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# INVESTIGATIONS IN THE NATURAL HISTORY OF BAJA CALIFORNIA

By


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## Introduction

The Belvedere Scientific Fund was established in San Francisco on May 13, 1959, to encourage research and make grants in the fields of natural sciences, and for publication of the findings from such activities. Negotiations between the California Academy of Sciences and the founders of the Belvedere Scientific Fund were begun in the spring of 1958 toward planning a long-range program of investigations in the natural history of Baja California. Since its founding in 1853 the California Academy of Sciences had sponsored many field expeditions to the peninsula and to its islands. Academy staff members, and others attached to the expeditions as specialists, had been affiliated with diverse fields of natural science. Scientific papers based on their collections and field observations constituted important portions of the *Proceedings* and, for a few years, of the *Bulletin* of the Academy. Continuation and revitalization of exploration and collecting activities in Baja California as an important aspect of the Academy's research programs seemed both logical and desirable.

By early autumn, 1958, a program of exploration and research had been formulated and a grant sufficient to implement the initial stages of the field work provided by the founders of the Belvedere Scientific Fund. Without this financial aid, the field work in Baja California would have been impossible. The Academy used part of the grant to purchase an International "Travelall" with four-wheel drive and extra low-speed gears for heavy work over difficult roads, to be used chiefly for field operations in Baja California. Plans were crystallized to send a small expedition the full length of the peninsula during December, 1958, and January, 1959. This expedition was considered a reconnaissance trip, with scientists from several disciplines participating. Tentative plans were made to stage subsequent field expeditions if results obtained on this trip indicated further work would be scientifically profitable. Such later field work would include workers from the California Academy of Sciences and from other organizations as well.

## WINTER FIELD TRIP

The first expedition under this program to reach the field was made up of only two scientists when it left San Francisco on December 3, 1958, owing to commitments that kept other keenly interested individuals at their regular duties. Mr. Alan E. Leviton, acting herpetologist at the Academy, was in charge of the expedition, and was accompanied by Mr. Hugh Leech, an entomologist on the Academy staff. The two men drove to San Diego, made final purchases of equipment and supplies, had a few adjustments made to the car after the shake-down drive from San Francisco, and crossed the border into Baja California at Tijuana on December 6. Since Mr. Leviton was anxious to get into the southern part of the peninsula, where the herpetological fauna was of more interest to him than was that in the northern area, and Mr. Leech had the water beetles as his main interest, the two men drove south as rapidly as the condition of the roads permitted. They found the four-wheel drive vehicle equal to the heavy grades and very rough, rocky roads, but rarely were able to make as much as 100 miles in a long day's driving. The new road recently cut through the Sierra de la Giganta between Loreto and the northern end of the Magdalena Plains eliminated some of the worst road between Canipolé and La Purísima, but itself was quite rough and left much to be desired as a through highway.

Leviton and Leech reached La Paz on December 15, placed part of their heavy load of gear in the house rented through the good offices of Mrs. Margaret Waters, and were at the airport to meet the plane on which Ira Wiggins flew to La Paz on December 16. Preparations to begin intensive field work in the Cape Region were begun at once.

A violent storm of hurricane force, locally called a "chubasco," had swept across the southeastern part of the Cape Region on August 8. Consequently, it was known that vegetation would be in excellent condition in those areas where rainfall had soaked the countryside. Reports as to the western boundary of the rains were conflicting. A reconnaissance flight around the Cape by plane was arranged in order to check conditions and to plan field operations effectively. The party left the La Paz airport at 11:20 A.M. on the 17th, flew southward to Todos Santos, thence along the west coast to Cabo San Lucas, and landed at La Palmilla, near San José del Cabo. Observations from the air clearly showed that there had been heavy rain from Todos Santos southward, as evidenced by the water in most of the major arroyos leading from the Sierra de la Laguna and the Sierra de la Victoria westerly toward the sea. Therefore, favorable conditions for collecting plants existed in all parts of the Cape Region, and pools and running water in the arroyos promised at least a fair amount of collecting for Mr. Leech. The situation with regard to the herpetological collecting became clearer within a few minutes of the landing at La Palmilla, for Mr. Leviton located lively lizards and collected eleven, including representatives of *Callisaurus, Urosaurus,* and *Cnemidophorus.*

After a brief inspection of some of the damage done to the buildings at La Palmilla by the chubasco, the plane took off and flew along the coast to the easterly point beyond San José del Cabo, swung northward to skirt the coast to Las Cruces, where it landed briefly and Leviton got a lizard, Wiggins found a score of plants in good collecting condition, but Leech was empty-handed. The group left Las Cruces at 5:00 P.M. and landed at La Paz fifteen minutes later.

It was obvious that there was much more water than usual in the canyons and arroyos at this time of the year on both the east and west flanks of the Sierras. Both Leech and Wiggins were pleased with the prospects. There was no doubt that reasonably good collecting could be found anywhere in the Cape Region for the botanists, and a number of promising localities were available to the water-beetle specialist and herpetologist.

Mr. Duncan Porter, a senior at Stanford University interested in carrying on work in botany after graduation, joined the field party on December 21, and remained in Baja California until January 1. Following the reconnaissance flight around the Cape Region, the field party carried on field exploration and did routine collecting of plants, insects, herpetological specimens, and land snails (in the interests of Dr. G Dallas Hanna and Mr. Allyn Smith). Their routes radiated from La Paz, with one- or two-day trips taken to Rancho Rodríguez on the southwestern shore of Bahía de la Paz, Puerto Coyote, Bahia Pichilinque, El Sargento on the western shore of Bahía de la Ventana, Los Planes, Bahía de los Muertos, south to about the vicinity of San Juan on the road between La Paz and Todos Santos, to Arroyo Pozo Grande enroute to Las Cruces, and to the vicinity of San Pedro, about eight miles south of Todos Santos. Collecting conditions varied somewhat, and in general were better in the low, rolling hills between La Paz and Todos Santos than they were to the northwest of La Paz. Some exceptional finds of herpetological material were made at Bahía de los Muertos and good water beetle collecting was found in the rivulets and pools in Arroyo Pozo Grande on the road to Las Cruces.

On December 27, a second reconnaissance flight was made up the west coast of the peninsula as far as La Purísima. It gave added information about the condition of the vegetation along the Magdalena Plains and on the mesas around La Purísima. The plane left La Paz at 8:00 A.M. and headed for the southern end of Magdalena Bay in order that watch might be kept for whales that were early in making the annual southward migration to the sheltered lagoons and coves where they give birth to their young. As on the circuit of the Cape Region, extensive notes were taken on the general appearance of the coastal area and the plains extending inland. Aside from the mangrove swamps that are characteristic features of the partially drowned coast along the islands of Magdalena and Santa Margarita and the adjacent peninsular coast, the vegetation showed little green, and it looked as though the chubasco had brought little, if any, rain to that side of the peninsula north of the latitude of La Paz.

A landing was made on an airstrip on the mesa about five miles from the village of La Purísima, and in about half an hour a car climbed the steep grade to the airstrip. Arrangements were made for all of the party except the copilot to ride to the village and to a fossil site nearby. Approximately two hours were spent selecting representative fossils from the Miocene beds about a mile up the arroyo from the village, and in scouring the adjacent slopes and arroyo banks for botanical and herpetological specimens, both of which were poorly represented. Fossil bones, that appeared to be those of a cetacean or possibly a few belonging to fish, occurred in certain horizons of the extensive exposures northeast of the village. These were difficult to obtain and few could be removed from the matrix with the limited tools available. Only a very small sampling of the fossils could be taken back to the plane. Photographs of the locality were made and a few minnows caught from the stream that flows past the village the year around. Considerable information was volunteered by the driver of the truck and his associates relative to the village and its activities and trials.

Upon returning to the plane the party flew easterly over San Ignacio, but did not land there, owing to the shortness of the time left during daylight. The return route led past Santa Rosalía, thence down the coast along the east side of the peninsula to La Paz. This route provided a good view of Mulegé, the beautiful Bahía de la Concepción, and a glimpse at Loreto. Water could be seen standing in many of the "lagunas" in the higher parts of the Sierra de la Giganta, something which the pilots of Trans Mar planes said they rarely see. Areas immediately adjacent to these lagunas were strikingly green. Indications were that the vegetation in such favored localities would be much more luxuriant than one would find during a year of ordinary rainfall.

On New Year's Day, the three biologists flew to La Palmilla for a trip from that resort to Cabo San Lucas by car, without the necessity of making the long, slow drive from La Paz to San José del Cabo with the "Travelall." A driver and car from San José del Cabo were engaged, and a number of stops were made, both westbound en route to Cabo San Lucas and on the return trip, to collect plants, beetles, butterflies, and lizards. At one such stop Mr. Leech collected the second known specimen of a rare water beetle he had in his possession at the California Academy of Sciences. Although he had been skeptical about the authenticity of the locality from which the type specimen was supposed to have come, namely, near Cabo San Lucas, the capture of one more specimen from a muddy little pool beside the road verified the original data, and increased the total number of specimens known to exist in entomological depositories by 100 per cent! A few miles from the pool where Mr. Leech found the rare water beetle, several specimens of the attractive, red-flowered, liliaceous plant *Behria tenuiflora*, endemic in the Cape Region, were collected.

Word came from the California Academy of Sciences that Mr. Allyn C. Smith, Research Malacologist at the Academy, would be landing at La Paz the evening of January 3, but that Mr. Rose, who had expected to bolster the ranks of the botanists, could not come. All were pleasantly surprised, therefore, when Dr. Reid V. Moran, botanist at the San Diego Natural History Museum, got off the Trans Mar plane with Mr. Smith at 10:30 P.M.

From January 4 through 10 the party of five – Leviton, Leech, Moran, Smith, and Wiggins – continued operations in the Cape Region, making one long trip from La Paz to San José del Cabo and return, camping out several nights while making the round trip, both ways being via El Triunfo, Santiago, and Miraflores. Again some very good collecting was enjoyed by each member of the party at one part or another of the area traversed. Mr. Smith made a particularly fine collection of minute land snails in the trash that had collected beside a small stream about one mile east of San José del Cabo. This finely crumbled, vegetable matter intermixed with silt and sand contained many minute shells, one of which was an undescribed species. Mr. Leviton collected a large specimen belonging to the genus *Ctenosaurus* just as camp was made on the evening of January 6. Later the same evening Mr. Smith found a colony of living land snails in a decaying stump. This snail usually is taken only as dead empty shells. His stroboscopic flash enabled him to get a good picture of the colony after dark.

The following quotation from Mr. Smith's report summarizes the malacological results obtained during this, and subsequent, collecting trips in 1959:

"Collections were made at about 50 stations, mostly at low altitudes, there being no opportunities to get into the higher mountains. Many specimens of the various species of *Bulimulus* that are characteristic of the Cape Region of Baja California were taken, and despite the midwinter conditions good collections were made. Many snails were taken alive and in at least one instance one of the rarer species was collected alive for the first time, so far as known. Special efforts were devoted to obtaining as many as possible of the smaller land snails by collecting and sorting stream 'drift,' which in some localities such as San José del Cabo and the Boca de la Sierra near Miraflores produced several new species, and a considerable number of new records for the Cape Region. Snails were also collected at a number of places north of La Paz by Dr. Wiggins and other members of the Expedition.

"As a result of these efforts and earlier collecting on the islands of the Gulf there is now available perhaps the best representation of the land and fresh-water mollusks of the lower end of the Baja California Peninsula in existence. A report on them will be made in subsequent papers of the Expedition series which will bring up to date the knowledge of the mollusk fauna of the region and will add to the Academy's collections all or nearly all of the species taken by former Academy expeditions in the early 1890's under the direction of Dr. Gustav Eisen and lost in the disastrous fire of 1906.

"Some attention was given to collecting marine shells in the La Paz region in January. A good representation of the chitons of La Paz was taken. During a short visit in November, 1959, an excellent collection of small marine shells was collected by Dr. Myra Keen at Puerta Balandra Bay and other localities near La Paz that produced many new records for the Gulf of California including several finds of special scientific interest. It is expected that a report on this marine work will also be covered in a subsequent report."

The canyon in which the village of San Bartolo is situated provided interesting territory for the botanists, although neither Mr. Leech nor Mr. Leviton was happy owing to the paucity of water beetles and lizards. Dr. Moran found a stunted mistletoe, which appears to be *Phoradendron digueti*, parasitizing the cardon (*Pachycereus pringlei*), apparently the first record of this mistletoe attaching itself to a member of the cactus family.

Wiggins left La Paz on January 10 to return to the Stanford campus. From that time until January 25 the field party consisted of Leviton, Leech, Moran, and Smith. These four continued to work various areas in the Cape Region, but spent most of the time on a trip entirely around the Cape. They

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**Plate 1 (Upper) Sunrise on Isla San Francisquito. Photographed by Ira L. Wiggins**

**(Lower) "Palo Adán" (*Fouquieria peninsularis*) near Bahiá de Los Angeles. Photographed by G.D. & M.M. Hanna**

drove south from La Paz to Todos Santos, thence to Cabo San Lucas, east to San José del Cabo, and from there to La Paz. The exploration of the region between Todos Santos and Cabo San Lucas was particularly illuminating, and helped to fill gaps in the coverage of the fauna and flora. During this circuit excellent collections of plants, snails, and herpetological specimens were made, and fair numbers of beetles were obtained by Mr. Leech. During one day, January 19, Allyn Smith found six species of *Bulimulus,* and Leviton got representatives of eight genera of lizards and snakes. The following day Allyn Smith obtained the first collection of living specimens of *Bulimulus montezumae* taken during field work by this group, and Leech found exceptionally good collecting in a stream swarming with tadpoles and water beetles.

During a visit to Arroyo Saltito Dr. Moran recollected *Bouvardia alexanderae* at the type locality, and collected mature seed of the species for experimental work at the Botanical Garden of the University of California at Berkeley. On the same day, and near the type locality of *B. alexanderae,* Leviton got a specimen of a rare snake, *Hypsiglena slevini,* of interesting taxonomic status.

On January 27 the "Travelall" was loaded on the S.S. *Korrigan IV,* for the voyage to Guaymas. After disembarking at Guaymas late in the afternoon of January 28, the four scientists drove to Nogales, Tucson, and San Diego. Dr. Moran remained there, and the other three continued to San Francisco, arriving at the California Academy of Sciences on January 31.

This first trip into Baja California with support from the founders of the Belvedere Scientific Fund provided valuable firsthand information about field and living conditions in Baja California and produced important collections of specimens of plants, insects, mollusks, snakes, and lizards. Over 8,000 sheets of herbarium specimens were collected by the three botanists. Mr. Leviton got about 200 specimens of lizards, snakes, and toads, representing 21 genera. Leech obtained enough beetles and other insects to occupy him full time for over a year in sorting and classifying them. Mr. Smith's collections of snails and the outstanding finds made by him were mentioned in the quotation from his written report quoted above. In addition to herbarium specimens, the botanists obtained buds of several genera from which chromosome counts have been made. These cytological collections included some of *Argemone* and of *Eschscholzia*, genera belonging in the poppy family and in which Mr. Wallace Ernst, a graduate student at Stanford, has a special interest. Each member of the party took pictures of both general and special subjects. Selected transparencies from the film exposed have been catalogued and cross referenced as the nucleus of a film library on Baja California and are on deposit at the Academy.

In view of the large series of specimens collected and the observations recorded, this trip, which was considered primarily one of reconnaissance, has produced substantial scientific information. Papers dealing with certain aspects of the field collections have been prepared for publication, and others are in progress.

## Spring Botanical Field Trip

Normal precipitation in the Cape Region brings some rain during January and February, or in both months, almost every year. Winter rainfall stimulates growth among certain annual and perennial plants rarely found in shape to collect before March. Accordingly, on April 18 Dr. John H. Thomas left the Stanford campus with the "Travelall" to initiate the first late spring botanical collecting trip under the sponsorship of the California Academy of Sciences in continuation of the program begun in 1958. At San Diego he was joined by Dr. Reid V. Moran. They drove to Tucson, thence southward to Mazatlán, where they obtained passage on the motor vessel *Viosca,* and sailed for La Paz on April 25. After landing at La Paz on the 27th they collected in various parts of the Cape Region adjacent to La Paz until May 4. On that date Mr. Donald Patterson, a member of the California Academy of Sciences interested in moths and butterflies, joined them for a pack trip into the Sierra de la Victoria.

They engaged pack animals and guides at the village of Caduaño, situated near the eastern foot of the Sierra de la Victoria. Dr. Thomas wrote as follows about the pack trip and the conditions of the vegetation: "Very few plants were in flower except in the immediate vicinity of stream beds. We camped at two different places, but spent most of our time at an abandoned ranch known as Potrero el Almenta at an altitude of about 3,400 feet. We returned to Caduaño on May 12 and to La Paz the following day. The cost of mules and/or burros at Caduaño was five pesos per animal per day and the charge per man was 15 pesos per day. The Castros were very pleasant people and we enjoyed having them as guides and packers despite their inexperience with our kind of equipment."

Even though the Sierra de la Victoria was unusually dry that spring, the men got sufficient specimens to make the pack trip worthwhile. Mr. Patterson found the skippers (small, rapidly flying butterflies) inhabiting the arroyos and higher canyons just as difficult to catch as those that had given Mr. Leech considerable trouble in December and January at lower elevations.

Mr. Patterson left La Paz by plane early on May 15, and later the same day Drs. Thomas and Moran started toward the Sierra de la Laguna. At

Rancho la Burrera they arranged for guides, pack mules, and saddle animals to take them and their collecting gear to the meadows that now mark the areas occupied by intermittent lakes said to have occurred in depressions among the higher peaks and ridges of the Sierra de la Laguna about a century ago. The pack trip from Rancho la Burrera to La Laguna required six hours and was made with the help of three guides, four pack mules, and a saddle mule each for Drs. Moran and Thomas. The Sierra de la Laguna, like Sierra de la Victoria, was abnormally dry for that season, but diligent work along the stream beds and in shaded canyons yielded enough botanical material to keep them fully occupied for several days.

On May 19 they returned to La Paz, and packed their equipment and supplies for the return trip up the length of the peninsula. On the morning of May 21 they headed north. Instead of driving over the paved highway from La Paz to Kilometer 212 near the north end of the Magdalena Plains, they used the older, now nearly abandoned roads. In this manner they were able to reach several localities on the Pacific Coast west of the Magdalena Plains, and the estuaries and embayments protected by the islands of Santa Margarita and Magdalena.

At La Purísima, approximately one day's drive north of the end of paved road, they turned inland and followed an abominable road to Canipolé, thence northward along the western shore of Bahía de la Concepción to Santa Rosalía. As they neared Santa Rosalía they discovered that the yoke supporting the rear of the engine had broken from one side of the frame and threatened to allow the motor to fall from the car. Twisting and strains caused while crossing rocky fords in the Arroyo de la Purísima and by the rough road around Bahía de la Concepción had placed too much stress on the cross member. A welder in Santa Rosalia repaired and reinforced the yoke. Henceforth it caused no trouble.

During the whole journey northward, Moran and Thomas collected along stream courses and arroyos, but in many areas the desert provided little for their presses. While in the field the two botanists collected 525 numbers of herbarium specimens, taking sets of 8 sheets of each number whenever material was sufficient. When the herbarium specimens were ordered up for labeling and distribution, it was found that they had over 3,000 sheets. Representative specimens have been set aside for shipment to the University of Mexico, or to such institution in Mexico as is designated by the Department of Agriculture and Public Works. Other sets will be divided among the California Academy of Sciences, the San Diego Natural History Museum, and Stanford University. Any specimens in excess of those needed to fill these claims will be distributed to selected herbaria on an exchange basis.

In addition to the herbarium specimens, Dr. Moran collected about 100 living succulent plants for cultivation at the San Diego Natural History

Museum, and 25 others that he sent to Dr. Helia Bravo in Mexico City before he left La Paz. Dr. Moran obtained, also, about a dozen collections of *Dudleya,* a genus in the Crassulaceae, in which he has been keenly interested for a number of years. Several of the dudleyas were taken at type localities.

Dr. Thomas collected 25 wood samples from shrubs and trees, one set of which was turned over to Dr. Virginia M. Page, Research Associate in the Department of Geology at Stanford University. Another set was sent to the United States National Herbarium.

Drs. Thomas and Moran placed many samples of plant material for morphological and cytological study in preservatives, most of it to go to Dr. I. W. Bailey (Harvard), Dr. C. H. Uhl (Cornell), Dr. Lincoln Constance (University of California), Mr. Wallace Ernst (Stanford), and to one or two others who had made special requests for material. They also made small collections of mollusks, insects, reptiles, and amphibians. The zoological specimens have been turned over to the appropriate curators at the California Academy of Sciences.

Mr. Patterson was well satisfied with his collection of lepidopterans. Most of these insects were taken in the Sierra de la Victoria, west of Caduaño. He caught 210 specimens, representing 28 species. The skippers were of particular interest in that they showed considerable local variation. Mr. Patterson's collections will be made available to the Academy after they are labeled.

To supplement the herbarium specimens, series of kodachrome transparencies were made. The photographic record included excellent slides showing such rare plants as *Nolina beldingii, Erythea brandegeei, Populus monticola,* an exquisite member of the Lobelia family, *Heterotoma aurita,* and the fragile beauty of a freshly opened blossom of one of the passion flowers (*Passiflora*) native in the Cape Region. Their most prized herpetological specimen was *Trimorphodon lyrophanes* (Lyre Snake), a small rare snake endemic to the Cape Region.

## Reconnaissance Trip to Bahía de los Angeles

Before Thomas and Moran had reached the International Boundary, a reconnaissance trip to Bahía de los Angeles and vicinity was made from May 15 through May 19. The flight from Oakland airport to Bahía de los Angeles was made quickly and comfortably, with a stop at El Centro for gasoline, another at Mexicali airport for the usual inspection by Mexican Immigration and Custom officials, and to file a flight plan with the authorities at the airport. The plane landed at Bahía de los Angeles at 1:15 p.m. after an interesting flight along the northwestern part of the Gulf. A particularly good view of Isla de la Guarda was obtained as the pilot brought the plane down from about 7,000 to only 750 feet above sea level while flying past the southern end of the island. Raza Island was circled several times in order to determine whether the bird population on that rookery was up to normal.

The rest of the afternoon of the 15th was spent in exploring the larger canyon leading westward just back of the village, and in collecting such plant specimens as were in satisfactory condition.

An early breakfast permitted the group to leave the resort operated by Sr. Antero Díaz at 7:30 A.M. on the 16th with, Sr. Díaz's son, Sammy, and one of his employees, a chap called "Jackie," driving the two cars that were to take the field party to Misión San Borja for a two-day trip. Several stops to collect specimens and to take photographs were made on the drive to San Borja. A detour to Agua Amarga, a bitterly mineralized spring, permitted Wiggins to collect specimens known from no other locality in the general area. Dr. Hanna had been looking for land snails as he climbed the canyon at Bahía de los Angeles but without success, so he was pleased to find empty shells of *Micrarionta peninsularis* at three different localities, and at least one mature, living animal in a crevice in rocks a few hundred yards from camp the evening of the 16th, about two miles north of Misión San Borja. One small lizard, *Phyllodactylus tuberculatus,* was obtained at the same site.

Botanical collections on the 16th totaled 49 separate collections, with the quantity in each collection varying from barely sufficient for a single herbarium sheet to enough for eight or ten sheets.

Since camp had been made late in the afternoon the day before, there were plants still uncollected the morning of the 17th, so the cars remained at camp while Dorothy and Ira Wiggins inserted plants between sheets of paper and the others walked ahead about two miles. Everyone had an opportunity to observe one of the factors that makes it possible for lichens and *Tillandsia* plants to grow in profusion on many of the shrubs in the central part of the peninsula, in spite of the absence of rain for protracted periods. There was a heavy dew during the night, but brilliant sunshine soon dried most of it by the time breakfast was completed. At about 8:00 A.M. a heavy bank of fog rolled up the arroyo from the west, completely blanketing the area and shutting off the direct rays of the sun as though a curtain had been drawn. Within minutes the shrubs and trees around camp were dripping with water condensed from the fog. Such fog banks are characteristic of the region, although they do not always extend so far to the east.

The return to Bahía de los Angeles was over the same road followed the day before only because there is no other road between San Borja and "La Bahía." At one of the seven collecting stops made on the return drive, Dr. Hanna enlisted the help of all members of the party to roll rocks from the side of a small hill in search of more land snails. This procedure was encouragingly productive, yielding several living snails and a number of empty shells. Nine or ten brief stops for photography were made in addition to those for collecting plants and snails. Lunch stop was in the scanty shade of an "Elephant Tree" covered with tiny, pink flowers but totally leafless.

The two cars arrived at the Díaz motel at 1:10 p.m. and the remainder of the afternoon was spent putting specimens in press and, from 3:00 p.m. until 5:00 p.m., in collecting shells and plants along the sand spit northeast of the resort. Botanical specimens for the day numbered 27 separate collections, one of the most interesting being specimens of the mangrove, *Rhizophora mangle,* found along the southeasterly shore of the bay. Fine series of several marine snails were obtained by Dr. and Mrs. Hanna during their walk around the sand spit, and they took photographs of general features of the country and close-up pictures of selected flowers during the course of the day.

At 7:00 o'clock on the morning of the 18th, six of the party left the village in two small boats, with the intention of visiting Smith Island, but were forced by strong winds and heavy seas to put into a sheltered cove near the southern end of Isla de la Ventana. The party was divided into three groups so as to cover the island as thoroughly as possible in an effort to determine the condition of the plants and the density of the animal population. Two complete traverses of the island were made. Even the careful search thus made revealed only 15 species of flowering plants in condition to collect, and not a trace of land snails was found. One lizard, *Uta stansburiana elegans,* was captured, and several partial skeletons of a much larger lizard were found in some of the arroyos, but no big lizards were seen alive.

At one place, about a mile from the landing, Dr. Hanna found striking geological features, an unusual contact between the underlying granites and the volcanic cap rock.

At 12:30 the group re-embarked and ran down wind to the cove containing the mangrove colony and explored the vicinity for specimens. Nine species of plants in reasonably good condition were found before a shift in wind made return to the village advisable.

This trip, which terminated at Oakland airport at 1:45 p.m. on May 19, had been partly to determine the facilities and airport conditions at Bahía de los Angeles, which were found adequate. Comparison of the vegetation at the end of a winter during which there had been scanty rainfall (1959) with the plant cover produced by a season of more than average annual rainfall (1935) showed that not only the total precipitation but its seasonal distribution is important in the responses of plant and animal life. Few land birds were seen on the trip to San Borja, and the plants collected were much smaller than the same species obtained in February, 1935. Many other plants that were common to abundant on the earlier visit were completely lacking in 1959.

Land snails also reflected the harshness of conditions obtaining in the spring of 1959. Even at the localities where shells were found, few living specimens could be obtained, either because they have been reduced in actual numbers or because those that survived the dry conditions had retreated so deeply into the crevices among the rocks that they were beyond reach.

## SEPTEMBER RECONNAISSANCE FLIGHT

News reports on September 10, 1959, told of a violent storm that swept up the Gulf of California, veered to the west, and buffeted the towns and countryside of Baja California along the Gulf coast from the general vicinity of La Paz almost to San Felipe. Winds of high velocity were accompanied by downpours of rain, and flash floods of unprecedented ferocity took heavy toll of property and caused a loss of life that was, for a part of the country sparsely populated, quite high. Summer rains are expected each year in the southern part of the peninsula, and heavy storms of hurricane violence, locally known as chubascos, occur at irregular intervals. Such a storm was not anticipated in 1959, for one had devastated parts of the Cape Region in August, 1958. Therefore, the occurrence of heavy rainstorms in the late summer in two successive years indicated that extraordinary vegetational growth would occur in the autumn of 1959. A reconnaissance trip by plane was arranged to get a general idea of the extent to which the precipitation had spread westward past the divide of the principal ranges, and how far to the north its effect would be prominent on the westerly slopes of the foothills of the Sierra Calamajue, Sierra Calmalli, and Sierra de la Giganta.

This flight was accomplished on September 26 through 28. The plane left the Mexicali airport at 12:45 P.M. and landed at Bahía de los Angeles at about 2:00 P.M. Although only two weeks had passed since the rains, a faint sheen of green was becoming visible on the hills, particularly along the arroyos leading easterly to the Gulf of California, about two-thirds of the way from the fishing village of San Felipe to Bahía de los Angeles. This green wash could be detected from an altitude of 7,000 to 9,000 feet.

On the southward flight from Mexicali to Bahía de los Angeles, several patches of the dinoflagellates that cause "red tide" were seen, some of them extending a distance of a mile or more in an irregularly sinuous pattern more or less parallel to the shore. All such "blooms" of this organism seen were from three to ten miles off shore. These organisms are microscopic in size but reproduce at a terrific rate under favorable conditions, and become so numerous that toxic substances in their bodies may kill thousands of fish in the area where the dinoflagellates are most numerous.

At Bahía de los Angeles two cars again were rented from Antero Díaz, for a drive around the southern arm of the bay and south toward the old ore dump, to determine how effective the rains had been in initiating growth in the perennial plants and in bringing up seeds of annuals. All shrubs, trees, and perennial herbaceous plants were in excellent condition, although insufficient time had elapsed to allow the production of flowers on any save a very few of the shrubs. Thousands of seedlings were present, many no more than 2 or 3 mm. high, and it was the close stand of millions of such seedlings that gave the green tint to the countryside when viewed from the air.

After the foray south of the village, the party rode westward toward Punta Prieta about ten miles in order to see the stage of development of plants in that area. The same conditions obtained west of Bahía de los Angeles that had been found south of the village. *Idria* and *Fouquieria* trees were swollen with an abundant supply of water, and had put out a full crop of leaves. Elephant Trees (*Pachycormus veatchii*), Torote (*Bursera microphylla*), Palo Verde (*Cercidium microphyllum*), Candelilla (*Pedilanthus macrocarpus*), and many small shrubs were beginning to put out leaves or start new growth. Cactus plants were turgid, the ribs of the cardon trees being low and rounded owing to the large quantities of water stored in their tissues.

Take-off the morning of the 27th was delayed only slightly by the local workmen who refueled the plane for the flight to La Paz. From Bahía de los Angeles the course led slightly west of south, skirting San Ignacio, Good visibility made it possible to see both the Gulf and the Pacific, and the Tres Vírgenes stood out commandingly just north of Santa Rosalía during an hour or more of the flight. At San Ignacio one could see that a great many date palms had been destroyed by the torrents that had swept down the arroyo. The landing field looked too soft for a landing, so the pilot set a course for Mulegé. Santa Rosalía was visible for a few minutes, from an altitude of about 8,000 feet, but too far to the left to permit recognition of damage that occurred there. The course then led over the Gulf just north of Mulegé, and one could see that here also the date palms had suffered extensive damage from wind and high water. The part of town built on low ground along the banks of the estero had been almost demolished.

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Plate 2 (Upper) "Granadito" (*Passiflora palmeri*) near Miraflores. Photographed by Reid Moran
(Lower) "Flor de San Miguel" (*Antigonon leptopus*) near La Paz. Photographed by G.D. & M.M. Hanna

Between Mulegé and the south end of Bahía de la Concepción, again there was evidence of the destruction done by walls of water, tumbling rocks, trees, and debris that had swept down the canyons and arroyos. Where arroyos entered the bay, fans of rubble extended farther into the water than they had previously, and where roads had crossed mouths of arroyos there was no trace of a thoroughfare. It would take much work to reopen a route to wheeled traffic.

A landing was made at Loreto, where high-water marks in the trees and and shrubs along the runway were three to five feet above the runway's surface. Great heaps of silt and gravel had been cleared from the landing strip only recently. Several cars came from the village to meet the plane, and the entire group drove into town to get firsthand information about the disaster and to see the destroyed, damaged, and water-stained buildings. The toll in physical damage had been staggering. Three hundred fifty of Loreto's 450 houses had been completely destroyed or severely damaged. Virtually every house in town had been flooded to depths varying from a few inches to several feet. The flood roaring down the canyon behind the village spread to make a river three kilometers wide, and one elderly gentleman said the water separating his house from the church was shoulder deep when he waded to the church to take refuge within its stone walls. Thousands of date palm, coconut, orange, mango, fig, and shade trees had been blown down, snapped off, or washed completely away. Trees that had been overturned by the wind, but still had their roots in place, were being lifted upright and guyed in place. There were many accounts of the terror that struck when inhabitants felt the fury of the storm. Despite the harrowing experiences, the death toll had been low. One old man who refused to leave his hut had been drowned. No other lives had been lost. People said Loreto really had been lucky as far as loss of life among its inhabitants was concerned, but that the floods had been much worse at San Ignacio and La Purísima, where the dead were reputed to have numbered nearly a score at each of these places. The Sportsman's Club at Loreto had several buildings unroofed, the fences partially destroyed, and many fine trees broken off or blown down.

The flight from Loreto to La Palmilla was routine, but when the party landed at this attractive resort it was scarcely prepared for the higher temperatures experienced when the door of the plane was opened. The strip there had not been damaged by the storm, or if damage had occurred it had been repaired, for the strip was reasonably smooth and Sr. Rodríguez's small plane was on the parking apron. A car arrived from the resort a half-mile away, and part of the group drove down to the buildings to talk with Sr. Rodríguez and to see what havoc had been wrought by the chubasco. There had been extensive damage in August, 1958, when the wind had attained such velocities that it beat reinforcing steel, standing vertically 10-12 feet above the concrete of a partially constructed building, to an angle of about 40 degrees.

The vegetation along the airstrip was in virtually full flower, with gorgeous festoons of *Antigonon leptopus* hanging from the upper branches of the larger trees. Several species of *Boerhaavia* made a pink mist, and many less spectacular annuals and perennials were in flower. The display was beautiful, and a large folio was filled to overflowing in less than an hour. No herpetological specimens were obtained, for neither the equipment to make such collections nor preservatives for specimens was available.

The flight back to La Paz required less than half an hour. The taxi driver said that neither the Guaycura nor the Los Cocos resorts were open at this time of the year. Quarters were obtained at Los Arcos, in artistic, two-unit cottages across the street from the main hotel and dining room.

There was still time for Dr. Miller and Ira Wiggins to make a quick inspection of the apartment the Academy had rented on the Malecón and into which Margaret Waters had arranged to have equipment moved from the place near the Plaza. Academy personnel had feared that the chubasco might have blown the roof from the apartment and left the place open to the elements. The damage had been minor; only a single panel of the metal roofing had been blown away. This panel was over the bathroom, in which nothing had been stored, so no supplies or equipment had suffered. The place was littered with leaves, broken branches from the trees outside, pieces of paper and a thick coat of silt that could have been swept in during the chubasco or partially deposited by wind after the rainstorm abated.

Departure from La Paz was accomplished in good time on the morning of the 28th, and a course set directly for La Purísima, in an effort to see whether or not the precipitation had reached the coastal mesas in that vicinity. The light was better for getting a good view of the southern Sierra de la Giganta than it had been the afternoon before, and extensive areas in the "lagunas" among the higher peaks and mesas were seen to contain water. Some of these temporary lakes were several miles long; some of them appeared very muddy, and others contained clear water through which one could see grass and inundated bushes.

The plane "buzzed" La Purísima several times before landing at the strip on the mesa. A brief examination of the mesa immediately adjacent to the strip showed that there had been some rain at that place either in conjunction with the chubasco or sometime in the late summer, for seedlings were present in small numbers, and such things as *Fouquieria peninsularis, Jacquemontia abutiloides, Franseria bryantii,* at least one species of *Perityle* and one of *Passiflora* were in bloom. *Maximowiczia* plants were in flower and some had nearly ripe fruits, so there probably had been some rain early in the summer. A few *Mammillaria* plants were beginning to flower, also.

In about half an hour two cars came charging up the grade, with so many people in them that it would have been impossible to take the visiting party back to the village had any of the local people ridden back, too. No-one in the plane wanted to take time to make the round trip to the village, so a short conversation with the villagers revealed that the reports heard at Loreto about the number of deaths at La Purísima had been exaggerated – the La Purísima people said five had died there, four of them belonging to one family. However, property damage had been staggering, and apathetic hopelessness seemed to be the general attitude of those who drove to the landing strip.

From La Purísima the course of flight was northwest over Scammon's Lagoon, and a landing was made at Guerrero Negro on the salt field that looked uncertain from the air but was as hard and smooth as concrete when the wheels touched. The group was met by several of the officers of the company, Exportador del Sal, taken on a tour of the evaporating ponds, shown the huge salt-harvesting machine, special trucks and trailers, each of which hauled from 80 to 114 tons of salt at a load, the loading facilities on an arm of Guerrero Negro Lagoon, and returned to the company village for a delightful coffee break. Arrangements were made to use this base as a clearing point during subsequent trips, and to have the company truckers keep alert for possible breakdown of Academy vehicles operating in the Vizcaíno Desert. Almost no plants were in condition to collect, but seedlings promised abundant material later in the autumn.

One objective of the reconnaissance flight had been to check possible landing strips for routine or emergency use on the peninsula. One strip considered for such checking was at Laguna Manuela, about 15 miles north of Guerrero Negro. When the people at the salt company's headquarters reported the strip at Laguna Manuela in good condition, a test landing was no longer necessary and the pilot preferred to use the time and fuel made available in by-passing Laguna Manuela to fly to Cedros Island. The flight to Cedros was less than one hour in length, and the landing made without incident, in spite of a terrific cloud of dust kicked up by the propwash and the wheels. Only a few minutes was spent at this airstrip, for the vicinity was exceedingly dry. Almost no plants were present except along the upper strand where *Salicornia* and *Allenrolfea* made a narrow, irregular strip of grayish green.

The landing at San Diego was made just after dark, so delay in getting United States medical, immigration, and quarantine officials to check the plane and its passengers had been anticipated, but clearance was accomplished promptly. The flight had been eminently worth while, for it provided information about roads, and the limits of useful precipitation for bringing plant cover into favorable condition for collecting during a trip down the length of the peninsula scheduled for the autumn and to begin within two weeks.

### Autumn Botanical Expedition

On October 10, 1959, a party of three – Ira L. Wiggins, Dorothy B. Wiggins, and John H. Thomas – departed from Palo Alto at 9:00 A.M. to drive the "Travelall" to San Diego, where final minor purchases were made, the vehicle was checked and serviced, and Mrs. Margaret Waters was added to the group to drive to La Paz. Originally the plans had called for Dr. and Mrs. Hanna to participate in the whole expedition, but pressing obligations at the California Academy of Sciences prevented them from doing so.

Weakness in the design of a luggage rack on the roof of the "Travelall" necessitated rebuilding that piece of equipment, so the party did not get away from San Diego until the forenoon of October 13. Another delay occurred in Ensenada, where the local Immigration Officer was involved in political receptions for the governor-elect, and the Americans were unable to secure his aid in acquiring tourist permits until too late in the evening to permit further driving that day. Rooms were engaged at a motel on the outskirts of Ensenada, and the party was up at 4:30 the following morning and on its way by 5:00 A.M. A lunch stop was made on the mesas a few miles north of El Rosario, a package from Dr. George Lindsay of San Diego for a family in the village was left with Señora Espinosa, gasoline was purchased, and several more miles were put behind before camp was set up near a colony of *Idria* trees 15 miles southeast of El Rosario. During the stop for lunch, and again in the evening, swarms of gnats were particularly troublesome. These noxious midgets continued to pester members of the party throughout most of the trip to the Cape Region and much of the time spent in the field during the autumn.

The first collecting on the autumn trip was done at the noon stop, October 14, between El Aguila and San Augustin. The arroyo at this point had carried some runoff earlier in the summer, and possibly a slight amount as a result of the chubasco, so there were several perennial herbs in flower. None of the annuals were large enough to collect, but they were numerous enough in swales and in the protection of steep banks to give promise of better collecting later in the fall.

Progress southward was steady, although not particularly rapid. Collecting remained scanty past Cataviñá, Laguna Chapala Seca, and Punta Prieta. There was a slight increase in the number and size of the plants in

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Plate 3 (Upper) "Biznaguita" (*Mammillaria evermanniana*) between La Paz and Los Planes. Photographed by G.D. & M.M. Hanna

(Lower) "Biznaguita" (*Mammillaria fraileana*) near Isla Pichilinque. Photographed by Ira L. Wiggins

bud or flower as the route led southward. South of Punta Prieta some of the washes had carried sufficient runoff from the heavy rains in the hills to the east for the flood waters to approach the Pacific Ocean. Along such arroyos were narrow strips of verdure breaking the monotony of the dry, parched mesas and hills between which they ran. Some days no more than 15 or 20 collections could be made; on others, when several large arroyos that had carried heavy freshets were crossed, over 50 were taken. Each collection was made in sets of six to eight sheets when the material was ample, so the presses were kept filled and placed over a gasoline stove each night in order to insure rapid drying and good specimens.

A normal day of operations began at about 6:00 A.M., with breakfast being prepared while Dr. Thomas and Ira Wiggins opened the press that had been over the heat the night before, removed the sheets that were dry, and put anything that had been held over from the previous night into the warm blotters and ventilators before strapping the presses up for the day. Breakfast finished, clean-up was begun immediately, the gear reloaded into the truck, and the expedition on the road, usually between 7:30 and 9:00 A.M.

Driving was shared by Wiggins and Thomas, each doing about a two-hour stint at the wheel before the other took over. Sometimes an area to reconnoiter and collect in would be found within five minutes of getting under way; other days 10 or 15 miles might pass before a stop was made. Photographs were taken whenever a subject of sufficient interest or novelty was seen, and a complete log of all collecting stops, photographs, general condition of the country and the vegetation was kept. A portable, battery-operated, tape recorder was utilized through the day to record observations on the vegetation, and the geographic distribution of a species seen near its southern limit or when its northern boundaries were reached. The more spectacular features of the terrain were noted and briefly described on the recorder. A noontime break was taken each day, although not always promptly at noon, for it was found that a half-hour in which to eat a light lunch and rest in the sparse shade of a mesquite, *Yucca,* or Elephant Tree helped to reduce excessive weariness before the end of the day. A satisfactory camping site usually was selected about 20 minutes to half an hour before sundown, in an opening in the shrubs, or on a stretch of desert pavement where the cars could be driven at least 100 yards from the road. The two women chose the spot they favored for their cots, usually about 30 to 40 yards apart, rolled out their sleeping bags, mentally marked the spot so they could find their beds after dark, which usually came quickly. John Thomas usually went a greater distance from the truck, and Wiggins slept beside the truck where he could also look at the stove under the plant presses once or twice during the night and pump up the pressure tank so the fire would burn until morning.

While Dorothy and Margaret prepared the evening meal, John and Ira again opened the presses, removed any specimens that were dry, and reinserted those that needed still more heat, together with the ones collected during the day. When that chore was finished, dinner was ready and the heaviest meal of the day was consumed. A few minutes were usually devoted to writing up notes on the day's operations, checking the mileage made, going over the car for any attention it might need, and all hands turned in early. It rarely was later than 9:00 P.M. when all were in their sleeping bags, and some evenings the camp was silent a full hour earlier.

The salt works at Guerrero Negro were reached just after noon on October 20. Rather than arrive at mealtime, the car was driven part way toward the loading dock so collecting could be done on the salt marsh and shells obtained for the malacologists. Company headquarters were approached in midafternoon and arrangements made with Mr. McClory to buy gasoline and call the San Francisco office on their short-wave radio. The call went through promptly and reception was good.

The route from Guerrero Negro led almost due east, along a looping curve through the sandy Vizcaíno Desert to El Arco, which was reached a short time after noon the second day from Guerrero Negro and thence along the main road to San Ignacio. At this desert oasis the devastation caused by the chubasco among the date palm groves, the vineyards, along the arroyo, and in the part of the village that had lain on low ground near the arroyo was appalling. The dam a half-mile or so above town, that had impounded the water for the villagers and orchardists, had been totally destroyed by the flood. Thousands of palm trees had been uprooted, snapped in two, or blown and washed over. Many of the wrecked trees had been carried down the arroyo for miles; others were still attached to the rocky soil but were lying flat on the rocks. Debris was lodged against the upstream side of many of the date palms that had withstood the ravages of the flood and in some instances was still piled to a height of 10 to 15 feet above the ground. These trees, with the trash still piled around their trunks, were growing along the margins of the arroyo. The center of the watercourse was 10 to 15 feet lower than the bases of the marginal trees, so the greatest depth of the rushing flood must have been 20 to 30 feet. It was a depressing sight and one could hardly blame some of the local inhabitants for having a defeatist attitude. Many, however, were busily engaged in clearing away the debris, straightening leaning trees, repairing damaged houses, fences, and irrigation ditches, and hauling boulders with which to rebuild the dam. It will be several years, at least, before the town of San Ignacio can erase the scars of the chubasco of September 9, 1959.

At San Ignacio it also was learned that the reports about the death toll heard at Loreto in September had been grossly overdrawn. Inquiry here elicited the information that only one person, a mentally retarded girl, had perished in the flood. All others had reached higher ground before the wall of water and its terrifying load of smashed trees, brush, sand, gravel, and boulders reached the area. The power of the flood was vividly attested by the presence of huge boulders, eight, ten, fifteen feet in diameter, strewn along the bed of the arroyo where none had been before.

Each member of the party had hoped there might be word at San Ignacio that the road south via Mulegé and Loreto had been opened to traffic since September 26. A couple of trucks had got to Santa Rosalía over a very bad road, but there was no possibility of driving beyond that town. The road between there and Mulegé was still out and no-one expected the route around Bahía de la Concepción to be passable for at least six weeks.

The only road open ran southwest, on a route none in the party had taken previously. Fortunately, it proved much less difficult than it had been painted, and avoided the steep grades twisting down the eastern escarpment to Santa Rosalía, the long stretches of rocky, bone-jarring road around Bahía de la Concepción, the one down the canyon from Canipolé to La Purísima, and that across the lava-strewn mesa between Canipolé and Comondú.

The "Travelall" got through the sandy areas with no serious difficulty, although a Mexican's truck had to be pulled out of an arroyo with the winch so traffic could get by. One unpleasant forenoon of driving slowly on a silt-floored valley before a tail wind had to be endured on the way inland from the salt flats between Salina Cuarenta and Rancho San José de García. Here the silt had been churned into powder, the ruts were axle-deep, and the dust billowed around the car in clouds so dense that several times it was necessary to stop and let the wind carry away the dust. During the summer months when the sandy areas are very dry, the coastal route is probably difficult to traverse, but in October, 1959, the general condition of that road was better than that on the "main" road.

In the vicinity of La Purísima the collecting conditions were less favorable than they had been 100 miles to the north, for rain on the mesas during the late summer had been very slight, or possibly lacking. It was apparent that the direct precipitation during the chubasco had not extended to the Pacific Coast at that latitude, and good growing conditions occurred only along the arroyos. One wash about eight miles south of Arroyo de la Purísima provided excellent collecting conditions. Shrubs, trees, vines, and herbs were in good condition, and a varied aggregation of plants kept John, Ira, and Dorothy busy much longer than had been anticipated, with the result that a camp site was selected very hurriedly, and not until too late to change was it discovered that camp, on the edge of a mesa, overlooked a small ranch where a tremendous herd of goats had stripped the ground bare half a mile from the buildings. However, their activities seemed to stop near the foot of the bluff below.

The road from La Purísima south to the northern end of the pavement had been graded, the roadbed divided into two strips separated by a line of cobblestones set into the clay, and, over considerable stretches, some cobbles set from side to side of the road. These cobbles were, apparently, covered with dirt when first laid, but most of the soil had been washed or blown away, so the rough surface hammers a car frightfully. The older roads, which consisted of nothing more than a clearing through the brush, and with a clay or sand base, were generally less trying to drive over and placed a less severe strain on the vehicle.

On October 28, 60 miles were covered before lunch, and the paved highway 212 kilometers from La Paz was reached half an hour later. Almost no stops were made between the beginning of the pavement and La Paz, and the apartment was reached at 7:30 p.m.

The following three days were devoted mainly to organizing supplies and equipment in the apartment, having the vehicle serviced at the International Harvester agency in La Paz, and in purchasing various supplies for use in the field and at headquarters. Most of the 30th was spent in driving back along the paved highway about 45 miles to collect in several arroyos that had been seen on the trip south. The specimens obtained were not as numerous as had been anticipated. The rainfall had dropped off sharply west of the escarpment that bounds the plains on which La Paz stands, so the vegetation west of the divide was nearly at a standstill and very few shrubs or trees bore either flowers or fruits.

### Special Field Party

In the afternoon of October 31 several more scientists arrived by plane to spend a few days on special projects centered near La Paz. The group included Dr. G Dallas Hanna, geologist, malacologist, and paleontologist at the Academy; Mrs. Hanna, a scientific illustrator who collaborates with her husband in photographic projects; Dr. Myra Keen, malacologist at Stanford University; Dr. Joseph Wood Krutch, naturalist and writer who was gathering material for a general and historical account of the natural history of Baja California; and Mr. Allyn Smith, Research Malacologist at the Academy. During their stay in the Cape Region members of this group collected specimens, took photographs, and secured notes at various localities several directions from La Paz. Their first excursion, on November 1, was to Isla Espíritu Santo, utilizing a landing craft operated by Richard Adcock, a young American living in La Paz. Dick landed first at Bahía San Gabriel, where extensive holding and rearing tanks for pearl oysters had been built by a French company about the turn of the century, but which never had been operated at full capacity because the project was scuttled during the Mexican Revolutions of 1910-17. The hillsides nearby were covered with many species of plants in flower or fruit, including hundreds of the attractive, red-flowered *Behria,* not previously reported from the island. Dr. and Mrs. Hanna obtained excellent photographs of several of the plants at this stop, and Allyn Smith found land snail shells high on the ridge above the landing.

Leaving Bahía San Gabriel, the skipper followed the western shore of Isla Espíritu Santo, which displays extraordinary horizons of volcanic ash, basaltic lava flow, and rhyolitic rocks in various shades of pink, buff, gray, black, umber, and red. He put in at Bahía Candelero, near the northwesterly point of the island, where the water was beautifully clear and the canyons leading back into the higher peaks promised good collecting for the botanists, the beach a mecca for the malacologists. High expectations as the LCP entered the cove were fully fulfilled ashore, for Dr. Keen obtained shells and worm tubes that are rare in collections, Allyn Smith found a few land snails on the ridges and in the canyon inland, and the botanists obtained over 50 different species of flowering plants in good condition. Mr. Smith even found a small night snake under a piece of driftwood, thereby contributing to the herpetological knowledge about the island.

The larger of the canyons leading inland from Bahía Candelero had recently contained water in the tinajas only a few hundred yards from the beach, and it is possible that small pools still may have existed higher in its course. Beautiful specimens of a native fig (*Ficus palmeri*) as much as 70 feet tall, and with grotesquely branched and flattened roots, occupied a partially shaded portion of the gorge. Several members of the bean family, both shrubs and small trees, were present along the canyon's walls or near its floor, and several were in flower or fruit. The bright, deep pink masses of flowers of *Antigonon leptopus* cascaded over many of the shrubs or formed attractive blankets where the vines enmeshed huge boulders. Large, golden yellow blooms of the morning-glory, *Merremia aurea,* were scattered along the canyon, but this plant rarely produces more than three or four flowers on any one day, and the blossoms wither by the end of the afternoon, so they rarely make an extensive display.

At this beach Mr. Smith filled a collecting bag with beach drift to be sorted under a lens after the party got back to the Bay Region. Several extraordinary mollusks later were separated from this accumulation, one of them representing a marine snail not previously known from an American coast. Final research on several of the shells from the drift had not been completed when this report was being written. Special papers will present the results of the investigations on this lot at a later date. The discovery of these marine shells emphasizes the importance of studying comparatively large quantities of material in a critical manner if one is to reap the greatest possible benefits from opportunities to visit field localities. Separate papers will no doubt be published to report results in other fields of investigation growing out of the few days spent in the Cape Region by this group of California scientists.

On November 2 four members of the party spent the day with the "Travelall" investigating a report that fossil fresh-water snails occurred in a limestone deposit about 35 miles south of La Paz. Dr. Krutch, Dr. Hanna, Allyn Smith, and Ira Wiggins made that reconnaissance trip, found a deposit of limestone that contained a few poorly preserved fresh-water snails and fragments of fossilized plant remains, and took a number of photographs of attractive plants and shrubs in full flower. Others, including Dr. Keen, Mrs. Wiggins, Mrs. Hanna, and Dr. Thomas, flew to La Palmilla, where a car was engaged to take them to Cabo San Lucas and back. While at the southernmost tip of the peninsula, Dr. Keen had an opportunity to see some of the marine mollusks and other sea life just under the lea of the Cape and to collect rare shells. This group returned to La Paz about dusk, and the two field parties compared notes during dinner at the Guaycura Motel that evening.

The morning of November 3, again there were two field parties operating. The Hannas and Wigginses drove the "Travelall" part way to Los Planes in an attempt to get a reasonably good photographic coverage of the flowers and characteristic trees and shrubs in that part of the Sierra Cacachile. The others embarked in Dick Adcock's *El Crepúsculo* to explore the shore of the peninsula east of La Paz. The latter group encountered rougher water than had been experienced on November 1, but was able to land at Balandra Bay and just northwest of Coyote Point. Near the latter locality a large limestone deposit, lying along the upper beach and uncovered by the storm on September 9, contained myriads of well-preserved fossil shells. Inadequate tools for removing the closely cemented material prevented collection of more than fragmentary pieces of the rock, but it was obvious that here was a deposit of great interest, and one that would yield rich dividends if studied intensively.

Dr. and Mrs. Hanna obtained outstanding photographs of several flowers during the course of the day, one of which was a milkweed with delicate, brownish filaments three to five millimeters in length attached to the face of the corolla, and fluttering in the slightest breeze. Another splendid color transparency was of a *Mammillaria* in full fruit, with a ring of bright red, elongate fruits completely encircling the oblong, spine studded body of the plant.

On the same little knoll where the fruiting *Mammillaria* grew, Dr. Hanna found both empty shells and living snails in fair numbers under the slabs of granitic rock. Three different species were represented among the shells obtained at this locality. Empty shells of land snails are numerous in most parts of the Cape Region, but the living animals are often hard to get, for they retreat far into the crevices among the rocks when drought sets in.

## Field Operations: Mostly Botanical

Everyone was up at 5:30 A.M. on November 4, had breakfast at 6:00, and the visiting scientists' plane took off at 7:20, taking Dr. Thomas with them, for he had to return to his duties as Assistant Curator in the Dudley Herbarium at Stanford University. The departure of the larger group left only the two Wigginses operating in the field in the Cape Region, and they missed the others greatly.

A number of collections of fruit of cacti, seeds of yuccas, and other botanical specimens needed attention, for if left in the paper bag containers mold would spoil much of the material. The next couple of days were spent in washing the seeds from the pulp of fruits, opening capsules and completing the drying of the seeds, changing the presses and removing specimens, and generally getting things into shape so additional field collecting could be carried on in the Cape Region and in the Sierra de la Giganta.

The morning of the 6th Ira and Dorothy left La Paz to accept an invitation from Mr. Rex Keller to visit the region around a mine in which he has an interest, located at El Valle Perdido, about 40 miles by road from La Paz. Numerous stops to collect were made en route to El Valle Perdido, so the Keller house on the bank of a large arroyo about a half-mile from the village was reached just a short time before sundown. A pleasant evening was spent talking with Mr. Keller and a visiting mining specialist, Arthur Johnson, who was at El Valle Perdido to inspect the mine. The conversation with Mr. Keller paid good dividends, for his suggestions concerning the local environment helped the Wigginses find nearly 50 species of collectible material within a mile of the mine buildings the next forenoon. He also suggested an extension of the trip another five miles up the arroyo past El Valle Perdido and over a low ridge, to a small ranch called La Junta.

There had been a few small pools and an occasional seep in the large arroyo running past La Mina San Antonio (the mine Keller supervised), but no actively running water there. It was, therefore, amazing to encounter a small but beautiful stream of clear, rapidly running water in the sandy bed of the arroyo only two and one-half miles above the village! Marks on the sand showed that the flow of water fluctuated during day and night periods, with the surface water extending fully 200 yards farther down the arroyo in the early morning that it does toward the end of a warm afternoon.

An oak, *Quercus brandegeei,* occurs commonly along the arroyos between El Valle Perdido and La Junta. Several had many shoots six to fifteen inches tall forming a dense carpet under the parent tree. At first glance these shoots appeared to be a huge crop of seedlings, but closer examination revealed that they are shoots from the roots of the tree, and are intricately intertangled three to six inches below the surface of the soil. Almost no true seedlings were found under such trees, although acorns were numerous on the branches and under one of the larger trees having these suckers growing from the roots. The acorns of some trees are reputed to be sweet and edible, and quantities are gathered each year and sold for human food in the La Paz markets.

A short distance above the point where the rill was encountered, the road climbed a ridge, through a low pass, and dropped down the opposite side into another drainage system, where a much larger stream occupied a channel about 20 feet wide, with a flow four to five inches deep over its gravelly bed. Willow trees, many introduced guamuchil trees, shrubs of *Baccharis,* and *Cryptostegia grandiflora* were abundant along the stream. The next morning four different species of morning-glories (*Ipomoaea* and *Merremia)* were in flower within 200 yards of camp. Amazingly, no mosquitoes were noticed during the evening or early morning hours nor had there been the usually abundant swarms of gnats. Hummingbirds were common along the stream and worked over the flowers of the morning-glories and those of a low shrub, *Ruellia californica,* as soon as the sun came up. Several dozen small toads, so recently metamorphosed that some still had vestiges of tails, hopped upward toward granitic boulders along the banks of the arroyo, apparently looking for the protection of overhanging ledges and for moist holes under some of the rocks where they could burrow into the damp soil. Within an hour after the direct rays of the sun struck the bottom of the canyon, not a baby toad was in sight.

Camp was broken in the middle of the forenoon, the car driven slowly back to El Valle Perdido, and many stops made to collect specimens that had not had their flowers open the afternoon before. Several specimens of *Cnemodophorus,* a large *Sceloperus* lizard, and one good-sized racer dead in the road where a passing vaquero had killed it just a few minutes earlier, were added to the herpetological collections.

Fewer collecting stops were made between El Valle Perdido and La Paz, because field work at the altitudes between the mining village and La Paz had been reasonably thorough during December of 1958 and January of 1959. El Valle Perdido is situated at an elevation of approximately 1,500 feet above sea level, and the highest point between there and La Junta only about 150 feet higher. Trails lead from the vicinity of La Junta to the meadows among the higher peaks of the Sierra de la Laguna, so it would be

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Plate 4 (Upper) "Pitahayita" (*Echinocereus brandegeei*) near Punta San Lorenzo. Photographed by Ira L. Wiggins
(Lower) "Biznaga" (*Ferocactus peninsulae*) near La Purísima.
Photographed by Ira L. Wiggins

possible to sample the vegetation and fauna of that range from the 1,500-foot level to over 5,000 feet above sea level in a few days with pack and saddle animals.

On November 11 the Wigginses headed northwest from La Paz to attempt penetration of the Sierre de la Giganta. Several side roads leading toward the northeast and east were investigated in the course of covering the first 100 kilometers, but none of them extended far enough from the highway to further plans for getting into the higher hills and mountains.

At Kilometer 100 is situated a small store and a building erected for government use when the highway was being built. A narrow, mainly ungraded, dirt road leads easterly at a sharp angle to the main highway, and Sr. Sabino, proprietor of the Guaycura Motel, had reported a beautiful oasis existed only four miles away, at Rancho San Hilario. Three miles from the highway, a small clump of fan palms attract attention, and although the arroyo was so dry that there were few plants to collect, fragments of fossil wood occurred as float along its bed. Diligent search revealed a few more pieces, but no log could be found in the slightly consolidated, volcanic ash along the banks of the ravine. The oasis itself lived up to the description given by Sr. Sabino, and one of the men at the ranch said that a little later in the fall there would be many ducks on the ponds that occur intermittently up and down the arroyo a distance of several miles. Collecting, however, was rather poor, because goats had harvested much of the vegetation in all directions from the rancho.

Dorothy and Ira returned to the paved highway, drove north about 10 kilometers, again turned eastward, and by the end of the day had laboriously traversed rocky, rough roads to El Pilar. At this village another beautiful oasis is formed by a spring that flows steadily from beneath a thick layer of tuff and forms several attractive pools at the feet of date and fan palms. Camp was made just after sundown on a bench a couple of hundred yards from a large pond in the bottom of Arroyo Colorado, north of El Pilar. A site any nearer the water would have put one uncomfortably close to the local concentration of mosquitoes.

The morning of the 13th was one of the most beautiful witnessed during the entire stay in Baja California. Rain had been threatening most of the previous day, and just before dawn a light shower occurred. The sun came up behind a huge jumble of clouds, and the play of colors was magnificent. Bright rays broke through a rift in the clouds at 6:05, and a double rainbow almost instantly appeared in the west and northwest, with a backdrop of deep purple clouds edged with rose, gold, and a faint tinge of green. The display was brief, but of sufficient duration to permit exposure of several frames of color film.

Most of the forenoon was devoted to collecting the many interesting things growing along the moist bed of the arroyo and around the pond that stretched for a half-mile upstream. A vial was filled with beetles and other arthropods screened from the water, and several lizards and a small snake were obtained on the sandy slopes high enough above the bed of the arroyo to have escaped inundation during the high water of the chubasco. Thousands of snail shells, belonging to three genera, marked the upper edge of the drift zone. The only birds seen were two pairs of killdeers, a few cliff swallows, and one lone goose flying southwest just after daybreak. It flew high, uttering its lonely call at intervals of about five or six seconds. It was the only goose seen that far south.

Progress the rest of the day was slow and the collecting was even slower, for the effects of the chubasco were almost absent from the lower foothills in that part of the peninsula. That evening's camp was only two miles south of Rancho La Punta del Cerro and dogs, chickens, and burros could be heard from time to time throughout the night.

A brief stop at La Punta del Cerro the next morning disclosed that the road no longer runs directly past the ranch, if it ever did, but is about a quarter of a mile east of the buildings, which are almost totally hidden from sight by trees lining the pools in the arroyo. Patches of corn, pumpkins, and beans occupy most of the arroyo's lower benches, and orange, mango, and avocado trees form a dark green pattern beneath the graceful crowns of a few date palms. Three men were butchering goats at Rancho La Punta del Cerro and were only mildly interested in questions phrased in halting Spanish, so their answers were prefunctory and brief. They had returned to their tasks before the "Travelall" had been fully turned toward the main road.

The numerous forks, lateral roads, and total lack of signs caused some inconvenience, but there were no serious delays nor overly long detours, and camp was set up on November 14 at the foot of an impressive remnant of a once large mesa. Much of the forenoon next day was spent exploring the mesa and the caves near its summit. About noon an abundance of *Marsilea* was found growing at the water's edge along an arroyo at Rancho Domicilio. Several ducks were frightened from a pond about a mile below Rancho La Presa, and that tranquil habitation was reached about the middle of the afternoon on November 15. Four and one-half days had been spent traveling 191 miles, the first 62 miles over good pavement! True, many stops had been made to collect, but usually each was for only a short time. The roughness of the "roads" had been the chief factor in reducing the rate of progress.

Within the course of an hour arrangements had been made for a couple of saddle animals, pack burros, and a guide for the trip farther into the

Sierra on the following morning. The welcome extended by the people at the ranch was warm and friendly, with the elderly lady of the hacienda serving coffee and hot milk within ten minutes of the botanists' arrival.

Four days were spent in riding up the trail to Laguna Caquihui, collecting the plants still in good condition there, and returning to Rancho La Presa. The trail was a good one, in fact followed the general route of a road that had just been finished in August of 1959, then destroyed by a rush of water during the chubasco on September 9. In making the gradual ascent into the higher mountains, the trail passed the ruins of Misión de la Pasión, which lie on a rounded knoll removed only a little way from an arroyo tributary to Arroyo La Presa, and which Sr. Ruperto de la Tova claimed always contains water, even when the main arroyo is dry except for scattered tinajas and pools. Several ranches, mostly devoted to raising goats, occur at intervals along this trail, and an attractive cattle and horse ranch is situated at the northern end of Laguna Caquihui, the main laguna between Rancho La Presa and Los Dolores.

The "lagunas" in this part of the Sierra de la Giganta are intermittently dry as dust, and flooded to a depth of several inches to four or five feet. Several years may go by with no water in the lagunas; in others the rainfall is sufficient to fill them deeply enough to permit runoff for a short time. The valleys in which they occur are broad, with very gentle slopes around the periphery of the ponds or lakes, and some are as much as two miles in length and about one-third as wide. Many ducks were rafted in the center of the laguna, but kept too far from shore to permit Ruperto to shoot them. Verdure was abundant on the flats along the laguna, but the number of species was low. A very beautiful delicately hued, purplish morning-glory, tangles of a wild bean (*Rhynchosia*), a weedy member of the hollyhock family, and tremendous numbers of the clover-like plants of the water fern, *Marsilea,* were the most abundant plants around Laguna Caquihui. Patches of ragweed (*Ambrosia*) and one of its near relatives, (*Franseria*) were numerous but not in full bloom.

Among the rocks surrounding the laguna, Ruperto found several plants of more than ordinary interest, among them a cactus that looks like dead twigs, *Wilcoxia striata,* and one plant of a still rarer cactus, *Peniocereus johnstonii. Wilcoxia* has a bundle of dahlia-like roots buried a few inches below the surface of the soil, and *Peniocereus* possesses a root that looks like a large sugar beet and may weigh several pounds. Such subsucculent roots help these peculiar plants to survive long, dry periods by storing water in their fibrous tissues. The spines of neither of these cacti are formidable, and the stems are sometimes severely damaged by rabbits. Cattle avoid them, for their juice is very bitter.

Ruperto said that the Laguna is only about 15 miles from Los Dolores, a cattle ranch and the site of one of the early missions on the gulf just west of Isla San José. However, the trail down the eastern escarpment of the Sierra de la Giganta is very steep, difficult, and in places dangerous, so Ruperto was unwilling to punish his burros and saddle horses by taking them down that trail and back up again.

On the return trip to Rancho La Presa, the second known collection of a delicate little member of the Loasaceae, *Sympetaleia tenella*, was made. It had been found first by Ivan M. Johnston only a few miles farther north in 1921. Only a single plant was found in collectible condition by Johnston, and just one plant was found in Arroyo la Presa. The latter specimen, however, was in full flower, whereas the one collected by Johnston had been past its prime and bore more fruits than flowers. This specimen from Arroyo La Presa provides adequate material for a fuller description of the endemic species.

Sr. de la Tova suggested a day or two of rest at Rancho La Presa to provide opportunities to collect in the immediate vicinity, but inasmuch as the foothills had been covered with considerable thoroughness on the way in and supplies were beginning to run low, his invitation was regretfully declined. Better time was made going out than had been possible on the trip from the highway to La Presa, largely because the owner of the ranch at El Domicilio told about a road running directly from El Obispo to the pavement at Kilometer 126. Consequently La Paz was reached by 5:30 P.M., November 19, only 27 hours after the Wigginses left La Presa, in contrast with the four days needed to make the drive to the ranch.

## ECOLOGICAL RECONNAISSANCE

On arrival at the La Paz headquarters November 19, Dorothy and Ira Wiggins learned that Dr. Paul B. Sears, world-renowned plant ecologist from Yale University, had arrived in La Paz that afternoon. While in California to deliver a series of lectures, Dr. Sears had expressed a desire to see the plant cover in the Cape Region, and the Belvedere Scientific Fund had arranged for him to join the Wigginses for a brief examination of several vegetation types in the vicinity of La Paz. Because Dorothy and Ira were away from headquarters more than a week during their trip to the Sierra de la Giganta, Dr. Sears arrived an hour before they received the telegram informing them of his visit. Arrangements were made for a trip to Isla Espíritu during the forenoon of November 20, and the local field workers accompanied Dr. Sears to the island and showed him characteristic vegetation near La Paz following the boat trip.

After an early breakfast the party left the dock at La Paz aboard Dick Adcock's barge at 6:20 A.M. on the 20th, and landed near the southern end of Isla Espiritu Santo at 8:20 A.M. Dorothy and Ira collected on the salt flats behind the beach ridge and on the nearby hills, and Dr. Sears took the opportunity to examine the ecological aspects of the salt flat and strand vegetation, which he found intriguingly different from salt marsh plant communities along the Atlantic coast of the United States.

After the collecting had been completed and ecological notes recorded, Adcock moved the landing craft to one of his favorite skin-diving spots in a quiet cove a mile or so farther north. There, all who wished to attempt it observed marine life with face mask and snorkle. The water was beautifully clear, only slightly ruffled by a light breeze, and the opportunity to watch colorful tropical fish and myriads of invertebrates was a rare one. Among the animals seen were several groupers, a huge marine gar, beautiful gorgonias, purplish and bluish corals, hydrozoans, starfish, an amazing variety of shellfish, sea cucumbers, at least one small shark, and three medium-sized rays. Mrs. Adcock's brother, Victor, brought up two or three small pearl oysters, and Mrs. Adcock obtained one gorgeous cone shell, being careful to hold the animal so it could not reach her fingers with its venomous tooth. A good collection of marine invertebrates, including snails, bryozoans, sea urchins, starfish, and seaweeds was obtained.

As the forenoon advanced, the snorkling members of the party were more and more frequently stung by jellyfish so tiny that they could be seen only as points of light when one looked obliquely through the water. Their stings were not serious, but the cumulative effects finally discouraged even the more rugged divers, and Adcock headed the barge for La Paz, arriving at the dock at 1:55 P.M.

By 2:30 P.M., Dr. Sears was ready to look at the desert vegetation west of La Paz. He and Ira Wiggins drove westerly along the paved highway about 30 miles so Dr. Sears could see the sharp change that occurred at the crest of the low range of hills about 18 miles west of the city. The ground east of this crest received a good soaking during the rain accompanying the chubasco in September, whereas the more gently sloping terrain extending to the Pacific had almost no rainfall at that time. Apparently the up-rising air currents occasioned by the abrupt ascent of the escarpment forming the eastern face of the range had brought about precipitation of nearly all moisture in the masses of air moving ahead of the strong winds, and had heavily watered the area from the escarpment to the eastern side of the Cape. The winds blowing westerly beyond the escarpment carried little uncondensed moisture, so a very remarkable break in the limits of the rainfall allowed heavy growth of the annual and perennial vegetation on the La Paz plains and the adjacent steep slopes to the top of the ridge, but gave little stimulus to the seeds and aestivating plants west of the crest. Only along a few of the canyons had there been some slight runoff, permitting growth of plants. East of the escarpment the *Bursera* and *Cyrtocarpa* trees were in full leaf and *Jatropha cinerea* was producing numerous flowers and fruits; west of this line, these trees were almost totally devoid of leaves and not a sign of flowers was to be found on the many shrubs of *Jatropha*.

### Other Cape Region Localities

Following the departure of Dr. Sears on November 21, three days were devoted to drying specimens collected on the La Presa trip, making various arrangements with Mr. Adcock about a boat trip to Los Dolores early in December, and getting ready for a short trip in the "Travelall" to the vicinity of Balandra Bay to obtain, in addition to plant specimens, fossils from the coquina beds for Dr. Keen. Detailed notes covering the trip to Laguna Caquihui were written up, and the data on photographs carefully checked and organized. November 24 was unusual in that there was scarcely a vestige of breeze all day, so the water of the bay was mirrorlike and the gnats were viciously bothersome.

On Wednesday, November 24, Dorothy and Ira left the apartment in La Paz to get a representative collection of the fossil shells seen near Coyote Point by Dr. Keen and Allyn Smith. Little had been learned about the road beyond Pichilinque by talking with local taxi drivers, but the road was unexpectedly good and the beach just east of Punta San Lorenzo was reached early in the afternoon. Several pictures of the yellow morning-glory (*Merremia aurea*), and the bright red flowers of *Cochemia poselgeri*, of an unidentified *Echinocereus*, and other attractive plants were made en route.

Thanksgiving Day was a memorable one, for only the two botanists were on the entire stretch of beautiful beach extending three or four miles from Punta San Lorenzo to Punta Coyote. Two boats, one a turtle-fishing canoe and the other a service tug going to a buoy several miles off shore, passed during the forenoon, but no other craft was seen the whole day.

There are several caves well up the side of Punta San Lorenzo, two of which showed definite evidence of having been used extensively for shelter and had deep deposits of shells, ash, and fragments of partially burned wood covering their floors.

*Jatropha palmeri*, which possesses mean stinging hairs on the foliage and young twigs, and *Coulterella capitata* are both common on the point. Another botanical feature of more than usual interest is the presence of *Behria tenuiflora*, the red-flowered member of the lily family related to our common blue Brodiaeas of the California foothills and valleys, on the steep slopes of Punta San Lorenzo. Partially dried scraps of *Tradescantia* (a member of the spiderwort family) were found along a small, dry waterway on the northeast slope of the point. There were insufficient materials available to make identification possible, but ripe capsules contained seeds that may grow, and furnish flowers with which determinations may be made later.

The beach east of Punta San Lorenzo is made up of myriads of tiny fragments of shells. Almost no sand of inorganic origin is present. Intermixed with the fragments are many fresh shells bearing slight evidence of the grinding and churning effects of breakers, so the area would be of great interest to malacologists. Moderately deep water around the rocky point itself might produce a wealth of living shells through skin-divers' activities, although favorable diving conditions might be found only during particularly mild weather.

The coquina beds there are extensive, and contain a remarkably rich fauna, probably of Pliocene age. About 60 pounds of material was obtained from randomly selected parts of the beds exposed along a small channel cut through the inner beach by outflow during the chubasco. This exposure had been wholly covered by sand before the storm. A few months hence it could again be covered, if heavy wave action is not offset by eroding streams from the playa extending inland a mile or more from the beach. Sand dunes, occupying a strip from a few yards to a quarter of a mile wide along much of this beach, present opportunities for botanists and herpetologists.

The distance from La Paz to Punta San Lorenzo is approximately 20 miles by road, and takes a little less than two hours to drive. The road is rough in spots, but can be negotiated by most stock cars if care is taken to avoid stumps, rocks partially hidden by weeds, and occasional abrupt gullies washed across the road since its construction. There was no evidence of appreciable traffic beyond Pichilinque, to which point trucks go regularly to load salt from the evaporating enclosures on the island. Apparently there had been only one other car at Punta San Lorenzo since the chubasco in September.

November 27 through 29 was devoted to a trip to Las Cruces, with many collecting stops en route. Ecological notes were made in more than usual detail, on a ridge 11.5 miles from La Paz near the fork where the road leading to Puerto Mejía diverges from the one to Las Cruces. The detailed work was done at that site because there is a striking contrast between the fairly heavy vegetational cover on the southeasterly side of the ridge as compared with that on its northwesterly face. These notes, together with others taken in various parts of the Cape Region, are planned to furnish material for a separate ecological paper on the area.

November 30 was spent packing the fossils for shipment to Dr. Keen, getting the food supplies for the boat trip to Los Dolores ready, and making final arrangements with Dick Adcock.

On the first of December collecting was done while making a loop from La Paz to the westerly margin of the valley in which Los Planes is located, thence southward along the road that connects with the main one from La Paz to El Triunfo, San Bartolo, and San José del Cabo, and back to La Paz. Comparatively few specimens were obtained but three different areas that appear to hold worth-while potentialities for future detailed investigation were spotted. One was a deep canyon in granitic hills east of La Huerta and lying south of the road, about 22 miles from La Paz. Another was a larger, broader canyon with a wide, sandy floor situated north of the main road and about a mile farther east, and the third region was the arroyo and adjacent hills near the village of Tescalama four miles from the old mining village of San Antonio. A series of well kept, small ranches lined this arroyo, with neat fields in which corn, beans, tomatoes, and other vegetables were grown. A few small patches of sugar cane were seen, and several orchards containing mango, banana, and date palms attested to the reliability of the water sources. Many fan palms had been planted along some of the irrigation ditches, and provided leaves with which to thatch the roofs of the local houses or for sale in La Paz. A feature of the native vegetation near Tescalama was the heavy predominance of the Palo Blanco (*Lysiloma candida*) on the hills above the cultivated fields. It formed relatively heavy stands, with no other accompanying trees attaining the height of the flat-topped Palo Blanco.

## Boat Trip to Los Dolores

On December 3 two additional botanists, Miss Annetta Carter, Senior Herbarium Botanist at the University of California in Berkeley, and Mr. Wallace R. Ernst, an advanced graduate student in botany at Stanford University, arrived in La Paz to participate in a trip by boat to Los Dolores and to several peninsular and island localities. Dr. and Mrs. Krutch also joined the party in order to accumulate additional data toward a book on the general characteristics and natural history of Baja California.

Most of the gear and supplies for the four-day trip to Los Dolores was loaded aboard Adcock's boat during the afternoon, and everyone tried to get some rest between dinner and 11:30 p.m., the time set to drive to the dock for a midnight departure. *El Crepúsculo* sailed promptly at midnight, in an almost complete calm, and with a brilliant display of luminescence in the water churned by the propeller and the hull of the boat. Occasionally a flying fish broke water, when the beams of flashlights were swept across its surface, and could be followed in its soaring flight until it again plunged into the bay. There were almost no clouds, so the stars were sparklingly brilliant.

The cruise north was smooth and the beach at Los Dolores was reached at about 8:45 A.M., December 4. Search was made up and down the coast for a mile or more to find a steeply sloping beach providing water deep enough to permit beaching the LCP adjacent to a suitable camp site. Failing to locate a suitable landing other than the one directly in front of the ranch, Adcock returned there and put the gear ashore so the cooks could prepare a belated breakfast.

The remainder of the day was devoted to scouring the hills south of the ranch for collectible plants. The nonbotanical members of the party hiked inland about three or four miles to the tumbled rubble that constitutes the ruins of Misión de los Dolores. Collecting was unexpectedly good on the precipitous hillsides south of the ranch, and the botanists returned to camp barely in time for dinner with their folios crammed with an excellent representation of the native flora of the region.

Ants of two kinds made themselves unwelcome at the beach camp: large, black ones stung viciously, and each person stung nursed a large, smarting, red welt at the site of each sting for two or three days thereafter. The tiny ones, also black, showed a tremendous liking for cake frosting. The frosting was almost completely sacrificed to the ants, for the snowy whiteness of one cake was completely hidden by the thousands of minute, black bodies swarming over it.

Everyone was awakened at the crack of dawn by an ominous increase in the murmur of the low breakers, and a few minutes later Sr. Rodríguez, the owner of the ranch, arrived to say that a heavy wind was on its way. He insisted that gear must be stowed in the LCP as soon as possible or the breakers would be so high that it would be impossible to land the *El Crepúsculo* or take a small boat through the surf. Breakfast preparations were speeded to the utmost, but with all the haste mustered it was impossible to beach the landing craft. Gear, supplies, and passengers had to be transferred from beach to landing craft in a dugout canoe owned by Sr. Rodríguez and manned by him and two of his men.

Dick Adcock cruised south about 10 miles to a sheltered cove. The group landed, with the thought that a move to another cove a little farther south would be made if this one did not provide good collecting. However, collecting was good, and an added incentive to stay more than three or four hours was furnished when a propeller blade was bent when it fouled the anchor chain. Adcock had to work several hours, submerged and wearing an aqualung, to repair the damage. The field workers scoured the hillsides and canyons within a mile of the camp, again obtaining excellent representatives of the native flora hugging the steep slopes of the eastern escarpment. Ample collections of the rare endemic, *Sympetaleia tenella,* of which a single plant had been found in Arroyo de La Presa, were found in the shade of a cliff having a large cave at its base, and many of the plants were growing inside the cave.

The wind was still blowing stiffly the morning of December 6 when *El Crepúsculo* left the cove to make the run across the channel to Isla San Jose. The crossing was uncomfortable until the boat hauled into the lea of island. A landing was made on a fine, sandy beach about a mile from the headquarters of the salt works, and collecting was good in a nearby arroyo. The botanists were kept so busy with the rich harvest that they delayed the planned departure by nearly an hour.

At 3:00 p.m. on December 6 *El Crepúsculo* left Isla San José and by four o'clock had coasted down the east side of Isla San Francisco. Waves in the cove facing the southeast were too high to permit landing, so Adcock rounded the southern end of the island and landed in a protected embayment opening toward the southwest. Plans had already been made to stay there overnight and spend most of the next day on Isla Espíritu Santo or Isla Partida, so the three botanists began collecting on the salt flat separating the two coves and on the adjacent steep, rocky slopes. They returned to the camp at dark, and after a hasty meal tucked all of the afternoon's take into presses.

Loading gear into the *El Crepúsculo* began before breakfast on the 7th, for Dick noted that the tide started running out shortly after daybreak. As it was, the craft settled on a rounded rock as the loading proceeded, and had to be rocked from side to side, with all hands in the water to their shoulders, to dislodge her. The delay was short, and by 8:20 a.m. the craft was headed for Isla Partida. A moderate sea was running in the open gulf but under the lea of a bird-covered rock just north of Isla Partida the waves were smaller, and flattened practically to a dead calm in a beautiful cove near the north end of the island.

A narrow canyon ran inland from this cove, and a variety of flowering plants was found. One of the most interesting plants there was a colony of *Fouquieria buragei,* which differs from *F. peninsularis* mainly in having pale cream, more widely flaring flowers and puberulent twigs. This species had not been reported previously from Isla Partida. A gnarled tree of *Forchammeria watsoni* grew from a slight cleft in the rocky wall of the canyon, about 200 yards from the beach. Miss Carter noticed faintly visible outlines of letters carved in its trunk. Closer scrutiny showed that, although the bark had completely overgrown the original cuts, the letters, arranged:

F. R.
1886
ENO 26.

were still legible. Unless someone had carved another person's initials and the date he had been at the spot, had died, or otherwise had done something to warrant this humble type of commemoration, a person whose initials were "F. R." had carved them on the trunk of the *Forchammeria* tree on January 26, 1886! If the latter is the history of these initials, the tree had borne the marks of the visitor nearly 75 years. A photograph of the carving distinctly shows the letters and date.

There are evidences of still earlier occupancy on this part of Isla Partida in caves and on the steep slopes below them across the canyon from the *Forchammeria* tree. Several large caves occur under the volcanic caprock at elevations of 150 to 200 feet above the sea, and about a quarter of a mile from the shore. Several caves show smoke stains on the roofs; others have been breached by seeping water and by spalling of the roof and show little or no evidence of fires. On the floors of some caves and strewn down the slopes below them were tons of shells of oysters, clams, conches, and lesser marine molluscs. Fish bones were present in considerable numbers, but owing to their greater susceptibility to disintegration under exposure there were fewer of them than of the shells. Many of the shells were of a huge, heavily-shelled oyster, with a valve eight to ten inches in length and nearly as wide. No living oysters of such proportions were seen in the cove, and one wonders if these ancient shell heaps contain remains of an oyster no longer existing in the waters around Isla Partida. No artifacts of aboriginal character were found in or near the caves; only the heaps of shells.

In the canyon below the caves was a tinaja containing perhaps 200 gallons of fresh water contaminated slightly by green algae and water striders, but with no evidence of water snails in or around it. Fig trees of moderate size were present, too, and might have been a small source of edible fruit for the Indians who once lived here, or visited the place periodically to dive for the large oysters, clams, and conches with which they had littered the hillsides.

At least four different kinds of lizards were seen along the canyon and on the rocks at its mouth. Representatives of the genera *Sceloporus, Uta, Cnemodophorus,* as well as a larger lizard that resembled a chuckwalla, were seen, but only a large fence lizard (*Sceloporus*) and one specimen of *Uta* were collected.

The cruise down the west side of Isla Espíritu Santo and across the channel to La Paz was comfortable and interesting, for the late afternoon sun showed the many stratified layers of volcanic ash, lava flows, and basaltic caps to advantage, emphasizing the bright colors of the pink, greenish, and gray layers in contrast to the dull gray-black of the basalt. The sea was an indescribable blue, fairly calm, and constantly changing.

## Final Phases of 1959 Field Operations

Tuesday morning, December 8, Miss Carter stayed in La Paz, instead of going to Loreto to carry on field work there, because the landing strip at Loreto was too wet for use. There had been a brisk shower during the night, and the threatening clouds at La Paz indicated the approach of the front that had closed the Loreto airport. Dorothy Wiggins accompanied Dr. and Mrs. Krutch on the northbound plane, and Mr. Ernst remained with Ira to share the driving when field work for 1959 should be terminated a few days later.

No field work was attempted on either the 8th or 9th, owing to the unsettled weather, but the showers provided an opportunity to give close attention to the presses and keep drying processes going steadily.

Shortly before daylight on the 10th, the rain stopped, and Wally, Miss Carter, and Ira Wiggins drove to Arroyo León, where Dorothy and Ira had seen the palm trees on an earlier trip. Rain was falling again by the time Arroyo León was reached, so collecting activities had to be postponed. On December 11 all intermediate collecting sites between La Paz and Arroyo León were ignored until the car was parked at the top of the trail leading to the bottom of the canyon. An amazing richness of botanical material was lining the steep slopes and cliffs flanking Arroyo León. Among the plants growing there was a fine colony of *Bouvardia alexanderae,* an attractive member of the Rubiaceae Miss Carter had described several years earlier from plants collected near El Saltito on the road between La Paz and Las Cruces. The site in Arroyo León is the second one known for this species, and Miss Carter obtained a generous supply of seed for experimental purposes. Nearly 40 species were represented among the specimens collected in Arroyo León in about three hours.

There was another deep, intriguing canyon about a mile south of Arroyo León, but there was insufficient time to investigate it on the 11th. Variation in the botanical composition of plant cover in canyons separated by a mile or less is often sufficient to make intensive work from ridge to ridge and canyon to canyon well worth the effort. Several localities in the vicinity of Arroyo León needed to be checked carefully to ascertain the extent of these variations.

Mr. Ernst and Ira Wiggins spent December 12 packing specimens and equipment for the drive north, and at 3:00 p.m. on the 13th they left La Paz. Only one stop of consequence was made between La Paz and the end of the pavement at Kilometer 212. It was to search for more adequate fossil wood material near Rancho San Hilario. The search failed to locate the main log or logs, but approximately five pounds of small pieces were picked up along the bottom of the gulley.

An abortive attempt was made to drive through the Sierra de la Giganta from Santo Domingo to Loreto, but that route had to be abandoned about eight miles southwest of Misión San Xavier. Damage to the road during the chubasco had not been repaired, and fords across the stream were too deep for even the "Travelall" to get through.

La Purísima was entered on December 18, gasoline purchased, and the slow, northward journey continued. The road over the mesas and across canyons was rougher than it had been on the southbound trip for the rains on December 8 and 10 had made the tracks muddy, and trucks had cut deep ruts and chuckholes. The going was better in the broad valley running inland from the south end of Salina Cuarenta than it had been in October, because the rain had settled the powdery dust. It was necessary to drive over a torturing road skirting the lower slopes of basaltic talus the full length of Salina Cuarenta to avoid getting stuck in the mud.

The road inland from the northern end of Salina Cuarenta had been almost obliterated by the last rains. The erosion in this area had been severe. Some arroyos had carried five to eight feet of runoff, and pools two or three feet deep were still present in rocky parts of several arroyos twelve days after the rain ceased. The clear skies and daily breezes had done much to dry out the road, which was still soft in spots, but the thoroughfare still would have been difficult or impossible for most stock cars. However, none of the streams between Arroyo San Raymundo and San Ignacio contained running water, where the road crossed them, between December 18 and 21. As nearly as could be determined, the "Travelall" was the third car to make the trip between La Purísima and San Ignacio after the rains, and both trucks had very heavy going.

Monday, December 21, camp was set up near Rancho Caracol, north of San Ignacio, and the next night about five miles south of Rancho Mesquital, where the glow from lights at the salt works an Laguna Guerrero Negro could be seen low on the horizon to the west. The 23rd, camp was made near a spot five miles north of Punta Prieta, where James I. McMurphy and Ira Wiggins had spent a night on their southbound trip in the early spring of 1931. During a brief stop at Punta Prieta for gasoline, Wally had asked a local patriarch if the threatening clouds would bring rain during the night. The old man assured him that there would be no rain that night, although there probably would be "a little rain" late the following day.

At midnight rain began to fall. About an hour later it was apparent that it was not a passing shower, so camp was struck, the gear loaded, and the "Travelall" driven northward over muddy, slippery, rough road. The ranch at Laguna Chapala Seca was reached at daylight, gasoline obtained, and the advice of the owner to continue via the road to San Felipe instead of toward Cataviñá and Rosario accepted. The old gentleman thought the

"Travelall" would have no trouble on the grades, and that San Felipe might be reached by dark that night.

Contrary to the ranchero's estimate, San Felipe was reached not the evening of the 24th, but after dark Christmas night! Rain and high wind hampered progress on the 24th, and good collecting in the southern San Felipe Desert prevented rapid travel on Christmas Day. The wealth of herbaceous growth, mostly of plants not yet in flower, augured well for a wonderful botanical display a month or six weeks later. Several areas between Laguna Chapala Seca and San Felipe were noted that should be examined after the young plants matured. Mr. Ernst made collections of herbarium specimens and cytological material from two species of *Eschscholzia* in the southern San Felipe Desert, an area from which such collections had not been obtained previously.

Wally and Ira reached Stanford University late in the evening of December 26, with three plant presses filled with specimens collected between Laguna Chapala Seca and San Felipe. In the interim between December 8 and 24 a special field project sponsored by the Belvedere Scientific Fund had been completed.

## Boojum Tree Project

On the flight north on December 8, the plane landed at Bahía de Los Angeles to permit Dr. Krutch to await arrival of Lew Walker and Karl Embrey. These men drove a second "Travelall" southward along the gulf side of the peninsula from Mexicali to Bahía de los Angeles, were joined by Dr. Krutch, and the three then drove north to El Mármol to observe the *Idria* forest and to relocate and rephotograph several *Idria* trees Lew Walker had photographed ten years earlier. Ten trees had been photographed in 1949, and Lew was anxious to learn what changes had taken place in the size and shape of these peculiar trees.

Mr. Walker had taken meticulous notes on the location of the trees, and his notes, aided by his remarkable memory for topographical features, made it possible for him to find all save one or two of the original ten. Unmistakable changes had occurred in the decade between the two series of photographs, but changes in other vegetation, such as nearby *Yucca* and Creosote Bush plants, were much more marked than those in the *Idria* trees. The data obtained by this group are believed to be the first record of this type for the "Boojum Tree" or *Idria,* and constitute valuable information about the growth rate and longevity of this weird plant.

After locating the selected Boojum Trees, the party returned to the road cutting across the mountains from Laguna Chapala Seca, drove to Bahía de San Luis Gonzaga, and then back to Tucson, Arizona. On this, as on other trips, the "Travelall" stood up well and demonstrated its value and reliability as an exceptionally sturdy field vehicle.

## Dinosaur Scouting Trip

Two graduate students in the Department of Paleontology at the University of California, Frank H. Kilmer and Dale A. Russell, applied to the Belvedere Scientific Fund for support to make a preliminary field survey to an area in Baja California reputed to contain skeletal material of dinosaurs. Their objective was to determine the extent of the deposits, and the probable amount of fossil dinosaur and other vertebrate material present. They believed a preliminary survey would determine whether or not the area held enough promise, paleontologically, to warrant one or both of them basing work toward a Ph. D. thesis on the stratigraphy and paleontology of the region.

Use of a second "Travelall" and financial aid were extended to Kilmer and Russell in mid-December, and the two men spent 29 days consulting specialists in southern California and doing field reconnaissance in Baja California. The field work, which extended into January, 1960, revealed enough fossil material to warrant extensive and detailed study of the sections under consideration. However, problems surrounding transportation and field support influenced both men to abandon the plan for doing intensive work in northern Baja California in partial fulfillment of the requirements for the Ph. D. degree, and the project was carried no farther.

## General Observations

**Weather and Collecting Conditions.** Weather conditions in Baja California are favorable for field work much of the year. During the summer months, particularly in August and September, torrential rains and winds of high velocity sometimes sweep the southern half of the peninsula. Heat is trying through the peninsula, except in the higher mountains, during the summer months. Gentle, intermittent rains fall during the late fall and winter, but their geographical distribution is spotty and unpredictable. Thunderstorms occur commonly during summer in the Sierra San Pedro Mártir. Rain, in most cases, rarely hampers the field worker for more than a few days at a time, and often brings welcome respite from long periods of hot weather.

Botanical collecting is good in the southern part of the peninsula following the summer rains, and in the months of January, February, and March in the Cape Region following the winter rains. In the waist of the peninsula, botanical collecting is good after any rainy period, but rains are unpredictable, both as to timing and amount, so it is highly desirable to correspond with people living in the region before one plans a field expedition. Such inquiries usually provide information about the condition of the vegetational cover.

The herpetologist finds collecting discouragingly poor during the cooler months, and gets comparatively little between November and March in most parts of the peninsula. By the latter half of March the reptiles begin to move about, and from that time into autumn, activity is high, with both diurnal and nocturnal forms occurring in many habitats. The collections obtained during the unfavorable parts of the year, however, are of more than ordinary interest, for a trained ecologist gains valuable information from the list of animals not taken as well as from the ones captured during the winter months. Thus Dr. Leviton's specimens taken in December and January supply information lacking in some earlier herpetological collections from the Cape Region.

Entomologists, ornithologists, and mammalogists have learned to arrange their field operations at different times of the year, depending on the area to be explored. They find different groups of animals active in a particular area in different seasons. Ornithologists often time their work to coincide with the migration habits of the birds.

Mr. Leech found an abundance of water beetles at the few spots where permanent water, or ponds of more than a few days' duration, occurred. He could have extended the period of profitable collecting considerably had it been practical to penetrate canyons along the western flanks of the Sierra de la Giganta, for streams there flow the year around.

During 1958-59 the precipitation was extraordinarily heavy in the southern half of Baja California. Consequently, biological collecting of all land and fresh-water organisms was remarkably good. There may not be another period with so much rainfall over such an extended period during the lifetime of any of the workers who got into the field from September, 1958, through 1959! It was a stroke of tremendous good fortune that the series of field trips outlined in this paper could be staged at this propitious time.

Field Equipment. The field equipment with which the various parties went into the field was good. Some minor details can be improved, and certain things perhaps eliminated in order to reduce transportation problems. The vehicle used, an International Harvester "Travelall" of the "120" series, equipped with locking hubs on the front wheels and an all-wheel drive transmission, plus a sturdy winch mounted on the front bumper, was eminently suitable. It had sufficient power to pull over the steepest grades encountered; the four-wheel drive helped innumerable times in mud and soft sand. The winch was used mainly to pull other cars out of the road when they had broken down and blocked the road to other traffic.

Some weaknesses in the frame and the metal parts of the body developed after the car had been driven over particularly rough, rocky terrain. The cross member under the rear of the engine broke in two near Santa Rosalía and had to be welded, as Dr. Thomas and Dr. Moran drove north in May of 1959. Overload springs are recommended if the field party is carrying supplies and gear for an extended stay. If a sixth tire is carried, it should be mounted on a rim.

