGM 5917, loc. CSUN 1293. **135, 136.** *Echinolampas?* sp. A., hypotype, IGM 5918, loc. CSUN 1470. **135.** Dorsal view, ×1.9, diameter 18 mm. **136.** Right lateral view, ×1.5, height 11 mm. **137.** *Echinolampas?* sp. B, dorsal view, ×2.7, diameter 12 mm, hypotype, IGM 5919, loc. CSUN 1470. **138–141.** *Schizaster* (*Paraster*) sp., aff. *S. lecontei* Merriam, 1899. **138.** Dorsal view, ×1.4, length 26.5 mm, width 25.2 mm, hypotype, IGM 5920, loc. CSUN 1220b. **139–141.** ×1.7, length 22 mm, width 21 mm, height 13 mm, hypotype, IGM 5921, loc. CSUN 1470. **139.** Dorsal view. **140.** Left side. **141.** Posterior view. **142–145.** *Eupatagus batequensis* new species, loc. CSUN 1470. **142–144.** ×1.4, length 29 mm, width 29 mm, height 14.3 mm, holotype, IGM 5922. **142.** Dorsal view. **143.** Ventral view. **144.** Left side. **145.** Dorsal view (lower left area missing), ×1.3, length 30 mm, width 27 mm, paratype, IGM 5923.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taxonomic history and has been known by at least eight synonyms (Fischer, 1966). One of the more commonly used names in old literature is *Euspatangus* Cotteau. Although the geologic range of *Eupatagus* is Eocene to Recent (Fischer, 1966), the genus was very common during the Eocene, with many species reported from all over the world (Kier, 1984).

We have endeavored to compare *E. batequensis* new species with all North American and West Indies Eocene species and many other Eocene species from Europe. We also included many Tertiary species from elsewhere in the world. The reader is referred to Cotteau (1889–1891), Clark and Twitchell (1915), Cooke (1942, 1959), and Kier (1984) for descriptions of many of the North American, West Indies, and European Eocene species. Nearly all of the studied species are not comparable to the new species because they do not possess the sharply inflated plastron and depressed anterior ambulacral area.

The new species has the lateral shape of *E. sanchezi* (Lambert *in* Sánchez Roig, 1949:211, pl. 24, figs. 2, 3; Kier, 1984:107–108, pl. 58, figs. 1–3) from Miocene strata in Cuba (Kier, 1984). The new species has the aboral shape of *Maretia arguta* (Clark and Twitchell, 1915:150, pl. 69, fig. 1a–d; Cooke, 1959:81, pl. 34, figs. 1–4) from lower middle Eocene strata in Mississippi (Cooke, 1959). *Maretia* belongs to the family Spatangidae. The new species has the tubercle ornamentation similar to that of *E. curvus* Cooke (1942:56–57, pl. 7, figs. 5–7) from upper Eocene strata in northern Florida.

The new species resembles *E. cordiformes* (Duncan and Sladen, 1884:238–240, pl. 38, fig. 14) from Eocene strata in western India. The new species differs by having a smaller test that is not indented posteriorly.

Previously, only one other species of *Eupatagus* has been reported from the Pacific coast of North America. It is *Eupatagus stevensi* Grant and Hertlein (1938:134–135, text fig. 12) from the middle Eocene part of the Llajas Formation, Simi Valley, southern California, and from upper Eocene beds in upper Cuyama Valley, southern California. The holotype of *E. stevensi* is an internal mold. To confirm that this species actually belongs in *Eupatagus*, it will be necessary to find specimens that show the exterior with the peripetalous and subanal fascioles that are so diagnostic of the genus *Eupatagut*. Until that time, *E. stevensi* can only be tentatively assigned to *Eupatagus*. Even if their species belongs to *Eupatagus*, the Bateque Formation species is the earliest representative of this genus from the Pacific coast of North America.

DESCRIPTION. Medium size (up to 43 mm in length), widest along line drawn laterally through apical system. Circular, truncated posteriorly. Anterior indented, left anterior side may project slightly beyond right side. Test elevated posteriorly and greatest height posterior at sharply inflated plastron. Test slopes downward anteriorly. Apical system slightly in front of the center, four genital pores, the anterior two more closely together. Anterior ambulacral area not petaloid, single pores along sides, ambulacral area slightly depressed with amount of depression increasing anteriorly.

Anterior ambulacra pair slightly depressed, extending four-fifths of the way to the margin, diverging almost directly opposite each other, but curving anteriorly near their extremities. Posterior ambulacra pair flat and approximately same length as anterior ambulacral pair. Interporiferous zones of petals wider than poriferous zones. Peripetalous fasciole without indentations. Paired interambulacral areas with about 6–10 irregularly spaced, large scrobiculated tubercles, confined within the peripetalous fasciole. No tubercles on aboral interambulacrum 5. Subanal fasciole very distinct at posterior end of plastron (elsewhere obliterated).

Peristome slightly farther forward than apical system (peristome details obliterated). Periproct terminal (periproct details obliterated). Plastron inflated with tubercles arranged en chevron. Posterior ambulacral areas smooth. Holotype width 28.7 mm, length 29 mm, greatest height 14.2 mm.