If gear is to be carried on the roof of the "Travelall" a sturdy luggage platform must be constructed to fit the car. Commercial, ready-built ones are inadequate and break down almost as soon as rough road is encountered. A custom-built platform should be bolted to the top through the gutters above the doors only, not through the metal forming the top. The bearing surfaces of the cross members should be contoured to fit the curve of the top and cushioned with strips of leather or some wear-resistant gasket material.

Most field workers, particularly those who need to use pack animals, will find it an advantage to have boxes of lightweight but sturdy construction built to fit into the back of the vehicle and properly proportioned to be tied to a pack saddle. Such boxes, made of plywood, fastened with screws and glue, should have hinged tops and a hasp to close the container. A strip screwed to each end, or ropes threaded through holes in the ends, might be helpful in securing the boxes to the pack. Larger storage boxes for extra supplies, and in which specimens can be stored after the supplies have been used, may be highly desirable.

During most trips, tents have been unnecessary and if carried are usually excess baggage. One large tarpaulin, about 12 × 16 feet, and several smaller ones, about 6 × 8 feet or 8 × 10 feet, should be carried to protect personnel and gear against occasional showers, heavy dew, or unseasonable low temperatures. There is nearly always need, sometime during a trip, for extra rope and for iron wire. Gasket material to prevent leakage from water and gasoline cans should be carried.

A new type of water-purifying tablet seems superior to those used previously. This tablet frees iodine when placed in the drinking water, and normally each tablet effectively treats one quart of water.

## Resumé

By the end of 1959 three major field expeditions had been put into the field, and seven reconnaissance or special emphasis trips of short duration completed. Nineteen scientists and their assistants carried on field work in Baja California under the auspices of the California Academy of Sciences and with support from the Belvedere Scientific Fund and its founders. The total number of man-days devoted to field investigations of the natural history of Baja California during these expeditions is impressive. Approximately 820 man-days were invested in the project by the scientists and their aides. This does not include time given to preparation for the expeditions or in organizing, naming, and studying the specimens collected.

As a result of the field work, more than 20,000 sheets of herbarium specimens were collected, several hundred herpetological specimens obtained, critical insects, and valuable collections of water beetles had been obtained by Mr. Leech and Mr. Patterson, and valuable malacological specimens secured by Dr. Hanna, Dr. Keen, and Mr. Smith. Important information had been recorded bearing on the ecology of the peninsula, its geological and topographic features, and on the various segments of its natural history represented by the field operators. Several papers dealing with certain aspects of botany, malacology, ornithology, and herpetology had been prepared and awaited publication by the year's end.

The "Travelall" purchased in the fall of 1958 covered 17,270 miles between its purchase and the end of 1959. About 12,000 miles of this distance was in Mexico, nearly 10,000 of them over unpaved roads. It went into the shops for checking and repairs at the end of each major trip, and was used in Baja California again in the early part of 1960. Its dependability placed it high in the esteem of those who drove, or rode in, it. Its riding qualities on rough road left something to be desired.

During the field operations the scientists were blessed with excellent equipment and logistic support through the generous aid given by the Belvedere Scientific Fund, by its founders, and by Dr. Robert C. Miller and members of the staff of the California Academy of Sciences. Sound advice and suggestions from scientists and others interested in the work, contributed greatly to the success of field operations. Their support is appreciated greatly by each participant in the field work.

## Suggestions for Further Field Work

By the end of 1959 the Cape Region of Baja California had been covered with sufficient frequency and thoroughness for the botanists, at least, to believe that, except for special groups of plants and for a few small areas, the point of diminishing returns had been reached. The same was true for the narrow strip through which the main north-south road from Tijuana to San José del Cabo is routed. The western slopes of the Sierra San Pedro Martír, and the immediate vicinity of several major towns, probably have been covered with reasonable thoroughness. The Magdalena Plains are well known, botanically, but the foothills lying to their east, the total length of The Sierra de la Giganta, the western part of the Desierto Vizcaíno, the mountains between Santa Rosalía and Bahía de los Angeles, the area near the Pacific Coast from the latitude of Punta Prieta north to the proximity of El Rosario, and the mountains adjacent to the southern parts of the San Felipe Desert all need much more exploration. Not only are these areas poorly known botanically, but the fauna of much of the territory is incompletely known. Even the Sierra Juarez and the Sierra Pinal, lying between the northern end of the Sierra San Pedro Martír and the International Boundary, still need careful exploration.

There is much yet to do on the islands in the Gulf of California, despite the several expeditions that have put collectors ashore on most of them during the past half century. Intensive, canyon to canyon and ridge to ridge exploration needs to be carried out on most of the islands of the Gulf, and those along the Pacific Coast of Baja California can, in the main, be given additional attention with profit. Much has been accomplished, but much remains to be done on the natural history of the region.

Field work continued into 1960, and further expeditions are planned for later in that and in subsequent years. It is believed that three to four years devoted closely to the natural history of the peninsula will reveal the main patterns of the web of life as it exists there today. Interpretations of some of the puzzles will, no doubt, be available by the end of such a period. Others will still vex, intrigue, and delight natural scientists for generations to come. There will long be work for scientists to do in Baja California.

The plates accompanying this report were prepared by the following members of the Academy: C. E. Crompton, M. C. Giles, G. D. Hanna and Margaret M. Hanna. The process used was developed by the Research Department of Eastman Kodak Company.

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# WEST AMERICAN SPECIES OF THE BIVALVED GASTROPOD GENUS *BERTHELINIA*


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## Introduction

So synonymous are the terms "bivalves" and "pelecypods" in our minds that even the layman is disturbed by the phrase "bivalved gastropod," feeling it is somehow contradictory. The detection of these unorthodox snails by a Japanese zoologist, Dr. Siro Kawaguti, in 1959, was a dramatic moment in malacology. It was, however, the second of two noteworthy molluscan discoveries of recent years that have opened new windows toward the past and have modified the standard classification. The first and major find, of course, was *Neopilina*, a limpet-like mollusk showing segmentation of its soft parts, which was dredged in very deep water off the west Central American coast (Lemche, 1957). Although such mollusks did not seem as newsworthy in the popular press as, say, the coelacanth (a fish supposedly extinct since Jurassic time), *Neopilina* actually was more astonishing, for its ancestors left their last trace in the fossil record during mid-Paleozoic time. Recognition of a separate molluscan class, Monoplacophora, resulted.

The bivalved gastropods turn out also to be living fossils, though not of such antiquity. No new major category must be erected, but several genera hitherto assumed to belong in Pelecypoda now must be shifted to Gastropoda, so that in effect a new definition of the dividing line between these two molluscan classes is required.

The first report on the Japanese discovery appeared late in 1959; within the year since, a half-dozen papers on the subject have been published and more are in press. This literature has been summarized by Keen (1960b); a paper by Burn (1960b) appeared later.

The present report covers west American occurrences of the bivalved gastropods, with a review of species elsewhere and an attempt at classification of the group as a whole. Dr. Kawaguti has already investigated the soft parts of the Japanese form and the developmental stages of the animals. A cursory examination of soft parts of our material reveals no evident differences and so we will confine our study to the shell alone, leaving for interested zoologists a more detailed comparison of the two.

The bivalved gastropods are mostly small, the shells ordinarily less than 10 mm. in maximum length, the animal itself being not much longer in its extended position. These snails feed on green algae of the genus *Caulerpa*. Both the tissues of the animal and the shell itself take on the same shade of green as the alga, making detection of the living animals in place very difficult. The left valve bears a spiral nucleus, which is retained throughout life. Within, there is a conspicuous subcircular central muscle scar. A thin periostracum covers both valves, which peels off readily if the valves are left in water after the animal dies. At the dorsal junction or hinge of the two valves the periostracum thickens and forms a crude ligament that is set into vague notches. The second valve is not a modified operculum, as one might hastily assume. Dr. Kawaguti (1960), who has kept several generations of the animals in his laboratory, shows that the second valve appears between the third and seventh days of larval life as an area of calcification alongside the left margin of the aperture. Two separate lobes of shell material continue growth, held together by the periostracal layer.

More than one author has, in the past, described species and genera that we now see are related to the Japanese find. When single left valves were all that were known, the species were assigned to Gastropoda. Bivalvedness has been so taken for granted as the hallmark of Pelecypoda that no one has questioned the propriety of transferring these species and genera out of Gastropoda whenever matching valves came to light, although some comment would usually be made as to the remarkable resemblance of the shells to those of opisthobranchs. Without the evidence of soft parts, any other course would have been unthinkable. Thus, when the Japanese authors Kawaguti and Baba came to describe their find, they were not in a position to question the placement of such a group as *Edenttellina*, an Australian genus of supposed pelecypods, and they merely called attention to its superficial resemblance to the genus *Tamanovalva*, which they proposed as new. Their description sparked a fresh search for a living example of *Edenttellina*, which, when found, proved to be a gastropod, as did also a west American form. With this evidence, we can now infer that certain fossils with similar shell form, supposedly pelecypods, classified hitherto in Galeommidae and Juliidae, actually belong in Opisthobranchiata, in a specialized division known as Sacoglossa, of which the genera *Oxynoe* and *Lobiger* have been the best-known representatives. Interestingly, all of these snails seem attracted to the green alga *Caulerpa*.

Reviewing these named groups and noting the general similarity of form among both the fossil and the Recent genera, one is tempted to regard them all as probable synonyms of the earliest, which would be *Berthelinia* Crosse, 1875. However, a closer study of the illustrations and of available material reveals that there are detectable, though slight, differences. How significant these are we cannot at present say, until more material can demonstrate whether the differences are merely points in one variable plexus or represent genuine divergences in the evolution of these snails. It has seemed best to us, therefore, to retain these named taxa – insofar as possible – as subgenera.

## Review of the Classification

Subclass OPISTHOBRANCHIA Milne-Edwards, 1848
Order SACOGLOSSA Von Ihering, 1876
Suborder TAMANOVALVIDA Kawaguti and Baba, 1959
(*ex* Tamanovalvacea Kawaguti and Baba, 1959)
Family JULIIDAE Dall, 1898
(= Prasinidae Stoliczka, 1871)

Small, bivalved, greenish shells, with a more or less well developed spiral nucleus in the left valve, posterior to the vertical mid-line; interior with a subcentral adductor muscle scar that may be partially or completely divided (*i. e.*, either circular or hour-glass-shaped).

### Subfamily JULIINAE

Cordate shells with a heavy hinge having a prominent tooth-like ridge in one valve and a fossette-like fold in the other; apical nucleus present in young stages, obsolete in adult; adductor scar with a central constriction or even divided into two parts, one above the other.

The type genus, *Julia* Gould, 1862 (synonym, *Prasina* Deshayes, 1863), is widely distributed in the Pacific. Its type species is *J. exquisita* Gould, from Hawaii. Although several species of *Julia* have been reported – from Madagascar to Japan and the west coast of Central and South America, as well as from fossil strata of Oligocene and Miocene age in Europe and the Caribbean – little is known about habits and ecology. The assignment to Gastropoda is on the basis of the analogy of the shell to that of other known bivalved gastropods.

## Subfamily BERTHELINIINAE Beets, 1949

Shells lenticular in shape, ovate to quadrate, with a weak hinge; spiral nucleus in one valve retained in the adult; adductor muscle scar central, undivided, circular.

### Genus **Berthelinia** Crosse, 1875.

*Berthelinia* Crosse, 1875, Jour. Conchyl., vol. 23, p. 79

Type species. *B. elegans* Crosse, 1875, by monotypy. Middle Eocene, Paris Basin, France.

Diagnosis. Left valve with spiral nucleus; right valve slightly smaller, without spiral apex; outline of shell somewhat quadrate. Color of shell, in living forms, greenish to yellowish.

Remarks. The type specimens of *B. elegans* are in the collection of the *Journal de Conchyliologie*, Paris. Dr. Edouard Fischer reports (letter dated 15 October 1960) that of the original five specimens catalogued in 1898 only two are extant, the larger measuring 1.5 mm. in length. Three other specimens have been available to us for study, in the Cloez collection, Museum of Paleontology, University of California, Berkeley. These, like the specimens examined by Dr. Fischer, match well the original illustration in the *Journal de Conchyliologie* (vol. 23, pl. 2) and those by Cossmann reproduced here (figs. 7, 8).

### Subgenus **Berthelinia**, s.s.

Diagnosis. Posterior end of shell somewhat set off by a ventral sinuosity. Size, minute (2 to 3 mm.). Hinge plate in left valve widened at ends, without teeth but with faint corrugations.

Additional species.

*B. elegans elata* Cossmann, 1888. Upper Eocene, France.

*B. schlumbergeri* Dautzenberg, 1895. Recent, Nossi-Bé, Madagascar

*B. elongata* Cossmann, 1906. Eocene, France.

The last two species are referred to *Berthelinia s. s.* with some reservation, as we have not seen specimens.

### Subgenus **Ludovicia** Cossmann, 1888, *ex* Deshayes MS.

*Ludovicia* Cossmann, 1888. Ann. Soc. r. Malac. Belgique, vol. 22 (for 1887), page 45.

Type species. *L. squamula* Cossmann, 1888, by monotypy. Middle Eocene, France. (Word has just been received from Professor Edouard Fischer that the holotype of *L. squamula* cannot be located and is presumed lost.)

**DIAGNOSIS.** Hinge weak to edentulous, with posterior dorsal margin widened and somewhat reflected; outline of shell inequilateral, rounded-trigonal to oblique; size of shell, large for the genus (to 15 mm.).

**REMARKS.** Type material of *Ludovicia* was not available for this study, but a single left valve in the Cloez collection, Museum of Paleontology, University of California, furnished valuable information. This specimen measures 6.5 mm. in length, less than half the size cited by Cossmann. The tip of the nucleus is broken off. The hinge is narrow but shows a slight prominence along the margin that might be interpreted as an incipient tooth. The central muscle scar, not shown by Cossmann, is apparent (figs. 25,26). Otherwise, the shell matches Cossmann's illustration well (figs. 3,4).

Subgenus **Anomalomya** Cossmann, 1888.

*Anomalomya* COSSMANN, 1888, Ann. Soc. r. Malac. Belgique, vol. 22 (for 1887), p. 169.

**TYPE SPECIES.** *A. corrugata* Cossmann, 1888, by monotypy. Upper Eocene, France.

**DIAGNOSIS.** Hinge with a fossette at posterior end in right valve, a tooth in left. Outline somewhat rounded. Size moderate (5 to 6 mm.).

**ADDITIONAL SPECIES.** An unnamed form (*fide* Burn, 1960b, p. 45) in South Australia, figured by Hedley (1920, figs. 1-5) as *Edenttellina typica* (figs. 11-15), would seem to belong here (see figs. 9, 10 for a reproduction of Cossmann's original figure of *A. corrugata*).

Subgenus **Edenttellina** Gatliff and Gabriel, 1911.

*Edenttellina* GATLIFF and GABRIEL, 1911, Proc. R. Soc. Victoria (n.s.), vol. 24, page 190.

*Tamanovalva* KAWAGUTI and BABA, 1959, Biol. Jour. Okayama Univ., vol. 5, pts. 3-4, p. 178 (type species, by monotypy, *T. limax*, Recent, Japan).

**TYPE SPECIES.** *E. typica* Gatliff and Gabriel, by monotypy. Recent, Victoria, Australia.

**DIAGNOSIS.** Hinge as in *Berthelinia*, strict sense, but with the hinge plate more nearly uniform in width, the outline of the shell more rounded, tending to be trigonal in adult with at most only a slight ventral sinuosity. Size, moderate (to 9.5 mm.).

**ADDITIONAL SPECIES:**

*Scintilla? chloris* Dall, 1918. Magdalena Bay, Baja California.
*Edenttellina corallensis* Hedley, 1920. Queensland, Australia.
*Tamanovalva limax* Kawaguti and Baba, 1959. Japan.
*Berthelinia (E.) chloris belvederica* Keen and Smith, new subspecies, La Paz, Gulf of California.

REMARKS. Conchologically, the shells of *Tamanovalva* seem inseparable from those of *Edenttellina*. It is possible that anatomical differences may be found that will justify retention of *Tamanovalva* as a subgenus. As Burn has reported (1960b, p. 46), Dr. Baba has observed a distinction in the formation of the apices in the radular teeth, which may or may not prove to be significant when more material becomes available for study.

Genus **Midorigai** Burn, 1960.

*Midorigai* BURN, 1960, Nature, vol. 187, no. 4731, pp. 45-46. figs. 8-14.

TYPE SPECIES. *M. australis* Burn, by original designation. Recent, Victoria, Australia.

DIAGNOSIS. Outline nearly rectangular; spiral nucleus of left valve not erect but reflected backward over hinge margin; adductor scar composite, with a flange that rises to a smaller scar under the hinge.

REMARKS. The inclined and flattened nucleus is so distinctive that this group may prove worthy of generic separation, as its author proposed. However, the muscle scar pattern (which unfortunately was not illustrated) seems to be at least simulated in some specimens of *Berthelinia chloris belvederica,* in which a faint line can be traced from the end of the central scar up to a smaller one under the margin of the hinge.

## WEST AMERICAN BERTHELINIINAE

**Berthelinia (Edenttellina) chloris chloris** (Dall), Text figure 20.

*?Scintilla chloris* Dall, 1918. Proc. Biol. Soc. Washington, vol. 31, p. 5.

*Scintilla (?) chloris* Dall. Keen, 1958, *Sea Shells of Tropical West America,* p. 108, fig. 235. (Figure of presumed type specimen).

TYPE LOCALITY. Magdalena Bay, Baja California, C. R. Orcutt, collector.

REPOSITORY. U.S. National Museum, No. 218179.

ORIGINAL DESCRIPTION. "Shell of a pale green color, translucent, with more or less evident paler rays, the umbo darker than the rest of the disk; inequilateral, rather compressed, the posterior end wider, longer, rounded; the anterior end shorter, attenuated; the exterior polished, with slight concentric irregularities of growth, and extremely faint, partly obsolete radial striulae; hinge with a long amphidetic ligament in front of which in the left valve is a single noduliform denticle, and behind which is a feebly indicated lateral lamella; the scar of the ligament is long and narrow, there is no evident division into ligament and resilium which might perhaps be visible in a perfectly fresh specimen. The interior of the disk is so polished that the muscular and pallial scars are not distinguishable, but under the microscope a sparse punctation can be made out; the margins are entire. Length of valve, 9.0; length of the part in front of the vertical from the umbo, 3.0; height, 6.0; double diameter of the left valve, 2.0 mm. ..Two left valves were obtained. . . .''

**Remarks.** The discrepancy between Dall's mention of two left valves and the obviously opposite valves in the photograph of the presumed type at the U.S. National Museum – sent upon request for publication in 1958 – came to light with the intensive study of newly collected material in Baja California. Dr. W.P. Woodring kindly made a restudy of the type lot and reported (letter to A.M. Keen dated February 16, 1960) that the two matching valves (apparently a pair but with the "right" one [upper figure in Keen, fig. 235] chipped along the ventral edge) are now labelled "Type," No. 218179, but were entered in 1918 merely as "*Scintilla*" and as "½ specimen," or one valve. A smaller "left" valve now labelled "Paratype," No. 610355, was entered in 1958 as "*ex* 218179." The three shells are practically transparent, and the only color seems to be from a thin and irregular coat of shellac, applied for preservation. Dimensions as taken from the photographs would be: "right" valve, length, 8.8, height 5.8 mm.; "left" valve, length, 8.4, height, 5.6 mm. These dimensions, though differing from Dall's statement, are proportional to his 9.0/6.0. The problem raised by the additional valve perhaps is resolved by a specimen now at the California Academy of Sciences (fig. 20) from the Orcutt Collection. It is from Magdalena Bay and carries an original label in Dall's handwriting: "*Scintilla*, n. sp." We interpret this as being one of the two original "left" (actually, right) valves, a conclusion strengthened by the fact that this specimen exhibits the paler rays mentioned by Dall. This and the "½ specimen" of U.S.N.M. No. 218179 would constitute the original lot. Perhaps by the time Orcutt received back his submitted specimen, he had sorted out more valves and then forwarded them to the National Museum to supplement the single valve remaining there. Dimensions of the California Academy syntype are: length, 9.4 mm., height, 6.5 mm., diameter (one valve), 1.8 mm. Dall's stated dimensions seem to be the average for the two syntype "left" valves, but his "double diameter" of 2.0 mm. is at variance both with the California Academy specimen and with the evident degree of inflation shown in the photograph. Ratios used elsewhere in this paper are therefore computed from the measurements of the available California Academy specimen. The subcentral adductor muscle scar shows clearly when one knows where to look for it. The habitat of *B. chloris chloris* is not known, as Orcutt's material was obviously from beach drift.

**Berthelinia (Edenttellina) chloris belvederica** Keen and Smith, new subspecies.
(Figures 18, 19, 21-24, 27-32. Plate 5, lower figure.)

**Holotype.** No. 12317, Paleo. Type Coll., California Academy of Sciences.

PARATYPES. Paleo. Type Coll., CAS Nos. 12318, 12318a – c; No. 9172, Stanford Univ. Paleo. Type Coll. Other specimens in collections of California Academy of Sciences; U.S. National Museum; British Museum (Natural History); University of California Museum of Paleontology; National Museum of Victoria, Australia; Universities of Osaka and Okayama, Japan; Instituto de Biología, Mexico; Museum d'Histoire Naturelle de France; Museum of Comparative Zoology, Harvard; Academy of Natural Sciences, Philadelphia; National Museum of Canada; Zoologisk Museum, Copenhagen; Naturhistoriska Riksmuseet, Stockholm; and others.

TYPE LOCALITY. Puerto Ballandra Bay, about 10 miles northeast of La Paz, Baja California. Allyn G. Smith, collector, 4 October, 1960.

ADDITIONAL LOCALITIES. Espíritu Santo Island, on northern margin of Candelero Bay, about ½ mile south of Isla Partida, Myra Keen and Allyn G. Smith, collectors, 31 August, 1960; Puerto Ballena, Espiritu Santo Island, Myra Keen and María Luisa Valdez de Adcock, collectors, 19 December 1960.

DIMENSIONS. Holotype (largest specimen): Length, 8.5 mm.; height, 5.5 mm., convexity or diameter (both valves), 2.5 mm. Comparable measurements of an average-sized specimen: length, 5.8 mm., height, 3.9 mm., convexity (both valves), 1.6 mm. Ratio of diameter to height, 0.33 to 0.47, average 0.41.

DESCRIPTION. Shell small, thin, translucent green in color, with a whitish-iridescent sheen internally; periostracum nearly transparent, most evident along hinge margin, where it becomes thickened into a weak ligament; outline ovate-trigonal in adult, trapezoidal in young shells, the anterior end broadly rounded, the posterior more pointed, a slight radial angulation marking off a posterior slope in some specimens; sculpture of growth lines and a few faint radial striae; nucleus on left valve only, whitish, of 1¼ turns, sharply set off from the rest of the shell by a change in color and texture; adductor muscle scar relatively large; hinge weak, with a small amount of ligamental material and faint pitting of the shell rim.

COMPARISONS. Specimens of *B. (E.) limax* (Kawaguti and Baba) have been available for study, both as live animals and as preserved material (Smith, 1960a) through the courtesy of both authors. The most evident differences between the two species are in the smaller nucleus of *B. limax,* which has only a single turn, and the slightly greater inflation of the valves. Sample dimensions: length, 5.8 mm., height, 3.7 mm., diameter (both valves), 1.7; ratio of diameter to height, 0.46.

Judging from the illustrations of *B. typica* (Gatliff and Gabriel) recently published by Burn (1960b, figs. 1-7), that shell is more trigonal than in *B. c. belvederica,* with a more pointed posterior end and a nucleus that may be more conspicuous. Burn regards *B. corallensis* (Hedley) as a synonym of *B. typica.* He also points out that the figures by Hedley (which have formed the concept of *B. typica* for most malacologists) actually are of an unnamed form from South Australia. We suggest that it may belong in the subgenus *Anomalomya.*

The three specimens of *B. elegans* examined for this study as well as the original figures show a more trapezoidal outline than in *B. c. belvederica,* with more definite hinge structures, the hinge margin slightly pitted or denticulate; also, the shells are smaller, less than 3 mm. in length.

The identification of the present form simply as *B. chloris* (Dall) would seem logical, and in fact this was our determination for the first valve, taken in beach drift on Espíritu Santo Island in November, 1959. It was thought to be a young specimen and to constitute an extension of range from Magdalena Bay, on the outer coast of Baja California. However, statistical comparison of the available syntype with a growth series of the La Paz material convinces us that they are significantly different. The largest shell of typical *B. chloris* is a full millimeter longer than the longest one of *B. c. belvederica.* This might not be a constant difference, but the difference in convexity is, for the valves of *B. c. belvederica* are flatter at every stage of growth. The height-diameter ratio for *B. chloris chloris* is 0.55, as compared to 0.46 for *B. limax* and 0.33 to 0.47 (average 0.41) for *B. c. belvederica.* Also, the hinge of the *B. c. chloris* is markedly wider and stronger, with a prominent lamellar tooth at the posterior end. Figures 18 and 19, drawn to the same scale, show the contrast. It would seem, then, that there are two forms of *Berthelinia* in Baja California, the one on the inner coast, the other on the outer.

**Habitat.** Living specimens of *Berthelinia* were first taken in the La Paz area on 30 August, 1960, at an 8–foot depth close to shore among large blocks of volcanic agglomerate broken from an adjacent rock wall at the north edge of Candelero Bay, Espíritu Santo Island, one-half mile south of Isla Partida. A small, loose clump of a feathery type of green alga (*Caulerpa sertularioides* [Gmelin] Howe) was brought up from the bottom by Sra. María Luisa Valdez de Adcock, which on careful search produced several small specimens. This type of alga being more prevalent in the sand and on dead coral chunks of the bay floor, about 100 yards to the south, further effort was concentrated there. Masses of the alga *Caulerpa* were brought up from depths of 5 to 8 feet. More living specimens were noted, as also a few living sacoglossan opisthobranchs of the genus *Oxynoe* (probably a new species). Water temperature was 82–84° F., air temperature about the same.

Some of the living specimens of *Berthelinia* were placed in a gallon-sized thermos jug, with an ample supply of the alga, for transportation to San Francisco by plane the following day. The remainder of the algae collected was transferred to plastic sacks, for more careful sorting. Unfortunately, the living specimens of *Berthelinia* and *Oxynoe* did not survive, for the *Caulerpa* was thickly inhabited by small sea anemones that,dying, fouled the water. The number of berthelinias later recovered amounted to around 35.

Quantities of minute mollusks also were found in the debris and some nudibranch egg masses, all of which were preserved for future study.

Another opportunity to try for living specimens of *Berthelinia* came on 4 October, 1960. At this time a search was made in Puerto Ballandra Bay, on the mainland of the peninsula north of La Paz. The sand of this bay did not have the masses of the feathery type of Caulerpa, although small patches of it were growing on the volcanic rocks in shallow water near the north end of the sand beach. This form of *Caulerpa* was clean of the troublesome small anemone. Careful search produced no specimens of *Berthelinia*. In the same general area, small patches of a second species of *Caulerpa, C. racemosa* (Forskal) var. *turbinata* (J. Agardh) Eubank, occurred growing along the sides of and between the boulders. This was a "bunch-of-grapes" type, similar in its dark blue-green color and general characters to the Japanese *Caulerpa okamurai* brought by Dr. Kawaguti, differing only in that many of the terminal branches have a flat, disk-like end. Berthelinias were discovered on this alga in some quantity, ranging in size from juveniles to one adult with a shell length of 8.5 mm., which was selected as our type specimen. Water temperature at this location was 82–83° F., air temperature 84° F. Except for the warmer water, conditions here were precisely those described by Kawaguti in Japan and by Burn in Victoria, Australia. A fair-sized sample of the alga from Puerto Ballandra Bay was brought back to San Francisco for further scrutiny, and from it a total of more than 100 specimens was obtained, with more of *Oxynoe* and several specimens of a grayish nudibranch about an inch long.

## Explanation of Figures

Figs. 1, 2, 5, 6. *Berthelinia elegans elata* Cossmann. Le Ruel, Upper Eocene, France. × 10. (After Cossmann, 1888, pl. 7, figs. 24-27). Page 50.

Figs. 3, 4. *Ludovicia squamula* Cossmann. Parnes, Middle Eocene, France. × 1-½. (After Cossmann, 1888, pl. 2, figs. 21-22). Page 50.

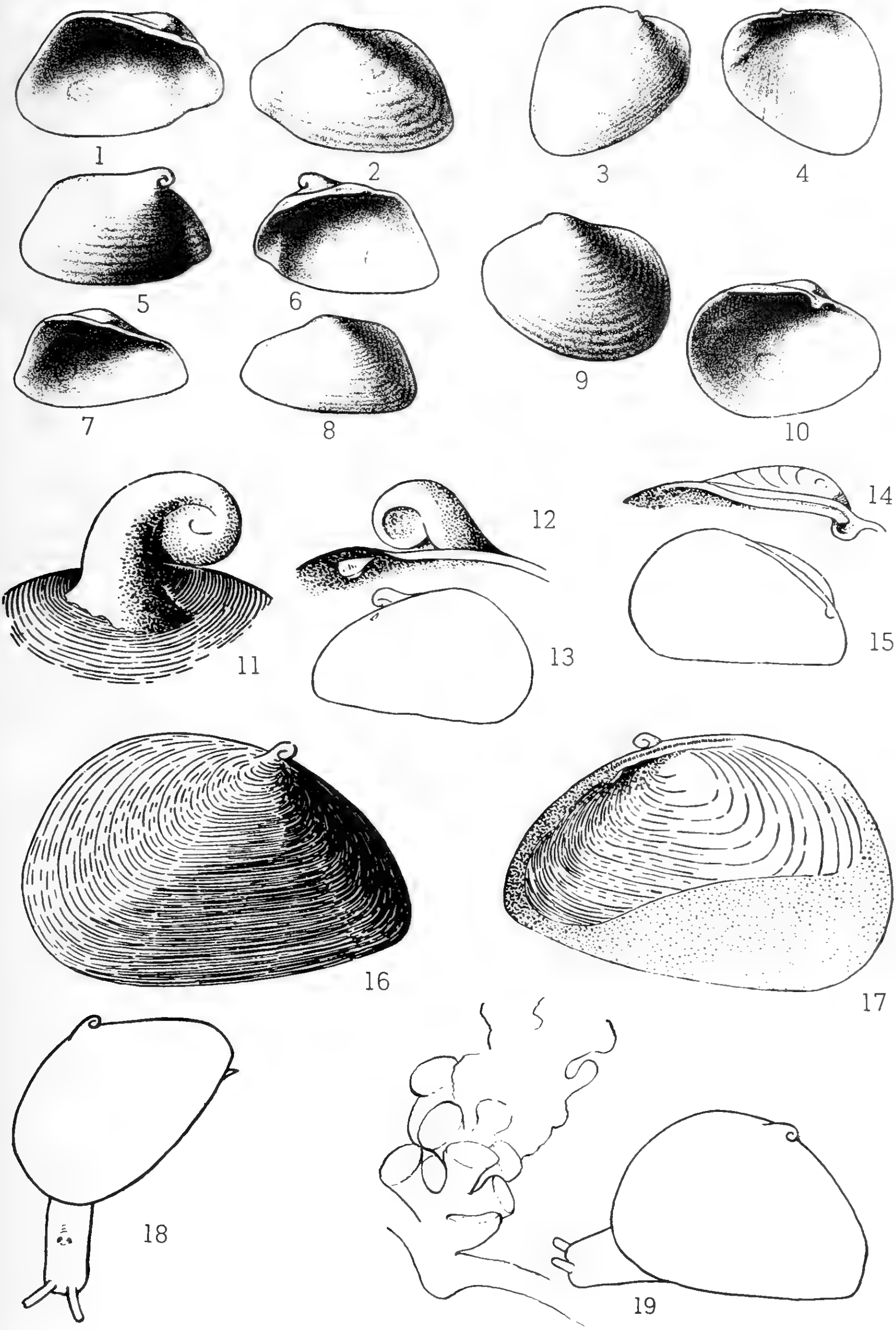
Figs. 7, 8. *Berthelinia elegans* Crosse. Holotype, Courtagnon, Upper Eocene, France. × 10. (After Cossmann, 1888, pl. 7, figs. 28-29). Page 50.

Figs. 9, 10. *Anomalomya corrugata* Cossmann. Le Fayel, Upper Eocene, France. × 4. (After Cossmann, 1888, pl. 7, figs. 31, 30). Page 51.

Figs. 11-15. *Berthelinia (Anomalomya)* sp. Recent, South Australia. Length, 5 mm. (After Hedley, 1920, figs. 1-5). Page 51.

Figs. 16, 17. *Berthelinia (Edenttellina) corallensis* (Hedley). Recent, Queensland, Australia [= *B. (E.) typica* (Gatliff & Gabriel), *fide* Burn, 1960] × 10. (After Hedley, 1920, figs. 7-8). Page 51.

Figs. 18, 19. *Berthelinia chloris belvederica* Keen & Smith, new subspecies. Enlarged drawings of living animals in the active stage from color slides taken in the field. Page 53.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Living specimens of *Berthelinia* and *Oxynoe* were photographed on board a boat at the site of collection, using an Exakta camera with extension tubes and electronic flash. Photography under improvised conditions proved difficult, mainly because the animals were so active, crawling over each other and either getting out of focus or spoiling the composition of the picture.

A second attempt was made to bring back specimens of both genera alive for laboratory observation, again unsuccessfully. Perhaps too much of the *Caulerpa* was put into the thermos jar in relation to the quantity of water.

On 18 December, 1960, six additional specimens were found on *Caulerpa racemosa* in Candelero Bay. These algae occurred sparingly in surge channels on the seaward side of a rock reef exposed at moderately low tide. The specimens ranged in size from 2.8 to 8.5 mm. in length. The next day four more were taken in Puerto Ballena, about a mile south of Candelero Bay, again on *C. racemosa,* which here grew in the closest possible association with the more abundant *C. sertularioides,* being intercalated among it on small rocks at the outer edge of a flat, shallow bay. Later, three more specimens of *Berthelinia* were picked out of dried samples of another green alga, *Halimeda* sp., that had been taken in slightly deeper water near the entrance to Puerto Ballena. Scrutiny of the live *Halimeda* material failed to reveal any mollusks

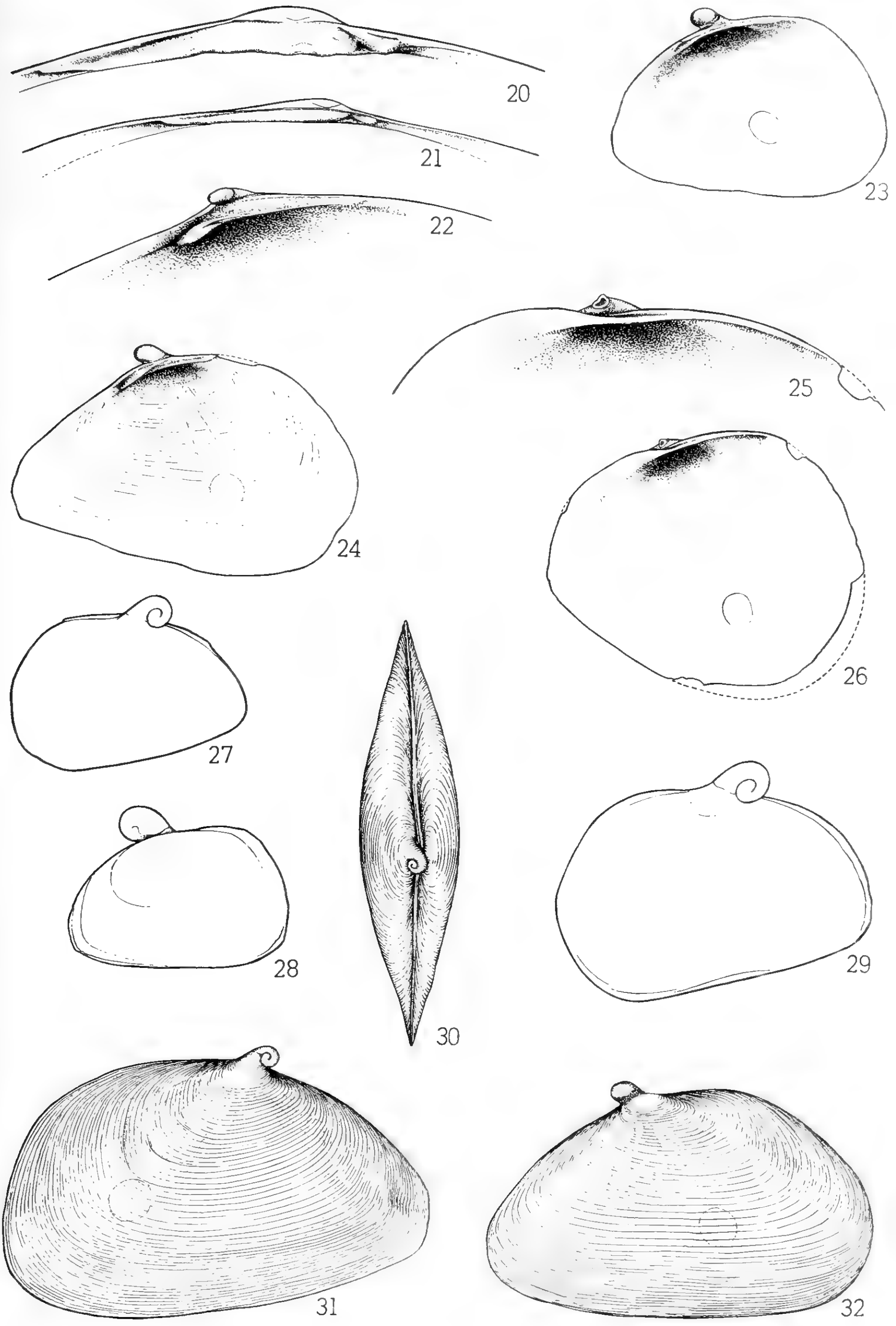
### Explanation of Figures

Fig. 20. ***Berthelinia (Edenttellina) chloris chloris*** (Dall). Syntype, CAS Paleo. Type Coll. No. 12316. Hinge of right valve. Recent, Magdalena Bay, Baja California. × 12.5. Page 52.

Figs. 21, 22. ***Berthelinia (Edenttellina) chloris belvederica*** Keen & Smith, new subspecies. Holotype, CAS Paleo Type Coll. No. 12317. Fig. 21, hinge of right valve; fig. 22, hinge of left valve. Recent, Puerto Ballandra Bay, near La Paz, Baja California. × 12.5. Page 53.

Figs. 23, 24, 27-32. ***B. (E.) chloris belvederica*** Keen & Smith, new subspecies. Hypotypes, Stanford University Paleo. Type Coll. Nos. 9173a-e. Recent, Candelero Bay, Espíritu Santo Island, Baja California. Fig. 23-24, interior of young left valves, showing variation in hinge development; × 24. Figs. 27, 29, exterior of left valve at two stages of growth of young shell, showing variations in outline but constant size of nucleus; × 32. Fig. 28, exterior of right valve and reverse of nucleus of left valve; × 30. Figs. 30-32, left and right dorsal views of a small, presumably adult specimen; length, 3.7 mm.; × 16. Page 53.

Figs. 25, 26. ***Ludovicia squamula*** Cossmann. Hypotype, Museum of Paleontology, University of California (Berkeley). Neauphle, Middle Eocene, France. Fig. 25, detail of hinge; × 12.5. Fig. 26, interior of left valve; × 6. Page 50.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at all on the surface of the fronds. Possibly the berthelinias had been detached from nearby clumps of *Caulerpa* when the *Halimeda* was uprooted and carried ashore, but further field observations should be made at this place to determine whether *Berthelinia* can live also on *Halimeda,* as it can on the two species of *Caulerpa.* Also, further investigations should be made as to the preference of *Berthelinia* for the two species of *Caulerpa* where both occur in proximity, to ascertain whether individuals that live on the *C. sertularioides* are always smaller (the maximum size of those taken at Candelero Bay did not exceed 4 mm.) and whether they can transfer from the one alga to the other without ill effect.

On the third attempt, live specimens of *Berthelinia* were transported by air to California, in spite of poor temperature control. The specimens taken on 18 and 19 December, in water with a surface temperature of 72°F., had been kept alive in a field laboratory by floating them in vials, with bits of *Caulerpa* (which they refused to touch) placed in shallow pans of seawater. At the time of departure from the field, 21 December, a few clumps of the alga (especially one that was collected without damaging the holdfasts, for it grew on a small clam valve) were transferred to a gallon-sized thermos container, which was half filled with clean seawater. The specimens of *Berthelinia,* after a change of seawater, were dropped, still in their closed vials, into the thermos. The lid was left off the thermos for better aeration except when in actual transit on the boat and airplane, and the specimens survived, even through one night of the cool temperatures of the San Francisco Bay area. As soon as daylight was available, the *Caulerpa* clumps were removed to a shallow bowl, near a window, and covered with seawater that had been vigorously shaken. The berthelinias were then transferred to the bowl. They appeared to be dead, the bodies being relaxed and protruding from the shell, but some soon proved able to retract upon stimulation. Most of them failed to revive beyond this, gradually losing color as they died. Two, however, began moving about, carrying the shell valves partially open over the dorsal part of the body. On 24 December one was observed in the act of feeding on the tip of a *Caulerpa* frond and was photographed. Perhaps the alga, which no longer showed the bright and healthy green of fresh material, failed to provide sufficient nourishment, for by the next day this specimen was visibly weaker. It still could cling to the alga by a mucous thread. On 26 December – one week from the time of collection – it was obviously dead, losing the green coloration. Temperature tolerance for the species thus proves to be substantially as great as that of the Japanese form, in spite of a more tropical habitat.

ASSOCIATED FAUNA. The green alga *Caulerpa* offers a microhabitat in which a number of invertebrates abound, notably the small anemone mentioned above and a small crab. There are also several species of mollusks occurring here in quantity that show up in beach drift only sparingly if at all. For example, no specimens of *Amphithalamus stephensae* Bartsch were found in over a quart of drift from Candelero Bay (in which the single first-seen valve of *Berthelinia belvederica* came to light), yet on the roots of the algae these were present by the hundreds. Almost as common at this place was *Tricolia cyclostoma* (Carpenter, 1864). It was also common at Puerto Ballandra Bay, but there the *Amphithalamus* was absent, at least in the sample taken. *Oxynoe*, n. sp., was fairly common at both places, as also *Jeffreysia bifasciata* Carpenter, 1864, and a small eulimid. About a dozen specimens of an undescribed columbellid resembling *Mitrella lalage* Pilsbry and Lowe occurred at Puerto Ballandra Bay. Further observations are needed to show what the relationship of all these mollusks is to the alga, whether feeding on it, as *Berthelinia*, or seeking protection beneath or among it.

## THE SIGNIFICANCE OF BERTHELINIA

*Berthelinia* is noteworthy on two counts – for its unusual distribution and for its anomalous shell. Hitherto only one species has been reported in the eastern Pacific (Keen, 1960a, 1960b). Now a second form is added. Thus, the range of the genus in the Recent fauna extends from Madagascar and Japan south to southern Australia and across the Pacific eastward to inside the tip of Lower California. Within the quadrangle so encompassed lies the East Indies and the whole of Polynesia. Perhaps an intensive search there on *Caulerpa* would produce more records. In any case, so wide a distribution of a genus in the Recent fauna without intermediate representatives is puzzling until one examines the fossil record. During early Tertiary time there was a great sea, the Tethys, that stretched east and west across what is now Europe and southern Asia. Its fauna seems to have originated mainly in the warm, shallow waters of what is now central France and to have spread eastward as far as Japan and Australia and westward across the Atlantic into the Caribbean and even farther, through an open Panamic portal to the west coast of the Americas. The present-day areas of distribution of *Berthelinia* are, then, peripheral to the ancient Tethyan sea and mark almost the farthest advances of its fauna. Other genera might be cited (for example, *Nemocardium*, in the broad sense, or *Typhis*) that have a somewhat similar range in time and space, but few could be found with so wide a gap between known occurrences of species. The range in time from Eocene to Recent is somewhat bridged by the related genus *Julia*, which seems to have originated also in Europe during the late Oligocene, to have spread west to the Caribbean and east to the East Indies in Miocene time, and also to have survived peripherally in the Pacific and Indian oceans, being known today from Madagascar eastward to Japan, Hawaii, and the west coast of Central and South America.

The anomalous shell of *Berthelinia* raises the question of how we shall interpret the phenomenon of bivalvedness in Gastropoda. Is it analogous to the first appearance of Pelecypoda, and does it imply that Pelecypoda branched out from Gastropoda in some such fashion? To answer this, one must look at the fossil record, which seems to indicate a negative reply to both questions. At the time the pelecypods first appeared, in late Cambrian or early Silurian time, the only gastropods present were rather simple limpet-like forms and notched-sided shells of the Pleurotomariidae, both not very far removed from Monoplacophora. Dr. C.M. Yonge and others have suggested that the pelecypod valves represent two areas of calcification that developed from either side of the body, bridged by tough chitinous periostracum of the outer shell layer, which in time became a hinge. The manner of outgrowth of the second valve in the juvenile *Berthelinia* lends force to this hypothesis. The *Berthelinia* group can, therefore, give us some insight into the mechanism of hinge formation, but we must not forget that the production of two valves is taking place in a gastropod family far removed from any family that could originally have given rise to Pelecypoda, so that this is no recapitulation of the original event, even granting a direct derivation of Pelecypoda from Gastropoda. It is interesting to note that the earliest pelecypods and the shelled sacoglossans have shells that are nearly smooth, not strongly ribbed. A development of a mortise-and-tenon joint – in other words, hinge-teeth and sockets – seems to be necessary for effective closure of the valves. Although in *Berthelinia* the teeth are neither consistent in size nor regular in shape and certainly not differentiated into cardinal and lateral areas as in clams, the very fact of their presence shows that the proper opening and closing of the two valves is facilitated by compensatory roughenings of the hinge surface. Why this two-valved device should have been adopted in Opisthobranchiata is a question we shall not try to answer here, though we may point out that this is a group of gastropods in which there has apparently been much evolutionary experimentation, even to the point of complete suppression of the shell.

The marked similarity in form of Eocene and Recent *Berthelinia* – so marked that we can separate them subgenerically only on rather minute points of difference – shows that during the last sixty million years or so, little or no evolutionary progress in the group has taken place. The mutation of bivalvedness occurred. It proved to be, if not advantageous, at least not unsuccessful. It persisted, but it evidently did not lead to organic change. We must suppose that the little Eocene snail wearing its two-valved shell looked much like its living descendant. The pelecypods, on the other hand, once they had achieved their tightly-closing double shell in that long-ago Paleozoic time went on to develop profound bodily changes, such as loss of the central or head ganglia and development of large, symmetrical gills, as well as to a change in habits, becoming sedentary or only clumsily mobile.

Hence it would seem that the principal significance of *Berthelinia* and the other Juliidae is that they demonstrate anew the dynamic pliableness of what Yonge calls the mantle-shell, which can produce a bivalved structure with an effective ligament and mortised tooth-and-socket junction from two quite unrelated stocks.


## Acknowledgments

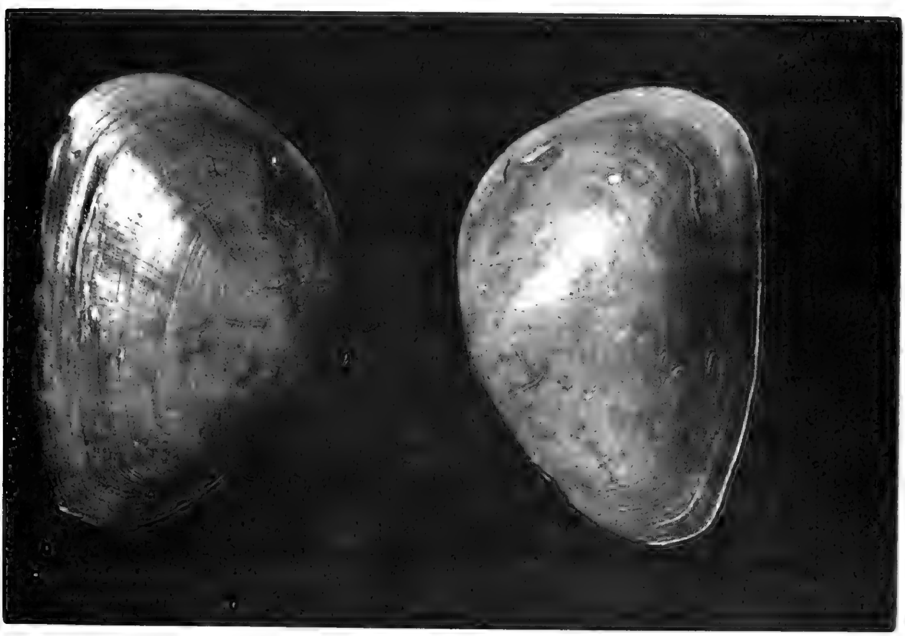
Without the sponsorship of the Belvedere Scientific Fund, this study and the recognition of bivalved gastropods on the shores of Baja California might have waited indefinitely. We are therefore most greatly indebted to those who made it possible. We wish to say a word of thanks also to those who participated in the actual collection and thus were present at the moment of discovery, whose rejoicing with us made the occasion memorable.

Our thanks go also to Dr. W.P. Woodring of the U.S. Geological Survey for notes on the type material of *Scintilla? chloris;* to Dr. George Papenfuss, Department of Botany, University of California, for identification of the *Caulerpa;* to Drs. J. Wyatt Durham and E.C. Allison and Mr. Joseph Peck, Jr., of the Museum of Paleontology, University of California, for the loan of comparative material; to the officers of the California Academy of Sciences for the loan of a syntype specimen; to Drs. S. Kawaguti and K. Baba of Japan for specimens of the Japanese *Tamanovalva* and for their eager cooperation, which facilitated our search for living material; to Dr. Edouard Fischer-Piette of the Museum National d'Histoire naturelle de Paris for information on the location of the type species of *Berthelinia* and for a search for other type material; and to Mr. Robert Burn of Victoria, Australia, for like cooperation in sending us information about his findings in advance of publication; to Patrick Milburn for advice on the interpretation of opisthobranch anatomy; and to Perfecto Mary for his excellent line drawings. We thank also our many colleagues and correspondents who have taken an enthusiastic interest in *Berthelinia.* Their stimulating questions and helpful suggestions have made the writing of this report a pleasure.

PLATE 5

(Upper figure) *Berthelinia (Edenttellina) limax* (Kawaguti & Baba). Tamano Bay, Japan. Living adult specimen on its food plant, *Caulerpa okamurai.* (Photo by Dr. Siro Kawaguti, reproduced by permission.)

(Lower figure) *Berthelinia (Edenttellina) chloris belvederica* Keen & Smith, new subspecies. Holotype, CAS Paleo. Type Coll. No. 12317, Puerto Ballandra Bay, near La Paz, Baja California. Length, 8.5; height, 5.8 mm.



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# LARGE SPECIES OF *TEREBRA* (MOLLUSCA) FROM THE EASTERN PACIFIC

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## INTRODUCTION

The genus *Terebra*, in a broad sense, occurs world wide, usually at comparatively shallow depths, mostly in inshore waters chiefly in tropical and to a lesser extent in warm temperate seas. They live just below the surface on sandy bottoms in generally shallow marine water. There are at least 200 and probably more Recent species. Only six species have been described from strata of Tertiary age in California, but the genus is now represented in west American waters by about 45 species and subspecies. This number, however, is only approximate; the true number depends upon the final disposition of the many names which have been proposed by various authors. Almost all of these species live in tropical and subtropical waters; only two forms range as far north as Santa Monica, California, one of which has been reported (rare) at Santa Barbara, California, in 34º 20' 21'' North Latitude.

The largest specimen of *Terebra* in the Henry Hemphill collection in the California Academy of Sciences belongs to the Indo-Pacific *T. maculosa* Linnaeus. It is 201.5 mm. long (the apex lacking). The largest specimen from west American waters in the collection is *T. strigata* which is 130 mm. long (the apex lacking).

The present paper deals only with five species of *Terebra,* in the strict sense; all except one find their northern range in the Gulf of California region. One of these is reported as far north as Magdalena Bay on the west coast of Lower California and one ranges as far south as Paita, Peru. Three of these have been reported as fossils in beds of Pleistocene age and one of these from strata of Pliocene age. The shells of these mollusks are rather thick, porcelaneous, the subsutural collar is not beaded or nodulous in the adult stage and they are colored with reddish-brown spots or stripes.

This group has at least one relative living in Caribbean waters but a number of allied species inhabit Indo-Pacific areas. The West American *T. strigata* bears a resemblance to the Indo-Pacific *T. maculata* Linnaeus and *T. robusta* to *T. subulata* Linnaeus.

Specimens of *Terebra* from various sources included in the collections of the California Academy of Sciences have been available for study during the preparation of this paper. Included among these are specimens in the Andrew Sorensen collection recently presented to the Academy. In addition we have had available specimens of *Terebra* in the collection at Stanford University, through the courtesy of Dr. A. Myra Keen, and those in the San Diego Society of Natural History, through the courtesy of Mr. Emery P. Chace.

Acknowledgment is here made to Mr. Allyn G. Smith and the late A. M. Strong, for advice and aid during the course of work on the present paper.

## Family TEREBRIDAE H. and A. Adams

### Genus Terebra Bruguière

*Terebra* BRUGUIÈRE, Encyclop. Méthod., Vers, vol. 1, p. XV, 1789. [No species cited.] LAMARCK, Mém. Soc. Hist. Nat. Paris, 1799, p. 71. Sole species cited, *Buccinum subulatum* Linnaeus. DALL, Bull. Mus. Comp. Zool., vol. 43, no. 6, p. 245, 1908. "Type *Buccinum subulatum* Linné." WOODRING, Carnegie Inst. Washington, Publ. 385, p. 135, 1928. Type (by monotypy): *Buccinum subulatum* Linné, cited by Lamarck.

*Terebrarius* DUMÉRIL, Zool. Analytique, p. 166, 1806. [No species cited.] Edition by Froriep, 1806, p. 167. Species cited, *Buccinum maculatum* Linnaeus. [See Iredale, T., Proc. Malacol. Soc. London, vol. 12, p. 83, 1916.]

*Terebrum* MONTFORT, Conch. Syst., vol. 2, p. 430, 1810. "Espèce servant de type au genre. Vis. tigre. *Terebrum tigreum*" [in the synonymy of which was cited, "*Buccinum subulatum,* Linn. et Gmel. sp. 131"].

*Terebraria* RAFINESQUE, Analyse de la Nature, p. 145, 1815. [Emendation of *Terebra* Bruguière.]

*Subula* SCHUMACHER, Essai Nouv. Syst. Hab. Vers Test., p. 233, 1817. Species cited: "*Subula maculata*" "*Buccinum maculatum* Lin." and "*Subula dimidiata*" "*Buccinum dimidiatum* Lin." HERRMANNSEN, Indic. Gen. Malacozoor., vol. 2, p. 522, 1847. "Typus: *Terebra maculata* L."

Type species. By subsequent monotypy by Lamarck and by subsequent designation Dall, 1908: *Buccinum subulatum* Linnaeus [Syst. Nat., ed. 12, p. 1205, 1767. "Habitat in Indiis." Ref. to "Rumph. mus. t. 30. f.B" and "Gault. test. 56, f. B," also others. Illustrated by Reeve, Conch. Icon., vol. 12, *Terebra,* sp. 22, pl. 6, fig. 22, 1860. "Hab. Society and Philippine Islands (in sand, on coral reefs, at low water); Cuming." See also, Dautzenberg, Mém. Mus. Roy. D'Hist. Nat. de Belge, Hors Sér., vol. 2, fasc. 17, p. 8, pl. 1, fig. 2, 1935. Various localities in Indo-Pacific region. See discussion of this species by Dodge, Bull. Amer. Mus. Nat. Hist., vol. 111, art. 3, pp. 219-221, 1956].

## Key to the Species of *Terebra*

A. A subsutural spiral groove present on all whorls
- a. Color markings a series of conspicuous stripes; apical angle 18° . . . . . . . . . . *T. strigata*
- aa. Color markings of four spiral rows of square spots on body whorl; apical angle 15° . . . . . . . . . . *T. ornata*

B. A subsutural spiral groove present only on whorls on posterior half of shell
- a. Apical angle 18° to 21°; later whorls tumid . . . . . . . . *T. dumbauldi*
- aa. Apical angle 8° to 12°; later whorls slender
  - b. Apical angle acute, 8° . . . . . . . . . . *T. lingualis*
  - bb. Apical angle broader, 12° . . . . . . . . . . *T. robusta*

### Terebra lingualis Hinds.

(Plate 6, figures 4, 5, 6.)

*Terebra lingualis* Hinds, Proc. Zool. Soc. London for 1843, p. 153, issued June, 1844. "Gulf of Papagayo, Bay of Montejo, west coast of America; ten to seventeen fathoms, sandy mud." Hinds, Zool.Voy. *Sulphur,* Moll., pt. 2, p. 33, October, 1844. [Same locality as in original reference.] Hinds, Thes. Conch., vol. 1, p. 167 (bis), pl. 43, fig. 50, 1845. [Hinds' localities cited.] Deshayes, Proc. Zool. Soc. London for 1859, p. 308, issued between July and October, 1859. "Golfe de Papagayo; Baie de Montijo". Reeve, Conch. Icon., vol. 12, *Terebra,* sp. 15, pl. 5, fig. 15, 1860. [Hinds' locality records cited.] Mörch, Malakozool. Blätter, Bd. 7, p. 105, 1860. "Realejo." [Nicaragua.] Tryon, Man. Conch., ser. 1, vol. 7, p. 11 (in text), pl. 2, fig. 17, 1885. (Copy of Reeve's pl. 5, fig. 15.) M. Smith, Panamic Mar. Shells (Trop. Photogr. Lab.: Winter Park, Florida), p. 35 (as *Terebra lingulais*), fig. 463, 1944. Cape San Lucas, Lower California, to Ecuador. Tomlin, Min. Conch. Club South. California, no. 41, p. 14, November, 1944. "Gulf of Papaguayo & Gulf of Montejo. Types B. M. (3)." Hertlein and Strong, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 213, 1955. "Piñas Bay" and "Guayabo Chiquito," Panama; "Ardita Bay," Colombia. Range: Mazatlan, Mexico, to northern Ecuador.

*Terebra formosa* Deshayes, Journ. de Conchyl., vol. 6 (ser. 2, vol. 2), p. 65, pl. 3, fig. 6, July, 1857. "Hab. la mer de Panama." Reeve, Conch. Icon., vol. 12, *Terebra,* sp. 49, pl. 12, fig. 49, 1860. "Panama." Tomlin, Jour. Conch., vol. 22, no. 5, p. 107, 1944. "Panama. Type B. M."

*Terebra insignis* DESHAYES, Journ. de Conchyl., vol. 6, (ser. 2, vol. 2), p. 70, pl. 3, fig. 2, July, 1857. "Panama." DESHAYES, Proc. Zool. Soc. London for 1859, p. 308, issued between July and October, 1859. "Panama." REEVE, Proc. Zool. Soc. London for 1860, p. 450, issued between August, 1860 and March, 1861. "Variety of *T. lingualis,* Hinds." TOMLIN, Jour. Conch., vol. 22, no. 5, p. 107, 1944. "Panama. Type B.M. = *lingualis* Hinds."

*Terebra (Subula) lingualis* Hinds, DALL, Bull. Mus. Comp. Zool., vol. 43, no. 6, p. 254, 1908. Panama in 322 fathoms and in 33 fathoms; off Guaymas, in 20 fathoms; near the head of the Gulf of California in 33 fathoms; Cape San Lucas; Puerto Libertad; Real Llejos. Also Hinds' localities cited.

*Terebra (Terebra) formosa* Deshayes, KEEN, Sea Shells of Tropical West America (Stanford Univ. Press: Stanford, California), p. 488, fig. 945, 1958. (Copy of Reeve's pl. 12, fig. 49.) Panama.

*Terebra (Terebra) lingualis* Hinds, KEEN, Sea Shells of Tropical West America (Stanford Univ. Press: Stanford, California), p. 488, fig. 946, 1958. Mazatlan, Mexico, to northern Ecuador.

TYPE SPECIMEN. British Museum (Natural History).

TYPE LOCALITY. "Gulf of Papagayo, Bay of Montejo, west coast of America; ten to seventeen fathoms, sandy mud."

RANGE. Near the head of the Gulf of California, to northern Ecuador, in 13 to 110 meters (7 to 60 fathoms). Cited from a depth of 322 fathoms by Dall, 1908, but he stated that the animal probably did not live at that depth. Pliocene of Costa Rica.

ORIGINAL DESCRIPTION. Ter. testâ turrito-subulatâ, albidâ, flammeis atrofuscis longitudinalibus ornatâ; anfractibus planulatis, duabus lineis impressis divisis, infrà suturam tuberculatis; areâ inferiore laevigatâ; anfractu ultimo subrotundato, laevigato, fasciato; aperturâ quadratâ; columellâ contorta. Axis 30 lin. (Hinds).

REMARKS. Hinds evidently illustrated an immature specimen of *Terebra lingualis* and Reeve gave a better figure of what may be the same one. The latter illustration shows only the early type of sculpture, namely the heavily beaded, double sutural band as in *T. robusta,* with close-set axial ribs below. The two species cannot be separated at this stage if our material is at all representative. The early sculpture fades to a considerable extent or may even disappear with age as it does on *T. robusta.* The apical angle is consistently slightly smaller, 8º rather than 12º in *T. robusta.* Coloration consists of very irregular brown dots or blotches, roughly arranged in axial manner but there is great variation from whorl to whorl and from specimen to specimen.

*Terebra formosa* Deshayes was described from Panama and it appears that no additional specimens, so identified, have been reported since. The original illustration reveals an acute apical angle and the color pattern on the body whorl consists of three rows of reddish-brown spots. These shell characters are so similar to those of slightly worn specimens of *T. lingualis* in the collections of the California Academy of Sciences that we refer the species described by Deshayes to *T. lingualis.*

### Terebra ornata Gray.

(Plate 6, figure 1.)

*Terebra ornata* GRAY, Proc. Zool. Soc. London for 1834, p. 62, issued November 25, 1834. [No locality cited.] REEVE, Conch. Systematica, vol. 2, p. 245, pl. 274, fig. 1, 1842. [No locality cited.] HINDS, Proc. Zool. Soc. London for 1843, p. 160, issued June, 1844. "Hab. Gallapagos Islands; five to seven fathoms, coral sand: Cuming. Panama; seven fathoms, mud: H." DESHAYES in Lamarck, Anim. s. Vert. (ed. 2), vol. 10, p. 253, 1844. "Habite la mer de Panama." HINDS, Thes. Conch., vol. 1, p. 152 (bis), pl. 42, fig. 34, 1845. [Same localities as mentioned by Hinds, 1844.] DESHAYES, Proc. Zool. Soc. London for 1859, p. 307, issued between July and October, 1859. "Hab. Galapagos." REEVE, Conch. Icon., vol. 12, *Terebra,* sp. 14, pl. 4, fig. 14, 1860. "Hab. Galapagos Islands (in coral sand, at a depth of from five to seven fathoms); Cuming." TRYON, Man. Conch., ser. 1, vol. 7, p. 12, pl. 2. fig. 28 (copy of Hinds' figure), 1885. "Galapagos Is." WOODRING, Carnegie Inst. Washington, Publ. no. 385, p. 136 (in text), 1928. "Panama." M. SMITH, Panamic Mar. Shells (Trop. Photogr. Lab.: Winter Park, Florida), p. 36, fig. 468, 1944. Panama; Galápagos Islands. Campbell, Veliger, vol. 3, no. 4, p. 112, 1961. Puerto Peñasco, Sonora, Mexico, in 60 to 80 feet.

Not *Buccinum ornatum* MARTYN, Universal Conch., vol. 3, fig., pl. 92, 1786. [Referable to the genus *Terebra.*] CHENU, Bibliothèque Conchyl., vol. 2, p. 25, pl. 33, fig. 1, 1845. "Chine."

*Myurella (Myurellina) ornata* Gray, BARTSCH, Nautilus, vol. 37, no. 2, p. 63, October, 1923. [This species designated as the type of the subgenus *Myurellina* Bartsch.]

*Myurellina ornata* Gray, VANATTA, Proc. Acad. Sci. Philadelphia, vol. 76, p. 425 (in text), 1925, issued February 15, 1924. [Synonymy discussed and the use of *Buccinum ornatum* by Martyn, 1786, is pointed out.]

*Terebra (Terebra) ornata* Gray, KEEN, Sea Shells of Tropical West America (Stanford Univ. Press: Stanford, California), p. 489, fig. 947, 1958. Panama.

TYPE SPECIMEN. Originally in British Museum (Natural History).

TYPE LOCALITY. No locality cited originally. "Gallapagos Islands; five to seven fathoms, coral sand: Cuming. Panama; seven fathoms, mud: H.," cited by Hinds, 1844. Same localities cited by Hinds 1845. "Hab. Galapagos Islands (in coral sand, at a depth of from five to seven fathoms); Cuming," cited by Reeve, 1860.

RANGE. Off Cape Tosco, Santa Margarita Island, west coast of Lower California, Mexico, to Puerto Peñasco, Sonora, Mexico, in the Gulf of California, and south to Panama and the Galápagos Islands, in 9 to 143 meters (5 to 80 fathoms).

ORIGINAL DESCRIPTION. Ter. testâ turritâ, ovato-subulatâ, solidâ; anfractibus planis, sulco spirali posteriore profundo, cingulo convexo subnoduloso; aperturâ ovatâ, labio interiore subincrassato declivi; albâ, seriebus quatuor macularum parvarum brunnearum quadratarum, serierum intermediarum maculis nonnunquam in strigas oblongas confluentibus. Axis 4 unc. (Gray).

REMARKS. This species can be separated from others in this group by the rather broad apical angle, about 15º, by the regular spiral rows of square dark brown spots and by the deep spiral groove setting off a wide subsutural band which extends from the apex to the aperture.

Vanatta discussed the name *Buccinum ornatum* Martyn, referable to the genus *Terebra*, a species identical with the one described in 1822 as *Terebra oculata* Lamarck. The work by Martyn was declared not valid for nomenclatorial purposes in opinion 456, published March, 1957, by the International Commission on Zoological Nomenclature. This action leaves the name *Terebra ornata* a valid one for the west American shell.

## Terebra robusta Hinds.

(Plate 6, figures 3,7,8; plate 7, figure 1.)

*Terebra robusta* HINDS, Proc. Zool. Soc. London for 1843, p. 149, issued June, 1844. "Hab. West coast of America, between 8° 57' and 21° 32' north latitude; namely at Panama, Gulf of Nicoya, Gulf of Papagayo, and San Blas: in from four to eighteen fathoms, sandy mud." HINDS, Zool. Voy. *Sulphur*, Moll., pt. 2, p. 32, October, 1844. [Same localities cited as in preceding reference.] HINDS, Thes. Conch., vol. 1, p. 152 (bis), pl. 42, fig. 35, 1845. [Same localities as cited earlier.] DESHAYES, Proc. Zool. Soc. London for 1859, p. 307, 1859. "Panama; Golfe de Nicoya; Golfe de Papayo; San Blas." REEVE, Conch. Icon., vol. 12, *Terebra*, sp. 10, pl. 3, fig. 10, 1860. [Same localities as originally cited.] MÖRCH, Malakozool. Blätter, Bd. 7, p. 105, 1860. "Realejo." [Nicaragua.] TRYON, Man. Conch., vol. 7, p. 11, pl. 2, fig. 16 (after Hinds), 1885. "W. Coast of Central America." M. SMITH, Panamic Mar. Shells (Trop. Photogr. Lab.: Winter Park, Florida), p. 36, fig. 471, 1944. Gulf of California to Panama. HERTLEIN and STRONG, Bull. Amer. Mus. Nat. Hist., vol. 107, art. 2, p. 214, 1955. "Off Cape Pasado, Ecuador," also other localities in that region. "Range: Guaymas in the Gulf of California to the Rio Esmeraldas, Ecuador. Galapagos Islands."

Not *Terebra robusta* Hinds, GABB, 1873, renamed *Terebra gabbi* DALL, 1896. A species from strata of Miocene age in the Caribbean.

*Terebra loroisii* GUÉRIN-MÉNEVILLE, Mag. de Zool., 1854, p. 218, pl. 4, fig. 5, 1854. See Reeve, Conch. Icon., vol. 12, *Terebra*, Addenda et Corrigenda, 1860. "*T. robusta.* — Add as synonym *T. Loroisii*, Guérin-Méneville." REEVE, Proc. Zool. Soc. London for 1860, p. 450, "the same as *T. robusta*, Hinds."

Not *Terebra loroisi*, DESHAYES, Proc. Zool. Soc. London for 1859, p. 313. "Hab.......?"

[?] *Terebra pachyzona* MÖRCH, Malakozool. Blätter, Bd. 7, p. 105, August, 1860. "Realejo." [Nicaragua.]

*Terebra macrospira* LI, Bull. Geol. Soc. China, vol. 9, no. 3, p. 273, pl. 8, fig. 66, 1930. "'Brought up by marine dredge from depths varying from 10.ft. to 40.ft. in the mud at the mouth of the Rio Grande near La Boca about one mile from the mainland in Panama Bay.'" PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, vol. 83, p. 434, 1931. "This is a rather small and slender specimen of *T. robusta* Hinds."

*Terebra (Terebra) robusta* Hinds, GRANT and GALE, Mem. San Diego Soc. Nat. Hist., vol. 1, p. 465, 1931. Earlier records cited. Pleistocene and Recent. KEEN, Sea Shells of Tropical West America (Stanford Univ. Press: Stanford, California), p. 489, fig. 948, 1958. Guaymas, Gulf of California, to Ecuador, and the Galápagos Islands.

TYPE SPECIMEN. Originally in British Museum (Natural History.)

TYPE LOCALITY. "West coast of America, between 8º 57′ and 21º 32′ north latitude; namely at Panama, Gulf of Nicoya, Gulf of Papagayo, and San Blas: in from four to eighteen fathoms, sandy mud." "Panama" selected as type locality by Hertlein and Strong, 1955.

RANGE. Guaymas, Sonora, Mexico, in the Gulf of California, to the Rio Esmeraldas, Ecuador, and Galápagos Islands, in 7 to 33 meters (4 to 18 fathoms). Also Pliocene to Recent.

ORIGINAL DESCRIPTION. Ter. testâ turrito-subulatâ, solidâ, ponderosâ, albidâ, flammeis longitudinalibus interruptè pictâ; anfractibus inferioribus rotundatis, indivisis, laevigatis, superioribus versùs extremitatem spirae subplanulatis, unocinguliferis, longitrorsum plicatis; anfractu ultimo rotundato triseriatim picto, ad basin coarctato; aperturâ elongatâ; columellâ arcuatâ, subcallosâ; epidermide luteo-fuscâ; operculo parvo, crasso. Axis 57 lin. (Hinds).

REMARKS. *Terebra robusta*, a supposedly common species, is represented by fewer specimens than *T. lingualis* in the collections studied by us. It has a slightly greater apical angle, about 12º, than does *T. lingualis* but otherwise the two species are difficult to separate.

The early whorls are highly sculptured with two spiral rows of close-set beads below the suture forming the subsutural band. The remainder of these early whorls has close-set retractively curved or straight axial ribs. This sculpture fades out with increasing age and the whorls become smooth with only growth lines, very fine spiral lines and no subsutural band present.

Coloration is very variable and even on the same individual there is no constancy from whorl to whorl but the flame-like reddish-brown axial stripes are normally present on some part of the shell. Immature shells with only the early sculpture cannot be separated from *T. lingualis.*

The original figures of *Terebra robusta* and *T. lingualis* of Hinds show shells with the upper spots on the body whorls coalesced into stripes. This seems to be a rare condition because in the rather large series available for this study only two shells from Panama check with these markings, one of

## Plate 6

Fig. 1. *Terebra ornata* Gray. Hypotype, no. 12321 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality 17724 (CAS), Ceralbo Channel, Gulf of California, dredged in 84 meters (46 fathoms); Beebe-Crocker Exped., 1936. Length, 75.8 mm., diameter of body whorl, 18.5 mm. P. 71.

Fig. 2. *Terebra dumbauldi* Hanna and Hertlein, new species. Paratype, no. 12322 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality 33149 (CAS), Panama; C.H. Dumbauld collector, 1950. Length, 89.1 mm., diameter of body whorl, 22.4 mm. P. 77.

Fig. 3. *Terebra robusta* Hinds. Hypotype, no. 12323 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from the same locality as the specimen shown in fig. 2. Length, 83.8 mm., diameter of body whorl, 17.9 mm. P. 72.

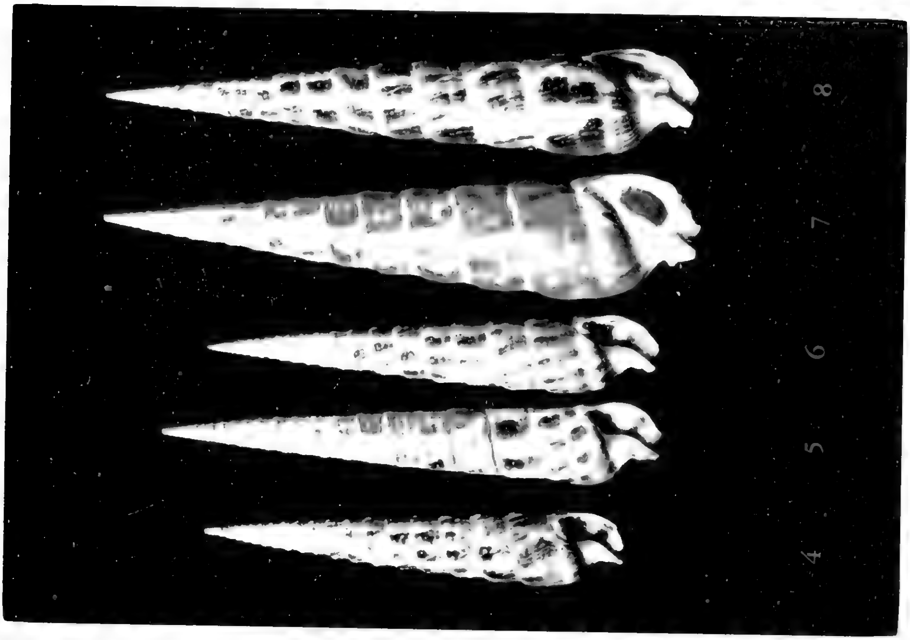
Fig. 4. *Terebra lingualis* Hinds. Hypotype, no. 12324 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from the same locality as the specimen shown in fig. 2. Length, 60.7 mm., diameter of body whorl, 11.2 mm. P. 69.

Fig. 5. *Terebra lingualis* Hinds. Hypotype, no. 12325 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality 17843 (CAS), Port Guatulco, Oaxaca, Mexico, dredged in 42 meters (23 fathoms); Beebe-Crocker Exped., 1937. Length, 60.7 mm., diameter of body whorl 11.2 mm. P. 69.

Fig. 6. *Terebra lingualis* Hinds. Hypotype, no. 12326 (CAS), from the same locality as the specimen shown in fig. 2. Length, 65.2 mm., diameter of body whorl, 11.5 mm. P. 69.

Fig. 7. *Terebra robusta* Hinds. Hypotype, no. 12327 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality 31699 (CAS), outside Miramar Lagoon, Guaymas, Sonora, Mexico; Andrew Sorensen coll., 1942. Length, 86.5 mm., diameter of body whorl, 18.4 mm. P. 72.

Fig. 8. *Terebra robusta* Hinds. Hypotype, no. 12328 (CAS), from the same locality as the specimen shown in fig. 2. Length, 85.4 mm., diameter of body whorl, 15.3 mm. P. 72.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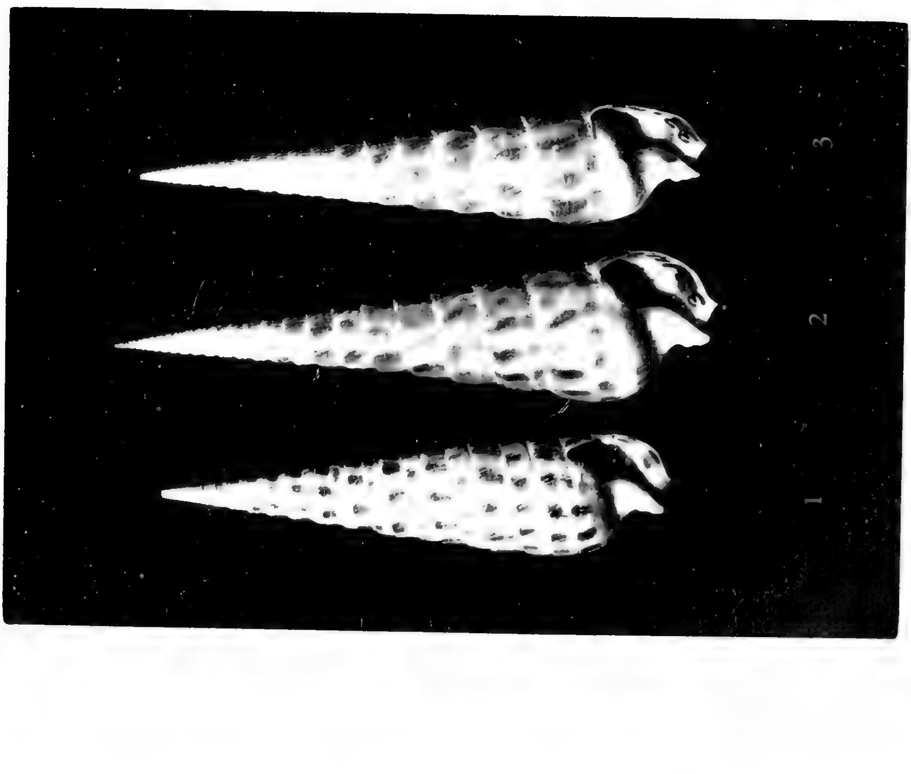
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which is illustrated on plate 7, figure 1. All of the others have the body markings broken into spots. The only reasonably constant character we can find for separating the two species is in the apical angle. This is not well brought out in the original descriptions or figures but in general *T. lingualis* is narrower. Upon checking the dimensions given in the original description of *T. pachyzona* Mörch (72 mm. × 15 mm., an unfigured species) the apical angle was near 12º. Therefore it seems that it should fall within the variation of *T. robusta.*

Reeve (Conch. Icon., vol. 12, *Terebra,* species 13b, 1860) illustrated a specimen said to have come from Panama. However, a decided subsutural spiral groove persisting from the apex to the aperture is shown on the figure. Such a groove is totally lacking on the later whorls of any specimen of typical *T. robusta* which we have seen.

In a remarkable series of *Terebra* from Panama which was collected by Captain C. H. Dumbauld, the apical angle on three of the figured specimens (plate 7, figures 2, 3, 4) varies from 17º to 21º and in some cases the sides of the spire are concave. It is possible that in a very large series this lot from Panama, together with *T. robusta* and *T. lingualis,* might merge into a single variable species. However, in the available series, the very large and wide shells from Panama appear to be sufficiently distinct to justify the proposal of a separate name for this form.

### Terebra strigata Sowerby.

(Plate 7, figures 6, 7.)

*Terebra strigata* SOWERBY, Cat. Shells in Coll. Tankerville, app. p. XXIII, 1825. "Panama." REEVE, Conch. Systematica, vol. 2, p. 245, pl. 274, fig. 3, 1842. [No locality cited.] HINDS, Proc. Zool. Soc. London for 1843, p. 160, issued June, 1844. "Hab. Panama, very abundant:H." DESHAYES in Lamarck, Anim. s. Vert. (ed. 2), vol. 10, p. 252, 1844. "Habite Panama." HINDS, Thes. Conch., vol. 1, p. 151 (bis), pl. 41, fig. 10, 1845. "West coast of America between Panama and Realejo." DESHAYES, Proc. Zool. Soc. London for 1859, p. 280, issued between July and October, 1859. "Hab. Panama, Realejo." REEVE, Conch. Icon., vol. 12, *Terebra,* sp. 5, pl. 2, fig. 5, 1860. "Panama, Galapagos." [Not the records "Philippine Islands"; "Moluccas."] TRYON, Man. Conch., Ser. 1, vol. 7, p. 12, pl. 2, fig. 29 [copy of Hinds' (1845) figure], 1885. "Panama, Realejo." M. SMITH, Panamic Mar. Shells (Tropical Photogr. Lab.: Winter Park, Florida), p. 36, fig. 470, 1944. Gulf of California to Payta, Peru; Galapagos Islands.

*Buccinum elongatum* WOOD, Index Test., Suppl., p. 13, pl. 4, fig. 25, 1828. "India." [This locality erroneous according to Hinds, 1845.]

*Terebra flammea* Lamarck, LESSON, Illustr. Zool., pl. 48, 1832. "vit sur les côtes de l'isthme de Panama." [Not "Hab. in mare Antillarum? ..... habite le golfe des Antilles."]

Not *Terebra flammea* LAMARCK, 1822.

PLATE 7

Fig. 1. *Terebra robusta* Hinds. Hypotype, no. 12329 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality 33149 (CAS), Panama; C. H. Dumbauld collector, 1950. Length (incomplete), 79.3 mm., diameter of body whorl, 18.5 mm. P. 72.

Fig. 2. *Terebra dumbauldi* Hanna and Hertlein, new species. Paratype, no. 12330 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from the same locality as the specimen shown in fig. 1. Length, 94.8 mm., diameter of body whorl, 21.8 mm. P. 77.

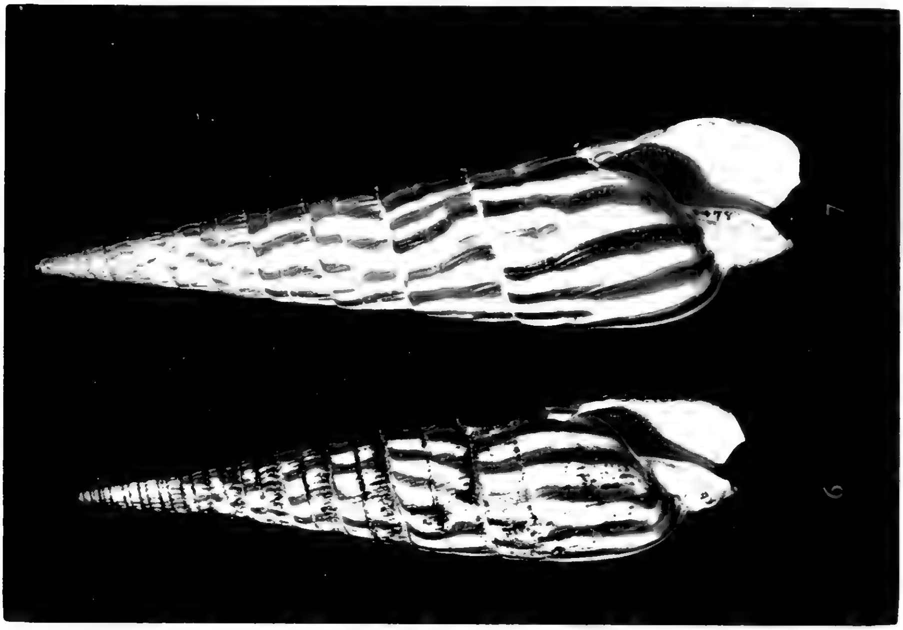
Fig. 3. *Terebra dumbauldi* Hanna and Hertlein, new species. Holotype, no. 12333 (Calif. Acad. Sci. Dept. Geol. Type Coll.) from the same locality as the specimen shown in fig. 1. Length, 106.6 mm., diameter of body whorl, 27 mm. P. 77.

Fig. 4. *Terebra dumbauldi* Hanna and Hertlein, new species. Paratype, no. 12331 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from the same locality as the specimen shown in fig. 1. Length, 102 mm., diameter of body whorl, 26.4 mm. P. 77.

Fig. 5. *Terebra dumbauldi* Hanna and Hertlein, new species. Paratype, no. 12332 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from the same locality as the specimens shown in fig. 1. Length, 79.6 mm., diameter of body whorl, 19 mm. P. 77.

Fig. 6. *Terebra strigata* Sowerby. Hypotype, no. 12334 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality 23502 (CAS), tropical western America; J. Vandenburgh collector. Length 102.4 mm., diameter of body whorl, 26.2 mm. P. 75.

Fig. 7. *Terebra strigata* Sowerby. Hypotype, no. 12335 (Calif. Acad. Sci. Dept. Geol. Type Coll.), from locality 1478 (CAS), Magdalena Bay, Lower California; H. Hemphill collector. Length, 117.1 mm., diameter of body whorl, 32.0 mm. P. 75.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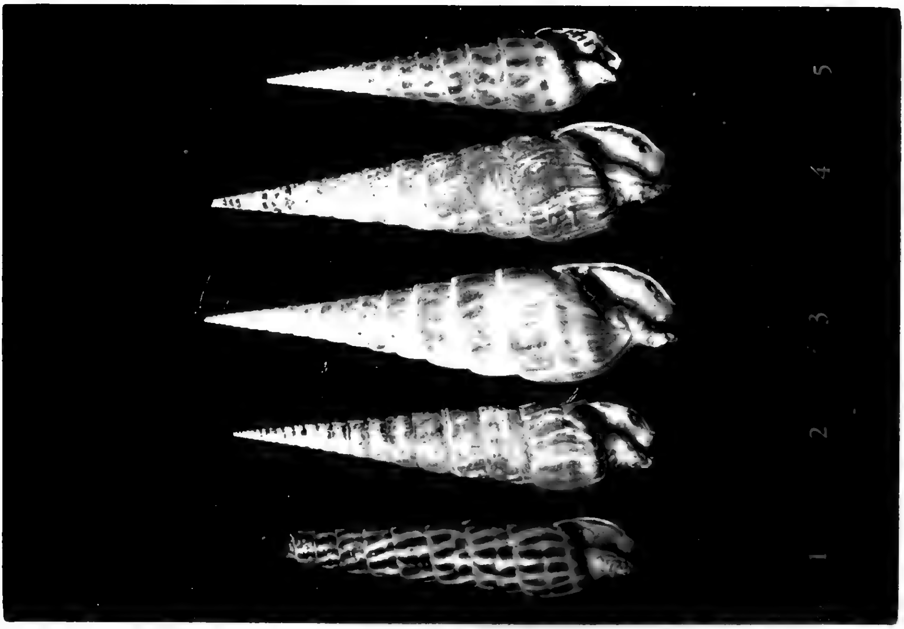
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*Terebra zebra* KIENER, Spéc. Gén. et. Icon. Coq. Viv., Fam. Purpuriféres *Terebra*, p. 5, no. 2, pl. 3, fig. 5, 1838-1839. "les côtes de l'isthme de de Panama." [Not "habite le golfe des Antilles."]

*Terebra elongatum* Wood, HANLEY, Edit. of Index Test., Suppl., p. 214, pl. 4, fig. 25, 1856. "Panama."

*Terebra (Subula) strigata* Sowerby, MÖRCH, Malakozool. Blätter, Bd. 7, p. 104, 1860. "Realejo." [Nicaragua.]

*Terebra (Terebra) strigata* Sowerby, DURHAM, Geol. Soc. America, Mem. 43, pt. 2, p. 97, pl. 33, fig. 16, 1950. Santa Inez Bay, Lower California, Pleistocene. KEEN, Sea Shells of Tropical West America (Stanford Univ. Press: Stanford, California), p. 489, fig. 949, 1958. Gulf of California to Panama.

TYPE SPECIMEN. Location unknown to the present authors.

TYPE LOCALITY. "Panama."

RANGE. Magdalena Bay, west coast of Lower California to Puerto Escondido in the Gulf of California and south to Paita, Peru; Socorro Island, Revillagigedo Islands, Mexico, and the Galápagos Islands, in 18 to 22 meters (10 to 12 fathoms) and perhaps deeper. Also Pleistocene at Magdalena Bay, Lower California.

ORIGINAL DESCRIPTION. T. testâ turrito-subulatâ, pallidâ, strigis longitudinalibus, fuscis, irregulariter ornatâ, anfractibus obliquè longitudinaliter subplicatis, lineâ impressâ centrali divisis: long. 51/5 lat. 11/5 unc. (Sowerby).

REMARKS. This large striped form of *Terebra* is quite distinct from any other west American species. The subsutural groove extends from the apex to the aperture, whereas in *T. robusta* and *T. lingualis* it fades out about half the distance to the aperture.

Sculpture on the upper half of the shell consists of a series of nodes both above and below the subsutural groove. As the shell approaches maturity these nodes gradually disappear.

The largest specimen in the collections of the California Academy of Sciences, collected by Dr. L. A. Waitzinger at locality 32347 (CAS), Manzanillo, Mexico, is 130 mm. long (apex lacking), maximum diameter, 32 mm.

Mörch, long ago, pointed out the East Indian affinities of this species.

Terebra dumbauldi Hanna & Hertlein, new species.

(Plate 6, figure 2; plate 7, figures 2, 3, 4, 5.)

Shell elongate, large, robust, thick, about 20 whorls on the holotype, tip of apex lacking, the outline of the spire slightly concave; whorls on posterior half of shell nearly straight on the sides but the later ones are slightly convex and progressively more tumid anteriorly, all are slightly shouldered posteriorly because of the impressed suture; sculpture, similar to that of *T. robusta*, consists of fine radial plications on the posterior one-third of the shell, but this becomes obsolete on the later whorls; an incised spiral line delimits a narrow posterior collar on the early whorls but this becomes obsolete on the later ones; aperture semi-elliptical, outer lip sinuated, inner lip with a thin callus layer; columella slightly excavated, below strongly twisted, with a strong spiral keel bordering a narrow siphonal fasciole; early whorls ornamented with chestnut-brown radial flammules or spots, the body whorl with three brown bands on a yellowish ground, the posterior third with a broad band of radial blotches, a central narrow band broken into spots and below this a basal band about twice as wide broken into occasional blotches; interior of aperture cream-colored to light brown. Length 106.6 mm., diameter of body whorl 27 mm., apical angle 21º.

Holotype, no. 12333 and paratypes nos. 12322, 12330, 12331, 12332 (California Academy of Sciences Geology Type Collection), from locality 33149 (CAS), Panama; Captain C. H. Dumbauld, collector. Paratypes also have been deposited in the collection at Stanford University and in the San Diego Society of Natural History.

This new species bears a general resemblance to *Terebra robusta* but it differs in several particulars. The apical angle of *T. dumbauldi*, new species, is greater (18º to 21º rather than about 12º), and the outline of the spire on large specimens is slightly concave. Another characteristic feature of this new species is the greater diameter of the whorls on the anterior half of the shell which results in a more tumid form with a deeper suture lending a faintly shouldered appearance.

*Terebra dumbauldi*, new species, closely resembles *T. gabbi* Dall (Proc. U.S. Nat. Mus., vol. 18, no. 1035, p. 34, 1895, issued April 23, 1896. "Habitat. —Older Miocene of Santo Domingo, at the Potrero, River Amina." Also, Dall, Trans. Wagner Free Inst. Sci., vol. 3, pt. 6, pl. 59, fig. 31, 1903. "Oligocene of St. Domingo"), a fossil described from the Caribbean and believed to be of Miocene age. Woodring (Carnegie Inst. Washington, publ. no. 385, p. 136, 1928), mentioned related species of Miocene age in that region.

*Terebra (Terebra) elena* Pilsbry and Olsson (Proc. Acad. Nat. Sci. Philadelphia, vol. 93, p. 13, pl. 1, figs. 1, 9, September 9, 1941), a fossil form of Pliocene age, was described from the Jama formation at Puerto Jama, Ecuador. It has an apical angle of about 16.5º. This species can be easily separated from *T. dumbauldi*, new species, by the presence of a concave band on the anterior third of the whorls which persists throughout the length of the shell.

The species described as new in the present paper is named for Captain C. H. Dumbauld, United States Navy, who generously presented the type lot of 24 specimens to the California Academy of Sciences.

## Other Terebras Which Have At Times Been Referred To The Foregoing Species

Several described species have been said to be closely related to or identical with *Terebra robusta* or *T. lingualis.* A review of the literature leads us to conclude that most, if not all, of these are referable to one Caribbean species. Pertinent references to these species are included here in chronological order.

*Buccinum taurinum* S[OLANDER]., Cat. Portland Mus., p. 142, no. 3158, 1786. "A pair of large and fine *Buccinum taurinum,* S. Lister, 841. 69, from China — very rare." DALL, Nautilus, vol. 34, no. 4, p. 125, April, 1921. "= *Terebra subulata* Linne, var. (1767)." ABBOTT, American Seashells (van Nostrand Co., Inc.: Toronto; New York; London), p. 265, pl. 13, fig. h, 1954 (as *Terebra taurinum* Solander). Southeastern Florida, the Gulf of Mexico and the West Indies.

Abbott pointed out that *Buccinum taurinum* is an earlier name for the species later named *Terebra feldmanni* Röding in Bolten and *T. flammea* Lamarck.

*E*[*pitonium*].*feldmanni* RÖDING in Bolten, Mus. Boltenianum, p. 94, 1798. Ref. to "Gmel. *Buccin. subulatum* sp. 131. *T.* Martini 4. t. 154 1446. 2 St." [No locality cited by Chemnitz.] HEDLEY, Proc. Linn. Soc. New South Wales, vol. 38, pt. 2, p. 306, 1913. "It does not appear to have been remarked that *Epitonium feldmanni* Bolten, 1798, is an earlier name for Lamarck's species" [that is, *Terebra flammea* Lamarck].

Clench considered *Terebra feldmanni* to be close to or identical with *T. robusta.* Upon comparison of figure 1446, given by Chemnitz in the Conchylien-Cabinet, with the original figure of *T. robusta* we fail to see sufficient similarity to warrant relegating this well known west American name to the synonymy of *T. feldmanni.* We are inclined to agree with Reeve, Hedley, and Abbott in considering *T. feldmanni* to be a Caribbean species.

*Terebra flammea* LAMARCK, Anim. s. Vert., vol. 7, p. 284, August, 1822. "Habite l'Océan des grandes Indes." Ref. to "Lister, Conch. t. 841. f. 69" and "Martini, Conch. 4. t. 154. f. 1446." KIENER, Spéc. Gén. et Icon. Coq. Viv., Fam. Purpurifères, *Terebra,* p. 12, pl. 5, fig. 10, 1838-1839. "Habite les mers de l'Inde." DESHAYES in Lamarck, Anim. s. Vert. (ed. 2), vol. 10, p. 239, 1844. Original locality cited. CLENCH, Nautilus, vol. 51, no. 4, p. 114, pl. 9, figs. 1, 2, 1938. "dredgings from Puerto Plata Harbour at depths of approximately 30 feet," "Santo Domingo." CLENCH, Nautilus, vol. 53, no. 1, pp. 7-8, 1939. M. SMITH, World-Wide Sea Shells (Trop. Photogr. Labor.: Lantana, Florida), pp. 74, 130, figs. 1010 and 1010A, 1940. Lake Worth, Florida; Dominican Republic. JAUME, Rev. Soc. Malacol. "Carlos de la Torre", vol. 2, no. 2, p. 49, fig. 1, 1944 [as *Terebra (Paraterebra) flammea*]. "Santa Fe, La Habana," Cuba.

There appears to be no doubt that this name applies to a species in the Caribbean region.

*Terebra incomparabilis* DESHAYES, Proc. Zool. Soc. London for 1859, p. 307, issued between July and October, 1859. "Hab. Panama." REEVE, Conch. Icon., vol. 12, *Terebra,* sp. 13, 1860. [*T. incomparabilis* placed in synonymy of *T. flammea* Lamarck.] REEVE, Proc. Zool. Soc. London for 1860, p. 450. ["variety of *T. flammea,* Lamarck".] HEDLEY, Proc. Linn. Soc.

New South Wales, vol. 38, pt. 2, p. 306, 1913. [Hedley considered *T. incomparabilis* to be a variety of *T. flammea*, and that both inhabited the West Indies.] CLENCH, Nautilus, vol. 51, no. 4, p. 114, 1938. [*T. incomparabilis* was considered to be a variety of *T. robusta* and both close to or identical with *Epitonium feldmanni* Röding in Bolten.]

Reeve and Hedley had access to collections in the British Museum where Hinds', Reeve's, and Deshayes' materials were stored. We are therefore inclined to accept their judgment in the disposition of this troublesome form and thus remove the name *T. incomparabilis* from west American records to those of the Caribbean region. The original description seems to fit that of *T. flammea* better than those of the west American forms.

*Terebra texana* DALL, Nautilus, vol. 12, no. 4, p. 45, August, 1898. "Gulf coast of Matagorda Island." J. B. HENDERSON in Nutting, Univ. Iowa Studies, vol. 8, no. 3, p. 89, pl. 40, fig. 5, 1919. "Barbados". CLENCH, Nautilus, vol. 53, no. 1, p. 7 (in text), 1939.

According to Clench, *Terebra texana* is identical with *T. flammea.*

**PROCEEDINGS**

OF THE

**CALIFORNIA ACADEMY OF SCIENCES**

Fourth Series

Vol. XXX, No. 4, pp. 81-90, pls. 8-9 August 31, 1961

## ERRATA

Proceedings of the California Academy of Sciences
4th Series, Vol. 30, No. 4

Page 83, line 14 - for "figure 2" read "figures 2-4"
Page 84, line 4 - for "Figure 2" read "Figures 2-4"
Page 84, line 7 - for "35.0" read "30.9", and
for "30.9" read "35.0".
Page 86, line 26 - for "figure 1" read "figure 2"
Page 87, line 34 - for "figure 2" read "figure 1"
Page 88, line 34 - for "Figure 1" read "Figure 2"
Page 88, line 37 - for "Figure 2" read "Figure 1"

Correspondence with Dr. Pilsbry prior to his death revealed the fact that the manuscript describing these species had not been published and could not be found. Recently, Drs. R. Tucker Abbott and Robert Robertson, and Miss Virginia Orr of the Academy of Natural Sciences at Philadelphia, kindly looked up original material relating to these four species and in the process discovered Pilsbry's notes on three of them. The specimens involved, together with the notes, were loaned for study. In order to complete the picture, Lowe's so-called paratypes and other pertinent specimens from the Lowe Collection at the San Diego Society of Natural History were loaned through the courtesy of Emery P. Chace, Curator. As a result there is now before me all of the known material needed to determine the status of the above four species, which can only be considered as *nomina nuda,* and which should be redefined.

PROCEEDINGS

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# FOUR SPECIES OF CHITONS FROM THE PANAMIC PROVINCE (MOLLUSCA: POLYPLACOPHORA)

By

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In working with the chiton fauna of the Panamic Province the problem arose of identifying three species from the Gulf of California and one from Panama collected by Herbert N. Lowe and listed subsequently in a paper by Pilsbry and Lowe (1932). These are:

*Nuttallina mexicana* Pilsbry, from Guaymas
*Chaetopleura raripustulosa* Pilsbry, from Guaymas
*Ischnochiton lowei* Pilsbry, from Manzanillo
*Acanthochitona panamensis* Pilsbry, from Panama and south

Correspondence with Dr. Pilsbry prior to his death revealed the fact that the manuscript describing these species had not been published and could not be found. Recently, Drs. R. Tucker Abbott and Robert Robertson, and Miss Virginia Orr of the Academy of Natural Sciences at Philadelphia, kindly looked up original material relating to these four species and in the process discovered Pilsbry's notes on three of them. The specimens involved, together with the notes, were loaned for study. In order to complete the picture, Lowe's so-called paratypes and other pertinent specimens from the Lowe Collection at the San Diego Society of Natural History were loaned through the courtesy of Emery P. Chace, Curator. As a result there is now before me all of the known material needed to determine the status of the above four species, which can only be considered as *nomina nuda,* and which should be redefined.

It now appears that two of Pilsbry's species, *Nuttallina mexicana* and *Chaetopleura raripustulosa*, have subsequently been named and described by Dr. S. S. Berry, the former not figured. The remaining two species, *Ischnochiton lowei* and *Acathochitona panamensis*, are new and descriptions and figures of them are published here for the first time.

### Nuttallina crossota Berry.

(Plate 8, figure 1.)

*Nuttallina mexicana* Pilsbry, PILSBRY and LOWE, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 129. [A *nomen nudum*.] STEINBECK and RICKETTS, Sea of Cortez, 1941, p. 549.

*N. crossota* BERRY, 1956, Leaflets in Malacology, vol. 1, no. 13, pp. 71-72; KEEN, 1958, Sea Shells of Tropical West America, p. 528, fig. 49.

Comparison between Berry's good description of his species and Pilsbry's notes on *N. mexicana* indicate general agreement on major characters, with minor differences that appear to be well within the range of individual variation. Pilsbry's notes on species relationships are pertinent and of interest. He says: "A much smaller species than *N. fluxa* Cpr., more elevated, with smaller girdle spines than in young *fluxa* of the same size. The mucro of valve viii is more posterior; in young *fluxa* equal in length to *N. mexicana* the mucro is before the posterior margin of the valve. In *N. thomasi* Pils. the posterior valve is wider with the mucro situated much less posteriorly and the girdle spines are far smaller.

"'*Nuttallina*' *allantophora* and '*N.*' *magdalena* Dall [1919] (Proc. U.S.N. Mus., 55: 502) are quite unlike this species and those previously known from California in sculpture, and indeed their reference to *Nuttallina* appears doubtful. Neither was figured. The presence of 'partly ocular' pustules in the first, and the beaded, *Pallochiton*-like sculpture of the second are certainly strange features for *Nuttallina!*"

Pilsbry's grave doubts that *N. allantophora* Dall and *N. magdalena* Dall are properly allocated to *Nuttallina* are echoed by Dr. Berry, the former being a *species inquirendum* and the latter having now been transferred to *Chaetopleura* (Keen, 1958: 524).

According to Pilsbry, *N. mexicana* was collected by Lowe at Guaymas, Mexico, "on top of rocks in mud flats." A type and paratype were designated, with other paratypes in the Lowe Collection. ANSP no. 243304 consists of two specimens collected by Lowe in January, 1939, at Guaymas and labeled "Type & paratype." The larger of these two specimens agrees with Pilsbry's measurements and is without doubt the intended type specimen of *N. mexicana.* The smaller specimen is partially disarticulated and represents a paratype. The other intended paratypes are two specimens in the Lowe Collection at San Diego, and are in the collection of the San Diego Society of Natural History. The type lot of *Nuttallina crossota* was collected by Dr. Berry on the reef and in tide pools at the west end of the long bight of Punta Peñasco, Sonora.

Based on specimens that have been seen by the writer so far, this species is fairly common on both sides of the upper end of the Gulf of California, particularly at Punta Peñasco and at San Felipe, Baja California. On the peninsula side it ranges at least as far south as La Paz, specimens having been collected in Los Angeles Bay by Mrs. Faye Howard, and a single one taken at Puerto Ballandra Bay, north of La Paz, by the writer. On the mainland side of the Gulf the southermost available collecting record is at Guaymas, Sonora, with specimens taken by Lowe at Puerto Libertad near Cabo Lobos. It should be noted that Lowe collected a single specimen on West San Benito Island in 1932 (SDNH no. 23685).

Chaetopleura (Pallochiton) euryplax Berry

(Plate 8, figure 2.)

*Chaetopleura raripustulosa* Pilsbry, in PILSBRY and LOWE, 1932, Proc. Acad. Sci. Philadelphia, vol. 84, p. 129. [A *nomen nudum.*] STEINBECK and RICKETTS, Sea of Cortez, 1941, p. 549.

*Chaetopleura (Pallochiton) euryplax* BERRY, 1945. The American Midland Naturalist, vol. 34, no. 2, pp. 491-492, text figs. 1-9 (p. 494); KEEN, 1958, p. 525, figs. 38 a-i.

Unfortunately, Pilsbry's notes do not cover this species. What he must have considered as a holotype and two paratypes are ANSP no. 152129 collected by Lowe at Guaymas in 1930. The label shows an original identification as "*C. lurida* Sowb.," which was later corrected with the pencilled note: "n.s.p. fewer lirae than *lurida* Sowb. *C. raripustulosa* Pils." The Lowe Collection at San Diego contains seven specimens collected by him at Guaymas in January, 1930, and labeled "paratypes" (Lowe no. 8183; SDNH no. 13240).

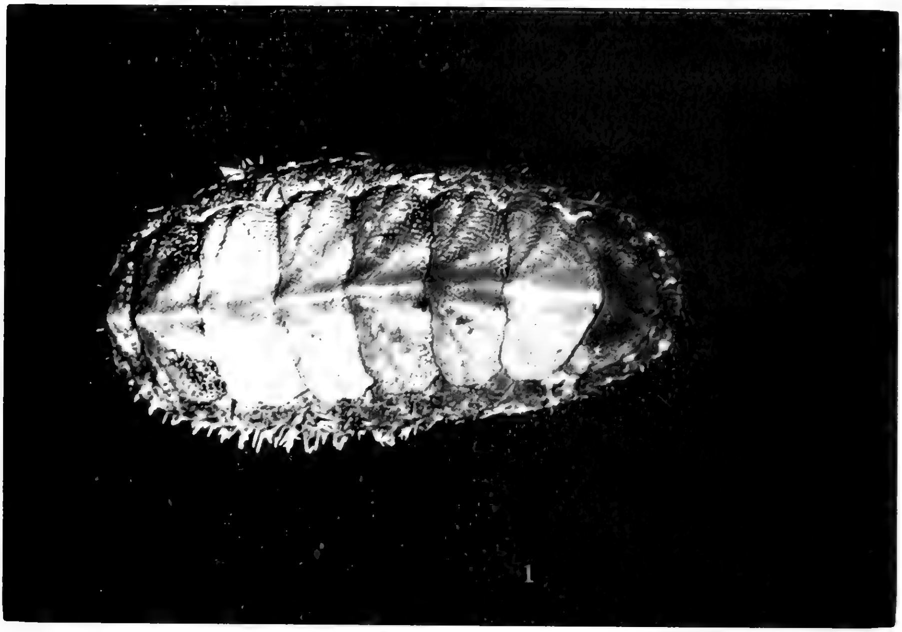
On the basis of considerable material collected in the Gulf of California recently there seems but little if any doubt that *C. raripustulosa* must fall into the synonymy of *C. euryplax*. Comparison of Dr. Berry's excellent description and figures, not only with the original lot of Pilsbry's material, but also with other specimens from the upper Gulf, both dry and in alcohol, can hardly lead to any other conclusion.

The name "*raripustulosa*" was well chosen by Dr. Pilsbry and it is to be regretted that it can have a status no better than a *nomen nudum.* Compared with *Chaetopleura (Pallochiton) lanuginosa* Carpenter in Dall, 1879, from the Pacific side of Baja California, *C. (P.) euryplax* tends to have fewer pustulate ribs on the tegmentum of all valves and a sparser distribution of the pustules themselves. This sculptural character is quite variable, however, and the elongated teeth of the head valve and other features pointed out by Dr. Berry must be used to differentiate between the two geographical

PLATE 8

Figure 1. *Nuttallina crossota* Berry. Hypotype, CAS Paleo. Type Coll. No. 12343 . Los Angeles Bay, Gulf of California. Faye Howard coll., March 1960. Length (dry), 12.8 mm. P. 82.

Figure 2. *Chaetopleura (Pallochiton) euryplax* Berry. Hypotypes, CAS Paleo. Type Coll. Nos. 12349-51. San Felipe, Baja California, G D. Hanna and J. Sefton, Jr., colls., 20-22 March 1951. Lengths (in alcohol), left to right, 35.0, 30.9, and 33.4 mm. P. 83.



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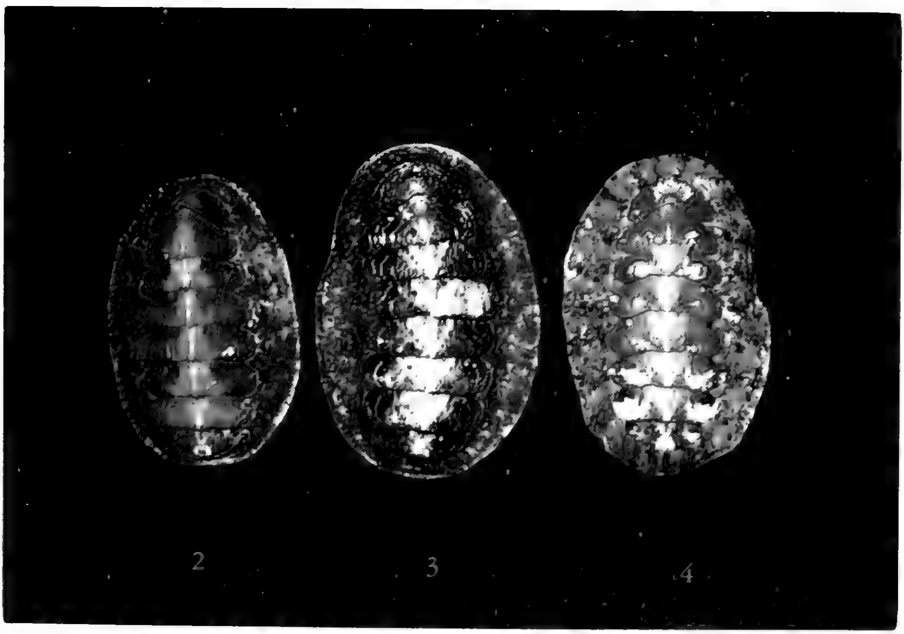

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assemblages. Color is not a criterion as this is also variable. It ranges from blackish to lighter brown specimens, such as those seen from Guaymas and Tiburon Island, to the fine, large specimens from San Felipe that run lighter in color with occasional white flammulations on the valves, or light greenish-brown with darker markings or sometimes with a pinkish band along the jugum. Dredged specimens from Conception Bay are smaller and generally redder, sometimes with reddish or yellowish-white bands on the jugal area or completely rose-red over all. It should be noted, however, that in all but one of the considerable number of Baja California pallochitons studied, the vertical white markings extending down the posterior slope of the tail valve are present (Pilsbry, 1893, 14: 258).

The present known distribution of *C. euryplax* may be inferred from table 1 which gives a list of material available for study:

TABLE 1

*List of collections of*
Chaetopleura euryplax *available for study*

| Locality | Collector & Date | Coll. no. | No. of Spec. | Pres. |
|---|---|---|---|---|
| Sonora, Mexico (Gulf of California, east side) | | | | |
| Guaymas | Lowe, 1930 | ANSP 152129 | 3 | Dry |
| Guaymas | Lowe, 1930 | SDNH 13240 | 7 | Dry |
| N. end, Tiburon Id. | Lowe, 1932 | SDNH 23652 | 4 | Dry |
| Baja California (Gulf of California, west side) | | | | |
| San Felipe (1) | Lowe, 1933 | SDNH 23649 | 12 | Dry |
| San Felipe (2) | G D. Hanna, 1951 | CAS 33281 | 16 | Alc. |
| San Felipe (3) | Faye Howard, 1959-60 | Howard | 11 | Dry |
| San Luis Gonzaga Bay | Faye Howard, 1960 | Howard | 1 | Dry |
| Conception Bay, 17 fms. | Lowe, 1932 | SDNH 23648 | 9 | Dry |

The type lot comes from Adair Bay, north of Punta Peñasco. The slit formula for the type lot of *C. euryplax* is given by Dr. Berry as 8-10: 1: 7-8. A slit count in several disarticulated specimens from the above lots indicates even more variability in the number of slits in the end valves, the formula ranging between 7: 1: 10 in a Conception Bay specimen and 8: 1: 8 in one from Tiburon Island. An 8: 1: 9 formula seems to be the most frequent. This compares with a slit formula for *C. lanuginosa* given by Pilsbry as 8-9: 1: 10-11. The relationship between *C. euryplax* from the upper end of the Gulf of California and *C. lanuginosa* from the Pacific side of the Baja California peninsula is close. There appear to be constant differences, however, between the two faunal assemblages, one being the brownish markings on the insides of the valves of *C. euryplax,* a feature not observed in the valves of *C. lanuginosa.* Should this be borne out from an examination of more material than is now available, valid grounds can probably be established to warrant reducing *C. euryplax* to the rank of a subspecies of *C. lanuginosa.*

It seems proper to note that no true Pallochitons have yet been seen or reported from Magdalena Bay south to Cape San Lucas on the Pacific side, and from there up into the lower end of the Gulf as far north as Guaymas, a distance roughly of 400-450 coast-line miles. Additional careful collecting could quite possibly fill this range gap. Of interest in this connection are four specimens in alcohol collected at 30 fathoms in the Gulf of Fonseca, El Salvador, by Mr. E. J. Purcell of Tucson, Arizona, in November, 1960, which have a remarkably close resemblance to *C. euryplax.* The principal difference appears to be in the configuration of the tail valve, which in *C. euryplax* is flattened, with the mucro nearly terminal, whereas in the specimens from El Salvador the mucro is slightly anterior to the center of the tegmentum area, with the posterior portion of the valve sloping sharply downward before flattening out to a less thickened posterior margin. In a partially disarticulated specimen, with a slit formula of 10: 1: 12, the teeth in the tail valve are much less thickened, sharper, and the slits are less obliquely cut than in the tail valve of *C. euryplax;* the internal semicircular ridge of callus also is proportionally less thickened. Whether these differences are constant and point to the existence of a geographical race of *C. euryplax* well south of its present known range can be left only to further study of more specimens from the general area than are now available.

**Ischnochiton colimensis A. G. Smith, new species.**

(Plate 9, figure 1.)

*Ischnochiton lowei* Pilsbry, in PILSBRY and LOWE, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 129. [A *nomen nudum.*]

The third of Pilsbry's undescribed species does not appear to have been reported upon subsequently. It is represented by a complete adult specimen, considered to be the holotype, and a disarticulated one including all eight valves and portions of the girdle, selected as a paratype (ANSP no. 152139). Although Pilsbry's notes on this lot state that paratypes of his *I. lowei* are in the Lowe Collection, these or anything like them have not been found. The original lot was collected at extreme low tide under stones at Manzanillo, Colima, Mexico. The species was stated to be rare.

The following diagnosis is based partly on the complete holotype and partly on the disarticulated paratype:

General appearance similar to *Lepidozona clathrata* (Reeve) from which it differs by having fewer radial ribs on the head and tail valves (12-13, many of them twinned); these ribs, as well as those on the lateral areas are irregularly but not as distinctly tuberculate as they are in *L. clathrata* and (in the paratype) are decorated with occasional, small, low rounded pustules which may represent a juvenile sculptural character that is lost with age and wear. The posterior borders of valves i to vii are very finely denticulate compared with the coarse denticulation in *L. clathrata.* The central areas show the usual latticed sculpture; the riblets of valve ii diverge slightly at the jugum but are generally parallel on subsequent valves, becoming wider spaced toward the sides and diverging forward, as usual in *Lepidozona.* There is no marked jugal area. The mucro of valve viii is low and slightly forward of the center of the tegmental area. Slit formula (of the paratype): 10: 1: 10; teeth not deeply cut. Insertion plates blunt, beveled on the end valves; eaves not appreciably overhanging, not spongy in structure. Sutural laminae sharp and shaped much as in *L. clathrata* but the jugal plate is relatively smooth and not notched at the sides nor denticulate across the sinus. Girdle normal, covered with usual overlapping scales, which are one-third smaller than those of *L. clathrata,* convex, very finely striate, and generally arranged in an oblique, forwardly-descending rather than longitudinal series.

Color of the dorsal area cinnamon, shading on the sides and ends into a dull brown, the girdle cinnamon tesselated with eight dull olivaceous spots on each side. Interior of valves whitish, with small bluegreen stains along the posterior edges and near the beaks.

Length (dry) of holotype, 24.5; width, 14.3 mm.

*Ischnochiton colimensis* can be separated easily from *L. clathrata* by the smaller, diagonally arranged girdle scales, and by the more cleanly cut sculpture of the dorsal surface of the valves, including the somewhat fewer ribs on the end valves and the lack of any strong pectination on the posterior edges of valves i to vii. Although comparison of *I. colimensis* has been made with a well-known common Baja California *Lepidozona,* to which it is sculpturally quite close, the lack of fine pectination along the jugal plate of the paratype, as well as the absence of notches at the ends of this plate argue for retaining the species in the genus *Ischnochiton* until more specimens can be examined for this feature, which is believed to have generic significance.

### Acanthochitona tabogensis A. G. Smith, new species.

(Plate 9, figure 2.)

*Acanthochitona panamensis* Pilsbry, in PILSBRY and LOWE, 1932, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, p. 130. [A *nomen nudum.*]

Valves rather depressed, rounded, not carinate, the side-slopes slightly convex. Jugal areas of intermediate valves sharply defined, more diverging anteriorly on valves ii and iii and less so on valves iv to viii, marked by extremely fine, closely spaced growth striae and by what appear to be fine longitudinal lines that are not incised but are actually part of the color pattern. Latero-pleural areas of intermediate valves covered with small, slightly ovate, low, closely spaced, concave-topped granules arranged in longitudinal rows generally parallel with the margins of the jugal areas. Head and tail valves with similar granules not arranged in any particular order. Mucro of tail valve projecting and situated a little behind the middle. The insertion plate of the head valve is narrowly grooved dorsally and is nearly half as long as the tegmentum area, with four dark bluish spots at the centers of each tooth back of their margins, a feature not occurring in Pilsbry's juvenile specimen. The tail valve has a tegmentum slightly wider than long, the outlines rounded in front, with a short, straight jugal margin and a nearly semicircular sinus; behind, the insertion plate is roughend outside, rather thick, with a straight terminal outline. Slit formula, 5: 1: 2.

Color of the dorsal areas generally blackish-brown over all, with a few lighter beige-colored granules bordering the jugal areas and elsewhere on some of the valves of the adult paratype; ventral sides dark bluish-green. In Pilsbry's juvenile specimen the insertion plates and sutural laminae are tinged with red-brown dorsally and are light bluish-green ventrally.

The broad girdle is covered with generally dark-colored, minute, closely-set, short spicules, with sutural rosettes of long, glassy, grayish-green spines; fringing spicules are bluish, especially when viewed from below.

Length of holotype, 28.5; width, 16.4 mm. Holotype and two paratypes, preserved dry, collected in 1931 at Taboga Island, Republic of Panama, by H. N. Lowe (SDNH no. 23668).

The type selected by Pilsbry for his *A. panamensis* (here designated as a paratype of *A. tabogensis*) is a partly disarticulated immature specimen about 15 mm. long, registered as ANSP no. 153556, which he collected during the Pinchot Expedition at Taboga Island, Panama, 31 May 1929. The lot collected by Lowe includes two adult specimens and one juvenile, which show the characters of both adult and immature stages. For this reason they are selected as the type lot, the adult paratype having been partially disarticulated for the purpose of the preceding diagnosis. An additional lot consists of two adult but much worn specimens and was collected by H. N. Lowe at San Juan del Sur, Nicaragua; it is registered as ANSP no. 155314. The species is also stated to have been collected by Lowe in Montijo Bay,

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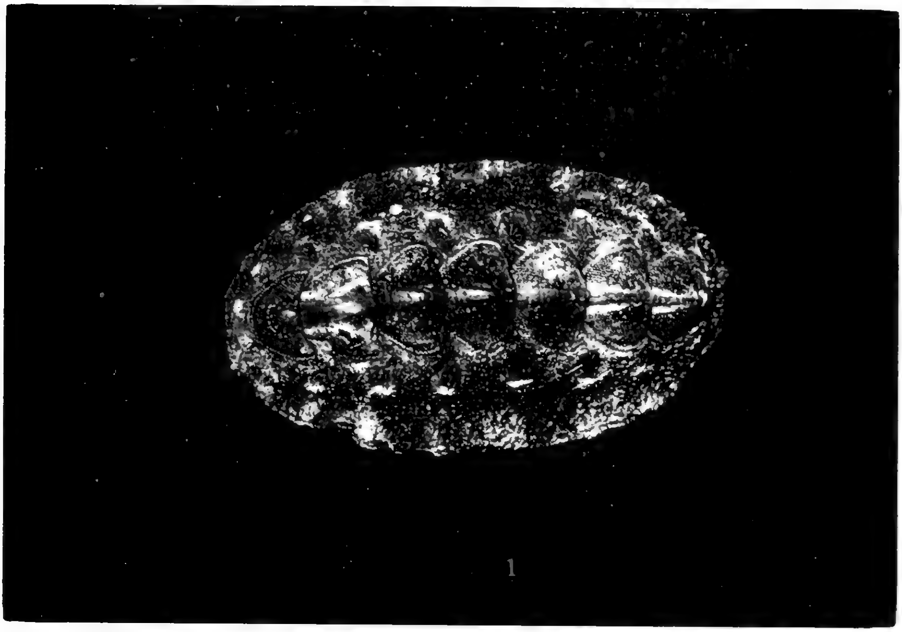
PLATE 9

Figure 1. *Ischnochiton colimensis* A. G. Smith, new species. Holotype, Academy of Natural Sciences of Philadelphia, no. 152139. Manzanillo Colima, Mexico. H.N. Lowe, coll. Length (dry) 24.5 mm. P. 86.

Figure 2. *Acanthochitona tabogensis* A.G. Smith, new species. Holotype, San Diego Society of Natural History, no. 23666. Taboga Island, Bay of Panama. H.N. Lowe, coll., 1931. Length (dry) 28.5 mm. P. 87.



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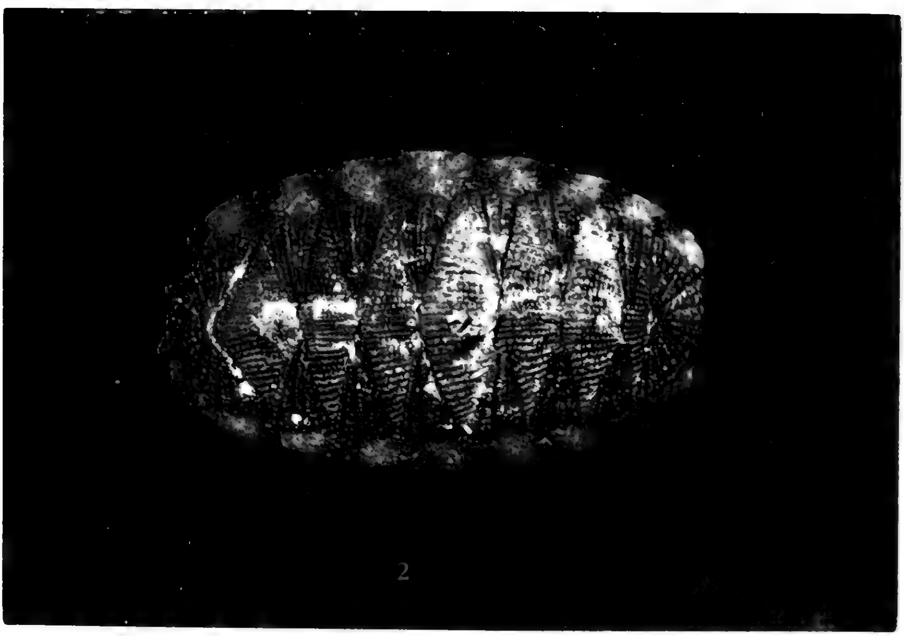

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# A PRELIMINARY REPORT ON THE HESPERIIDAE OF BAJA CALIFORNIA (LEPIDOPTERA)


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## Introduction

A contribution to an understanding of the biota of Baja California has been the objective of a number of biological explorations and reports. Since 1888 the California Academy of Sciences has played an especially prominent role in this regard (Nelson, 1921, pp. 143-144; Michelbacher and Ross, 1942, p. 1). Numerous entomological collections have been made, but until relatively recently the Lepidoptera of the peninsula were little studied. In his list of the Lepidoptera of Mexico, Hoffmann in 1941 attributed a number of hesperiids to the Baja California fauna, and in 1948, Rindge listed in some detail the butterflies of the region, including twenty-one species of skippers. More recently Powell (1958) and Patterson and Powell (1959) added substantially to the lists by Hoffmann and Rindge owing to their repeated collecting in Baja California Norte. Species of Hesperiidae reported for the peninsula now number exactly fifty. This figure may represent as little as one-half the total to be expected ultimately, and it includes several of quite doubtful occurrence.

There is need for much additional collecting on the peninsula, certainly in the more remote regions; but even along the well traveled routes. The hesperiid fauna has only been sampled as a by-product of general collecting in the region, and, although collectors have returned with many skippers, much is certain to have been overlooked. In addition, considering the climatic whimsy of this generally xeric region, together with the vast relatively inaccessible or inhospitable portions of the area, it is clear that much concentrated work must be done before we can consider the Hesperiidae well understood in Baja California.

The incompleteness of our knowledge of the total skipper fauna of Baja California notwithstanding, a fairly recognizable picture as to the origins of that fauna emerges from the portions thus far known. The hesperiid fauna of the peninsula is composed of three principal elements. The first of these is intrusive and its nature might be presumed from an examination of the conformation and position of the peninsula on maps as a California appendage in Mexico. The California element, however, presently extends into Baja California only about a quarter of the length of the peninsula, being essentially restricted to the northern boreal ranges and the coastal lowlands west of these. It is comprised of the fauna of boreal southern California and the Pacific slope. Certain endemic derivitives of this fauna in the extreme south of the peninsula represent insular relicts.

A second intrusive element enters the peninsula from the northeast and consists of austral representatives of the Sonoran biotic province of the southwestern United States and northwestern Mexico. Many of the species representing this portion of the fauna occur in Baja California as disjunct populations far removed from the nearest population clusters to the east and northeast, relicts of former closer association of habitable environments. Such species occur in the upper austral or in the dry boreal portions of the northern boreal ranges. Lower austral species of this fauna are present through the extensive eastern and central desert regions of the peninsula, and in the northwest mingle to some extent with the lowland California fauna. The Sonoran element of the central deserts penetrates well into the southern part of the peninsula and mingles with the neo-tropical element in the lowlands of the Cape Region. A few endemic derivitives of upper austral species of this Sonoran element are isolated in the higher mountains of the Cape Region.

The most conspicuous fauna in the Cape Region is comprised of a neotropical element which is widely distributed on the mainland of Mexico, principally species which also attain the sub-boreal regions of the central plateau of Mexico. Such species are restricted, or nearly so, to the once isolated Cape Region of the peninsula, but some extend northward along the Sierra de la Giganta to the vicinity of Concepcion Bay on the gulf coast.

This paper is intended to represent a compilation of all published reports of Hesperiidae in Baja California, with added comments concerning the probable distribution of the species. Any compilation, in attempting to summarize the pertinent published knowledge, also serves to emphasize, intentionally or not, the incompleteness of that knowledge. To state that the latter function constitutes the major contribution of this paper would be to suggest a cliché, in the form of a well known Shakespearian title, as a handy means of reference to what follows here. I have no intention of doing that. Nevertheless, it is my hope that the quite conspicuous gaps in our knowledge, together with the brief suggestions offered as to the nature of some of the problems, will serve as well as my mistakes to stimulate further interest in the skippers of this region. A good deal of such interest and resultant field work is essential before sufficient information will accumulate to make possible the publication of a comprehensive treatment on the Hesperiidae of Baja California.

All material cited under additional records is in the collection of the California Academy of Sciences unless the parenthetical abbreviation symbols (AMNH) or (CIS) indicate otherwise. Species designated with an asterisk (*) are those of which I have not seen specimens from Baja California. The genus *Erynnis* Schrank is omitted from this paper because Dr. John M. Burns is treating the Baja California material in considerable detail in his monograph of this group. The Megathymidae, considered a separate family of skippers, also are not treated here.

In view of the fragmentary state of our knowledge of this family in Baja California I am including no keys or descriptions in this paper. No new names are introduced here. In several instances rather striking geographic segregates seem to be suggested but, owing to insufficient material, any such conclusions must remain tentative. In these cases, a brief diagnostic statement is provided indicating the nature of variation reflected by the available sample. In other instances, some geographic variation of a minor nature is indicated in adequate samples, but such diversion is not considered to be of sufficient magnitude to warrant a subspecific designation.

The terminal bibliography contains only papers dealing with or citing Baja California. The synonymical citations provided for each species include, aside from the original description, only references specifically placing that name on the faunal list for Baja California, and I have attempted to include all such citations. Published statements which embrace this region by inference from a broad generalization of geographic range, for example "En todo la Republica" for Mexico, are neither cited, nor interpreted, as constituting a reference to Baja California for the species concerned. Hoffmann (1941) made many such generalized statements: some for species almost certainly not inhabitants of this region, others for species definitely recorded for the area, and still others for species which probably occur there but have not yet been reported. Hoffmann, in referring a species to the fauna of Baja California, provided no definite locality data. There is reason to doubt that he actually had seen any specimens from that region. It is known that he obtained a collection from Medlar for San Diego County, California, and there seems to be no material from Baja California in the Hoffmann collection at the American Museum (Rindge, *in lit*). It is quite possible that from the San Diego County collection and the several publications dealing with southern California butterflies, he inferred the composition of the fauna of Baja California Norte.

The important works by Eisen (1895) and by Nelson (1921) provide excellent physical and biotic descriptions of the region. Historically important discussions of entomological expeditions to the peninsula are presented in the two above-mentioned works, as well as by Slevin (1923) and Michelbacher and Ross (1942). Localities mentioned in previous accounts may be located on one or more of the maps provided by Eisen (1895), Nelson (1921), Michelbacher and Ross (1941), and Patterson and Powell (1959).

## Acknowledgments

I am indebted to Dr. Jerry A. Powell of the California Insect Survey, University of California, Berkeley (CIS) and to Dr. Fred H. Rindge of the American Museum of Natural History (AMNH) for the loan of material in their care from their several expeditions to Baja California.

Mr. Hugh B. Leech and Dr. Edward S. Ross, both of the California Academy of Sciences, and Mr. Don Patterson of Burlingame, California, provided many useful impressions gained during their trips to the Cape Region. Dr. Powell also contributed important comments and observations concerning the region and fauna with which he was familiar. Dr. Rindge very kindly examined critical parts of the Carlos Hoffmann collection for me and offered several helpful suggestions. To all I extend my thanks.

The expeditions of H. B. Leech (1959) and D. Patterson (1959) to the Cape Region of the peninsula were made possible through the generous support of the Belvedere Foundation.

## Species Treated

### Epargyreus clarus clarus (Cramer).

*Papilio clarus* CRAMER, 1779, Pap. Exot., vol. 1, p. 66, pl. 41, figs. E, F.
*Proteides clarus*, HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 245.
*Epargyreus clarus*, DIXON, 1955, Ent. News, vol. 66, pp. 6, 7.
*Epargyreus clarus ? huachuca*, PATTERSON and POWELL (not Dixon, 1955), 1959, Jour. Lep. Soc., vol. 13, p. 232.

*Epargyreus clarus* is to be expected only in the northern boreal ranges of the peninsula. The Sierra San Pedro Martir represents the southern distributional limit of the Pacific slope populations of this species. The specimen referred to by Patterson and Powell has been examined and does not resemble

the populations of southeastern Arizona as defined by Dixon (1955, pp. 7-9).
No additional material has been seen.

***Epargyreus exadeus** (Cramer).

*Papilio exadeus* CRAMER, 1782, Pap. Exot., vol. 3, p. 118, pl. 260, fig. C.
*Proteides exadeus*, HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 245.

Hoffmann's reference to the occurrence of this species in Baja California is open to question for two reasons. The genus was revised in 1952 and the specific definitions of five Mexican species superficially resembling *E. exadeus* were tentatively set forth at that time. Consequently many of the previous references to this species applied to one or more of these five insects, and the Hoffmann reference conceivably applied to all five species. Without examination of the specimen upon which the Baja California record was based it is impossible to do other than cite Hoffmann's determination.

There is in addition, some doubt that Hoffmann had seen any specimens of this complex from Baja California. As previously mentioned, Hoffmann may have attributed many species to the peninsula by inference from published reports on southern California and Arizona lepidoptera. "*Epargyreus exadeus*" has been reported to occur in southern California but it certainly cannot be considered resident in that state. Rindge *(in lit.)* reports he was unable to locate in the American Museum any Hoffmann specimens of this complex from Baja California.

**Chioides catillus albofasciatus** (Hewitson).

*Eudamus albofasciatus* HEWITSON, 1867, Desc. Hesp., p. 3.
*Chioides albofasciatus*, RINDGE, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 305.

This species is distributed throughout the Cape Region and the adjacent offshore islands. It extends northward along the Sierra de la Giganta where it is probably confined to the relatively lush canyon bottoms.

Specimens from the Cape Region reflect the insular nature of the area in that they slightly differ phenotypically from the populations of the mainland. The wings are much more broadly dark, almost blackish brown above and below. On the under surface the gray marginal overscaling is more extensive and prominent, and the rusty patches adjacent to the white band of the hindwings are more contrasted to the darker ground color. The translucent spots of the forewing above are well developed with a costal spot usually distinct above the cell, and there is a tendency for the normally small spot in cell Cu 2 (space 1b) to be enlarged across the cell as a constricted or double spot. The forewings tend to be more produced apically than is usual, particularly in the females.

Additional records: *Baja California:* San Pedro, about 4 miles S. Todos Santos, 1 female, I-13-59 (H. B. Leech); 2 miles N. Colonia Calles on Highway Sur 17, 2 males, 1 female, I-15-59 (H.B.Leech); 3 miles NW. La Palmilla on Highway Sur 19, 2 males, I-18-59 (H. B. Leech); Rancho Potrero, 14 mi. up canyon San Pedro from Caduano, 1 male, V-9-59 (D. Patterson), 4 males, 1 female, V-10-59 (D. Patterson).

*Codatractus arizonensis (Skinner).

*Heteropia melon* var *arizonensis* Skinner, 1905, Ent. News, vol. 16, p. 232.
*Heteropia cyda,* Rindge (not Godman, 1901), 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 306.

The specimen recorded by Rindge is tentatively placed in this species. The specimen was not located in the American Museum material and so could not be re-examined. Superficially *C. cyda* somewhat resembles *C. arizonensis* and, based upon the mainland distribution of the genus in Mexico, *C. arizonensis* is most likely to be the species represented in the Cape Region of the peninsula. *Codatractus arizonensis* is reasonably to be expected in this area and until such time as the specimen is located or further material becomes available, the name is provisionally included on the faunal list.

Goniurus proteus proteus (Linnaeus).

*Papilio proteus* Linnaeus, 1758, Syst. Nat., 10th Ed., vol. 1, p. 484.
*Urbanus proteus,* Rindge, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 305.

Populations in Baja California do not significantly differ from mainland populations of this widespread species. *Goniurus proteus* is well established in the Cape Region but may also be expected in the northern state west of the Sierra Juarez and the Sierra San Pedro Martir.

Additional records: San Pedro, about 4 miles S. Todos Santos, 1 female, I-30-59 (H. B. Leech); 3.4 miles NE. Cabo San Lucas on Highway Sur 19, 1 female, I-1-59 (H. B. Leech); Buena Vista, Highway Sur 19, 2 females, I-6-59 (H. B. Leech); 39.5 miles S. La Paz on road to Todos Santos, 2 females, XII-24-58 (H. B. Leech); near ocean beach 2 miles E. El Coyote, NE. La Paz, 3 males, XII-30-58 (H. B. Leech).

Goniurus dorantes calafia (Williams).

*Eudamus dorantes* race *calafia* Williams, 1926, Trans. Amer. Ent. Soc., vol. 52, p. 63, pl. 2, fig. 2.
*Urbanus dorantes calafia,* Hoffmann, 1941, An. Inst. Biol. Mex., vol. 12, p. 242.
*Urbanus dorantes,* Rindge, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 305.

This widespread species, although individually variable, does not display any well marked geographical variation through its mainland range from southwestern United States to Argentina and Chile. Most insular populations, however, are quite distinctive and several island subspecies are recognized. The populations inhabiting the Cape Region of Baja California are consistently different in several characteristics from those of the nearby mainland. Skinner's name for this population has been either ignored or synonymized with that for the nomenotypic subspecies by all authors but Hoffmann, who very likely had seen no material from the peninsula. The name is here re-instated and, since Skinner's description was very brief and his figure rather poor, I will emphasize the diagnostic features as follows:

Wings above as in *G. dorantes dorantes* except that in fresh specimens the abundant pale overscaling produces a quite grizzled appearance, and the basal anal and discal hair vestiture is pale gray-olive which conspicuously contrasts with the dark brown of the hairless outer portions of the wings. The hindwings below largely lack a violet cast and are much paler, being cream-brown to pale gray except for the dark bands. The marginal area distad of the discal dark band is conspicuously pale, often quite whitish, as is the cell and costal area to the apex of the forewing.

Additional records: 39.5 miles S. La Paz on road to Todos Santos, 2 males, 1 female, XII-24-58 (H. B. Leech); 17.5 miles N. Todos Santos, road to La Paz, 3 males XII-26-58 (H. B. Leech); 5.5 miles NW. Todos Santos, 1 female, I-13-59 (H. B. Leech); Punta Lobos, 1 mile SE. Todos Santos, 1 male, 1 female, XII-25-58 (H. B. Leech); 2 miles N. Coloma Calles on Highway Sur 17, 1 male, I-15-59 (H. B. Leech); 2 miles N. Cabo San Lucas on Highway Sur 17, 1 male, I-15-59 (H. B. Leech); Cabo San Lucas, 2 males, I-16-59 (H. B. Leech); 3.4 miles NE. Cabo San Lucas on Highway Sur 19, 4 males, 2 females, I-1-59 (H. B. Leech); 7.7 miles NE. Cabo San Lucas, 1 male, I-1-59 (H. B. Leech); 7 miles N. Santa Anita on Highway Sur 19, 1 male, 5 females, I-7-59 (H. B. Leech); 1.3 miles N. San Jose Viejo on Highway Sur 19, 1 male, I-7-59 (H. B. Leech); Rancho Cayucos, 7 miles up Canyon San Pedro from Caduano, 1 male, 1 female, V-7-59 (D. Patterson); Rancho Potrero, 14 miles up Canyon San Pedro from Caduano, 1 male, V-9-59 (D. Patterson); Bahia de los Muertos, 1 female, XII-20-58 (H. B. Leech); 18.5 miles from La Paz airport, Los Planes Road, 3 males, 2 females, XII-19-58 (H.B. Leech); 14.5 miles E. La Paz on road to Las Cruces, 1 male, 2 females, I-4-59 (H. B. Leech).

## Thorybes pylades (Scudder).

*Eudamus pylades* Scudder, 1870, Proc. Bost. Soc. Nat. Hist., vol. 13, p. 207.

*Thorybes pylades*, Patterson and Powell, 1959, Jour. Lep. Soc., vol. 13, pp. 232, 233.

This is a species extending into the northern boreal ranges of Baja California from the Pacific slope to the north. Populations of *T. pylades* may exist in the Sierra de la Victoria in the Cape Region as well, in which case it would not be surprising if they comprised a well defined subspecies.

No material other than that mentioned by Patterson and Powell has been seen.

***Thorybes mexicana mexicana** (Herrich-Schäffer).

*Eudamus mexicana* HERRICH-SCHÄFFER, 1869, Corr. Blatt. Regensb., vol. 23, p. 188.

*Thorybes mexicana,* HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 249.

*Thorybes mexicana* must be considered of doubtful occurrence in Baja California. Hoffmann's record is very likely based upon southern California specimens of *T. pylades* which were misidentified in several earlier publications as *T. mexicana.*

**Cogia hippalus** subsp.

*Eudamus hippalus* EDWARDS, 1882, Papilio, vol. 2, p. 27.

This species has not previously been reported for Baja California. If the population shares the characteristics of the specimen described below, it is sufficiently distinct to warrant a subspecific designation. Additional material must be available, of course, before the population can be adequately defined.

The specimen is slightly smaller and darker than most mainland representatives of *C. hippalus,* measuring 19 mm. from base to apex of one forewing (compared with an average of about 22 mm.). Forewing above with discal spots very slender except for that in cell $M_3$ (space 3) which is nearly quadrate, much less than twice as long as broad. Costal spot above discal cell very elongate, its length nearly twice the greatest width of the cell spot. Basal and discal hair vestiture brown, without any ochre tint, hence scarcely contrasting to brown ground color of wings. Fringes light brown with dark-brown broad checkering suggested, but vanal portion of fringe smoky gray. Hindwings with fringe strongly checkered, the dark-brown portions broad, exceeding the gray areas which are brown basally. The vanal pale portion of fringe becoming dirty white outwardly. Below as normal but dark bands of hindwing very broad, their width equal to that of intervening paler violet-brown areas. No whitish bloom marginal to discal dark band. Fringe brown with narrow whitish interruptions.

Populations more closely allied to the nomenotypic subspecies may occur in the Sierra San Pedro Martir. The specimen recorded below represents a population in the Sierra de la Victoria of the Cape Region: Rancho Potrero, 14 miles up Canyon San Pedro from Caduano, 1 male, V-11-59 (D. Patterson).

**Staphylus ceos** (Edwards).

*Pholisora ceos* Edwards, 1882, Papilio, vol. 2, p 140.

*Staphylos ceos*, Patterson and Powell, 1959, Jour. Lep. Soc., vol. 13, p. 232.

This species is known only from the Sierra San Pedro Martir at present. It represents part of the disjunct intrusive element from the Sonoran mountain districts of southeastern Arizona and northwestern Mexico far to the east. The species should also occur in the Cape Region.

No additional material has been examined.

***Systasea pulverulenta** (Felder).

*Leucochitonea pulverulenta* Felder, 1869, Verh. Zool. Bot. Ges. Wien, vol. 19, p. 478.

*Antigonus pulverulenta*, Rindge (in part?), 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 307.

If this species occurs in Baja California at all it is probably restricted to the Cape Region. I have examined a portion of the material reported under this name by Rindge (1948, p. 307) but have not seen specimens which he recorded from Cape San Lucas, Pulpito Bay, or Puerto Escondido. It is likely that these specimens, like all the Baja California material of this genus I have examined, belong to the following species. The records of this species on the peninsula require verification.

**Systasea evansi** (Bell).

*Antigonus evansi* Bell, 1941, Ent. News, vol. 52, pp. 165-167, fig. 2.

*Antigonus pulverulenta*, Rindge (in part) (not Felder, 1869), 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 307.

*Systasea evansi*, Powell, 1958, Lepid. News, vol. 12, p. 31.

It is rather interesting that this species ranges the length of the peninsula inasmuch as it evidently scarcely penetrates into Mexico on the central plateau of the mainland, being instead replaced by *S. pulverulenta*. It may be, of course, that the distribution of this species in northern Mexico is not really understood, and the contrast to the range in Baja California therefore more apparent than real. The known records of this species from the peninsula form clusters both to the northwest and to the south of the vast central barrier of the Viscaino Desert. *Systasea evansi* probably occurs in isolated colonies within the central desert region as well. The species extends into the peninsula from California along the eastern desert escarpment of the northern boreal ranges.

In his description of this species Bell (1941, p. 167) mentions that part of the type series was from Baja California.

Additional records: Aquajita (*sic*), 1 female, III-5-35; 3 miles NW. La Palmilla on Highway Sur 19, 1 male, I-18-59 (H. B. Leech).

**Chiomara asychis georgina** (Reakirt).

*Pyrgus georgina* REAKIRT, 1868, Proc. Acad. Nat. Sci. Phil., vol. 20, p. 88.
*Pyrgus pelagica* WEEKS, 1891, Can. Ent., vol. 23, p. 126; WEEKS, 1905, Illust. Diurn. Lep., pp. 4-5, pl. 1, fig. 5.
*Chiomara asychis*, HOFFMANN, 1941, An. Inst. Biol. Mex. vol. 12, p. 264; RINDGE 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 307.

The northernmost record for this species on the peninsula is the Concepcion Bay locality reported below, which may be very near the northern limits of its range in Baja California.

ADDITIONAL RECORDS: 17.5 miles N. Todos Santos on road to La Paz, 1 female, XII-26-58 (H. B. Leech); 5.5 miles NW. Todos Santos, road to La Pastora, 1 male, I-13-59 (H. B. Leech); San Pedro, about 4 miles S. Todos Santos, 4 males, I-13-59 (H. B. Leech); 9 miles S. Todos Santos on Highway Sur 17, 1 male, I-14-59 (H. B. Leech); 2 miles N. Cabo San Lucas on Highway Sur 17, 1 male, I-15-59 (H. B. Leech); Cabo San Lucas, 3 males, I-17-59 (H. B. Leech); 3.4 miles NE. Cabo San Lucas on Highway Sur 19, 1 male, I-1-59 (H. B. Leech); 7 miles N. Santa Anita on Highway Sur 19, 1 male, I-7-59 (H. B. Leech); San Bartolo, 2 males, I-20-59 (H. B. Leech); 25 miles SE. La Paz on Highway Sur 19, 1 male, I-21-59 (H. B. Leech); near ocean beach, 2 miles E. El Coyote, NE. of La Paz, 1 male, XII-30-58 (H. B. Leech); Coyote Cove, Concepcion Bay, 1 male, X-1-41 (Ross and Bohart).

**Erynnis** spp.

(The half-dozen species of *Erynnis* Schrank known for Baja California are being treated in detail elsewhere. See introduction.)

**Pyrgus scriptura** (Boisduval).

*Syrichtus scriptura* BOISDUVAL, 1852, Ann. Soc. Ent. France (ser. 2), vol. 10, p. 312.
*Pyrgus scriptura*, PATTERSON and POWELL, 1959, Jour. Lep. Soc., vol. 13, p. 231.

Known in Baja California only from the single specimen mentioned by Patterson and Powell, this species should be found fairly commonly associated with disturbed areas, particularly agricultural communities, in the north State.

**Pyrgus communis albescens** Plötz.

*Pyrgus tesselata*, WRIGHT (not Hewitson, 1866), 1883, Papilio, vol. 3, p. 119.
*Pyrgus albescens* PLÖTZ, 1884, Mitth. Nat. Ver. Vorpomm., vol. 15, p. 4.
*Pyrgus communis albescens*, RINDGE, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 306; POWELL, 1958, Lepid. News, vol. 12, p. 31.

This widespread species should be found throughout the peninsula in all but the most barren areas.

ADDITIONAL RECORDS: 2 miles W. Socorro, 3000', Sierra San Pedro Martir, 2 males, V-26-58 (J. A. Powell, CIS); Socorro, 4000', Sierra San Pedro Martir, 1 male, V-26-58 (J. A. Powell, CIS); 2 miles W. La Sanja, 6500', Sierra San Pedro Martir, 1 female, VI-2-58 (J. A. Powell, CIS); La Grulla, 6500', Sierra San Pedro Martir, 1 male, V-28-58 (J. A. Powell, CIS), 1 female, V-29-58 (J. A. Powell (CIS), 1 female, V-30-58 (J. A. Powell, CIS), 1 female, VI-1-58 (J. A. Powell, CIS); La Encantada, 7000', Sierra San Pedro Martir, 1 male, V-30-58 (J. A. Powell, CIS); 19.2 miles W. La Paz, [El Rancho] Rodrigues, 2 females, XII-31-58 (H. B. Leech); 21.6 miles N. Todos Santos, road to La Paz, 1 male, XII-26-58 (H. B. Leech); 3 miles NW. Miraflores, 1 female, I-19-59 (H. B. Leech).

**Pyrgus philetas** Edwards.

*Pyrgus philetas* EDWARDS, 1881, Papilio, vol. 1, p. 46; RINDGE, 1948, Proc. Cal Acad. Sci., fourth ser., vol. 24, p. 306.

*Pyrgus philetas* has recently been placed as a subspecies of *P. oilus* (L.) (=*P. syrichtus* Fab.) but is a distinct species. The two species are broadly sympatric in Mexico and I have taken them together at several widely separated localities on the mainland.

The species in Baja California is confined to the Cape Region. The population phenotypically is similar to those elsewhere except for the commonly expressed tendency of the lower surface of the hindwings in both sexes to be suffused with a smoky-ochreous shade which blurs the usually sharply defined dark bands and spots. This dark, rather than gray-white, color of the hindwings below also is frequent among specimens from the mainland, but it appears as a distinct reddish-brown color, not a vague suffusion, and the dark bands and spots are maintained in sharply defined contrast.

ADDITIONAL RECORDS: 2 miles N. Colonia Calles on Highway Sur 17, 2 males, 1 female, I-15-59 (H. B. Leech); 17.5 miles NW. Cabo San Lucas, 2 females, I-15-59 (H. B. Leech); 2 miles N. Cabo San Lucas on Highway Sur 17, 4 males, I-15-59 (H. B. Leech); Cabo San Lucas, 1 male, 1 female, I-17-59 (H. B. Leech); 7 miles N. Santa Anita on Highway Sur 19, 1 female, I-7-59 (H.B.Leech); 3 miles NW. Miraflores, 6 males, 2 females, I-19-59 (H.B.Leech); Rancho Cayucos, 7 miles up Canyon San Pedro from Caduano, 1 male, V-7-59 (D. Patterson); Rancho Potrero, 14 miles up Canyon San Pedro from Caduano, 1 male, V-10-59 (D. Patterson), 1 female, V-11-59 (D. Patterson); 18.5 miles from La Paz airport on road to Las Planas, 1 female, XII-19-58 (H. B. Leech).

**Heliopetes domicella domicella** (Erichson).

*Syrichtus domicella* Erichson, 1848, Schomb. Reise in Brit. Guiana, vol. 3, p. 604.

*Pyrgus domicella*, Rindge, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 306.

But few specimens are known from the peninsula; all from the southern region. The species may also occur in the canyons of the Sierra San Pedro Martir, and in the more lushly vegetated canyons and washes of the central desert region.

Additional records: Cabo San Lucas, 1 male, I-17-59 (H. B. Leech).

**Heliopetes ericetorum** (Boisduval).

*Syrichtus ericetorum* Boisduval, 1852, Ann. Soc. Ent. France, ser. 2, vol. 10, p. 313.

*Heliopetes ericetorum*, Powell, 1958, Lepid. News, vol. 12, p. 31; Patterson and Powell, 1959, Jour. Lep. Soc., vol. 13, p. 232.

This species is confined to Baja California Norte in the mountain regions. It represents, on the peninsula, an essentially Californian intrusion which reaches its southern limits in the Sierra San Pedro Martir.

No additional specimens have been seen.

**Heliopetes laviana laviana** (Hewitson).

*Leucochitonea laviana* Hewitson, 1868, Desc. Hesp., p. 48.

*Heliopetes laviana*, Rindge, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, pp. 306-307.

This wide-spread tropical species occurs commonly in the Cape Region in the mountains as well as the lowlands, and extends north along the Sierra de la Giganta.

The rich yellow olive or cream suffusion of the lower-wing surface is striking in all of these peninsula specimens, but examples from the mainland which display a similar suffusion of equal magnitude are rather frequent. The Baja California populations are, if anything, somewhat less variable in appearance than are those from elsewhere.

Additional records: 39.5 miles S. La Paz on road to Todos Santos, 1 male, XII-24-58 (H. B. Leech); 17.5 miles N. Todos Santos, road to La Paz, 1 male, XII-26-58 (H. B. Leech); San Pedro about 4 miles S. Todos Santos, 6 females, I-13-59 (H. B. Leech); 9 miles S. Todos Santos on Highway Sur 17, 1 female, I-14-59 (H. B. Leech); 2 miles N. Cabo San Lucas on Highway Sur 17, 1 male, I-15-59 (H. B. Leech); 3.4 miles NE. Cabo San Lucas on Highway Sur 19, 2 males, 1 female, I-1-59 (H. B. Leech); 7.7 miles NE. Cabo San Lucas, 1 male, I-1-59 (H. B. Leech); 3 miles NW. La Palmilla on Highway Sur 19, 2 males, I-18-59 (H. B. Leech); Rancho Potrero, 14 miles up Canyon San Pedro from Caduano, 2 males, V-9-59 (D. Patterson), 1 male, V-10-59.

### Pholisora catullus (Fabricius).

*Hesperia catullus* FABRICIUS, 1793, Ent. Syst., vol. 3, p. 348.
*Pholisora catullus,* HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 262; POWELL, 1958, Lepid. News, vol. 12, p. 31.

Very few specimens of this species are known from Baja California, but the insect probably occurs throughout much of the peninsula.

ADDITIONAL RECORDS: Coyote Cove, Concepcion Bay, 1 female, X-1-41 (Ross and Bohart); Arroyo San Bartolo, 1 mile SE. San Bartolo, 1 male, I-8-59 (H. B. Leech).

### *Pholisora mejicanus (Reakirt).

*Nisoniades mejicanus* REAKIRT, 1866, Proc. Acad. Nat. Sci. Phil., vol. 18, p. 334.
*Pholisora mejicanus,* HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 262.

This is another of the species listed by Hoffmann without any specific locality for Baja California. I have seen no specimens from the region, and rather doubt that Hoffmann had. It may occur in the Cape Region but for the present must be considered to be of doubtful occurrence on the peninsula.

### Pholisora libya (Scudder).

*Heteropterus libya* SCUDDER, 1878, Bull. Geol. Surv. Terr., vol. 4, p. 258.
*Pholisora libya,* HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 262; RINDGE, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 307; POWELL, 1958, Lepid. News, vol. 12, p. 31.

A desert species, *P. libya* has only been taken, up to now, in Baja California Norte. It should be widely distributed throughout the Viscaino Desert well into the southern portion of the peninsula.

No recently collected material has been seen.

### Nastra neamathla (Skinner and Williams).

*Lerodea neamathla* SKINNER and WILLIAMS, 1923, Trans. Amer. Ent. Soc., vol. 49, p. 145, fig. 33.

This species has not previously been reported for Baja California. *Nastra neamathla* occurs in the Sierra de la Victoria of the Cape Region. The insect is known to be resident on the central plateau of Mexico, and in the gulf area of the United States, particularly. Its distribution in the southwestern states and in western Mexico is not well understood, but this species, as well as another of the genus, occurs in southwestern Arizona and should be expected in the delta region of northeastern Baja California.

MATERIAL EXAMINED: Rancho Potrero, 14 miles up Canyon San Pedro from Caduano, 3 males, 2 females, V-10-59 (D. Patterson), 1 female, V-11-59 (D. Patterson).

***Parphorus decora** (Herrich-Schäffer).

*Cobalus decora* HERRICH-SCHÄFFER, 1869, Prodr. Syst. Lep., vol. 3, p. 81.
*Vorates decorus,* RINDGE, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 310.

Rindge records this insect from Santa Maria Bay in the southern territory. He stated (*in lit.*) that he was unable to locate the specimen under that name in the American Museum collection. It is probable that the specimen was determined as belonging to another species, possibly *Panoquina panoquinoides* and will be found under that series. Females of *P. panoquinoides* from that region frequently are unmarked on the hindwings below except for the very obvious yellow veins, a conspicuous feature of *P. decora,* as well as many other hesperiines. *Panoquina panoquinoides* is, however, the only dark-brown, yellow-veined skipper definitely known to be resident along the coasts of Baja California. I cannot at the present, rule out the possibility that *P. decora* is a part of the Baja California fauna; however, the species is an inhabitant of tropical Mexico and I doubt that it occurs very far north along the western mainland coast. The name is retained here as of very doubtful occurrence.

**Copaeodes aurantiaca** (Hewitson).

*Ancyloxipha aurantiaca* HEWITSON, 1868, Descr. Hesp., p. 45.
*Copaeodes aurantiaca,* RINDGE, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 308; POWELL, 1958, Lepid. News, vol. 12, p. 31.

Known from numerous localities in the Cape Region and along the east coast of the southern territory, this species has seldom been collected in the north. The insect should be found generally distributed throughout the peninsula and is probably the dominant skipper of the vast central deserts. It should be especially common in the lowland canyons and washes, but can be expected as well in all the mountains except for the highest portions of the northern ranges.

ADDITIONAL RECORDS: Las Encinas, 6000', Sierra San Pedro Martir, 1 male, VI-2-58 (J.A. Powell, CIS), 1 male, VI-3-58 (J.A. Powell, CIS); 21.6 miles N. Todos Santos, road to La Paz, 1 male, XII-26-58 (H. B. Leech); 9

miles S. Todos Santos on Highway Sur 17, 1 female, I-14-59 (H. B. Leech); Cabo San Lucas, 3 males, 3 females, I-17-59 (H. B. Leech); 7.7 miles NE. Cabo San Lucas, 1 female, I-1-59 (H. B. Leech); 3 miles NW. Miraflores, 1 male, I-19-59 (H. B. Leech); Rancho Potrero, 14 miles up Canyon San Pedro from Caduano, 1 male, V-10-59 (D.Patterson), 1 male, V-12-59 (D. Patterson).

***Pseudocopaeodes eunus** (Edwards).

*Copaeodes eunus* EDWARDS, 1881. Papilio, vol. 1, p. 47.

*Pseudocopaeodes eunus,* HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 267.

This species, recorded for the peninsula without specific reference to locality by Hoffmann, probably inhabits the eastern escarpment of the Sierra Juarez and the Sierra San Pedro Martir. It may also occur in the northeastern delta region, particularly where the land has been somewhat disturbed by agriculture. The insect is known from very close to the border in the California desert foothills and, although I know of no specific Baja California records, I see no reason to doubt that the species resides in the northern State.

***Hesperia juba** (Scudder).

*Pamphila juba* SCUDDER, 1872, Rept. Peabody Acad. Sci., vol. for 1871, p. 77.

*Hesperia viridis,* HOFFMANN (not Edwards, 1883), 1941, An. Inst. Biol. Mex. vol. 12, p. 268.

I have seen no specimens of *H. juba* from Baja California but there is no question but that the insect occurs in the northern boreal ranges, at least in the Sierra Juarez. Dr. Jerry Powell (personal communication) reports a sight record in this region of an hesperia which, from his description, almost certainly refers to this species.

Hoffman's hesitant reference to *H. viridis* unquestionably applies to *H. juba* since he restricted the citation to "Baja California (Norte)(?)." Southern California lepidopterists commonly used the name *H. viridis* for the local *H. juba* both in their collections and in publication. As was mentioned, Hoffmann evidently largely depended upon a collection and publications of southern California Lepidoptera for his interpretations of the Baja California fauna. *Hesperia viridis* does not occur in southern California; the nearest population known is in southeastern Arizona where it constitutes an intrusion from the Rocky Mountains. There are, to my knowledge, as yet no published authentic records for *H. viridis* in Mexico.

***Hesperia harpalus leussleri** Lindsey.

*Hesperia colorado* form *leussleri* LINDSEY, 1940. Ann. Ent. Soc. Amer., vol. 33, pp. 373-375; HOFFMANN, 1941. An. Inst. Biol. Mex., vol. 12, p. 268.

This is another species credited to the fauna by Hoffmann. I know of no specimens from Mexico but the insect can be expected in the Sierra Juarez in

June. The northern boreal ranges will constitute the southern extremity of the Pacific slope range of the holarctic *Hesperia comma* complex. The question of the proper use of *H. comma* or *H. harpalus* for certain of the populations of this complex is purely academic and need not concern us here. That problem is discussed in some detail in my forthcoming paper on the genus (in press).

### *Hesperia columbia (Scudder).

*Pamphila columbia* SCUDDER, 1872, Rept. Peabody Acad. Sci., vol. for 1871, p. 77.

*Hesperia columbia,* HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 268.

*Hesperia columbia* is another species of this genus which certainly occurs in Baja California but of which I know of no Mexican specimens. This species is restricted to the Pacific slope and has the southern limit of its range in the northern boreal mountains of Baja California. It is certain to be found in the Sierra Juarez. It will be of considerable interest if it is found to occur in the Sierra San Pedro Martir as well, since it is in these latter mountains that the range of one of its near relatives, the following species, most closely approaches the range of *H. columbia.* I consider these two specifically distinct on morphological grounds, but it is quite possible that in the Sierra San Pedro Martir these characteristics will be found to intergrade.

### Hesperia pahaska williamsi Lindsey.

*Hesperia pahaska* form *williamsi* LINDSEY, 1940, *Ann. Ent. Soc. Amer., vol.* 33, pp. 375-376.

*Hesperia pahaska* pop. nr. *williamsi,* PATTERSON and POWELL, 1959, Jour. Lep. Soc., vol. 13, pp. 233-234.

The occurrence of an isolated population of this species in the Sierra San Pedro Martir is rather puzzling. The nearest areas outside of Baja California where other populations of this insect can be expected is in the Sierra Madre Occidental of Sonora and south central Arizona. On the other hand, as mentioned above, the closely related *H. columbia* can reasonably be expected in the Sierra San Pedro Martir. Further, the specimens taken by Powell and and Patterson (all males) do indeed resemble *H. columbia* in certain superficial characters of wing pattern, but structurally they are clearly *H. pahaska.* Both species are quite variable in wing markings and the superficial resemblance of these specimens to *H. columbia* falls well within the normal range of variation of populations of *H. pahaska williamsi* from other localities. In the only really diagnostic wing markings separating these two species, the specimens under discussion are typical of *H. pahaska williamsi.*

This species is part of the intrusive austral element from the northwestern portion of the central plateau but is, unlike the others of that ele-

ment discussed in this paper, evidently a boreal inhabitant in Baja California.
No additional material has been examined.

**Atalopedes campestris** (Boisduval).

*Hesperia campestris* BOISDUVAL, 1852, Ann. Soc. Ent. France, ser. 2, vol. 10, p. 316.
*Atalopedes campestris,* POWELL, 1958, Lepid. News, vol. 12, p. 31.

This widespread species inhabits the northern mountains and can be also expected anywhere in the more heavily vegetated portions of the lowlands, particularly where agricultural activities have slightly modified the environment.

ADDITIONAL RECORDS: Las Encinas, 6000', Sierra San Pedro Martir, 1 male, V-27-58 (J. A. Powell, CIS); 21.6 miles N. Todos Santos, road to La Paz, 1 male, XII-26-58 (H. B. Leech).

**Ochlodes agricola** (Boisduval).

*Hesperia agricola* BOISDUVAL, 1852, Ann. Soc. Ent. France, ser. 2, vol. 10, p. 314.
*Ochlodes nemorum,* HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 269.
*Ochlodes agricola,* HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 269.
*Ochlodes agricola agricola,* POWELL, 1958, Lepid. News, vol. 12, p. 32.

*Ochlodes agricola* represents a California element in Baja California. The species probably does not extend south of the northern boreal ranges where it can be expected in the western lowlands and foothills of the major mountains. It may be especially associated with riparian and heavily wooded habitats.

ADDITIONAL RECORDS: 7 miles. SE. Santo Tomas, 1 female, V-25-58 (J. A. Powell, CIS).

**Ochlodes sylvanoides** (Boisduval).

*Hesperia sylvanoides* BOISDUVAL, 1852, Ann. Soc. Ent. France, ser. 2, vol. 10, p. 313.
*Ochlodes sylvanoides,* HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 269.
*Ochlodes sylvanoides sylvanoides,* POWELL, 1958, Lepid. News, vol. 12, p. 32.

The comments made above for *O. agricola* apply as well to *O. sylvanoides* and need not be repeated. This skipper, however, is less likely to express a particular preference for stream-bottom habitats except in the lowlands or wooded situations, being equally partial to dry open hillsides and savanna.

No additional material has been seen.

### Hylephila phyleus (Drury).

*Papilio phyleus* Drury, 1770, Ill. Exot. Ent., vol. 1, p. 25, pl. 13, figs. 4, 5.
*Hylephila phylaeus,* Rindge, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 308.

The genus *Hylephila* is customarily treated near the genus *Pseudocopaeodes.* It is placed in the present sequence in this paper because, although I cannot devote the space here to develop my argument, I believe that the genera *Yvretta, Hylephila, Polites, Wallengrenia,* at least one species of the genus *Pompieus* (but not the type species), and perhaps *Stinga,* are very closely related and should be associated in any linear treatment. This opinion is based upon genitalic resemblances which, by and large, in the Hesperiinae are relatively useful for interpreting relationships.

*Hylephila phyleus* is common in the lowlands of the Cape Region. Elsewhere on the peninsula it may be associated primarily with areas under cultivation, particularly gardens in settlements.

Additional records: 17.5 miles NW. Cabo San Lucas, 1 male, 1 female, I-15-59 (H. B. Leech); Cabo San Lucas, 1 male, I-17-59 (H. B. Leech); 3.4 miles NE. Cabo San Lucas on Highway Sur 19, 2 males, 3 females, I-19-59 (H. B. Leech); 18.5 miles from La Paz airport on road to Las Planas, 1 male, XII-19-58 (H. B. Leech); Arroyo Saltito near Las Cruces, E. of La Paz, 1 male, 5 females, I-23-59 (H. B. Leech); 12.4 miles E. La Paz on road to Las Cruces, 1 male, I-4-59 (H. B. Leech); 4 miles E. La Paz on road to Las Cruces, 1 male, XII-23-58 (H. B. Leech).

### Polites sabuleti (Boisduval).

*Hesperia sabuleti* Boisduval, 1852, Ann. Soc. Ent. France, ser. 2, vol. 10, p. 316.
*Polites sabuleti,* Hoffmann, 1941, An. Inst. Biol. Mex., vol. 12, p. 268; Rindge, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 309.
*Polites sabuleti sabuleti,* Powell, 1958, Lepid. News, vol. 12, p. 31.
*Polites sabuleti tecumseh,* Patterson and Powell (not Grinnell, 1903), 1959, Jour. Lep. Soc., vol. 13, p. 232.

There appear to be at least three distinct geographic segregates of this species in Baja California. As more material becomes available I would not be surprised to find that the species is represented by at least five geographic segregates. The nature of such segregates within this species remains to be determined. In view of the phenotypic diversity expressed by this insect through its extensive ecological range in western North America, inquiries into the possible direct environmental influence upon the phenotype seem appropriate. The appearance of apparently polytopic populations in similar ecological situations further suggests the need for such investigations.

The members of the populations occupying the boreal uplands of the Sierra San Pedro Martir, although slightly larger, resemble those of the populations referred to under the name of *P.s. tecumseh* (Grinnell) which inhabit higher elevations in the Sierra Nevada of California. I am inclined to doubt, however, that these two population assemblages phenotypically reflect similar genetic constitutions.

Populations of the lowlands to the west of the boreal ranges are relatively pale and less contrastingly marked below than those mentioned above. They correspond to the nomenotypic subspecies and represent a southern penetration of the coastal populations of California.

To the east of the northern boreal ranges and in the delta region doubtless will be found other populations which have a very pallid appearance with very pale or no markings below. Such populations would represent the populations designated as *P.s. chusca* (Edwards) of the Sonoran desert.

I have seen one specimen from the southern territory of the peninsula; this is a female from Santa Maria Bay, recorded by Rindge, and presents yet another phenotype. This is much larger than *P.s.tecumseh* which it otherwise somewhat resembles above. The hindwings below are rather striking. The dark ground color and contrasting spots which are prolonged along the veins in *P. s. tecumseh* are characters also displayed by this specimen but these tendencies are amplified and modified as follows. The ground color is uniformly very dark brown (probably chocolate in fresh specimens). The cream-colored spots are reduced so that the basal loop is obsolete being represented by thin bars on the veins on each side of the cell. The spots of the macular band are reduced in length but not in width; hence the band is narrow but uninterrupted, with a straight, not sinuate, posterior arm. The cubital and anal veins are pale, as are all others distad of the macular band. The specimen resembles to a considerable extent an undescribed species from the Mexican mainland nearby, but is more typical of *P. sabuleti* in the form of the macular band so I am placing it here, at least for the present. The Santa Maria Bay locality is quite isolated from the Sierra de la Victoria where still other populations of this species can be expected.

Additional records: La Grulla, Sierra San Pedro Martir, 1 male, 4 females, IX-3-61 (D. Patterson); La Encantada, Sierra San Pedro Martir, 2 males, 4 females, IX-4-61 (D. Patterson).

### Polites mystic sonora (Scudder).

*Ochlodes sonora* Scudder, 1872, Rept. Peabody Acad. Sci., vol. for 1871, p.78.

*Polites mystic sonora,* Patterson and Powell, 1959, Jour. Lep. Soc., vol. 13, p. 233.

This insect attains the southern limit of its range in the Sierra San Pedro Martir. The specimens I have seen from this region resemble samples from the Transverse Ranges of southern California except that their coloring above is slightly brighter and paler. On the lower surface the pale olive over-scaling has a more yellowish cast than is usual in more northern specimens. The stigma and post-stigmal patch of the males above are slightly narrower than in specimens from California.

No additional records have come to my attention.

**Paratrytone melane melane** (Edwards).

*Hesperia melane* Edwards, 1869, Trans. Amer. Ent. Soc., vol. 2, p. 312.
*Poanes melane,* Hoffmann (in part), 1941; An. Inst. Biol. Mex., vol. 12, p. 270.
*Paratrytone melane melane,* Powell, 1958, Lepid News, vol. 12, p. 32.

The nomenotypic subspecies of this insect is restricted in Baja California to the Sierra Juarez, the Sierra San Pedro Martir and the less xeric of the western foothills to the north. These populations represent the California element which penetrates into Mexico from the Laguna Mountains of southern California.

Additional records: 3 miles S. Encinas, Sierra San Pedro Martir, 1 male, 2 females, VI-3-58 (J. A. Powell, CIS).

**Paratrytone melane** subsp.

*Poanes melane,* Rindge, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 309; Powell, 1958, Lepid. News, vol. 12, p. 32.

The available sample of the populations inhabiting the Sierra de la Victoria of the Cape Region is comprised of only two specimens. Nevertheless, these two males are sufficiently distinctive in appearance to make me almost certain that the populations they represent constitute a very distinct geographical segregate. Powell (1958, p. 32) offered a similar opinion.

Males of the California population invariably have present on the upper wing surface considerable ochre overscaling on the forewing except for a large dark patch proximal to the discal spots and posterior to the cell. This dark patch is basally demarked by a particularly rich overscaling on the basal third of the wing. The overscaling imparts an impression of a very dark, yet ochre colored wing bearing a large black or dark brown discal spot.

The Cape Region specimens almost totally lack this overscaling; hence the forewing is uniformly brown, without a conspicuous black discal patch. The discal ochre spots are very reduced in one specimen and almost absent in the other. The hindwings are as dark as the forewings. The macular band is narrowed as in the Mexican subspecies but not particularly shortened, and even more vaguely defined than is the case with the northern subspecies. The Cape specimens differ from the Mexican populations in having even darker forewings with much smaller spots, and in the very vaguely defined spots of the hindwing.

On the lower surface of the wings the Cape specimens resemble those of the California populations but have less of the reddish cast basally, and on the hindwings the spots are sharply defined outwardly, as in Mexican examples, but they scarcely contrast to the ochre-brown ground color of the wing. The abdominal venter is a rich ochre, neither buff colored as in Mexican specimens, nor pale buff-ochre as is the case in samples from California.

No additional material was examined.

***Euphyes vestris vestris** (Boisduval).

*Hesperia vestris* Boisduval, 1852, Ann. Soc. Ent. France, ser. 2, vol. 10, p.317.
*Atrytone ruricola,* Hoffmann, 1941, An. Inst. Biol. Mex., vol. 12, p.271.

It is likely that *E. vestris* occurs in the northern boreal ranges of Baja California. The species is known from San Diego County in California, and probably can be found associated with damp meadows in the higher mountains. The presence of the insect in Baja California requires confirmation however, since Hoffmann's citation in all probability was based upon an inference similar to that above.

***Amblyscirtes cassus** Edwards.

*Amblyscirtes cassus* Edwards, 1883, Papilio, vol. 3, p. 72; Hoffmann, 1941, An. Inst. Biol. Mex., vol. 12, p. 272.

I am aware of no examples of this species from Baja California, and I rather doubt its presence in the region. The insect inhabits southeastern Arizona and the Sierra Madre Occidental of Sonora. Hoffmann's statement placing *A. cassus* in the Baja California fauna was punctuated with a question-mark and it must, for the present, continue to be regarded as a doubtful resident.

***Amblyscirtes tolteca tolteca** Scudder.

*Amblyscirtes tolteca* Scudder, 1872, Rept. Peabody Acad., vol. for 1871, p. 76.
*Stomyles tolteca,* Rindge, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 309.

Rindge (*in lit.*) informs me that the specimen he recorded from the Cape Region is not in the series of this species at the American Museum. The specimen has probably been re-identified as belonging to another species and will ultimately be properly recorded so that this name can be definitely retained on or dropped from the list of the Baja California fauna. It is retained here as a doubtful inhabitant.

**Lerodea eufala eufala** Edwards.

*Hesperia eufala* Edwards, 1869, Trans. Amer. Ent. Soc., vol. 2, p. 311.
*Lerodea eufala*, Hoffman, 1941, An. Inst. Biol. Mex., vol. 12, p. 280; Rindge, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 309.
*Lerodea arabus*, Rindge (in part) (not Edwards, 1882) 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 309.

*Lerodea eufala* is known at present only from the lowlands of the Cape Region. The species probably also occurs in the northeast delta region as well as along the west coast of the northern state where it should be found associated with agriculture or settlements.

The material examined from the Cape Region differs only slightly when in fresh condition from comparable specimens from California. The basal and discal portions of the hindwings above in males are more distinctly a very pale olive gray which clearly contrasts to the broad grayish brown marginal border. The interface between these areas is accentuated by a crescentic series of faint paler spots. Older museum specimens from the same region show somewhat less contrast on the hindwings and thus resemble more closely specimens from California and Arizona. The female mentioned below from the Cape is fresh but very dark brown above with none of the pale gray hindwing discal and basal area seen in the males.

Additional records: 21.6 miles N. Todos Santos, road to La Paz, 1 male, XII-26-59 (H. B. Leech); Cabo San Lucas, 2 males, 1 female, I-16-59 (H. B. Leech); 1.3 miles N. San Jose Viejo on Highway Sur 19, 2 males, I-7-59 (H. B. Leech); Muertos Bay, 1 male, 1 female, XII-29-38 (F. H. Rindge, AMNH).

**Lerodea dysaules** Godman.

*Lerodea dysaules* Godman, 1900, Biol. Centr.-Amer. Rhop., vol. 2, p. 500, p. 95, figs. 19,20.
*Lerodea arabus*, Rindge (in part) (?not Edwards, 1882), 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 309.

I have seen only two male specimens of this species from Baja California. The specimen recorded by Rindge from Pulpito Bay has the large hyaline spots fully developed on the forewing, with distinct traces of a pale band of spots above and below on the hindwing, where also the vanal angle is conspicuously darkened, as dark as the costal wedge. The specimen recorded below is a darker gray-brown with much reduced spots on the forewing above. Only the apical spots are large and hyaline. The spot in cell $M_3$ (space 3) is also hyaline but is a minute point. The discal cell spot and that in cell $Cu_1$ (space 2) are nearly obsolete and not hyaline. There is no pale spot in

$Cu_2$ (space 1b), nor a trace of pale spots on the hindwing. Below on the forewing this specimen is spotted as above except that the pale spot of cell $Cu_1$ is large and crescentic, and on the hindwing there are no pale spots and the vanal angle is not particularly darkened, the costal wedge being conspicuously darker. Genitalically the two specimens are identical.

I am not sufficiently familiar with this or *L. arabus* Edwards from Arizona to comment on the specific or subspecific distinctness of these. I here follow the Evans catalogue, but must point out that the more northern, Rindge specimen would key out in Evans to *L. arabus*, while the individual from the Cape Region keys to *L. dysaules*.

ADDITIONAL RECORDS: Cabo San Lucas, 1 male, I-17-59 (H. B. Leech).

### Calpodes ethlius (Stoll).

*Papilio ethlius* STOLL, 1782, Pap. Exot., vol. 4, p. 212, pl. 392, figs. A, B.
*Calpodes ethlius*, POWELL, 1958, Lepid. News, vol. 12, p. 32.

I have had no field experience with this skipper in other than a cultivated area. The only specimens known at present from Baja California were taken in flower gardens at the settlement of Colonia Guerrero (Powell, 1958). This is possibly one of the few hesperiids the adults of which are inclined to travel considerably distances, and the insect can probably occur anywhere in Baja California that *Canna* is grown. It will doubtless be found in and about towns where there exists a suitable nectar source and an abundance of the larval food plant.

No additional records.

### Panoquina panoquinoides errans (Skinner).

*Pamphila errans* SKINNER, 1892, Ent. News, vol. 3, p. 174.
*Panoquina errans*, HOFFMANN, 1941, An. Inst. Biol. Mex., vol. 12, p. 274; RINDGE, 1948, Proc. Cal. Acad. Sci., fourth ser., vol. 24, p. 310.
*Panoquina panoquinoides errans*, POWELL, 1958, Lepid. News, vol. 12, p. 32.

Associated with a coastal grass, this species ranges from southern California south along the coast of Baja California to the Cape Region, then north along the gulf coast nearly, if not quite, to the delta region. The species exhibits a clinal change from Santa Barbara, California, to Cabo San Lucas. Specimens from the Cape Region are slightly larger and darker than are those from California. On the lower surface the ground color becomes almost black in the south, with the scattered yellowish overscaling conspicuous in contrast. The short band of spots, usually quite prominent on the hindwing below in northern specimens, becomes quite reduced, often obsolete, especially in females, in southern specimens, and the pale veins of this lower wing surface become more brightly yellow and conspicuous. Material examined from near San Quintín Bay are intermediate in these characters.

ADDITIONAL RECORDS: 5.5 miles NW. Todos Santos, road to La Paz, 1 female, I-13-59 (H. B. Leech); Punta Lobos, 1 mile SE. Todos Santos, 5 males, 1 female, XII-25-58 (H. B. Leech); San Pedro, about 4 miles S. Todos Santos, 1 male, I-13-59(H. B. Leech); Cabo San Lucas, 1 male, I-1-59 (H. B. Leech); Buena Vista, Highway Sur 19, 1 male, 1 female, I-6-59 (H. B. Leech); Bahia de los Muertos, 2 females, XII-20-58 (H. B. Leech).

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# A HISTORY OF EXPLORATIONS FOR VERTEBRATES ON CERRALVO ISLAND, BAJA CALIFORNIA

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The onset of a year-long study on various aspects of the biology of the terrestrial vertebrate animals of Cerralvo Island, Baja California, Mexico, prompted the compilation of this report concerning previous investigations on that island. A number of biologists have mentioned Cerralvo in reports of their activities in Baja California, but such discussions have usually been brief. The available information is scattered through a number of books and journals and has not previously been brought together into a single report.

The southernmost island in the Gulf of California, Cerralvo (variously spelled Ceralbo or Ceralvo) is approximately eighteen miles in length and four miles in greatest width. A high ridge extends nearly the entire length of the island, reaching the maximum elevation of 2518 feet (chart H.O. 1664, United States Navy Hydrographic Office, 24th ed., May, 1943). The nearest part of the peninsula of Baja California is Punta Arena de la Ventana, about five miles distant, to which Cerralvo was apparently connected in times of shallower seas.

Cerralvo is uninhabited, although Indians are reported to have lived there in early times. More recently a ranch was operated near the southern end of the island, but it is now abandoned. There are a number of temporary fishing camps on the west side of the island. Previous discussions of the is-

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land report that it is without fresh water (there was a well at the ranch), but there are several small springs at the heads of arroyos which provide limited quantities of good water. The scarcity of water, however, coupled with the general desert-like nature of the island, would not be attractive to modern human habitants.

Nelson (1921), Slevin (1923), and Goldman (1951) have given brief characterizations of the island in their reports. The following remarks are offered to supplement these descriptions. Cerralvo is a very rugged island, and much of the shoreline is sheer cliff rising from the water. There are a number of rock or gravel beaches, however, at the mouths of the larger arroyos, where landing is possible. These arroyos, which wind into the interior of the island with a gradual but perceptible increase in elevation, provide access to much of the island, although it is generally difficult to climb their steep walls. There is a large flat area of sand, with a good beach, at the southwest point of the island (often referred to as the south end), which somehow seems out of character with the rest of the steep, rocky island.

The vegetation of Cerralvo is similar to that of the Cape Region of Baja California in both species composition and general aspect. Vegetation is sparse near the northern end of the island but varies to the extreme of being nearly impenetrable in other areas. The most outstanding plant is the large cardón, *Pachycereus pringlei*, but other species of cactus are also abundant. There are large fig trees, *Ficus palmeri*, clinging to the walls of some of the arroyos, and patches of grass and rushes in moist areas near some of the springs. I have been told that there are palms in one canyon on the east side of the island.

Nelson (1921) gives a chronological history of the biological exploration of Baja California. The first mention of Cerralvo Island is to the effect that J. Ellis McLellan, representing the United States Biological Survey, worked out of La Paz from June to September, 1895, and, during this time, visited Cerralvo. I have been unable to find any published report on McLellan's work of this period, and his name has not been mentioned in any account of specimens taken on Cerralvo. Dr. Richard H. Manville, Director of the Bird and Mammal Laboratories of the Fish and Wildlife Service, successor to the Biological Survey, has informed me that the files of that office contain seven reports made by McLellan in 1895 "which pertain to Baja California, but in none of them is mention made of Cerralvo Island." McLellan's itinerary, reconstructed from his notes, does not include Cerralvo, but there are large periods of time unaccounted for (Manville, *in litt.*, Oct. 12, 1961). The nature, extent, and results of McLellan's visit to Cerralvo remain a mystery.

In the course of their extensive exploration of Baja California on behalf of the Biological Survey, E. W. Nelson and E. A. Goldman were on Cerralvo for parts of three days. They reached the island from Espiritu Santo Island on February 11, 1906, and departed on February 13 (Nelson, 1921; Goldman, 1951). From Goldman's reported elevations of "10 to 30 feet" it appears that these men did not move far from their landing place on the beach at the south end of the island. In a description and discussion of the island, Nelson includes a list of the plants observed. He records the capture of two kinds of mice; these were described as endemic subspecies, *Perognathus penicillatus siccus* (Osgood, 1907) and *Peromyscus eremicus avius* (Osgood, 1909). The former was subsequently transferred to the species *Perognathus arenarius* (Nelson and Goldman, 1929). The use of 19 specimens of *Peromyscus* and 11 adult *Perognathus* in Osgood's descriptions apparently indicates the success of trapping by Nelson and Goldman.

Nelson (1921, p. 91) mentioned the occurrence of "iguanas which are not known from the mainland of the peninsula but do occur on some of the other islands farther north in the gulf." This reference is certainly to the genus *Sator* (see beyond), and must have been written in retrospect as that lizard was not described until 1919, thirteen years after Nelson was on the island. No account of reptiles observed or collected is given by either Nelson or Goldman. Concerning birds, Nelson (*loc. cit.*) states that "Fish hawks [*Pandion haliaetus*], sparrow hawks [*Falco sparverius*], ravens [*Corvus corax*], black-throated sparrows [*Amphispiza bilineata*], San Lucas house finches [*Carpodacus mexicanus*], and rock wrens [*Salpinctes obsoletus*] were among the few land birds noted here." No reference is made to any bird specimens which may have been obtained. The United States National Museum, however, contains four skins of the oystercatcher, *Haematopus ostralegus frazari*, which were taken by these men on Cerralvo. These unreported specimens apparently form the basis for Ridgway's (1919) inclusion of Cerralvo Island in the range of the species.

The next report of activity in exploration of the vertebrates of Cerralvo is for 1910. W. W. Brown, a well-known collector of Mexican birds, was employed in Baja California by John E. Thayer during the years 1906-1910. Nelson (1921, p. 146) outlines Brown's travels on the peninsula; he does not mention that Brown was on Cerralvo. Thayer (1911) reported on a series of eggs of the elegant tern, *Thalasseus elegans*, which were sent to him from Cerralvo (written "Cerraloo") but made it clear that the eggs were collected by Eduardo Manriquez, a friend of Brown's, and not by Brown himself. There is no evidence that Brown was on Cerralvo, although Mailliard (1923, p. 446) implies this by attributing to Brown a comment made by Thayer. The eggs referred to above, eighteen sets of one egg each, were collected on April 9 and 15, 1910; once in Thayer's private collection, they are now in the Museum of Comparative Zoology.

The United States Fisheries steamer *Albatross* carried members of an American Museum of Natural History expedition to the Gulf of California for a period of two months in the spring of 1911. A general account of this voyage and of the localities visited was prepared by C. H. Townsend (1916), the director of the expedition. Zoologists who devoted at least part of their time to terrestrial vertebrates included Townsend, H. E. Anthony, P. I. Osburn, and P. Bartsch. The *Albatross* stopped at Cerralvo for only three hours, from 3 to 6 P. M., on April 19. No mention is made of where the party landed on Cerralvo, but the map in Townsend's general report (*op. cit.*) suggests that it was on the western shore, near the north end.

Although a large number of herpetological specimens were obtained, Townsend made little mention of them. "The most interesting find here was the large black and white lizard (*Ctenosaura hemilopha*)..." of which seven specimens were taken (Townsend, 1916, p. 430). Altogether, the lizards collected on this voyage formed the basis for the descriptions of 23 new species, including two of a new genus, by Dickerson (1919). The genus described was *Sator*, endemic to Cerralvo and Santa Cruz islands. *Sator grandaevus*, from Cerralvo, was chosen as the type species of the genus. The ctenosaur regarded as so interesting by Townsend was described as a new species, *Ctenosaura insulana*, but Schmidt (1922), in reviewing the reptiles taken on the *Albatross* voyage, did not accept that designation; this form is now generally recognized as a subspecies of *C. hemilopha*.

A single mammal specimen, of the bat *Pipistrellus hesperis*, was taken while the *Albatross* party was on Cerralvo (Townsend, 1912). The island is mentioned in the accounts of four species of birds seen on the voyage (Townsend, 1923). These are the Heermann gull, *Larus heermanni*; ash-throated flycatcher, *Myiarchus cinerascens*; verdin, *Auriparus flaviceps*; and blue-gray gnatcatcher, *Polioptila caerulea*. Specimens of the flycatcher and gnatcatcher were obtained.

Most of the results of the early interest of the California Academy of Sciences in the biology of Baja California were lost in the disastrous fire of 1906. In an effort to replace those collections, the Academy sponsored field work in the Cape Region in 1919 and on the islands of the Gulf of California in 1921. Among the islands visited by the latter expedition was Cerralvo, June 6 to 8 (Slevin, 1923). Members of the expedition were interested in a variety of scientific fields; those concentrating on the biology of the terrestrial vertebrates were Joseph Slevin, leader of the trip, and Virgil W. Owen, representing the Department of Ornithology and Mammalogy.

Slevin's (*op. cit.*) general account of the voyage of the chartered schooner *Silver Gate* gives a brief description of each island visited, and mentions some of the more important observations, but records little about the specimens taken. Several reptiles, including *Verticaria* (now *Cnemidophorus*) *ceralbensis* from Cerralvo, were described as new species (Van Denburgh and Slevin, 1921a, 1921b), but no general account of the herpetofauna of the islands was published. Specimens of *Dipsosaurus dorsalis lucasanus* obtained by Slevin on Cerralvo were first reported by Van Denburgh (1922). Owen took few specimens of or notes on the birds or mammals; no report on the mammals of the islands was published. Ornithological observations made by Selvin were incorporated into a report (Mailliard, 1923) on the birds and eggs taken on the expedition. The only birds reported from Cerralvo were the brown pelican, *Pelecanus occidentalis*; great blue heron, *Ardea herodias*; verdin; and black-throated sparrow. Eggs of the latter three species were obtained, as well as one skin of the sparrow. These specimens are now in the collections of the California Academy of Sciences.

The next recorded observations on Cerralvo Island were made by Donald R. Dickey. His notes were brought to light by van Rossem (1943), who wrote as follows: "In the summer of 1928, the late Donald Dickey spent several weeks cruising in the Gulf of California. Many mainland and insular points were touched, although usually not for more than a day or two at a time and often for only a few hours." The black vulture, *Coragyps atratus*, is "listed as present at Cerralvo Island on May 22, although in what manner or numbers is not stated. This appears to be the first record for Lower California..." There is no indication of a specimen to substantiate this record. A specimen of the oystercatcher is recorded for the same date.

Nearly a quarter of a century lapsed before the next exploration of Cerralvo Island by vertebrate zoologists. During the springs of 1952 and 1953 the Sefton Foundation research vessel *Orca* carried a party of biologists, mainly from Stanford University, to a number of the islands of the Gulf of California. The principal emphasis of these trips was placed on fishes and reptiles, and little or no information on other vertebrates was recorded. Dr. G Dallas Hanna, a member of the 1953 expedition, has reported (personal communication) that a number of unidentified bats flew from the well at the site of the old ranch.

Herpetologists taking part in the *Orca* expeditions included Frank S. Cliff, Jay M. Savage, Alan Leviton, and John P. Figg-Hoblyn, all of Stanford University, Joseph Slevin of the California Academy of Sciences, and Joseph Ball of the San Diego Zoo. No general account of these trips has been published.

The only publication resulting from the *Orca* trips which refers to Cerralvo is that by Cliff (1954). Cliff described as endemic to the island the snakes *Chilomeniscus savagei* and *Crotalus enyo cerralvensis*, and records as present also *Masticophis flagellum piceus* and *Crotalus mitchelli mitchelli*. Despite the previous herpetological work done on Cerralvo, this constitutes the first report of snakes on the island. Specimens obtained on these trips are housed in the Stanford Natural History Museum.

A later expedition from Stanford University, similarly sponsored by the Sefton Foundation, added *Lampropeltis getulus conjuncta* to the list of snakes known from Cerralvo. A single specimen, now in the Stanford Natural History Museum, was taken by John P. Figg-Hoblyn and Kenton L. Chambers in the course of a brief visit to the southern end of the island on August 23, 1955 (Figg-Hoblyn and Banta, 1957).