PRIMARY TYPE MATERIAL. Holotype, IGM 5923 (= LACMIP plastoholotype 8863); paratype, IGM 5924 (= LACMIP plastoparatype 8864); all from locality CSUN 1470.

TYPE LOCALITY. Locality CSUN 1470.

MOLLUSCAN STAGE RNAGE. "Capay."

GEOGRAPHIC DISTRIBUTION. Eastern Laguna San Ignacio area, Baja California Sur, Mexico.

LOCAL OCCURRENCE. Localities CSUN 1220b, 1470, 1471.

REMARKS. Specimens are common at locality 1470 and rare at the other localities. Preservation is fair, but well-indurated matrix adheres in places to all specimens. Most are also missing parts of the test due to weathering. Crushing is a minor problem.

Eupatagus batequensis new species may be the first species of this genus from the Pacific coast of North America.

ETYMOLOGY. The new species is named after the Bateque Formation.

LOCALITIES

All localities are in the Bateque Formation. Unless otherwise noted, they are in the Mexican government topographic quadrangle map (scale 1:50,000) of San José de Gracia (number G12A64), Baja California Sur, Mexico, 1982.

CSUN MACROFOSSIL LOCALITIES

1219. Low-relief bluffs along main dirt road from San Ignacio to La Fridera fish camp, at 113°05′W and 26°56′N, Mexican government topographic quadrangle map (scale 1:50,000) of Laguna San Ignacio (number C12A53), Baja California Sur, Mexico, 1982.

1220a. South side of a tributary canyon, at an elevation of 120 m and about 850 m southeast of the mouth of the main canyon, on the west side of Mesa La Salina, 80–104 m above the bottom of the exposures of the Bateque Formation in this area, at 1.25 km southeast of the intersection of 113°00′W and 26°45′N.

1220b. Along a prominent ridge, north side of a minor canyon on the west side of Mesa La Salina, 84–130 m above the bottom of the exposures of the Bateque Formation in this area, approximately 1.25 km southeast of the intersection of 113°00′W and 26°45′N.

1220c. Along the same prominent ridge where locality CSUN 1220b is located, 160–170 m above the bottom on the exposures of the Bateque Formation in this area.

1220d. Along the same prominent ridge where localities CSUN 1220b and 1220c are located, 180–185 m above the bottom of the exposures of the Bateque Formation in this area.

1291a. South side of a minor canyon near the southern end of Mesa La Salina at 120-m elevation, at 112°56′13″W and 26°40′N.

1291b. South side of the same minor canyon where locality CSUN 1291a is located, 32 m stratigraphically above locality 1291a.

1291c. South side of the same minor canyon where localities CSUN 1291a and 1291b are located, 12–16 m stratigraphically above locality 1291b.

1292. Small bluff immediately north of road on east side of El Saucito Arroyo, about 5 km east of San Juanico, Mexican government topographic quadrangle map (scale 1:50,000) San Juanico (number G12A75), Baja California Sur, Mexico, 1983.

1293. West-facing, 40-m-high bluff on east side of Arroyo El Mezquital, 0.5 km east of the northeast-trending part of the prominent loop in the dirt road leading to San Juanico (13.5 km north), Mexican government topographic quadrangle map (scale 1:50,000) of Punta Pequena (number G12A85), Baja California Sur, Mexico, 1983.

1470. At base of canyon wall along west side of Arroyo San Juan de Abajo, about 40-m elevation, about 0.75 km west of dirt road from San José de Gracia to El Datilon, at 112°44′W and 26°29.5′N, Mexican government topographic quadrangle map (scale 1:50,000) of Punta Santo Domingo (number G12A74), Baja California Sur, Mexico, 1982.

1471. Near middle of same canyon wall where locality CSUN 1470 is located, about 80-m elevation, Mexican government topographic quadrangle map (scale 1:50,000) of Punta Santo Domingo (number G12A47), Baja California Sur, Mexico, 1982.

CSUN MICROFOSSIL LOCALITIES

Mi1. At elevation of approximately 225 m, near top of cliff, along south side of Mesa El Carrizo, at 113°30′W and 26°57′N, about 4.5 km due west of main dirt road leading to Punta Abreojos, Mexican government topographic quadrangle map (scale 1:250,000) of San Isidro (number G12-4), Baja California Sur, Mexico, 1981.

Mi2. Approximately same as macrofossil locality CSUN 1220a, at about 80 m above the bottom of the exposures of the Bateque Formation in this area.

Mi3. Along the same prominent ridge where macrofossil localities CSUN 1220b and 1220c are located, about halfway between them, at 138 m above the bottom of the exposures of the Bateque Formation in this area.

Mi4. Same as macrofossil locality CSUN 1293.

CAS LOCALITIES

30667. Southwest corner of section 27 through NE¼ of the SE¼ of section 28, T28S, R19E, south side of headwaters of Media Agua Creek, Kern County, California, Eocene strata.

30677A. From top of ridge, 0.4 km northwest of locality CAS 30667, Eocene strata.

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