Members of the staff of the American Museum of Natural History again visited the Gulf of California in 1957, on the schooner *Puritan.* Under the leadership of W. K. Emerson the vessel visited the islands on both coasts of Baja California. At the time that the ship reached Cerralvo, on April 20, the staff of vertebrate zoologists included Richard G. Van Gelder, mammalogist, and Oakes A. Plimpton, scientific assistant (Emerson, 1958). These two men set small mammal traps in three areas near their landing place on the south end of the island, just east of Piedras Gordas, taking one specimen of *Peromyscus* and one of *Perognathus* in the single night of trapping (Van Gelder, *in litt.*). A few lizards were also secured on the island.

Michael E. Soule and Robert G. Crippen visited Cerralvo for a few hours on March 6, 1960, landing near the south end of the island. In this short time a snake new to the island, *Eridiphas slevini,* was collected, the third known specimen of this species (Soule, 1961). This trip was sponsored by the Belvedere Scientific Fund and the California Academy of Sciences. Specimens obtained are in the Academy, the Stanford Natural History Museum, and the Museum of Vertebrate Zoology.

Also in 1960, Richard Etheridge and Allan Schoenherr collected herpetological specimens on Cerralvo, from July 14 to July 22. The base camp for this time was at the edge of the sand dune area near the south end of the island. Etheridge (1961) records the first amphibian known from the island, *Scaphiopus couchi,* and reports the first specimens of the lizards *Phyllodactylus unctus* and *Callisaurus draconoides draconoides* taken there. He also presents additional information on the habits and distribution of other reptiles known from the island. A complete list of the herpetofauna of Cerralvo is given for the first time. The specimens obtained by Etheridge are in the California Academy of Sciences.

Under the auspices of the Belvedere Scientific Fund, Robert G. Crippen and Richard C. Banks landed on Cerralvo Island late in the afternoon of October 24, 1960. A camp was established near the shore in an arroyo on the east side of the island about one-third of the way from the north end. The narrow mouth of this arroyo gave access to a rather broad area farther inland, and, with some difficulty, to the ridge of the island. Crippen engaged himself in work on lizards and Banks concentrated on birds and mammals, although both men spent some time with each of these animal groups. In five days of collecting on the island, twenty-six birds were preserved as study skins and two bird skeletons were saved, for a total representation of 19 species. In addition, ten bird species were observed but not collected. Eighteen mammals were prepared, including one specimen of *Pipistrellus,* two of *Perognathus* and 15 of *Peromyscus.* A large number of lizards were collected, of the species *Sator grandaevus, Ctenosaura hemilopha,* and *Cnemidophorus cer-*

*albensis*. Also obtained on this trip were the first specimens of *Bufo punctatus* known from the island; one adult and a number of tadpoles were secured in a small spring at the head of the arroyo in which we camped (Crippen, in press). We left the island on the morning of October 30. Specimens are on deposit in the California Academy of Sciences and the Museum of Vertebrate Zoology.


## ACKNOWLEDGMENTS

I wish to thank the Belvedere Scientific Fund for the opportunity to visit Cerralvo Island in October, 1960. Appreciation is also expressed to Drs. Frank S. Cliff, G Dallas Hanna, Alan Leviton, and Richard G. Van Gelder for sharing with me information concerning their work on the island, and to Richard H. Manville for supplying information on J. Ellis McLellan. Dr. Benjamin H. Banta offered a number of helpful comments during the preparation of the report. Dr. Robert T. Orr read the manuscript and made valuable suggestions. This report was prepared during the tenure of a grant from the National Science Foundation at the California Academy of Sciences.


## SUMMARY

From 1895 through 1960, Cerralvo Island, Baja California, Mexico, was visited thirteen times by investigators interested in the biology of the terrestrial vertebrate animals of the island. The major emphasis of the work has been on herpetology, although some work has been done on both birds and mammals. Cerralvo is characterized by the presence of two endemic snakes, *Chilomeniscus savagei* and *crotalus enyo cerralvensis*, three endemic lizards, *Sator grandaevus*, *Cnemidophorus ceralbensis*, and *Ctenosaura hemilopha insulana*. Two amphibians have been reported. Three native mammals are known from the island, two of which, *Peromyscus eremicus avius* and *Perognathus arenarius siccus*, are endemic. No complete list of the birds of the island is yet available, and that group has so far been relatively little studied.

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# MIDWINTER RECONNAISSANCE OF THE HERPETOFAUNA OF THE CAPE REGION OF BAJA CALIFORNIA, MEXICO [1]

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2. During the summer of 1961 the authors visited the United States National Museum where they had an opportunity to examine some of the Belding collections from the Cape Region of Baja California. Funds for this trip were provided by grants from the Penrose and Johnson funds, respectively, of the American Philosophical Society.

## Introduction

Historically, the Cape Region of Baja California has been visited and its herpetofauna sampled during the spring and summer months. Unfortunately, few have collected there during the midwinter, in this, one of the few semi-arid areas in North America where climatic conditions during that period are mild, and amphibians and reptiles are active during the entire year.

Among those who had the opportunity to collect during the winter months are: John Xantus, an observer for the U. S. Coast Survey stationed in La Paz; Lyman Belding, who visited La Paz in the winter of 1881-82 and 1882-83; Gustav Eisen, who landed at San Jose del Cabo in September, 1893, and stayed in the Cape Region through October of that year and then revisited the region again between September and November, 1894; and Goldman and Nelson, who were there in December, 1905, and January, 1906. Of these, only Eisen and Belding collected any substantial numbers of reptiles. Most of these animals were taken during the months of October and November of 1894, and were reported on by Van Denburgh (1895a, 1885b); or were captured in February, 1882, and were reported on by Yarrow (1882).

In early December of 1958 the senior author, in company with Mr. Hugh B. Leech of the Academy's entomological staff, and under the auspices of the California Academy of Sciences and the Belvedere Scientific Fund, drove the length of Peninsular Baja California in a vehicle especially equipped for the purpose. In La Paz they were joined by several other scientists for a two-month reconnaissance of the biota of the Cape Region (Wiggins, 1960, p. 2-8). The other workers on the expedition were: Dr. Ira L. Wiggins and Mr. Duncan Porter, botanists from Stanford University; Mr. Allyn G. Smith, malacologist from the California Academy of Sciences; and Dr. Reid Moran, botanist from the San Diego Natural History Museum. Mr. Kenneth K. Bechtel, President of the Belvedere Scientific Fund, spent some days in the field with the group and provided additional transportation to enable them to visit a number of otherwise inaccessible outlying areas of interest.

A base of operations was established in La Paz and trips were made from that point. At least two complete circuits of the Cape were made and numerous shorter trips were undertaken. At no time did the group get into the mountains except at the Boca de la Sierra, which lies at an altitude of 1000 feet; rather, all work was done in the lowlands from the coasts to the base of the *massif central* of the Cape Region, the Sierra de la Victoria. Frequent stops allowed each of the party an opportunity to collect and to study the prevailing ambient conditions and their effects on the organisms of his particular interest. The stops of particular importance to the herpetological work are given in table I.

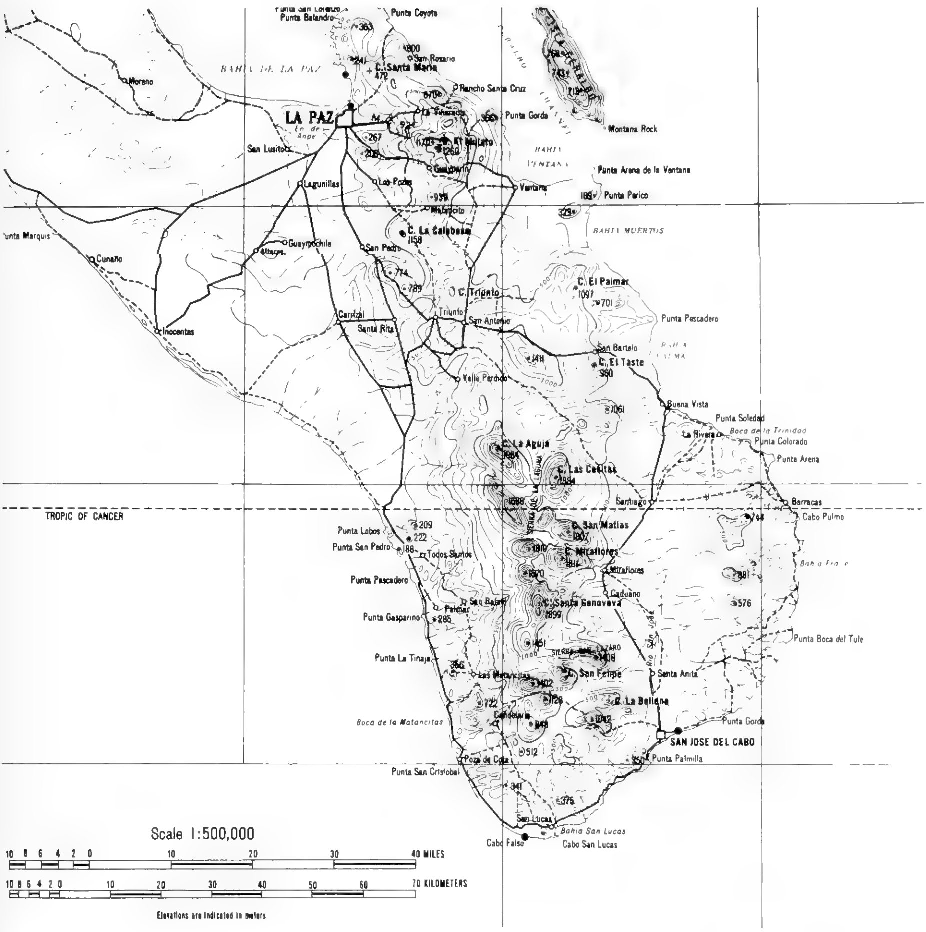


FIGURE 1. Map of Cape Region, Baja California Sur, Mexico (taken from Mexico Air Navigation Map, La Paz section, Geographic Branch, Military Intelligence Division, U.S.A., 1936, map number 3507-60 12-S and San Jose del Cabo section NF 12-North).

## GENERAL GEOGRAPHY

The Cape region of Baja California, as defined here, is that region of the Peninsula south and southeast of a line extending from La Paz to Todos Santos (figure 1). While typical elements of the fauna and flora of the Cape region extend somewhat north of this line, into the Magdalena Plain and southern fringe of the Sierra Giganta, the Cape nevertheless forms a logical geographical unit. Within the Cape there is a *massif central*, the Sierra de la Victoria, an old granitic mass, attaining a maximum elevation of about 6,300 feet.

Table 1. *Herpetological collecting stations in the Cape Region, Baja California, Mexico, December, 1958 - January, 1959.*

| Station | Date | Locality |
|---|---|---|
| 1 | 11 Dec. | 7 miles N. of El Arco, along main road. |
| 2 | 17 Dec. | La Palmilla, 5 miles SSW. of San Jose del Cabo. |
| 3 | " | Las Cruces. |
| 4 | 19 Dec. | 18.5 miles from junction of Los Planos road and La Paz airport road, 21 miles ESE. of La Paz. |
| 5 | 20 Dec. | La Ventana. |
| 6 | " | 8.8 miles by road from Los Planos, at junction of Bahia de los Muertos-Punta Arena de la Ventana roads. |
| 7 | " | Bahia de los Muertos. |
| 8 | 21 Dec. | 7.3 miles WNW. of Los Planos, along road to La Paz. |
| 9 | " | La Paz. |
| 10 | 23 Dec. | 4 miles E. of La Paz, along road to Las Cruces. |
| 11 | " | 8.8 miles E. of La Paz, along road to Las Cruces. |
| 12 | " | 9 miles E. of La Paz, along road to Las Cruces. |
| 13 | " | 12.4 miles E. of La Paz, along road to Las Cruces. |
| 14 | 24 Dec. | 39.5 miles S. of La Paz, along road to Todos Santos. |
| 15 | " | 36.4 miles S. of La Paz, along road to Todos Santos. |
| 16 | 25 Dec. | 2.8 miles SSE. of Todos Santos. |
| 17 | " | Punta Lobos. |
| 18 | 26 Dec. | 6.4 miles N. of Todos Santos, along road to La Paz. |
| 19 | " | 15.1 miles N. of Todos Santos, along road to La Paz. |
| 20 | " | 17.5 miles N. of Todos Santos, along road to La Paz (fig. 2). |
| 21 | " | 21.6 miles N. of Todos Santos, along road to La Paz. |
| 22 | " | 23.9 miles S. of La Paz, along road to Todos Santos. |
| 23 | 27 Dec. | Arroyo de la Purissima, approximately 1 kilometer N. of La Purissima. |
| 24 | 29 Dec. | 9.4 miles N. of La Paz, along road to Bahia Pichilinque. |
| 25 | " | 12.5 miles N. of La Paz, 0.9 miles from Bahia Pichilinque. |
| 26 | " | 10.8 miles N. of La Paz, along road to Bahia Pichilinque. |
| 27 | " | 10.2 miles N. of La Paz, along road to Bahia Pichilinque. |
| 28 | 30 Dec. | El Coyote Beach, 16.4 miles NNE. of La Paz (fig. 3). |
| 29 | " | Santa Victoria Ranch, 11.2 miles NNE. of La Paz. |
| 30 | " | 5.8 miles NNE. of La Paz, along road to El Coyote. |
| 31 | 31 Dec. | Rodreguiz Ranch, 19.2 miles WNW. of La Paz (fig. 4&5). |
| 32 | " | 10.3 miles WNW. of La Paz, along main road; 9.6 miles N. of Los Aripes. |
| 33 | 1 Jan. | 1.6 miles E. of Cabo San Lucas. |
| 34 | " | 3.4 miles NE. of Cabo San Lucas. |
| 35 | " | 7.7 Miles NE. of Cabo San Lucas. |

TABLE 1. (CONTINUED)

| STATION | DATE | LOCALITY |
|---|---|---|
| 36 | 1 Jan. | 11.0 miles NE. of Cabo San Lucas. |
| 37 | 3 Jan. | 13.1 miles WNW. of La Paz (3.5 miles N. of Los Aripes, along road to Rodreguiz Ranch). |
| 38 | " | 10.2 miles WNW. of La Paz (0.6 miles N. of Los Aripes, along road to Rodreguiz Ranch). |
| 39 | 4 Jan. | 12.9 miles E. of La Paz, along road to Las Cruces (Arroyo de los Pozos) (fig. 6). |
| 40 | " | 15.6 miles E. of La Paz, along road to Las Cruces. |
| 41 | 6 Jan. | 24.9 miles SE. of La Paz, along road to San Antonio. |
| 42 | " | 0.2 miles S. of Buenavista (Gulf side) |
| 43 | 6-7 Jan. | 0.7 miles N. of Miraflores. |
| 44 | 7 Jan. | 0.2 miles SSE. of San Jose del Cabo, on road to La Playa (fig. 7). |
| 45 | " | 1.3 miles N. of San Jose Viejo. |
| 46 | 8 Jan. | 7.0 miles N. of Santa Anita. |
| 47 | " | 0.6 miles S. of Miraflores. |
| 48 | " | 1.1 miles SE. of San Bartolo. |
| 49 | 9 Jan. | 1.5 miles NW. of San Bartolo. |
| 50 | " | 12.1 miles NW. of San Bartolo. |
| 51 | 11 Jan. | 6.0 miles No. of La Paz, along road to Bahia Pichilinque. |
| 52 | 13 Jan. | 5.3 miles NW. of Todos Santos, along road to La Pastura. |
| 53 | " | 4.6 miles NW. of Todos Santos, along road to La Pastura. |
| 54 | " | 2,8 miles NW. of Todos Santos, along road to La Pastura. |
| 55 | " | Todos Santos. |
| 56 | 14 Jan. | San Pedro (or Pedrito) Bay, 3.9 miles SE of Todos Santos. |
| 57 | 15 Jan. | 4.9 miles SE. of Pescadero. |
| 58 | " | 6.6 miles S. of Pescadero. |
| 59 | " | 9.5 miles S. of Pescadero. |
| 60 | " | 5.9 miles SE of Migrino (Arroyo Candelaria). |
| 61 | 16 Jan. | 0.5 miles E. of school in Cabo San Lucas. |
| 62 | " | 2.3 miles N. of Cabo San Lucas, along road to Todos Santos. |
| 63 | " | 2.4 miles N. of Cabo San Lucas, along road to Todos Santos (fig. 8). |
| 64 | " | Los Pozos, 11 miles N. of Cabo San Lucas. |
| 65 | " | 0.9 miles S. of Cabo San Lucas, on hill behind cannery. |
| 66 | 17 Jan. | 1.3 miles ENE. of Cabo San Lucas. |
| 67 | " | 0.3 miles SW. of Cabo San Lucas (fig. 9). |
| 68 | " | 5.4 miles ENE. of Cabo San Lucas, along road to San Jose del Cabo. |
| 69 | 18 Jan. | 18 miles ENE. of Cabo San Lucas, along road to San Jose del Cabo. |
| 70 | 19 Jan. | Boca de la Sierra (fig. 10). |
| 71 | " | 1.6 - 2.6 miles ESE. of Boca de la Sierra, along road leading to main road (La Paz - San Jose del Cabo road). |

TABLE 1. (CONTINUED)

| STATION | DATE | LOCALITY |
|---|---|---|
| 72 | 20 Jan. | San Bartolo Arroyo, 1.3 miles SE. of San Bartolo. |
| 73 | 20-21 Jan. | 1.3 miles N. of El Triumpho. |
| 74 | 21 Jan. | 8.3 miles N. of El Triumpho. |
| 75 | 23 Jan. | 1.5 miles W. of El Saltito Ranch, above waterfall in El Saltito Arroyo, 19.5 miles E. of La Paz (fig. 11). |

Surrounding this central highland is a broad sandy lowland dissected by numerous arroyos.

Geologically, the Cape Region highland is old, perhaps Jurassic, at least Cretaceous, in age. The surrounding lowlands have been subject to more recent marine transgressions. The general geology of the area has been reviewed by Beal (1948).

## GENERAL ENVIRONMENT

The climate of the Cape Region of Baja California Sur can be categorized as arid subtropical. The average diurnal temperature in the winter is about 20° C., the extremes range from 9° C. to 30° C. The temperature variation is somewhat less than in desert areas of the southwestern United States. That the general climate of southern Baja California is not subject to the extreme temperature variation common to areas on the mainland or to the north, is chiefly because of the so-called maritime effect of the Pacific Ocean on its western and southern borders and of the Gulf of California to the east.

With specific reference to temperature, incidental observations were made of air and ground temperatures during December and January of 1958-1959. In table II the data are summarized. These data are of interest for they show clearly that while air temperature is low, ground temperature may be high enough to provide a source of radiant heat to warm ground dwelling animals, even relatively early in the morning.

Precipitation during the winter months is scanty. Three days in the latter part of December, 1958, there was a light mist-like rainfall, but otherwise it was dry. A few incidental relative humidity readings, taken during December and January, are summarized in table III; they show that the relative humidity tends to be low. However, enough rain fell during the three days just mentioned to form small puddles in the arroyos to provide breeding ponds for frogs and toads. During the early autumn, rain is frequently abundant for a few days and the streams may flow freely. Much water sinks into the loosely compacted sandy channels of the arroyos and may be found close to the surface during the winter months. In one or two places water was found actually flowing in the arroyos, particularly at the Boca de la Sierra. Except in the irrigation ditches at Todos Santos and San Jose del Cabo, a little water was found issuing from small springs at the Arroyo El Saltito and in the Arroyo San Bartolo.

TABLE II. *Irregular observations on air and ground temperatures during December and January, 1958 - 1959.*

| DATE | TIME [4] | AIR TEMPERATURE IN DEGREES C. | GROUND TEMPERATURE IN DEGREES C. |
|---|---|---|---|
| Dec. 19 | Noon | 24.0 | ..... |
| Dec. 20 | 8:00 | (Cool) | 20.5 |
| | Noon | 26.3 | 31.5 |
| | **3:00** | 27.8 | 37.0 |
| Dec. 21 | Noon | 27.0 | 40.0 |
| Dec. 23 | 10:45 | 25.3 | 29.0 |
| | **2:30** | 21.7 | 27.0 |
| | **3:00** | 22.2 | ..... |
| Dec. 24 | **2:00** | 21.7 | 24.5 |
| Dec. 25 | **2:00** | 24.1 | ..... |
| | **4:45** | 24.4 | ..... |
| Dec. 26 | 10:45 | 27.2 | ..... |
| | Noon | 27.8 | 35.0 |
| | **3:30** | 29.4 | ..... |
| | **2:30** | 29.4 | ..... |
| Dec. 29 | 10:30 | 26.7 | ..... |
| | Noon | 27.8 | ..... |
| | **2:00** | 26.7 | ..... |
| | **3:30** | 26.7 | ..... |
| Dec. 30 | 11:00 | 24.4 | 31.0 |
| | **2:00** | 24.5 | 38.5 |
| | 5:15 | 17.0 | ..... |
| Dec. 31 | 10:45 | 24.8 | 35.0 |
| Jan. 1 | 9:55 | 27.8 | 32.0 |
| | Noon | 28.3 | 38.0 |
| | **? 3:00** | 23.3 | 36.0 |
| Jan. 3 | 10:45 | ..... | 34.0 |
| | 11:30 | 27.8 | ..... |
| Jan. 4 | Noon | 25.0 | 31.5 |
| | **2:45** | 26.7 | ..... |
| Jan. 6 | 11:00 | 26.1 | 28.9 |
| | **2:30** | 25.6 | ..... |
| Jan. 7 | **4:00** | 26.1 | ..... |
| Jan. 8 | **12:15** | 29.4 | ..... |
| | **4:15** | ..... | 28.9 |
| Jan. 9 | 9:00 | 22.2 | 23.0 |
| | 9:45 | 24.1 | 33.0 |
| Jan. 13 | **1:45** | 28.3 | 40.5 |
| Jan. 15 | **12:45** | 26.7 | 40.5 |
| Jan. 17 | Noon | 27.8 | ..... |

4) P. M. hours indicated by bold face type.

Table III. *Irregular observations on relative humidity and barometric pressure taken in La Paz, Baja California Sur, Mexico, December, 1958 - January, 1959.*

| Date | TIME [5] | HUMIDITY % | TEMPERATURE °C | BAROMETER IN INCHES Hg |
|---|---|---|---|---|
| Dec. 27 | 6:00 | 63 | 21.7 | 29.50 |
| Dec. 28 | Noon | 63 | 23.3 | 29.51 |
| | **4:00** | 66 | 24.4 | ...... |
| | **8:00** | 78 | 20.6 | 29.53 |
| Dec. 29 | 8:00 | 75 | 20.0 | 29.58 |
| | **4:00** | 47 | 22.2 | 29.51 |
| | **8:00** | 59 | 20.0 | 29.56 |
| Dec. 30 | 8:00 | 52 | 19.4 | 29.58 |
| | **4:00** | 47 | 17.2 | 29.52 |
| Dec. 31 | 8:00 | 49 | 17.2 | 29.50 |
| | **4:00** | 45 | 20.6 | 29.42 |
| Jan. 1 | **8:00** | 59 | 18.9 | ...... |
| Jan. 2 | 8:00 | 57 | 13.9 | 29.53 |
| | Noon | 58 | 22.8 | 20.45 |
| | **4:00** | 53 | 22.2 | 29.35 |
| Jan. 3 | 8:00 | 82 | 16.2 | 29.49 |
| | Noon | 49 | 22.2 | 29.45 |
| | **8:00** | 65 | 21.1 | 29.42 |
| Jan. 4 | **8:00** | 80 | 19.4 | 29.52 |

5) P. M. hours indicated by bold face type.

## General Herpetological Observations

A broad cross section of the amphibians and reptiles known to inhabit the lowlands of the Cape Region was obtained during the winter months. More juveniles than adults were collected. This is particularly true for species of *Cnemidophorus, Phrynosoma, Callisaurus, Uta,* and *Masticophis,* but not for *Sceloporus, Ctenosaura, Phyllodactylus, Salvadora, Hypsiglena, Chilomeniscus,* or *Petrosaurus.* The specimens of *Sauromalus, Dipsosaurus, Phyllorhynchus,* and *Eridiphas* were found under logs, rocks or in crevices in rocks and were not active.

The earliest daily appearance of lizards was between 9:30 and 10:00 A. M. By this time ground temperature often reached 30° C. or above while air temperatures ranged from 24° to 26° C. *Sceloporus, Uta,* and *Petrosaurus* were most abundantly represented. Later in the day other animals appeared, usually in early afternoon, including young individuals of *Cnemidophorus, Phrynosoma,* and *Callisaurus,* and large specimens of *Ctenosaura.* Examples of *Hypsiglena* were found active under cover at mid-morning, and of *Chilomeniscus* in late afternoon. By 4 P. M., as sunset approached and air temperature and ground temperature began to drop most lizards disappeared. Only those belonging to the genus *Sceloporus* remained and some of these continued to bask on rocks until dusk (4:45 P.M.).

Based on the observations recorded above it seems likely that the animals received much heat from ground radiation rather than from the direct exposure to the incident rays of the sun. The smaller body mass of young animals allowed them to warm faster than the large adult animals of the same speies, which accounts for the early appearance of the young. However, few juveniles were taken in the late afternoon, while adults of *Sceloporus* and *Ctenosaura* were found active. Because of the smaller body mass compared to surface area in smaller individuals, body heat is radiated more rapidly than in adults and these younger animals arė thus limited to morning and early afternoon activity during the winter months.

In the course of the two winter months spent in the Cape Region, 345 animals were collected. These are reported on below; within the major systematic groupings the species are arranged alphabetically by genus.

FIGURE 2. Station 20, approximately 15.1 miles north of Todos Santos, illustrating the effects of three days of light misty-rain on the roads. *Coleonyx variegatus* was found in this general environment hidden beneath rocks or fallen cacti debris.

## Account of Species

### AMPHIBIA

**Bufo punctatus** Baird and Girard.

Material Collected (22). Station 7 (CAS 91242); Station 14 (CAS 91259); Station 20 (CAS 91271); Station 39 (CAS 91332-91334); Station 73 (CAS 91473-91475); Station 74 (CAS 91488); Station 75 (CAS 91492-91496).

Remarks. Of the 22 specimens collected, 13 were found active on or around sand and rocks in wet arroyos, especially at the Arroyo de los Pozos, about 13 miles east of La Paz, in early January; 2 were taken under dead cardon trees, and 5 were found burrowed into the sandy banks of El Saltito Arroyo below the waterfall. Two other individuals were discovered within the soft, moist decaying pulp of a dead cardon log.

There are no previous records for this species for the winter months from the Cape Region though Van Denburgh (1895b, p. 560) notes specimens taken as late as October, in 1890. Van Denburgh and Slevin (1921, p. 54) state that the species was very common in the vicinity of San Antonio where they were heard calling late into the evening in the spring.

**Hyla regilla** Baird and Girard.

Material collected (4 adults and 2 lots of tadpoles). Station 23 (CAS 91277); Station 70 (CAS 91462); Station 72 (CAS 91468, tadpoles); Station 73 (CAS 91470, tadpoles; CAS 91471-91472, adults).

Remarks. Previously reported from the Cape Region by Yarrow (1882, p. 171), Van Denburgh (1895b, p. 557) and Van Denburgh and Slevin (1921, p. 54) this species seems to be present wherever there is a supply of relatively permanent water. The 4 adults collected were found in the vegetation (grass and reeds) near streams and pools. Two specimens were seen under dead palm fronds alongside an irrigation ditch at Todos Santos (January 13) but escaped. Tadpoles were taken on two occasions, at San Batolo and at El Triumpho in late January.

### REPTILIA

#### Amphisbaenids

**Bipes biporus** Cope.

Material collected (1). Station 31 (Stanford University 21907).

Remarks. A living specimen of this singular burrowing amphisbaenid lizard was obtained from underneath a dead cardon cactus, in slightly damp sand on the leeward side of the coastal sand dunes at Rodreguez Ranch, 19 miles northwest of La Paz. The animal was pink in life. It had no pattern and

FIGURE 3. Station 28, El Coyote Beach, about 16 miles north-northeast of La Paz. The sand dunes were inhabited by *Callisaurus* and *Uta*. This is a fairly typical beach-sand dune environment along the east coast of the Cape region.

no melanophores were evident. When first observed it was burrowing vertically into the sand. The animal was kept alive for several days in a large pot with a shallow bed of sand. Under these conditions it burrowed into the sand by a "swimming motion" in which the head was moved from side to side, and forward, and the two front feet were actively moving a "sweeping movement," apparently pushing sand backward as the animal progressed forward.

In February of 1882 Belding obtained twelve specimens which formed the type series Cope had before him when he described the species.

## Lizards

### Callisaurus draconoides draconoides Blainville.

Material collected (43). Station 2 (CAS 91209-91215); Station 7 (CAS 91227-91240); Station 8 (CAS 91245); Station 10 (CAS 91248); Station 28 (CAS 91299-91301); Station 31 (CAS 91308-91310); Station 33 (CAS 91321); Station 37 (CAS 91328); Station 39 (CAS 91366); Station 42 (CAS 91374); Station 53

(CAS 91403-4); Stations 62 and 63 (CAS 91425-91430); Station 64 (CAS 91436); Station 66 (CAS 91441-91444); Station 70 (CAS 91455).

REMARKS. Van Denburgh and Slevin (1921, p. 57) remarked that this lizard in the Cape Region "is a fairly common species, especially near the coast ...Here it was found in the sandy areas back of the beaches...In the interior it frequented the hot sandy bottoms of the canyons and adjacent arroyos." Of the 43 specimens collected in 1958-1959, 41 were found active on the ground, generally between 11:00 A.M. and 2:30 P.M.; only 2 were found under cover of a log. All individuals were taken in sandy areas, either along beach dunes or in sandy arroyos.

FIGURE 4. Station 31, Rodriguiz Ranch, approximately 19 miles west-northwest of La Paz, leeward side of coastal dune. Arrow points to fallen cardon log (see figure 4) beneath which *Bipes biporus* was found.

## Cnemidophorus hyperythrus hyperythrus Cope

MATERIAL COLLECTED (35). Station 2 (CAS 91216); Station 4 (CAS 91219-91221); Station 5 (CAS 91223); Station 6 (CAS 91225); Station 21 (CAS 91272-91274); Station 28 (CAS 91295-91298); Station 31 (CAS 91313); Station 34 (CAS

91418); Station 38 (CAS 91330); Station 45 (CAS 91379); Station 52 (CAS 91399); Station 62-63 (CAS 91424, 91431-35); Station 69 (CAS 91450-53); Station 74 (CAS 91479-91485); Station 75 (CAS 91499).

REMARKS. A very abundant animal in the Cape Region during the winter months; all but 3 individuals were observed on the ground. Most of the specimens collected were taken early in the afternoon though a few were obtained late in the morning.

**Cnemidophorus tigris rubidus** Cope.

MATERIAL EXAMINED (1). Station 6 (CAS 91224).

REMARKS. The single specimen of this species collected during the winter was a young adult taken just before 10:00 A.M. At this time the air temperature was about 25° C. Though no record of ground temperature was made, it must have been about 30° C. Within two hours, by noon time, ground temperature had reached 31.5° C., air temperature, 26.5° C.

**Coleonyx variegatus peninsularis** Klauber.

MATERIAL COLLECTED (5). Station 14 (CAS 91257); Station 15 (CAS 91260); Station 16 (CAS 91261); Station 18 (CAS 91265); Station 20 (CAS 91267).

REMARKS. Klauber (1945) based his name for this population on three specimens, one each from the vicinity of La Paz, San Jose del Cabo, and along the trail between Loreto and Comondu. We find that our specimens agree closely with Klauber's description.

These 6 specimens were found beneath rocks or wood; the soil was composed of a very fine sandy loam.

TABLE IV. *Counts and measurements ( in mm.) for specimens of* Coleonyx variegatus peninsularis.

| NUMBER | SEX | SNOUT-VENT LENGTH | BODY | TAIL | GULARS TOUCHING MENTALS | SPOTS IN BETWEEN BANDS |
|---|---|---|---|---|---|---|
| CAS 91257 | male | 43 | 6[6] | 8 | 5 | none |
| CAS 91260 | female | 49 | 5 | 3[7] | 6 | none |
| CAS 91261 | male | 39 | 5 | 4[8] | 6 | none |
| CAS 91265 | juv. | 30 | 5 | 3[7] | 7 | none |
| CAS 91267 | | 42 | 5 | - | 7 | none |

6) Fourth and fifth bands joined. 7) Tail largely regenerated. 8) Tail broken.

FIGURE 5. Same as figure 3, but showing exposed ground and underside of cardon log beneath which a specimen *Bipes biporus* was found. Arrow (lower center) points to small hole in ground into which the animal was burrowing when discovered.

**Ctenosaura hemilopha** Cope

Material collected (2). Station 43 (CAS 91375); Station 49 (CAS 91391).

Remarks. Three specimens of this large lizard were collected (one was sent to the Secretaria de Agricultura, Mexico, D. F., before the writing of this report), though many others were seen. Of the three collected, one was taken on the ground, one on a large boulder, and one on the trunk of a tree. Others were seen clinging on the vertical granitic walls of the Arroyo San Bartolo as early as 9:00 A. M. (air temperature 21° C.; ground temperature, 23° C.) as well as in an area of large boulders between San Lucas and Todos Santos. It seems quite remarkable that so massive a beast as this could venture forth so early in the day.

**Dipsosaurus dorsalis lucasensis** Van Denburgh.

Material collected (1). Station 71 (CAS 91467).

Remarks. A single juvenile was found under a small rock late in the afternoon. It was not active. At the same time adult specimens of *Sceloporus orcutti licki* were collected on rocks where they were basking just before dusk. No desert iguanas were seen active on the ground during the entire trip. Though Van Denburgh and Slevin (1921, p. 56), and Murray (1955, p. 35) emphasize the occurrence of this species in sandy terrain, particularly near the coast, our specimen was taken in an area of silt with scattered granitic rocks and boulders, a good distance from the coast.

**Petrosaurus thalassinus thalassinus** Cope.

Material collected (2). Station 49 (CAS 91390); Station 63 (CAS 91428).

Remarks. Both specimens collected were taken in the morning. CAS 91390, collected at 9:00 A.M. was found basking on the walls of San Bartolo arroyo along with half-grown individuals of *Ctenosaura.* The air temperature at that time was 21° C., the rock surface 23° C.

Though only two specimens were captured, these animals were more abundant. Several were seen in the San Bartolo Arroyo, but they were very shy and excaped into crevices in the rocks as one approached.

Linsdale (1932, p. 359) reports that the altitudinal range for this species is 800 to 5700 feet. The site of Station 63 could not have been more than 200 feet above sea level, though no accurate measurements were taken; we suspect that the animal may even come down to sea level in those places where appropriate habitats are to be found.

**Phrynosoma coronatum coronatum** Blainville.

Material collected (3). Station 45 (CAS 91378); Station 67 (CAS 91448); Station 74 (CAS 91486).

Remarks. The three specimens collected were juveniles. They were all collected during the early afternoon, on days when the air temperature reached 26° to 28° C., and ground temperatures between 35° and 40° C. According to Yarrow (1882b, p. 66) Belding collected three specimens at La Paz in February, 1882, and Van Denburgh (1895a, p. 118) noted that this lizard had been taken as late as November, in 1893, in the Cape Region.

In the three specimens at hand, ventral spotting is widespread. There are three pair of dark dorsal blotches, each blotch bordered behind by white. The cephalic spines number 5+1+5; they are not curved. The dorsal scales are strongly spinose.

**Phyllodactylus unctus** Cope.

Material examined (34). Station 13 (CAS 91256); Station 14 (CAS 91258); Station 16 (CAS 91262); Station 17 (CAS 91264); Station 36 (CAS

91322); Station 39 (CAS 91342-91355); Station 40 (CAS 91370-91371); Station 50 (CAS 91395); Station 51 (CAS 91396-91398); Station 54 (CAS 91411); Station 51 (CAS 91400); Station 56 (CAS 91406-91407); Station 58 (CAS 91412); Station 65 (CAS 91439); Station 67 (CAS 91447); Station 75 (CAS 91497-91498).

REMARKS. This species was the most common gecko obtained during the winter period. Of the 34 specimens collected, 15 were found under exfoliating slabs of granite, 14 were taken from under rocks, 3 were on the rocks, and 2 were found in or under decaying cardon logs. All were active at mid-day and all made strenuous efforts to escape capture. Previous midwinter records for this species include those of Van Denburgh (1895a, p. 88), who recorded 9 specimens obtained by Gustav Eisen at San Jose del Cabo in January, 1893, and Yarrow (1882, p. 73) who reported on Belding's specimens from La Paz, taken in February, 1882.

One specimen, obtained under a rock at Station 36, was placed in a cloth bag with an adult night snake, *Hypsiglena ochrorhyncha*; it later had to be removed from the snake's stomach.

FIGURE 6. Station 39, Arroyo de Los Pozos, about 13 miles east of La Paz. Water was present immediately beneath the surface. Some can be seen in small pockets on the left. Young *Bufo punctatus* were especially abundant. On the low hills in the background, *Phyllodactylus unctus* was found in abundance under exfoliating slabs of granitic rock.

FIGURE 7. Station 44, 0.2 miles south-southeast of San Jose del Cabo. Irrigation ditch supplying water to fields. *Hyla regilla* may be found on occasion in or alongside these ditches.

Phyllodactylus xanti xanti Cope.

MATERIAL COLLECTED (5). Station 31 (CAS 91311); Station 62 (CAS 91423); Station 63 (CAS 91426-91427); Station 70 (CAS 91460).

REMARKS. Recently Dixon (1960) showed that the name *P. tuberculatus* by which name this form has been known for years, must be applied to another population of *Phyllodactylus* entirely. He reinstated Cope's old name *P. xanti* for the Cape Region population, the type locality of which is the "vicinity of Cabo San Lucas." Of the 5 specimens obtained, 4 were found under rocks, 1, under a cardon log. Belding obtained 1 specimen at La Paz in February.

Sauromalus australis Shaw.

MATERIAL COLLECTED (2). Station 39 (CAS 91368-91369).

REMARKS. The two young specimens collected were found squeezed into a fracture crevice in a very large boulder. Specimens of *Phyllodactylus unctus* were taken from under exfoliating slabs on the same boulder. No chuckwallas were observed to be active during this winter period. In February of 1882, Belding also obtained a specimen of this species in the vicinity of La Paz, but there is no indication in Yarrow's note (1882, p. 51) whether the animal was active or not.

Ventral counts for these two specimens are 124 and 157, the former being considerably lower than that indicated by Shaw (1945) for the six specimens forming the type series which he had before him (151-186, mean 163.5).

Sceloporus magister zosteromus Cope.

MATERIAL COLLECTED (None). Record based on one field observation late in the afternoon of December 31, 1958, 8 miles northwest of La Paz. A single large individual was flushed out of some low bushes bordering a shallow, silty water course. The animal, an adult male, darted rapidly from under one bush into another and could not be found.

Sceloporus orcutti licki Van Denburgh.

MATERIAL COLLECTED (22). Station 3 (CAS 91218); Station 4 (CAS 91222); Station 13 (CAS 91255); Station 35 (CAS 91319-91320); Station 39 (CAS 91367); Station 48 (CAS 91383-91387); Station 49 (CAS 91389); Station 67 (CAS 91445-91446); Station 70 (CAS 91457-91458); Station 71 (CAS 91463-91466); Station 73 (CAS 91476); Station 74 (CAS 91487).

REMARKS. Van Denburgh and Slevin (1921, p. 61) and Murray (1955, p. 37) state that these animals are usually to be seen on boulders, though Murray states the case a little too strongly when he says, "invariably...on boulders." Of the 22 specimens collected 15 were taken off of rocks or boulders or were observed running about on the sides of large granitic outcroppings; however, 4 were on the ground when collected and not close to any boulders at the time, and 1 was found under a rock.

Remarkably, though this is one of the really common lizards of the Cape Region, it did not show up in the mid-winter collections of Belding, Xantus, or others. It is a very agile beast, however, and the few individuals that may have been about at that time probably darted into cracks and fissures in the rocks before they could be collected.

Urosaurus nigricaudus Cope.

MATERIAL COLLECTED (33). Station 2 (CAS 91217); Station 7 (CAS 91241); Station 9 (CAS 91246, 91324); Station 10 (CAS 91247); Station 12 (CAS 91250); Station 20 (CAS 91269); Station 21 (CAS 9175-91276); Station 30 (CAS 91303); Station 31 (CAS 91312); Station 33 (CAS 91316); Station 34 (CAS 91317); Station 46 (CAS 91381-91382); Station 47 (CAS 91376-7, 91380); Station 49 (CAS 91388); Station 50 (CAS 91392-91393); Station 52 (CAS 91402); Station 57 (CAS

91410); Station 61 (CAS 91420); Station 62 (CAS 91421-91422); Station 64 (CAS 91437); Station 68 (CAS 91449); Station 69 (CAS 91454); Station 70 (CAS 91456); Station 72 (CAS 91469); Station 74 (CAS 91489); Station 75 (CAS 91490-91491).

REMARKS. This species was the most abundant and widely distributed of the several iguanid lizards encountered during the winter months. Of the 33 specimens collected, 19 were found active on the ground, 8 were on rocks, 2 were found inside of decaying cardon logs, 2 were in houses, 1 was on sand, 1, on a log, and 1, on a cactus stump about six feet above the ground. Many additional individuals were seen, mostly on the ground, but were not or could not be collected.

The above observations are in marked contrast to those of Van Denburgh and Slevin (1921, pp. 58-59) and Linsdale (1932, p. 361) who found these animals most frequently off the ground, on low bushes or on stone or wooden fences. Of course, their observations were made during the spring when air and ground temperatures were much higher and the animals might well seek a semi-arboreal habitat to help maintain a lower body temperature by moving away

FIGURE 8. Station 63, about 2.4 miles north of Cabo San Lucas, looking toward the southern most tip of the Cape. Hidden by the undergrowth to the left of the road are some larger granitic boulders. *Phyllodactylus xanti* were taken from beneath exfoliating rock slabs. *Petrosaurus thalassinus* was found here, too.

from the very high ground radiation. Certainly these animals could not have kept warm during the winter months unless on the ground where they could absorb ground radiation, for air temperatures were too low and would have allowed for too rapid a transfer of heat from the animal to the air in an arboreal situation.

Belding collected 10 specimens of this species at La Paz in February of 1882.

FIGURE 9. Station 67, hills immediately south of Cabo San Lucas, overlooking cannery (arrow). *Phyllodactylus xanti, Phrynosoma coronatum,* and *Sceloporus orcutti* were found in this environment. This is probably the type locality area of *P. xanti,* said to be in the vicinity of Cabo San Lucas, since it is the only environment in the immediate vicinity of either the present town, or of its earlier location, suitable for that lizard.

Uta stansburiana elegans Yarrow.

MATERIAL COLLECTED (35). Station 6 (CAS 91226); Station 11 (CAS 91249); Station 13 (CAS 91251-91253); Station 16 (CAS 91263); Station 20 (CAS 91268); Station 24 (CAS 91278); Station 25 (CAS 91279-91280); Station 26 (CAS 91281); Station 27 (CAS 91282); Station 28 (CAS 91283-91284); Station 29 (CAS 91302); Station 31 (CAS 91304-91307); Station 32 (CAS 91314-91315); Station 38 (CAS 91331); Station 37 (CAS 91325-91327, 91329); Station 54 (CAS 91405); Station

Station 57 (CAS 91409); Station 59 (CAS 91413-91317); Station 63 (CAS 91429); Station 66 (CAS 91440).

. REMARKS. In 1944, Cowles and Bogert stated that extensive observations on southern California populations of *Uta stansburiana* indicated that these animals will not remain active when the air temperature drops below 26° C., though in the late afternoons when the ground is relatively warm, they continue to be active for a time. In the Cape Region, during the winter months, a few animals were seen active at air temperatures of 24.1° to 24.7° C. At these air temperatures, ground temperature would reach between 28° to 36° C., so if this forms the major source of radiant-heat energy for keeping the animals warm, it comes close to the limits given by Cowles and Bogert of 26° - 36° C.

Thirty-five specimens were found; 14 on rocks, 11 on the ground, 4 on sand, 2 under rocks, and 2 under cardon logs. Van Denburgh and Slevin (1921, p. 59) stated that "This lizard, which generally is common in desert areas, was not found so in the Cape Region, and strange to day, was taken only at the sea-coast. None was seen in any of the interior country. All the specimens taken were found in brushy areas back of the beaches." The collections made in the winter of 1958-1959 largely came from coastal areas; indeed, only one

FIGURE 10. Station 70, near the Boca de la Sierra. Permanent water flowing in the Arroyo Miraflores. One specimen of *Natrix valida*, was taken here.

specimen, CAS 91268, was taken in the "interior," 17.5 miles north of Todos Santos.

Belding secured 15 specimens at La Paz in February, 1882.

## SNAKES

### Chilomeniscus cinctus Cope.

MATERIAL COLLECTED (2). Station 7 (CAS 91244); Station 52 (CAS 91401).

REMARKS. The specimen found at Bahia de los Muertos (Station 7), taken from under a board on the sandy beach, was very active and made strenuous efforts to espace. CAS 91401 was found dead on the ground at 10:40 A.M. in a sandy arroyo just south of La Pastura. It had been dead for only a short time before being picked up. It seemed likely that it was caught out in the open when the sun came up and died as a result of excessive heat, for it was quite warm, though no temperature records were made at the time.

TABLE V. *Counts and measurements for specimens of* Chilomeniscus cinctus.

| | CAS 91244 | CAS 91401 |
|---|---|---|
| Sex | male | female |
| Ventrals | 113 | 118 |
| Subcaudals | 27 | 27 |
| Dorsal body bands | 32 | 28 |
| Tail bands | 9 | 5 |
| Dorsal scale rows | 14-13-12 | 14-13-13 |

In CAS 91244 there is a wide creamy white interspace, 3 to 4 scale rows in width, between the tenth and eleventh dorsal bands, with dark markings on several scales. CAS 91401 has a conspicuously narrowed head; the dorsal bands become narrower toward mid-body, then widen and become narrower again near the anus.

### Chilomeniscus stramineus stramineus Cope.

MATERIAL COLLECTED (2). Station 70 (CAS 91461).

REMARKS. Two specimens were obtained by Belding in the vicinity of La Paz in February, 1882. The solitary specimen botained during the winter of 1958-1959 was found in a very dry rocky area in the immediate vicinity of a water-filled reservoir which forms the water supply for Miraflores. This specimen, a male, has 106 ventrals and 33 subcaudals. It is 83 mm. in snout-vent length, with a tail of 34 mm. Its color pattern is typical of the subspecies.

Eridiphas slevini (Tanner).

MATERIAL COLLECTED (1). Station 75 (CAS 86093).

REMARKS. Leviton and Tanner (1960) proposed the nominal genus *Eridiphas* to accommodate *Hypsiglena slevini,* a species described by Tanner, in 1946, based on a single young specimen collected some years earlier in the vicinity of Loreto, Baja California Sur, Mexico by J. R. Slevin. They were led to question the generic affinities of that species when they examined a second specimen, an adult female, that was taken in January, 1959, a few miles from La Paz. More recently, a third specimen was turned up on Ceralvo Island (Etheridge, 1961; Soule, 1961), which agrees closely with the material already at hand. Based on available material we find no reason to question the conclusions reached by Leviton and Tanner.

The individual taken in 1959 was found beneath a small rock resting on slightly damp sand alongside a trickle of water above the waterfall in El Saltito Arroyo. It was not especially active.

Hypsiglena torquata ochrorhyncha Cope.

MATERIAL COLLECTED (7). Station 12 (CAS 91254); Station 36 (CAS 91323); Station 39 (CAS 91372); Station 56 (CAS 91408); Station 59 (CAS 91418); Station 60 (CAS 91419); Station 65 (CAS 91438).

REMARKS. Of the several specimens collected, four were found beneath rocks or boards (the latter on a sandy beach), one was under a log, one was in a decaying log, and CAS 91408 was found dead on the ground in a dry, rocky area. All localities at which these animals were found are near the coast, and all but one of the specimens collected were active when uncovered.

TABLE VI. *Counts and measurements (in mm.) of specimens of* Hypsiglena torquata ochrorhyncha.

| CAS NUMBER | 91254 | 91323 | 91372 | 91408 | 91418 | 91419 | 91438 |
|---|---|---|---|---|---|---|---|
| Sex | female | male | male | male | male | female | female |
| Ventrals | 174 | 170 | 163 | 164 | 175 | 178 | 179 |
| Subcaudals | 45 | 51 | 51 | 54 | 55 | 46 | 48 |
| Snout-vent length | 275 | 260 | 270 | 246 | 270 | 315 | 350 |
| Tail length | 46 | 55 | 54 | 52 | 55 | 53 | 62 |
| Body blotches | 69 | 66 | 62 | 67 | 48[9] | 65 | 56 |
| Tail blotches | 21 | 22 | 23 | 34(?) | 24 | 21 | 22 |

9) Some blotches on posterior portion of body fused together.

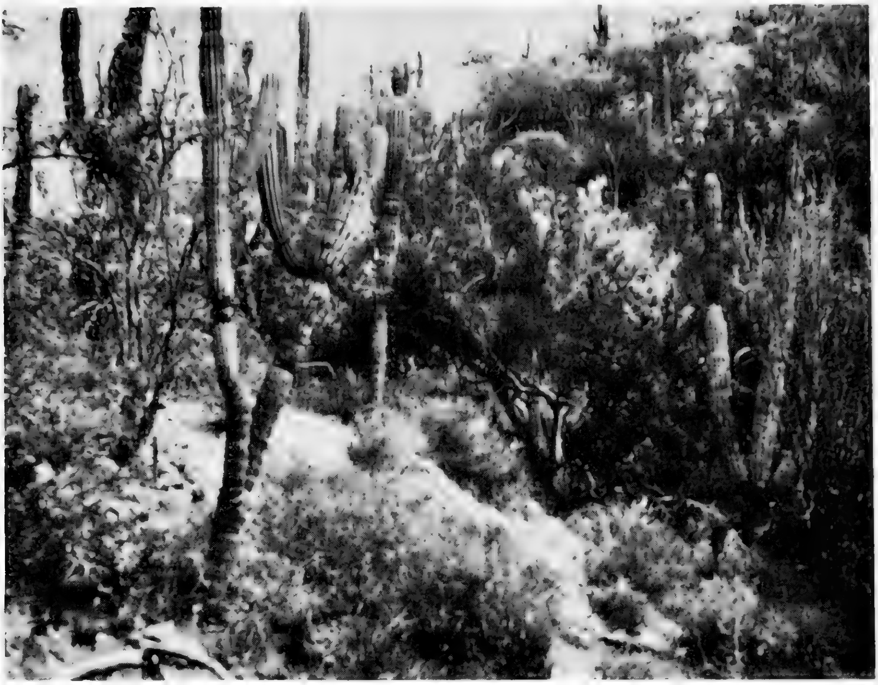

FIGURE 11. Station 75. El Saltito Arroyo, near water falls. Though only a trickle of water was flowing from a small spring, the dense growth clearly indicates underground water was available. *Eridiphas slevini* was taken in this general area. Also, *Bup punctatus* adults were quite common, but all were found burrowed into the sandy banks of the arroyo channel.

Masticophis flagellum piceus Cope.

MATERIAL COLLECTED (2). Station 7 (CAS 91243); Station 74 (CAS 91478).

REMARKS. Three individuals of this snake were seen, but only 2 were collected. Of the 3, 2 young, 1 red phase and 1 black phase, were seen late in the afternoon; only 1 was taken. Both were very active on the leeward side of sand dunes, 1 at Station 7, at Bahia de los Muertos, 1 at Station 57, 4.9 miles southeast of Pescadero. The large specimen, taken at Station 74, was found coiled up inside of a dead cardon log, the cavity of which had decayed. It was lethargic and made no attempt to move away when its shelter was torn apart.

Belding obtained three specimens in the winder of 1882, but whether they were taken while moving about or were found in hiding is not known.

Natrix valida celaeno Cope.

MATERIAL COLLECTED (1). Station 70 (CAS 91459).

REMARKS. Previously recorded as being active during the winter months by Yarrow (1882, p. 133) for 5 specimens obtained by Belding in February, 1882, near La Paz and, by Van Denburgh (1895a, p. 153) for a specimen taken in November, 1893, it is evident that relatively few individuals are about during those months compared to their abundance during the spring and autumn.

The 1 specimen collected in 1958-1959 was found in a concrete irrigation ditch leading from the Miraflores reservoir through the village of Boca de la Sierra. It is an adult male 515 mm. in snout-vent length, with a tail length of 175 mm. It has 145 ventrals. 79 subcaudals and 19 scale rows at midbody. Narrow, light lateral stripes are visible, but are not conspicuous.

## Phyllorhynchus decurtatus decurtatus Cope.

MATERIAL COLLECTED (1). Station 20 (CAS 91270).

REMARKS. Mr. Hugh Leech found the specimen reported on here under a dead cardon log which was lying on the compacted sandy soil of an arroyo channel. It is an adult male (snout-vent length 330 mm., tail length 58 mm.). There are 21 rectangular dorsal blotches, two pairs of which, though quite distinct, are obviously fragments of a single pair. There are 5 caudal blotches. The margins of all blotches are darker than their centers. It has 157 ventrals, 36 subcaudals, and dorsal scales in 21-19-17 rows.

## Salvadora hexalepis klauberi Bogert.

MATERIAL COLLECTED (3). Station 1 (CAS 91208); Station 19 (CAS 91266); Station 41 (CAS 91373).

REMARKS. Two of the three specimens collected were found dead on the road, the third was taken crossing the road. All were found early in the morning and were very active. Two other individuals were seen during this winter period, both very active, but disappeared into dense bushes along side the road.

TABLE VII. *Counts and measurements (in mm.) for specimens of* Salvadora h. klauberi.

| | CAS 91208 | CAS 91266 | CAS 91373 |
|---|---|---|---|
| Sex | female | female | male |
| Ventrals | 205 | 196 | 200 |
| Subcaudals | ...[10] | 90 | 91 |
| Dorsal scale rows | 21-17-15 | 21-17-15 | 23-17-13 |
| Upper labials | 10-10 | 9-9 | 9-9 |
| Lower labials | ?-11 | 11-11 | 11-12 |
| Snout-vent length | 640 | 538 | 795 |
| Tail length | ...[10] | 195 | 250 |

10) Tail damaged.

**Tantilla planiceps** Blainville.

MATERIAL COLLECTED (2). Station 50 (CAS 91394); Station 73 (CAS 91477).

REMARKS. Van Denburgh (1896, p. 1008) reported on one of these snakes collected at San Jose del Cabo in November of 1895. Both of the specimens obtained in January, 1959, were found by digging into rocky banks along the Arroyo San Bartolo and near Triumpho. The head in CAS 91394 is light charcoal black, and there is a conspicuous creamy white collar, one scale row wide, on the neck separating the head color from that of the body. The total length of CAS 91477 is 252 mm.; this is greater than that recorded by Blanchard (1938, p. 371) for this species. Though the ventral counts fall within the range given by Blanchard (134-140), the subcaudal count of CAS 91477 of 48 is lower than the range cited by Hartweg (1944, p. 3) of 56-60. We believe that *T. planiceps* is more closely allied to *T. eiseni* of southern California than has been previously suspected.

TABLE VIII. *Counts and measurements (in mm.) of specimens of* Tantilla planiceps.

| | CAS 91394 | CAS 91477 |
|---|---|---|
| Sex | female | male |
| Ventrals | 139 | 140 |
| Subcaudals | 60 | 48 |
| Dorsal scale rows | 15 | 15 |
| Snout-vent length | 126 | 200 |
| Tail length | 42 | 52 |

## CHECK LIST OF KNOWN AMPHIBIANS AND REPTILES INHABITING THE CAPE REGION, BAJA CALIFORNIA SUR, MEXICO

### AMPHIBIANS

FROGS

Bufonidae

*Bufo punctatus* Baird and Girard

Hylidae

*Hyla regilla* Baird and Girard

Pelobatidae

*Scaphiopus couchii* Baird

## REPTILES

AMPHISBAENIDS

Amphisbaenidae

*Bipes biporus* Cope

LIZARDS

Anguidae

*Gerrhonotus paucicarinatus* Fitch

Gekkonidae

*Coleonyx variegatus peninsularis* Klauber
*Phyllodactylus unctus* (Cope)
*Phyllodactylus xanti* Cope

Iguanidae

*Callisaurus draconoides draconoides* Blainville
*Crotophytus wislizeni copei* Yarrow
*Ctenosaura hemilopha* Cope
*Dipsosaurus dorsalis lucasensis* Van Denburgh
*Petrosaurus thalassinus thalassinus* (Cope)
*Phrynosoma coronatum coronatum* (Blainville)
*Sauromalus australis* Shaw
*Sceloporus magister zosteromus* Cope
*Sceloporus orcutti licki* Van Denburgh
*Urosaurus nigricaudus* (Cope)
*Uta stansburiana elegans* Yarrow

Scincidae

*Eumeces lagunensis* (Van Denburgh)

Teiidae

*Cnemidophorus hyperythrus hyperythrus* Cope
*Cnemidophorus maximus* Cope
*Cnemidophorus tigris rubidus* Cope

Xantusiidae

*Xantusia gilberti* Van Denburgh

SNAKES

Boidae

*Lichanura trivirgata* Cope

Colubridae

*Arizona elegans pacata* Klauber
*Chilomeniscus cinctus* Cope
*Chilomeniscus stramineus stramineus* Cope
*Elaphe rosaliae* (Mocquard)
*Eridiphas slevini* (Tanner)
*Hypsiglena ochrorhyncha ochrorhyncha* Cope
*Lampropeltis getulus conjuncta* Cope

*Lampropeltis nitida* Van Denburgh
*Masticophis flagellum piceus* (Cope)
*Natrix valida celaeno* Cope
*Phyllorhynchus decurtatus decurtatus* (Cope)
*Pituophis vertebralis* (Blainville)
*Salvadora hexalepis klauberi* Bogert
*Tantilla planiceps* (Blainville)
*Trimorphodon lyrophanes* (Cope)

Crotalidae

*Crotalus enyo enyo* (Cope)
*Crotalus mitchellii mitchellii* (Cope)
*Crotalus ruber lucasensis* Van Denburgh

Leptotyphlopidae

*Leptotyphlops humilis slevini* Klauber

Turtles

Emydidae

*Pseudemys scripta nebulosa* (Van Denburgh)

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# PROCEEDINGS

OF THE

# CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

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# THE GENUS *ALVORDIA* (COMPOSITAE) OF A BAJA CALIFORNIA, MEXICO


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## INTRODUCTION

The genus *Alvordia* Brandegee, endemic to Baja California, Mexico, has been interpreted as consisting of two taxa described by T. S. Brandegee before the turn of the century and one described by S. F. Blake in 1917. It is herein augmented by a fourth taxon found to occur on some of the islands of the Gulf of California. Evaluation of this newly recognized taxon brought to light a nomenclatural inadvertence involving the two taxa of the Cape Region, which, unfortunately, necessitates the changes which follow.

The species upon which *Alvordia* was based, *A. glomerata* Brandegee (1889), occurs in the south-central part of the peninsula of Baja California. The other two previously described taxa (*A. fruticosa* Brandegee and *A. angusta* Blake) are confined to the tip of the peninsula, the "Cape Region."

Blake (1917) found that Brandegee's concept of *A. fruticosa* actually encompassed two taxa, an ovate-leaved shrub and a lanceolate- to linear-lanceolate-leaved one. Because Brandegee had not cited a type when describing *A. fruticosa*, Blake designated as lectotype for this species, an ovate-leaved specimen seen by Brandegee (*Anthony 339*, San José del Cabo, in 1890) and then described the linear-lanceolate-leaved taxon as *A. angusta.* Unfortunately, the exigencies of war must have prevented Blake from consulting the Brandegee collections at the University of California. Had he done so, he would have found that Brandegee *had* designated a type specimen for *A. fruticosa* and that, contrary to Blake's assumption, it represented the linear-lanceolate-leaved taxon, not the ovate-leaved one. Therefore Blake's appropriately descriptive name, *A. angusta*, must be referred to synonymy under *A. fruticosa*, and another name must be provided for the ovate-leaved taxon. This is done in the following treatment, wherein it is described as *A. Brandegeei.*

## TAXONOMIC TREATMENT

**Alvordia** T. S. BRANDEGEE, 1889, Proc. Calif. Acad. Sci., ser. 2, vol. 2, p. 174.

Frutescent, many-stemmed, up to 2.5 m. tall. Leaves entire or some inconspicuously irregularly toothed, densely to sparsely strigillose, opposite below, the reduced upper ones alternate. Inflorescence of aggregated terminal glomerules, the subtending bracts often simulating phyllaries, the glomerules bearing (1-) 2 to 5 involucres; phyllaries (3-) 4 to 5 (6), graduate, slightly to strongly navicular; receptacular bracts subtending all flowers, those subtending disk flowers enfolding the achenes; ray flowers, when present, 1 to 3, neutral, the limb yellow, the pappus of 3 to 4 inconspicuous awns; disk flowers fertile, 1 to 3 (-4), the corolla yellow; anthers loosely joined, 2-2.8 mm. long, inconspicuously auriculate at base, the sterile apical appendage 0.6-1.0 mm. long and bearing subsessile glands on the cupped abaxial surface; style slender with linear stigma lobes; achenes slightly flattened or obscurely quadrangular, narrowly obconic, the pappus of 15 to 20 unequal, lanceolate, hispid awns, 2 or 3 of them longer than the others.

### KEY TO THE SPECIES AND VARIETIES OF *Alvordia*

Phyllaries strigillose abaxially, ciliate-margined, at least the outer brownish- or greenish-yellow, with the corky-thickened navicular keel strongly arcuate; ray flowers present, usually conspicuous; disk flowers 3 (occasionally 1 or 4) to a head; pappus [1] equalling or longer than the achenes. . . . . . . . . . . . . . . . 1. *A. glomerata*

Leaves lanceolate to ovate-lanceolate, acute, 1.6 to 3.3 times as long as wide; achenes 3.5-4 mm. long, equalling the pappus in length . . . . . . . . . . . . . . . . . . . . . . . . . 1a. *A. glomerata* var. *glomerata*

Leaves oval to ovate or obovate, obtuse (except for San Marcos Island specimens which have both acute and obtuse leaves on a plant), 1.4 to 2.4 times as long as wide; achenes 2.5-2.8 mm. long, shorter than the pappus . . . . . . . . . . . 1b. *A. glomerata* var. *insularis*

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1. Measurements based on longest pappus awns.

Phyllaries glabrous abaxially, finely ciliolate-margined, straw-colored, the navicular keel straight or slightly curved; ray flowers lacking (except for occasional inconspicuous ones in *A. Brandegeei);* pappus shorter than (or sometimes equalling) the achenes.

Leaves lanceolate to linear-lanceolate, acute, 3.4 to 6.4 times as long as wide; inflorescence 3-4 cm. in diameter; disk flowers 1 (occasionally 2) to a head. . . . . . . . . . . . . . . . . . 2. *A. fruticosa*

Leaves ovate, acute, 1.5 to 2.2 times as long as wide; inflorescence 1.5-2.5 cm. in diameter; disk flowers 2 (occasionally 1 or 3) to a head . . . . . . . . . . . . . . . . . . . . . . . 3. *A. Brandegeei*

**1. Alvordia glomerata** BRANDEGEE, 1889, Proc. Calif. Acad. Sci., ser. 2, vol. 2, p. 174.

Leaves ovate to ovate-lanceolate or lanceolate; inflorescence 1.5-3 cm. in diameter; involucres enclosing (2-) 3 (-4) disk flowers and 1 to 3 sterile ray flowers; phyllaries greenish- or brownish-yellow, strigillose abaxially, the margins ciliate, the outer 2 phyllaries navicular with the strongly arcuate keel broadly corky-thickened; receptacular bracts subtending all flowers, those of the disk flowers strongly enfolding the achenes; an aborted flower and 2 to 3 hispid bristles borne at the center of the receptacle.

**1a. Alvordia glomerata** BRANDEGEE var. **glomerata.**

Leaves lanceolate to ovate-lanceolate, acute (21-) 30-70 mm. long, 10-25 (-38) mm. wide, 1.6 to 3.3 (mean 2.59) times as long as wide; the often sessile glomerules bearing 5 to 7 involucres 6-9 mm. long and 2.6-4.6 mm. wide with a mean length to width ratio of 1.87; phyllaries and receptacular bracts 7-10 (-12), the outer phyllaries conspicuously strigose abaxially, the margins irregularly ciliate; limb of the ray flowers 5-6 mm. long, the sterile achenes 4 mm. long, the pappus awns 3 or 4, 0.4-1.0 mm. long; disk corollas 6-7 mm. long, the lobes 1.0-1.8 mm. long, the anthers 2.8 mm. long with sterile tips 0.8 mm. long, the pollen (including spines) 28.4-48.8 (mean 40.17) microns in diameter; achenes (3-) 3.5-4 mm. long, the pappus 3.5-4 mm. long; receptacular bristles 2 to 3, 8 mm. long; chromosome number, n = 60 *(Carter 4458, 4483).*

This species, upon which the genus is based, is the most widespread of the taxa, extending from Latitude 24° 35′ N. (where it was collected on Isla Partida, the only "non-peninsular" locality) northward to Latitude 28° N. (Calmallí). In the Sierra de la Giganta it occurs at elevations from 600-1050 m. and is often abundant on north-facing slopes. Its distribution is undoubtedly more continuous than would appear from reference to the distribution map (figure 1). Almost no field work has been carried on in the mountainous areas between the currently known localities for *A. glomerata.* One would like to know,

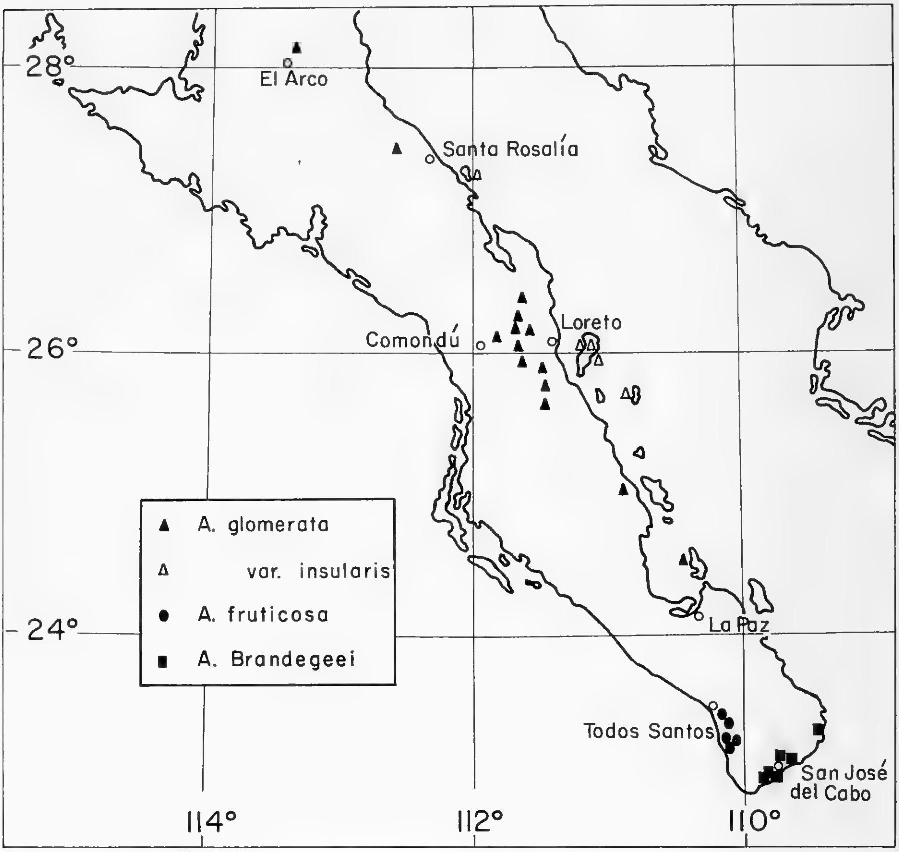


FIGURE 1. Distribution of *Alvordia* in Baja California.

however, if there is a gradual descent in altitudinal range of the plants from north to south in the Sierra Giganta. The Isla Partida and Misiòn Dolores collections, made at much lower altitudes than those in the northern Sierra Giganta, display characters that show close relationship to *A. Brandegeei* which occurs on coastal bluffs of the Cape Region.

TYPE. Baja California, Mexico: Comondú, 16 February 1889, *Brandegee* (UC, no. 84277; duplicates US, GH).

OTHER COLLECTIONS. Arroyo Calmallí, January-March, 1898, *Purpus 59* (UC, US[2]); Purgatorio Grade, 7 March 1935, *Wiggins 7934* (UC, US, DS); Sierra

2. The abbreviations for herbaria are those cited by Lanjouw and Stafleu, 1959.

de la Giganta: Cerro de Naucajoa, 25 November 1962, *Carter 4483, 4493*[3], Arroyo Hondo, north slope of Cerro Giganta, 14 December 1938, *Gentry 4136* (UC, GH), Cañon de las Palmas, west side of Cerro Giganta, 22 April 1955, *Carter & Ferris 3432* (UC, US, SD), Los Encinos, 28 March 1960, *Carter & Ferris 4032*, Upper "aguaje", Arroyo del Carrizo near San Javier, 15 March 1960, *Carter & Ferris 3815*, headwaters of Cañon Gabilán, 18 November 1962, *Carter 4458, 4459, 4467,* Cañon de Tiojo, La Victoria, 22 March 1960, *Carter & Ferris 3943*, Pilón de las Parras, 14 March 1961, *Carter & Sharsmith 4032*, La Esperanza, 20 April 1962, *Carter 4405*, peak south of Portezuela de Peloteado, 10 October 1963, *Carter & Medellin-Leal 4676*, Misión Dolores, 4 December 1959, *Wiggins, Carter & Ernst 252* (DS); Isla Partida, 7 December 1959, *Wiggins, Carter & Ernst 426* (DS).

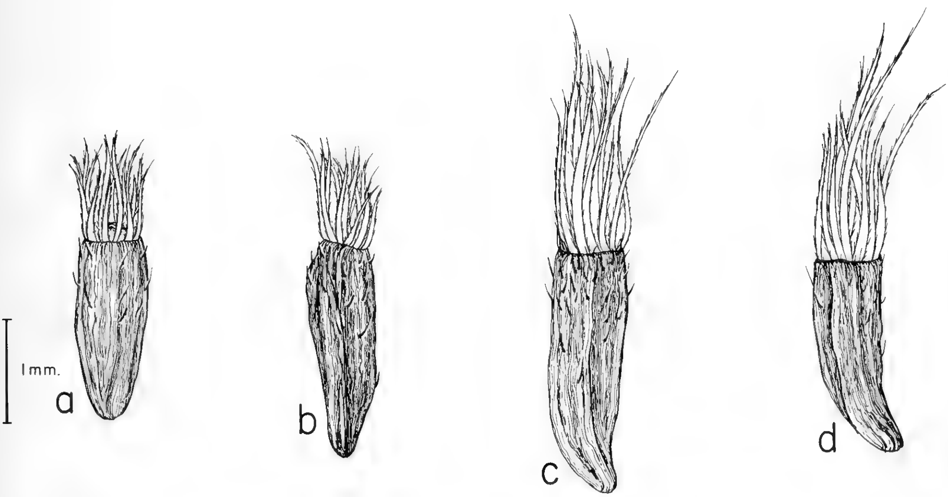


FIGURE 2. Achenes of *Alvordia:* a, *A. fruticosa* (Carter & Chisaki 3610); b, *A. Brandegeei* (Carter, Alexander & Kellogg 2273); c, *A. glomerata* (Carter & Ferris 3815); d, *A. glomerata* var. *insularis* (Carter & Ferris 3744).

## 1b. **Alvordia glomerata** var. **insularis**, var. nov.

A var. *glomerata* foliis ovatis obtusis longitudine 4 cm. haud excedentibus, involucri bracteis minus strigillosis valdius ciliatus ac acheniis minoribus (2.5-2.8 mm. longis) quam pappo (eo 2.8-4 mm. longo) brevioribus discedit.

3. All *Carter & Carter et al.* collections herein undesignated as to institution will be widely distributed.

Leaves oval to ovate (or obovate), obtuse or sometimes cuspidate (except on specimens from San Marcos Island which have most of the leaves acute), 14-37 (52) mm. long, 8-19 (30) mm. wide, 1.4 to 2.4 (mean 1.94) times as long as wide; involucres 5-7 mm. long, 3-4 mm. wide with a mean length to width ratio of 1.91; phyllaries and receptacular bracts 8 to 10, the outer phyllaries only slightly strigillose abaxially, strongly ciliate-margined; limb of the ray flowers 4-5 mm. long, the sterile achenes 3 mm. long, the pappus awns 1 to 4, 0.4-2 mm. long; disk corolla 6 mm. long, the lobes 0.8 mm. long; anthers 2.4 mm. long with sterile tips 0.4-0.8 mm. long; pollen (including spines), 34.6-42 (mean 38.5) microns in diameter; achenes 2.5-2.8 mm. long, the pappus 2.8-4 mm. long; receptacular bristles 2 to 3, 5-6 mm. long.

The variety *A. g. insularis* has been collected on islands on the peninsular side of the Gulf of California from latitudes 25° 39′ N. to 27° 15′ N.

TYPE. Baja California, Mexico: broad arroyo inland from Puerto Balandra, Isla Carmen, 11 March 1960, *Carter & Ferris 3744* (UC no. 1,245,032).

OTHER COLLECTIONS. San Marcos Island, 29 March 1962, *Moran 9000* (SD, UC); Carmen Island: 1-7 November, 1890, *Palmer 827* (GH, US, UC), 4 April 1962, *Moran 9142* (SD, UC); Catalina Island, 9 April 1962, *Moran 9350* (SD, UC).

2. **Alvordia fruticosa** BRANDEGEE, 1899, Erythea, vol. 7, p. 5.

*Alvordia angusta* Blake, 1917, Contrib. Gray Herb., vol. 52, p. 42. *A. fruticosa* var. *angusta* Wiggins, 1950, Contrib. Dudley Herb., vol. 4, p. 26.

Leaves lanceolate to linear-lanceolate, acute, (30) 40-115 mm. long, 6-32 mm. wide, 3.4 to 6.4 (mean 4.27) times as long as wide; inflorescence 3-4 cm. in diameter (often spherical in outline in pressed material) the numerous 1- (2) flowered heads in short-peduncled glomerules; involucres (4) 5.2-7 mm. long, 1.2-2.2 mm. wide; with a mean length to width ratio of 3.45; phyllaries and receptacular bracts (3-) 4-6, straw-yellow, glabrous except for the ciliolate margins, the outer two navicular with a straight or slightly arcuate narrow keel; ray flowers lacking; receptacular bract slightly enfolding the disk achene; disk corolla 5-6 mm. long, the lobes 1.2-2 mm. long; anthers 2.4-2.6 mm. long with sterile tips 0.8-1 mm. long; achenes 2.5-3 mm. long, the pappus awns 1-2.5 mm. long; sterile bristles in center of receptacle lacking. Pollen size, 37.8-50.4 (mean 42.9) microns (including spines). Chromosome count, n=30 *(Carter 4445).*

Collections to date indicate that *A. fruticosa* is confined to the lower western slopes of the Cape Region mountains and coastal mesas in the vicinity of Todos Santos and a short distance southward. The 1902 Brandegee collection labeled simply "Cape Region" may be assumed to be from this area inasmuch as the Brandegee itinerary (Moran, 1952) shows him to have been in the vicinity of Todos Santos in November of that year.

Type. Baja California, Mexico: San Jacinto, 23 October 1893, *Brandegee* (UC no. 84275).

Other collections. Cape Region, November 1902, *Brandegee* (US); Todos Santos, 29 January 1890, *Brandegee 311* (UC, US[4], GH[4]), type of *A. angusta* Blake), 14 February 1928, *Marcus Jones 24105* (SD); southern edge of Todos Santos, 8 November 1962, *Carter 4444 & 4445*, 11 miles south of Todos Santos, 25 March 1935, *Whitehead 872* (DS); foothills west side of Cape Region mountains about 3.2 km. northwest of Rancho San Jacinto, 12 November 1955, *Carter & Chisaki 3610* (UC, DS, US, SD); 16 miles south of Todos Santos, 24 March 1935, *Shreve 7225* (US, DS, GH).

### 3. **Alvordia Brandegeei**, sp. nov.

(Figure 3.)

Planta perennis basi suffrutescens foliis ovatis acutis vel aliquando obtusis longitudine 1.5-2.2 (2.7) - plo quam latitudine, involucris flosulos duos (interdum unum vel tres) ac aliquando florem unicum radialem depauperatum cingentibus, phyllaribus 5-7 (9) stramineis marginibus ciliolatis exceptis glabris, eis daubus extimis navicularibus utraque carina crassiuscula leviter arcuata instructa, flosculis 5 mm. longis, polline diametro 29.9-39.4 microns, achenis 1-2.4 mm. longis, chromosomi numero = 15.

Leaves ovate to broadly lanceolate-acute (occasionally obtuse) 14-47 mm. long, 8-22 mm. wide, 1.5 to 2.2 (mean 2.27) times as long as wide; inflorescence 1.5-2.5 cm. in diameter (not spherical in outline in pressed material), the short-peduncled glomerules bearing 2 to 5 involucres 5.4-6.2 mm. long, 2-3 mm. wide with a mean length to width ratio of 2.24; involucres usually enclosing 2, or sometimes 1 or 3, disk flowers and occasionally 1 poorly-developed ray flower; phyllaries and receptacular bracts 5-7 (9), straw-yellow, glabrous except for the ciliolate margins, the outer 2 slightly navicular with a thickened narrow keel; a single inconspicuous ray flower occasionally present; receptacular bracts slightly enfolding disk achenes; disk corolla 5 mm. long, the lobes (1.4-) 2 mm. long, the anthers 2-2.8 mm. long with sterile tips 0.4-0.6 (0.8) mm. long; pollen (including spines) 29.9-39.4 (mean 33.7) microns in diameter; achenes 2.4-3 mm. long, the pappus 1-2.4 mm. long; sterile bristles in center of receptacle lacking; chromosome number, $n = 15$ *(Carter 4442).*

This ovate-leaved taxon appears to be confined to the tip of the Cape Region, extending from near Cabo San Lucas east to San José del Cabo and north along the Gulf coast to Punta Frailes. This is the taxon which Blake misinterpreted as representing Brandegee's *A. fruticosa.*

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4. The date of 29 January 1889 given on the US and GH specimens is in error. (Neither of these labels is in Brandegee's handwriting.) Brandegee was at the coastal Magdalena Plain localities of Boca de Santo Domingo and Boca de las Animas on that date (Moran, 1952). His first trip to the Cape Region was in January and February of 1890.


FIGURE 3. Type of *Alvordia Brandegeei* Carter.

TYPE. Baja California, Mexico: San José del Cabo, Baja California, Mexico, 9 September 1890, *T. S.Brandegee 311a* (UC, no. 84274).

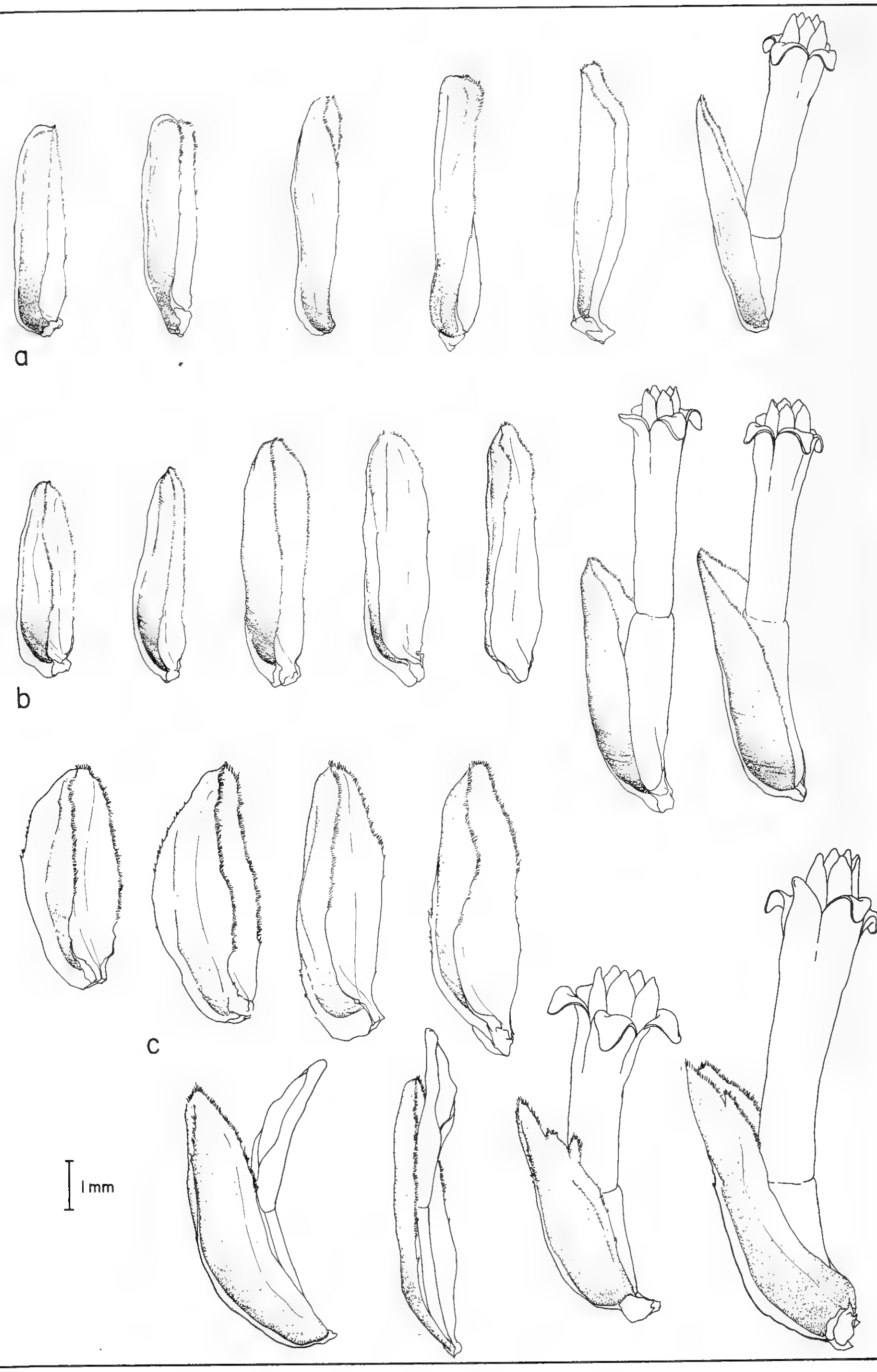
OTHER COLLECTIONS. Cape Region: November 1902, *Brandegee* (UC, US); Punta Frailes, 16 February 1940, *Dawson 1114* (US); San José del Cabo: 29 September 1893, *Brandegee* (US), March-June (April 23) 1897, *Anthony 339* (designated by Blake as lectotype of *A. fruticosa* Brandegee, UC, DS, US, GH), March 1890, *Grabendorfer* (UC); January-March 1901, *Purpus 346* (UC), *Purpus 499* (UC, US), 29 October 1941, *Gander 9730* (CAS, SD), 17 February 1940, *Dawson 1172* (US); 4.5 km. westerly from La Palmilla, 18 January 1959, *Moran 7072* (DS, SD); 4 (5) miles east of Cabo San Lucas, 26 March 1935, *Shreve 7263* (UC, DS); 9.6 km. east of Cabo San Lucas, 4 November 1962, *Carter 4442*, 8 miles east of village of Cabo San Lucas, 1 January 1959, *Wiggins 14651* (UC, DS); 11.5 km. east of Cabo San Lucas, 18 December 1947, *Carter, Alexander & Kellogg 2273* (UC, US, DS).

## DISCUSSION

The members of the genus *Alvordia* (placed in the Engler and Prantl system between the two large helianthoid genera *Viguiera* and *Helianthus*) exhibit a wide range of the characters, considered, by those concerned with theories of evolution in the Compositae, as phylogenetically significant (Cronquist, 1955). The plants range from those bearing flower-head clusters having no ray flowers through those with inconspicuous sterile rays to those with obvious sterile ray flowers, and from those with involucres bearing a single disk (and no ray) flower to those bearing three to four disk flowers plus the sterile rays. The simpler arrangements are found in the Cape Region plants. The phyllaries in the Cape Region taxa, especially in *A. fruticosa*, tend toward a paired arrangement, while in the other taxa a spiral arrangement is more evident. The earlier workers considered that there were no receptacular bracts present in the Cape Region plants, but that these structures occurred in the northern *A. glomerata*. In describing *A. fruticosa*, Brandegee (1899) stated, "If this species from the Cape had been the one first collected, its relationship would have been somewhat doubtful on account of the absence of receptacular bracts."

In order to resolve the question of absence or presence of receptacular bracts and establish criteria for differentiation between phyllaries and receptacular bracts in *Alvordia*, dissections were made of the flower-heads of all four taxa. Measurements of the length of the phyllaries and bracts served to bring to light sequential relationships which aid in differentiating these structures as well as in separating the taxa.

The phyllaries are graduated, both in length and in degree of navicularness (figure 4, a, b, c). In the northern *A. glomerata* and its variety, the increase in length between the phyllaries is in gradual steps (figures 4, c; 5).


a
b
c
1mm

In the two Cape Region taxa, *A. fruticosa* and *A. Brandegeei*, however, there is a noticeable length gap between the first two phyllaries and the remainder of these structures (figure 5). In addition the phyllaries are straw-color and not strongly navicular in outline in the Cape Region plants while in *A. glomerata* and its variety they are brownish- or greenish-yellow and more strongly navicular. It is undoubtedly these points of similarity between *A. fruticosa* and *A. Brandegeei* that have caused previous investigators to consider *A. Brandegeeii* to be more closely related to *A. fruticosa* than to the northern *A. glomerata.* On the other hand, even though the outer two phyllaries of *A. Brandegeei* are much shorter than those succeeding, they are tending towards the strongly graduated sequence found in *A. glomerata,* while those of *A. fruticosa* are subequal (figure 5).

As for the distinction between phyllaries and receptacular bracts, it was found that in all taxa the bracts subtending the flowers are shorter (occasionally sub-equal in *A. fruticosa* and *A. Brandegeei*) than the ultimate bract of those not subtending a flower (figure 5). Moreover, the bracts subtending the flowers are more membranous than the preceding structures and are not navicular nor are they saccate at the apex, but instead taper to a point which tends to be erose (figure 4, a, b, c). Although the transition from the phyllaries to the bracts subtending the flowers is gradual, the relations of position and length, in addition to slight differences in morphology, serve to justify designation of all those structures subtending flowers (whether they be sterile ray flowers or fertile disk flowers) as receptacular bracts and to designate all others as phyllaries. Therefore, all taxa in *Alvordia* may be considered to have flower-heads bearing at least one receptacular bract.

How many of the phyllaries may be considered "navicular" is subject to interpretation. The term as defined by Lindley (1848) aptly describes the first two or three strongly arcuate and keeled phyllaries of *A. glomerata.* In *A. fruticosa,* however, the keel of the first two phyllaries is straight (or only slightly arcuate) and in *A. Brandegeei* it is slightly arcuate. In all of the taxa (figure 4, a, b, c) as one examines the head progressively inward, the phyllaries are seen to become gradually less prominently keeled and less strongly arcuate until they resemble a flat-bottomed boat with saccate apices. These inner phyllaries might be described as shallowly navicular.

Heretofore, the two Cape Region taxa have been considered more closely related to each other than to the northern *A. glomerata.* The present investigation indicates that *A. fruticosa* of the Cape Region is the most distinct taxon in the genus and that the other Cape Region taxon, *A. Brandegeei,* is more closely related to *A. glomerata* than had been realized. As to the pres-

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FIGURE 4. Components of flower heads in *Alvordia* showing the transition from phyllaries to receptacular bracts: series a, *A. fruticosa* (Carter 4444, 4445); series b, *A. Brandegeei* (Grabendorfer in 1890); series c, *A. glomerata* (Carter 4483).

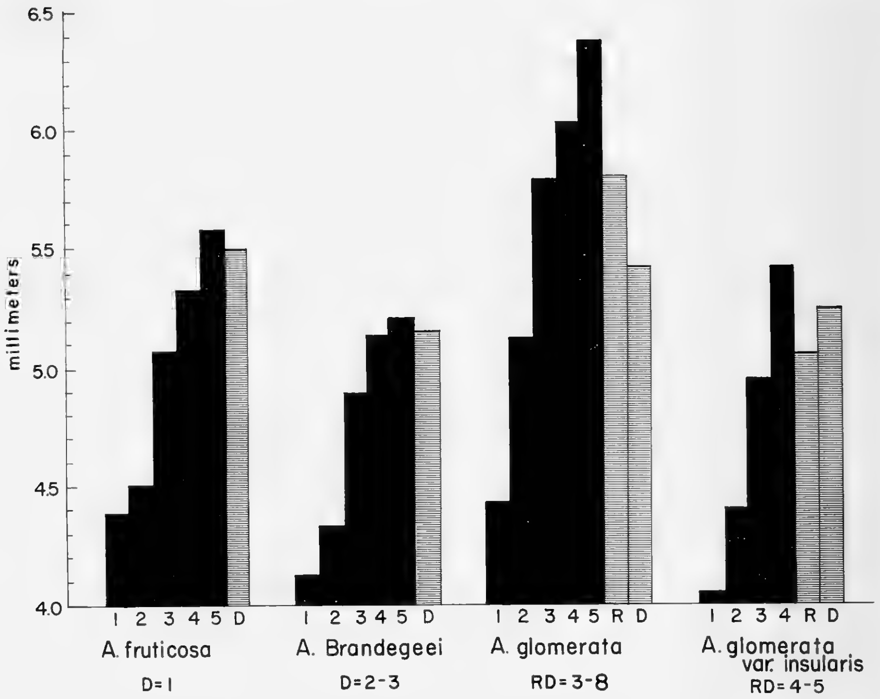


FIGURE 5. Histograms representing the relative lengths of phyllaries and receptacular bracts in *Alvordia.* Columns 1 to 5 represent the successive phyllaries; column R represents the bracts subtending the ray flowers, and column D represents the bracts subtending the disk flowers. (The histograms represent only that portion of the structures in excess of 4 mm. in length. The exceptional number of ray or disk flowers is not included.) See discussion in text.

ence or absence of sterile ray flowers, for instance, in *A. fruticosa* there are none; in *A. Brandegeei* (previously considered to have none), there is an occasional inconspicuous sterile ray flower; in *A. glomerata,* rays are always present and conspicuous in plants of the middle and northern part of its known range, but in the two southernmost collections (at Isla Partida and Misión Dolores, rays are inconspicuous, few or sometimes lacking. In other characters, too, the southernmost collections of *A. glomerata* approach those of *A. Brandegeei,* e.g., the relative length of the pappus and the achene (figure 2) and the ratio of leaf-length to width. Although there is a wide geographic gap between the northernmost known locality for *A. Brandegeei* (figure 1) and the southernmost one of *A. glomerata,* the southernmost *A. glomerata* plants are clearly transitional between the more northern members of that taxon and *A. Brandegeei.* (Graphic representation of certain characters in the four taxa is given figures 6 and 7.)

Leaves vary tremendously in size in this group of plants. Those of *A. glomerata* may be anywhere from 30 to 70 mm. in length and those of *A. fruticosa* from 30 to 115 mm. Conversion of the length and width measurements to length/width ratio, demonstrates that the leaves of each taxon do fall within

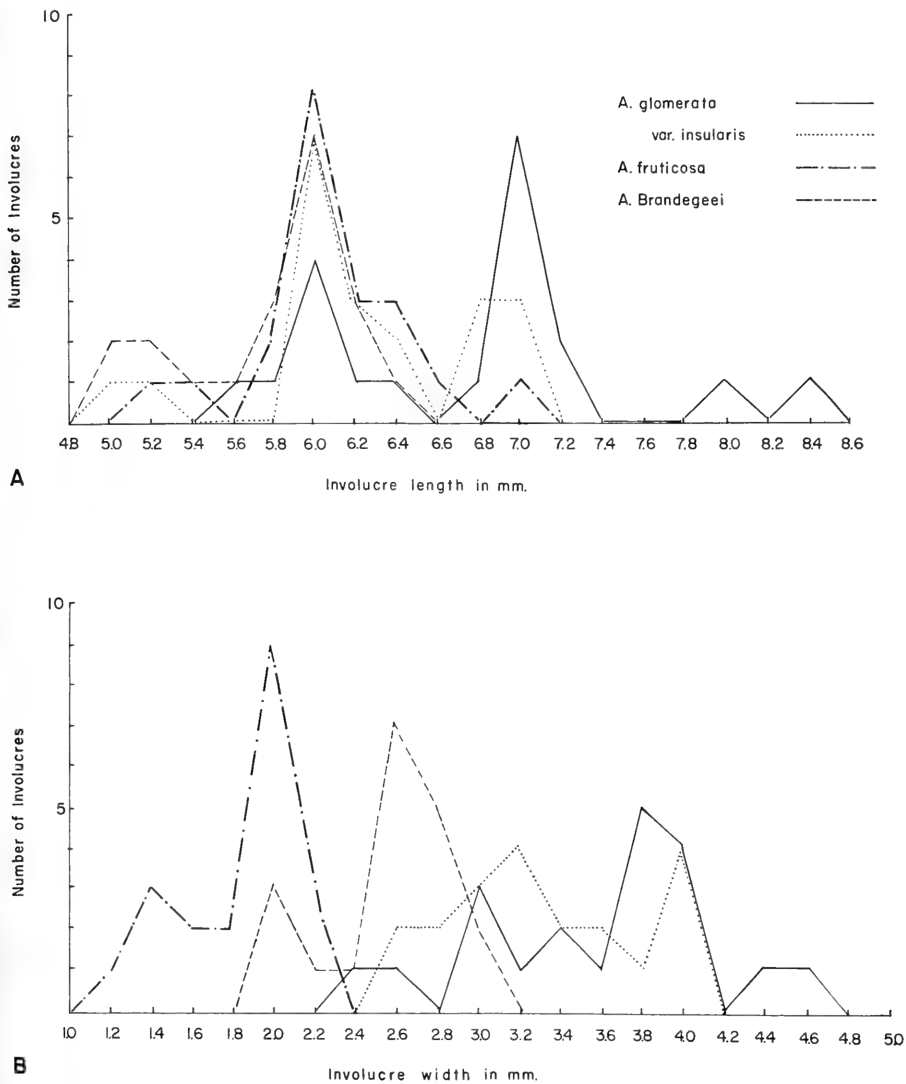


FIGURE 6. Graphs comparing involucre length and width in the taxa of *Alvordia*. See discussion in text. A, involucre length; B, involucre width.

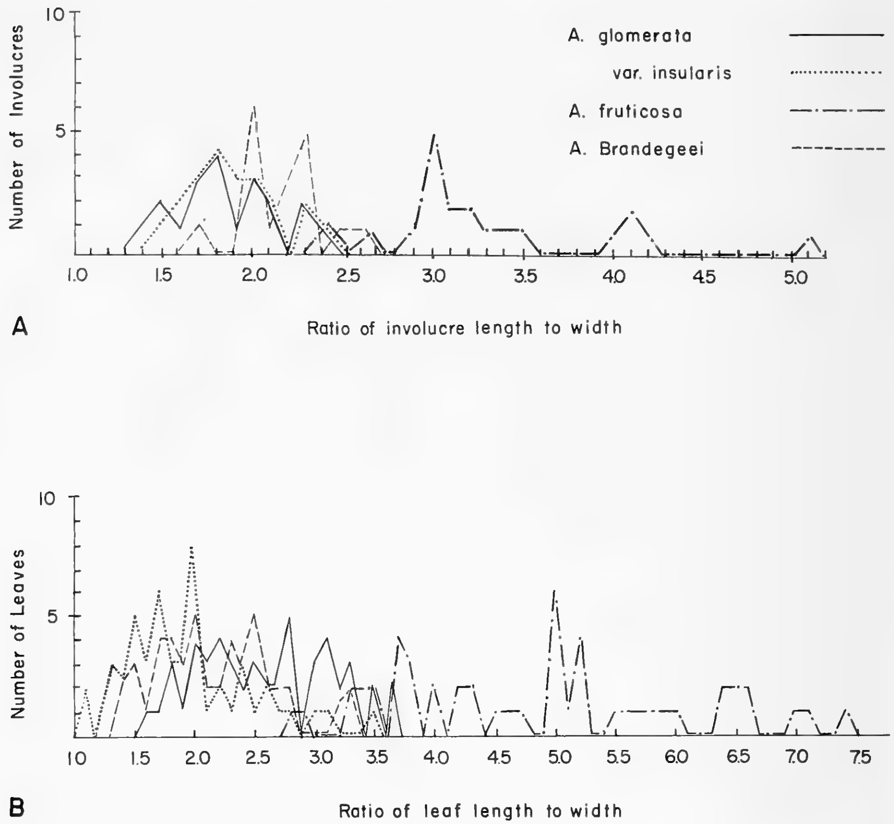


FIGURE 7. Graphs representing length to width ratio of structures in taxa of *Alvordia*. See discussion in text. A, ratio of involucre length to involucre width; B, ratio of leaf-length to leaf-width.

certain limits (figure 7B). Those of *A. glomerata* and its variety and *A. Brandegeei* occupy much the same area of the graph, but each with its separate peak, while most of those of *A. fruticosa* occupy a separate part of the graph. The graph representing length of the involucres (figure 6A) shows that a large proportion of all of the taxa in *Alvordia* have involucres within the size range of 5.8 to 6.2 mm. but that *A. glomerata* also has a high proportion of much longer involucres (6.8 to 7.2 mm. long). In the character of involucre width (figure 6B), however, as might be expected from the number of flowers per head, each of the three species shows a separate peak in the graph. When these involucre measurements are converted to length/width ratios, *A. fruticosa* stands well apart and the other three are in close approximation to each other although each species maintains a distinct peak (figure 7A). In pollen size (figure 8), that of *A. fruticosa* and *A. Brandegeei* is found to be at the opposite extremes for members of the genus and that of *A. glomerata* is in the middle.

Chromosome counts in *Alvordia* are of interest, the two Cape Region taxa having counts of n=15 (*A. Brandegeei*) and n=30 (*A. fruticosa*). Counts of several collections of *A. glomerata* indicate that it is a polyploid with a chromosome number of n=60. To date, no count has been obtained for *A. glom-*

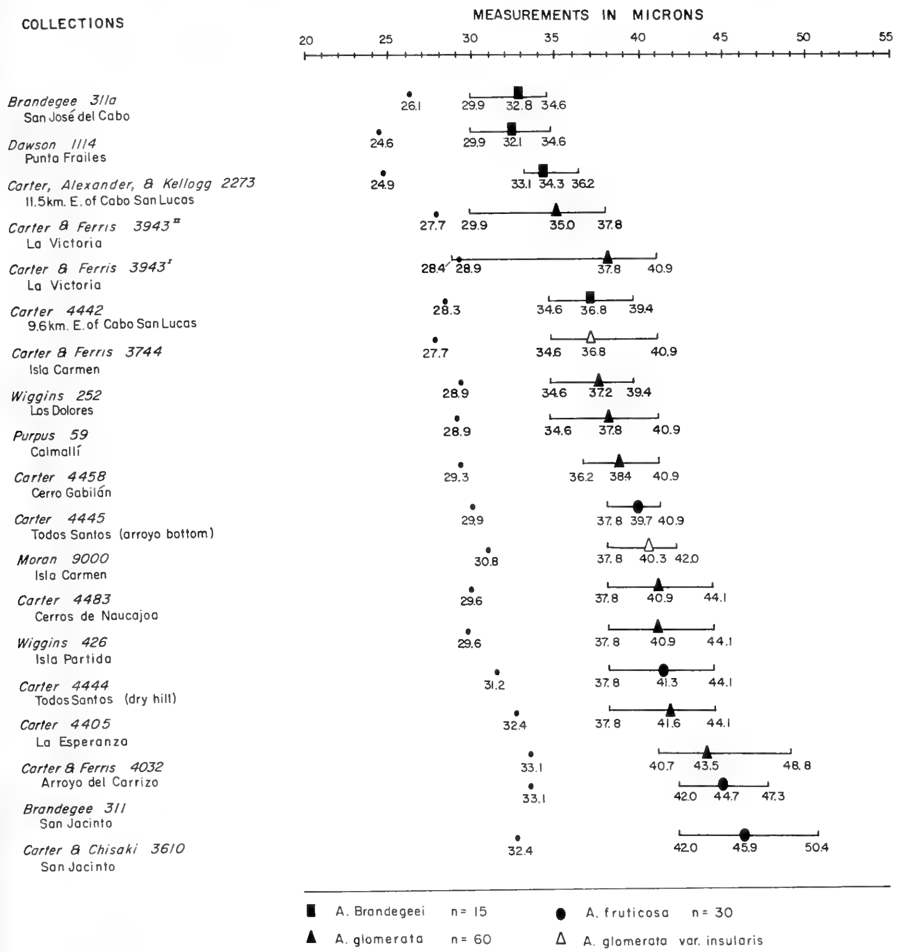


FIGURE 8. Comparative size of pollen grains in *Alvordia.* The left-hand series of figures represents the measurements excluding the spines; the right-hand series (showing minimum, mean and maximum measurements) includes the spines.

*erata* var. *insularis*, but on the basis of correlation of pollen size with chromosome number (figure 8), one would expect it also to have a count of n = 60. The fact that the polyploid occupies the territory to the north of the Cape Region, correlates well with the geological history of southern Baja California. Not until the Pleistocene did the Cape Region, which had a long geologic history as an island, become permanently connected with the rest of the peninsula. To the north of the Cape Region during the Miocene, seas are thought to have covered all of western southern Baja California except for the islands in the Magdalena Bay area and the mountains in the Viscaino Desert and Ced-

TABLE 1. *Comparison of Taxa of* Alvordia

| CHARACTER | *A. fruticosa* | *A. Brandegeei* | *A. glomerata* | *A. glomerata* var. *insularis* |
|---|---|---|---|---|
| Leaves | | | | |
| shape | narrowly lanceolate to linear-lanceolate, acute | ovate to broadly lanceolate, acute | lanceolate to ovate-lanceolate, acute | oval to ovate or obovate, obtuse (sometimes cuspidate) |
| mean length/width ratio | 4.27/1 | 2.27/1 | 2.59/1 | 1.94/1 |
| Involucres | | | | |
| mean length/width ratio | 3.45/1 | 2.24/1 | 1.87/1 | 1.91/1 |
| flowers per involucre | 1 (-2) disk only | 2 (-3) disk; occasional inconspicuous ray | 1-3 ray; 2-3 disk | 1-2 ray; 2-4 disk |
| Phyllaries & receptacular bracts | | | | |
| number | 4-6 (mostly 6) | 5-8 | 7-9 (sometimes up to 12) | 7-10 (mostly 8-9) |
| color | straw-yellow | straw-yellow | greenish- or brownish yellow | yellow-green to gray-green |
| pubescence | glabrous, finely ciliolate-margined | glabrous, ciliolate-margined | strigose abaxially, ciliate-margined | slightly strigillose abaxially, ciliate-margined |
| Achenes | pappus shorter than achene | pappus shorter than or sometimes subequal to achene | pappus equalling achene | pappus longer than (sometimes equalling) achene |
| Pollen diameter (inc. spines) | | | | |
| extremes | 37.8-50.4 microns | 29.9-39.4 microns | 28.4-48.8 microns | 34.6-42.0 microns |
| mean | 42.9 microns | 33.7 microns | 40.17 microns | 38.5 microns |
| Chromosomes | n = 30 | n = 15 | n = 60 | ? |

ros Island; and on the eastern side of the peninsula only the mountainous area from about the latitude of Loreto to a little north of Santa Rosalía is thought to have been above water (Durham & Allison, 1960). Subsequent elevation resulted in the outlines of the peninsula becoming much as we now know them, but there was also extensive volcanic action which must have made much of this area untenable to higher plants for some time. So the polyploid *A. glomerata* undoubtedly evolved from the Cape Region form or forms then extant and worked its way northward as this new territory became available (Stebbins, 1950), becoming more and more distinct from the Cape Region plants as it advanced towards the present northern limit of its range.

ACKNOWLEDGMENTS

In conclusion, I wish to express my deep appreciation to those who have supported my work in Baja California during the past fifteen years: Miss Louise Kellogg and the late Miss Annie M. Alexander with whom I made my first collecting trip in the peninsula, the Belvedere Scientific Fund in cooperation with the California Academy of Sciences, the Associates of Tropical Biogeography of the University of California, and the Herbarium of the University of California which has granted me time to carry on field work. Collecting trips in the Sierra de la Giganta have been facilitated by the friendship and cooperation of the residents of the area. In addition, I wish to thank Dr. Barbara Briggs who assisted me by making the chromosome counts, Miss Nel Rem who measured the pollen, and Miss Marsha Jenkins who executed the illustrations, as well as the curators of the several herbaria who made their specimens of *Alvordia* available to me for study.

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# A QUANTITATIVE ANALYSIS OF MOLLUSCAN COLLECTIONS FROM ISLA ESPÍRITU SANTO, BAJA CALIFORNIA, MEXICO

BY

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On a reconnaissance trip to Espíritu Santo Island, made November 1, 1959, we noticed, as we waded ashore at Candelero Bay, an unusual concentration of fine drift shells. About three pounds of the material was brought back for sorting. From this, plus the larger shells picked up during a moderately low tide that day, there resulted a total count of nearly 200 molluscan species, which at the time seemed indicative of a very rich fauna offshore.

A second trip to the area in August, 1960, yielded living specimens of *Berthelinia*, a bivalved gastropod (Keen and Smith, 1961), as well as several other obviously new species, adding to the conviction that more intensive work should be done here.

A longer survey was undertaken in December, 1960, under the auspices of the California Academy of Sciences and the Belvedere Scientific Fund. Facilities were provided both for shore collecting and for dredging. The party consisted of Dr. Robert C. Miller of the California Academy, Dr. and Mrs. Ira Wiggins of Stanford University, Drs. Antonio Garcia Cubas and Alejandro Villalobos Figueroa, professors from the Instituto de Biología, University of Mexico, and myself. We spent nine days (December 12-21) aboard a barge anchored in El Cardonal, an embayment to the north of Candelero Bay -- technically on Isla Partida rather than on Isla Espíritu Santo proper.

## DESCRIPTION OF THE AREA

Isla Espíritu Santo, about 12 miles long, lies some 20 miles north of La Paz, at 24° 30' North Latitude, 110° 30' West Longitude. It consists of two parts -- Isla Partida to the north and Espíritu Santo proper, the junction between being a narrow neck of land that is submerged at high tide. Both parts are of volcanic origin, composed of old lava flows and volcanic agglomerates forming east-west parallel ridges. The outer or eastern face rises steeply from the Gulf of California, and the land surface tilts at a low angle to the westward. Between the ridges on the western side are a number of tongue-shaped shallow bays that resemble drowned stream valleys. At the heads of most of these are beaches veneered with "coral" sand, consisting of broken fragments of organically derived calcium carbonate, intermixed with fine to coarse particles of volcanic tuffs. Some of the bays are extremely shallow and nearly level, depths being from a few inches to a few feet. Others have a deeper channel near the center. One of the latter sort is El Cardonal -- that being the name used on the U. S. Hydrographic Chart No. 1664 (24th edition, 1960) and in the Mexico and Central American Pilot (U. S. Hydrographic Office, edition 6, 1920), although it seems not to be used locally at present. In the field we

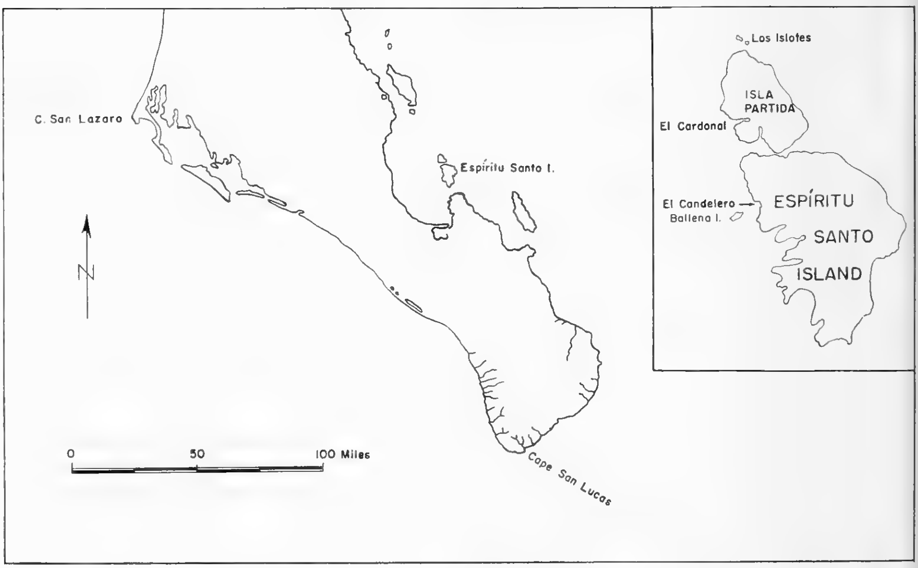


FIGURE 1. Generalized map of the southern end of Baja California, modified from Slevin (1923) and the U.S. Hydrographic Chart no. 1664.

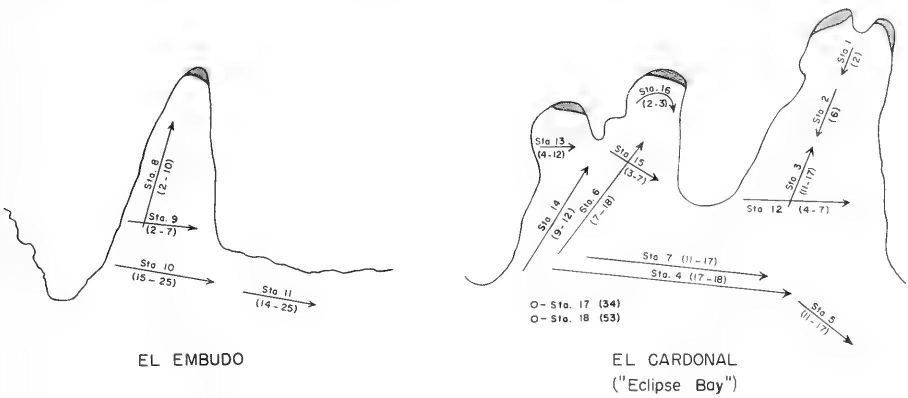


FIGURE 2. Dredging stations off Isla Partida. Sketch map drawn in the field by Dr. R. C. Miller. Directions of the 18 hauls are shown by arrows; depths, in fathoms are in parentheses, following station number. Dark-shading at the heads of embayments indicates areas of sand beaches.

adopted the name "Eclipse Bay," bestowed on this largest indentation of Isla Partida by an earlier Belvedere Scientific expedition.

There are no large-scale modern maps showing the area in detail. Most published maps (including the two given here) are only approximately correct. Figure 1 is modified from Slevin (1923)--a map originally drawn by Dr. G Dallas Hanna from an earlier version of the U. S. Hydrographic Chart cited above. Figure 2 is from a freehand sketch made by Dr. R. C. Miller in the field.

Two embayments on Isla Partida were sampled, El Embudo (The Funnel), toward the northern end, and El Cardonal, near the center of the west side. Candelero Bay, northernmost indentation on Espíritu Santo proper, lies to the south a distance of perhaps two to three miles. Being partially floored by non-coralline sediments, it may afford more varied ecologic conditions near shore, but offshore, the situation seems to be fairly uniform throughout the area.

The predominant material of the floor in El Cardonal is a sand composed of broken bits of coralline algae, hydrocorals, and such corals as *Cycloseris elegans* (Verrill), *C. mexicana* Durham, and *Porites* sp. The total biomass of living molluscan material is proportionately small. Even the total amount of dead shell material is scanty in comparison to a shallow-shelf dredging site near Guaymas, on the Sonora coast of Mexico, which I observed in August, 1960, with the *Ariel* Expedition.

Any sea floor area tends to be littered with a quantity of dead shell material, principally molluscan, that has accumulated over the past hundreds or perhaps thousands of years from the predation of fish, crabs, and even other mollusks. At Espíritu Santo this dead rubble seems to be not so much molluscan as coralline. Living coral is reported by divers as occurring in deeper water. One gets the impression that in the not-too-distant past there was much more life here, for along the intertidal area and just below, the barnacles are dead, and although numbers of intact specimens of the sessile pelecypod *Pseudochama* were seen in Candelero Bay, we could not find a single living one. Possibly the conditions of 1959-1960 were temporary, the result of a red tide reported to us by Richard Adcock, local boat-owner, as having occurred a year or so previously. If so, the ecological situation may change within the next few years, when new populations replace the present dead remnants. In any case, there is evidence of a moderately rich though sparse molluscan fauna, as the graphs and table given below will show.

## Methods and Results

As the shore collecting added little to the list compiled in 1959, no separate analysis of this material is made here, but the 1959 list is given as list 2. One new species of the gastropod family Vermetidae, *Dendropoma*, new species B, was the principal novelty.

A total of 18 dredge hauls were made, and all of the hauls proved productive. Dredging was done from a converted Navy-surplus personnel landing craft owned by Richard Adcock, who had constructed a box at the stern to serve as preliminary sorting tray and a platform to hold the winch. An anchor-type winch with 1200 feet of three-sixteenths inch woven wire cable was used. The dredges were made of quarter-inch mesh hardware cloth, over metal frames measuring 5 by 16 by 24 inches. No dredges were lost, but one was so worn from hanging upon rocks and coral heads that the hardware cloth came apart. The cable could be wound on the winch by a hand crank but most of the time was raised by use of an electric hand drill applied instead of the crank, power being furnished by a gasoline-driven generator.

As each dredge load came in, it was emptied into a bucket in the wash-box and freed of unneeded rubble, such as pebbles. It was then washed through sieves of varying sizes and samples were kept of the promising materials in each or (if the hauls were small enough) of all material. These lots were then transferred to the field laboratory, a second Navy-surplus landing craft, converted for use as living quarters and large enough to accommodate our entire field party. Here, with the help of willing hands among the crew, the lots were scanned for molluscan material, dead or alive, for it was impracticable to transport the entire bulk lots back to California. All fragments of shells large enough for specific recognition were retained, to form the basis for this later quantitative analysis. Notes were kept, of course, on obviously live-taken material in each lot.

In order to complete the molluscan faunal picture in the Espíritu Santo area, a list of the chitons collected there intertidally at various times has been supplied by Allyn G. Smith and is included as list 5. Curiously enough, no chitons appeared in any of our dredge hauls. As data are not available on the occurrence of individuals of any species, the chitons are omitted from the faunal analysis.

In any quantitative analysis, a certain amount of grouping of the raw data is necessary to reveal trends. Here, grouping of the dredging stations in terms of depth and relative location seems most desirable. The 18 stations of list 3 can thus be reduced to five basic types:

A. Stations 1, 16 (2 to 3 fathoms, near upper end of bay).

B. Stations 2, 8-9, 12-15 (3 to 12 fathoms, slightly offshore).

C. Stations 3-7 (10 to 18 fathoms, near bay channel center).

D. Stations 10-11 (14 to 25 fathoms, near bay entrance).

E. Stations 17-18 (30 to 53 fathoms, off Isla Partida, outside entrance to "Eclipse Bay").

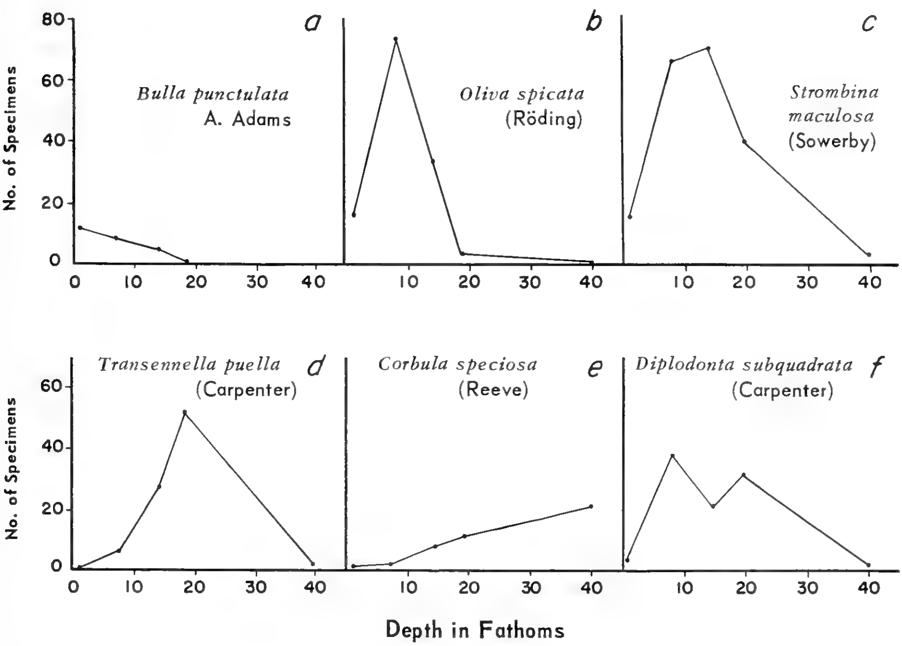


FIGURE 3. Analysis of abundance with depth for six representative species.

Although there seemed to be a paucity of material at any one station, surprisingly enough the total number of molluscan species identified in the dredging amounts to 361: 208 gastropods, 146 pelecypods, and 7 scaphopods (list 4). This compares to 180 taken alongshore (intertidally or in drift) at Candelero Bay (136 gastropods, 41 pelecypods, and 3 scaphopods). Only 56 of the species are common to the two lists (31 gastropods, 22 pelecypods, and 3 scaphopods), which would suggest that most of the forms that wash ashore as drift live intertidally or very near shore and that little offshore material reaches the beach. Also (at least as far as this area is concerned), most of the forms that have adapted to intertidal existence on an arid tropical coast do not extend their range far offshore into deeper water.

To represent the picture as a whole, we might select for special scrutiny the ten species of gastropods and pelecypods, respectively, that had the highest counts of individuals. In list 1, below, the number of specimens and level of greatest concentration (in terms of the grouping indicated above) are given; an asterisk preceding the name means that living material occurred in at least one sample.

LIST 1

| NAME | TOTAL NUMBER | MAXIMUM AT STATION GROUP |
|---|---|---|
| PELECYPODA | | |
| * *Anadara multicostata* (Sowerby) | 69 | B |
| * *Glycymeris tessellata* (Sowerby) | 109 | D |
| * *Pecten vogdesi* Arnold | 29 | B |
| * *Aequipecten circularis* (Sowerby) | 43 | C |
| *Diplodonta subquadrata* (Carpenter) | 99 | B (also D) |
| * *Laevicardium elenense* (Sowerby) | 303 | B (also D) |
| * *Transennella puella* (Carpenter) | 90 | D |
| * *Megapitaria squalida* (Sowerby) | 151 | B |
| * *Chione undatella* (Sowerby) | 49 | B |
| * *Corbula speciosa* Reeve | 44 | E |
| GASTROPODA | | |
| * *Turritella mariana* Dall | 65 | D |
| * *Hipponix grayanus* Menke | 32 | B |
| *Calyptraea mamillaris* Broderip | 48 | E (also C) |
| * *Polinices uber* (Valenciennes) | 65 | D |
| *Strombus gracilior* Sowerby | 41 | C |
| * *Strombina maculosa* (Sowerby) | 193 | C |
| * *Nassarius angulicostis* (Pilsbry and Lowe) | 26 | C |
| * *Oliva spicata* (Röding) | 123 | B |
| *Bulla punctulata* A. Adams | 26 | A |

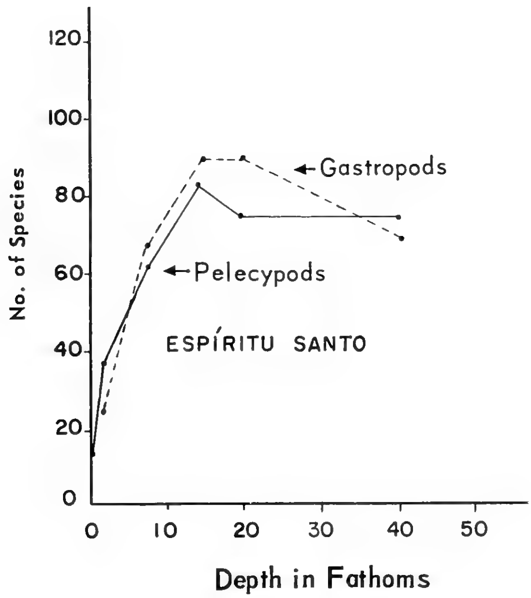


FIGURE 4. Relative abundance curves for pelecypod and gastropod species at the several stations, Espíritu Santo Island.

Plotting numbers of specimens against water-depth of occurrence, one sees that the distribution falls into six possible patterns, samples of which are shown in figure 3. Of the 20 selected species, only one, *Bulla punctulata*, has its maximum in the shallowest dredgings (less than 2 fathoms). Eight are most abundant at 3 to 12, 5 between that and 18, 4 between 14 to 25, and 2 between 30 to 50 fathoms. Three forms had a bimodal distribution, with one secondary peak of abundance, the significance of which can only be speculative until more observations are made. The distribution patterns otherwise seem remarkably consistent.

In examining the material collected, one gets the impression of sparseness, especially as compared to richer areas across the Gulf, as at Guaymas or Mazatlán. However, an inspection of the overall picture -- the total number of species present at each dredging level -- modifies this view somewhat. Figure 4 shows the number of pelecypod and gastropod species at the combined stations, a maximum of 80 pelecypod and 90 gastropod forms, which compares not too unfavorably with 120 pelecypod species recorded (in manuscript) by members of the *Ariel* expedition at Cabo Haro, off Guaymas, in 15 to 25 fathoms, and 115+ gastropod species (complete list not yet available). The species population at Espíritu Santo, therefore, is only moderately rich but very thinly scattered, so that few individuals of any form are present in one spot. The paucity of other than coralline algae in the shallower waters perhaps accounts for the relative fewness of forms at depths of less than 7 fathoms. Beyond this the numbers of species present is surprisingly uniform to the greatest depth explored. In the intertidal area the number might increase with intensive collecting, for doubtless many forms were concealed beneath the larger rocks and in crevices. The number found alive in a single afternoon of collecting at low tide was not as great as even Group A of the dredgings (13 pelecypod and 23 gastropod species). This is again in harmony with the conclusion that the populations are thinly scattered. To recover all of the forms alive that are indicated by beach drift as present would require repeated forays.

## Conclusions

From a single suite of data of the sort summarized here, one should not draw sweeping conclusions. Repeated samples from the same area, taken in the same way, might reveal changes of composition of the population. The same type of study done in nearby areas of slightly different ecology might bring out the effects of change in physical factors on the faunal components. For example, the infauna at some places along the Baja California coast must be astonishingly rich, especially in minute forms, for the intestine of a single large holothurian which I collected near Cape San Lucas contained 120 specimens of 33 species of mollusks -- some bivalves were still intact, and gastropods had opercula in place.

When enough comparative studies are made, we may have at hand a tool useful in the interpretation of the past history of the area. The molluscan fauna may well give clues as to the relationship of the Baja California land mass to the mainland and may even provide a commentary on the tantalizing suggestion that the tip of the peninsula once joined the mainland coast near the Tres Marias Islands, now being displaced northward some two to three hundred miles. This, of course, is for the future. From the present observations, however, some less profound deductions can be made.

Paleontologists are prone to conclude, if an assemblage is made up of disassociated bivalve shells or of worn fragments, that transportation from the original site is indicated. This may not necessarily be true. Inspection of a dredge haul reveals much fragmental and disarticulated material, even in situations beyond the influence of nearshore currents. The constant work of predators sifting the upper layers of the sea floor in search of prey and the accumulation of the discards after the mollusks have been found and consumed may result in large amounts of disorganized shell material that has not been moved more than a few inches. Could not, perhaps, the very occurrence in the fossil record of finely fragmented shells, with occasional intact specimens, actually be indication of an offshore deposit?

A second tentative conclusion is that under fairly uniform conditions, the offshore mollusks have a wide bathymetric range. The sea floor in a few fathoms depth presents an optimum habitat, but mollusks that occur in abundance there may range shoreward and seaward for some distance. Therefore, except for near-shore species and those with a known sharply limited niche, such as the requirement of highly oxygenated water, the numbers of individuals present in a given unit area may be a better index of depth than the numbers of species. Further sampling is needed, of course, to establish this principle. Certain forms are always indicative of intertidal conditions (the littorines, for example, or, in the tropics, the nerites). Others are always indicative of deep water, such as some of the turrids. For the in-between areas, however, and the assessment of relative depth for fossil assemblages, the use of some such measure as relative abundance might be very convenient if it can be demonstrated to be a trustworthy guide.

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## LISTS OF MOLLUSCA AND DREDGING STATIONS

List 2. Intertidal molluscan fauna from drift at Candelero Bay, Espíritu Santo Island, November, 1959.

List 3. Dredging Stations. Extracted from the field notes of Dr. Robert C. Miller.

List 4. Mollusca dredged off Isla Partida, December, 1960.

List 5. *Polyplacophora* (Chitons) from Isla Espíritu Santo and Isla Partida, Baja, California, Mexico.

List 2. *Intertidal molluscan fauna from drift at Candelero Bay, Espíritu Santo Island, November, 1959.*

In the following tabulations, total numbers of specimens collected are shown. An asterisk (*) preceding the number indicates that at least some individuals were alive when taken intertidally, and a number sign (#) preceding the name of the species that this is an extension of reported geographic range.

I have utilized here (as also in list 4) the new insights on classification reflected in papers by Taylor and Sohl (1962), Steinberg (1963), and Keen (1963); but where there is variance of opinion, as in Opisthobranchiata, some compromises are made. Arrangement within superfamilies is mainly alphabetical, with a few exceptions where it seemed desirable to keep family units intact.

## PELECYPODA

Solemyacea

*Solemya panamensis* Dall, 5

Arcacea

*Anadara multicostata* (Sowerby), 3
*Barbatia gradata* (Broderip and Sowerby), 1

Mytilacea

*Hormomya adamsiana* (Dunker), 10
*Lithophaga aristata* (Dillwyn), 1
*Lithophaga spatiosa* (Carpenter), 1
*Septifer zeteki* Hertlein and Strong, 4

Pteriacea

*Isognomón chemnitzianus* (Orbigny), 4
*Atrina tuberculosa* (Sowerby), 1
*Pinctada mazatlanica* (Hanley), 1
*Pinna rugosa* Sowerby, 2

Carditacea

*Cardita affinis californica* Deshayes, *8
*Condylocardia digueti* Lamy, 12

Lucinacea

*Lucina (Callucina) lampra* (Dall), 3
*Lucina (Cavilinga) prolongata* Carpenter, *100+
*Lucina (Parvilucina) mazatlanica* Carpenter, 2
*Lucina (Pleurolucina) undatoides* Hertlein and Strong, *10
*Divalinga eburnea* (Reeve), 1
*Codakia distinguenda* Tryon, *2

LIST 2. *(Continued)*

LUCINACEA *(Continued)*

*Ctena chiquita* (Dall), 1
*Ctena mexicana* (Dall), 3

LEPTONACEA

*#Basterotia peninsularis* Jordan, 6
*Mysella compressa* (Dall), 1

CHAMACEA

*Chama* species, juvenile, 2
*Pseudochama panamensis* (Reeve), 8

CARDIACEA

*Americardia biangulata* (Broderip and Sowerby), 1
*Laevicardium elenense* (Sowerby), 1

VENERACEA

*Megapitaria squalida* (Sowerby), 4
*Transennella tantilla* (Gould), 100+
*Chione (Timoclea) picta* Willett, 1
*Chione* species, juvenile, 20
*Protothaca grata* (Say), 1

TELLINACEA

*Tellina (Tellinella) cumingii* Hanley, 4
*Tellina (Moerella)* new species, *6
*Heterodonax bimaculatus* (Linnaeus), 5
*Semele flavescens* Gould, 1
*Cumingia lamellosa* Sowerby, 7

MYACEA

*Corbula bicarinata* Sowerby, 1

PANDORACEA

*Cyathodonta undulata* Conrad, 1

SCAPHOPODA

DENTALIIDAE

*Dentalium quadrangulare* Sowerby, 1
*Dentalium semipolitum* Broderip and Sowerby, 6
*Dentalium splendidulum* Sowerby, 4

GASTROPODA

PATELLACEA

*Acmaea strongiana* Hertlein, 10
*Acmaea semirubida* Dall, 1

LIST 2. *(Continued)*

TROCHACEA
*Tegula globulus* (Carpenter), 1
*Liotia acuticostata stearnsi* Dall, 4

FISSURELLACEA
*Diodora alta* (C. B. Adams), 2
*Diodora saturnalis* (Carpenter), 3
*Fissurella rugosa* Lamarck, 10

NERITACEA
*Nerita funiculata* Menke, 1
*Nerita scabricosta* Lamarck, 1

LITTORINACEA
*Littorina dubiosa penicillata* Carpenter, 10
*Littorina* species, 11
*Lacuna* species, 1

RISSOACEA
# *Alleorus deprellus* Strong, 8
*Cyclostremiscus trigonatus* (Carpenter), 20
? *Solariorbis ditropis* Pilsbry and Olsson, 1
*Teinostoma amplectans* Carpenter, 20
*Teinostoma gallegosi* E. K. Jordan, 1
*Alvania lirata* Carpenter, 50
*Alvania tumida* Carpenter, 1
*Alvania* species, 2
*Barleeia alderi* (Carpenter), 10
*Barleeia orcutti* Bartsch, 4
*Assiminea translucens* (Carpenter), 1
*Rissoella excolpa* (Bartsch), 1
*Rissoella tumens* (Carpenter), 1
*Rissoina burragei* Bartsch, 1
*Rissoina mexicana* Bartsch, 15
*Rissoina stricta* (Menke), 1
*Rissoina woodwardi* Carpenter, 16

ARCHITECTONICACEA
*Heliacus bicanaliculatus* (Valenciennes), 4
# *Heliacus chiquita* Pilsbry and Lowe, 2
*Heliacus mazatlanicus* Pilsbry and Lowe, 1

CERITHIACEA
*Alaba jeannettae* Bartsch, *50
*Alaba supralirata* Carpenter, 10

LIST 2. *(Continued*

CERITHIACEA *(Continued)*

*Bittium cerralvoense* Bartsch, 1
*Caecum* 3 species, 30
*Fartulum farcimen* (Carpenter), 2
*Micranellum* 3 species, 8
*Cerithiopsis abreojosensis* Bartsch, 2
*Cerithiopsis cassi* Baker, Hanna, and Strong, 1
*Cerithiopsis halia* Bartsch, 1
*Cerithiopsis subgloriosa* Baker, Hanna, and Strong, 1
*Cerithium maculosum* Kiener, 20
*Cerithium (Liocerithium) sculptum* Sowerby, 100+
*Litiopa melanostoma divisa* Carpenter, 1
*Metaxia convexa* (Carpenter), 1
*Seila assimilata* (C. B. Adams), 10
*Modulus disculus* (Philippi), 1
*Petaloconchus (Macrophragma) macrophragma* Carpenter, *2
*Serpulorbis margaritaceus* (Chenu), *10

EPITONIACEA

*Epitonium bakhanstranum* Keen, 1
*Epitonium hexagonum* (Sowerby), 2
*Epitonium* species, 3

EULIMACEA

*Eulima linearis* (Carpenter), 1
*Eulima mexicana* (Bartsch), 2

HIPPONICACEA

*Hipponix pilosus* Deshayes, *7
*Fossarus parcipictus* Carpenter, 2
*Fossarus* species, 5

CALYPTRAEACEA

*Cheilea cepacea* (Broderip), 2
*Crepidula aculeata* (Gmelin), *5

LAMELLARIACEA

*Erato columbella* Menke, 5

NATICACEA

*Polinices uber* (Valenciennes), *4

TONNACEA

*Cymatium gibbosum* (Broderip), 1

LIST 2. *(Continued)*

MURICACEA

*Morula ferruginosa* (Reeve), 6
*Thais triangularis* (Blainville), 1
# *Typhis (Tripterotyphis) lowei* (Pilsbry), 1

BUCCINACEA

*Mitrella ocellata* (Gmelin), 8
*Parametaria dupontii* (Kiener), 2
*Strombina maculosa* (Sowerby), 3
*Cantharus pallidus* (Broderip and Sowerby), 2
*Nassarius (Arcularia) tiarula* (Kiener), 4
*Nassarius* species, juvenile, 1
*Fusinus ambustus* (Gould), 5

VOLUTACEA

*Oliva spicata* Röding, *20
*Olivella alba* (Marrat in Sowerby), *115+
*Olivella dama* (Wood), 2
*Marginella californica* Tomlin, 2
*Marginella (Cystiscus)* compare *M. (C.) polita* Carpenter (?), 50

MITRACEA

*Mitra dolorosa* Dall, 8

CONACEA

*Clavus attalia* (Dall), 1
*Knefastia funiculata* (Kiener), 5
*Crassispira appressa* (Carpenter), 1
*Crassispira nymphia* Pilsbry and Lowe, 2
*Mangelia (Agathotoma) subdiaphana* (Carpenter), 25+
# *Mangelia trichodes* Dall, 10
*Mangelia (?Kurtziella)* compare *M. (K.) dane* Dall, *1
*Mangelia*, species,1
Conus , species, juvenile, 5
*Terebra* species, 10

PYRAMIDELLACEA

*Pyramidella (Longchaeus) adamsi* Carpenter, 4
*Pyramidella (Voluspa)* species, affinity with
*P. (V.) auricoma* Dall, *100
# *Pyramidella (Pharcidella) hastata* A. Adams, 20
# *Odostomia (Miralda) aepynota* Dall and Bartsch, 5
*Turbonilla*, 4 species, 24
*Iselica pura* (Carpenter), 5

LIST 2. *(Continued)*

BULLACEA
*Atys casta* (Carpenter), 3
*Bulla punctulata* A. Adams, 5
*Haminoea angelensis* Baker and Hanna, *25

SCAPHANDRACEA
*Acteocina angustior* Baker and Hanna, 5
*Acteocina inculta* (Gould and Carpenter), 100+
*Cylichna defuncta* Baker and Hanna, 1

SIPHONARIACEA
*Trimusculus stellatus* (Sowerby), 1

ELLOBIACEA
*Melampus* species, 1
*Pedipes liratus* Binney, 2

JULIACEA
*Berthelinia chloris belvederica* Keen and Smith, 1
*Julia thecaphora* (Carpenter), 3[1]

APLYSIACEA
*Dolabella californica* Stearns, 1

Undetermined gastropods, 6 species, 10 specimens

1. Mr. A. A. Olsson has pointed out to me (written communication, September 18, 1960) that the earliest valid name for this form, which has been called *J. exquisita* Gould, 1862, and *J. equatorialis* Pilsbry and Olsson, 1944, by authors, was proposed by Carpenter (Mazatlán Catalogue, 1857, p. 533) as *Smaragdinella thecaphora,* in family Philinidae. The type locality is Mazatlán.

LIST 3. *Dredging Stations.* Extracted from the field notes of Dr. Robert C. Miller

| STATION No. | LOCATION | DEPTH (FEET) | TIME (MIN.) | BOTTOM |
|---|---|---|---|---|
| 1. | South arm of "Eclipse Bay." | 13 | 10 | Coralline algal sand, December 13, 1960. |
| 2. | Continuation of no. 1. | 34 to 39 | 10 | Similar bottom, with a few rocks and coral heads. |
| 3. | Starting near entrance of South arm, dredging toward inner end of bay. | 100 to 65 | 10 | Finer sand of same type; coralline algae, mostly *Lithothamnion*. |
| 4. | Across entrance to "Eclipse Bay," | 110 to 105 | 10 | Small haul, bottom apparently sand and shell, smooth, with small bushy brown algae; a number of *Turritella* noted. |
| 5. | Mouth of "Eclipse Bay," from end of no. 4, above, due south toward east end of Ballena Island. | 105 to 65 | 10 | Rocky bottom, the haul terminating by the dredge being caught on a rock. |
| 6. | North side of "Eclipse Bay," from entrance in toward middle arm. | 105 to 40 | 10 | Dredge filled with coralline and shell sand, few animals. |
| 7. | Across "Eclipse Bay," parallel to no. 4, but closer to shore. | approx. 100 to 66 | 20 | |
| 8. | El Embudo, from entrance toward beach at its head. | 60 to 12 | 6 | Sand bottom, many corallines. December 14, 1960. |
| 9. | El Embudo, across channel inside. | 13 to 43 | 5 | Haul terminating by dredge being caught on a rock. Bottom similar to no. 8. |
| 10. | El Embudo, off entrance, from north to south or southwest, parallel to shore. | approx. 100 to 150 | 6 | Rocky bottom, haul ending with dredge caught on a rock, with little in it. |
| 11. | Continuation of no. 10, southward along headland. | 150 to 83 | 12 | Same as above. |

List 3. *(Continued)*

| Station No. | Location | Depth (feet) | Time (Min.) | Bottom |
|---|---|---|---|---|
| 12. | Across entrance to south arm of "Eclipse Bay." | start at 22 to 45 end 35 | 5 | Bottom of sand that packed hard in dredge but with rocks that sometimes jerked cable. December 16, 1960. |
| 13. | Across entrance to north arm of "Eclipse Bay." | 25 to 48 | 6 | Bottom of coarse sand and corallines that did not pack. |
| 14. | "Eclipse Bay," from outer headland toward middle arm. | 73 to 55 | -- | Coralline and sand bottom that did not pack; dredge only about 1/3 full, most of sand apparent-washing out, with more coral heads than at any other station. (? *Porites*, both whitish and reddish, clumps 4 - 8" in diam.) |
| 15. | "Eclipse Bay," across entrance to middle arm. | start at 20 to 45 end 35 | 10 | Bottom of sand that packed so hard it had to be washed out with water. |
| 16. | "Eclipse Bay," semi-circular haul off beach of main arm. | start at 15 to 10 end 16 | 8 | Bottom of coarse sand and broken corallines that did that did not pack, also numerous white branching corals. |
| 17. | Across mouth of "Eclipse Bay," about ¾ mile seaward from north headland (not shown on map). | est. 200 | 5 | Very small haul, dredge coming up with metal bridles crossed in front. December 20, 1960. |
| 18. | Continuation of no. 17, ½ mile west of south headland marking outer boundary of "Eclipse Bay" (not shown on map). | est. 315 | 15 | Fine coralline mud. |

LIST 4. *Mollusca dredged off Isla Partida, December, 1960*

In the following tabulation a number sign (#) before a species name signifies an extension of reported range; an asterisk (*) before the number of specimens indicates some were alive when collected.

| SPECIES | NO. OF SPECIMENS (STATIONS GROUPED) DEPTH IN FATHOMS | | | | |
|---|---|---|---|---|---|
| | 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
| SOLEMYACEA | | | | | |
| *Solemya panamensis* Dall | | 4 | | 1 | |
| NUCULACEA | | | | | |
| *Nucula declivis* Hinds | | 1 | 3 | | |
| *Nucula exigua* Sowerby | | | 3 | | 4 |
| # *Nucula schencki* Hertlein and Strong | | | | 1 | |
| *Nuculana marella* Hertlein and Strong | | | | | 3 |
| *Nucula elenensis* (Sowerby) | | | *14 | | 26 |
| ARCACEA | | | | | |
| *Arca mutabilis* (Sowerby) | | | | | 8 |
| *Arca pacifica* (Sowerby) | | | 4 | 16 | 4 |
| *Barbatia alternata* (Sowerby) | | | | | 1 |
| *Barbatia gradata* (Broderip and Sowerby) | 1 | | | | |
| *Barbatia lurida* (Sowerby) | | 1 | 1 | 2 | 1 |
| *Barbatia reeveana* (Orbigny) | | | | 2 | |
| *Anadara concinna* (Sowerby) | | | 2 | 5 | 3 |
| *Anadara multicostata* (Sowerby) | 5 | *35 | *25 | 2 | 2 |
| *Anadara reinharti* (Lowe) | | 1 | | | 1 |
| *Glycymeris gigantea* (Reeve) | | 1 | | | 1 |
| *Glycymeris multicostata* (Sowerby) | | 1 | | | |
| *Glycymeris tessellata* (Sowerby) | | 2 | *61 | *80 | 26 |
| *Glycymeris tessellata canoa* Pilsbry and Olsson | | | | | 1 |
| # *Nucinella subdola* (Hertlein and Strong) | | | 2 | | 2 |
| MYTILACEA | | | | | |
| *Amygdalum pallidulum* (Dall) | | | *6 | 3 | |
| *Crenella divaricata* (Orbigny) | | | 4 | 1 | 7 |
| *Gregariella coarctata* (Carpenter) | | | | 1 | |
| *Modiolus americanus* (Leach) | | 1 | | 1 | |
| *Septifer zeteki* Hertlein and Strong | 2 | 7 | 2 | 3 | 4 |
| *Solamen columbianum* (Dall) | | | 1 | | 1 |

List 4. *(Continued)*

| Species | No. of specimens (stations grouped) Depth in fathoms 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
|---|---|---|---|---|---|
| **Pteriacea** | | | | | |
| *Pteria sterna* (Gould) | | | | 1 | |
| **Ostreacea** | | | | | |
| *Ostrea fisheri* Dall | 1 | 3 | 1 | 1 | |
| *Ostrea* species, juvenile | | | | 1 | |
| **Pectinacea** | | | | | |
| *Pecten sericeus* Hinds | | | | 1 | |
| *Pecten vogdesi* Arnold | 2 | *13 | *6 | 7 | 1 |
| *Aequipecten circularis* (Sowerby) | 4 | *8 | *17 | 14 | 2 |
| *Chlamys lowei* (Hertlein) | | 1 | 4 | 31 | 15 |
| *Cyclopecten pernomus* (Hertlein) | | 1 | 1 | 10 | 9 |
| *Lyropecten subnodosus* (Sowerby) | | 1 | | 4 | 4 |
| *Lima tetrica* Gould | | | 1 | | |
| *Lima hemphilli* Hertlein and Strong | | | 2 | 2 | 3 |
| *Plicatula inezana* Durham | | | | | 3 |
| *Plicatula penicillata* Carpenter | | | | | 1 |
| *Spondylus princeps* Broderip | | | | 11 | 1 |
| **Anomiacea** | | | | | |
| *Anomia peruviana* Orbigny | | | | 2 | |
| *Placunanomia cumingii* Broderip | | | | 1 | 1 |
| **Astartacea** | | | | | |
| *Crassatella gibbosa* Sowerby | | | *5 | 3 | 2 |
| *Crassinella pacifica* (C.B. Adams) | | | 7 | 5 | 1 |
| *Crassinella varians* (Carpenter) | | | | | 14 |
| *Tellidorella cristulata* Berry | | | | | 17 |
| **Carditacea** | | | | | |
| *Cardita affinis* Sowerby | | 7 | | | 7 |
| *Cardita crassicostata* (Sowerby) | | | | 1 | 14 |
| *Cardita megastropha* (Gray) | | 1 | 3 | 3 | 2 |
| *Condylocardia digueti* Lamy | 1 | | | | |
| **Lucinacea** | | | | | |
| *Lucina (Bellucina) cancellaris* Philippi | 3 | 3 | | | 2 |
| *Lucina (Callucina) lampra* (Dall) | 1 | 1 | 1 | | |

LIST 4. *(Continued)*

| SPECIES | NO. OF SPECIMENS (STATIONS GROUPED) DEPTH IN FATHOMS | | | | |
|---|---|---|---|---|---|
| | 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
| LUCINACEA *(Continued)* | | | | | |
| *Lucina (Cavilinga) prolongata* Carpenter | 1 | 7 | | | |
| *Lucina (Lucinisca) liana* (Pilsbry) | 1 | 5 | 3 | | 39 |
| *Lucina (Parvilucina) approximata* (Dall) | | 1 | | | |
| *Lucina (Parvilucina) mazatlanica* Carpenter | | 2 | | | |
| *Lucina (Pleurolucina) leucocymoides* (Lowe) | | | 6 | 21 | 9 |
| *Lucina (Pleurolucina) undatoides* Hertlein and Strong | 2 | 6 | 2 | | |
| *Anodontia edentuloides* (Verrill) | | 1 | 6 | 2 | 2 |
| *Codakia distinguenda* (Tryon) | 1 | 5 | | | |
| *Ctena chiquita* (Dall) | 1 | 6 | 30 | 15 | 5 |
| *Ctena mexicana* (Dall) | 10 | 16 | 3 | 1 | 1 |
| *Divalinga eburnea* (Reeve) | | 19 | 3 | 2 | |
| *Miltha xantusi* (Dall) | | 1 | 1 | 1 | |
| # *Thyasira* species | | | 1 | | 2 |
| *Diplodonta inezensis* (Hertlein and Strong) | | 1 | 3 | | |
| *Diplodonta obliqua* Philippi | | | 2 | | 1 |
| *Diplodonta sericata* (Reeve) | | | | 1 | |
| *Diplodonta subquadrata* (Carpenter | 6 | 38 | 21 | 32 | 2 |
| LEPTONACEA | | | | | |
| ?*Axinopsida* species | | | | | 8 |
| *Aligena cokeri* Dall | | | | 1 | |
| *Basterotia peninsularis* Jordan | | 1 | | | |
| *Kellia suborbicularis* (Montagu) | | 1 | 1 | | |
| *Mysella chalcedonica* (Carpenter) | | 1 | | | |
| *Orobitella chacei* (Dall) | | | | | 2 |
| *Orobitella stearnsii* (Dall) | 1 | | | | |
| *Solecardia eburnea* Conrad | 1 | 4 | 2 | 1 | 1 |
| # *Lasaea* species | 1 | | | | |
| Genus and species undetermined | | | | | 1 |
| CHAMACEA | | | | | |
| *Chama squamuligera* Pilsbry and Lowe | 1 | | 1 | 11 | 28 |

List 4. *(Continued)*

| Species | No. of specimens (stations grouped) Depth in Fathoms 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
|---|---|---|---|---|---|
| **Chamacea** *(Continued)* | | | | | |
| *Chama* species | | 2 | 1 | | 1 |
| # *Pseudochama corrugata* (Broderip) | | | | 3 | |
| # *Pseudochama panamensis* (Reeve) | | 1 | | | |
| *Pseudochama saavedrai* Hertlein and Strong | 1 | | | 1 | |
| **Cardiacea** | | | | | |
| *Laevicardium elenense* (Sowerby) | *19 | 183 | 40 | 58 | 3 |
| *Lophocardium annettae* (Dall) | | | 2 | 3 | |
| *Nemocardium pazianum* (Dall) | | | 3 | 3 | 24 |
| *Papyridea aspersa* (Sowerby) | | | 1 | 1 | |
| *Trachycardium consors* (Sowerby) | 1 | 34 | | 1 | |
| *Trachycardium belcheri* (Broderip and Sowerby) | | | 13 | *13 | 1 |
| *Trigoniocardia biangulata* (Broderip and Sowerby) | *9 | 5 | 4 | 2 | 3 |
| **Veneracea** | | | | | |
| *Chione compta* (Broderip) | *3 | *12 | 5 | 1 | 2 |
| *Chione mariae* (Orbigny) | | | 2 | 1 | *4 |
| *Chione picta* Willett | 1 | | 1 | | |
| *Chione undatella* (Sowerby) | | *37 | 6 | 6 | |
| *Cyclinella singleyi* Dall | | | 1 | 1 | |
| *Gouldia californica* Dall | 1 | 4 | 11 | 3 | 11 |
| *Megapitaria squalida* (Sowerby) | *30 | *70 | *41 | 8 | 2 |
| *Pitar frizzelli* Hertlein and Strong | | | | 1 | |
| *Pitar newcombianus* (Gabb) | | 4 | *13 | 2 | |
| # *Pitar perfragilis* Pilsbry and Lowe | | | | | 6 |
| *Pitar pollicaris* (Carpenter) | | | 1 | | |
| *Protothaca grata* (Say) | 1 | | | | |
| *Transennella puella* (Carpenter) | | 6 | *28 | 53 | 3 |
| *Transennella sororcula* Pilsbry and Lowe | 1 | | | 1 | |
| *Transennella tantilla* (Gould) | | 9 | | | 1 |
| *Ventricolaria isocardia* (Verrill) | | | 2 | 2 | 1 |
| *Petricola* species | | 1 | | | |

LIST 4. *(Continued)*

| SPECIES | NO. OF SPECIMENS (STATIONS GROUPED) DEPTH IN FATHOMS | | | | |
|---|---|---|---|---|---|
| | 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
| TELLINACEA | | | | | |
| *Tellina (Elliptotellina) pacifica* Dall | | 1 | | 6 | |
| *Tellina (Eurytellina)* species | | 1 | 1 | | |
| *Tellina (Eurytellina) inaequistriata* Donovan | | | 1 | | |
| *Tellina (Merisca) meropsis* Dall | | | | 1 | |
| *Tellina (Merisca) proclivis* Hertlein and Strong | | 1 | 5 | | 1 |
| *Tellina (Merisca) reclusa* Dall | 3 | 3 | 1 | 2 | 14 |
| *Tellina (Moerella) amianta* Dall | 2 | 2 | 13 | 2 | |
| # *Tellina (Moerella) felix* Hanley | | | 1 | | |
| *Tellina (Moerella) paziana* Dall | | | | | 1 |
| *Tellina (Moerella)* new species | | 5 | 1 | | |
| *Tellina (Phyllodina) pristiphora* Dall | | | | | 9 |
| *Tellina (Tellinella) cumingii* Hanley | 1 | 2 | 1 | | |
| *Tellina (Tellinella) zacae* Hertlein and Strong | | | | 1 | |
| *Macoma siliqua* (C.B.Adams) | | | | | 1 |
| *Gari regularis* (Carpenter) | | | 2 | 1 | |
| *Solecurtus guaymasensis* Lowe | | | 1 | | |
| *Tagelus politus* (Carpenter) | 1 | 2 | | | |
| # *Semele mediamericana* Pilsbry and Lowe | | | | 2 | |
| *Semele pacifica* Dall | 1 | 2 | 5 | 4 | 3 |
| *Cumingia lamellosa* Sowerby | 1 | 1 | | | |
| MYACEA | | | | | |
| *Corbula biradiata* Sowerby | | | 4 | | |
| *Corbula luteola* Carpenter | 1 | | | 2 | |
| *Corbula nasuta* Sowerby | 1 | | | 5 | 11 |
| *Corbula speciosa* Reeve | 1 | 2 | *9 | 11 | 21 |
| *Corbula* species indeterminate | | | 3 | | 4 |
| ? *Gastrochaena ovata* Sowerby | | | | 2 | |
| PHOLADACEA | | | | | |
| #*Xylophaga mexicana* Dall | | | 1 | | |

List 4. *(Continued)*

| Species | No. of specimens (stations grouped) Depth in Fathoms | | | | |
|---|---|---|---|---|---|
| | 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
| **Pandoracea** | | | | | |
| *Pandora cornuta* C. B. Adams | | | | 1 | |
| *Pandora granulata* Dall | | | 5 | | |
| *Pandora uncifera* Pilsbry and Lowe | | | 3 | 4 | |
| *Lyonsia gouldii* Dall | 1 | | 9 | | 1 |
| # *Asthenothaerus villosior* Carpenter | | 1 | | | 1 |
| *Cyathodonta undulata* Conrad | | | | 1 | |
| **Poromyacea** | | | | | |
| *Cuspidaria dulcis* Pilsbry and Lowe | | | 4 | | |
| # *Cuspidaria lanieri* Hertlein and Strong | | | | | 5 |
| *Plectodon scaber* Carpenter | | | 3 | 1 | 3 |
| *Verticordia ornata* (Orbigny) | | | | | 1 |
| SCAPHOPODA | | | | | |
| **Dentaliidae** | | | | | |
| *Dentalium hancocki* Emerson | | 8 | 3 | | |
| *Dentalium inversum* Deshayes | | | | *3 | |
| *Dentalium oerstedii* Mörch | | | | | 5 |
| *Dentalium quadrangulare* Sowerby | | | 7 | 4 | 1 |
| *Dentalium semipolitum* Broderip and Sowerby | 1 | | | | |
| *Dentalium splendidum* Sowerby | 4 | *6 | 5 | | 8 |
| # *Dentalium tesseragonum* Sowerby | | | | 2 | |
| GASTROPODA | | | | | |
| **Patellacea** | | | | | |
| *Acmaea semirubida* Dall | | 1 | | | |
| *Acmaea strongiana* Hertlein | | 1 | | | |
| *Nomaeopelta stanfordiana* (Berry) | | | | 1 | |
| **Pleurotomariacea** | | | | | |
| *Scissurella* species | | | 5 | 1 | |
| **Trochacea** | | | | | |
| *Arene* new species | | | 1 | | |
| *Arene rammata* (Dall) | | 1 | | | |

List 4. *(Continued)*

| Species | No. of specimens (stations grouped) Depth in Fathoms 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
|---|---|---|---|---|---|
| Trochacea *(Continued)* | | | | | |
| *Liotia acuticostata* Carpenter | | | | 3 | |
| *Liotia acuticostata stearnsi* Dall | | 3 | 2 | | |
| *Solariella triplostephanus* Dall | | | 6 | 3 | |
| *Tegula byroniana* (Wood) | | | 1 | | |
| *Tricolia typica* (Dall) | | | 1 | | |
| *Tricolia* species | | | 1 | | |
| *Turbo squamiger* Reeve | | | | | |
| Fissurellacea | | | | | |
| *Diodora inaequalis* (Sowerby) | 2 | 2 | 2 | 1 | 3 |
| *Diodora saturnalis* (Carpenter) | | | | 3 | |
| *Hemitoma hermosa* Lowe | 1 | 3 | 1 | 3 | |
| *Lucapinella* new species? | | | | 3 | |
| Littorinacea | | | | | |
| *Lacuna* species | | | 5 | | |
| Rissoacea | | | | | |
| *Alleorus deprellus* Strong | | 1 | 1 | | |
| *Alvania* species | | 10 | 16 | 7 | 7 |
| *Amphithalamus* species | | | | | 1 |
| *Barleeia* species | | | 15 | 45 | |
| *Cyclostremiscus tricarinatus* (C. B. Adams) | | | | | 1 |
| *Rissoella* species | | | | | 3 |
| *Rissoina* species | | 7 | | 1 | |
| *Solariorbis (Hapalorbis) liriope* Bartsch | | | | | 3 |
| *Solariorbis (Hapalorbis) seminudus* (C. B. Adams) | | | | | 1 |
| *Teinostoma* species | | | | 1 | |
| *Vitrinella* species | | | 1 | | |
| Architectonicacea | | | | | |
| *Architectonica nobilis* Röding | 1 | | | | 2 |
| *Heliacus bicanaliculatus* (Valenciennes) | | 1 | | | |
| *Heliacus* species | | 2 | 5 | 2 | |

List 4. *(Continued)*

| Species | No. of specimens (stations grouped) Depth in Fathoms | | | | |
|---|---|---|---|---|---|
| | 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
| **Cerithiacea** | | | | | |
| *Alaba supralirata* (Carpenter) | | 15 | | | |
| *Alaba* species | | 2 | 15 | | |
| *Alabina diomedeae* Bartsch | | 3 | | | |
| *Cerithiopsis* species | | 10 | 11 | | |
| *Cerithium gemmatum* (Hinds) | | 1 | 1 | | |
| *Caecum* species | | 5 | 6 | | 2 |
| *Elephantanellum* species | | | | 2 | |
| *Elephantulum* species | | | | 1 | 1 |
| *Fartulum* cf. *F. laeve* (C. B. Adams) | | | 15 | | |
| *Metaxia convexa* (Carpenter) | | 3 | 9 | | |
| *Metaxia* species | | | | 1 | |
| *Modulus catenulatus* (Philippi) | | | 6 | 4 | |
| *Modulus cerodes* (A. Adams) | | 7 | 4 | 2 | |
| *Seila assimilata* (C. B. Adams) | | 3 | 1 | 1 | |
| *Triphora* species | 2 | 5 | 8 | 9 | |
| *Turritella mariana* Dall | | | *31 | *32 | 2 |
| *Turritella nodulosa* King and Broderip | | | 3 | 9 | |
| *Petaloconchus (Macrophragma) indentatus* (Carpenter) | | 1 | | | |
| *Petaloconchus (Macrophragma) indentatus* variety | | 1 | | | |
| *Vermetus (Thylacodus)* species | | | | 1 | |
| **Epitoniacea** | | | | | |
| *Epitonium (Asperiscala) walkerianum* Hertlein and Strong | 2 | | | | |
| *Epitonium (Nitidiscala) wurtsbaughi* Hertlein and Strong | | 1 | | | |
| *Epitonium* species | | 1 | | | |
| *Scalina ferminiana* (Dall) | | | | 1 | |
| **Eulimacea** | | | | | |
| *Balcis* species (possibly *Eulima*) | | | | 1 | |
| *Balcis* species | 1 | | 5 | | 4 |
| *Niso excolpa* Bartsch | | | | 4 | |

List 4. *(Continued)*

| Species | No. of specimens (stations grouped) Depth in Fathoms 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
|---|---|---|---|---|---|
| Hipponicacea | | | | | |
| *Hipponix antiquatus* (Linnaeus) | | | | 1 | |
| # *Hipponix grayanus* Menke | | *30 | | 2 | |
| Calyptraeacea | | | | | |
| *Calyptraea conica* Broderip | | | | | 8 |
| *Calyptraea mamillaris* Broderip | | | 11 | 7 | 30 |
| *Cheilea cepacea* (Broderip) | | 1 | 1 | | |
| *Crepidula aculeata* (Gmelin) | | | | | 20 |
| *Crepidula arenata* Broderip) | | 1 | 1 | 4 | |
| *Crepidula excavata* (Broderip) | | | 3 | 7 | |
| *Crepidula striolata* Menke | | | | | 3 |
| # *Crucibulum concameratum* Reeve | | | | | 3 |
| *Crucibulum scutellatum* (Wood) | | 1 | 1 | 1 | 2 |
| *Crucibulum spinosum* (Sowerby) | 1 | 2 | 1 | 1 | |
| Lamellariacea | | | | | |
| *Erato columbella* Menke | 2 | | | | |
| Cypraeacea | | | | | |
| *Trivia californiana* (Gray) | | | | 1 | |
| *Trivia sanguinea* (Sowerby) | | | 1 | 2 | |
| Strombacea | | | | | |
| *Strombus gracilior* Sowerby | | | 33 | 8 | |
| *Strombus granulatus* Swainson | 6 | 2 | 27 | 5 | 1 |
| Niticacea | | | | | |
| *Natica grayi* Philippi | | | 1 | | |
| *Natica idiopoma* Pilsbry and Lowe | | | 1 | 2 | |
| *Natica (Stigmaulax) broderipiana* Récluz | | | | 1 | |
| *Polinices bifasciatus* (Gray) | | | 1 | 1 | |
| *Polinices uber* (Valenciennes) | *10 | *34 | 14 | 4 | 3 |
| *Polinices* species | | | | | 2 |
| *Sinum debile* (Gould) | 1 | | 1 | | |
| Atlantacea | | | | | |
| # *Atlanta* species | | | | 1 | 2 |
| Tonnacea | | | | | |
| *Colubraria siphonata* (Reeve) | | | | | 1 |
| *Cymatium gibbosum* (Broderip) | | 1 | | | |

LIST 4. *(Continued)*

| SPECIES | NO. OF SPECIMENS (STATIONS GROUPED) DEPTH IN FATHOMS | | | | |
|---|---|---|---|---|---|
| | 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
| TONNACEA *(Continued)* | | | | | |
| *Cymatium tigrinum* (Broderip) | | | | | 1 |
| *Ficus ventricosa* (Sowerby) | | | | | 1 |
| MURICACEA | | | | | |
| #*Aspella pyramidalis* (Broderip) | | | | 1 | |
| *Morula lugubris* (C. B. Adams) | | 1 | 1 | | |
| *Murex recurvirostris* Broderip | | | | | 6 |
| *Ocenebra parva* (E.A. Smith) | | | | 1 | |
| *Pterynotus centrifuga* (Hinds) | | | | | 3 |
| BUCCINACEA | | | | | |
| *Anachis coronata* (Sowerby) | | | 1 | | |
| *Anachis coronata hannana* Hertlein and Strong | | | | 1 | |
| ?*Strombina carmencita* Lowe | | | 4 | 2 | 4 |
| *Strombina maculosa* (Sowerby) | *15 | *66 | *70 | *39 | 3 |
| *Cantharus pallidus* (Broderip | | | 2 | 3 | 5 |
| and Sowerby | | | | | 1 |
| *Engina reevei* Tryon | | | | 2 | |
| *Engina solida* (Dall) | | 1 | 1 | 4 | |
| #*Metula amosi* Vanatta | | | | | 1 |
| *Phos veraguensis* Hinds | | | | | 3 |
| *Nassarius angulicostis* (Pilsbry and Lowe) | *3 | | 20 | 3 | |
| *Nassarius gallegosi* Hertlein and Strong | | 1 | 2 | 1 | |
| *Nassarius versicolor* (C. B. Adams) | | 7 | 5 | 6 | |
| *Nassarius (Arcularia) tiarula* (Kiener) | *2 | | | | |
| *Nassarius* cf. *Nassarius mendicus* (Gould) | | | | 1 | |
| *Nassarius*, ? new species | | | | 2 | |
| #*Fusinus irregularis* (Grabau) | | | | 1 | 2 |
| #*Fusinus panamensis* Dall | | | | | 1 |
| *Fusinus* species | | | 1 | | |
| VOLUTACEA | | | | | |
| *Cancellaria buccinoides* Sowerby | | | | | 1 |
| *Marginella californica* Tomlin | 7 | 1 | 1 | | 2 |

LIST 4. *(Continued)*

| SPECIES | NO. OF SPECIMENS (STATIONS GROUPED) DEPTH IN FATHOMS | | | | |
|---|---|---|---|---|---|
| | 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
| VOLUTACEA *(Continued)* | | | | | |
| *Marginella (Cypraeolina)* species | | | 3 | | |
| *Marginella (Cystiscus)* species | | 1 | | | |
| *Marginella (Gibberulina)* species | | 1 | 4 | | |
| *Oliva spicata* (Röding) | *15 | *73 | *32 | 3 | |
| *Olivella alba* (Marrat in Sowerby) | | | 3 | | |
| *Olivella dama* (Wood) | | | 3 | | |
| *Olivella gracilis* (Broderip and Sowerby) | | | 1 | | |
| *Olivella tergina* (Duclos) | | | | 1 | |
| MITRACEA | | | | | |
| *Mitra crenata* Broderip | | | 4 | 6 | |
| *Mitra dolorosa* Dall | | 2 | 3 | | |
| *Mitra mexicana* Dall | | | | | 2 |
| *Mitra (Tiara) hindsii* Reeve | | | 5 | 9 | 11 |
| *Mitra (Tiara) sulcata* Sowerby | | | | | 1 |
| CONACEA | | | | | |
| *Clathrodrillia alcestis* Dall | | | | 3 | |
| *Clathrodrillia haliplexa* Dall | | 1 | | | |
| *Clathrodrillia pilsbryi* Lowe | | | | 1 | 1 |
| *Clathurella candida* (Hinds) | | | | | 4 |
| *Clathurella* cf. *Clathurella serrata* Carpenter | | 1 | | | |
| *Clathurella rava* (Hinds) | | | 1 | | |
| *Clathurella* species | | | 1 | | |
| # *Clavus acapulcanus* (Lowe) | | | | 2 | 1 |
| # *Clavus alcmene* (Dall) | | | | 3 | |
| *Clavus asaedai* (Hertlein and Strong) | | | | 1 | |
| # *Clavus melea* (Dall) | | | | 2 | |
| # *Clavus pilsbryi* (Bartsch) | | 2 | | | |
| # *Clavus plicatellus* (Dall) | | | | | 2 |
| # *Clavus pudicus* (Hinds) | | | | 1 | |
| # *Clavus roseolus* (Hertlein and Strong) | | | | 1 | 1 |
| # *Clavus turveri* (Hertlein and Strong) | | | | 1 | 1 |
| *Clavus* species | | | 4 | 2 | |

LIST 4. *(Continued)*

| SPECIES | NO. OF SPECIMENS (STATIONS GROUPED) DEPTH IN FATHOMS | | | | |
|---|---|---|---|---|---|
| | 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
| CONACEA *(Continued)* | | | | | |
| *Crassispira ericana* Hertlein and Strong | | | | | 2 |
| *Crassispira* cf. *Crassispira incrassata* (Sowerby) | | | | | 1 |
| *Crassispira martinensis* Dall | | | 1 | | |
| *Crassispira tepocana* Dall | | | 1 | | |
| *Gemmula hindsiana* Berry | | | | | 1 |
| #*Mangelia cyrene* (Dall) | | | | 1 | 1 |
| *Mangelia occata* (Hinds) | | | | | 1 |
| *Mangelia trichodes* (Dall) | 1 | 3 | 2 | 2 | |
| *Mangelia* species | | 1 | 4 | 1 | 1 |
| *Pleuroliria oxytropis* (Sowerby) | | | 1 | 1 | |
| *Pleuroliria oxytropis albicarinata* (Sowerby) | | | 1 | 5 | 15 |
| *Pleuroliria picta* (Reeve) | | | 5 | 9 | |
| #*Syntomodrillia cybele* Pilsbry and Lowe | | 1 | | | |
| *Tenaturris burchi* (Hertlein and Strong) | 2 | | 1 | 1 | |
| *Tenaturris verdensis* (Dall) | | | | 2 | |
| *Turricula libya* Dall | | | | | 2 |
| *Turricula nigricans* Dall | | | | | 1 |
| Turridae, undetermined; possibly new genus, new species | | | 3 | 3 | |
| #*Conus bartschi* Hanna and Strong | | | | 1 | |
| *Conus gradatus* Wood | 2 | 1 | | | |
| *Conus recurvus* Broderip | | | | | 1 |
| *Conus scalaris* Valenciennes | | | 1 | 4 | 6 |
| *Terebra ?albocincta* (Carpenter) | | | | 1 | |
| *Terebra armillata* Hinds | | 1 | | 3 | |
| *Terebra intertincta* Hinds | | | 1 | | |
| # *Terebra lingualis* Hinds | | | | 1 | |
| # *Terebra panamensis* Dall | | | 3 | | |
| *Terebra specillata* Hinds | | | | 2 | |
| *Terebra variegata* Gray | | | | 6 | |
| *Terebra* species | | | | | 1 |

LIST 4. *Continued)*

| Species | No. of specimens (stations grouped) Depth in Fathoms 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
|---|---|---|---|---|---|
| PYRAMIDELLACEA | | | | | |
| *Odostomia (Miralda) exarata* Carpenter | | 2 | | | |
| *Odostomia (Miralda)* species | | | 2 | | |
| *Odostomia (Scalenostoma) dotella* Dall and Bartsch | | | | | 1 |
| *Odostomia* species | | | 1 | | |
| *Pyramidella adamsi* Carpenter | 3 | 1 | 2 | | |
| *Pyramidella auricoma* Dall | | 1 | 2 | | |
| *Pyramidella (Voluspa)* new species | 2 | | | | |
| *Triptychus* new species | | | | 1 | |
| *Turbonilla (Careliopsis) stenogyra* Dall and Bartsch | | | 1 | | |
| *Turbonilla (Careliopsis)* species | | | | 2 | |
| *Turbonilla (Mormula) coyotensis* Hanna and Strong | | 1 | 4 | 1 | |
| *Turbonilla* species | | 5 | 3 | 1 | 15 |
| BULLACEA | | | | | |
| #*Atys casta* Carpenter | | 3 | | | |
| *Atys chimera* Baker and Hanna | | | | 1 | |
| *Bulla punctulata* A. Adams | 12 | 9 | 5 | | |
| *Bulla* species | | 5 | | | |
| *Haminoea angelensis* Baker and Hanna | | 2 | | | |
| *Haminoea* species | | 1 | | | |
| ?*Sulcoretusa* species | | | | | 2 |
| *Volvulella* species | | | | | 1 |
| SCAPHANDRACEA | | | | | |
| *Acteocina angustior* Baker and Hanna | 3 | 6 | 1 | | |
| *Cylichnella* species | | 5 | 9 | | |
| PTEROPODA | | | | | |
| *Cavolina trispinosa* Lesueur | | 1 | | | |
| *Cavolina* species | | | | | 1 |
| *Clio* species | | | | 1 | |

LIST 4. *(Continued)*

| SPECIES | NO. OF SPECIMENS (STATIONS GROUPED) DEPTH IN FATHOMS | | | | |
|---|---|---|---|---|---|
| | 1-3 | 3-12 | 10-18 | 14-25 | 30-50 |
| SIPHONARIACEA | | | | | |
| #*Siphonaria brannani* Stearns | | | 1 | | |
| *Williamia peltoides* (Carpenter) | 2 | | | 5 | |
| UMBRACULACEA | | | | | |
| *Umbraculum ovale* (Carpenter) | | | | 1 | |

LIST 5. Polyplacophora *(Chitons) from Isla Espíritu Santo and Isla Partida, Baja California, Mexico.*

ISCHNOCHITONIDAE
*Ischnochiton (Radsiella) tridentatus* Pilsbry - Abundant.
*Lepidozona serrata* (Carpenter) - Fairly common.
*Stenoplax mariposa* Dall - Fairly common.

CHAETOPLEURIDAE
*Chaetopleura lurida* (Sowerby) - Common.

CHITONIDAE
*Chiton virgulatus* Sowerby - Common.

ACANTHOCHITONIDAE
*Acanthochitona exquisita* (Pilsbry).

The above list is based on specimens in the collection of the California Academy of Sciences. More intense collecting in the area would undoubtedly add more species to it.

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# BATS FROM ISLANDS IN THE GULF OF CALIFORNIA


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The Gulf of California is rich in islands, a number of which are inhabited by land mammals. Fifteen species and 39 subspecies of insular terrestrial mammals are currently recognized as occurring here. Records for aerial mammals from these islands, nevertheless, are exceedingly few, except for *Pizonyx vivesi.*

Through the generosity of the Belvedere Scientific Fund of San Francisco, Mr. Roy E. Marquardt of Van Nuys, California, and Mr. Richard Adcock of LaPaz, Baja California, Mexico, the authors along with nine other scientists had an opportunity from June 20 to July 1, 1964, to visit a number of islands situated in the Gulf of California between Loreto and LaPaz. Mr. Adcock provided his boat, the *Marisla,* for transportation. Several new insular records for bats were secured on this trip, which induced us to summarize briefly the information available to date on the distribution of members of the order Chiroptera on islands in the Gulf. Permission to collect scientific specimens was granted by Dr. Rodolfo Hernandez Corzo, Dirección General de la Fauna Silvestre, Mexico City.

Fish-eating Bat *(Pizonyx vivesi).* This is one of the most distinctive endemic species of the Baja California region (see Orr, 1960). The type locality given by Menegaux (1901) is "Ilot du Cardonal au Islo, parti de l'Archipel Salsi puedes." This locality is considered to be Isla Partida which is just southeast of Isla Angel de la Guarda. Reeder and Norris (1954) summarized the known localities from which this species had been recorded up to the year 1951. Included were records of specimens from eight islands as follows: Isla Partida, Isla Tiburon, Isla Pescadora, Isla San Jorge, Isla Pond, Isla Encantada, Isla Granito, Isla Patos, in addition to those from localities along the coast of Sonora and both the gulf and Pacific coasts of Baja California. They also included a sight record from Isla San Pedro Nolasco. All localities listed are north of 27° 30' N. Lindsay (1962, p. 32) later recorded this species from Isla Cayo which is just west of the southern tip of Isla San José at approximately 24° 53' N. (for further details see Banks, 1946b).

When the writers visited Isla Cayo on June 28, 1964, bats of this species were located in three separate crevices on this islet. Five individuals were collected by members of the expedition. One of these, a slightly more than half-grown male probably not much more than one month in age, is now in the collection of the California Academy of Sciences. Three are in the San Diego Natural History Museum, and one has been selected for deposit with the Dirección General de la Fauna Silvestre in Mexico City. On June 29 and again on June 30, 1964, one of us (Orr) found a colony of these bats still farther south on Los Islotes, a group of rocks at about 24° 37' N., one-half mile north of Isla Partida (not to be confused with Isla Partida, the type locality for *Pizonyx vivesi*, at 28° 54' N.). They were located by their characteristic vocal utterances as well as the presence of reddish droppings beneath their daytime retreat. The crevice in which they were situated, however, was inaccessible. We were later informed by Dr. and Mrs. T. Eric Reynolds of Piedmont, California, that they had observed *Pizonyx vivesi* on Cerralvo Island in the spring of 1964.

Western pipistrelle *(Pipistrellus hesperus australis).* Townsend (1912, p. 127) recorded a female of this species taken on Ceralbo [=Cerralvo] Island on April 19, 1911, although this was apparently overlooked by Hatfield (1936) in his revision of the species. Several additional specimens were collected on this island from 1960 to 1962 (see Banks, 1964c). The species was also reported from Monserrate Island by Banks (1964a) on the basis of two specimens collected on May 10, 1963.

On April 20, 1962, a female was obtained on Isla Espíritu Santo by Chris Parrish (Lindsay, 1962, p. 37). The specimen, of which the skull was lost, is in San Diego Natural History Museum. The species had not previously been reported from this island.

On the evening of June 25, 1964, we collected four individuals of this species between sundown and dark at the south end of Isla Catalina. An adult male and an adult female were saved as study skins and are now in the collection of the California Academy of Sciences. The other two, one of which was a male, were so badly shot that they were discarded. This is the first record of this species for this island.

On the evening of June 26, 1964, two adult females were secured at Arroyo Aguada on the northeast side of Isla San José and on the following evening three more females were secured on the shore of Amortajada Bay at the south end of this island. These are the first specimens of *Pipistrellus hesperus* to be recorded from Isla San José. Four of these (three study skins and one skull only) are in the collection of the California Academy of Sciences and one is in the collection of the San Diego Natural History Museum.

All of the insular specimens of *Pipistrellus hesperis* examined from Isla Monserrate, Isla Santa Catalina, Isla San José, Isla Espíritu Santo and Isla Cerralvo appear referable to the race *australis*.

BIG BROWN BAT *(Eptesicus fuscus penninsulae).* As noted by Banks (1964b), a female of this species was secured on Cerralvo Island on May 27, 1962. On the evening of June 27, 1964, one of us (Orr) secured another female at Amortajada Bay on the south end of San Jose Island. As far as known these are the only records for this species from islands in the Gulf of California. Both specimens (now in the collection of the California Academy of Sciences) are small in size and dark in color. As noted by Engles (1936, p. 658), the progressive decrease in size in *Eptesicus fuscus* and the tendency toward rich coloration down through the peninsula "provides a means of recognizing the race *peninsulae*."

TOWNSEND'S BIG-EARED BAT *(Plecotus townsendii pallescens).* A single specimen of this bat (now in the San Diego Natural History Museum) was secured by Banks on Santa Catalina Island on the evening of June 24, 1964. This is the first record for this species from an island in the Gulf of California as well as the most southern record for the Baja California region published to date. It is tentatively assigned to the race *pallescens*.

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**PROCEEDINGS**

OF THE

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# SEA OF CORTEZ EXPEDITION OF THE CALIFORNIA ACADEMY OF SCIENCES

## June 20 - July 4, 1964

By

George E. Lindsay

*Director*
*California Academy of Sciences*

The peninsula of Baja California and the Gulf of California are of particular biological interest and have had the attention of scientists of the California Academy of Sciences since long before the start of this century. In 1888 Walter E. Bryant made a trans-peninsular collecting trip from Isla Magdalena and San Jorge to Loreto. This initiated a series of expeditions which accomplished the basic biological exploration of the southern half of the peninsula and the outlying islands. Large and significant collections of the animals and plants were made by Bryant, Charles D. Hains, Gustav Eisen, Frank H. Vaslit, T. S. Brandegee (who was independently associated with the Academy expeditions), and several others. Unfortunately those collections were destroyed by the fire which accompanied the San Francisco earthquake on April 18, 1906.

In 1921 the Academy conducted a very productive expedition to the islands of the Gulf of California. Using a sixty-five foot gasoline schooner, the *Silver Gate*, a scientific complement of eight, under the leadership of Joseph

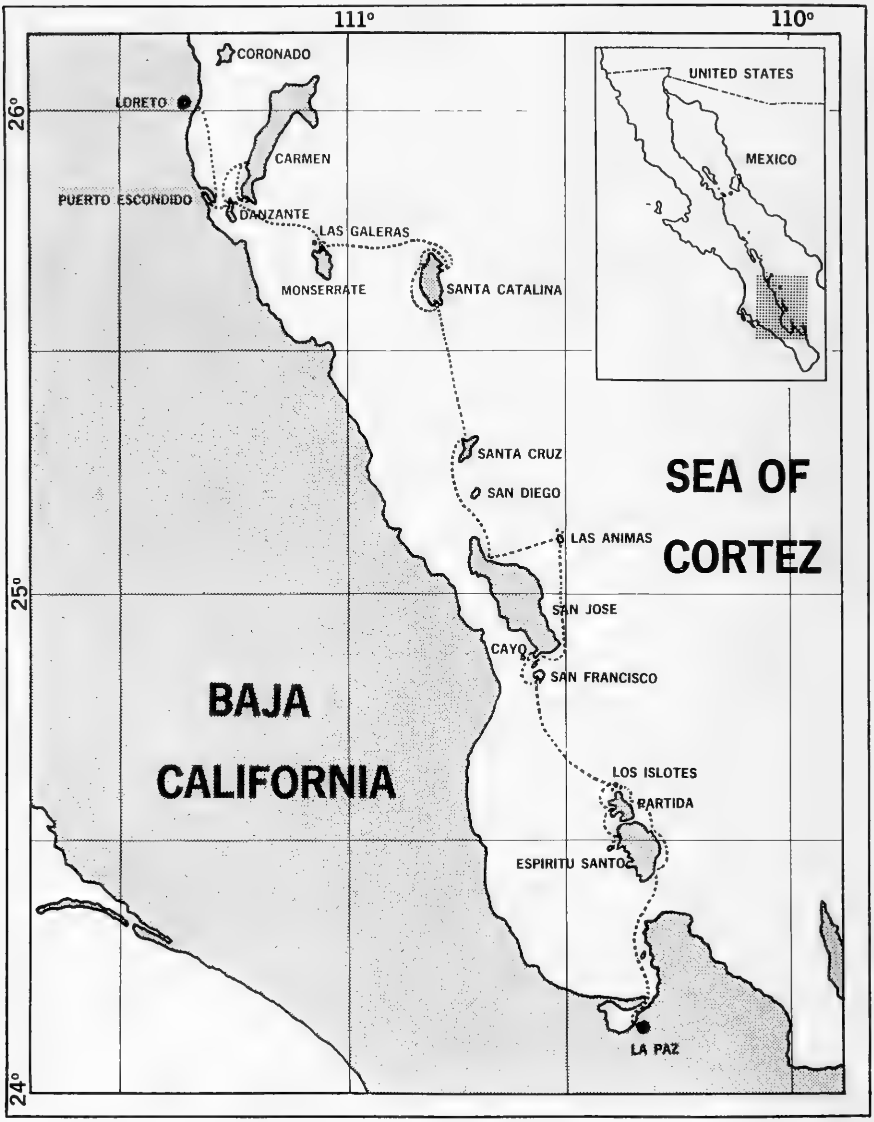


Figure 1. Route of the Sea of Cortez Expedition. MAP BY BOB OLSON.

R. Slevin, spent 87 days in intensive field investigation. The resulting collections are an important part of the Baja California and Gulf of California material preserved at the Academy. This has been augmented by frequent but smaller collecting trips, many of the most recent of which were sponsored by the Belvedere Scientific Fund. Since 1914 more than 3,500 pages of the Acad-

Members of the expedition, left to right: Muñoz, Jr., Markham, Chivers, Herald, Tsegeletos, Adcock, Powell, Banks, Parrish, Wiggins, Villalobos F., Orr, Parker, Sloan, Bandar, Fuller.

The *Marisla* at Las Animas.

emy's *Proceedings* have been devoted to scientific accounts and reports of the biota of Baja California and islands of the west coast of Mexico.

Field work in the Gulf of California continues to be productive. The area is large and the islands are many. Modern diving techniques and equipment make possible the exploration of the fascinating submarine environment which earlier could only be inadequately sampled with dredges and other inefficient devices.

On December 16, 1963, Richard M. Adcock of the La Paz Skin Diving Service invited the Academy to use his new diving vessel, the *Marisla*, for two weeks of biological investigations in the southern part of the Gulf of California. The invitation was accepted and an area of unusual interest, the chain of islands between Loreto and La Paz, was chosen for the operation. Because of other activities by Academy personnel and Adcock's charter commitments, the period of June 20 to July 1 was selected for the trip.

It was early decided to place some emphasis on marine work, both because of the unique diving facilities offered by Adcock and because the Academy needed to augment its collection of marine invertebrates. Also, this served as an exploratory trip for possible sources of living fishes for the Steinhart Aquarium. But general collections of terrestrial organisms were made on most of the islands which were visited.

The scientific party included:

George E. Lindsay, Director, California Academy of Sciences, in charge.
Ira L. Wiggins, Scientific Director, Belvedere Scientific Fund, botanist.
Alejandro Villalobos F., Instituto de Biología, Mexico, invertebrate zoologist.
Robert T. Orr, California Academy of Sciences, mammalogist and ornithologist.
Earl S. Herald, California Academy of Sciences, ichthyologist.
David C. Powell, California Academy of Sciences, aquatic biologist.
Dustin Chivers, California Academy of Sciences, invertebrate zoologist.
Raymond Bandar, California Academy of Sciences, assistant to Dr. Orr.
Allan J. Sloan, San Diego Natural History Museum, herpetologist.
Richard C. Banks, San Diego Natural History Museum, ornithologist and mammalogist.
Chris Parrish, San Diego Natural History Museum, arachnologist.
Bruce E. Marquardt, student collector, particularly of marine organisms.
Francisco Muñoz, Jr., student collector.

A documentary film of the trip was made by the Television Department of the Academy. David Parker, director of the television series "Science-in-Action," and Dana Fuller, cinematographer, were members of the expedition. George Tsegeletos, an experienced diving instructor and underwater cameraman from San Rafael, California, volunteered his services and was a very valuable member of the party, both as cameraman and collector.

Richard Adcock had three guests, Bruce Markham of Pocatello, Idaho, and Dr. and Mrs. Wright Cortner of Tucson, Arizona, all of whom participated in the expedition activities and made valuable collections for the biologists.

It was first planned to be aboard the *Marisla* for two weeks, but the schedules of some of the biologists and Adcock's commitments for his vessel reduced this to 11 days. In order to take full advantage of the time, Adcock suggested that he meet our party in Loreto and that the trip end in La Paz. Arrangements were made with Captain Francisco Muñoz, of the Servicio Aereo Baja, to fly the Academy party from Tijuana to Loreto on June 20 and from La Paz to Tijuana on July 4.

We met at the Tijuana International Airport at 0900 June 20. Villalobos had flown from Mexico City the previous day. Personnel from San Francisco drove or flew to San Diego. Members of the staff of the San Diego Natural History Museum had assembled supplies and equipment and transported it to Tijuana. They also drove our party from the San Diego airport to the Tijuana airport. The same help was provided on the return trip, for which I express appreciation.

## Log of the Trip

*June 20, 1964. Tijuana to Puerto Escondido.*

We departed from the Tijuana International Airport in a Lockheed Lodestar at 1034. Captain Francisco Muñoz was the owner and pilot, and Victor Manuel Corral his co-pilot. Our 15 passengers and their bulky collecting gear made a near-capacity load.

The direct course to Loreto is 575 miles. As we flew southeast down the peninsula the San Diego Museum people, who are very familiar with this area, pointed out landmarks and interesting features to those who had not flown there before. At first we were over chaparral-covered hills, and could see the rugged crest of the Sierra de Juárez on our left and the seaport of Ensenada on our right. The country became more arid as we passed over the old mining town of El Alamo and Valle de la Trinidad, and we could see the north end of the Gulf of California (Sea of Cortez) to the east. Our route took us over the great range of the Sierra San Pedro Martir, which is an undulating forested plateau with an average elevation of more than 7,000 feet and one peak, La Encantada or Picacho del Diablo, which reaches 10,000 feet. Flying on, our course took us down the "backbone" of the peninsula. The mountains beneath us were arid but arroyo bottoms were sometimes lined with palm trees. The narrowness of the peninsula was apparent, with the islands of the Sea of Cortez visible on one side of the aircraft and the top of Isla Cedros rising above the Pacific fog on the other. We saw Bahía San Luis Gonzaga with its assort-

Figure 2. A chartered Lockheed Lodestar aircraft transported expedition personell from Tijuana to Loreto, and La Paz to Tijuana.

ment of brown islands, Bahía de los Angeles with Ballenas Strait and Isla Angel de la Guarda in the background, the volcanic Tres Vírgenes peak near Santa Rosalía, the great expanse of Bahía Concepcíon, and then the village of Loreto. We were happy to see the *Marisla* waiting as we "buzzed" the town to alert all four of its taxis to our need for their services at the airport. We landed at 1324.

The airplane was unloaded and taxis transported people and equipment to the dock, where Richard Adcock gave each of us a warm welcome and a cold bottle of beer, and introduced us to his vessel.

The *Marisla* is a houseboat built on a LCM hull. It is 60 feet long and has a 20-foot beam, and draws only three feet. Twin 671 GMC diesel engines provide a normal cruising speed of 10 knots. There are six double staterooms for guests, a galley, and owners' and crews' quarters in the cabin area. The pilot house, a large sundeck, and an open dining area are above. The *Marisla*

Figure 3. Baggage and equipment were unloaded in the landing strip at Loreto.

proved to be comfortable and admirably suited to our island work. Its shallow draft, great maneuverability, and sturdy steel hull made it possible to use the craft inshore and next to rocks where conventional vessels could not have ventured. Adcock had a crew of six; three men to operate the boats and equipment and three girls for the galley and housekeeping chores.

A 36-foot LCPR, equipped with a compressor for charging air tanks, and with other diving equipment, was used as a general utility boat. Its bow ramp facilitated landings, and when lowered into the water the ramp served as a diving stage. This boat was used constantly to transport personnel, service divers, make plankton hauls, and for other purposes.

Loreto is a picturesque and historic spot, the place where Jesuit Juan María Salvatierra established the first permanent California mission in 1697. The massive stone mother mission with its recently reconstructed tower dominates the village of modest houses, most of which are concealed in groves of date palms. We visited the mission and did final shopping while waiting for the Captain of the Port to complete our authorization to sail.

Departing from Loreto at 1750, we cruised south about 13 miles to the little land-locked harbor of Puerto Escondido, where we arrived at dusk. The inner harbor is about a mile long and a quarter of a mile wide. Its narrow entrance is only 75 feet wide, with a depth of nine feet at high tide, and the advantage of the *Marisla*'s shallow draft was demonstrated when Adcock cruised through without slowing, a thrilling experience.

Collecting started immediately, the same day most of us had left San Francisco. Sloan, Parrish, and Bandar were ashore with a light, looking for snakes and scorpions--and followed by cameraman Fuller and director Parker. From the boat we heard shouts ashore, and occasionally the brilliant light of Fuller's daylight floods indicated the chase was being filmed. Two Baja California rattlesnakes, *Crotalus enyo enyo*, and seven scorpions, *Hadrurus hirsutus*, and *Vejovis spinigerus*, were taken and their capture photographed. At the same time the launch took the divers to a rocky point off the outer harbor for night diving with lights. Many marine creatures, vertebrates and invertebrates, come out only in the dark. For example, *Dolabella californica*, a large opisthobranch mollusk, was common but was usually seen only at night.

Figure 4. Skipper Richard Adcock and the young ladies in charge of the galley watching Dick Banks prepare a study skin.

Figure 5. An aerial view of Puerto Escondido, which was our anchorage the first night.

*June 21. Puerto Escondido to Isla Danzante.*

Dawn revealed the beauty of our little "hidden harbor," backed as it was by the towering red cliffs and crags of the rugged Sierra Giganta. The east side of the bay was lined with mangroves and the west side with mud flats, then with a green line of *Allenrolfea occidentalis*, *Salicornia pacifica*, and *Laguncularia racemosa*, which gave way to the spiny trees and cacti typical of the Sonora Desert flora. Sloan, Banks, and Bandar were ashore at daylight. The divers were soon in, collecting and filming. Giant hatchet clams, or pinnas, *Pinna rugosa*, were collected for specimens and food. Some of these were fourteen inches long and were difficult to remove from the sand in which they were embedded. The mouth of the bay through which the tide raced was particularly rich in sea stars and other life, specimens of which were taken.

More than twenty-five species of starfish, sea urchins, and brittle stars were taken at Isla Danzante.

It was apparent that our Mexican colleague, Dr. Villalobos, had broad interests as he divided his time between marine and land collecting. At Puerto Escondido he first dove, then was ashore with an insect net, and next was collecting swimming crabs from the sand beach and moments later other crabs from the mangroves. Dr. Villalobos was a most enthusiastic and learned biologist and a fine companion.

For several of our people this was the first visit to southern Baja California, and they prowled through the thickets of desert plants noting the birds and other inhabitants of an interesting area.

At 1000 we had a short discussion of our general plans for the operations of the following ten days. then departed from Puerto Escondido and made the three-mile run to the northwest side of Isla Danzante. We anchored in a beautiful little cove with our bow secured to shore and a stern anchor which snubbed the vessel just short of touching. Water was so clear that when the launch drifted in at our side it appeared to be suspended in the air.

Divers were in the water immediately, and found this a most productive station for echinoderms. More than 25 species of starfish, sea urchins, and brittle stars were taken. Sorting trays filled with specimens covered more and more of the deck space of the *Marisla.*

Isla Danzante is a rough little island, only three and a half miles long and less than 500 feet high, and from the air it looks like a giant lizard. It was dry and land collecting was poor. Orr, Banks, and Bandar trapped but caught only six spiny pocket mice, *Perognathus spinatus seorsus.* Parrish, Muñoz, Marquardt, Sloan, and Lindsay collected after dark, finding only two scorpions, *Centruroides exilicauda,* some grasshoppers, camel crickets, and tubercular geckos. While waiting to be picked up on the beach we found isopods abundant and easy to capture, and bottled a large series of *Ligyda occidentalis.* No snakes have been reported from Isla Danzante, but Bandar found a fragment of a shed skin of a large snake while setting his traps. It was not collected at the time and he was unable to locate it the next day.

A thirty-gallon aquarium was set up on the large table which served as an all-purpose laboratory. Fishes were captured and held for observation and eventual shipment to San Francisco. The fish were taken with small hand nets, with "slurp guns" which sucked them into a chamber, with dip nets around a light at night, and with the chemical, quinaldine, which anesthetized them when introduced into the water. At Danzante four curious gulf jawfish, *Opisthognathus punctatus*, blennies which live in holes in the mud bottom with only their massive heads exposed, were taken, as were many other very colorful and interesting species. The capture of the expedition's only pipefish, *Doryrhamphus melonopleura,* which proved to be a record for this area, pleased Herald.

*June 22. Isla Danzante to Isla Carmen.*

The launch was sent to Loreto for ice and instructed to meet us at Bahía Marquer on the southwest side of Isla Carmen. Mammals and birds were skinned and prepared, other specimens were sorted and preserved, and our laboratory table had full use as we cruised to Carmen. We arrived at Bahía Marquer at 1000, just as the launch pulled in from Loreto.

Ashore there were tremendous deposits of fossils. While the marine biologists were diving, the land party worked up a steep-sided canyon which cut through the fossil-bearing strata. An endemic barrel cactus, *Ferocactus diguetii carmenensis*, bore red flowers, and there were many little *Wilcoxia striata* plants, rare little cacti which had pencil-thin stems and dahlia-like tubers. A native cotton, *Gossypium armourianum*, with its striking sulphur colored flowers, each petal of which bore a spot of red at its base, was one of the few plants in blossom. Another was *Pedilanthus macrocarpus*, a milky-juiced

Figure 6. The lowered low ramp of the launch made an excellent diving platform.

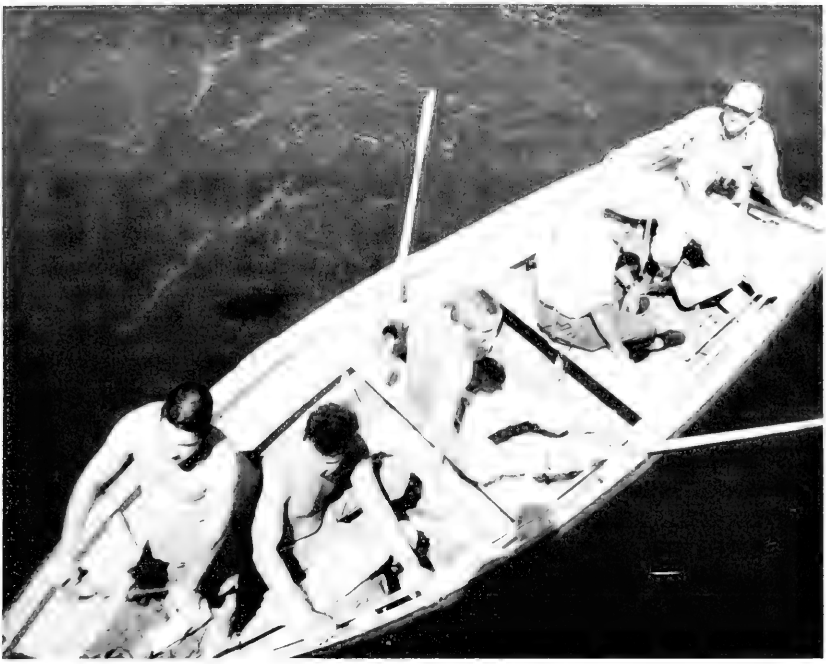

Figure 7. Expedition members Sloan, Bandar, Parrish, Villalobos F., and Orr return from an island.

succulent spurge with slipper-shaped red flowers. Fossils, a few plants, and some birds were collected ashore, and were prepared during the short run to the southern low-lying end of the island, where anchorage was made for the night.

The launch took the divers to a deep area off the north end of Isla Danzante, while the shore party worked the fossiliferous limestone flats of Isla Carmen. Pectens, rock oysters, and many types of gastropods were the most common fossils. Parrish collected nine specimens of four kinds of scorpions in decaying giant cactus; *Hadrurus hirsutus*, *Broteas alleni*, *Vejovis spinigerus*, and *Centruroides exilicauda*. Orr observed or collected ash-throated flycatchers, black-throated sparrows, ladder-backed woodpeckers, verdins, blue-gray gnatcatchers, white-winged doves, cardinals, oyster catchers, and Wilson's plovers. A large school of dolphins, *Lagenorhynchus* sp., passed during the afternoon.

The island was very warm and all hands took to the water as soon as they got back to the beach. The divers returned from Danzante with a big cabrillo which Adcock had speared at a depth of 125 feet, and which was cooked for supper. After dark, Sloan captured a spotted night snake of the genus *Hypsiglena*.

*June 23. Isla Carmen to Las Galeras and Isla Monserrate.*

Trapping was poor and only one white-footed mouse, *Peromyscus eremicus carmeni*, and two spiny pocket mice, *Perognathus spinatus occultus*, were caught--but one of Bandar's mousetraps held a large scorpion, *Hadrurus hirsutus!* About 0900 the *Marisla* was moved back to the northeast end of Isla Danzante, which the divers had found profitable the previous evening. The island ended abruptly in huge undersea cliffs. Tsegeletos filmed the colorful fishes and a large green moray eel, while Fuller recorded "Sally Lightfoot" and other crabs.

The great variety and beauty of the fishes and other marine animals, and of the marinescapes themselves, were in remarkable contrast to the sterile and forbidding cliffs above. Some of the divers worked the depths as two-man teams while others explored the fissures in the barely submerged rocks with only snorkel equipment. It was a fantastic place. Among the common starfish were *Acanthaster ellissi*, *Mithrodia bradleyi*, *Othilia tenuispina*, and *Oreaster occidentalis*. *Ophiocoma aethiops* and *Ophiocoma occidentalis* were abundant serpent stars. But two brilliant purple starfish were the rare *Leiaster teres*, which in 1941 was known from only three specimens. The genus has only six species, and *L. teres* is the only one from the eastern Pacific. Colorful bumpheads and parrot fish, and snake eels which looked like kingsnakes,

PHOTO BY BRUCE MARKHAM

Figure 8. A bottle-nosed dolphin jumping clear of the water near Las Galeras.

and little fish which looked like jewels against the brown algae and sargasso weed, held the attention of photographers and divers until we reluctantly departed toward Isla Monserrate at 1300, lunching enroute. We stopped at two rocks, Las Galeras, anchoring the *Marisla* in the shallow channel between. Frigate birds were soaring overhead as Wiggins, Sloan, Bandar, and Lindsay explored the eastern rock, which is seventy feet high, and Orr, Banks, and Parrish, accompanied by Parker and Fuller for film coverage, went to the lower western one. These were barren and desolate islets which in season are active bird rookeries. The divers found the area of little interest, but did capture a rare slipper lobster, *Evibacus princeps*, of the family Scyllaridae, as well as spiny lobsters, *Panulirus inflatus*.

As the launch picked up the shore party from West Galeras, a large school of jumping, bottle-nosed dolphins, *Tursiops*, passed--and the chase was on! The beautiful animals were in a particularly playful mood and jumped high out of the water, landing with great splashes on either side of the launch. It was a wonderul display of animal vigor.

We anchored off sand dunes at the north end of Isla Monserrate. The film crew again photographed Sloan and Parrish collecting rattlesnakes at night. Bandar bagged five specimens of *Crotalus ruber*. Ghost crabs, *Ocypode* sp., and land hermit crabs, *Coenobita* sp., wandered about springing mousetraps and startling biologists. Banks caught a pocket mouse by hand.

*June 24. Isla Monserrate to Isla Santa Catalina.*

A very brisk wind rose during the night and some equipment was lost overboard. The anchors were readjusted, and by morning the wind had abated and the sea was again calm. The terrestrial collectors were ashore early. Five traps held hermit crabs, but four specimens of *Perognathus* and one of *Peromyscus* were caught. Banks took the first speckled rattlesnake, *Crotalus mitchelli*, to be recorded from Monserrate, and the second king snake, the first having been collected by Curtis Croulet and Sloan in April, 1964. Banks and Wiggins each picked up a racer, *Masticophis flagellum*. The divers did general collecting until everybody was aboard and we departed on the 15-mile run to Isla Santa Catalina at 1030. Finback whales were observed in the distance. During the crossing Dick Adcock and Dr. Cortner lectured on the use of SCUBA equipment and the physiology of diving.

Isla Santa Catalina is about seven and one-half miles long, two miles wide, and is 1543 feet high. Its orientation is north and south. It is precipitous but good anchorages are to be found in coves. We went to the north end of the island, cruising close to the rocks to observe California sea lions which were sunning themselves. Villalobos, Wiggins, Sloan, Parrish, Fuller, Parker, and Lindsay were put ashore at a cobble spit on the northeast side of the island at 1230. Parrish found scorpion collecting excellent, getting nine specimens of three genera, *Broteas*, *Vejovis*, and *Centruroides*, from one decaying cardon. Spectacular giant barrel cacti, *Ferocactus diguetii diguetii*, some of which were more than ten feet tall, were photographed. Isla Catalina is the type locality of this largest of barrel cacti, which is endemic to a few Gulf islands. The clean and chic cardons, *Pachycereus pringlei*, were nearly spineless and carried quantities of large, bristly golden-colored fruit which looked like chestnut burrs. Some of these were split open, the rind curling back to reveal bright red flesh and glistening black seeds which were esteemed by white-winged doves and Gila woodpeckers.

Figure 9. Expedition members Wiggins, Villalobos F., Parrish, Sloan, Parker, Lindsay, and Fuller on Isla Santa Catalina.

By this time the divers were eagerly wading into the problems of fish identification. Although Herald had worked at many places in the Indo-Pacific, and Powell had worked in the upper Gulf, neither was familiar with the fauna of the entire Gulf, and its numerous endemic species. Tentative identifications were made of all fishes as they were brought aboard and tested for "aquarium toughness" in the shipboard tank.

While our land party was ashore, the *Marisla* returned the divers to the north end of the island to explore among the large rocks. Pelicans and brown boobies were abundant. The *Marisla* stayed in a cove on the northwest corner of the island until the shore party was picked up at 1430, then moved south a short distance to an anchorage where an arroyo gave access to the interior. A pod of perhaps fifty bottle-nosed dolphins escorted us on the way.

Cardon cacti in an arroyo on west side of Isla Santa Catalina.

Fruit of the cardon cactus, *Pachycereus pringlei.*

Figure 10. Chris Parrish found nine scorpions of three genera, *Broteus, Vejovis,* and *Centruroides,* in one decayed cardon cactus.

Sloan was particularly interested in collecting *Crotalus catalinensis,* the "rattleless rattlesnake," which is endemic to this island. Only four specimens were known, the holotype taken by Frank Cliff on the *Orca* cruise in 1953, two specimens taken on the Belvedere Expedition of the San Diego Natural History Museum in 1962, and one living specimen which Sloan collected while cruising with the *Gringa* in April, 1964. Bandar, Sloan, and Banks collected three more during the evening, as well as one specimen of *Hypsiglena torquata,* a spotted night snake taken on Isla Santa Catalina only once before. Banks shot a big-eared bat, *Plecotus townsendii,* for the first record from a Gulf island. Parrish found scorpion collecting good at the junction of the arroyo with the rocky hillside encountering those of *Broteas* under rocks and representatives of *Centruroides exilicauda* our running around.

*June 25. Isla Santa Catalina.*

Sloan collected five additional "rattleless rattlesnakes"! The first was found by Banks, coiled next to one of his mousetraps, where it was photographed by Wiggins. Sloan saw the second one under a *Pithecellobium* bush, and he than collected three more in a pile of brush under a large *Bursera* tree.

Figure 11. Lunchtime for the shore party on Isla Santa Catalina.

Sloan used a hand cultivator for searching through brush piles. It is an excellent tool. Lindsay picked up a second specimen of *Hypsiglena.* Three shed skins of *Crotalus catalinensis* were found under one bush. Sloan and Wiggins collected a long series of a live, endemic land snail, *Bulimulus johnstonii*, which was abundant under loose rocks and on the underside of logs.

Isla Santa Catalina has a fairly heavy vegetation cover. The cardon cactus, *Pachycereus pringlei*, barrel cactus, *Ferocactus diguetii*, sweet pitahaya, *Lemaireocereus thurberi*, senita, *Lophocereus schottii*, and sour pitahaya, *Machaerocereus gummosus*, form natural cactus gardens. Other typical plants are ironwood, *Olneya tesota*, palo verdes, *Cercidium microphyllum* and *Cercidium* sp., copals, *Bursera microphilla* and *B. rhoifolia*, jojoba, *Simmondsia chinensis*, and *Beleperone californica.* Near the beach the succulent *Abronia maritima* bore deep crimson flowers, and in the lower arroyos the desert poppy,

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Figure 12. A "rattleless rattlesnake," *Crotalus catalinensis*, which John Sloan collected on Isla Santa Catalina.

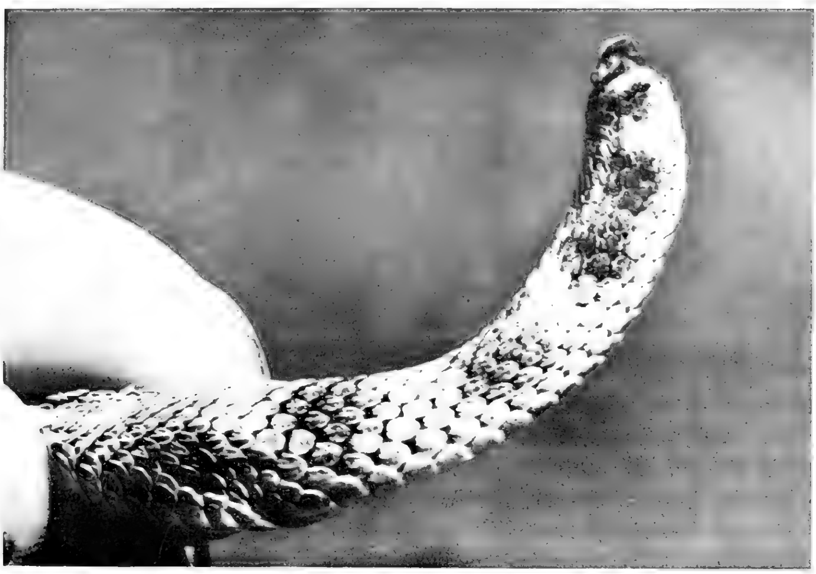

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Figure 13. The vestigial rattle of the "rattleless rattlesnake."

*Argemone* sp., was also in blossom.

Diving was excellent. A school of bottle-nose dolphins came into our cove. Two divers with cameras swam to join them, but the dolphins withdrew.

Figure 14. Dr. Alejandro Villalobos F. examining a giant barrel cactus, *Ferocactus diguetii diguetii*, at its type locality, Isla Santa Catalina. Cardons, *Pachycereus pringlei*, in the background.

The divers speared a large garropa and the sequence was filmed, then the fish was broiled over charcoal for lunch. This was a prolific spot for large fishes - amber jack, yellow tail, groupers to 300 pounds, golden cabrillo, and many others. Near the rocks there were many species of reef fish, parrot fish, wrasses, and others. In the bottom at intermediate depths were "forests" of burrowing eels which live in holes in the sand with only their heads and a few inches of their bodies exposed - all looking in the same direction. As a diver approached they sank out of sight, to reappear as soon as he passed. All attempts to anesthetize or dig out specimens were unsuccessful. The same experience was encountered later at Cabo San Lucas, and the reason is that this eel, whose exact identity is unknown at the moment, undoubtedly belongs to the pointed-tail ophichthid family, most of whose members can swim faster backwards in the sand than we less well endowed human beings can swim forwards. Dr. William Beebe, one of the first divers in the gulf area, described these phalanxes as "gardens of eels" in his volume on the *Zaca Venture* (1938). The Aquarium staff is currently working on an eel-dredge that will sneak up on these wary beasts faster than any skindiver; so if all goes well, Steinhart will eventually have this elusive eel on display for the first time. Night collecting was most interesting at Isla Santa Catalina. Many invertebrates, as well as such fish as squirrel fish, were noted at night only. One of the spectacular nocturnal invertebrates was the giant worm-like sea cucumber, *Euapta godeffroyi*, which was common and sometimes more than five feet long and three to four inches in diameter! A large nocturnal opisthobranch, *Dolabella californica*, was also collected.

We cruised down the west side of the island in the afternoon, anchoring for the night in a beautiful cove near the southern end. A metal meteorological tower seemed incongruous in that deserted region. There was also an abandoned shark fisherman's camp, with primitive shelters, turtle carapaces filled with salt, dried shark skins, and many carcasses of hammerhead and bonito sharks. Bandar caught another specimen of *Crotalus catalinensis*, making a total of nine of a rare reptile of which only four had previously been known. Parrish caught 30 scorpions in two hours, 16 of which were taken from one decaying cardon. Four western pipistrel bats, *Pipistrellus hesperus*, were shot at dusk. During the night the marine biologists collected in the littoral zone at low tide.

*June 26. Isla Santa Catalina to Isla Santa Cruz and Isla San José.*

The land party was ashore at 0600 and found only empty traps. Fuller and Parker filmed Sloan capturing a rattlesnake, and with Herald recorded the deserted shark camp. We were underway on the 20 mile run to Isla Santa Cruz at 0745. After breakfast the biologists prepared specimens and wrote up field notes. We arrived at Isla Santa Cruz at 1130, and anchored for an hour at the northwest end. Wiggins and Lindsay worked on shore while the others dove or swam. There were many fish and several interesting nudibranchs, two of which are apparently undescribed.

We passed Isla San Diego without stopping. Tsegeletos' new Bolex camera froze, and since it was our only underwater camera capable of fulfilling our requirements, we had decided to accelerate our schedule and try to have one flown from La Paz to Isla San José. Adcock contacted a yacht at La Paz by radio and attempted to make the arrangements. We arrived at Arroyo Aguada, on the northeast side of Isla San José, at 1645.

Parrish and Sloan captured two specimens of *Crotalus ruber* at the edge of a broad sandy arroyo which ran inland from the beach. Bandar captured one of *Crotalus mitchelli*, and Lindsay took a leafnose snake, *Phyllorhynchus decurtatus*, for an island record. Wiggins followed a fresh snake track to find a freshly dead example of the endemic brushrabbit, *Sylvilagus mansuetus*, which the reptile had apparently killed and was unable to swallow. The rabbit's skull was preserved, and additional specimens were taken. At dusk two bats, *Pipistrellus hesperus*, were shot by Orr and Parrish. Bandar spent the night on shore.

The divers found a good place to collect lobsters and got 16, most of which were broiled for dinner. Lobster shells thrown into the water attracted many four- to six-foot-long sharks, some of which were hooked but not landed. Villalobos headed a group which collected with dip nets around the night light and many small crustaceans were preserved.

**Figure 15. Fuller photographing squids, *Sthenoteuthis bartramii*, which Chivers and Powell had just netted near Las Animas. Bandar looks on.**

Figure 16. A young brown pelican, *Pelecanus occidentalis*, on Las Animas.

*June 27. Isla San José to Las Animas and Isla San José.*

At daybreak a school of active pilot whales passed just off the bow and were silhouetted against the red sky of pre-sunrise as they rose high out of the water. Pelicans dove repeatedly. Wiggins and Muñoz were ashore early collecting fossils from the cliffs and bluffs north of the landing beach. Some of the fossil strata were 20 feet thick and contained pectens, rock oysters, some sand dollars, and sea biscuits. Orr, Banks, Bandar, and Sloan took care of their traps and hunted for two and one-half hours before breakfast.

We departed for Las Animas at 0900 and the 11-mile run did not give sufficient time for most of the biologists to prepare their specimens. Nearing

Las Animas we saw a red swirl of disturbed water which contained a mass of squid, several of which were netted. The cephalopods appeared to be breeding and were being fed upon by fish. Their remarkable color changes from red to mottled to white and back again were photographed, and the animals were later identified as *Sthenoteuthis bartramii.* Although it has been taken from the mid-Pacific and has a wide distribution, it has apparently never been reported from the Gulf of California.

Las Animas is a group of whitewashed rocks, the largest of which is a few hundred yards long and ninety feet high. It is a rookery for pelicans and brown boobies, and abandoned nests and ambulatory checks indicated heavy use by the birds. We anchored in a beautiful cove after circling the rocks to observe California sea lions, but only eight animals were seen, five of which were adult males and three were subadult or females. Parrish and Wiggins found *Vejovis* and *Centruroides* scorpions and two lizards, *Phyllodactylus xanti* and *Urosaurus microscutatus.* A large finback whale surfaced near the islet and a marlin was observed jumping time after time. A huge school of "pargo lisa" or red snapper worked by the rocks, turning the water red. An adult bull sea lion swam by a school of several kinds of fishes with complete indifference, and in turn was ignored by the fish.

Figure 17. Bruce Marquardt and Francisco "Kiko" Muñoz watching Bob Orr pinning down mammal specimens.

The divers reported the area was extremely rich in fishes and invertebrates and the water was crystal clear. George Tsegeletos regretted that his camera was inoperable. A short-spined but very toxic urchin, *Toxopneustes roseus*, "bit" Dr. Villalobos in the palm of his hand, apparently with a single pedicellaria but it caused him considerable pain and his hand became discolored.

We took two turns around Las Animas for a final look at the sea lions and departed for the southwest side of Isla San Jose, where we anchored a short distance south of the mouth of the lagoon at Bahia Amortajada. Orr, Wiggins, Sloan, Banks, Bandar, Parrish, and Lindsay went ashore about one-half mile north of the lagoon at 1800 to set traps and collect. Parrish caught a huge scorpion, *Hadrurus hirsutus*, 6-5/8 inches long. This was a new record for the island and also presented Parrish with problems in its capture, because its tail was longer than his forceps and the animal was larger than his vials. Jets of vemon were ejected as it stabbed at the stick with which he held the animal down. Finally it was backed into a vial and secured. This specimen was nearly as large as those of *Pandinus imperator* of Africa, the largest scorpion, which reaches 7-1/4 inches.

Reptile collecting was good. Red rattlesnakes, *Crotalus ruber*, and several racers, *Masticophis flagellum*, were taken, as were geckos. Bandar also collected two beach skulls of false killer whales, *Pseudorca crassidens*, the seventh and eighth records from the eastern Pacific Ocean.

As usual, bats appeared and were hunted just at dusk. They are difficult targets for 22-caliber shot pistols. A fusilade of pistol shots, punctuated by an occasional blast of a shotgun, netted a big brown bat, *Eptesicus fuscus*, and two representatives of *Pipistrellus hesperus*, new records for the island.

Biting gnats, "no-see-ums" or "jejenes," were bad before the shore party was picked up at 2030, and were worse on the boat. Everybody had a miserable night and Tsegeletos and Parrish were ill as a result of the bites the next day. Reaction time varied with the individuals. Francisco Muñoz became covered with lumps five days later.

*June 28, Isla San José to Isla Cayo, Isla San Francisco, Isla Partida, and La Paz.*

We were up with the "jejenes" early. Orr, Banks and Bandar made a hurried trip ashore to pick up their traps, which contained a fair catch. We moved out to Isla Cayo, a rocky ridge about one-quarter mile long and 40 feet high, where the capture of fish-eating bats, *Pizonyx vivesi*, was filmed. The bats were found in crevices in cliffs over the water. A great number of purple martins, *Progne subis*, swooped about the cliffs and some were collected by Sloan for Banks, who found that the behavior of the birds and the gonadal condition of the males suggested that they were nesting, but this was not con-

Figure 18. Wright Cortner, Bruce Markham, and George Tsegeletos repairing their diving suits.

firmed. Martins are birds of montane forests or palm oases in Baja California and nest in holes in trees. Thus their presence on this tiny, treeless, guano-covered rock was surprising.

We moved south past Isla Coyote and its picturesque cluster of houses belonging to a large family of fishermen, then anchored for two hours in a beautiful cove at the southwest corner of Isla San Francisco. The usual collecting was carried on, then we cruised to and circled Los Islotes for Orr to reconnoiter the sea-lion herd he was to study later, and left Bandar and the launch in a cove on Isla Partida. Our efforts to arrange for the air delivery of a camera having failed, we proceeded to La Paz, arriving at 2100.

George Tsegeletos and Lindsay contacted Mr. William Curry who very generously loaned us his Bolex camera which fitted Tsegeletos' underwater camera box. The *Marisla* was watered and ice and coke were brought aboard. The biologists visited the town.

*June 29. La Paz to Isla Partida.*

We departed La Paz at 0200. The wind was up and the seas were rough, so we cruised up the sheltered east side of Isla Espíritu Santo and Isla Partida, to round the north end and anchor at 0615. Bandar came aboard with six mice, *Perognathus* and *Peromyscus*, three of which he caught in a single trap beside his sleeping bag. Orr was taken to Los Islotes, three rocky islets about one-half mile off the northern end of Isla Partida, to study the colony of sea lions there. Wiggins, Banks, and Parrish climbed an arroyo on Isla Partida to a large dry lake which was bordered with cliffs and *Ficus palmeri*, *Forchammeria watsonii*, and *Lysiloma candida*. They shot a "black" jack rabbit, *Lepus insularis*, for which islas Partida and adjacent Espíritu Santo are famous among mammalogists. Most of the biologists did marine collecting or underwater photography.

In the afternoon we cruised south along Isla Partida, looking for an anchorage from which a shore party could have easy access to the interior of the island. We passed up several attractive coves for one reason or another, and finally stopped for the night in a picturesque little bight in Isla Espíritu Santo, which Adcock called Bahia Cañon. Actually, it was a little box canyon with black basalt cliffs capped with red rhyolite. There were many caves, some of which were explored by Wiggins, who found metates, bones of small mammals and fish, and other evidences of human occupation. There were bat droppings and an accumulation of butterfly and dragonfly wings among the stones on the floor, but no bats were observed. Wild figs, *Ficus palmeri*, and stunted cacti grew on the cliffs.

The water was not clear, which disappointed the divers, and the land collecting was poor. Banks used a predator call on shore, because Adcock had seen a ring-tailed cat, *Bassariscus astutus*, at the end of the cove - but the lure did not work.

*June 30. Isla Espíritu Santo to Isla Partida, Los Islotes, and Espíritu Santo.*

The launch took Orr and Fuller back to Los Islotes to study and film the sea lion colony, and carried divers to work the north end of Isla Partida. The *Marisla* stopped at Bahía Candelero. Dr. Villalobos wanted to find *Berthelinia chloris*, a small bivalved gastropod that is associated with the seaweeds of the genus *Caulerpa*, which had been collected at that spot before by Adcock. Two species of *Caulerpa*, *C. sertularioies* and *C. racemosa*, were found, but no representatives of *Berthelinia*. There is a walled well or spring of fairly fresh water at the mouth of an arroyo behind the beach. Sloan had noticed that a pool below the spring held fish in April, so he collected several for Herald. They were an eleotrid species, *Dormitator latifrons mexicanus*, which are known to frequent brackish water. Sloan and Wiggins used snares to capture seven handsome turquoise-colored banded rock lizards, *Uta thalassina*. The walls of the canyon were of red rhyolite, and there were large cliff faces and caves, some shaded by wild fig trees. The lizards were quite tame, sitting on the vertical walls and watching us, or sometimes creeping or even darting away. Wiggins also collected a fine specimen of *Cnemidophorus maximus*.

The *Marisla* cruised to the north end of Isla Partida to meet the launch, which had picked up Orr and Fuller from Los Islotes. There Orr had noted fish-eating bats, purple martins, and made important observations of the large colony of California sea lions which inhabits the islet. At 1400 we started cruising down the east side of the island. At one point we stopped and George Tsegeletos, Bruce Markham, Wright Cortner, and Richard Adcock made a deep dive to 190 or 200 feet, bringing up magnificent gorgonians, a basket star, and a

Figure 19. John Sloan holding a banded rock lizard, *Uta thalassina*, which he noosed at Bahia Candelero.

Figure 20. Dr. Alejandro Villalobos F. examining a gorgonian which the divers collected at a depth of 190 feet.

large bass. We anchored for the night at La Bonanza, a large sandy-beached cove on the southeast side of Espíritu Santo. Sloan and Bandar went ashore for night collecting.

This chronicle would be remiss if mention were not made of International Pufferfish Day -- so declared by the divers in order that all underwater efforts could be directed to the capture of the elusive but attractive puffers. The usual reaction of these fishes to removal from the water is to blow up so that they are at least twice their normal size. Pufferfish do well in aquaria and concentrated efforts with small underwater collecting nets were made in order to accumulate sufficient numbers for shipment later to Steinhart Aquarium.

*July 1. Isla Espíritu Santo to La Paz.*

After the usual morning activities of shore collecting, some motion picture filming, and diving, we departed for La Paz. All personnel were busy packing equipment and collections. We arrived at La Paz at 1200. Sloan and Wiggins arranged to return to San Diego and San Francisco via an Aeronaves de Mexico flight that evening. Bruce Markham flew Bruce Marquardt and Dr. and Mrs. Wright Cortner to Tucson in his Aerocommander. He also took three carboys containing 61 living fish, representing 16 species, for shipment from Arizona to Steinhart Aquarium. The remaining members of the party offloaded their equipment and moved into Hotel La Perla.

Figure 21. Earl S. Herald.

*July 2. La Paz to Cabo San Lucas.*

Dr. Villalobos returned to Mexico City by air after arranging for the air shipment of his several boxes of specimens.

Herald, Powell, and Tsegeletos flew to Cabo San Lucas to sample the fish fauna there. Chivers was to have accompanied them but was ill and stayed in La Paz. Orr, Lindsay, Banks, Bandar, Muñoz, Fuller, and Parrish took two

Figure 22. Ira L. Wiggins.

taxis to Cabo San Lucas, driving through El Triunfo, San Antonio, San Bartolo, and stopping for lunch at Buena Vista, where we found Ted Hobson of the University of California at Los Angeles. He was investigating the behavior of groupers. In the afternoon we drove on to the village of Santiago, where we purchased a skin and skull of a mountain lion, *Felis concolor improcera*, which had recently been killed in the Sierra Victoria. We arrived at Cabo San Lucas and met the rest of our party at the new and comfortable hotel Hacienda Cabo San Lucas. There we were pleased to find Charles M. Bogert and William E. Old of the American Museum of Natural History.

At the Cape the divers fell in with a new breed of marine geologists -- these were thoroughly aquatic types from the Naval Electronics Laboratory in San Diego. Under Dr. Robert Dill, they were surveying the changes in the bottom topography and effects of underwater erosion. With their help as guides, the Academy divers quickly found the best diving spots and were amazed at the large schools of fishes which were mostly of the tropical Indo-Pacific fauna and not of the endemic Gulf fauna. An observation record of the long-nosed but-

Figure 23. Cabo San Lucas.

terfly fish, *Forcipiger longirostris*, proved to be a new record for the Gulf.

On the second day of diving a cold water mass moved into the Cape area with the surface temperatures dropping to 62 degrees, and below the thermocline 20 feet down, it was even colder. Of course, every aquarist known that tropical fishes cannot live at such temperatures -- and yet there they were -- alive and healthy. Steinhart Aquarium rules have now been rewritten!

*July 3. Cabo San Lucas to La Paz.*

The overland group departed from Cabo San Lucas at 1000 and drove up the west coast road to La Paz, where we arrived at 1600. The air party returned the same afternoon. Francisco Muñoz and Victor Manuel Corral arrived from Tijuana and met us at the hotel in the evening.

*July 4. La Paz to San Diego.*

Hundreds of pounds of equipment and luggage was transported to the La Paz airport in taxis, and Captain Muñoz's ingenuity was taxed to get it all aboard his Lodestar. We took off at 0835 and flew up the Sea of Cortez, so the islands and areas in which we had worked could be photographed. Arriving at Tijuana at noon, we were met by John Sloan with the San Diego Natural History Museum carryall. It was July 4 and the International Border Station at San Ysidro was crowded, but the courteous officials quickly inspected the few living plants we were importing and cleared our entry into the United States. Specimens were left at the San Diego Natural History Museum for truck shipment to San Francisco, and personnel boarded their plane for San Francisco. The Sea of Cortez Expedition was over.

## ACCOMPLISHMENTS

This was a short trip with only 11 days of actual collecting activity, most of which was highly selective. Those 11 days were productive in new information about the Sea of Cortez. For example, the marine invertebrate specialists, Dr. Alejandro Villalobos F., Dustin Chivers, Bruce Marquardt, and other collectors took more than 500 samples representing more than 250 species. Dr. Villalobos also collected land invertebrates and plants for his colleagues in Mexico.

Dr. Herald and David Powell ran 13 observation stations for fish, using both snorkeling and SCUBA gear. Again, many other biologists assisted the ichthyologists. Preserved specimens were returned to the Department of Ichthyology to aid in final species determination of the fishes sent alive from La Paz. Twenty-four of the 61 living fish died enroute because of a serious error of the airline carrier which allowed the shipment to remain on its San Francisco dock for five critical hours. The survey of fishes at Cabo San Lucas showed a tremendous variety of kinds which would be of interest to the Aquarium, and this area will be a practical source of living specimens and an area for study.

Important new mammalian records were obtained by Dr. Orr and Dr. Banks. There were extensions of ranges and the first records of bats on several islands. Valuable behavioral and life-history studies of California sea lions will be continued and correlated with similar studies on the Galápagos Islands off Ecuador and Año Nuevo Island near San Francisco. Few birds were collected but many were observed, and interesting new records will be published.

The snakes and lizards collected were especially significant because of Allan J. Sloan's current study of the herpetofauna of the islands of the Gulf of California. There were new records and possibly new taxa discovered, and new material for venom studies at the Academy and by Dr. Findlay Russell at Loma Linda University and the San Diego Zoo.

Chris Parrish is studying the scorpion fauna of the southwestern United States and northwestern Mexico, with particular emphasis on the islands of the Gulf of California and Baja California. This expedition provided an opportunity for him to make further ecological observations and collect, with the aid of his companions, 147 specimens, several of which were new records and possibly new taxa. Other terrestrial invertebrates were collected, particularly by Dr. Villalobos and Raymond Bandar, and were sent to specialists who are investigating the various groups.

Dr. Wiggins found botanical collecting poor because of extremely dry conditions on the islands. Still, he obtained new information not revealed during his previous field work, or that of I. M. Johnston and Reid Moran, in the same area. Dr. Wiggins did much general collecting, sampling fossil deposits, getting reptiles, and was a very heavy contributor to the scorpion survey.

The opportunity to work the Sea of Cortez with the cooperation and interest of his fellow biologists in the same or other fields was of value to every one of the participants. A scientific investigation of this sort is indeed a cooperative effort, and the spirit and interest on our little trip was exceptionally fine. We were very fortunate that Dr. Alejandro Villalobos, our friend and Mexican colleague, was with us. And the opportunity to associate with biologists working in the field was excellent for our two teen-age participants, Bruce Marquardt, who is particularly interested in marine work, and Francisco Muñoz. These youths were a real asset and their hard work and enthusiasm added to the whole results. Mr. Bruce Markham of Pocatello, Idaho, a Sustaining Member of the Academy, and Dr. and Mrs. Wright Cortner of Tucson, Arizona, were guests of Mr. Adcock, and aided the work of the biologists.

## ACKNOWLEDGMENTS

The Belvedere Scientific Fund provided a grant of $3,000 for logistic expenses of the Sea of Cortez Expedition. Mr. Roy E. Marquardt gave $2,000 which was used for the charter of the *Marisla*. Mr. Richard M. Adcock reduced his normal charter rates as a gift to the Academy. The Expedition Fund of the California Academy of Sciences, and some of the participants, covered the other expenses of the trip.

The salaries of scientific personnel were paid by their respective institutions. Chris Parrish's scorpion investigations have grant support from the American Association for the Advancement of Science and the California Academy of Sciences.

Marine investigations were under permits granted by Biol. Rodolfo Ramirez Granados of the Direccíon General de Pesca e Industrias Conexas, de la Secretaría de Industria y Comercio. C. Dr. Enrique Beltrán, Subsecretario de Agricultura y Ganadería, personally arranged for permits to collect plants and for additional courtesies from his offices. C. Dr. Rodolfo Hernandez Corzo, Director General de Caza de la Secretaría de Agricultura y Ganadería, issued the permits to take land animals. The generous and interested cooperation and help of the above gentlemen, officials of the Government of Mexico, is greatly appreciated.

# PROCEEDINGS

OF THE

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# NEW SPECIES OF PLANTS FROM BAJA CALIFORNIA, MEXICO


BY

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Five new species of flowering plants native in Baja California are described in this paper. The first three were collected during field trips financed by the Belvedere Scientific Fund, through the generosity of its founder and president, Mr. K. K. Bechtel.

One of the other two, a species of *Encelia*, was collected by Dr. Peter H. Raven, who provided me with field notes and his personal evaluation of the taxon and permitted me to study and describe it. The new species of *Tanacetum* was collected nearly twenty years ago while on a field trip into the Sierra San Pedro Martir with Dr. Albert M. Vollmer, who financed the expedition and personally helped with the chores of collecting and pressing specimens during our stay in the field. It is a real pleasure to acknowledge the help extended by these gentlemen and to thank them, individually and collectively, for their interest, aid, and encouragement.

The types of the species here described are deposited in the Dudley Herbarium at Stanford University, California.

**Dalea bechtelii** Wiggins, sp. nov.

(Plate 13, figures 1-9.)

Planta annua, erecta vel 2-6 ramis ascendentibus, 1-3.5 dm. alta, inflorescentibus exceptis glaber leviter glaucaque; ramis teretibus, gracilibus, 0.5-1.5 mm. diametro; foliis imparipinnatis, 2.5-4 mm. latis, 2-6 cm. longis, foliolis 21-41, lateralibus oppositis, orbicularibus vel late obovatis, integris vel apice emarginatis, 1-2 mm. longis, crassis, foliolo terminali libri, lanceolato, 2-5 mm. longo, apice acuto, basi rotundato; stipulis subulatis, 1.5-2.5 mm. longis, fragilibus, caducis; inflorescentibus terminalibus spiciformibus, sub fructu 1-6 cm. longis, 6-8 mm. diametro, dense hirsutis, bracteis lanceolato-ovatis, 1-1.5 mm. longis, inter glabris, extus hirsutis et 6-10 glandulos ellipticos ferens; calyce 5-lobata, lobis anguste lanceolatis vix 4 mm. longis, attenuatis, extus hirsutis glandulosisque; petalis caeruleis, caducis, vexilo flabelliformi, 2 mm. longo, basi tubo staminum inserto; petalis alarum carinarumque circa apice tubo staminum insertis; staminibus 9, equalibus; fructu 2.5-3 mm. longo, parce hirsuto glandulosisque; semine solitario.

Slender, ascending to erect annual 1-3.5 dm. tall, glabrous, slightly glabbrous, slightly glaucous; stems 0.5-1.2 mm. in diameter, often somewhat zigzag, internodes 1-3.5 cm. long; flowering scape to 1 dm. long; leaves lance-linear in outline, pinnately compound, 2.5-4 mm. wide, 2-6 cm. long; petiole slender, 5-25 mm. long; leaflets 10-20 pairs, plus a longer, lanceolate, terminal one, lateral leaflets orbicular to broadly obovate; 1-2 mm. long, entire or faintly emarginate, glabrous, subsessile; terminal leaflet linear-lanceolate, 2-5 mm. long, acute; rachis bearing a circular, subpunctate, dark reddish to nearly black gland between each of the lower 3-8 pairs of lateral leaflets; stipules narrowly subulate, 1.5-2.5 mm. long, reddish to brownish, fragile; inflorescence a dense, spike-like raceme 1-6 cm. long, 6-8 mm. in diameter, with many crowded flowers, each flower axillary to a narrowly lance-ovate, caducous, green, densely hirsutulous bract 1-1.5 mm. long, its margins beset with several reddish, subulate, gland-tipped teeth; pedicels yellowish, about 0.5 mm. long; calyx about 4 mm. long, equally and deeply 5-lobed, the lobes linear-lanceolate, hirsute externally, with 6-10 elliptic to linear yellowish glands more or less paired between the costa and the margins of each lobe, toothed like the bracts; corollas blue near tips of petals, whitish or cream

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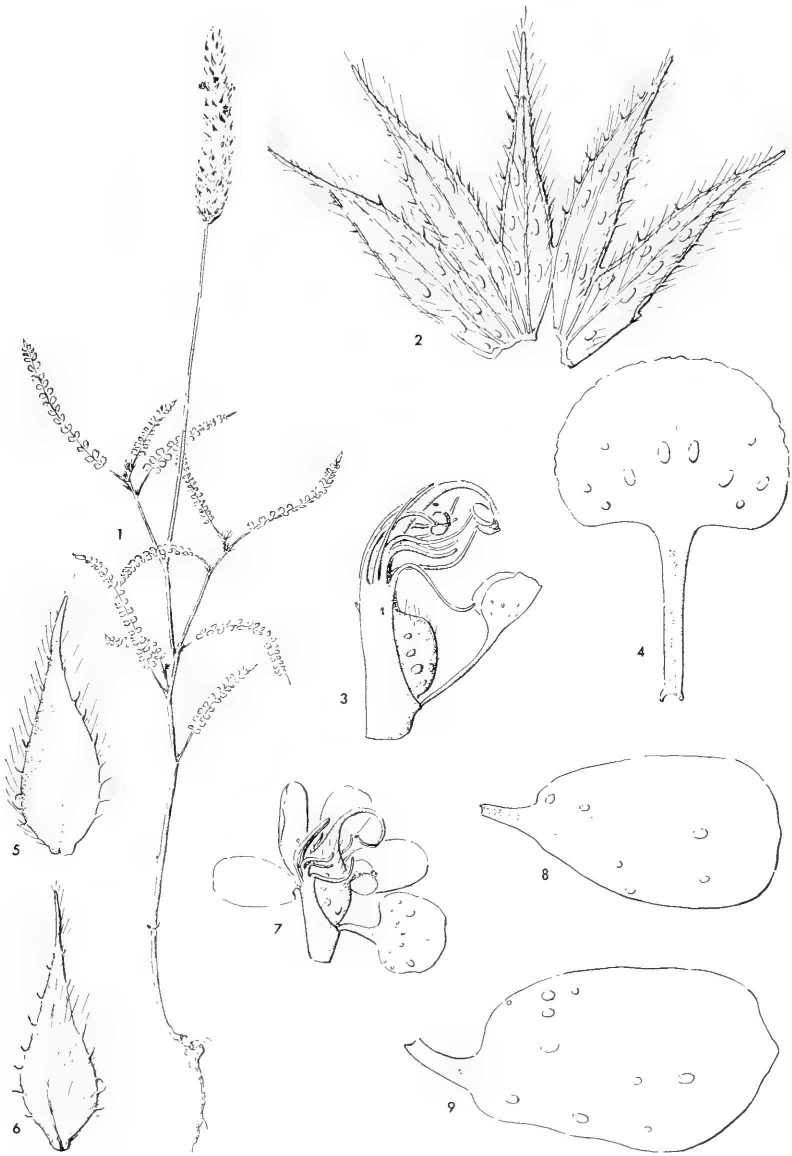
PLATE 13

Figures 1-9. *Dalea bechtelii*, sp. nov.

Figure. 1. Habit of plant, × ½. Figure 2. Calyx, split and spread out, × 10. Figure 3. Staminal tube, ovary, and banner, × 10. Figure 4. Banner, × 25. Figure 5. Bract, adaxial surface, ×10. Figure 6. Bract, abaxial surface, ×10. Figure 7. Flower, with calyx removed, × 10. Figure 8. Wing petal, × 25. Figure 9. Keel petal, × 25.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near the base; banner flabelliform, inserted at base of staminal tube, its claw about 1.5 mm. long, blade 1.2-1.4 mm. wide, about 1 mm. long, with 8-12 circular to oblong glands evenly distributed across the lower one-half of the blade; wings and keel petals inserted near apex of staminal tube, short-clawed, blue, gland-dotted; stamens 9 (rarely 10), nearly equal, curved upward around style; legume 1-seeded, indehiscent, about 2.5-3 mm. long, sparingly hirsute, gland-dotted near both dorsal and ventral sutures; seeds brownish, smooth and shining, 1.2-1.5 mm. long.

Holotype. On rocky slopes at Santispaquis Cove, Bahía de la Concepción, Territorio del Sur, Baja California, Mexico, *Ira L. Wiggins* and *Dorothy B. Wiggins, 17,985,* 18 October, 1962 (Dudley Herbarium, Stanford University, No. 508,795).

In the keys in the *Flora of the Sonoran Desert* this species would key out to *Thornbera pringlei,* but that species is perennial, has much more conspicuously glandular-punctate leaflets, and larger flowers. *Dalea bechtelii,* furthermore, has considerably smaller leaflets and much smaller bracts than one finds in *T. pringlei.*

It is agreat pleasure to name this beautiful little *Dalea* in honor of Mr. Kenneth K. Bechtel, whose interest in the plants and birds of Baja California has lead him to support a number of field expeditions into the peninsula, and to finance publication of the results of many papers dealing with the area's biota.

**Euphorbia taluticola** Wiggins, sp. nov.

(Plate 14, figures 1-17.)

Planta annua, repens, tota pilis albidis puberulentibus; caulibus ramulisque gracilibus, 0.6-1.5 mm. diametro, 5-25 cm. longis; internodiis 0.5-3 cm. longis; stipulis interpetiolaribus, minutis; foliis anisomeris, oblongis rotundatisve, rubro-maculatis, cum petiolo vix 0.4 mm. longo; cyathiis subsolitariis, ob internodi a abbreviata sub apices sat congestis, anguste, campanulatis vix 1.5 mm. longis, albidis puberulentibus; glandulis 4, reniformibus, 0.3-0.4 mm. latis, purpurescentibus vel nigrescentibus, exappendiculatis; staminibus 8-32; ovario rotundato-ovato, 1.2-1.8 mm. longo, hispidulo, deflexo, albicante; capsula 1.8-2 mm. longa, tota puberulenta; semine carinato-ovoideo, 0.8 mm. longo, maturo pallide brunneo-rubicundo, facie quisque cum 3-4 foveis minutis.

Prostrate annual from a slender taproot 5-20 cm. long; branches 5-25 cm. long, 0.6-1.5 mm. in diameter, branching at most of the nodes; internodes to 3 cm. long; stipules lance-acicular, about 0.5 mm. long, obscured by white, coarse, subappressed hairs; petioles very short, mostly 0.2-0.4 mm. long, rarely to 1 mm. long; leaf blades subfleshy, broadly oblong, 2.5-4 (6) mm. wide, 3-8 (12) mm. long, markedly reddish purple and bearing a median spot and several to many small, dark reddish to liver-colored spots on the upper, or both surfaces, moderately puberulent with subappressed, white, obliquely curved hairs 0.2-0.3 mm. long; base of blade asymmetrical; cyathia usually solitary, each on a short, stoutish peduncle, obovoid, about 1.5 mm. long at anthesis, densely appressed-puberulent with shining, white, relatively coarse hairs similar to those on the leaves, but more closely crowded; glands 4, narrowly reniform, about 0.4 mm. wide, without appendages, very dark purple to nearly black, often slightly crateriform; ovary ovoid, 1.2-1.8 mm. long, densely white-puberulent, conspicuous, early exserted, bent downward sharply on a pedicel slightly exceeding the cyathium; stamens in 2-4 groups of 4-8 in each group, about equaling or barely exceeding the lip of the cyathium, 1-3 narrowly lanceolate bracts 0.6-0.8 mm. long inserted at base of each group of stamens; capsule ovoid, about 2 mm. long, reddish, pubescent; seeds ovoid, about 0.8 mm. long, acute at the apex, obscurely triangular in cross section, with 3-4 rows of shallow pits encircling each seed, the testa reddish brown, microscopically pappilate, not becoming gelatinous when wetted.

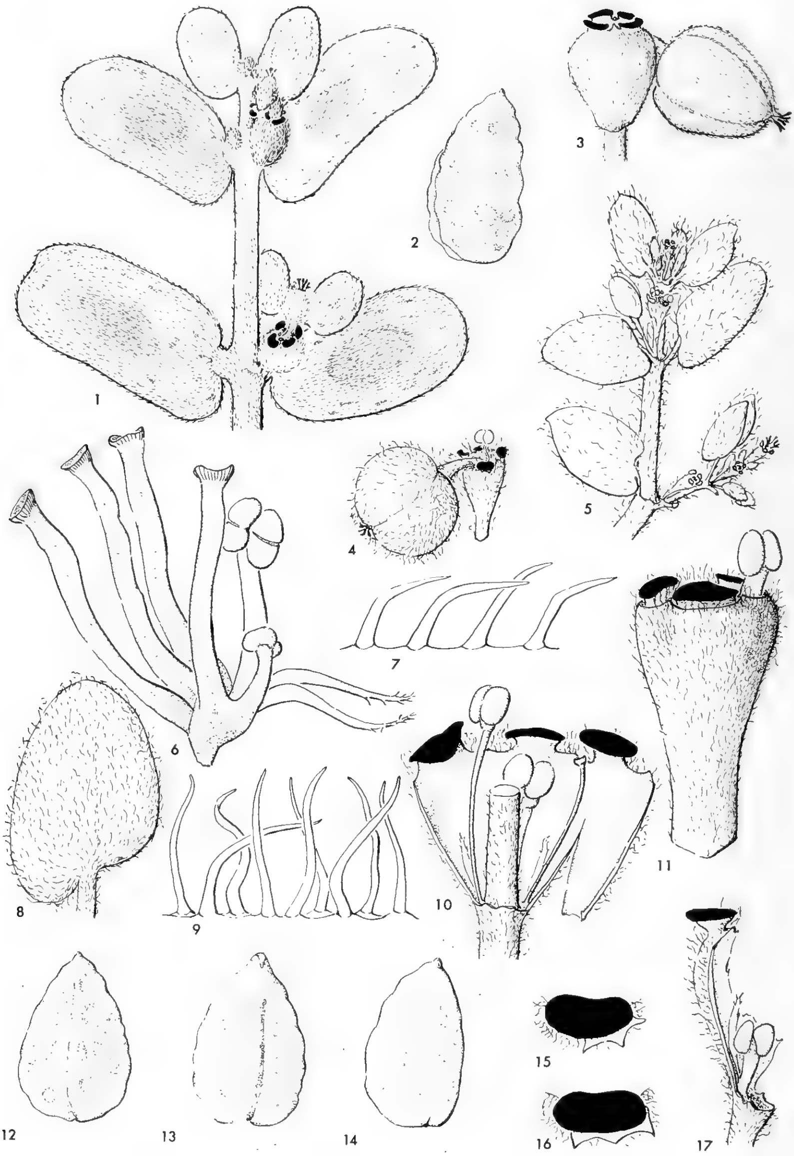
HOLOTYPE. Talus slope about 1 mile east of Punta San Ignacio, east of Punta San Ignacio, east shore of Bahía de la Concepción, Territorio del Sur, Baja California, Mexico, *Ira L. Wiggins* and *Dorothy B. Wiggins, 18,036,* 19 October 1962 (Dudley Herbarium, Stanford University, No. 508,796).

Similar to *Euphorbia petrina* S. Watson, but differing from that species in its larger, oblong instead of ovate leaves (Compare plate II, figure 1 with figures 5-6); in the coarser, simply curved instead of crinkly hairs (plate II, figures 1, 3, 4); in the absence of appendages on the involucral glands (some glands in *S. petrina* bear small appendages; see plate II, figures 15-16); in the larger number of stamens in each group and in the whole cyathium in *E. taluticola*; and in the absence of gelatinous sheaths around the seeds when wet in *E. taluticola* (plate II, figure 2) in comparison with the conspicuous gelatinous sheath developed when seeds of *E. petrina* are moistened (plate II, figures 12, 13). The peculiar color and spotting on the leaves of *E. taluticola* is striking, although probably of little or no significance in this group of species.

**Cynanchum mulegensis** Wiggins, sp. nov.

(Plate 15, figures 1-11.)

Suffrutex volubilis gracilis, caulibus 0.5-2 mm. crassis, tamdiu 5 m. longis pallido-viridibus vel purpurescentibus pallido-glaucisque; ramis novellis 0.5 mm. crassis, parce hirsuto-puberulentibus mox glabris; foliis oppositis, linearibus, deflexis, 0.5-2 mm. latis, 2-5cm. longis, parce hirsutis mox glabris, cum odore injucundo; floribus solitariis, vel 2-3 in pedunculo brevi, pedicelis gracilibus, 1.5-3 mm. longis, sub fructu 2-5 mm. longis; calyce 5-lobato, lobis ovatis, acutis vel breve attenuatis; lobis corollae lanceolatis, 1-1.5 mm.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latis, 4-5.5 mm. longis, virido-luteis, margine virido-brunneis, toto glabris; corona 5-lobata, lobis subcarnosis, erectis, albido-luteis vix 2 mm. altis; appendicibus staminum incurvis ovatis, 0.2 mm. latis longisque, hyalinis; corpatro-purpurascentibus; folliculis fusiformibus, 6-8 mm. crassis, 8-22 cm. longis, pallide viridibus, brunneo-purpurascentibus maculatis, glabris; seminibus 1.5-2 mm. latis, 6-7 mm. longis; coma argenteo-alba, ca. 3 cm. longa.

A slender, twining vine forming dense masses over rocks and shrubs; stems to 5 m. long, dying back almost to the ground in unfavorable seasons; branches 0.5-1 mm. in diameter, pale green to purplish, faintly glaucous, sparsely hirsutulous when young but soon glabrate; internodes 3-6 cm. long; leaves opposite, linear, 0.5-2 mm. wide, 2-5 cm. long, sparsely hirsutulous, soon glabrate, slightly to strongly deflexed, all herbage with a strong, unpleasant odor when crushed; flowers solitary or sometimes 2-3 on an axillary peduncle, the latter about 1 mm. long, subtended by a linear-lanceolate bract about as long as the peduncle; pedicels slender, 1.5-3 mm. long at anthesis, 2-5 mm. long in fruit; calyx shallowly cup-shaped, 5-lobed, 2-3 mm. in diameter, the lobes ovate, acute to short-attenuate, 1-1.5 mm. long, sparsely appressed-hirsutulous, soon glabrate; corolla lobes ascending-spreading, lanceolate, 1-1.5 mm. wide, 4-5.5 mm. long, pale yellow, tinged along margins and on outer surface with greenish brown, glabrous; corona 5-lobed, subfleshy, erect, yellowish, about 2 mm. high, one-fourth as wide; anthers united into a conical columella about 1.5 mm. in diameter at the base, 1.8-2 mm. high; appendages alternating with the corpusculi, incurved over the columella, ovate, about 0.2 mm. wide, slightly longer than wide, hyaline; corpusculi erect, dark purple to black, attached to pollinia by translators attached about one-third of the distance from base to apex of corpusculum, slanting downward slightly to the broadly obloid pollinia; follicles slenderly fusiform, 5-6 mm. in diameter, 8-12 cm. long, pale green, irregularly maculate with purple or brownish purple, glabrous; seeds strongly flattened, 6-7 mm. long, 1.5-2 mm. wide, truncate; coma silvery white, silky, about 3 cm. long.

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PLATE 14

Figures 1-17. *Euphorbia taluticola*, sp. nov., and *Euphorbia petrina* S. Watson.

Figures 1-3; 6, 7. *Euphorbia taluticola.* Figure 1. Flowering branch, dorsal surface, × 5. Figure 2. Seed, × 50. Figure 3. Cyathium with young fruit, ×10. Figure 6. Staminate flowers, ×25. Figure 7. Hairs from surface of leaf, ×50.

Figures 4, 5; 8-17. *Euphorbia petrina.* Figure 4. Cyathium with ovary and stamen, × 10. Figure 5. Flowering branch, dorsal surface, ×5. Figure 8. Leaf, ×7½. Figure 9. Hairs from surface of leaf, × 50. Figure 10. Involucre split to show stamens, × 25. Figure 11. Cyathium and 1 stamen, × 25. Figures 12-14. Dorsal, ventral, and lateral views of seed, with gelatinous coat that develops when moistened, × 25. Figures 15, 16. Glands and appendages, × 30. Figure 17. Part of involucre of cyathium and staminate floret, × 25.

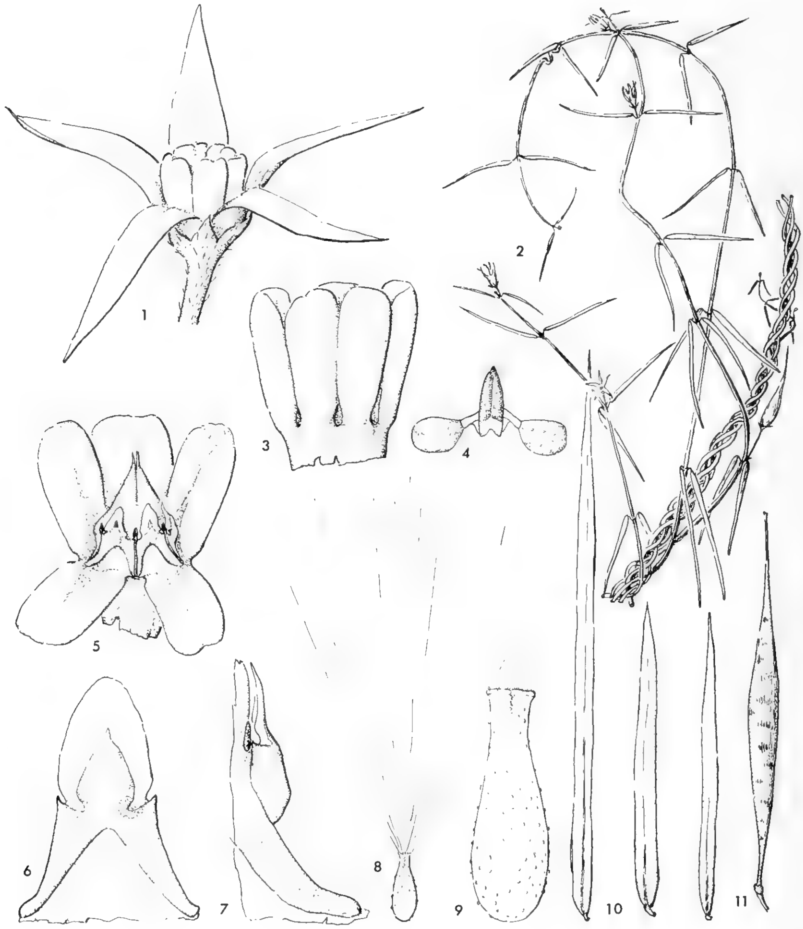



PLATE 15

Figures 1-11. *Cynanchum mulegensis,* sp. nov.

Figure 1. Flower, × 5. Figuıe 2. Habit of plant, × ½. Figure 3. Corona detached from rest of flower, × 10. Figure 4. Pollinia and translators, × 50. Figure 5. Interior of flower with nearer corona lobes turned downward, × 10. Figure 6. Segment of columella and appendage, dorsal view, × 25. Figure 7. Segment of columella and appendage, lateral view, × 25. Figure 8. Seed and coma, × 1½. Figure 9. Seed without coma, × 5. Figure 10. Representative leaves, × 1½. Figure 11. Mature follicle, × ½.

HOLOTYPE. On shrubs and clambering over rocks just below lighthouse, at mouth of Estero Mulegé, Territorio del Sur, Baja California, Mexico, *Ira L. Wiggins* and *Dorothy B. Wiggins*, *18,085*, 21 October 1962 (Dudley Herbarium, Stanford University, No. 508,797).

This is unlike any other *Cynanchum* known to me. A few years ago I would have placed it in *Metastelma*, but since Woodson and Holm have investigated a number of the milkweeds and combined several groups once considered distinct genera, I defer to their judgement and place it in *Cynanchum*. *Cynanchum mulegensis* is unusual in having completely glabrous corolla lobes, in the size of the flowers, which are considerably larger than most of those in the old *Metastelma* group, and in the very narrow, strongly deflexed leaves.

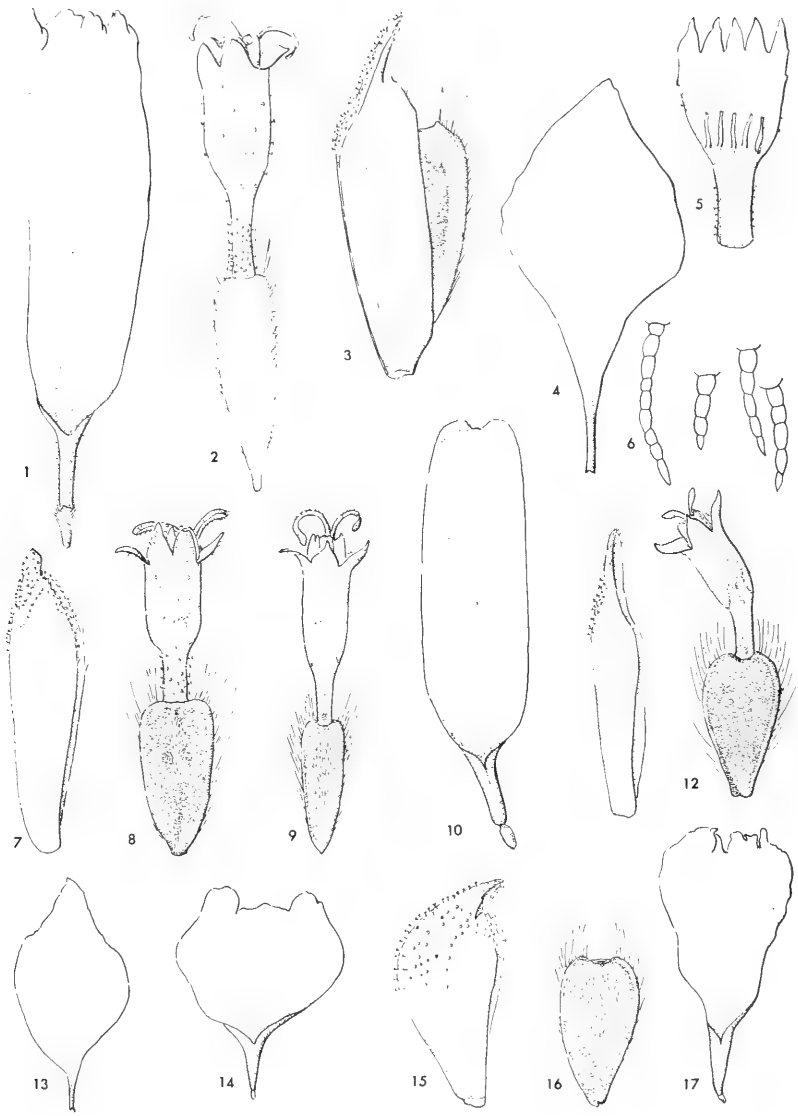
It seems appropriate to name it for the pleasant Mexican village near which the type collection was made.

**Encelia ravenii** Wiggins, sp. nov.

(Plate 16, figures 1-6.)

Frutex rotundatus, 2-6 dm. altus, ramis procumbentibus 2-6 dm. longis ad apicem dense foliatis, ramis novellis dense lanato-tomentosis; foliis numerosis, petiolis gracilibus, 1-1.5 cm. longis, lamina ovata, 1-3 cm. lata, 2-4.5 cm. longa, trinervia, acuta, basi late cuneata vel rotundata, margine integra, minute albido-pubescenti, maturata minute puncticulato-glandulosa; pedunculo 1.2-2 mm. crassa, basi glabra sub capitula glanduloso-puberulenti, 1-2.5 dm. alto; capitulis ad apicem ramorum solitariis; involucro 1.5-2.5 cm. diametro, 10-12 mm. alto; phyllaribus 3-4 seriatis, 1-2 mm. latis, lanceolato-attenuatis, valde curvatis, marginibus basi dense stipitato-glandularibus, parce pilosis, exterioribus 5-7 mm. longis, intermediis gradatim imbricatis, intimis 12-15 mm. longis, apice acutis vel attenuatis, omnibus margine leviter ciliatis; paleis receptaculis numerosis, naviculatis, 1.5-2 mm. latis, 7-8 mm. longis, carina glanduloso-puberulenti; floribus ligulatis 15-20, ligulis albis, 5-6 mm. latis, 2-2.5 cm. longis, apice vadose trifidis, intus glabris, extus lamina tubique parce stipitato-glandularibus, tubo 3.5-4 mm. longo; seminibus florum ligulatorum abortivis; floribus discoideis numerosis, actinomorphis, flavis, tubo 1.2-1.5 mm. longo, lobis ovalis, acutis, atroflavis; achaenia brunnei vel fusca, oblongo-ovata, 1.5-2.5 mm. lata, 5-6 mm. longa, marginibus valde hispidis, pilis erectis; pappi nullo.

Low, rounded semishrub 2-6 dm. tall, with spreading to procumbent branches 2-6 dm. long, cinereous with closely appressed, dense puberulence of simple, white hairs; tips of branches turned upward, each terminated by a simple scape 1-2.5 dm. tall;. leaves numerous, crowded near tips of branches, petioles slender, 1-1.5 cm. long, blades broadly ovate, 1-3 cm. wide, 2-4.5 cm. long, broadly cuneate at the base, acute at the apex, prominently 3-nerved,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minutely and densely appressed-puberulent, whitish on both surfaces, numerous small, globular, golden-yellow glands showing through puberulence in age; scapes 1.2-2 mm. in diameter, finely glandular-puberulent on the upper one-fourth to one-third, glabrate or nearly so below, stramineous to reddish in youth; involucres low-hemispherical, 1.5-2.5 cm. in diameter at anthesis, 10-12 mm. deep; involucral bracts dark green, in 3-4 series, narrowly lanceolate-attenuate, 1-2 mm. wide, outermost 5-7 mm. long, progressively longer, innermost 12-15 mm. long, strongly curved, their margins ciliate-pubescent near the base, densely glandular with sessile to stipitate glands, and with a few coarse, whitish hairs scattered near base; ray florets about 15-20, ligules spreading, white to pale cream, 5-6 mm. wide, 2-2.5 cm. long, 10-nerved, irregularly and shallowly trifid at the apex, glabrous on the inner surface, sparsely stipitate-glandular on the outer surface and along the veins of the slender tube, the latter 3.5-4 mm. long; ray achenes abortive, triangular in cross section, 2-3 mm. long, closely hirsute on the angles, hirsutulous along midline of outer face, glabrous on inner face; chaffy bracts subtending disk florets naviculate, 7-8 mm. long, 1.5-2 mm. wide from back to front, slightly attenuate above, glabrous on the lateral faces, glandular-puberulent on terminal part of keel, yellowish; disk florets many, tube 1.2-1.5 mm. long, broadening abruptly into the tubular throat, this 3-4.5 mm. long, pale cream; corolla lobes of disk florets 5, ovate, acute, 0.5-0.7 mm. long, deep yellow, spreading only slightly at anthesis, markedly thicker than tissue of throat, microscopically papillate along the edges; tips of anthers cartilaginous, erect, narrowly triangular-ovate, acute, dark yellow; style branches narrowly oblanceolate, about 1.5 mm. long, sparsely hispidulous with stiff, blunt hairs along the inner face, stipitate-glandular elsewhere; achenes very thin, pale yellowish brown at maturity, oblong-obovate, 1.5-2.5 mm. wide, 5-6 mm. long, with a fringe of upward-

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PLATE 16

Figures 1-17. *Encelia ravenii,* sp. nov. and other species.

Figures 1-6. *Encelia ravenii.* Figure 1. Ray floret, × 2½. Figure 2. Disc floret, × 5. Figure 3. Receptacular bract, partially enclosing achene, × 5. Figure 4. Leaf, × 1. Figure 5. Disc corolla split and spread open (anthers removed, but filaments in place). × 5. Figure 6. Hairs from abaxial surface of ligule, × 50.

Figures 7-8. *Encelia virginensis* var. *actonii.* Figure 7. Receptacular bract, × 5. Figure 8. Disc floret, × 5.

Figures 9-11. *Encelia californica.* Figure 9. Disc floret, × 5. Figure 10. Ray floret, × 5. Figure 11. Receptacular bract, × 5.

Figures 12-17. *Encelia farinosa.* Figure 12. Disc floret, × 5. Figure 13. Leaf, × 1. Figures 14, 17. Ray florets, × 2½. Figure 15. Receptacular bract, × 5. Figure 16. Achene, × 5.

ly pointing stiff hairs along each margin, faces sparsely beset with slender hairs near the mid line; pappus none.

HOLOTYPE. Rocky wash 16.5 miles north of San Felipe, Baja California del Norte, Mexico, *Peter H. Raven, 14,788,* 22 February 1960 (Dudley Herbarium, Stanford University, 508,798).

*Encelia ravenii* is similar in habit to *E. californica,* but its leaves are larger and more densely white-puberulent than those of *E. californica.* It is distinctive in its dense, procumbent habit, the crowding of the leaves at or near the tips of the branches; in having white rays (which turn cream in drying) that at 2-2.5 cm. long (fully twice as long as average rays in *E. farinosa* ---compare plate 16, figure 1, with figures 14, 17); in having stipitate glands intermingled with glandless hairs on the abaxial surface of the ligules of the ray florets. It differs from *E. californica* further in having non-branching scapes, each of which bears a solitary head, and in having yellow instead of purplish disk florets. It resembles *E. virginensis* subsp. *actonii* in the 1-headed scapes, but differs from that taxon in having more silvery leaves, slightly larger, more acute receptacular bracts, and considerably longer and more slender disk florets and achenes (compare plate 16, figure 2 with figure 8).

**Tanacetum martirensis** Wiggins, sp. nov.

(Plate 17, figures 1-12.)

Herba perennis, radice simplice vel ramoso, ramulis paucis vel numerosis, prostratis, 1-5 cm. longis; foliis ad apice ramulis brevis congestis, flabelliformibus, 1.2-4 cm. longis, prope apicem utroque 1-5 lobatis, lobis oblongis, 1-2 mm. latis, 1.5-8 mm. longis, cinereo-hispidulis; capitula discoidea ad apice rami solitaria; involucro 7-12 mm. diametro, 5-7 mm. alto, late campanulato; phyllaribus 3-4 seriatis, 1.4-2.2 mm. latis, 4-6 mm. longis, apice rotundatis vel acutis, externis dorso viridibus vel brunneis, parce vel dense hirsutulosis, glandularibus, intimis basi glabris eglandularibusque; corolla 4.5-5 mm. longa, faucibus 1.2-1.4 mm. diametro, parce irregulariter glandularibus, tubo gracile, lobis atro-flavis; achaenia ca. 2 mm. longa, leviter 5-costata, rubro-brunnea, glabra; pappo nullo.

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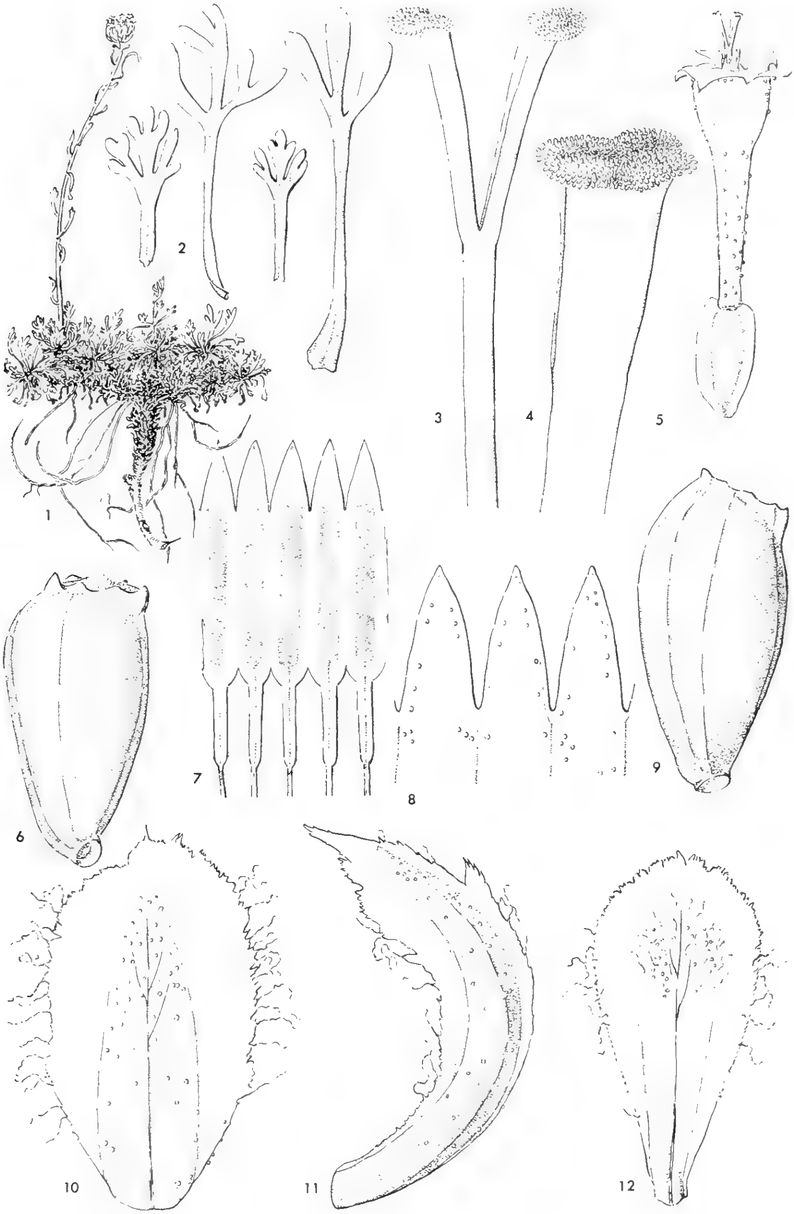
PLATE 17

Figures 1-12. *Tanacetum martirensis,* sp. nov.

Figure 1. Habit of plant, × ½. Figure 2. Representative leaves, × 1½. Figure 3. Upper part of style and stigma lobes, × 25. Figure 4. Stigma lobes, × 50. Figure 5. Disc floret (stippled halo represents gelatinous sheath when moistened), × 10. Figures 6, 9. Achenes, × 25. Figure 7. Anther tube, split and flattened, × 25. Figure 8. Tip of corolla lobes, × 50. Figure 10. Outer surface of exterior involucral bract, × 10. Figure 11. Lateral view of same, × 10. Figure 12. Outer surface of interior involucral bract, × 10.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Small perennial herb from a stout, slightly branched or simple taproot, which given rise to several to many prostrate-spreading branches, each of these bearing a cluster of canescent, pinnately lobed leaves, each plant forming a cushion 5-10 cm. in diameter, and made up of several vegetative rosettes; leaves flabelliform in outline, 1.2-4 cm. long, lobed into 3-8 oblanceolate or oblong divisions 1-2 mm. wide, 1.5-8 mm. long, all lobes on the upper one-third or one-half of the leaf, canescent with relatively coarse, simple hairs 1 mm. long or less; scapes borne singly from 1-several rosettes, erect, slender, 5-10 cm. tall, bearing alternate, simple, oblanceolate leaves 5-15 mm. long, apex of scape sparsely canescent to nearly glabrate in age; flowering heads hemispherical, 5-7 mm. high, 7-12 mm. wide at anthesis; involucral bracts in 3-4 series, imbricated, 4-6 mm. long, 1-4-2.2 mm. wide, greenish to brownish along midrib, broadly fringed with thin, hyaline, silvery to roseate wings, these erosulate and sparsely ciliate along the margins, otherwise nearly glabrous, or the thicker, middle part sparsely to moderately pubescent with crinkly hairs and beset with sessile or subsessile glands, glabrous and eglandular below on the inner bracts; receptacle naked; ray flowers very few or lacking, when present differing from the disk florets only in having 3-4 instead of 5 teeth, pistillate and fertile; disk florets orange, 4.5-5 mm. tall (including achene) 1.2-1.4 mm. in diameter at anthesis, bearing scattered, subsessile, globose glands on tube and in irregular patches at bases of corolla lobes; tube slender, about twice as long as the funnelform throat, lobes bright orange; anther tube slender, about 1.2 mm. long, the apical appendages acute, horny; style branches about twice as broad as thick, 0.2 mm. wide, 0.5 mm. long, truncate, tips bearing short, blunt papillae; achenes of disk florets obovoid, about 2 mm. long, faintly 5-ribbed, smooth and glabrous, dark reddish-brown, with an obscurely toothed ring at the apex, producing a thick, transparent, gelatinous sheath nearly as wide as the diameter of the achene when wetted; pappus none.

Holotype. At summit of rim just north of Picacho de la Encantada, overlooking San Felipe Desert, altitude 9,200 feet, Sierra San Pedro Martir, Baja California del Norte, Mexico, *Ira L. Wiggins, 11,277,* 18 October 1946 (Dudley Herbarium, Stanford University, No. 321,859).

The monocephalic scapes arising from nearly flat rosettes suggests *Tanacetum simplex* A. Nelson, (*Sphaeromeria simplex* Rydberg), but the divided leaf blades and broader involucral bracts readily separate it from the Wyoming species. *Tanacetum martirensis* resembles *T. compactum* Hall (*Chamartemisia compacta* Rydberg), but the epappose achenes and smaller disk florets separate our plant from *T. compactum,* which occurs in the Charleston Mountains, Nevada. The gelatinous sheath around the moistened achene suggests a relationship with *T. potentilloides* A. Gray (*Vesicaria potentilloides* Rydberg), but our plant has simple, unbranched flowering scapes, and a disk floret that is totally different in several minute structural characteristics from those of *T. potentilloides.*

**PROCEEDINGS**

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**CALIFORNIA ACADEMY OF SCIENCES**

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# OBSERVATIONS ON THE TYPE SPECIMEN OF THE SCORPION *SYNTROPIS MACRURA* KRAEPELIN

BY

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In his original description of *Syntropis macrura*, Kraepelin states that "as yet only a male is known." This statement, sixty-four years later, is still true since no other specimens have been taken of this unusual scorpion. This lack of additional material is apparently due to two conditions: the specimen represents a species of a small population and a very limited distribution; conditions not uncommon in the order scorpionida. These could have been subverted, however, if adequate collection data were available. Unfortunately, all we know is that L. Diguet was the collector and the locality "Lower California." Kraepelin described the species in 1900. A copy of the original German description of the genus and a translation of it follow.

Gattung *Syntropis* n. g.

Diese neue Gattung der *Vejoviden* schliesst sich in ihren Merkmalen eng an die Gattung *Vejovis* C. Koch an, unterscheidet sich aber von ihr in auffallender Weise dadurch, dass statt der zwei unteren Medialkiele im ersten bis vierten Caudal segment nur ein einziger, unpaarer Mediankiel vorhanden ist, wie bei den *Urodacinen* und *Hemiscorpioninen.* Die Endtarsen der Beine mit grossem Gehstachel, die Unterkante mit einer Reihe kurzer Dörnchen. Unterrand des beweglichen Mandibularfingers zahnlos. Palpenfinger auf der Schneide mit einer Längsreihe kaum unterbrochener Körnchen, daneben innenseits sechs Seitenkörnchen. Mittellamellen der Kämme zu vielen, zum Teil perlschnurartig gerundet wie die Fulcren. Sternum fast so lang wie breit. Oberarm und Unterarm des Maxillarpalpus mit scharfen, gekörnten Randkielen, Unterarm in der Mitte der Vorderfläche ebenfalls mit gekörnter Langscrista.

## Genus *Syntropis* n.g.

"This new genus of vejovid agreed closely in its characteristics to the genus *Vejovis* C. Koch, but it differs in a remarkable way from it in this way, that instead of the two inferior median keels on the first to the fourth caudal segments there is only a single, unpaired median keel, as in the case of the *Urodacinen* and *Hemiscorpioninen.* The terminal tarsal joint of the leg with a row of short small spines. The inferior edge of the movable mandibular finger toothless. The cutting edge of the palp fingers with a long almost unbroken row of small granules, six small side granules beside it on the innerside. The middle lamella of the pectines are numerous, part of which are bead-like as are the fulcra. Sternum almost as long as wide. Upperarm and forearm of pedipalps with sharp, granulated marginal keels. The middle of the forearm anterior surface likewise with granulated longitudinal keels."

The original description of the species (Kraepelin, 1900, pp. 16-17) follows:

### *Syntropis macrura* n. sp.

Bisher nur ♂ bekannt. Truncus und Cauda rostfarben, die Mitten der Abdominalsegmente etwas dunkler; Maxillarpalpen am Grunde gelbrot, dann rostrot, die Finger fast braunrot; Beine gelbrot.

Cephalothorax grob buckelkörnig, die Gegend um den Augenhügel feinkörnig, Stirn schwach gekörnt. Abdomen oberseits äusserst fein chagriniert, dazu auf den Seiten mit gröberen Höckerkörnchen. Bauchseite des Abdomens glatt, letztes Segment jederseits mit einem etwas körnigen Längskiel. Cauda lang, schlank und dünn, über doppelt so lang wie der Truncus, das funfte Segment etwa siebenmal so lang wie dick. Caudalkiele alle deutlich entwickelt, der untere Mediankiel im fünften und vierten Segment reihenkörnig, im dritten und zweiten Segment glatt, scharf gratig, im ersten Segment glatt, wulstig gerundet; die unteren Lateralkiele im den vorderen Segmenten fein sägekörnig, in den hinteren deutlicher perlkörnig; obere Lateralkiele gleich den Dorsalkielen reihenkörnig, die Dorsalkiele ohne stärken Enddorn; ein unterbrochen körniger Nebenkiel im ersten Caudalsegment entwickelt, im zweiten nur durch zwei Körnchen am Ende angedeutet. Caudalflächen glatt, matt, auch im fünften Segment. Blase lang walzig, fein gekörnt, allmählich in den kurzen Stachel übergehend. Ober- und Unterarm des Maxillarpalpus mit gekörnten Randkielen, die Flächen glatt, nur der Oberarm unterseits in der Grundhälfte mit fast gereihten Körnchen in der Mittellinie, und der Unterarm auf der Vorderfläche mit Mediancrista. Hand gerundet, schlank, schmal, mit gekörnten Aussenrandkiel, sonst fast kiellos, fast glatt, nur am Innenrande etwas körnelig; ebenso die äussere Unterfläche mit schwacher Körnchenlängsreihe. Finger mit schwachem Lobus, mit sechs inneren Seitenkörnchen, fast doppelt so lang wie de Hinterhand. (Beweglicher Finger: Hinterhand: Dicke der Hand = 11,2: 6,5:3.) Schenkel der Beine feiner und gröber gekörnelt, dorsal und aussenseits oben eine schwache, ventral eine stärkere Körnchencrista. Kämme äusserst lang und schlank, fast mit halber Länge die Coxen des vierten Beines überragend; Mittellamellen etwa 20, Fulcra perlschnurförmig; Kammzähne 29.--Lange 94 mm. (Truncus: Cauda = 28:66); Fünftes Caudalsegment 17 mm., Blase mit Stachel 11,5 mm., Dicke der Blase 2,5 mm.

Unter-Kalifornien. --Bisher nue ein ♂ im Pariser Museum (L. Diguet ded.).

A translation of the above follows:

*Syntropis macrura* n. sp.

"As yet only the male is known. The trunk and cauda are rust colored, the middle of the abdominal segments is somewhat darker; the pedipalps are yellowish red at the base, then rust red, the fingers are almost brownish red; the legs are yellowish red.

"Cephalothorax densely, coarsely granulated, the region around the ocular tubercle is finely granulated, anterior portion weakly granular. Dorsum of abdomen very finely shagreened, in addition on the sides are thicker, tuberculated granuled. The ventral surface of the abdomen smooth with a somewhat granulated longitudinal keel on each side of the last segment. Cauda long, slender and thin, over twice as long as the trunk, the fifth segment is nearly seven times as long as thick. The caudal keels are all well developed, the inferior median keel on segments IV and V bears a row of granules, on segments II and III smooth, acutely ridged, on the first segment smooth, with a rounded swelling; the inferior lateral keels on the anterior segments with fine, serrate granules but distinctly bead-shaped granules on posterior ones; the superior lateral keels like the dorsal keels bear a row of granules, the dorsal keels are without large terminal spine; an intermittently granulated lateral keel developed on the first caudal segment, in the second segment indicated only by two granules at the end. Caudal surface smooth, flat, even in the fifth segment. Ampulla long and cylindrical, finely granulated, changing gradually into the short aculeus. Upper and forearm of the pedipalps have granulated marginal keels, surface smooth, only interior surface of upperarm in the basal half with almost continuous rows of granules on median line, and the forearm anterior surface with median keels. Hand rounded, slender, small with granulated exterior marginal keel, otherwise almost without keels, nearly smooth, only somewhat granular on inner margin; likewise the outer inferior surface with weak, longitudinal rows of little granules. Finger with weak lobe, with six inner, lateral granules, almost twice as long as the back hand. (Movable finger: back hand: thickness of the hand = 11.2 : 6.5 : 3.). Femur of the legs is thinner and more coarsely granulated, dorsal and exterior sides have above a weak, ventrally a stronger granulated keel. Pectines very long and slender, almost surpassing the coxa of the fourth leg on account of its length: about 20 middle lamellae, the fulcra are moniliformed; 29 pectinal teeth. -- Length is 94 mm. (trunk: cauda = 28 : 66); the fifth caudal segment is 17 mm., ampulla plus aculeus 11.5 mm., the thickness of ampulla 2.5 mm.

"Lower-California. -- As yet only one male in the Paris Museum (L. DIGUES ded.)."


Figure 1. Note the long, slender pectines and the single, ventral median keel on segments I and II; all other known vejovids have two on segments I through IV.

## DISCUSSION

In 1961, while in Paris, the writer examined the type specimen in the Laboratoire Zoologie, Museum Nationale D'Histoire Naturelle. At this time it was more of a dark straw color and not a "rust color" as Kraepelin states; a change very likely produced by the preservative. The specimen is 97.95 mm. long which is the sum of the lengths of the non-telescoping, scleritized parts of the trunk and cauda. The sternum is distinctly vejovid in form (fig. 1) as are also the presence of an interior and exterior pedal spur. However, the unusual length of the caudal segments and the extremely long and slender pedipalps are out of character for this family (fig. 2). The most unusual characteristic, as Kraepelin mentioned, is the presence of a single ventral median keel on caudal segments I (fig. 1) through IV. This cristate condition is found only in the Urodacinae (Scorpionidae), an exclusive Australian group and in the Hemiscorpioninae, found only in Arabia. In the latter group, the male telson is also very similar in shape to that of *S. macrura*. The inferior surface of the second tarsomeres has a median row of short, thick spines which become increasingly longer and are arranged in a Y-configuration distally similar to that found on Paruroctonus (Vejovid). Three lateral eyes are present. The granules of the cutting edge of the pedipalp fixed finger are in a continuous row and serrate. Both fixed and movable fingers are terminated with a large, claw-like granule and their tips are capped with an elongate, whitish spot. The stigmata are slit-like. The seventh sternite bears two distinct lateral keels which extend throughout approximately the median half of the segment. The crests of the anal arch are not strongly developed. The proximal one bears confluent granules while the distal one is agranular.

Measurements in millimeters:

| | | |
|---|---|---|
| Total Length | 97.95 | |
| Cauda | 67.50 | |
| Trunk | 30.35 | |
| Carapace | 8.75 | |
| Pre-abdomen | 21.60 | |
| Caudal segments: | | |
| NUMBER | LENGTH | WIDTH |
| I | 7.6 | 3.6 |
| II | 9.2 | 3.2 |
| III | 10.1 | 3.0 |
| IV | 13.3 | 2.7 |
| V | 16.5 | 2.3 |
| Appendages: | | |
| Pedipalp: | | |
| Tibia | 17.4 | |
| Hand | 7.8 | 2.5 |
| Movable finger | 11.3 | |

| Appendages (Cont'd) | LENGTH | WIDTH |
|---|---|---|
| Patella | 8.7 | 1.9 |
| Femur | 8.4 | 1.9 |
| Leg IV: | | |
| Femur | 9.8 | 1.6 |
| Patella | 7.8 | 1.9 |
| Tarsomere I + tibia | 9.0 | |
| Sternum | 1.8 | 1.5 |
| Telson | 10.9 | |
| Aculeus | 2.33 | |
| Ampulla | 8.57 | 2.40 |
| Thickness | 2.50 | |
| Genital plate | 1.5 | 2.4 |
| Basal piece | 1.5 | 2.0 |
| Pectinal teeth | 29/29 | |

Figure 2. Note unusually long, slender pedipalps, caudal segments and telson.

The above measurements indicate unusual proportions for a vejovid. The only other North American vejovids approaching these proportions are those of the genus *Paruroctonus*. The comparative ratios, with those of a male *Paruroctonus mesaensis* Stahnke given in parentheses, are as follows: Cauda/trunk, 2.23 (2.19); caudal segment I L/W, 2.11 (1.42)(1); caudal segment IV L/W, 4.93 (2.96); caudal segment V L/W, 7.17 (4.80); movable finger of pedipalp, L/hand width, 4.52 (1.84).

The unusual morphology of this species raises a number of questions to which the potential collector should be alert. The first of these is the possible variance in its behavior from that of the more commonly known vejovids which are often referred to as "ground" scorpions. This is in contrast to the slender buthids (genera *Centruroides* and *Tityus)* called "bark" scorpions. Ground scorpions hiding under objects show a positive geotropism and are efficient active burrowers. Bark scorpions most frequently seem to be negatively geotropic and cling to the underside of objects under which they are concealed. If. *S. macrura* reacted in a similar manner the potential collector should be careful in turning over objects so as not to contact a specimen inadvertently. One would hardly expect the fragile looking *S. macrura* to be an efficient and active burrower, but would expect it to behave like a buthid.

The stouter and more robust vejovids, whether at rest or moving about, generally carry the cauda curled over their back. In contrast, the slender buthids generally curl the cauda to one side while at rest but have a tendency to drag the cauda while traveling. One would hardly expect *S. macrura* to behave like a vejovid.

(1) Vejovids generally have caudal segment I width as greater than the length.

Part of the defensive behavior of the vejovids, especially those of the genus *Hadrurus* and *Paruroctonus*, is to go through a threatening strutting reaction. At this time the preabdomen (mesasoma) and cauda (metasoma) are stiffened and held quite vertical to the substrate. The very slender buthids, on the other hand, have more of a tendency to give a flicking thrust and flee. The behavior of *S. macrura* and whether or not it will attempt to sting defensively is unknown.

No known vejovid has a venom sufficiently potent to be lethal to man through the natural sting except in relatively rare occurrences of hypersensitivity to scorpion venom. All scorpions known to have a lethal venom are buthids. The toxicity of the venom of *S. macrura* is unknown but those who seek this species should be wary.

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# PROCEEDINGS

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# PLIOCENE FOSSILS FROM RANCHO EL REFUGIO, BAJA CALIFORNIA, AND CERRALVO ISLAND, MEXICO

BY


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## Introduction

Sedimentary deposits along the east coast of Baja California as well as on many of the islands in the Gulf of California are abundantly fossiliferous. Studies of fossils from that area have yielded information concerning the age and distribution of the strata enclosing them as well as information concerning the paleobiology of the organisms represented.

The occurrence of fossil bearing strata on Rancho El Refugio, about 17 kilometers southeast of Santiago, Baja California, Sur, came to the attention of Mr. Victor J. Bergeron, a member of the Board of Trustees of the California Academy of Sciences. His interest in the locality was aroused and later he generously furnished his airplane and other logistic support for an expedition to that area by Academy personnel. Mr. Cesar Osuna Peralta, Mayor of Santiago, and Mr. Walter R. Heyneman of Sonoma, California, had previously visited this locality on Rancho El Refugio and communicated with the writer concerning a collection of fossils which they had assembled there.

The field party was composed of Dr. George Lindsay, Director; Dr. Robert T. Orr, Associate Director; Dr. G Dallas Hanna, Curator of the Department of Geology, all of the staff of the California Academy of Sciences; and Dr. J. Wyatt Durham, Department of Paleontology, University of California. The party left San Francisco, California, April 23 and returned April 26, 1965. A general account of this expedition was published by Lindsay (1965).

On April 24, Mr. Harry ("Bing") Crosby and Mr. Cesar Osuna Peralta took the party to Rancho El Refugio where fossils were collected at four localities.

On April 25, Drs. Lindsay, Orr, Hanna, and Durham, investigated the strata at Ruffo's Ranch on the west coast of Cerralvo Island where invertebrate fossils were known to occur. This trip was made possible through the generosity of Mr. Crosby, who furnished his yacht *True Love* for transportation to that area.

The field work and the fossils collected during this expedition add considerably to the knowledge of the stratigraphic succession of the beds and their age. This work also furnished information for a basis of comparison with the results of similar earlier studies made in the southern portion of the Gulf of California region. Two subspecies in the fauna are described as new in the present paper.

All specimens illustrated in this paper are in the collection of type specimens in the Department of Geology in the California Academy of Sciences.

## Acknowledgments

The writer here expresses his appreciation to Dr. G Dallas Hanna and to Dr. J. Wyatt Durham for the privilege of studying and preparing a report on the present collection and for making available their field notes. Photographs used to illustrate the fossils were prepared by Mr. Maurice Giles.

## Rancho El Refugio

Rancho El Refugio was visited by geologists of the Marland Oil Company in 1920 or 1921 (see anonymous, 1924, p. 33; Beal, 1948, p. 81) who made observations on the geology of that region where strata of Pliocene age were reported (Beal, p. 117) to occur to an elevation of 1400 feet. They collected various invertebrate fossils which were reported by Hertlein (1925) and by Beal (1948). More recently (1964) Mr. Walter R. Heyneman, accompanied by Mr. Cesar Osuna Peralta, visited the area containing fossiliferous strata on Rancho El Refugio. The fossils collected at that time were generously donated to the California Academy of Sciences. These are indicated in the present list of fossils under Locality 38849 (CAS).

According to Dr. Durham, the strata in the vicinity of the ranch house dip 20° to 25° SE., strike N. 30° E. This dip prevails for a considerable distance over the ranch and the section apparently is several thousand feet thick. In the vicinity of the ranch the sequence is composed of silty beds, poorly sorted sandstone and gravelly and cobbly sandstone, mostly not well sorted. Sands vary from fine to coarse, sometimes white but otherwise the color is gray, grayish green, yellow, and brown. Fossils are scattered throughout the sequence. Concretions of various shapes, to a length of two feet, are present. Fossil whale bones occur abundantly.

Durham mentioned that the localities visited by the field party were apparently in the same area where fossils reported by Beal were collected. He mentioned, however, that "according to Beal's map (1948), if our distances and directions are correct, we collected fossils in sediments which he mapped as 'Ysidro sandstone' (Miocene), but in his text (1948, p. 66) he notes that fossils reported by Hertlein were from localities (not shown on the map) in an area mapped as Salada, about 4 kilometers northwest of the Ysidro-Salada contact. Either the distance estimated from the ranch to the localities is wrong or the contact is not correctly located on the map."

The following information concerning the localities where fossils were collected is taken from field notes furnished by Dr. J. W. Durham.

Locality 39411 (CAS). On ridgetop, about 200 meters east of the ranch house. Fossils from silty and sandy beds, strike N. 30° E., dip 20-25° SE.

Locality 39412 (CAS). Along the trail about 100 meters to the southeast, fossils from similar beds ± 100 feet higher stratigraphically

Locality 39413 (CAS). Along the trail about 200 meters to the southeast, higher stratigraphically, gravelly beds with abundant oysters. Slightly lower topographically than the preceding locality. An apparent unconformity visible on side of hill 250-300 meters to the west, with overlying nearly flat gravels.

Locality 39414 (CAS). From bottom of arroyo about 200 meters northeast of Locality 39411 (CAS). Similar strata, but slightly lower stratigraphically.

The entire sequence is thick, poorly bedded, and poorly sorted, composed of silts, sands, gravels, and pebble conglomerates. Marine shells and occasional whale bones are scattered higher and thither on the surface. Only shells such as oysters and pectens (with $MgCo_3$ in shell) are well preserved; others are usually leached.

Locality 39415 (CAS). From outcrops along north bank of main arroyo, on return trip to Santiago, said to be about 8 kilometers southeast of the village. Here outcrops of diatomite ±100 feet thick, with silty interbeds overlie other silts. Quite low dipping generally to the southeast, these beds are believed to be stratigraphically below the beds at Rancho El Refugio.

The following list represents the identified fossil fauna collected by Hanna and Durham, also those reported from that area by Hertlein and Beal and those collected by Heyneman.

Table 1. *List of Fossils from Rancho El Refugio*

| | LOCALITIES | | | | | |
|---|---|---|---|---|---|---|
| | Hertlein & Beal | 38849 | 39411 | 39412 | 39413 | 39414 |
| **Brachiopoda** | | | | | | |
| *Glottidia* cf. *G. audebarti* Broderip | | | × | | | × |
| **Echinoidea** | | | | | | |
| ?*Centrostephanus* species | | × | | | | |
| **Pelecypoda** | | | | | | |
| *Amusium* species | | × | | | | |
| *Anomia peruviana* d'Orbigny | × | × | × | | × | |
| *Atrina* species | | × | | | | |
| *Chione* cf. *C. californiensis* Broderip | | | × | | | |
| *Chlamys mediacostata grewingki* Hertlein, new subspecies | | | | | × | |
| *Chlamys (Aequipecten)* cf. *C. (A.) palmeri* Dall | | | | | × | |
| *Chlamys (Argopecten) abietis* E. K. Jordan and Hertlein | | | | | × | |
| *Chlamys (Argopecten) calli* Hertlein | × | | cf. | | | |
| *Chlamys (Argopecten) circularis* Sowerby | × | | | | | |
| *Chlamys (Leptopecten) latiaurata* Conrad | | | × | | | |
| *Chlamys (Nodipecten) subnodosa* Sowerby | | | × | | | |
| *Chlamys (Pacifipecten) tumbezensis* d'Orbigny | | × | | | | |
| *Lucina* species | | × | | | | |
| *Ostrea californica osunai* Hertlein, new subspecies | | × | × | | × | |
| *Ostrea fisheri* Dall | | | | | | × |
| *Ostrea megodon* Hanley | × | × | | × | × | |
| *Ostrea palmula* Carpenter (as *O mexicana* Sowerby by Hertlein and Beal) | × | | cf. | | | |
| *Pecten (Pecten) aletes* Hertlein | × | | | | | × |
| *Pecten (Pecten)* cf. *P. (P.) lunaris* Berry | | | × | | | |
| *Pecten (Pecten)* species | | | × | × | | |
| *Pecten (Euvola) keepi* Arnold | × | | | | | |
| *Pecten (Euvola) refugioensis* Hertlein | × | × | × | × | | |
| ?*Placunanomia* species | | | × | | | |
| *Spondylus princeps* Broderip | | × | | | | |
| *Teredo* species | | × | | | | |

TABLE 1. *List of Fossils from Rancho El Refugio* (Continued).

| | LOCALITIES | | | | | |
|---|---|---|---|---|---|---|
| | Hertlein & Beal | 38849 | 39411 | 39412 | 39413 | 39414 |
| GASTROPODS | | | | | | |
| *Calyptraea* species | | | | × | | |
| *Crepidula* cf. *C. arenata* Broderip | | | × | | | |
| *Ficus* cf. *F. ventricosus* Swainson | | × | | | | |
| *Fusinus* species | | | × | | | |
| *Malea ringens* Swainson | | | × | | | |
| *Murex* species | | × | | | | |
| *Oliva spicata* Röding in Bolten | | | | | × | |
| *Strombus* cf. *S. granulatus* Swainson | | | | | × | |
| *Strombus* species | | × | | | | |
| *Turbo* species | | | | | | × |
| *Turritella* cf. *T. gonostoma* Valenciennes | | | × | | | |
| *Vasum* cf. *V. muricatum* Broderip | | | | | | × |
| ARTHROPODA | | | | | | |
| Geocarcinidae | | × | | | | |
| SHARK TEETH | | | | | | |
| *Carcharodon arnoldi* Jordan | | × | | | | |
| *Hemipristis heteropleurus* Agassiz | | × | | | | |
| *?Carcharhinus species* | | × | | | | |
| WHALE JAW | | × | | | | |
| WOOD | | × | | | | |

This list contains 29 species of which 19 are positively identified and 10 are provisionally identified. In addition to there there are 13 forms identified only as to genus, one as to family, and two of general classification.

Of the 29 species, 20 are living in the adjacent warm, shallow waters in the Gulf of California and 9 are extinct. All these species except two, *Chlamys (Argopecten)* cf. *C. (A.) palmeri* and *Pecten* cf. *P. (P.) lunaris* have been reported previously from strata of Pliocene age.

Study of the present assemblage leads the writer to the opinion that the age is Pliocene, probably middle Pliocene.

## ISLA CERRALVO

Fossils from the west side of Cerralvo Island at El Mostrador (Ruffo's Ranch) have been reported by several authors including Hanna and Hertlein (1927), Hertlein (1957), Emerson (1960), and Emerson and Hertlein (1964).

Collections were assembled by Hanna and Durham from outcrops in sea cliffs to the north and to the south of "Farallones Blancos." According to Durham "the total length of outcrops of sediments along the beach is perhaps a mile. These sediments appear to be small inliers dipping toward the interior of the island where, perhaps, they may be bounded by two faults. A terrace face is present at an elevation of 20 to 25 feet.

"The island as a whole appears to be composed of granites and metamorphics overlain by volcanics with an inlier of sediments in the vicinity of 'Farallones Blancos.' However, the sediments may continue on into the island underneath some of the volcanics.

"The oldest beds south of the arroyo at Ruffo's Ranch, are exposed at the mouth of the arroyo. ...The total thickness of the section investigated is approximately 550 feet."

The following are localities where fossils were collected by Hanna and Durham.

| | |
|---|---|
| Locality 39405 (CAS). | 250 feet above base of section. |
| Locality 39406 (CAS). | 170 feet above base of section. |
| Locality 39407 (CAS). | 160 feet above base of section. |
| Locality 39408 (CAS). | 125 feet above base of section. |
| Locality 39409 (CAS). | 85 feet above base of section. |
| Locality 39409A (CAS). | Same beds as Locality 39409 (CAS) ±100 yards to the north. |

Locality 39410 (CAS). The distance is uncertain but probably 300 to 400 yards north of the arroyo near the base of the sedimentary sequence. The strike is N. 20° E., the dip 15° SE., near base of conglomerates. Some sandy and silty beds are present but the sequence is predominantly cobble-boulder conglomerate for some distance. Occasional beds of *Pocillopora*, algae, and echinoids are present.

"The outcrop ends at the next (to north) small arroyo, the beds dipping steeply to the southeast. Metamorphics occur to the north, dipping steeply to the northwest. Faulting may exist along the contact." (Durham.)

In addition to the species collected by Hanna and Durham, those reported earlier from that area are indicated in the left hand column in the list.

Fourteen species and subspecies are recorded in this list. Of these nine are positively identified and five are only provisionally identified. Three other forms are identified only as to genus and two as to phylum.

Nine of the 14 species and subspecies are Recent and five are extinct. All of these have been reported previously from strata of Pliocene age. Judging from the known occurrence of the forms represented in this faunule and their associated fauna elsewhere, a middle Pliocene age can be assigned to this assemblage. This is in agreement with the opinion expressed by Emerson and Hertlein (1964, p. 347) who studied a faunule from the same area.

Table 2. *List of Fossils from Isla Cerralvo.*

| | LOCALITIES | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Earlier Records | 39405 | 39406 | 39407 | 39408 | 39409 | 39409A | 39410 |
| Bryozoa | | | | | | | | |
| *Conopeum commensale* Kirkpatrick and Metzelaar | × | | | | | | | |
| Echinoidea | | | | | | | | |
| *Clypeaster bowersi* Weaver | × | | | | | | | |
| *Clypeaster* cf. *C. speciosus* Verrill | × | | | | | | | |
| *Clypeaster* species | × | | | | | | | |
| *Meoma* species | | × | | × | | | | × |
| Pelecypoda | | | | | | | | |
| *Ostrea angelica* Rochebrune | | | | | × | | | |
| *Ostrea* aff. *O. heermanni* Conrad | × | | | | | | | |
| *Pecten (Oppenheimopecten) vogdesi* Arnold | × | | | | | × | | |
| *Chlamys (Argopecten) abietis* E. K. Jordan and Hertlein | × | | × | | × | | × | |
| *Chlamys (Argopecten) revellei* Durham | × | | | | × | | | |
| *Chlamys (Nodipecten) subnodosa* Sowerby | × | | × | | × | | | |
| *Chlamys (Nodipecten) subnodosa intermedia* Conrad | × | | | | | | | |
| *Spondylus princeps* Broderip | × | | | × | × | × | | |
| Gastropoda | | | | | | | | |
| *Turritella marcosensis* Durham | | × | | | | | | |
| Cirripedia | | | | | | | | |
| *Balanus tintinnabulum californicus* Pilsbry | × | | | | | | | |
| *Balanus trigonus* Darwin | × | | | | | | | |
| *Balanus* species | × | | | | | × | | |
| Coelenterata | | | | | | | | |
| Colonial stony coral of undetermined generic affinity | × | | | | | | | |
| *Parona* species | | | | × | | | | |
| *Pocillopora* species | | | | | | | | × |
| *Porites* species | | | | × | | | | |
| Algae | | | | | | | | |
| Calcareous algae | × | × | × | × | × | × | × | |

The general composition of this assemblage is similar to that now living in warm, shallow waters in the same region.

Figure 1. View of west shore of Isla Cerralvo at El Mostrador (Ruffo's Ranch). The white stratum is composed of calcareous algae of Pliocene age. (Photograph by G Dallas Hanna.)

## Description of Species

**Ostrea californica osunai** Hertlein, new subspecies.
(Figures 2, 3, 4, 5, 6, 8, 9.)

*Ostrea* cf. *O. californica* Marcou, Emerson and Hertlein, Trans. San Diego Soc. Nat. Hist., vol. 13, no. 17, pp. 337, 353, 354, 1964. "Northwest side of Isla Salsipuedes." Also "Concepcion Peninsula, Concepcion Bay, Baja California." Pliocene.

Description. Shell, a left valve, elongated, longer than wide, thick with uneven, wavy growth laminae; exterior flattish, lacking ornamentation; interior with a shallow body cavity; ligamental pit rather wide, concave, elongate, the laminae of growth form a nearly straight line across the pit; muscle impression on the type specimen indistinct, apparently at about one third the length of the shell from the ventral margin. Dimensions: Length (apex lacking), 393 mm., maximum width, 140 mm., maximum thickness, 84 mm.

Right valve, a paratype, ventral portion lacking; a raised, convex ridge corresponds to the ligamental pit of the opposite valve. Dimensions: length (ventral portion lacking), 238 mm., maximum width, 133 mm., maximum thickness, 53 mm.

HOLOTYPE, left valve, no. 12823 and paratype, a right valve, no. 12822, California Academy of Sciences, Department of Geology Type Collection, from Locality 38855 (CAS), from the **southwest end of Concepcion Peninsula, Baja California**; C. C. McFall, collector, March, 1964; Pliocene.

COMMENTS. This elongate oyster was reported by Emerson and Hertlein from Salsipuedes Island and from the southeast end of Concepcion Peninsula, Baja California (1964, p. 354, footnote), under the name of *Ostrea* cf. *O. californica* Marcou. Specimens from Rancho El Refugio, Baja California, are believed to be identical. One lower and three upper valves were collected at Locality 39413 (CAS). One thick lower valve, rectangular in outline, was taken at Locality 39411 (CAS). Similar variation in the shape and thickness of the shells of various individuals of *Ostrea puelchana* d'Orbigny from the late Miocene of Trinidad was illustrated by Maury (Bull. Amer. Paleo., vol. 10, no. 42, p. 239 (79), pl. 21 (10), figs. 1, 2; pl. 22 (11), figs. 1, 2; pl. 23 (12), figs. 9, 10, 1925).

The type specimen of the new subspecies described here was collected by Dr. C. C. McFall from strata on Concepcion Peninsula at Concepcion Bay on the east coast of Baja California. It is selected as holotype because the state of preservation is better than that of specimens from other localities. According to Dr. McFall (oral communication), banks composed of the shells of this oyster occur in the strata on Concepcion Peninsula. The associated fauna of Pliocene age includes *Chlamys (Nodipecten) subnodosa* Sowerby, *Chlamys (Argopecten) abietis* E. K. Jordan and Hertlein, *Ostrea heermanni* Conrad, *Hanetia* cf. *H. pallida* Broderip and Sowerby, *Turritella* cf. *T. imperialis* Hanna.

The dorsal half of two specimens about 130 mm. long, from Locality 39413 (CAS), Rancho El Refugio, closely resemble specimens of *O. californica* Marcou [Geology of North America, p. 32, pl. 5, figs. 2, 2a, 1858. From "near Carrizo Creek;" Imperial County, California; see also Hanna, Proc. Calif. Acad. Sci., Fourth Ser., vol. 14, no. 18, p. 468, pl. 26, figs. 4, 5, 6, 7, 1926 (as *O. iridescens*)] from Locality 692 (CAS), Alverson Canyon, Imperial County, California, differing only in the larger and thicker shell. One lower valve from Rancho El Refugio is recessed under the hinge, but others are not. Similar variability can be observed among specimens of *O. californica*.

None of the valves of *Ostrea californica* observed by me are as large and thick nor is the ligamental pit and corresponding ligamental ridge on the opposite valve as large as those on valves from Concepcion Peninsula or on those from Rancho El Refugio. However, the similarities in shell characters between the fossils from Baja California and those from Imperial County California, are such that it seems best to adopt a conservative course and describe the peninsular form as a subspecies of *O. californica*.

Some of the large valves from Baja California bear a general resemblance to *Ostrea bourgeoisii* Rémond as illustrated by Clark (Univ. Calif. Publ. Bull. Dept. Geol., vol. 8, no. 22, p. 447, pl. 43, 1915) from strata of late Miocene age in central California. The present specimens differ from Rémond's species in their much more elongate, narrower outline, and broader ligamental pit.

This subspecies is named for Mr. Cesar Osuna Peralta, Mayor of Santiago, Baja California, Sur.

## **Pecten (Euvola) refugioensis** Hertlein.

(Figures 16, 17.)

*Pecten (Pecten) refugioensis* Hertlein, Proc. Calif. Acad. Sci., Fourth Ser., vol. 14, no. 1, p. 7, pl. 1, fig. 2; pl. 5, fig. 9, July 21, 1925. Hanna and Hertlein, Proc. Calif. Acad. Sci., Fourth Ser., vol. 16, no. 6, p. 142. Punta Santa Antonita, Baja California; Pliocene.

*Pecten (Euvola) refugioensis* Hertlein, Durham, Geol. Soc. America, Mem. 43, pt. 2, p. 61, pl. 6, fig. 3, 1950. Punta Santa Antonita, Baja California; middle Pliocene.

*Pecten refugioensis* Hertlein, Lindsay, Pacific Discovery, vol. 18, no. 6, p. 20, illustr. (p. 21), 1965. Rancho El Refugio.

Type locality. "Rancho Refugio, north of San Jose del Cabo, Lower California." "Upper Miocene or Lower Pliocene."

Range. Middle Pliocene.

Occurrence in Baja California. Localities 38849; 39411; 39412 (CAS), Rancho El Refugio; Locality 795 (CAS), Punta Santa Antonita.

Comments. The present collection, assembled from three localities, contains about 25 valves, mostly left ones, in various degrees of preservation. The largest is a left valve collected by Walter Heyneman from Locality 38849 (CAS), which is 88 mm. high and 95 mm. long (slightly imperfect on one end). The smallest is a left valve 29 mm. high and 27.6 mm. long. The largest right valve in the collection is a fragment 75 mm. high.

The shell of this species differs from that of *Pecten (Euvola) keepi* Arnold usually in the lack of radial ribbing on the ventral half of the valves or if ribbing is present it is much more weakly developed.

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Figure 2. *Ostrea californica osunai* Hertlein, new subspecies. Holotype no. 12823 (CAS), from Locality 38855 (CAS), Concepcion Peninsula, Concepcion Bay, Baja California; Pliocene. Length 393 mm. View of the exterior of a lower valve.

Figure 3. *Ostrea californica osunai* Hertlein, new subspecies. View of the interior of the specimen shown in figure 2.

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**Chlamys mediacostata grewingki** Hertlein, new subspecies.

(Figure 12.)

Description. Shell, a right valve, higher than long, nearly equilateral, gently convex; with about 17 or 18 low, rounded, radial ribs widest at the middle of the ventral margin and separated by interspaces narrower than the ribs; surfaces of the ribs with traces of concentric imbricating lines of growth which loop upward; each interspace on the ventral half of the shell with a well developed riblet; the ears are imperfectly preserved but the direction of the lines of growth on the posterior ear indicate a nearly squarely truncated posterior margin, a well developed notch is present under the remnant of the anterior ear. No sculpture is visible on the ears; if originally present, it has been eroded. Dimensions: length 34.2 mm., height 39.6 mm., apical angle 81.5° .

Holotype. A right valve, no. 12812, California Academy of Sciences, Department of Geology Type Collection from Locality 39413 (CAS), along the trail about 200 meters to the southeast from Locality 39412 (CAS), **southeast of the ranch house, Rancho El Refugio, Baja California;** G D. Hanna and J. W. Durham, collectors; Pliocene.

Comments. The shell of this new subspecies bears a decided resemblance to *Pecten mediacostatus* Hanna (Proc. Calif. Acad. Sci., Fourth Ser., vol. 14, no. 18, p. 472, pl. 22, fig. 6; pl. 24, fig. 2, 1926; see also Durham, Geol. Soc. America, Mem. 43, pt. 2, p. 65, pl. 7, fig. 4, 1950), which was originally described from "Alverson Canon on the south side of Coyote Mountain, Imperial County, California, in the Pliocene coral reef about midway up the canyon." It differs from that species in the less numerous ribs (17 or 18 rather than 23 or 24) and in the narrower apical angle. All the specimens of *C. mediacostata* in the collections of the California Academy of Sciences, many rather imperfectly preserved, have more numerous ribs than the present specimen. Durham mentioned a specimen with 24 ribs from the San Marcos formation on San Marcos Island in the Gulf of California. A species described from strata of Pliocene age in Florida, *Pecten (Lyropecten) tamiamiensis* Mansfield (U. S. Geol. Survey, Prof. Paper 170-D, p. 47, pl. 16, figs. 4, 6, 1932), 69 mm. long and 74 mm. high, with 23 ribs, is quite similar to *C. mediacostata.*

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Figure 4. *Ostrea californica osunai* Hertlein, new subspecies. Hypotype no. 12820 (CAS), from Locality 39413 (CAS), Rancho El Refugio, Baja California; Pliocene. Length (incomplete) 273 mm. View of the exterior of a lower valve.

Figure 5. *Ostrea californica osunai* Hertlein, new subspecies. Hypotype no. 12821 (CAS), from Locality 39411 (CAS), Rancho El Refugio, Baja California; Pliocene. Length 224 mm. View of the exterior of a somewhat rectangular lower valve.

Figure 6. *Ostrea californica osunai* Hertlein, new subspecies. View of the interior of the specimen shown in figure 5.

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In view of the fact that only a single valve is represented in the present collection and its decided similarity to *C. medicostata*, it seems best to describe it as a subspecies of that species.

Similar species of late Tertiary age have been described from the Caribbean region.

*Pecten interlineatus* Gabb (see Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, vol. 73, pt. 2, p. 411, pl. 45, fig. 3, 1922), from strata of Miocene age in Santo Domingo, 23 mm. long and 24.7 mm. high, was described as possessing 15 to 16 radial ribs and the posterior ear is said to be sculptured with coarse riblets. A subspecies, *Pecten interlineatus aidei* (Williston MS.) Harris (Bull. Amer. Paleo., vol. 13, no. 49, p. 29, pl. 15, figs. 6, 9, 1927) from beds of Miocene age in Venezuela is said to be similar to but about twice as large as the type specimen of *P. interlineatus*.

A geologically earlier member of this group of pectens is *Pecten crocus* Cooke (Carnegie Inst. Washington, Publication no. 291, p. 135, pl. 9, figs. 2a, 2b; pl. 11, fig. 9, 1919), 36 mm. long and 39 mm. high, from the island of Anguilla in the West Indies which was described as possessing 22 ribs. The age was given as Oligocene.

This subspecies is named for Constantin Grewingk, author of an early report containing observations on the geology of portions of the Gulf of California region.

## **Chlamys (Argopecten) abietis** E. K. Jordan and Hertlein.

(Figure 15.)

*Pecten (Plagioctenium) abietis* E. K. JORDAN and HERTLEIN, Proc. Calif. Sci., Fourth Ser., vol. 15, no. 4, p. 214, pl. 23, figs. 1, 3, 7, April 26, 1926.

*Aequipecten abietis* E. K. Jordan and Hertlein, DURHAM, Geol. Soc. America, Mem. 43, pt. 2, p. 62, pl. 10, figs. 4, 7; pl. 11, fig. 4, 1950. Various localities in the Gulf of California region, lower, middle, and upper Pliocene.

*Chlamys (Argopecten) abietis* E. K. Jordan and Hertlein, EMERSON and HERTLEIN, Trans. San Diego Soc. Nat. Hist., vol. 13, no. 17, pp. 349, 354, figs. 4 a-e, 1964. Early to middle Pliocene (with synonymy).

TYPE LOCALITY. "Arroyo Hondo, Maria Madre Island, Mexico; upper Pliocene."

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FIGURE 7. *Ostrea megodon* Hanley. Hypotype no. 12814 (CAS), from Locality 39411 (CAS), Rancho El Refugio, Baja California; Pliocene. Length 50.2 mm. View of the exterior of a lower valve.

FIGURE 8. *Ostrea californica osunai* Hertlein, new subspecies. View of the interior of the specimen shown in figure 4. Thick layers of shell material of this specimen are visible on the left side of this illustration.

FIGURE 9. *Ostrea californica osunai* Hertlein, new subspecies. Paratype no. 12822 (CAS), from Locality 38855 (CAS), from Concepcion Peninsula, Concepcion Bay, Baja California; Pliocene. Length (incomplete), 238 mm. View of the interior of an upper valve.

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RANGE. Pliocene.

OCCURRENCE IN BAJA CALIFORNIA. Numerous localities in the Gulf of California region. Localities 39406, 39408, 39409a (CAS), Cerralvo Island; Locality 39413 (CAS), Rancho El Refugio. Also Tres Marias Islands.

COMMENTS. The radial ribs of this species are triangular to subtriangular in cross-section, especially in the early stage of growth. These are separated by narrow interspaces and the sides of the ribs and the interspaces are covered with a dense fringe of concentric lamellae.

This species is characteristic of strata of Pliocene age in the Gulf of California region and in the Tres Marias Islands.

**Chlamys (Argopecten) revellei** Durham.

(Figure 10.)

*Aequipecten revellei* DURHAM, Geol. Soc. America, Mem. 43, pt. 2, pt. 63, pl. 9, figs. 3, 6, 9, August 10, 1950.

*Chlamys revellei* Durham, EMERSON AND HERTLEIN, Trans. San Diego Soc. Nat. Hist., vol. 13, no. 17, pp. 345, 346, 349, 1964. Isla San Jose; Isla Cerralvo. Pliocene.

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FIGURE 10. *Chlamys (Argopecten) revellei* Durham. Hypotype no. 12819 (CAS), from Locality 39408 (CAS), Cerralvo Island, Baja California; Pliocene. Height 53.3 mm. View of the exterior of a right valve.

FIGURE 11. *Turritella marcosensis* Durham. Plastohypotype no. 12815 (CAS), from Locality 39405 (CAS), Rancho El Refugio, Baja California; Pliocene. Length 36 mm.

FIGURE 12. *Chlamys mediacostata grewingki* Hertlein, new subspecies. Holotype no. 12812 (CAS), from Locality 39413 (CAS), Rancho El Refugio, Baja California; Pliocene. Height 39.6 mm. View of the exterior of a right valve.

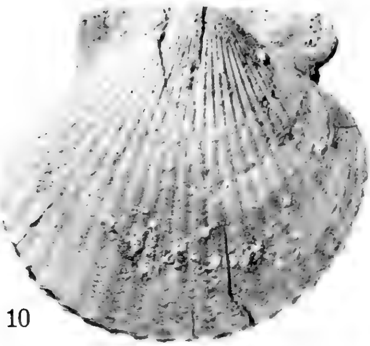
FIGURE 13. *Chlamys (Nodipecten) subnodosa* Sowerby. Hypotype no. 12824 (CAS), from Locality 39408 (CAS), Cerralvo Island, Baja California; Pliocene. Height 77 mm. View of the exterior of a right valve.

FIGURE 14. *Turritella marcosensis* Durham. Plastohypotype no. 12816 (CAS), from Locality 39405 (CAS), Rancho El Refugio, Baja California; Pliocene. Length 21 mm.

FIGURE 15. *Chlamys (Argopecten) abietis* E. K. Jordan and Hertlein. Hypotype no. 12813 (CAS), from Locality 39406 (CAS), Cerralvo Island, Baja California; Pliocene. Height 60.3 mm. View of the exterior of a right valve.

FIGURE 16. *Pecten (Euvola) refugioensis* Hertlein. Hypotype no. 12768 (CAS), from Locality 39413 (CAS), Rancho El Refugio, Baja California; Pliocene. Height 55.3 mm. View of the exterior of a left valve.

FIGURE 17. *Pecten (Euvola) refugioensis* Hertlein. Hypotype no. 12772 (CAS), from Locality 39412 (CAS), Rancho El Refugio, Baja California; Pliocene. Height 32 mm. View of the exterior of a right valve.



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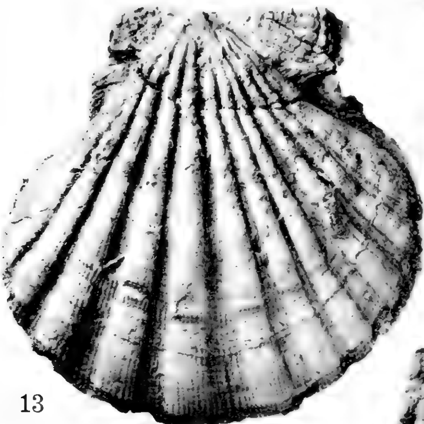

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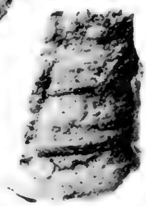

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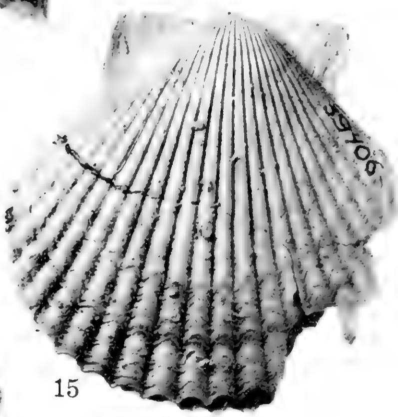

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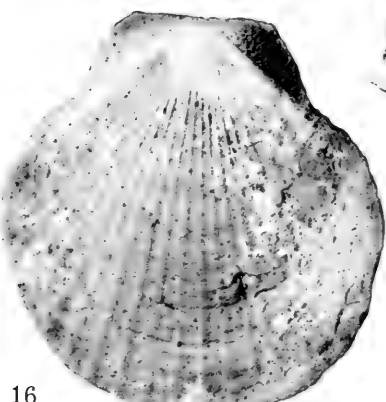

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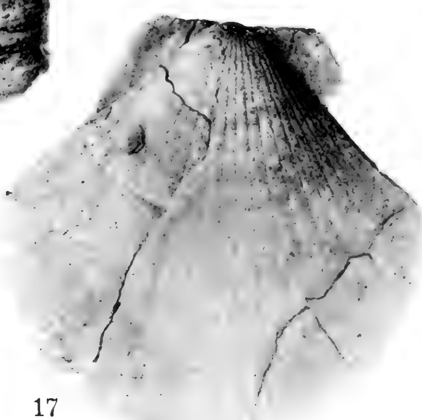

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Type locality. Locality A3566 (Univ. Calif.), "Middle Pliocene, Monserrate Island. From pecten bed in calcareous 'sandstone' overlying algal sandstone which is in fault contact with breccia. On east side of southern tip of island."

Range. Middle Pliocene.

Occurrence in Baja California. Isla Monserrate; Isla San José; Isla Cerralvo.

Comments. One well preserved specimen of this species, 58.2 mm. long and 53.3 mm. high, is present in the collection from Locality 39408 (CAS), Cerralvo Island.

This species is very similar to the species described as *Pecten (Plagioctenium) subdolus* Hertlein (1925, p. 20, pl. 5, figs. 2, 4, 7) from the San Diego formation of Pliocene age, at Pacific Beach, San Diego, California. It differs from that species chiefly in the more circular outline and in that the hinge line (41 mm. long) is longer in proportion to the length of the valves.

**Turritella marcosensis** Durham.

(Figures 11, 14.)

*Turritella marcosensis* Durham, Geol. Soc. America, Mem. 43, pt. II, p. 122, pl. 28, fig. 3, August 10, 1950.

Type locality. Locality A 3576. "Lower Pliocene, San Marcos formation San Marcos Island. On east side of island in northeast corner of outcrop of gypsum beds. From cliff in mesalike hill. In grey calcareous algal sandstone some 150-200 feet stratigraphically higher than gypsum. Overlies conglomerate and is overlain by a conglomerate containing pebbles of granite."

Range. Early Pliocene (Durham); middle Pliocene.

Occurrence in Baja California. San Marcos Island; Locality 39405 (CAS), Rancho El Refugio.

Comments. Two impressions of a *Turritella,* 21 mm. and 36 mm. long respectively, agree in general characters with those on a cast of the holotype of *Turritella marcosensis* in the collections of the California Academy of Sciences. One of these fossils represents an earlier portion of the shell than does the type specimen of that species. The position of the two carinas on the anterior portion of the whorls and the fine spiral ribbing are so similar to those of *T. marcosensis* that the present specimens are assigned to that species.

This species, as mentioned by Durham, bears a resemblance to a specimen of *Turritella vanvlecki teglandae* Merriam (see Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 26, no. 1, p. 126, pl. 37, fig. 4, 1941), from strata of

Pliocene age near Newhall, California. The apical angle of the present specimens is decidedly less than that of the fossil from California.

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# FOSSIL DIATOMS FROM SOUTHERN BAJA CALIFORNIA


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In April, 1965, Mr. Victor J. Bergeron of San Francisco put his airplane and pilot, Edward Osborn, at the disposal of a party from the California Academy of Sciences to investigate a deposit of fossils in southern Baja California, Mexico. Some bones and shells from the locality had attracted Mr. Bergeron's attention on an earlier visit. The field party consisted of Drs. George E. Lindsay, J. Wyatt Durham, Robert T. Orr, Harry ("Bing") Crosby, and the senior author of the present article. Mr. Crosby knew the country well from previous visits and acted as guide along with Sr. Cesar Osuna Peralta, Mayor of Santiago. The nearest landing field to the fossil-bearing deposits at Rancho El Refugio was at Santiago. This Rancho is about 15 kilometers south.

On the way back to Santiago from there, some exposures on the right-hand side of the road, about eight kilometers south of Santiago, attracted attention. Upon hand lens inspection it was at once obvious that the fine grained pale buff shales contained considerable numbers of fossil diatoms and it is upon these that the present paper is based.

The mollusks at Rancho El Refugio occur in sands and silts believed to be Pliocene in age. The diatom-bearing marine shales, however, are Miocene, believed to be approximately equivalent in age to the late part of that period, known as the Delmontian stage in California. The nearest equivalent strata known in Mexico are the diatomites exposed in Arroyo Hondo, Maria Madre Island of the Tres Marias group (Hanna, 1926). There are some diatom-bearing shales near Purissima, Baja California, but it is believed from the meager evidence available that they are considerably older.

A general account of the trip to Santiago has been published by Dr. Lindsay (1965).

**Actinoptychus splendens** (Shadbolt).

(Figures 1, 4.)

*Actinophaenia splendens* Shadbolt, 1854. Trans. Micr. Soc. London, n.s., vol. 2, p. 16.

*Actinoptychus splendens* (Shadbolt), Ralfs in Pritchard, 1861, p. 840. Schmidt, Atlas Diat., pl. 153, 1890, figs. 3, 15, 16. Hustedt, Kieselalgen, vol. 7, pt. 3, 1929, p. 478, fig. 265.

Shadbolt's name seems to be the first of a long series which have been assigned to various forms of this extremely variable species. It is a wide-spread living form (if the interpretation be a broad one) and is also abundant in most marine Miocene deposits of fossil diatoms.

**Actinoptychus gruendleri** Schmidt.

(Figures 2, 3, 5.)

*Actinoptychus gruendleri* Schmidt, Atlas Diat., pl. 1, 1874, fig. 22. "Monterey." [Miocene.]

*Actinoptychus stella* Schmidt, Atlas Diat., pl. 90, 1886, figs. 1, 2; pl. 132, 1888, fig. 23.

*Actinoptychus gallegosi* Hanna and Grant, 1926. Proc. Calif. Acad. Sci., ser. 4, no. 2, p. 120, pl. 11, fig. 6. Maria Madre Island, Mexico.

Many specific and varietal names have been given to the various forms this plastic species has taken during past geologic periods. Some of these names have acquired wide usage in diatom literature. *Actinoptychus gruendleri* seems to have been the earliest and it has page priority over any of the others illustrated by Schmidt. Most of the names can be found in Mill's Index to the genera and species of Diatomaceae, but in the early history of the subject, there is confusion due to the idea that species could be separated on the basis of the number of sectors into which the disk is divided.

The illustration on plate 132 (fig. 23) of the Atlas was stated by Schmidt: "probably to be attached to *A. stella* A. S. Grunow determined this form as *A. moronensis* (Grev.) Grunow var."[1] *Omphalopelta moronensis* was described in 1866 by Greville (p. 122), and if Grunow was correct, this name must replace *A. gruendleri* and many others. A comparison of Greville's figure of "*A. moronensis*" is not entirely convincing, and we do not have any material available from Moron. Perhaps if Greville's slide is still intact, this group of diatoms can be put in better order. His drawing is not very satisfactory and he commented on the difficulty in showing the sculpture correctly. Azpeitia (Diat. Española, 1911), in his extended work on diatoms of Spanish deposits, listed both *A. gruendleri* and *A. moronensis* from Moron thus implying that the two species may be separately recognized.

Greville stated that his "*A. moronensis*" might be compared to *Omphalopelta versicolor* Ehrenberg (1844, p. 270), an unfigured species, which Mills (Index, Diat., 1934, p. 1255) considered to be equivalent to "*Actinoptychus gruendleri.*" In our opinion *Omphalopelta versicolor* is a *nomen nudum.*

The specimen shown in our figure 5 has a very wide border zone marked with fine decussating lines of dots. This has not been seen by us before and may represent some one of the named forms of *A. gruendleri* or perhaps an unnamed one.

### **Stictodiscus hardmanianus** Greville.

(Figure 6.)

*Stictodiscus hardmanianus* GREVILLE, 1865. Trans. Micr. Soc. London, n.s., vol. 13, p. 98, pl. 8, fig. 4. SCHMIDT, Atlas Diat., 1882, pl. 74, fig. 8.

The frustules of this species are much more delicate than those of *Stictodiscus californicus*. This feature is not evident in illustrations and therefore there may be confusion in some cases. Mills (Index, Diat. 1935, p. 1496) questioned the 1927 illustration of the upper Eocene diatom, which one of us studied (Hanna, 1927, p. 121).

### **Coscinodiscus radiatus** Ehrenberg.

(Figure 7.)

*Coscinodiscus radiatus* EHRENBERG, Abh. Akad. Wiss. Berlin, 1839, p. 148. EHRENBERG, Mikrog. 1854, pl. 35A, 17, fig. 6; pl. 39, 3, fig. 17.

Diatoms of this general form are often referred to *Coscinodiscus radiatus*. There are numerous other names of later date available; however, most of these differ by minor variation. Specimens are very common in the Baja California material.

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[1] E. V. Preston, Explanatory Comments on A. Schmidt's Atlas of the Science of Diatoms. Translated from the German. [Unpublished manuscript in the library of the California Academy of Sciences, extending to plate 152.]

## **Coscinodiscus floridulus** Schmidt.

(Figure 8.)

*Coscinodiscus floridulus* SCHMIDT, Atlas Diat.,pl. 113, 1888, fig. 16. "Santa Monica." California.

The specimens from Santiago, Baja California, agree in most details with the original figure. Schmidt's figure and his material came from the old collection with the locality "Santa Monica." It now seems certain that material actually came from a short distance southeast of Redondo, California, the age of which is upper Miocene, the Delmontian stage of students of Foraminifera.

## **Coscinodiscus kurzii** Grunow.

(Figure 9.)

*Coscinodiscus kurzii* GRUNOW in Schmidt, Atlas Diat., pl. 113, 1888, fig. 17. LOHMAN, 1938. U. S. Geol. Surv. Prof. Ppr. 189C, pl. 20, fig. 1; pl. 21, fig. 2. Kettleman Hills, California. Pliocene.

The specimens we have examined agree almost entirely with the original figure in Schmidt's Atlas, even to the enlarged areolae in the center. The original locality is given simply as "Elephant Point," which Schmidt identified at times elsewhere in the Atlas as being in "Bengal."

## **Coscinodiscus lineatus** Ehrenberg.

(Figures 10, 11.)

*Coscinodiscus lineatus* EHRENBERG, 1838. Abh. Akad. Wiss. Berlin, p. 129 [1840]. EHRENBERG, Mikrog. 1854, pl. 18, fig. 33; pl. 22, fig. 6 a-b; pl. 35A, group 16, fig. 7. SCHMIDT, Atlas Diat., 1874, pl. 1, figs. 26-32. WOLLE, Diat. N. Amer. 1894, pl. 87, fig. 10. HANNA AND GRANT, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 2, p. 139, pl. 15, fig. 6. Maria Madre Island, Mexico.

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FIGURE 1. *Actinoptychus splendens* Shadboldt. Hypotype no. 3657 (CAS). Diameter, 0.1240 mm.

FIGURE 2. *Actinoptychus gruendleri* Schmidt. Hypotype no. 3658 (CAS). Diameter 0.160 mm.

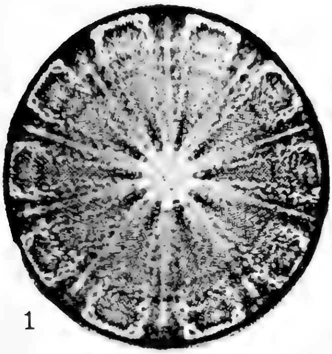
FIGURE 3. *Actinoptychus gruendleri* Schmidt. Hypotype no. 3659 (CAS). Diameter 0.1696 mm.

FIGURE 4. *Actinoptychus splendens* Shadboldt. Hypotype no. 3660 (CAS). Diameter 0.10 mm.

FIGURE 5. *Actinoptychus gruendleri* Schmidt. Hypotype no. 3661 (CAS). Diameter, 0.1512 mm.

FIGURE 6. *Stictodiscus hardmanianus* Greville. Hypotype no. 3662 (CAS). Diameter 0.0572 mm.

Specimens represented by figures 1-6 are from locality no. 39301 (CAS), eight kilometers south of Santiago, Baja California, and are deposited in the type collection of the Department of Geology of the California Academy of Sciences.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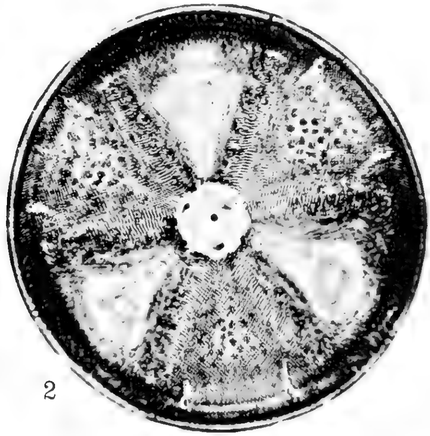
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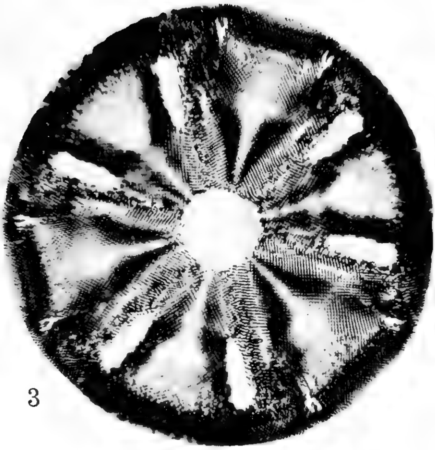
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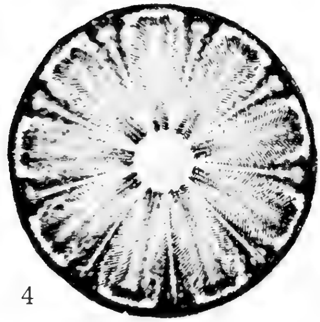
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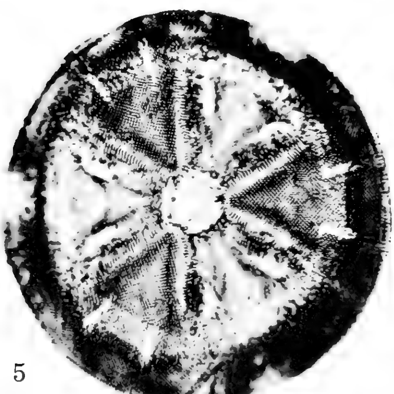
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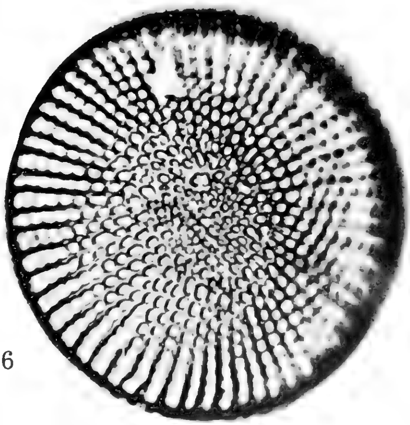
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This very common species is readily recognized by the regular spacing of the surface markings in a 60-degree pattern. There is much variation, especially in the border where there may actually be a series of very low projections. A form usually put in another genus has actual spines on the margin and also on the surface of the disk.

**Coscinodiscus evermanni** Hanna and Grant.

(Figures 12, 13.)

*Coscinodiscus evermanni* Hanna and Grant, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 2, p. 137, pl. 15, fig. 3. Maria Madre Island, Mexico.

The sharply raised zone near the border sets this diatom apart from any other which we have found in the literature. The nearest one it seems to resemble is *Craspedodiscus klavsdenii* Gruendler (Schmidt Atlas Diat., pl. 184, 1893, fig. 5, "Mors.") which, however, has much finer areolae. The structure of the diatom is best shown in a cross section such as that given in the Maria Madre Island paper cited above.

**Stictodiscus californicus** Greville.

(Figures 14, 16.)

*Stictodiscus californicus* Greville, 1861. Trans. Micr. Soc. London, n.s., vol. 9, p. 79, pl. 10, fig. 1, Monterey, fossil. Schmidt, Atlas Diat., pl. 74, 1882, figs. 4, 5. Hanna and Grant, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 2, p. 167, pl. 20, fig. 12. Maria Madre Island, Mexico. Lindsay, Pacific Discovery, vol. 18, no. 6, 1965, p. 22.

The species is common in many California deposits of upper Miocene age and was abundant in the heavy fraction of the Santiago, Baja California collection.

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Figure 7. *Coscinodiscus radiatus* Ehrenberg. Hypotype no. 3663 (CAS). Diameter, 0.1452 mm.

Figure 8. *Coscinodiscus kurzii* Grunow. Hypotype no. 3664 (CAS). Diameter, 0.1232 mm.

Figure 9. *Coscinodiscus floridulus* Schmidt. Hypotype no. 3665 (CAS). Diameter 0.1172 mm.

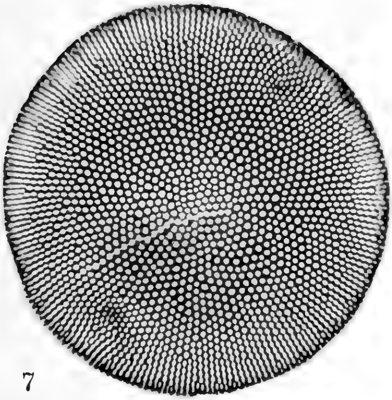
Figure 10. *Coscinodiscus lineatus* Ehrenberg. Hypotype no. 3666 (CAS). Diameter, 0.1068 mm.

Figure 11. *Coscinodiscus lineatus* Ehrenberg. Hypotype no. 3667 (CAS). Diameter, 0.0942 mm.

Figure 12. *Coscinodiscus evermanni* Hanna and Grant. Hypotype no. 3668 (CAS). Diameter, 0.1648 mm.

Figure 13. *Coscinodiscus evermanni* Hanna and Grant. Hypotype no. 3669 (CAS). Diameter 0.1704 mm.

Specimens represented by figures 7-13 are from locality no. 39301 (CAS), eight kilometers south of Santiago, Baja California, and are deposited in the type collection of the Department of Geology of the California Academy of Sciences.



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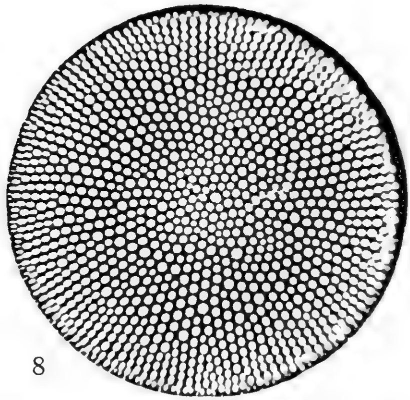

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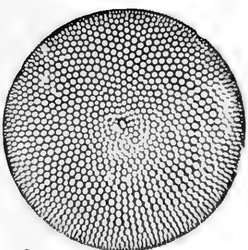

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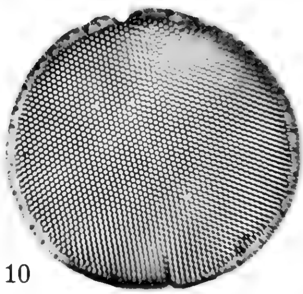

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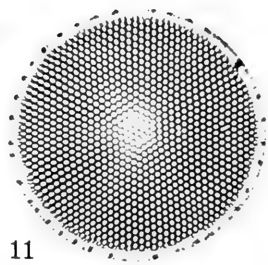

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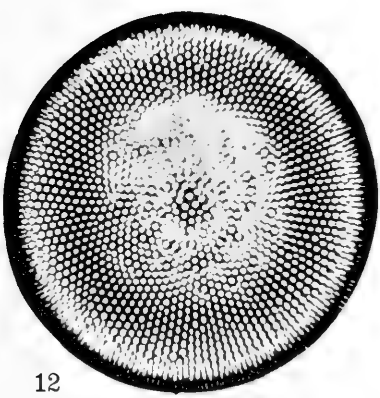

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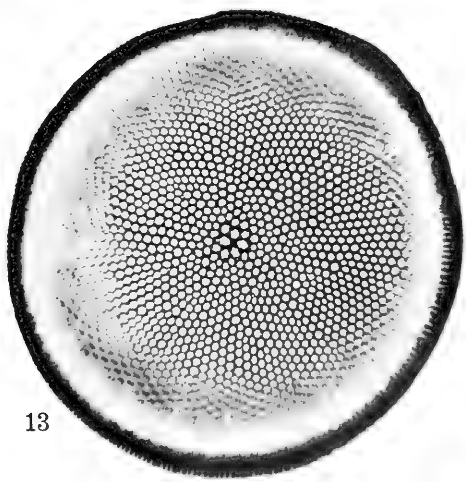

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**Eupodiscus radiatus** Bailey.

(Figures 15, 17.)

*Eupodiscus radiatus* Bailey, var. *antiquua* Cox, in Kain and Schultze, Bull. Torrey Bot. Club, vol. 16, no. 8, 1889, p. 209. Wolle, Diat. N. Amer., 1894, pl. 77, fig. 8.

*Eupodiscus antiquus* Cox, Hanna, 1932. Proc. Calif. Acad. Sci., ser. 4, vol. 20, p. 190. Middle Miocene, Sharktooth Hill, California.

The difficulties inherent in the unscrambling of names in this group were pointed out to a certain extent in the Sharktooth Hill paper in 1932. The border zone in the material from there was much heavier than in the present specimens and as illustrated in most figures. However, this hardly seems to warrant separation at this time. As pointed out by Hendey (1954, p. 540, footnotes 1 and 2), the International Botanical Congress at Stockholm, July, 1952, p. 71, conserved the genus name *Eupodiscus* in the manner in which Rattray (Journ. Roy. Micr. Soc., 1888, p. 909) used it.

**Auliscus sculptus** (W. Smith).

(Figure 18.)

*Eupodiscus sculptus* W. Smith, Syn. British Diat., vol. 1, 1853, p. 25, pl. 4, fig. 42.

*Auliscus sculptus* (W. Smith), Ralfs in Pritchard, 1861, p. 845, pl. 6, fig. 3.

*Auliscus coelatus* Bailey, 1854. Smithsonian Cont. Knowl., vol. 7, p. 6, pl. 1, figs. 3, 4. Schmidt, Atlas Diat., pl. 32, 1875, fig. 15. Monterey, fossil. Hanna and Grant, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 2, p. 129, pl. 13, fig. 8. Maria Madre Island, Mexico.

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Figure 14. *Stictodiscus californicus* Greville. Hypotype no. 3670 (CAS). Diameter, 0.1728 mm.

Figure 15. *Eupodiscus radiatus* Bailey. Hypotype no. 3671 (CAS). Diameter, 0.1424 mm.

Figure 16. *Stictodiscus californicus* Greville. Hypotype no. 3672 (CAS). Diameter, 0.1400 mm.

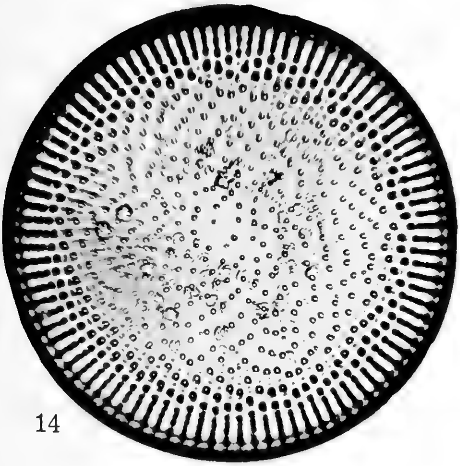
Figure 17. *Eupodiscus radiatus* Bailey. Hypotype no. 3673 (CAS). Diameter, 0.1488 mm.

Figure 18. *Auliscus sculptus* (W. Smith), Ralfs in Pritchard. Hypotype no. 3674 (CAS). Diameter, 0.0744 mm.

Figure 19. *Auliscus pruinosus* Bailey. Hypotype no. 3675 (CAS). Diameter, 0.090 mm.

Figure 20. *Auliscus pruinosus* Bailey. Hypotype no. 3676 (CAS). Diameter, 0.1164 mm.

Specimens represented by figures 14-20 are from locality no. 39301 (CAS), eight kilometers south of Santiago, Baja California, and are deposited in the type collection of the Department of Geology of the California Academy of Sciences.



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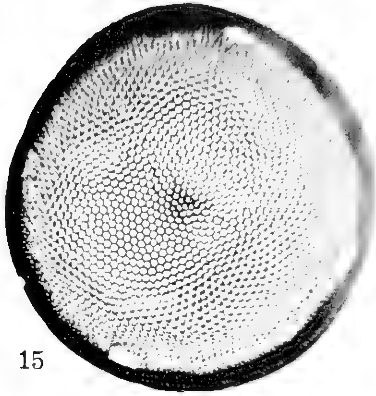

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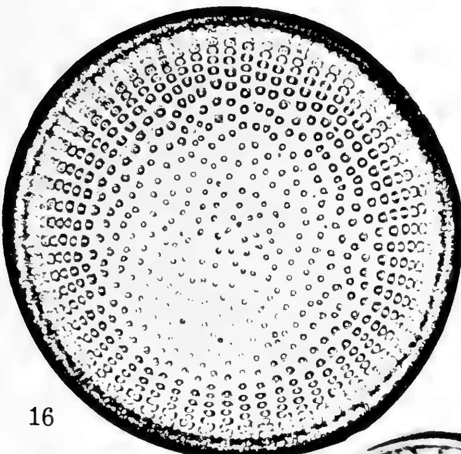

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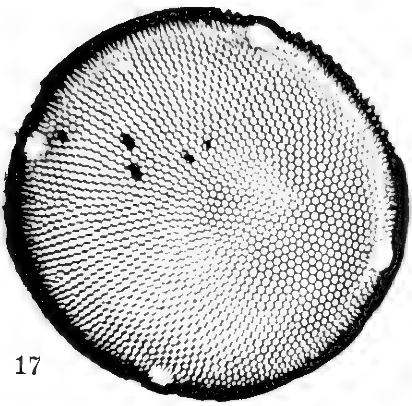

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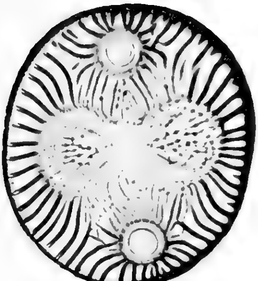

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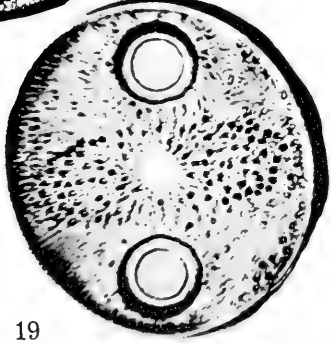

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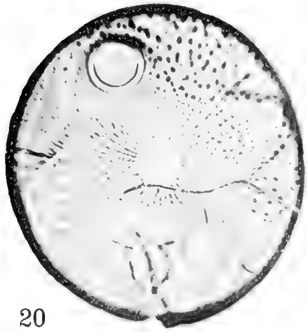

20

Although there are many species of *Auliscus* in west American deposits of diatomite, this is one of the most distinct and least variable. There is much confusion among the records in the literature between diatoms identified as *A. coelatus* and those called *A. sculptus*. The latter was described in 1853 and therefore has priority over Bailey's name. Hendey (1964, pp. 98-99) pointed out that the two names apply to the same species after he had examined Bailey's type slide and we agree fully that the later name should be reduced to synonymy.

**Auliscus pruinosus** Bailey.

(Figures 19, 20.)

*Auliscus pruinosus* Bailey, 1854. Smithsonian Cont. Knowl., vol. 7, p. 5, pl. 1, figs. 5-8. Schmidt, Atlas Diat., pl. 31, 1875, figs. 6, 7, 11, 13-15; pl. 32, 1875, fig. 5, pl. 108, 1886, fig. 10. Hanna and Grant, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, p. 130, pl. 13, fig. 10. Maria Madre Island, Mexico.

This is a common species at the Santiago, Baja California, locality. It is found in many west American deposits of upper Miocene age.

**Aulacodiscus scaber** Ralfs.

(Figure 21.)

*Aulacodiscus scaber* Ralfs, in Pritchard, Infusoria, ed. 4, 1861, p. 844. Schmidt, Atlas Diat., pl. 33, 1876, figs. 4-8.

This diatom, and the two following, have been identified for us by Dr. Joseph Burke of Staten Island Museum. He has been engaged in a special

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Figure 21. *Aulacodiscus scaber* Ralfs. Hypotype no. 3677 (CAS). Diameter, 0.1244 mm.

Figure 22. *Aulacodiscus thumii* Schmidt. Hypotype no. 3678 (CAS). Diameter, 0.1244 mm.

Figure 23. *Aulacodiscus margaritaceous* Bailey. Hypotype no. 3679 (CAS). 0.1488 mm.

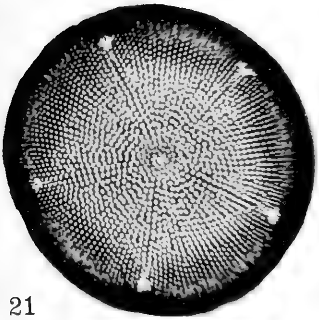
Figure 24. *Cerataulus imperator* Hanna and Grant. Hypotype no. 3680 (CAS). Major diameter, 0.1072 mm.; minor diameter, 0.100 mm.

Figure 25. *Surirella fastuosa* Ehrenberg. Hypotype no. 3681 (CAS). Major diameter, 0.1368 mm.; minor diameter, 0.1100 mm.

Figure 26. *Campylodiscus hodgsonii* W. Smith. Hypotype no. 3682 (CAS). Diameter, 0.140 mm.

Figure 27. *Campylodiscus kittonianus* Greville. Hypotype no. 3683 (CAS). Diameter, 0.0896 mm.

Specimens represented by figures 21-27 are from locality no. 39301 (CAS), eight kilometers south of Santiago, Baja California, and are deposited in the type collection of the Department of Geology of the California Academy of Sciences.



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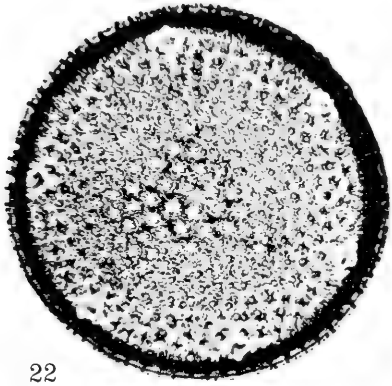

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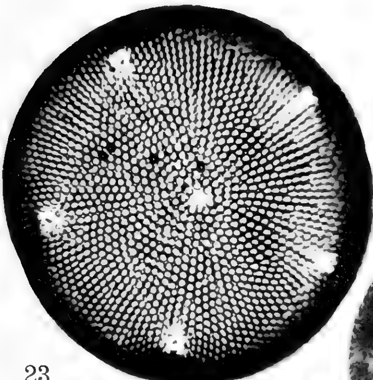

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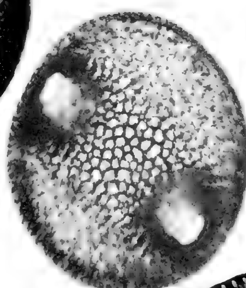

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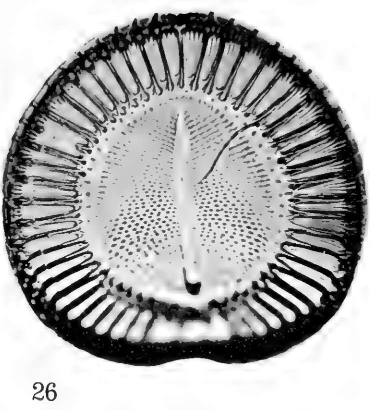

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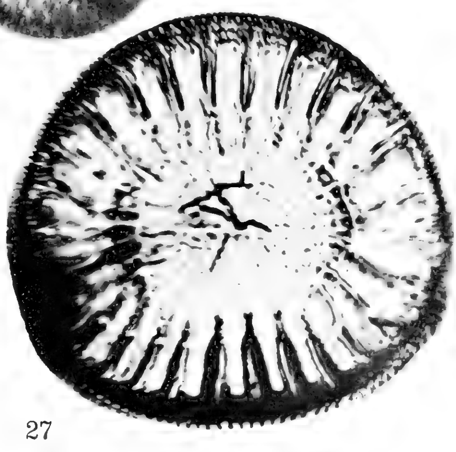

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study of the species of this genus for some time and it appears that when this is completed the group will not be so difficult to interpret as it has been in the past. The original specimens came from "Peruvian guano."

**Aulacodiscus thumii** Schmidt.

(Figure 22.)

*Aulacodiscus thumii* SCHMIDT, Atlas Diat., pl. 102, 1886, fig. 8.

There is some confusion over the application of the genus name *Eupodiscus* to this and a few other species which are obviously not very different from *Aulacodiscus*. Boyer selected the species *"argus"* as the genotype of *Eupodiscus*, but Hendey (1964, p. 97) placed that species in *Aulacodiscus*. The problem is entangled by some early ill-defined names resulting in large part from imperfections in the optics of microscopes of that early era.

**Aulacodiscus margaritaceous** Ralfs.

(Figure 23.)

*Aulacodiscus margaritaceous* RALFS in Pritchard, Infusoria, ed. 4, 1861, p. 844. SCHMIDT, Atlas Diat., pl. 37, 1876, figs. 1-8. "California."

Our specimens from Santiago, Baja California, agree very well with Ralfs' description and Schmidt's figures.

**Cerataulus imperator** Hanna and Grant.

(Figure 24.)

*Cerataulus imperator* HANNA AND GRANT, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 2, p. 134, pl. 14, fig. 9. Maria Madre Island, Mexico.

Diatoms of this genus are so convex and the processes are so high that they are very difficult to photograph. This present species has the surface markings heavier than most others. It has been referred to *C. ovalis* Schmidt (Atlas Diat., pl. 115, 1888, figs. 5-7) (by Mann in letter) but that is a much finer sculptured diatom and intergrading specimens have not been found thus far. It may be suspected that they do occur, because Schmidt's material was all recorded simply as from "Californien."

**Surirella fastuosa** Ehrenberg (?).

(Figure 25.)

*Surirella fastuosa* EHRENBERG, Abh. Akad. Wiss. Berlin, 1840, p. 214 [Mills]. EHRENBERG, C. G., Verbreitung und Einfluss des mikroskopischen Lebens in Süd-und Nord-Amerika. Abh. Akad. Wiss. Berlin, 1841 [1843], pl. 4, fig. 7. [This publication is often cited in diatom literature simply as "Amer."]

Most species of this genus are very attractive diatoms and this specimen, because of its simplicity, is especially so. However, if all of the published figures which have been referred to it or some of its "varieties" then it is one of the most protean of diatoms. Our specimen differs from any of the illustrations we have seen in that the marginal bars are very short, and except for the central spindle-shaped row of small dots, there are no apparent surface markings.

This may be of sufficient difference to consider the only specimen we found in the Santiago material, a new species, but under the circumstances it seems best to defer such action until more evidence is available. The closest approach to any of the illustrations we have seen is that of Pantocsek (1893, pl. 38, fig. 530), which he named *Surirella subfastuosa.*

**Campylodiscus hodgsonii** W. Smith.

(Figure 26.)

*Campylodiscus hodgsonii* W. SMITH, 1853. Syn. British Diat., vol. 1, p. 29, pl. 6, fig. 53. SCHMIDT, Atlas Diat., pl. 53, 1877, fig. 5. WOLLE, Diat. N. Amer., 1894, pl. 70, fig. 3.

*Campylodiscus imperialis* GREVILLE, 1860. Trans. Micr. Soc. London, n.s., vol. 8, p. 30, pl. 1, fig. 3. SCHMIDT, Atlas Diat., pl. 17, 1875, fig. 20; pl. 52, 1877, fig. 7; pl. 53, 1877, figs. 6, 7. Campechy Bay, Mexico.

Only a few specimens of this beautiful diatom were found in the Santiago, Baja California, samples.

**Campylodiscus kittonianus** Greville.

(Figure 27.)

*Campylodiscus kittonianus* GREVILLE, Trans. Micr. Soc. London, vol. 8, n.s., 1860, p. 32, pl. 1, fig. 7. SCHMIDT, Atlas Diat., pl. 16, 1875, verb. ed. 1885, figs. 19, 20.

Our specimen from Santiago, Baja California, agrees very well with Schmidt's figures. His specimens were supposed to have come from Samoa and Brazil and presumably were not fossils.

**Surirella patens** Schmidt.

(Figures 28, 29.)

*Surirella patens* SCHMIDT, Atlas Diat., pl. 4, 1874 [ed. 2, 1885], figs. 16, 17; pl. 56, 1877 [ed. 2, 1886], figs. 10, 11. HANNA AND GRANT, Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 2, 1926, p. 168, pl. 21, fig. 2. "Maria Madre Island, Mexico." Upper Miocene.

This is one of the earliest names which we have found for a large group of supposed species separated by very minute differences. One of these is *S. hybrida* (Grunow in Van Heurck, Syn. Diat. Belgique, pl. 73, 1881, fig. 18; Schmidt, Atlas Diat., pl. 358, 1925, figs. 1-7), which Van Heurck stated was one of numerous forms between *S. lata, S. macraena, S.*

*lorenziana*, and *S. patens*. Of these, *S. lata* is the earliest and seems to be a good representative of the entire group. There are several other names involved in the complex, but it may be as well to use *S. patens* until a comprehensive study of them all can be made.

In our search we have been able to match our figure 28 fairly closely among Schmidt's figures, but we have not found one to correspond with our figure 29 which has prominent markings across the central area.

### **Stephanopyxis pediastriformis** Forti.

(Figures 30, 31, 32.)

*Stephanopyxis pediastriformis* Forti, Cont. Diat. XI; Atti, Reale Instituto Veneto, p. 1310 (62). Forti, Cont. Diat. XIII; Atti del Reale Instituto Veneto du Scienze, Lettere ed Arti, Anno accademico 1912-1913, Tomo LXXII, pt. 2, 1913, pp. 1544-1546 (10-12) pl. 1, figs. 7, 12-17, 19-20. Middle Miocene, Marmorito, Italy.

A species to which we are referring, the one described from the Miocene of Italy, is abundant in the material from the outcrop south of Santiago on the road to Rancho El Refugio, Baja California. It is with some hesitation that this is done although Forti's figures are very good. They do not show the fine dots on the large areolae which are readily resolved on our specimens.

There is considerable doubt as to whether these diatoms should be referred to the genus *Stephanopyxis*, the type species of which is *Pyxidicula (Stephanopyxis) aculeata* Ehrenberg (1844, p. 264; 1854, pl. 18, fig. 124), selected by Boyer (1927, p. 35), Ehrenberg's 1854 figure, upon which the

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Figure 28. *Surirella patens* Schmidt. Hypotype no. 3684 (CAS). Length, 0.1920 mm.

Figure 29. *Surirella patens* Schmidt. Hypotype no. 3685 (CAS). Length, 0.1640 mm.

Figure. 30. *Stephanodiscus pediastriformis* Forti. Hypotype no. 3686 (CAS). Diameter, 0.0632 mm., abnormal specimen.

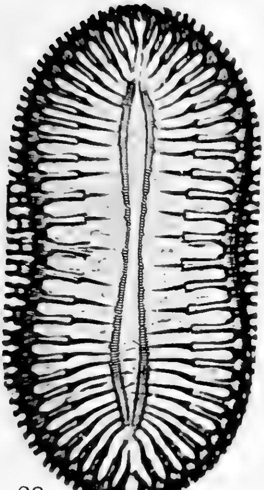
Figure 31. *Stephanodiscus pediastriformis* Forti. Hypotype no. 3687 (CAS). Diameter, 0.0752 mm.

Figure 32. *Stephanodiscus pediastriformis* Forti. Hypotype no. 3688 (CAS). Diameter, 0.060 mm.

Figure 33. *Hemidiscus cuneiformis* Wallich. Hypotype no. 3689 (CAS). Length, 0.1656 mm.

Figure 34. *Triceratium tabellarium* Brightwell. Hypotype no. 3690 (CAS). Length of one side 0.1584 mm.

Specimens represented by figures 28-34 are from locality no. 39301 (CAS), eight kilometers south of Santiago, Baja California, and are deposited in the type collection of the Department of Geology of the California Academy of Sciences.



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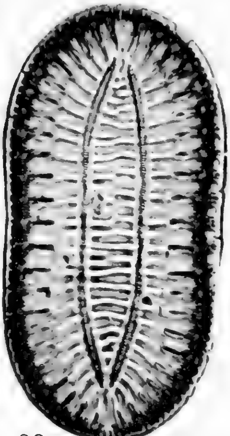

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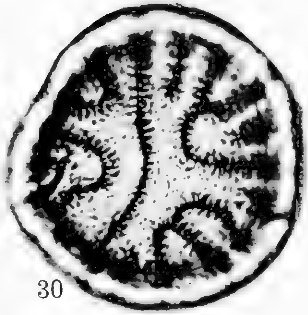

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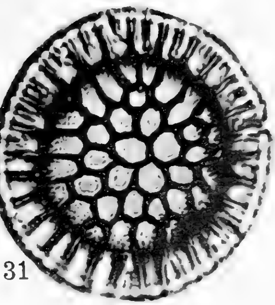

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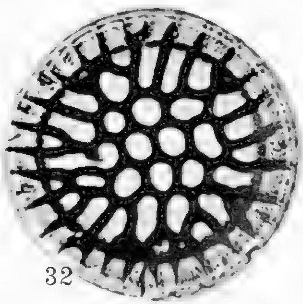

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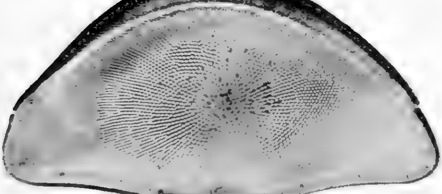

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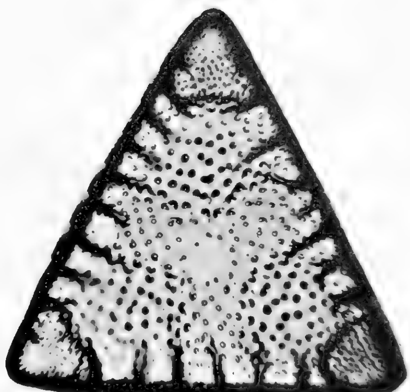

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species and genus must be based, unless officially ruled otherwise, is not very satisfactory as Grunow pointed out (1884, pp. 34-40). *Dictyopyxis, Peristephania,* and *Systephania* are best considered to be synonyms although the first has priority of two pages over *Stephanopyxis.*

For the present we consider figure 30 to represent an abnormal specimen of *S. pediastriformis.* It may not be possible to separate these diatoms with the very large aerolae from those which have smaller markings. Several names are involved and until an analytic study of the entire genus is made it seems best to identify our specimens with well reproduced illustrations.

**Hemidiscus cuneiformis** Wallich.

(Figure 33.)

*Hemidiscus cuneiformis* Wallich, 1860. Trans. Micr. Soc. London, vol. 8, n.s., p. 42, pl. 2, figs. 3, 4. Hustedt, 1930, Kieselalgen, vol. 7, pl. 5, p. 904, fig. 542, a-h.

This is a fairly common diatom in the Santiago, Baja California, deposit. It has received many names, but probably very few can be considered to be distinguishable. Two, *H. nivalis* and *H. simplicissimus,* were described as new from the deposit on Maria Madre Island, Mexico, on the basis of sculpture and largely through lack of literature as well as comparative material. It seems likely that they would be better kept with *H. cuneiformis.*

**Triceratium tabellarium** (Brightwell).

(Figure 34.)

*Triceratium tabellarium* Brightwell, 1856. Quart. Journ. Micr. Sci., p. 275, pl. 17, fig. 15. Schmidt, Atlas Diat., pl. 77, 1882, figs. 1, 2. Wolle, Diat. N. Amer., 1894, pl. 100, fig. 1.

*Biddulphia riedyi* Hanna and Grant, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, p. 132, pl. 14, fig. 6. Maria Madre Island, Mexico.

If minor variation be overlooked, this is one of the most distinctive and common of the tricerati. There are several synonyms. The species is common in the sample studied. Oddly enough, no other species of this genus was found after a reasonable amount of search of well cleaned and segregated material.

**Navicula variolata** Cleve.

(Figures 35, 37.)

*Navicula variolata* Cleve, 1892. Le Diatomiste, vol. 1, p. 76, pl. 12, fig. 7. "Oamaru," New Zealand.

Schmidt (pl. 174, 1892, fig. 26) illustrated a diatom under the name *Navicula variolata* Cleve and which was stated to have come from "Oamaru"

[New Zealand]. Our specimens bear a close resemblance to that figure. Although it may be doubted that an upper Miocene *Navicula* in Baja California would be the same species as one from Oligocene or upper Eocene halfway around the world, we leave the identification that way for want of a better one.

**Navicula hennedyi** Smith.

(Figures 36, 38, 40, 42.)

*Navicula hennedyi* Smith, Syn, British Diat., vol. 2, 1856, p. 93. Schmidt, Atlas Diat., pl. 3, 1874, figs. 17, 18.

We group under the name *N. hennedyi* diatoms having a general lyrate marking in the center which is more or less swollen. In *N. lyra* the width of this line is fairly uniform until near the ends.

**Navicula californica** Greville.

(Figure 39.)

*Navicula californica* Greville, New Phil. Journ., vol. 10, n.s., 1859, p. 29, pl. 4, fig. 5. Schmidt, Atlas Diat., pl. 3, 1874, fig. 16. Wolle, Diat. N. Amer., 1894, pl. 14, fig. 17.

*Navicula stippi* Hanna and Grant, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 2, p. 156, pl. 17, fig. 12. Maria Madre Island, Mexico.

This species was described from material sent to England about the middle of the last century from the deposit at Monterey, California, It, and many other species were recorded from "Monterey Stone" and this has since been determined to be very close to the upper boundary of the Miocene. This part has been named the "Del Montian Stage" by Robert Kleinpell and was based upon a thorough study of Foraminifera. The species is not as common in the Baja California samples as are some of the other members of the genus. There are other synonyms besides the one listed above.

**Navicula spectabilis** Gregory.

(Figure 41.)

*Navicula spectabilis* Gregory, Trans. Roy. Soc. Edinburgh, vol. 21, pt. 4, 1857, p. 9, pl. 1, fig. 10. Schmidt, Atlas Diat., pl. 3, 1874, figs. 20, 21. Hanna and Grant, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 2, p. 156, pl. 19, fig. 2. Maria Madre Island, Mexico.

This is another of a group of *Navicula*, the members of which are far from uniform in shape or surface markings. This has led to a very large number of names both binomial and polynomial. The chief distinguishing feature of the specimens which we have referred to the name consists of the central inward projecting of the lateral, heavily striated zones.

**Navicula praetexta** (Ehrenberg).

(Figures 43, 44.)

*Pinnularia (Mononeis) praetexta* EHRENBERG, Monatsber. Akad. Wiss. Berlin, 1844, p. 62, 73 ff.

*Pinnularia praetexta* EHRENBERG, Mikrogeol, 1854, pl. 19, fig. 28. "Thon aus Aegina." Greece.

*Navicula praetexta* (Ehrenberg), GREGORY, 1857. Trans. Roy. Soc. Edinburgh, vol. 21, pt. 4, pp. 9-12, pl. 1, fig. 11. HANNA AND GRANT, 1926. Proc. Calif. Acad. Sci., vol. 15, no. 2, p. 154, pl. 18, figs. 10, 11, 12. Maria Madre Island, Mexico.

In a long discussion of this species, Gregory was led to believe that the locality from which Ehrenberg's material came, was the most ancient record of diatoms at that time. He considered the Aegina deposit to be Eocene or possibly Cretaceous and since his own specimens were living in the Firth of Clyde, he was inclined to believe that all diatom species were still living. Our specimens agree very well with Gregory's figure. The species has been recorded many times from western North America.

**Navicula lyra** Ehrenberg.

(Figure 45.)

*Pinnularia lyra* EHRENBERG, Monatsber, Akad. Wiss. Berlin, 1845, p. 315.

*Navicula lyra* (Ehrenberg), GREGORY, 1857. Trans. Roy. Soc. Edinburgh, vol. 21, pt. 4, p. 14, pl. 1, figs. 14, 14b. HANNA AND GRANT, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 2, p. 152, pl. 18, fig. 5. Maria Madre Island, Mexico.

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FIGURE 35. *Navicula variolata* Cleve. Hypotype no. 3691 (CAS). Length, 0.1300 mm.

FIGURE 36. *Navicula hennedyi* Smith. Hypotype no. 3692 (CAS). Length, 0.0844 mm.

FIGURE 37. *Navicula variolata* Cleve. Hypotype no. 3693 (CAS). Length, 0.1240 mm.

FIGURE 38. *Navicula hennedyi* Smith. Hypotype no. 3694 (CAS). Length, 0.1112 mm.

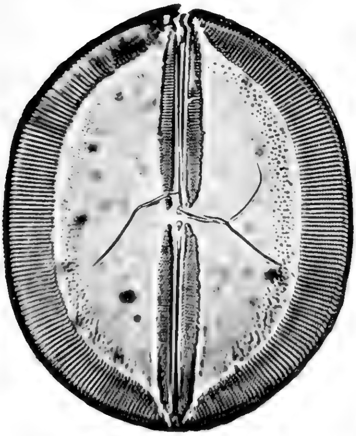
FIGURE 39. *Navicula californica* Greville. Hypotype no. 3695 (CAS). Length, 0.1065 mm.

FIGURE 40. *Navicula hennedyi* Smith. Hypotype no. 3696 (CAS). Length, 0.1392 mm.

FIGURE 41. *Navicula spectabilis* Gregory. Hypotype no. 3697 (CAS). Length, 0.1168 mm.

FIGURE 42. *Navicula hennedyi* Smith. Hypotype no. 3698 (CAS). Length 0.1168 mm.

Specimens represented by figures 35-42 are from locality no. 39301 (CAS), eight kilometers south of Santiago, Baja California, and are deposited in the type collection of the Department of Geology of the California Academy of Sciences.



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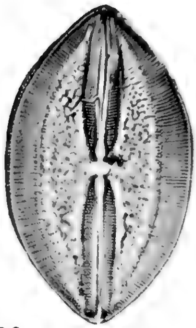

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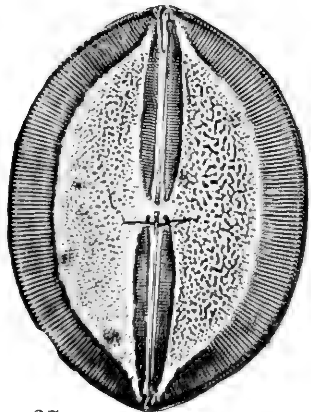

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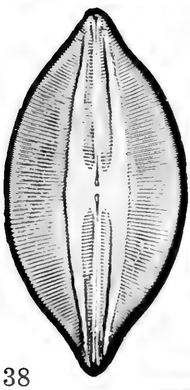

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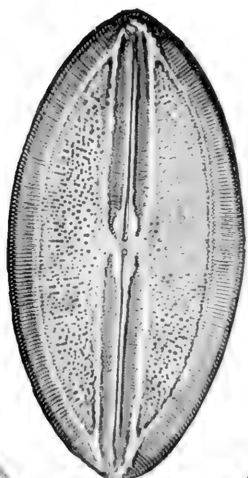

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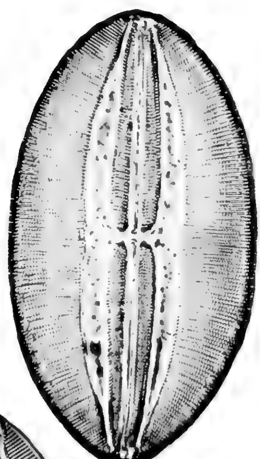

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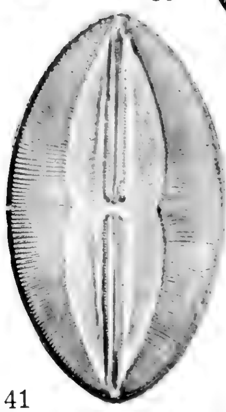

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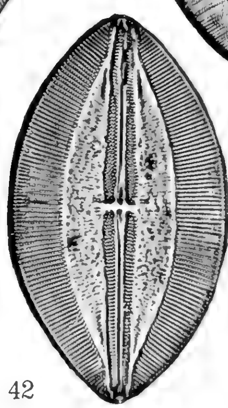

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Many minor variations of this species have received names but it is believed that they serve no useful purpose except to show how many forms it may take. It was fairly common in the Baja California samples.

**Navicula clavata** Gregory.

(Figure 46.)

*Navicula clavata* Gregory, 1856. Trans. Micr. Soc. London, n.s., vol. 4, p.46, pl. 5, fig. 17. Schmidt, Atlas Diat., pl. 3, 1874, fig. 13; pl. 70, 1881, fig. 50; pl. 129, 1888, fig. 16. Hanna and Grant, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 2, p. 140, pl. 17, fig. 7. Maria Madre Island, Mexico.

Only a few specimens were found in the Santiago, Baja California, deposit which come close to the figures cited above. Its characters place it between *N. lyra* and *N. hennedyi* as Mann (1907, p. 340) pointed out. If, as seems likely, the number of nominal species in this group of *Navicula* is reduced, then forms such as *clavata* will probably be placed in *Navicula lyra.*

**Diploneis crabro** Ehrenberg.

(Figures 47, 48.)

*Pinnularia (Diploneis) crabro* Ehrenberg, Monatsber. Akad. Wiss. Berlin, 1844, p. 85. "Thon aus Aegina." Greece.

*Diploneis crabro* Ehrenberg, Mikrogeologie, 1854, pl. 19, fig. 29, a, b, c. Hendey, Journ. Roy. Micr. Soc., vol. 71, 1951, p. 59, pl. 16, fig. 13.

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Figure 43. *Navicula praetexta* Ehrenberg. Hypotype no. 3699 (CAS). Length, 0.1580 mm.

Figure 44. *Navicula praetexta* Ehrenberg. Hypotype no. 3700 (CAS). Length, 0.1256 mm.

Figure 45. *Navicula lyra* Ehrenberg. Hypotype no. 3701 (CAS). Length, 0.1360 mm.

Figure 46. *Navicula clavata* Gregory. Hypotype no. 3702 (CAS). Length, 0.0856 mm.

Figure 47. *Diploneis crabro* Ehrenberg. Hypotype no. 3703 (CAS). Length, 0.170 mm.

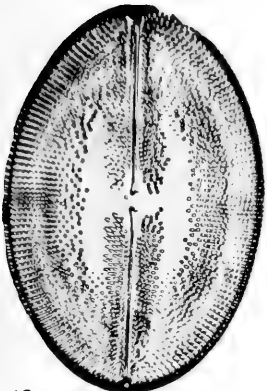
Figure 48. *Diploneis crabro* Ehrenberg. Hypotype no. 3704 (CAS). Length, 0.1360 mm.

Figure 49. *Diploneis densistriata* Schmidt. Hypotype no. 3705 (CAS). Length, 0.108 mm.

Figure 50. *Plagiogramma validum* Greville. Hypotype no. 3706 (CAS). Length, 0-140 mm.

Figure 51. *Plagiogramma tessellatum* Greville. Hypotype no. 3707 (CAS). Length, 0.1720 mm.

Specimens represented by figures 43-51 are from locality no. 39301 (CAS), eight kilometers south of Santiago, Baja California, and are deposited in the type collection of the Department of Geology of the California Academy of Sciences.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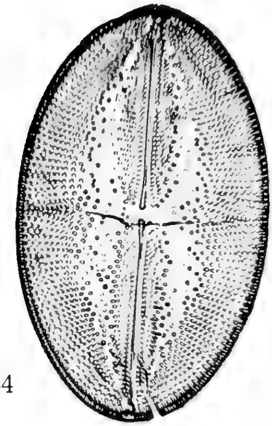
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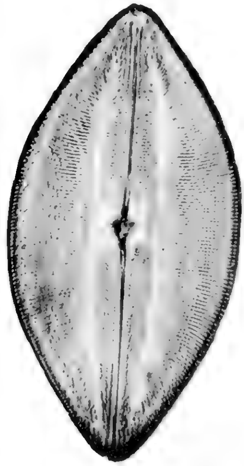
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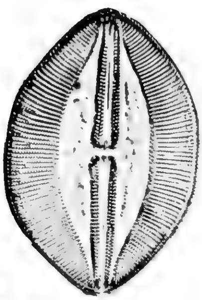
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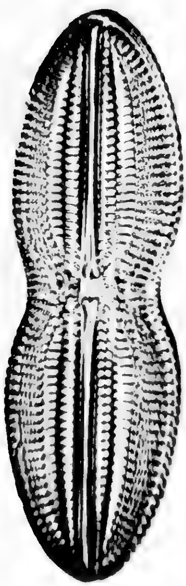
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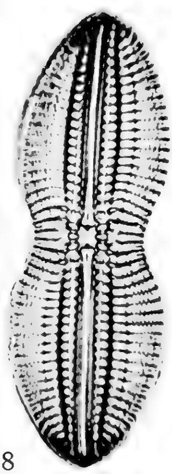
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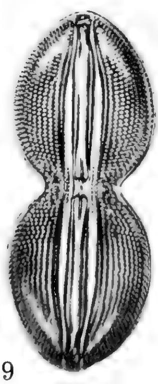
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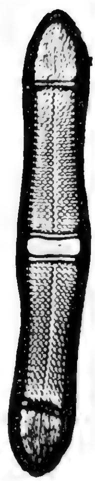
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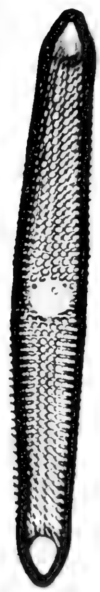
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There is definite need for giving a broad interpretation to species such as this which pass through a multiplicity of minor variations all connected by intermediate individuals.

**Diploneis densistriata** Schmidt.

(Figure 49.)

*Navicula bombus* var. *densistriata* Schmidt, Atlas Diat., pl. 13, 1875, figs. 11, 12. "California."

*Navicula densistriata* Schmidt, Hanna and Grant, 1926. Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 2, p. 150, pl. 17, figs. 8-10. Maria Madre Island, Mexico.

There is certainly reason to doubt if the fineness of the surface markings of Schmidt's figures are sufficiently constant and distinct from what might be considered a typical specimen of *Diploneis bombus*. However, this may be, the specimens we found in the Baja California samples do not differ greatly from those found in the deposit on Maria Madre Island.

**Plagiogramma validum** Greville.

(Figure 50.)

*Plagiogramma validum* Greville, 1859. Quart. Journ. Micro. Sci., vol. 7, p. 209, pl. 10, fig. 8. "California Guano." Wolle, Diat. N. Amer. 1894, pl. 45, figs. 8, 9. California and Campechy Bay, Mexico.

The hyaline area in the center of this species is rectangular, the sides are slightly smaller than in the species *tessellatum* which is also present in the Santiago deposit.

**Plagiogramma tessellatum** Greville.

(Figure 51.)

*Plagiogramma tessellatum* Greville, 1859. Quart. Journ. Micr. Sci., vol. 7, p. 208, pl. 10, fig. 7. "California guano." Wolle, 1894. Diat. N. Amer., pl. 45, figs. 18, 19.

The central hyaline area of this species is usually nearly circular and the sides are not constricted above and below the center as in *P. validum*. The species is rather common in the Santiago deposit.

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**PROCEEDINGS**

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FOURTH SERIES

Vol. XXX, No. 16, pp. 309-355, figs. 1-23. December 30, 1966.

# THE GULF ISLANDS EXPEDITION OF 1966

**By**

**George E. Lindsay**

*Director*

*California Academy of Sciences*

The Gulf Islands Expedition of 1966 was a joint venture by the California Academy of Sciences, and San Diego Natural History Museum, and the Instituto de Biología of Mexico. Thirteen scientists from those institutions participated in the 10-day cruise, 19-29 April, to 13 islands in central Gulf of California. The expedition was financed partly by a grant from the Belvedere Scientific Fund of San Francisco and partly from a National Science Foundation grant to the San Diego Natural History Museum.

The biogeography of the islands of the Gulf of California, and the systematic classification of the organisms of that region, have long interested scientists from the Academy and the Museum. Their most recent field work in that area includes the Belvedere Expedition of the Museum in 1962 (Lindsay, 1962) which visited 32 islands on a 43-day cruise; the Sea of Cortez Expedition of the Academy in 1964 (Lindsay, 1964; Orr, 1965), which worked the islands south of Loreto between 20 June and 4 July; and the Gulf of California Expedition in 1965 which from 9-20 August again concentrated on the southern area. In addition the personnel of the Natural History Museum carry on continuing investigations of the biota and geology of the region near the Museum's Vermilion Sea Field Station at Bahía de los Angeles, Baja California.

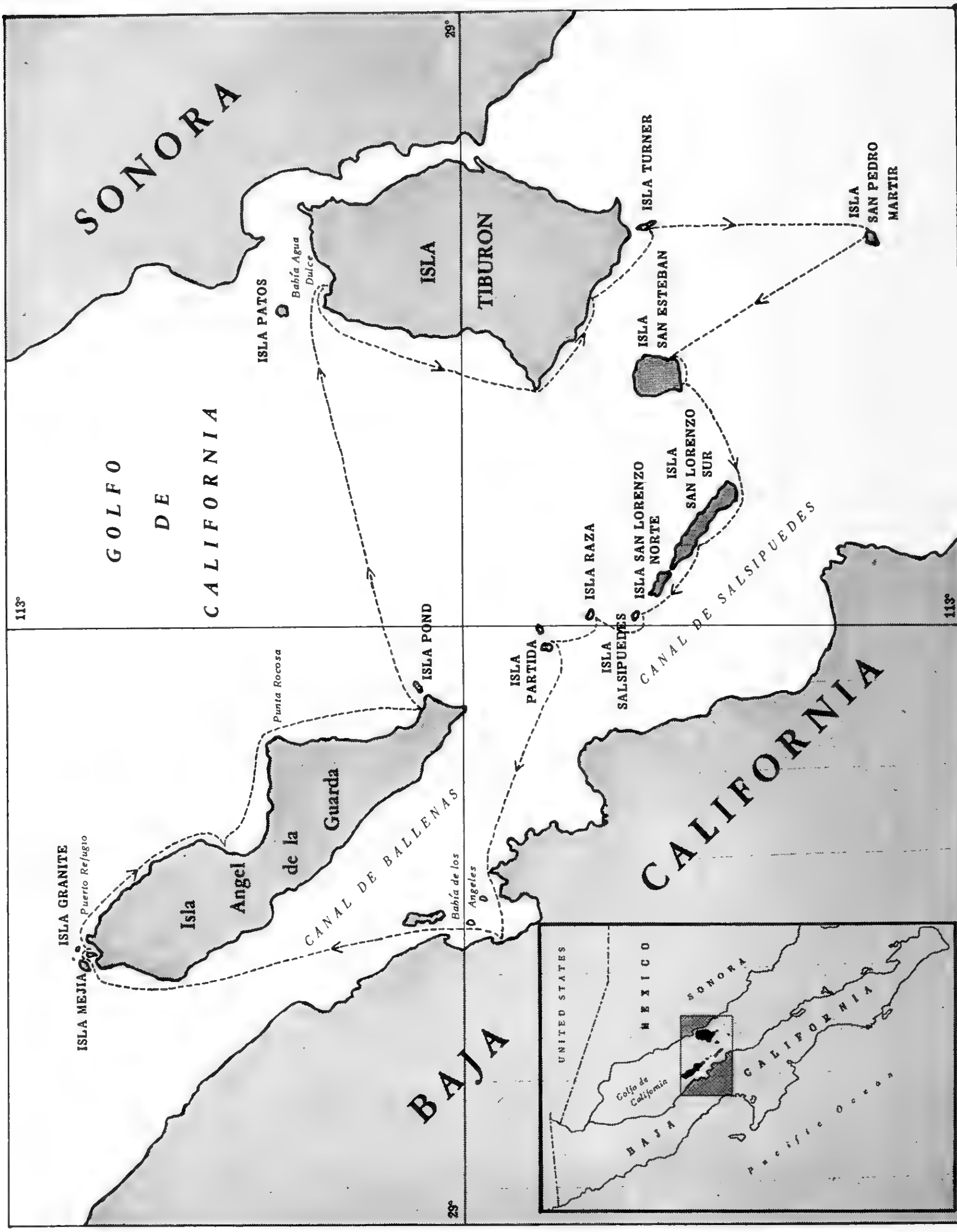


Figure 1. Route of *San Agustin II* to northern Gulf of California islands shown on expedition-route chart. (From Lindsay, Pacific Discovery, vol. 19, no. 5, p. 3, October, 1966.) (Drawn by D. Ludlow.)

Having concentrated on the southern Gulf of California during the previous two summers, Academy personnel were anxious to survey the islands of the central portion. Dr. Alejandro Villalobos F., Chief of the Hydrobiology Section of the Instituto de Biología, who participated in the two previous trips, was also interested in exploring farther north. The San Diego Natural History Museum was approached and agreed to co-sponsor an expedition. An 85-foot motor vessel, *San Agustin II*, belonging to Mr. Antero Diaz, of Bahía de los Angeles, was chartered. Mr. Diaz has supplied his vessel for several biological cruises, and he and his crew were most pleasant, cooperative, and helpful.

The scientific party included:

George E. Lindsay, Director, California Academy of Sciences
Richard P. Phillips, Director, San Diego Natural History Museum, geologist
Alejandro Villalobos F., Chief, Sección de Hidrobiología, Instituto de Biología, invertebrate zoologist
Robert T. Orr, Associate Director, California Academy of Sciences, mammalogist and ornithologist
Tom Tilton, Trustee of the California Academy of Sciences, observer
Reid Moran, San Diego Natural History Museum, botanist
Richard C. Banks, San Diego Natural History Museum, mammalogist and ornithologist
Allan J. Sloan, San Diego Natural History Museum, herpetologist
Dustin Chivers, California Academy of Sciences, invertebrate zoologist
Virgilio Arenas F., Instituto de Biología, assistant to Dr. Villalobos
Raymond Bandar, California Academy of Sciences, assistant to Dr. Orr
Ken Lucas, California Academy of Sciences, collector
Luis Baptista, California Academy of Sciences, collector.

It is felt that a brief narrative log and itinerary of this cruise may be of use to others who are interested in the Gulf of California. The scientific results of an expedition will appear, sooner or later, in diverse publications, and this is but a preliminary report.

The islands visited were:

Isla Angel de la Guarda, 19-22 April
Isla Mejía. 19-21 April
Isla Granite, 20-21 April
Isla Pond (Isla Víbora, Isla Estanque), 22-23 April.
Isla Tiburón, 23-25 April
Isla Patos, 23 April
Isla Turner, 24-25 April
Isla San Pedro Mártir, 25-26 April
Isla San Esteban, 26-27 April
Isla San Lorenzo Sur, 27-28 April
Isla Salsipuedes, 28 April
Isla Raza, 28 April
Isla Partida Norte (Cardonosa), 28 April

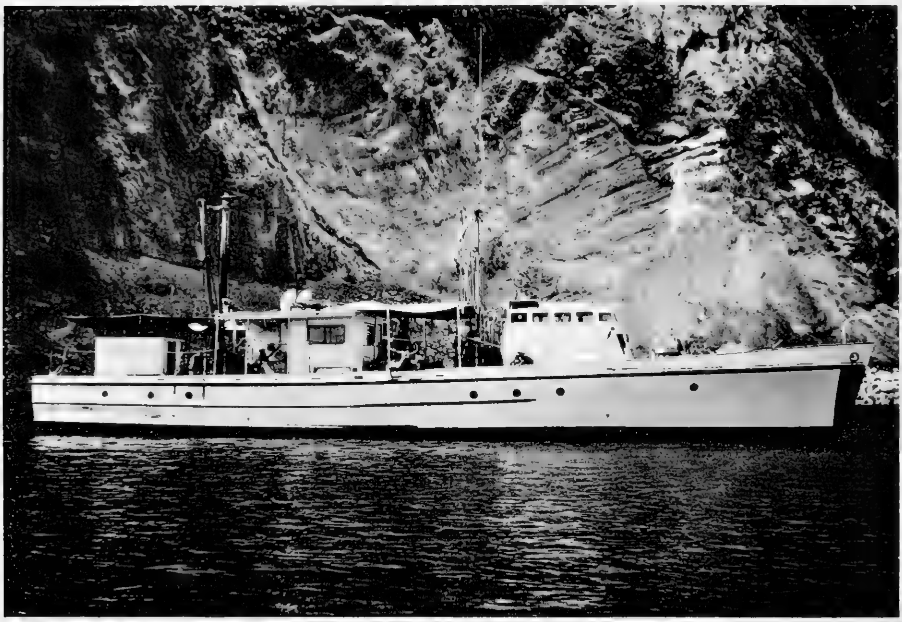

FIGURE 2. The 85-foot motor vessel, *San Agustin II*, was chartered for the expedition. (Photo by Tilton.)

## LOG OF THE EXPEDITION

**19 April 1966. San Francisco, California to Puerto Refugio, Isla Angel de la Guarda, Baja California.**

Orr, Tilton, Chivers, and Bandar departed from San Francisco by air at 0700, and were met in San Diego by Phillips, Moran, Banks, and Sloan. At the Tijuana International Airport, they were joined by Villalobos and Arenas who had flown up from Mexico City. Victor Corral, one of the fine pilots that fly for the Servicio Aero Baja of Captain Francisco Muñoz, took the party to Bahía de los Angeles, where they arrived at 1145. Gear brought down by the scientists and equipment from the Vermilion Sea Field Station, maintained at Bahía de los Angeles by the Natural History Museum, were loaded aboard the *San Agustin II*, which after lunch departed for the north end of Isla Angel de la Guarda. Eight large finback whales were sighted in the distance in Ballenas Channel, and a school of many hundreds of dolphins, *Delphinus bairdii*, were about the boat for 15 or 20 minutes, swimming on either side of the bow, and often leaping clear of the water. The ship anchored between Isla Angel de la Guarda and Isla Mejía at dusk.

Isla Angel de la Guarda is 42 miles long, with a maximum width of about 10 miles. It is separated from Baja California by the Ballenas Channel which is about 8 to 13 miles wide. Tidal currents may reach a velocity of 6 knots in the channel (Roden and Groves, 1959).

This is a rugged island, with precipitous mountains which drop away into the sea, particularly on its west side. No permanent supply of fresh water is known on the island, but native palms *(Erythea armata)* in canyons on the east side may indicate possible sources. The island is not inhabited.

There is a fine bay at the north end, Puerto Refugio, formed by an indentation between two headlands, with additional protection from three small islands, Isla Mejía, Isla Granite, and a smaller one, about ½ mile long, which has no name.

Isla Mejía, which is at the northwest side of Puerto Refugio, is about 1½ miles long, 1 mile wide, and 850 feet high. Isla Granite, which protects the harbor from the north, is about 1600 yards long, 300 yards wide, and 281 feet high.

Banks and Bandar set small mammal traps on Isla Mejía after dark, and Sloan looked for reptiles. There was considerable luminescence in the water, and many sizable luminescent organisms were noted.

Figure 3. Bahía de los Angeles, Baja California. (Photo by Tilton.)

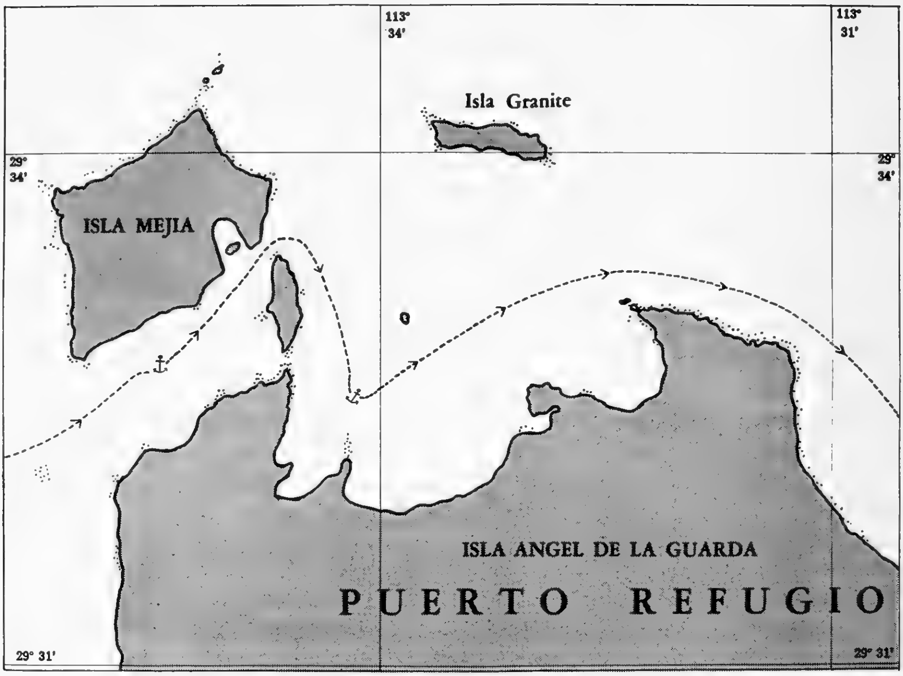


FIGURE 4. Detail of area showing north end of Isla Angel de la Guarda and adjacent islands. (Drawn by D. Ludlow.)

**20 April 1966. Puerto Refugio.**

Moran landed about 5 miles south of Puerto Refugio and climbed a 1100-meter (3600 feet) peak, which is perhaps the highest on Isla Angel de la Guarda. The opportunity to study the plants on this peak was his most important objective on the trip, and the day's work yielded seven additions to the known flora of the island. Perhaps the most interesting was *Leptodactylon pungens* ssp. *hallii*. He also saw *Idria columnaris*, which he had previously found on another high peak of the same island.

Phillips studied the geology of the west side of Isla Angel de la Guarda, about 12 miles from the north end. Here a "younger" sequence of volcanic flows, breccias, and sediments rest unconformably on massive andesitic and rhyolitic volcanics that make up the bulk of the mountains. A period of faulting is marked by a zone of intense hydrothermal alteration and silicification. These silicified rocks are included among the clasts in gently dipping conglomerates and sandstones which are truncated by coastal terraces which occur at an elevation of about 60 feet.

Orr, Banks, and Bandar landed on Isla Mejía to collect their traps before breakfast and took specimens of *Peromyscus guardia* and *Perognathus spinatus*. Then Orr and Tilton spent the morning on Isla Granite observing pelicans and sea lions. There were several thousand pelicans, mostly in great aggregations on points of rocks and beaches. Many nests were built of twigs and other debris, on rocks or fallen cardón cacti on the steep western slope of the island. The nests usually contained from one to three eggs, or one or two newly hatched naked young which could be heard calling 50 to 100 feet away. The brooding or incubating adults were rather timid and flew when approached closer than 20 or 30 feet.

Sloan was ashore on Isla Mejía at 0600 and took a good series of the endemic rock lizard *(Petrosaurus slevini)*, as well as side-blotched lizards *(Uta stansburiana)* and chuckwallas *(Sauromalus hispidus)*.

Villalobos and Arenas settled into their routine of the trip, which consisted of making plankton hauls with the small boat, intertidal collecting during periods of low water, processing their large collections, and frequent excursions ashore for nonmarine organisms. At Puerto Refugio, particularly, an intensive study of the intertidal ecological zonation was made, with collections of representative species of plants and animals, a full photographic record, and written descriptions. This area was later compared with the in-

Figure 5. Puerto Refugio, Isla Angel de la Guarda. (Photo by Orr.)

Figure 6. Robert T. Orr photographed ospreys on Isla Angel de la Guarda. (Photo by Tilton.)

tertidal areas at Estero de la Víbora near the south end of Isla Angel de la Guarda, at Bahía Agua Dulce on Isla Tiburón, on Isla San Esteban, and on Isla Salsipuedes.

Chivers made as complete a synoptic collection of the marine invertebrates as was possible, working in the intertidal zone during low water, and diving. Orr, Tilton, and others assisted him from time to time. The specimens taken were of unusual interest, because they complemented the collections from the southern area which Chivers had made in the summers of 1964 and 1965. The unique physical factors of great tidal range, strong currents, cold upwellings, and beach topography contribute to the development of quite different invertebrate assemblages from those found farther south. This northern area has many endemic species which were very poorly represented or were entirely lacking in the Academy collections.

Banks spent the morning on the main island, observing birds, and collected a Vaux swift, a new record. Mockingbirds with young were particularly common and conspicuous. Banks also collected an endemic rattlesnake *(Crotalus mitchelli angelensis)*, as did Bandar.

Orr, Banks, and Bandar went to Isla Mejía in the late afternoon to set traps up one of the arroyos.

**21 April 1966. Puerto Refugio to the south end of Isla Angel de la Guarda.**

The mammalogists were ashore on Isla Mejía at daybreak, to collect their traps and catch. Banks found that one mouse, caught by its tail, had been swallowed by a snake up to the trap. Most of the party spent the morning on the main island, at the south side of Puerto Refugio. Moran worked Isla Mejía as well, but having been there previously, found little of particular interest. Orr and Tilton photographed an osprey nest, with the handicap of being the targets of disconcerting dives of the screaming parent birds, and recorded the unstable maiden flight and crash landing of one of the young ospreys.

Phillips worked the geology of the west side of Puerto Refugio, and found an extensive section of the "younger" volcanic sequence exposed, unconformably on top of metamorphic basement. His careful search failed to reveal any fossils in the volcanic sediments. Sea cliffs cutting into fanglomerate filled valleys, with no evidence of marine deposition, indicate recent subsidence of that area.

Phillips also found a "long-dead" dolphin on the beach, and Diaz took Orr, Tilton, and Bandar to investigate. It was identified as *Delphinus bairdii* and the skull was collected.

The anchor was lifted at 1250 and the party cruised along the east side of Angel de la Guarda. At 1500 a stop was made at a lagoon called Estero del Pulpito. Reddish egrets, elegant terns, and American oystercatchers were observed, and western gulls were nesting on the strand which separates the lagoon from the beach. The nests contained one to three eggs. Moran reported that the plants he found were predried, and Banks picked up a sea lion mummy.

Anchorage was made after dark in the broad Bahía Cardoncito, north and west of Isla Pond, which is also called Víbora and Estanque. Isla Pond is only about 1 mile long and 400 feet wide. After dinner, Bandar and Sloan went ashore on Isla Angel de la Guarda and collected a rattlesnake *(Crotalus ruber)*, and two leaf-nosed bats *(Macrotus californicus)*. The crew caught a turtle.

**22 April 1966. Isla Angel de la Guarda and Isla Pond (Víbora, Estanque).**

At 0650 Moran went ashore for a day on Angel de la Guarda. He walked west across the insular divide, climbed a low peak on the divide, and then followed a twisting arroyo southeasterly to the beach, arriving just before dark. He got two new plant records for the island on the barren-looking peak.

Phillips, too, spent most of the day on the big island, making a geological reconnaissance. He found a gently sloping surface rising from sea cliffs to at least 600 feet at the base of mountains some 2 miles inland. This surface is developed on coarse, well cemented conglomerate and sand-

Figure 7. Allan J. Sloan preserving a large rattlesnake, *Crotalus mitchelli angelensis*, from Isla Angel de la Guarda. (Photo by Lindsay.)

FIGURE 8. Reid Moran was the expedition botanist. (Photo by Lindsay.)

stone, with volcanic clasts. This grades into diorite-bearing conglomerate to the south. The land surface is stepped, which may represent faults, or terraces, as are now developing in the major streams of the area. To the southeast, this surface is in contact and apparently intertongued with marine beds containing oyster and pecten reefs that resemble the "Imperial formation" fauna of Pliocene age.

Most of the biologists spent the morning working Estero de la Víbora, a productive lagoon on Isla Pond, which provided some of the best intertidal collecting of the whole trip. Numerous marine snails, chitons, an octopus with her eggs *(Octopus digueti)*, and other marine invertebrates were taken. A large and delicious rock oyster *(Ostrea angelica)* was particularly abundant, and the biologists and crew gathered these for food. Later Orr, Tilton, and some of the crew fished for the commissary, and caught garoupa and cabrilla.

Banks spent the morning on Isla Pond but found few birds. He captured one rattlesnake *(Crotalus ruber ruber)* and some fish-eating bats, which he exposed from loose rocks while searching for cone-nose bugs *(Triatoma)*. The preparation and preservation of bird and mammal specimens required many hours of monotonous work every day. The time required for the preparation of specimens is a limiting factor and one must collect selectively.

FIGURE 9. Phillips, Baptista, Lucas, Chivers, Sloan, and Orr on the foredeck of the *San Agustin II*. (Photo by Lindsay.)

Bandar also worked Isla Pond, and found murrelet eggs under loose rocks while collecting bats and chuckwallas. Sloan was on the southern end of Isla Angel de la Guarda in the morning, and collected chuckwallas, gridiron-tailed, and whiptail lizards.

The ship was moved to the south side of Isla Pond in late morning, and at 1215 was "buzzed" by the aircraft bringing Lindsay, Lucas, and Baptista to join the expedition. Delayed by Academy business until then, the three flew to San Diego at 0700 on 22 April. There they were met by Captain Muñoz, who took them to the Tijuana International Airport. Pilot Victor Corral flew them to Bahía de los Angeles in a Beechcraft B-18. Enroute they saw six finback whales just north of Bahía San Luis Gonzaga. The pilot obligingly flew over Puerto Refugio and down the east side of Isla Angel de la Guarda, looking for the ship, which was located at Isla Pond. He then flew directly to Bahía de los Angeles. There were also finback whales in the mouth of that bay.

Mrs. Diaz contacted the *San Agustin II* by radio, and at 1515 the biologists departed in a speedboat for Isla Pond, where they boarded the *San Agustin II* at 1645.

At dusk the ship was moved back to Bahía Cardoncito west of Isla Pond, and everybody went ashore on Angel de la Guarda for an oyster bake and turtle barbecue. The turtle had been cooked in its half shells before an open fire for several hours. The oysters were placed on glowing coals, then raked out, and served with a slice of lime.

Some concern was felt for Moran, who had been gone all day, but he appeared an hour or so after dark, carrying a large endemic rattlesnake (*Crotalus mitchelli angelensis*), which he had brought for Sloan.

**23 April 1966. Isla Pond to Bahía Agua Dulce, Isla Tiburón, and Isla Patos.**

Banks was ashore on Isla Pond at daylight to pick up his traps, which contained one peromyscus and one damaged perognathus, both of which were new records for the island. The peromyscus probably belongs to a new subspecies. The ship departed for Isla Tiburón at 0615.

Isla Tiburón is the largest island in the Gulf of California, having a length of about 29 miles and an average width of approximately 15 miles. There are two or more mountain ranges, with peaks nearly 4000 feet high. The island is separated from the mainland by a shallow channel, El Infernillo, only about a mile wide in some places. The plants and animals of Isla Tiburón are Sonoran in affinity, as would be expected.

Isla Tiburón has recently been declared a game preserve and put under the jurisdiction of the Patronato para la Conservación y Aprovechamiento de la Fauna Silvestre en el Estado de Sonora. Unauthorized visits to or collecting on the island are strictly prohibited. Permission for our activities was granted by Lic. Rene Martinez de Castro, President of the Patronato, on the condition that we first report to the Jefe de la Vigilancia at Bahía de Agua Dulce. Therefore we set course for the north end of the island.

Enroute some common dolphins, a finback whale, many northern phalaropes, 61 black petrels, and other animals were seen. Arriving at Bahía de Agua Dulce, Villalobos, Phillips, and Lindsay went ashore where they were met by an armed guard. Sr. Alfredo Topete, the Jefe de Viligancia, was not then in camp but was expected in the evening. Permission to proceed with collecting was given.

Orr, Tilton, Lindsay, and Baptista decided to visit Isla Patos, four miles north of Tiburon, during the afternoon. This little island has one small granitic hill, 275 feet high, and considerable flat land. There were great masses of brown pelicans along the shore line. Orr walked around the island and estimated there were between 50,000 and 100,000 of those birds, but found no sign of nesting. Several hundred elegant terns occupied one end of a beach and some off-lying rocks, but were not nesting. Neither were several hundred Heermann's gulls at the north end of the island, although

FIGURE 10. Bandar, Orr, Baptista, and Banks examining small mammals which were trapped on Isla Tiburón. (Photo by Tilton.)

they seemed to have definite territories. They dove at Orr when he approached, as did some nesting western gulls. Baptista collected a fish-eating bat *(Pizonyx vivesi)* from the tumbled walls of a rock building. Lindsay picked up an injured phalarope. Several pairs of Wilson's plovers were nesting under a shrubby chenopod *(Atriplex barclayana)* which was almost the only kind of plant on the island. There were also brown boobies, blue-footed boobies, Hudsonian curlews, ravens, white-crowned sparrows, rock wrens, a mourning dove, and a green and white Cessna 182 which had crashed two weeks earlier. The group returned to the ship at 1630.

Most of the party spent the afternoon on Isla Tiburón. Bahía Agua Dulce is at the mouth of a broad valley which separates two north-south mountain ranges. Phillips found the western range composed of volcanic rocks, primarily dacites, andesites, and basalts, similar to the "older" volcanic sequence of Angel de la Guarda, with overlying "younger" volcanics and associated sediments becoming prominent farther south. The eastern range is composed of quartz-diorite and intruded metamorphics. The northernmost point is white marble and intrusive quartz-diorite. Alteration and shearing are prominent, with silicification on the west side. The cliff cut in the fill of the broad valley between the ranges exposes marine beach deposits, probably of Pleistocene age, at the base of a 30-to 45-foot cliff.

Moran had collected at Bahía de Agua Dulce before, but most of the plants were lost in a fire. Although the vegetation was dry on the flats, he found a north slope which had interesting plants in good condition. His notes further state, "Although I don't usually risk impalement on cacti by chasing lizards, I couldn't resist a blue-green collared lizard and caught it twice." Gila woodpeckers were common, feeding noisy young in nests dug into cardon and saguaro cacti. Banks saw a pair of nesting red-tailed hawks, one of which was melanistic.

Sloan collected reptiles, and in the late afternoon Banks, Bandar, and Lucas set their small mammal traps. Villalobos, Arenas, and Chivers worked the intertidal area for invertebrate animals.

Bandar and Lucas erected an insect flight trap, which they had borrowed for the trip from Paul Arnaud of the Academy's Entomology Department. It was Arnaud's own modification of a Malaise flight trap and was made of nylon netting and shaped like an umbrella tent. It was so constructed that vanes within it intercepted flying insects and led them into a killing jar at its top. The simple trap was very effective, and many night-flying as well as day-flying insects were collected.

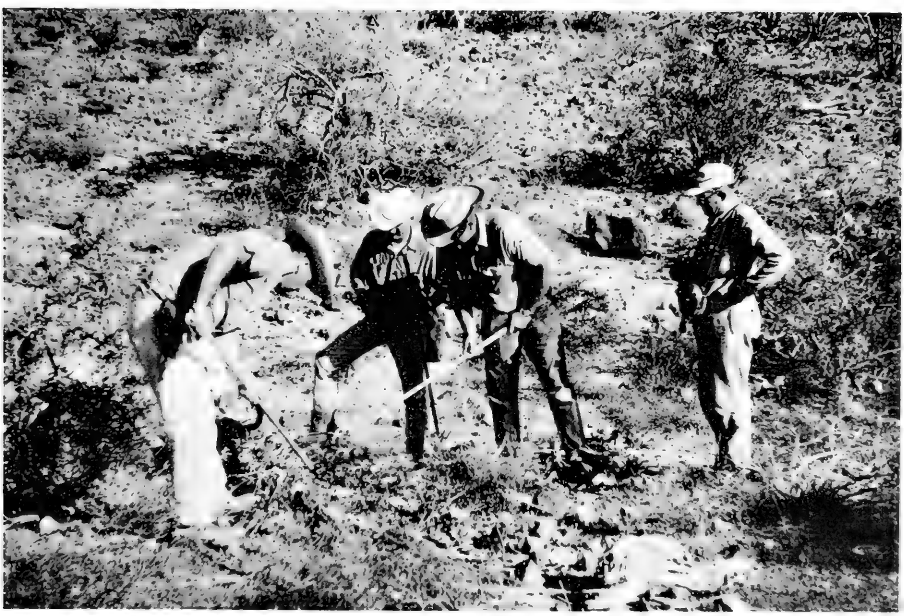

FIGURE 11. Sloan, Lucas, Lindsay, and Orr searching for reptiles at Ensenada de la Cruz, Isla Tiburón. (Photo by Tilton.)

Figure 12. Finback whales were seen frequently. (Photo by Tilton.)

**24 April 1966. Isla Tiburón.**

Banks, Bandar, and Lucas went ashore at 0500 to pick up their traps, and were accompanied by Orr, Chivers, Baptista, and Lindsay. They found they had taken representatives of *Neotoma labigula, Peromyscus eremicus, Perognathus arenarius*, and *Dipodomys merriami.*

Villalobos and Arenas were ashore, and learned that Sr. Topete had arrived during the night. Phillips and Orr joined them and gave Sr. Topete a manifest of the scientific crew. After a friendly meeting the party boarded the ship and departed for the south end of Tiburón at 0840.

While sailing down the west coast, finback whales were seen, as well as large numbers of phalaropes, and numerous brown boobies and brown pelicans. There were also many Craveri's murrelets, some elegant terns, and a few blue-footed boobies.

Anchorage was made at noon at Ensenada de la Cruz, on the south side of Isla Tiburón. A party of American tourists, with several outboard motorboats, were camped on shore. The tourists were puzzled by the ship and its crew's activities.

Phillips and Moran hiked inland. Bandar explored caves in cliffs, and found human bones and charred woven matting which probably were ancient Seri Indian burials. Sloan captured a greenish rattlesnake *(Crotalus molossus)* in a cave, and Tilton caught a specimen of *Coleonyx variegatus*. Orr and Lucas set a trap line, then Lucas concentrated on scorpion collecting and found many under rocks and in wood rat nests. The endemic barrel cactus *(Ferocactus wislizenii tiburonensis)* was in full bloom.

Phillips reported that the oldest rocks at Bahía de las Cruces are rhyolites and rhyolite tuffs, similar to the "older" volcanics to the north, but more acid. These are cut by glassy rhyolite and banded silica, indicating acid igneous activity and extensive hot-springs deposition. He had sighted the same type of material from the ship on the northwest coast of the island. Overlying this is a section up to 50 yards thick, of reddish, medium indurated conglomerate with clasts of locally derived, rounded, volcanic rocks. No metamorphic or intrusive igneous rocks were noted in the clasts. Fossiliferous light-yellow tuffaceous sandstone lies unconformably over the rhyolite at the beach, and may be equivalent to this conglomerate.

Phillips caught a red racer *(Masticophis flagellum)* in a palo verde tree.

During the afternoon several finback whales swam past the boat, most of them traveling westerly. One circled and came within 200 feet. Villalobos found great quantities of euphausid crustaceans during the night collecting, which may explain the presence of the giant whales so close to shore.

Banks and Baptista had gone to Isla Turner to set traps early in the afternoon, and had not returned after dark. The second boat was sent to see if they were in trouble, but it met them a few minutes out and all returned to the ship. Banks had captured a specimen of *Crotalus atrox* on Isla Turner.

**25 April 1966. Isla Tiburón, Isla Turner, and Isla San Pedro Mártir.**

At daylight Banks and Baptista returned to Isla Turner in a small boat, while Phillips, Bandar, and Lucas went ashore on Tiburon to check a geologic outcrop and to collect traps. As soon as they were aboard, the ship went to Isla Turner, where it anchored about half way down the west side. The small boats took the biologists to the east and more accessible side. Banks found that his traps contained specimens of *Peromyscus collatus* and a form of *Perognathus*, neither of which was represented in the Museum collection.

Isla Turner is only 1¼ mile long, ½ mile wide, and 550 feet high. None of our party had been there before, although it has frequently been visited by other biologists, particularly from the University of Arizona, who approached from nearby Sonora. In fact Phillips found a "snake stick," a device for handling live snakes which was made from the shaft of a golf club, and two or three "museum special" mouse traps! Phillips caught a Sonora racer *(Masticophis bilineatus)* which made him the racer specialist of the expedition. Bandar took a rattlesnake *(Crotalus atrox)*.

There were many birds on Turner. Baptista noticed a Costa hummingbird feeding at a cardon flower, verdins nesting in cactus, and three snowy egrets on the shore. Lindsay took motion pictures of ash-throated flycatchers taking food to their young in a cardon. The island had a comparatively thick cover of vegetation, and Moran took such plants as were in any condition for collecting and as far as possible listed the others. Villalobos, Arenas, Chivers, Orr, and Tilton concentrated on intertidal zone collecting, and found it the richest station of the expedition.

Phillips observed that the northern two-thirds of Isla Turner is composed of slates and banded quartzites, with some black marbles and thinly laminated and contorted anhydrites and marbles. These have been cut by rhyolite dikes. The southern third of the island is quartz-diorite.

At 1100 the ship departed for Isla San Pedro Mártir, which lies in the center of the Gulf about 20 miles south of Isla Turner, and anchored on its southeast side at 1330. San Pedro Mártir is a small triangular island less than 1 mile long and about 1050 feet high. Except for a heavy cover of cardon cacti which, from a distance, gives the top of the island the appearance of a piñon forest, it has little of botanical interest. There are two kinds of lizards on the island, *Uta palmeri* and *Cnemidophorus tigris martyris*, both of them endemic. The only snake found or reported is *Crotalus atrox*. There are no native land mammals, but there are introduced rats.

Most of the biologists went ashore as soon as the anchor was in place. Orr, Phillips, and Lindsay took a small boat around the island in order to take a census and study the sea lion population, and to examine and sample the geology and petrology of the exposed sea cliffs. That was a beautiful trip. Most rock ledges and beaches were covered with sea lions. A group of young ones raced along beside their boat, porpoising. When they stopped to take a rock sample, the sea lions waited, erect in the water, watching.

There were thousands of pelicans, too, on the rocks along the water. Unlike noisy gulls and terns, a great flight of pelicans gets into the air with only a swishing of wings.

San Pedro Mártir was formerly a guano island, because it is a giant rookery for blue-footed and brown boobies. The guano was harvested before the turn of the century, and the company which had the guano concession made great efforts to provide facilities for collecting new supplies as it was deposited. Terraces were built for the nesting birds, and parts of the island, with series of rock walls, look like Inca ruins.

Blue-footed boobies were nesting everywhere, from sea cliff ledges over the water to the top of the island. It was impossible to walk without disturbing the parent birds and their downy young, some of which stood their ground and pecked at the intruders. Of those that stayed, quite a few regurgitated their fish dinners. Higher on the island brown pelicans were nesting, and there were a few brown boobies with young. There were many annoying gnats which bothered the birds and biologists.

Moran climbed to the summit, and finding no plants which he had not previously collected, claims to have taken a half-holiday, enjoyed the view, and made observations and notes about the cardon cacti. These are night-through-morning flowering cerei, and he found that matured buds placed in a paper bag opened well before those left on the plant, which waited for nightfall. The Mexican biologists, too, gave up the ocean for land work that afternoon. Villalobos and Lucas caught a large specimen of *Crotalus atrox* in a pelican nest area. Banks collected two tropic birds. These nested under huge rocks near the water, and soared high overhead, their long tail feathers streaming behind them.

Finback whales were very close to the ship. One mother and calf had to turn to avoid running into the anchored vessel. They were magnificent as they rose to the surface and exhaled with a loud puff.

Phillips, after circling the island in the small boat and hiking over it, reported that it is composed of lavender andesites and associated sandstones

Figure 13. Tilton and Orr photographing blue-footed booby birds on Isla San Pedro Mártir. (Photo by Lindsay.)

FIGURE 14. Blue-footed booby bird on Isla San Pedro Mártir. (Photo by Lindsay.)

and conglomerates. The steep sea cliffs reveal many unconformities, faults, and offsets of several hundred feet, and sudden changes of rock type laterally. Although local dips to the north were observed, the overall impression is of southerly dipping layers, offset and repeated by steep northerly dipping normal faults.

The night was warm. With darkness, the gnats which had plagued everyone on the island and aboard ship disappeared. The ship was anchored close to the beach, and the sea lions, which appeared to sleep most of the day, were very active and noisy. There was a constant roar which echoed from the cliffs. Sometime after midnight one of the crew turned the searchlight on the animals, and they protested all the louder.

**26 April 1966. Isla San Pedro Mártir to Isla San Esteban.**

Banks, Bandar, Baptista, and Lucas were put ashore at 0600 to pick up the traps that they had set the night before. Trapping on this island was particularly intense with the hope of disproving the report that there are no native land mammals on it. Only two specimens of *Rattus rattus*, probably introduced by the guano gatherers, were caught in the traps, and they were near the beach. Banks' traps, which were highest on the land, had not been sprung, but he caught a rattlesnake *(Crotalus atrox)* while picking them up.

FIGURE 15. This blue-footed booby stayed with her nest, although her more timid mate regurgitated his fish and departed. (Photo by Lindsay.)

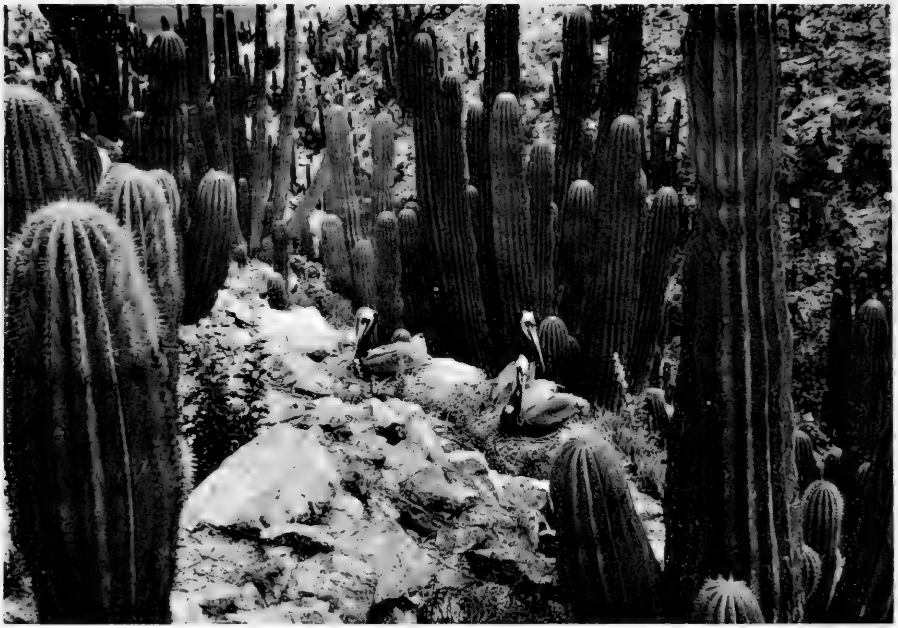

FIGURE 16. Brown pelicans nested on Isla San Pedro Mártir. (Photo by Lindsay.)

Orr, Tilton, and Chivers were also ashore. Chivers collected in the water until driven ashore by a belligerent bull sea lion.

All were aboard at 0845 and the run was made to Isla San Esteban, where anchorage was made off the mouth of a broad arroyo at the southeast side at 1145. San Esteban is about 4 miles long, north and south, and 3 miles wide and has a peak shown on charts to be 1772 feet high. It is an interesting island biologically, with several endemic animals.

Phillips and others had previously worked a rich Pliocene fossil deposit at the mouth of the arroyo, but he carefully resampled it, taking two types of echinoids, pectinids, coralline algae, and other material. He determined that the fossiliferous layer lies unconformably over the "older" volcanic rocks that make up the bulk of the island.

After a spirited chase, Sloan, Lindsay, and Tilton captured two spiny-tailed iguanas *(Ctenosaura hemilopha conspicuosa)* which they found resting high in an ironwood tree. A blotched chuckwalla *(Sauromalus varius)* was also taken. These two kinds of giant lizards are much less common than formerly, when they could be observed in great numbers along the arroyo banks. A series of old reptile can-traps were found in the bottom of the large arroyo. These were five-gallon cans, with tops removed, sunk to their brims in the soil. Such traps are used by some biologists to collect specimens. However, many of those which were found had been abandoned without having been filled with dirt, so were acting as perpetual booby traps for lizards for no purpose whatsoever. All that could be found were filled with soil.

Lucas and Baptista collected some birds for Banks, concentrating on those that vary geographically, so that avifaunal relationships of the island could be re-examined. Lucas and Lindsay collected scorpions. Moran climbed to the peak near the northwest corner of the island, went down the north slope and to the west, crossed the divide into the head of the main arroyo, and got back to the beach at dusk. At the summit of the peak at about 1500 feet, both Moran and Phillips noted several semicircular to circular walls of loosely piled rock, built apparently by the Indians. These were about 2 or 3 feet high, each structure about 3 feet wide, the open ones facing alternately in opposite directions. Moran collected eight species of plants not previously listed for the island.

Bandar and Lucas put up the insect trap, and Lucas and Lindsay collected scorpions. Villalobos, Chivers, and Arenas worked the intertidal zone. A reptile search after dark was unproductive, but Sloan took a beautiful tarantula (*Aphonopelma* sp.).

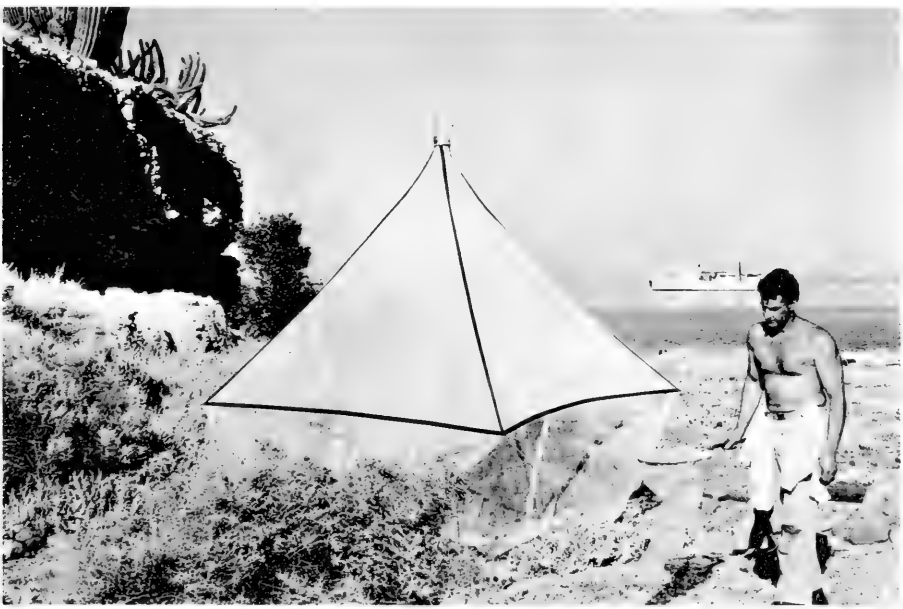

FIGURE 17. Bandar with the nylon insect flight trap on Isla San Esteban. (Photo by Orr.)

Large flocks of eared grebes were around the anchored ship most of the afternoon. One group of about 125 amused the biologists who were watching them. The grebes would duck under the water almost simultaneously; about ½ minute later they would all bob to the surface at some other place, and ¼ or ½ minute later they would disappear again, as if on some signal.

Figure 18. Marine invertebrate biologist Arenas examining jellyfish which he collected at Isla Salsipuedes. (Photo by Lindsay.)

**27 April 1966. Isla San Esteban to Isla San Lorenzo Sur.**

A party went ashore at 0545 to pick up traps, and for low tide collecting. Lucas continued to hunt birds for Banks. The insect tent-trap was struck, and all returned to the ship at 0745.

Orr and Bandar wanted to examine a long rock spit extending from the southwestern corner of the island, in the hope of finding bones of stranded cetaceans. The ship was anchored close to the spit and general collections were made for an hour. Forty or 50 pairs of western gulls were nesting on the spit, their nests nothing more than a little seaweed in a hollow in the coarse gravel. American oystercatchers made no nest at all, and simply deposited a single egg among the rocks.

Three young Mexican fishermen with a large canoe had stayed with the ship during the night, and were towed to Isla San Lorenzo Sur, where they were cast off in order for them to continue on to Puerto San Francisquito on the peninsula. The ship proceeded north up the Salsipuedes Channel to near the center of the west side of Isla San Lorenzo Sur, where Phillips wanted to hike inland, and anchored at 1200 for the afternoon and night. The Islas San Lorenzo are two islands, Norte and Sur, separated by a narrow boat channel. Their combined length is 12¼ miles, and the southern island is 2 miles wide and 1590 feet high. With Isla Salsipuedes, which is a northern extension of an emergent mountain ridge, they form the east side of the Canal de Salsipuedes, which is notorious for its rapid tide flow.

As has been previously reported, there are thick deposits of gypsum on the island. Phillips climbed to the top of the ridge, and his notes state "Metamorphic basement rocks, consisting of schists, hornfels, and gypsiferous marbles. This is unconformably overlain by 'older' volcanics, which are in turn unconformably overlain by 'younger' volcanics and associated sedimentary rocks, in part marine. The upper unconformity is locally marked by the development of a thick section of gypsum. This sequence is repeated by faulting both north and south of here."

Moran crossed a low divide to the northeast side of the island. He collected four plants not previously recorded from the island. Sloan found an attractive and docile adult rattlesnake *(Crotalus ruber)* which lacked all but the proximal rattle segment. This was of particular interest. In the evening, collecting with lights, Bandar found a kingsnake *(Lampropeltis getulus)*, which is probably the only living specimen ever collected on a northern Gulf island.

Chuckwallas *(Sauromalus hispidus)* were common. Large ones sunned themselves just outside of their burrows at the base of a cliff. Lucas picked one up while it was asleep in the sun on top of a cardon. These lizards often climb up trees and bushes while browsing. As was the case at many of the anchorages, a large nest with ospreys was on a cliff above the boat.

It was hot on shore and several of the biologists bathed and swam, but the water was very cold.

**28 April 1966. Isla San Lorenzo Sur, Isla Salsipuedes, Isla Raza, Isla Partida, and Bahía de los Angeles.**

The traps were collected at daylight and had good catches of *Peromyscus* and *Perognathus*. The ship departed for Salsipuedes and anchored there at 0820, for 1½ hours. There were several pairs of ospreys, and a pair of peregrine falcons flying about. Pelicans were nesting along the crest of the island, with western gulls standing by to steal their eggs or chicks.

The departure for Isla Salsipuedes was at 1025. A large finback whale was in the little cove and appeared to be within a very few feet of the rocky cliffs. Arriving at the southwest side of Isla Raza at 1115, everybody went ashore to observe and photograph the birds on this remarkable island.

Isla Raza is about ¾ mile long, ½ mile wide, and no more than 100 feet high. It is the principal nesting area for Heermann's gulls and elegant terns. For many years egg collectors have come during the nesting season, to collect eggs by the canoe load, for the markets of Santa Rosalia and Guaymas. In order to insure that the eggs were unincubated, the collectors de-

Figure 19. A valley on Isla Raza was covered with nesting Heermann's gulls, and at one side was a densely packed colony of elegant terns. (Photo by Orr.)

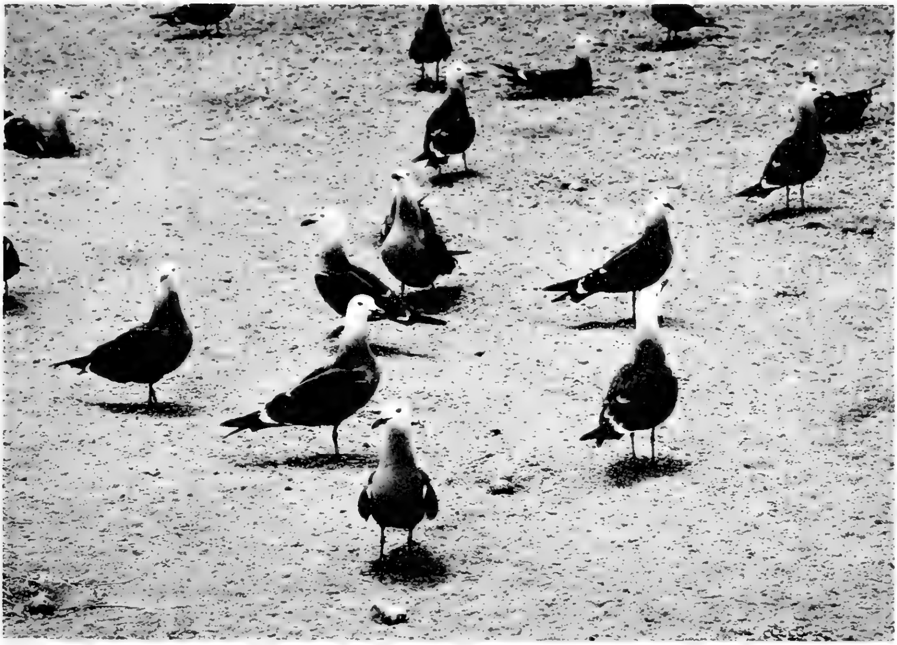

FIGURE 20. The nests of Heermann's gulls were quite evenly spaced, and occupied most parts of Isla Raza. (Photo by Lindsay.)

stroyed all that were there, and then gathered the fresh ones as they were laid. At first this was not serious, because there were many birds and comparatively few egg collectors, who filled their canoes and left the island before the birds stopped laying. In recent years, however, more and more men came, and extended their collecting period through the whole season of ovulation. The bird population collapsed.

Largely because of the interest of Lewis Wayne Walker, of the Arizona Sonora Desert Museum, attention was focused on this catastrophe. The Belvedere Scientific Fund of San Francisco sponsored expeditions for American biologists to investigate the situation, and then provided a substantial grant to encourage the Mexican Government to make a sanctuary of the island. This was done by Presidential decree on 30 May 1964.

The scientists were anxious to find out what effect that protection was having. On shore they were met by Eduardo G. F. Arrington, a biologist from Mexico City, and José L. Valazquez and Loreto Fuerte Amador, wardens, who were resident during the nesting season. Sr. Arrington estimated there were 80,000 Heermann's gulls, 40,000 elegant terns, and 7000 royal terns on the island at the time of our visit. His estimate is probably very conservative.

FIGURE 21. Elegant terns occupied dense colonies, surrounded by Heermann's gulls. (Photo by Lindsay.)

The Heermann's gulls were rather evenly spaced over all of the flat areas of the island. The main broad valley, several acres in extent, was populated by thousands of gulls, standing by their clutches of eggs, spaced about 3 feet apart. In the central portion of the island was a great mass of elegant terns, well over an acre in extent. They were much more closely packed than the gulls, and seemed nervous and were fluttering and giving grating cries. Near the edge of some parts of the colony were royal terns.

If the terns were startled they rose as a body into the air, and the gulls walked in and began to eat their eggs. The terns settled in waves, and the gulls retreated before them. It was a breathtaking sight.

The headquarters of the wardens, a concrete building built with funds from the Belvedere Scientific Fund grant, which was administered through the National Audubon Society, was visited. Sr. Arrington said that no egg collectors had attempted to visit the island, and that the birds were making a remarkable recovery. There were several tern colonies, and the gulls were everywhere. This was a fitting climax for a very interesting trip.

Departing from Isla Raza at 1345, the ship proceeded to Isla Partida, locally called Isla Cardonosa, which was the last island to be visited.

This is the type locality of the fish-eating bat *(Pizonyx vivesi)*, which had been seen or heard at nearly every one of the stops. It is also a nesting place of both least and black petrels, which were of special interest to Baptista. Bats and black petrels were abundant in the loose rocks of the talus slopes of the island. Antero Diaz took Orr, Tilton, and Lindsay around a small outer islet, Lobera Partida, to observe sea lions. Brandt cormorants were also abundant on the islet.

Phillips photographed a spectacularly developed columnar basalt exposure on the southeast side of Partida, and collected specimens from what he thought might be a Pleistocene bed of fossil turritellas in a low central divide between the two higher parts of the island.

The ship departed for Bahía de los Angeles at 1640, and arrived at 2000. All hands fell to, unloading gear. During this activity what was thought to be a yellow-bellied sea snake swam by, and Sloan tried to capture it from a small boat, but it escaped. The gear and collections were taken to the beach in small boats and then transported to the Vermilion Sea Field Station for sorting and packing. The last day had been very busy and many islands were visited, so Banks, Bandar, Lucas, and Baptista, who ordinarily spent several hours skinning specimens every day, worked at that job most of the night.

**29 April 1966. Bahía de los Angeles to San Francisco.**

After an early breakfast at Casa Diaz, Lindsay, Orr, Tilton, Villalobos, Lucas, Arenas, Bandar, and Baptista drove inland in the Museum Travelall in order to see the forest of cirios *(Idria columnaris)*, and the other remarkable desert vegetation of the peninsula. The rest continued to pack their collections and equipment. Francisco Muñoz arrived with his Lodestar at 1140, and everything was put aboard while the party had lunch. They departed at 1320, leaving Moran behind to do a little more botanical work and to drive the Travelall to San Diego, where he arrived 4 May.

The plane landed at Tijuana International Airport at 1510, and was met by Museum personnel, who took the scientists to the San Diego Natural History Museum. Some of the San Francisco gear was left there for later pickup, and Phillips took Tilton, Orr, Lucas, Bandar, Baptista, and Lindsay to the airport. They arrived at the San Francisco International Airport at 1745.

FIGURE 22. The personnel of the Gulf Islands Expedition of 1966 at Bahía de los Angeles, Baja California, on April 29. From left to right: Arenas, Chivers, Phillips, Lucas, Orr, Lindsay, Villalobos, Bandar, Sloan, Baptista, Banks, Moran, Tilton, and pilot Muñoz.

## REPORT OF THE SCIENTIFIC RESULTS

Even a very preliminary and necessarily superficial statement of the scientific results of the expedition may have a place in this narrative report in spite of the obvious disadvantage of attempting such a discussion before the material is worked up and the appropriate scientific papers are published. The sponsors of the expedition, and the various Mexican officials and departments that issued the permits under which the collections were made, should have a preview of the results as soon as possible. Specific information and detailed reports will be published in due time.

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## BOTANY

Dr. Reid Moran, Curator of Botany, San Diego Natural History Museum, is an authority on the flora of Baja California and the islands of the Gulf of California and off the west coast of Mexico. He served as botanist on the Sefton-Stanford Expedition to the Gulf of California in 1952, and on the Belvedere Expedition in 1962. He has collected the plants of Isla Socorro, made many collecting trips to Isla Guadalupe, and spent many months in the field in Baja California.

The following is an abstract of Dr. Moran's preliminary report:

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### Plant Collections from the Northern Gulf Islands, April, 1966

On the trip of April, 1966, to the northern islands of the Gulf of California, sponsored jointly by the California Academy of Sciences and the San Diego Natural History Museum, I made 180 numbered collections of plants. Having visited all these islands except Turner at least once, most of them twice, and Angel de la Guarda several times, I carried a list for each island and so avoided collecting the common plants at the same localities as before.

Despite comparatively few man days of collecting, the floras of these islands are now fairly well known, aside from summer annuals. For the smaller islands of Salsipuedes, Raza, and Partida, with comparatively small floras, the perennials and spring annuals probably are mostly known. But on the larger islands, collecting continues to yield new records, if at a decreasing rate.

Our trip was too late for best collecting of spring annuals at low elevations, but it was timed better for plants of high north slopes. My best collecting was on a high peak near the north end of Angel de la Guarda and on a peak near the northeast corner of San Esteban. My collections added nine species to the known flora of Angel de la Guarda, bringing the total to about 197, and also included five species reported before but not collected. On

San Esteban, my collections added eight species, bringing the total to 84. Since my list for Tiburón is not up to date with the many recent collections of Richard Folger, additions to my list may not be significant.

Apparently no one has collected summer annuals on any of these islands unless on Tiburón. It would be interesting to visit any of them, but particularly the larger ones, about a month after a good summer rain. Also, the larger ones need further exploration in spring following good winter rains. In particular, the higher peaks in the northern part of Angel de la Guarda are likely to yield further interesting additions to the flora.

### AFTER THE ISLANDS

*29 April.* After the rest of the expedition had headed for home, I spent several hours searching for flowers in a colony of *Castela* 3 miles north of the village of Los Angeles Bay. This shrub has been a puzzle to botanists for several years, since complete flowering material to permit identification and proper description had not been collected before. Only a few plants had flowers, and there were mostly few per plant; but I found enough.

*30 April.* For several years I have wanted to collect on Cerro Santa Marta, in the Sierra San Borja southwest of Los Angeles Bay. In June, 1962, I climbed the 5000-foot summit nearest the Bay, but the round trip from sea level left little time for collecting there and none for the peaks beyond. So a two-day trip was necessary.

At 0615 I started for the abandoned Santa Marta Mine at 3000 feet, with food and water for two days. After making camp, I collected locally and visited the Santa Marta spring, about 2 miles to the southwest, which had supplied water for the mine but was now dry.

*1 May.* Starting up the mountain at 0610, I visited each of the summits, collected many plants, started down at 1530, and reached the Station at 2030. Among the plants collected were four species which apparently have not previously been found south of the Sierra San Pedro Mártir, as well as several that I found only once or twice before in Sierra San Borja. This was one of the most productive days of this season's field work in Baja California.

*2 May.* After taking care of previous days' collections, I went to El Terminal to collect cytological and herbarium material for a man at Brigham Young University of what he supposes to be a new species of *Erigonum.*

*3-4 May.* I drove to San Diego, making a few collections and photographs en route.

*Reid Moran*
*10 May 1966*

## ENTOMOLOGY

While this expedition did not carry an entomologist, some collections of insects were made. The Arnaud version of a Malaise trap was used whenever possible by Raymond Bandar. This device caught a large number of nocturnal as well as diurnal insects. Bandar also did general insect collecting from time to time. Ken Lucas concentrated on scorpions and other arachnids, taking 63 specimens of several species of three genera of scorpions, and he also collected insects, as did Luis Baptista and other personnel.

Dr. Villalobos collected insects and other land arthropods for his colleagues at the Instituto de Biología.

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## GEOLOGY

Dr. Richard P. Phillips, Director of the San Diego Natural History Museum, welcomed this opportunity to continue his studies of the geology of the islands of the north central Gulf of California. His remarks about specific areas which were visited on this trip are quoted in the body of the narrative report. His general statement concerning the geology of the region follows:

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### Geological Framework of the Gulf Islands

The oldest rocks exposed on these islands are metamorphic, of undetermined age, including thinly laminated quartzite, anhydrite, and marble. This succession has been intruded by coarse-grained quartz-diorite. Unconformably over these crystalline basement rocks is a succession of volcanic flows, tuffs, and sandstones up to 1000 meters thick which constitute the bulk of the exposed rocks on the island. They may be divided into two sequences; the "older" volcanics tend to be massive or poorly bedded, sometimes showing flaggy parting, with complex internal structures, local unconformities and minor faulting. Steep dips, probably initial, are noted locally. These predominantly andesitic rocks are similar to the mid-Tertiary Comondu formation of the Baja California peninsula. The "younger" volcanics and associated sediments are rhyolite, andesite, and basalt flows and tuffs interbedded with considerable amounts of sandstones, conglomerates, and breccias, and some mudstone. The sediments are predominantly derived from the associated volcanic rocks. These "younger" volcanics are unconformable to the "older" volcanics, but may, in places be contemporaneous with them. They may be equivalent to the San Marcos formation of Durham, of lower Pliocene age. Locally, all older rocks are unconformably overlain by a succession of sandstones, conglomerates, and fanglomerates up to several hundreds of meters thick. On the basis of fossil remains, these appear to be equivalent to the Imperial formation of California, and may be as young as upper Pliocene. Local uplifted Pleistocene beach deposits indicate a recent episode of emergence for some parts of some of the islands.

*Richard P. Phillips*

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## HERPETOLOGY

Mr. Allan J. Sloan, Curator of Herpetology, San Diego Natural History Museum, was in charge of the reptile collecting on this expedition. He served as herpetologist on the Sea of Cortez Expedition in 1964, the "Gringa" expedition earlier the same year, and has carried on extensive field work throughout the area. He recently published a review of the herpetofauna of the islands of the Gulf (in Soulé and Sloan, 1966). Other expedition members assisted Sloan by collecting unusual reptiles which they found while carryon their own activities. Mr. Raymond Bandar took some of the rarer reptiles for the Herpetology Department of the Academy, which were not represented on the expedition.

The following is from Mr. Sloan's report:

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### Herpetological Results

A total of 166 specimens of reptiles and amphibians were collected on the islands and at Bahía de los Angeles. These specimens consisted of 9 frogs, 16 snakes, and 141 lizards.

Emphasis was placed on securing those reptiles reported from the various islands but not represented in our collections. The following were obtained and are new to the collection:

| | | | |
|---|---|---|---|
| *Sauromalus hispidus* | Mejía | *Crotalus atrox* | Tiburón |
| *Masticophis flagellum* | Tiburón | *Crotalus molossus* | Tiburón |
| *Salvadora hexalepis* | Tiburón | *Uta stansburiana* | Patos |

Significant additions to the collection include the following species, previously represented by one or only a very few specimens:

| | |
|---|---|
| *Petrosaurus slevini* | Mejía |
| *Petrosaurus mearnsi* | Bahía de los Angeles |
| *Crotaphytus collaris* | Angel de la Guarda, Tiburón |
| *Crotalus ruber* | Angel de la Guarda, Pond, San Lorenzo Sur |
| *Sauromalus hispidus* | Pond, San Lorenzo Sur |

| | |
|---|---|
| *Cnemidophorus tigris* | Tiburón, San Esteban, San Lorenzo Sur, Salsipuedes |
| *Coleonyx variegatus* | Tiburón |
| *Crotalus atrox* | Turner, San Pedro Mártir |
| *Sauromalus varius* | San Esteban |
| *Phyllodactylus xanti* | San Esteban, San Lorenzo Sur, Salsipuedes |
| *Ctenosaura hemilopha* | San Esteban |
| *Uta stansburiana* | San Lorenzo Sur |

Two new island records were obtained:

| | |
|---|---|
| *Masticophis bilineatus* | Turner |
| *Lampropeltis getulus* | San Lorenzo Sur (California Academy of Sciences). |

The racer occurs on nearby Isla Tiburón, and on the Mexican mainland. The king snake is the only living specimen of its kind (as far as I know) ever collected on a northern Gulf island.

Many colored pictures were taken to aid in studies currently in progress on the lizard genera *Petrosaurus, Uta, Callisaurus*, and *Cnemidophorus*.

Several adult female chuckwallas (of three species) were secured and returned alive in the hope that they will produce young at the San Diego Zoo.

### List of Species Obtained

**Mejía**
*Petrosaurus slevini*
*Uta stansburiana*
*Sauromalus hispidus*

**Angel de la Guarda**
*Callisaurus draconoides*
*Cnemidophorus tigris*
*Crotaphytus collaris*
*Sauromalus hispidus*
*Crotalus mitchelli*
*Crotalus ruber*

**Pond**
*Sauromalus hispidus*
*Crotalus ruber*

**Tiburón**
*Callisaurus draconoides*
*Cnemidophorus tigris*
*Coleonyx variegatus*

**Tiburón** *(Cont.)*
*Crotaphytus collaris*
*Sauromalus obesus*
*Masticophis flagellum*
*Salvadora hexalepis*
*Crotalus atrox*
*Crotalus molossus*

**Turner**
*Masticophis bilineatus*
*Crotalus atrox*

**San Pedro Mártir**
*Uta palmeri*
*Crotalus atrox*

**San Esteban**
*Cnemidophorus tigris*
*Ctenosaura hemilopha*
*Phyllodactylus xanti*
*Sauromalus varius*

**San Esteban** *(Cont.)*
*Uta stansburiana*

**San Lorenzo Sur**
*Cnemidophorus tigris*
*Phyllodactylus xanti*
*Sauromalus hispidus*
*Uta stansburiana*
*Crotalus ruber*

**Salsipuedes**
*Cnemidophorus tigris*
*Phyllodactylus xanti*
*Uta stansburiana*

**Partida Norte**
*Uta stansburiana*

**Patos**
*Uta stansburiana*

*Allan J. Sloan*

## INVERTEBRATE ZOOLOGY

Dr. Alejandro Villalobos F., Jefe de la Sección de Hidrobiología del Instituto de Biología de la Universidad Nacional Autónoma de México, has been a member of our most recent three expeditions to the Gulf of California. Professor Virgilio Arenas F., Becario de la Sección de Hidrobiología, was Dr. Villalobos' assistant on the present trip. They were interested in all aspects of marine biology and made large collections for their institution.

Mr. Dustin Chivers, Technical Assistant, Department of Invertebrate Zoology, California Academy of Sciences, collected most of the marine invertebrate animals which were taken for the Academy. Mr. Chivers was also a member of the two previous expeditions which worked in the southern Gulf, and was pleased with this opportunity to obtain comparative material from the more northern area. Reports by Dr. Villalobos, Professor Arenas, and Mr. Chivers follow:

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### Informe de Nuestras Actividades Durante La Excursion Al Norte Del Golfo de California, Organizada por La California Academy of Sciences, Bajo La Direccion Del Dr. George E. Lindsay

La oportunidad que se nos brindó a miembros del Instituto de Biologia para tomar parte en la expedición de la California Academy of Sciences, organzada para visitar entre el 19 y 29 de abril del año en curso, diversas localidades de la parte norte del Golfo de California, nos permitió llevar al cabo colectas de animales marinos en las localidades que fuimos visitando a lo largo de nuestro itinerario.

Durante los días 19, 20 y 21 de abril, en el puerto El Refugio, al norte de la Isla Angel de la Guarda, hicimos--desembarcos para examinar la zona litoral durante la baja mar. En la zona intercotidal (intertidal zone) hicimos colectas de diversos invertebrados marinos y pudimos observar una zonación ecológica muy aparente en la que se ponía de manifiesto una sucesión de *Sargassum, Calpomenia, Lactuca* con *Balanus* intercalados, después los *Balanus* solos y en la parte superior un balánidos del género *Tetraclita.* Hicimos muestreos cuidadosos y tomamos notas y fotografías de la zona, para hacer un estudio posterior o para ilustracion de la cátedra de Ecología Marina. En la zona intercotidal de otras localidades pusimos el mismo interés, tales como Estero de la Víbora, al este de la Isla Angel de la Guarda; Agua Dulce, en el norte de la Isla Tiburón; en Isla San Esteban, Isla Salsipuedes, Isla Rasa, etc., en donde observamos aspectos semejantes. Las diferencias consistieron en falta o sustitución de algunos miembros de las asociaciones.

En el curso de la expedición hicimos rastreos de plancton y las muestras obtenidas presentan aspectos muy diversos, hay predominio de fitoplancton en las del norte de Angel de la Guarda y sur de la I. Tiburón. La abundancia de zooplancton la pudimos apreciar en los muestreos nocturnos obtenidos en la parte sur de la I. Tiburón, con gran predominio de Euphausiaceos (Crustacea Malacostraca), justificando con esto la presencia de ballenas que posiblemente buscaban este tipo de alimento muy cerca de la costa. En la Isla Salsipuedes por el contrario, había abundancia de Mysidáceos (Crustacea Malacostraca).

La colecta en la zona intercotidal aprovechando la baja mar, nos produjo un interesante material de moluscos, equinodermos, crustáceos y otros invertebrados. Pusimos especial cuidado en la obtención de Porcelánidos (Crustacea Anomura), para estudios futuros.

La expedición nos dió además, la fortuna de poder apreciar en toda su magnificencia, las agrupaciones de aves marinas, leones marinos, delfines, ballenas y aves insulares. Este espectáculo, grandioso para un naturalista, nos dejará un recuerdo imborrable.

El material que hemos acumulado en nuestras colecciones, procedente del Golfo de California y colectado en las tres últihemos asistido, nos permitirá en futuro cercano hacer estudios que contribuirán al conocimiento de la Biología de la región.

Solo nos queda agradecer al Dr. George E. Lindsay las facilidades que periodicamente nos ofrece para formar parte de sus expediciones al Golfo de California.

*Alejandro Villalobos F.*
*Virigilio Arenas F.*
*del Instituto de Biología de la*
*Universidad Nacional Autónoma de México*

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## Lists of Invertebrates Collected

The collections made on this trip to the north central islands of the Gulf of California augment the material obtained on the Sea of Cortez Expedition in 1964, and another Academy trip in 1965, both of which were in the southern Gulf. The present collections are of unusual significance to this department, for the following reasons:

1. The more northern part of the Gulf has many endemic species and representatives of a number of them were collected.

2. Little marine collecting had hitherto been done in this region of the Gulf. Until 1961 only nine records of Molluscan collecting in the littoral zone have been reported from the general vicinity of our stations (McLean, 1961).

3. The unique physical factors (large tidal range, strong currents, cold upwellings, beach topography, etc.) contribute to far different invertebrate assemblages from those found farther south.

4. The department had few preserved invertebrate animals from the important Gulf islands which were visited on this trip.

Although the tides were not favorable at a number of stations and the intertidal environment in many areas was poor, some stations were extremely rich, and the total results of the trip were gratifying. A total of 486 lots from 19 stations have been processed and a few mixed lots remain to be sorted. A phylogenetic breakdown follows:

| | | | |
|---|---|---|---|
| 1. Porifera | 23 | 6. Annelida | 22 |
| 2. Coelenterata | 8 | 7. Echinodermata | 50 |
| 3. Sipunculoidea | 5 | 8. Arthropoda | 100 |
| 4. Echiuroidea | 5 | 9. Tunicata | 12 |
| 5. Bryozoa | 11 | 10. Mollusca | 250 |
| | | Total....... | 486 |

## INVERTEBRATE ZOOLOGY COLLECTING STATIONS

| | |
|---|---|
| **D-35** | Isla Angel de la Guarda - Puerto Refugio. |
| **D-36** | Isla Angel de la Guarda - northeast side of island. |
| **D-37** | Isla Angel de la Guarda - east side. |
| **D-38** | "Cardoncito" - near southwest end of Isla Angel de la Guarda. |
| **D-39** | Isla Pond. |
| **D-40** | Southeast end of Isla Angel de la Guarda, opposite Isla Pond. |
| **D-41** | Isla Tiburón, north end; Bahía Agua Dulce. |
| **D-41A** | Same as D-41. |
| **D-42** | Isla Turner - northeast side. |
| **D-43** | San Pedro Mártir - small islands of Tiburón. |
| **D-44** | Southeast end of Isla San Esteban. |
| **D-44A** | Southwest end of Isla San Esteban. |
| **D-45** | Isla San Lorenzo del Sur - southwest end. |
| **D-46** | Isla Salsipuedes. |
| **D-47** | Isla Raza - Lagoon on north side. |
| **D-47A** | Isla Raza - south side. |
| **D-48** | Isla Partida. |

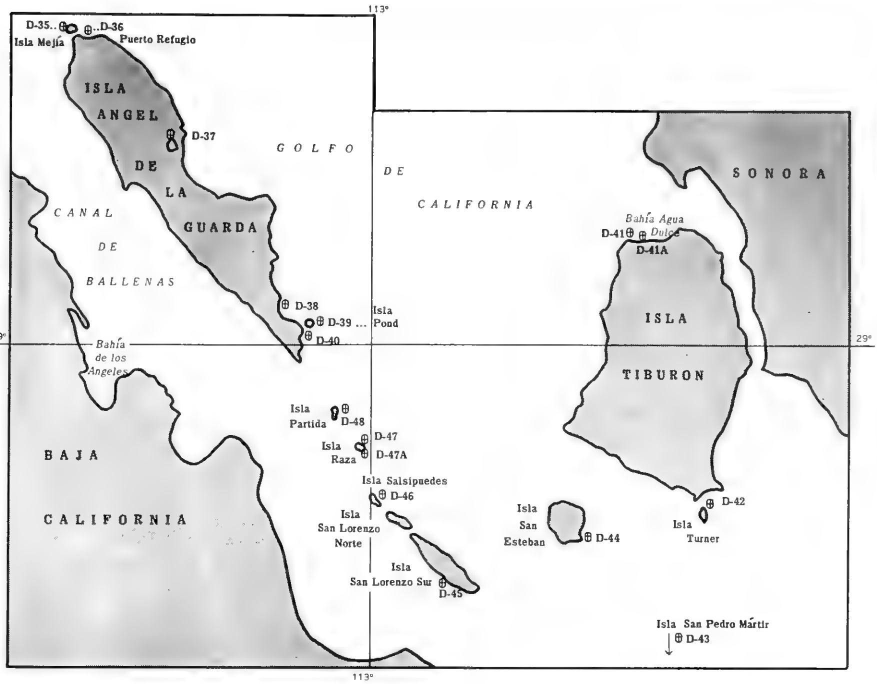


FIGURE 23. Chart showing collecting stations where marine invertebrates were taken. (Adapted from U. S. Hydrographic Office Chart No. 0620, July 17, 1963.)

## CHITONS

*Acanthochitona avicula* (Carpenter, 1864), D-42, Isla Turner.

*Acanthochitona exquisita* Pilsbry, 1893, D-42, Isla Turner; D-35, Isla Angel de la Guarda; D-46, Isla Salsipuedes.

*Basiliochiton lobium* Berry, 1925, D-42, Isla Turner.

*Callistochiton gabbi* Pilsbry, 1893, D-42, Isla Turner; D-36, Isla Angel de la Guarda.

*Callistochiton infortunatus* Pilsbry, 1893, D-42, Isla Turner; D-39, Isla Pond.

*Chaetopleura* cf. *C. mixta* (Dall, 1919), D-42, Isla Turner; D-46, Isla Salsipuedes.

*Chiton virgulatus* Sowerby, 1840, D-41A, Isla Tiburón; D-35, Isla Angel de la Guarda; D-42, Isla Turner; D-48, Isla Partida; D-46, Isla Salsipuedes.

*Ischnochiton mariposa* Dall, 1919, D-41A, Isla Tiburón; D-42, Isla Turner.

*Ischnochiton tridentatus* Pilsbry, 1893, D-42A, Isla Tiburón; D-42, Isla Turner; D-48, Isla Partida; D-35, Isla Angel de la Guarda; D-39, Isla Pond.

*Lepidozona clathrata* (Reeve, 1847), D-41A, Isla Tiburón; D-35, Isla Angel de la Guarda; D-48, Isla Partida.

*Lepidozona serrata* (Carpenter, 1864), D-41A, Isla Tiburón; D-42, Isla Turner.

*Leptochiton* cf. *L. rugatus* Pilsbry, 1892, D-41A, Isla Tiburón; D-42, Isla Turner.

*Nuttallina crossota* Berry, 1956, D-48, Isla Partida.

*Stenoplax conspicua sonorana* Berry, 1956, D-41A, Isla Tiburón; D-42, Isla Turner.

*Stenoplax limaciformis* (Sowerby, 1832), D-41A, Isla Tiburón; D-42, Isla Turner.

## Gastropods

*Acanthina angelica* I. Oldroyd, 1918, D-35, Isla Angel de la Guarda.

*Acanthina muricata* (Broderip, 1832), D-41A, Isla Tiburón.

*Acanthina tuberculata* (Sowerby, 1835), D-42, Isla Turner.

*Acanthina tyrianthina* Berry, 1957, D-35, Isla Angel de la Guarda; D-42, Isla Turner.

*Acmaea turveri* Hertlein and Strong, 1951, D-44, Isla San Esteban.

*Anachis pygmaea* (Sowerby, 1852), D-41A, Isla Tiburón.

*Aplysia* cf. *A. parvula* Guilding in Mörch, 1863, D-44A, Isla San Esteban.

*Architectonica nobilis* Röding, 1798, D-39, Isla Pond.

*Assiminea* sp., D-42, Isla Turner; D-44A, Isla San Esteban.

*Berthella* sp., D-35, Isla Angel de la Guarda; D-41A, Isla Tiburón.

*Calliostoma angelenum* Lowe, 1935, D-42, Isla Turner.

*Cerithidea mazatlanica* Carpenter, 1856, D-41, Isla Tiburón; D-47, Isla Raza.

*Cerithium sculptum* (Sowerby, 1824), D-35, Isla Angel de la Guarda; D-41A, Isla Tiburón.

*Conus scalaris* Valenciennes, 1832, D-35, Isla Angel de la Guarda.

*Crepidula incurva* (Broderip, 1834), D-41A, Isla Tiburón; D-42, Isla Turner.

*Crepidula striolata* Menke, 1851, D-41A, Isla Tiburón; D-42, Isla Turner.

*Crucibulum spinosum* (Sowerby, 1824), D-42, Isla Turner.

*Cypraea annettae* Dall, 1909, D-39, Isla Pond; D-42, Isla Turner.

*Diodora inaequalis* (Sowerby, 1835), D-39, Isla Pond, D-42, Isla Turner; D-44A, Isla San Esteban.

*Diodora saturnalis* (Carpenter, 1864). D-42, Isla Turner.

*Fissurella rugosa* Sowerby, 1835, D-44A, Isla San Esteban.

*Glossodoris californiensis* (Bergh, 1879), D-42, Isla Turner.

*Haminoea strongi* Baker and Hanna, 1927, D-35, Isla Angel de la Guarda; D-44A, Isla San Esteban.

*Hipponix pilosus* (Deshayes, 1832), D-42, Isla Turner.

*Jeffeysia* sp., D-42, Isla Turner; D-44A, Isla San Esteban.

*Jenneria pustulata* (Solander, 1786), D-36, Isla Angel de la Guarda.

*Littorina pullata* Carpenter, 1864, D-35, Isla Angel de la Guarda.

*Mitra tristis* Broderip, 1836, D-41A, Isla Tiburón.

*Mitrella lalage* Pilsbry and Lowe, 1932, D-41A, Isla Tiburón.

*Mitrella ocellata* (Gmelin, 1791), D-48, Isla Partida.

*Morula ferruginosa* (Reeve, 1846), D-36, Isla Angel de la Guarda; D-41A, Isla Tiburón.

*Nerita funiculata* Menke, 1861, D-47, Isla Raza.

*Nerita scabricosta* Lamarck, 1822, D-41, Isla Tiburón.

*Nomaeopelta mesoleuca* (Menke, 1851), D-41A, Isla Tiburón.

*Onchidiella binneyi* (Stearns, 1893), D-41, Isla Tiburón.

*Parametaria dupontii* (Kiener, 1849-1850), D-39, Isla Pond.

*Parametaria* sp., D-36, Isla Angel de la Guarda.

*Pyrene fuscata* (Sowerby, 1832), D-36, Isla Angel de la Guarda; D-41A, Isla Tiburón.

*Tegula* cf. *T. corvus* (Philippi, 1849), D-39, Isla Pond; D-44A, Isla San Esteban.

*Tegula globulus* (Carpenter, 1856), D-41A, Isla Tiburón.

*Tegula ligulata* (Menke, 1850), D-39, Isla Pond.

*Tegula mariana* Dall, 1919, D-35, Isla Angel de la Guarda; D-39, Isla Pond; D-42, Isla Turner.

*Tegula rugosa* (A. Adams, 1853), D-41, Isla Tiburón.

*Terebra specillata* Hinds, 1844, D-41, Isla Tiburón.

*Thais biserialis* (Blainville, 1832), D-45, Isla San Lorenzo del Sur.

*Thais triangularis* (Blainville, 1832), D-45, Isla San Lorenzo del Sur.

*Tridachiella diomedea* (Bergh, 1894), D-36, Isla Angel de la Guarda.

*Trivia radians* (Lamarck, 1810), D-39, Isla Pond.

*Trivia solandri* (Sowerby, 1832), D-36, Isla Angel de la Guarda; D-42, Isla Turner.

*Turbo fluctuosus* Wood, 1828, D-41, Isla Tiburón; Isla Turner.

### Pelecypods

*Anomalocardia subimbricata tumens* (Verrill, 1870), D-39, Isla Pond.

*Arca mutabilis* (Sowerby, 1833), D-42, Isla Turner.

*Arcopsis solida* (Sowerby, 1838), D-35, Isla Angel de la Guarda; D-41A, Isla Tiburón.

*Barbatia reeveana* (Orbigny, 1846), D-39, Isla Pond.

*Carditameria affinis* (Sowerby, 1833), D-39, Isla Pond; D-41, Isla Tiburón; D-42, Isla Turner; D-46, Isla Salsipuedes.

*Chama squamuligera* Pilsbry and Lowe, 1932, D-41A, Isla Tiburón.

*Hiatella arctica* (Linnaeus, 1767), D-39, Isla Pond.

*Hormomya adamsiana* (Dunker, 1887), D-35, Isla Angel de la Guarda; D-41A, Isla Tiburón; D-46, Isla Salsipuedes.

*Isognomon chemnitzianus* (Orbigny, 1853), D-39, Isla Pond; D-46, Isla Salsipuedes; D-47, Isla Raza.

*Isognomon janus* Carpenter, 1856, D-39, Isla Pond; D-41A, Isla Tiburón.

*Lima tetrica* Gould, 1851, D-36, Isla Angel de la Guarda.

*Lithophaga aristata* (Dillwyn, 1817), D-36, Isla Angel de la Guarda.

*Lyonsia* sp., D-42, Isla Turner.

*Modiolus capax* (Conrad, 1837), D-36, Isla Angel de la Guarda.

*Pododesmus* cf. *P. pernoides* (Gray, 1853), D-39, Isla Pond.

*Protothaca grata* (Say, 1831), D-41A, Isla Tiburón.

*Semele* sp., D-41, Isla Tiburón.

*Thracia curta* Conrad, 1837, D-42, Isla Turner.

### Cephalopods

*Octopus* cf. *O. bimaculatus* (Verrill, 1883), D-39, Isla Pond.

*Octopus digueti* Perrier and Rochebrune, 1894, D-39, Isla Pond.

*Octopus* sp., D-36, Isla Angel de la Guarda.

*Dustin Chivers*

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## ORNITHOLOGY AND MAMMALOGY

Dr. Richard C. Banks, then Curator of Birds and Mammals of the San Diego Natural History Museum and now with the United States Fish and Wildlife Service, has investigated the island fauna of the Gulf of California during the last six years, starting with a detailed study of the birds of Isla Cerralvo (Banks, 1963). He was a member of the Museum's Belvedere Expedition to all of the major islands in 1962, and visited the islands between San

Diego, California, and Isla Carmen while on the research vessel *Gringa*, now *Sea Quest*, in 1963. He was with the Sea of Cortez Expedition in 1964.

Dr. Banks' informal report, which was not submitted for publication, is reproduced here:

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*19 April.* Proceeded from San Diego to Tijuana to Bahía de los Angeles, to Puerto Refugio, between Islas Angel de la Guarda and Mejía. Set traps on Mejía after dark. Pocket mice were very abundant, and Sloan and I had four before returning to the boat. They were particularly common in the weeds on flat ground, less so in the rocky canyons.

*20 April.* Had several other specimens of *Perognathus* in the traps, and one of *Peromyscus*. Spent the morning on Angel de la Guarda, observing birds and found two rattlesnakes. Mockingbirds, with young, were particularly common and conspicuous. There was a large flock of white-crowned sparrows, most apparently of the "*leucophrys*" rather than of the "*gambelli*" type. Collected a Vauz swift, a record for the island. Skinned in afternoon, until late, when I set traps again on Mejía.

*21 April.* Again had good supply of *Perognathus* specimens to skin, but none of *Peromyscus*. One mouse in the trap, caught only by tail, had been swallowed by a snake up to the trap. Spent a couple of hours on Angel in the morning. Moved south along Angel in early afternoon, stopping at a lagoon on east side, where I picked up a mummy of a sea lion and counted gull eggs in the nests. Anchored farther south at dark. Sloan and Bandar went ashore for snakes, and found bats *(Macrotus)* using chuckwalla burrows as night roosts. Collected two, which are island records.

*22 April.* Got to Isla Pond early in morning, and I spent until noon ashore there. Virtually no birds. Captured one rattler for Sloan, and dug in rocks for kissing bugs *(Triatoma)* for Ray Ryckman. Saved two specimens of *Pizonyx*, one skeleton and one alcoholic, which I found during the latter activity. Skinned during afternoon, going ashore late to set mouse traps. Pocket mouse signs were fairly abundant here, even though no mice were reported from the island. Turtle barbecue on beach.

*23 April.* Ashore early to pick up traps; had one peromyscus and one damaged perognathus. Both are new records for the island, and the peromyscus probably belongs to a new subspecies. Departed for Tiburón, going ashore on north end, Bahía Agua Dulce, in early afternoon. Gila woodpeckers common, feeding young in nests in cardons. Cactus wrens also common. Saw red-tailed hawk paid at nest, one of adults was melanistic. Saw *Citellus grammurus*, but unable to obtain one. Found a series of caves which bats use at night, and a wild bee colony in one. Set traps just before dark, putting rat traps as well as mouse traps.

*24 April.* Got a late start from here although we went ashore to check traps in a hurry. Had six wood rats, one dipodomys, one perognathus, and one specimen of *Peromyscus erentmicus.* Went to south end of Tiburón, then took small boat to Isla Turner to trap. Caught a rattlesnake *(Crotalus atrox).* Saw abundant pocket mouse signs.

*25 April.* Picked up traps, finding specimens of *Peromyscus collatus* (new to museum collection) and three perognathus, probably belonging to *P. penicillatus,* not previously reported from the island. It is probably an undescribed form. No wood rats, unfortunately. Went back ashore after breakfast, but accomplished little. Departed for Isla San Pedro Mártir. Arrived in early afternoon, but did not go to shore until late afternoon. Hiked to near the top of the island to set traps. Many blue-footed boobies nesting, and also some tropic birds. Collected three of the latter for special investigation--adults as alcoholic and skeleton, a chick from one of them. The other had an egg. Took a dead baby pelican from a nest.

*26 April.* Had nothing in traps, but caught a rattler while checking them. Took some photos of boobies. Moved on to Isla San Esteban. Hiked a good ways in mid-afternoon, but it was the wrong time of day for birds. Black-throated sparrows were carrying food to nestlings here, and one juvenile was collected. Set traps late in afternoon, mostly near large clumps of cactus on a slope.

*27 April.* Had two mice *(Peromyscus stephani)* and four small rats *(Rattus)* in my traps. One of the mice had a crushed skull. Got a total of about 13 birds here, with the help of Ken Lucas, concentrating on those that vary geographically, so that the avifaunal relationships of the island could be re-examined. Moved from here to Isla San Lorenzo Sur. Spent a little time ashore in late afternoon, setting a few traps. Went back ashore in the evening, to look for snakes, and took one mouse from traps.

*28 April.* Early in morning moved on up to Isla Salsipuedes, where a pair of peregrine falcons were flying about the anchorage. I spent a couple of hours roving around the south end of the island trying to find their nest, but only found a place where I thought they were keeping house. Found a raven nest. Moved from here to Raza, where we spent a couple of hours ashore looking at the Heermann gulls and elegant and royal terns. What a bird colony! The terns particularly were packed about as tightly as possible in the space they occupied. Whenever they flushed, the gulls were there to eat eggs, and they seemed to be selective about the eggs they took. From here we went on to Isla Partida, where Luis Baptista and I searched the rocks for fish-eating bats and petrels. We found a number of bats, and quite a few black petrels, the latter with eggs, but no least petrels. From here we returned to Bahía de los Angeles, arriving after dark; unloaded the boat, and prepared a few last remaining specimens.

*29 April.* Spent the morning organizing gear and packing. About noon Sloan and I visited the springs for the town, and he collected some frogs. I picked up a dead yellow bat next to one of the springs, the second specimen of this species in our collection and a good record for the area. Flew back to Tijuana in early afternoon, and arrived back at museum about 1630.

*Highlights of trip:* Birdwise, the high spots were seeing the large flocks of migrant water birds--Arctic loons, eared grebes, and northern phalaropes, and, of course, the nesting colonies of gulls, terns, and boobies. Getting the tropic birds was quite exciting, and may prove to be good material with which to review the relationships of this group. The Gila woodpeckers from Tiburón may help to clarify the validity of that race, which I have previously questioned. The birds from Isla San Esteban should help in a reconsideration of the avifaunal relationships of that island--Van Rossem placed it with the Cape region, which is geographically improbable.

From the mammal standpoint, the addition of *Peromyscus collatus* to the collection was nice. Similarly, the finding of pocket mice on Isla Turner, pocket mice and *Peromyscus guardia* on Isla Pond, which have not been reported. The seeming absence of native rodents on Isla San Pedro Mártir is interesting. Reports of rats and mice on Isla Raza is confirmed by specimens taken by a student there. There was what appeared to be a pocket mice sign on Isla Partida, but we had no chance to trap. I was disappointed in *Peromyscus* trapping--but I did succeed in getting alcoholic males of five populations (four species) to send to Michigan for study of the glans penis and relationships.

A total of 79 specimens was obtained, all valuable. I consider the trip to have been very successful.

*Richard C. Banks*

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The Academy's Department of Ornithology and Mammalogy was represented by its Chairman, Dr. Robert T. Orr, who was assisted by Raymond Bandar, Field Associate, and Luis Baptista, a graduate student at the University of San Francisco. Effort was made to secure representative collections of small mammals from all the islands where the *San Augustin II* anchored overnight.

Dr. Orr's primary interest was to continue his population studies on the California sea lion *(Zalophus californianus)* in the Gulf of California, which were begun in the summer of 1965. A report on this is planned for the near future. Studies were also made on cetaceans and marine birds. Mr. Bandar, in addition to collecting small mammals, participated actively in collecting reptiles for the Academy's Department of Herpetology and for Steinhart Aquarium. Mr. Baptista also collected small mammals and assisted Dr. Banks in his work on birds.

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## ACKNOWLEDGMENTS

The Gulf Islands Expedition of 1966 was sponsored by the Belvedere Scientific Fund of San Francisco, and by the National Science Foundation through its support of the Vermilion Sea Field Station of the San Diego Natural History Museum.

The scientific collections were made with the permission of various officers and officials of Mexico. The generous help and cooperation of the following gentlemen is particularly appreciated. Marine collections were made under permits signed by C. Biol. Rodolfo Ramirez Granados, Subdirector of the Dirección General de Pesca e Industrias Conexas, de la Secretaría de Industria y Comercio. C. Lic. Noe Palomares, Subsecretario de Agricultura y Ganadería, personally arranged for permits to collect plants and for additional courtesies from his offices. C. Dr. Rodolfo Hernandez Corzo, Director General de la Fauna Silvestre de la Secretaría de Agricultura y Ganaderia, issued the permits for taking land animals. Permission to land and collect on Isla Tiburón was granted by C. Lic. Rene Martinez de Castro, Presidente, and C. Ing. Luis Carlos Felix, Secretario, of the Patronato para la Conservación y Aprovechamiento de la Fauna Silvestre en el Estado de Sonora.

Specimens destined to the San Diego Natural History Museum were taken under the appropriate permits granted to Dr. Richard P. Phillips, Dr. Richard C. Banks, Dr. Reid Moran, and Mr. Allan J. Sloan. Specimens for the California Academy of Sciences were collected under the permits of its Director, Dr. George E. Lindsay.

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# PROCEEDINGS

OF THE

# CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

Vol. XXX, No. 17, pp. 357–380; 2 figs. February 23, 1968


# SHALLOW WATER FORAMINIFERA FROM CAPE SAN LUCAS, LOWER CALIFORNIA


By

Clifford C. Church


The Foraminfera described in this paper were secured from coarse sand and shell debris dredged in water from 2 to 8 fathoms deep off Cape San Lucas, Baja California.

The collection was made by G D. Hanna and the late Eric K. Jordan during the cruise of the U.S.S. *Ortolan* on an expedition to the Revillagigedo Islands, Mexico, in 1925. The expedition was sponsored by Dr. Barton W. Evermann, then Director of the Museum of the California Academy of Sciences, and was made possible through the cooperation of the Hon. Curtis D. Wilbur, Secretary of the Navy and his department. At the direction of the Secretary, the mine sweeper *Ortolan* was detached from the main fleet and placed at the disposal of the expedition authorities.

The fauna is a shallow-water, open-ocean type, with a number of pelagic species included with the benthonics. The area is just within the northern limits of tropical waters which, however, do extend farther north within the Gulf of California. A shallow water foraminiferal fauna collected off the east shore of Maria Madre Island during the same expedition, is very similar to the Cape San Lucas fauna. This island is the largest of the Tres Marias Islands which lie 250 miles southeast of Cape San Lucas and about 60 miles west of the mainland of Mexico.

Since 1930 many papers concerning the ecology of Foraminifera from the littoral zone outward into the deep basins in the gulf of California and north and south of Cape San Lucas, have appeared. These have been consulted and are listed in the bibliography. In this study I have made an earnest attempt to see and review all of the papers pertinent to this area and general environment and if any have been overlooked it is unintentional and no reflection on their worth.

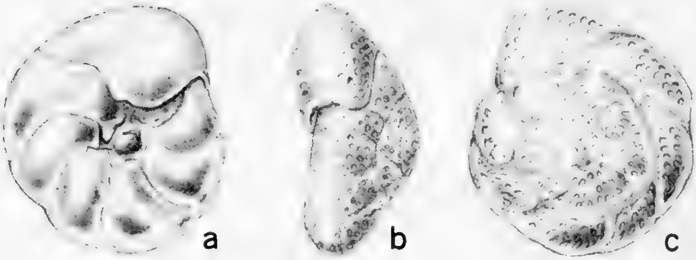


Figure 1 (a–c). *Discorbis hannai* Church, new species. Holotype no. 13034 (CAS). a, ventral view; b, apertural view; c, dorsal view.

As an example, some excellent work has been done by graduate students in universities as theses for advanced degrees. These have not been referred to because of their general unavailability.

Among the described foraminiferal faunas of this area, one from Carmen Island and vicinity, in the lower half of the Gulf, by M. L. Natland, closely resembles the Cape fauna. This fauna was extracted from sediments of Pliocene and Pleistocene age collected by Drs. C. A. Anderson and J. Wyatt Durham of the University of California in the 1940 *E. W. Scripps* Cruise to the Gulf of California. Some of the species are also described or listed by Cushman and McCulloch (1939–1948). Other papers on the ecology of the area by O. L. Bandy, F. B. Phleger, J. J. Bradshaw, Frances L. Parker, T. Uchio, and O. L. Bandy and R. E. Arnal, have greatly extended our knowledge and understanding of the Foraminifera of the Gulf and coastal area. In Dr. Bandy's (1961) paper, 17 separate foraminiferal faunas from nine biofacies are recognized and illustrated. Dr. Phleger (1964), in a similar paper, described the variations of foraminiferal populations and he figured or listed a large number of species, many of which are represented in the more open ocean, shallow water fauna of the Cape.

In this study I have been aided by the loan of comparative specimens, and suggestions on the identification of questionable species, by M. L. Natland of the Richfield Oil Corporation, Los Angeles, and by Frances L. Parker and Jean P. Hosmer of Scripps Institution of Oceanography, La Jolla, California. To these people I wish to express my thanks for their generous cooperation.

For assistance in obtaining important papers relative to this study, I am indebted to Dr. G D. Hanna, California Academy of Sciences; Andrew W. Marianos, Humble Oil Company, Bakersfield, California; R. Stanley Beck, consultant at Bakersfield, and of the Standard Oil Company Laboratory, Oildale, California. For the excellent illustrations I am indebted to the accomplished illustrator of Foraminifera, Mrs. Margaret M. Hanna of the California Academy of Sciences, San Francisco, California.

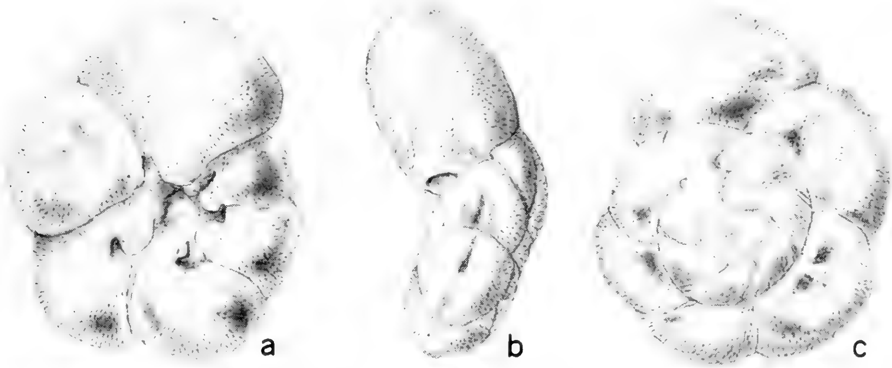


FIGURE 2 (a–c). *Rosalina natlandi* Church, new species. Holotype no. 13035 (CAS). a, ventral view; b, apertural view; c, dorsal view.

The material which forms the basis of this report was studied many years ago. Species were picked out, slides were prepared, and tentative identifications were made. All of this, together with an introduction similar to the above, was sent to Dr. Joseph A. Cushman of Sharon, Massachusetts, with the understanding that a joint paper would result. This was in accordance with a procedure he often followed. Dr. Cushman died before he was able to even acknowledge the receipt. The material was discovered by Miss Ruth Todd among his collections and papers after their receipt in Washington. It is through her interest that the present paper has resulted.

## SYSTEMATIC DESCRIPTIONS

### Family TEXTULARIIDAE

### Subfamily TEXTULARIINAE

### Genus **Textularia** Defrance in de Blainville

**Textularia agglutinans** d'Orbigny.

*Textularia agglutinans* d'Orbigny, Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 363, pl. 43, figs. 1–3. CUSHMAN, U.S. Nat. Mus., Bull. 71, pt. 2, 1911, p. 9, fig. 10.

This species, which is common in the Cape San Lucas material, is as much as 1 mm. or more in length.

**Textularia agglutinans** var. **porrecta** Brady.

*Textularia agglutinans* var. *porrecta* BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 364, pl. 43, figs. 4a, b.

The species of *Textularia* from Cape San Lucas which is referred to this variety may belong to another species as it is extremely small and not as elongate as the one figured by Brady. However, not considering the internal structure, which is difficult to determine because of its small size, the test corresponds in every way to the variety named.

**Textularia gramen** d'Orbigny.

*Textularia gramen* d'Orbigny, BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 365, pl. 43, figs. 9, 10. CUSHMAN, U.S. Nat. Mus., Bull. 71, pt. 2, 1911, p. 8, figs. 6–8.

This is a highly variable form in the Cape San Lucas material and fairly abundant.

Family ATAXOPHRAGMIIDAE

Subfamily VALVULININAE

Genus **Goesella** Cushman

**Goesella parva** Cushman and McCulloch.

*Goesella parva* CUSHMAN and MCCULLOCH, 1939, Allan Hancock Pac. Exped., Univ. South. Calif., vol. 6, no. 1, p. 98, pl. 10, figs. 13, 14.

The smallness of the test of this species renders it very inconspicuous in a fauna of larger forams and it might easily be overlooked. It is listed as occurring at a number of places along the coast of Baja California and Mexico. The type is from near Magdalena Bay, Mexico in 19 fathoms.

Family TROCHAMMINIDAE

Genus **Trochammina** Parker and Jones

**Trochammina inflata** (Montagu).

*Trochammina inflata* (Montagu), BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 338, pl. 41, figs. 4a–c. CUSHMAN, 1910, U.S. Nat. Mus., Bull. 71, pt. 1, p. 121, fig. 188.

Several good specimens of this species were found but it could not be considered common.

Family LITUOLIDAE

Genus **Haplophragmoides** Cushman

**Haplophragmoides canariensis** (d'Orbigny).

*Nonionina canariensis* D'ORBIGNY, 1839, Barker-Webb and Berthelot, Hist. Nat. Iles Canaries, vol. 2, pt. 2, Foraminifères, p. 128, pl. 2, figs. 33, 34.

*Haplophragmium canariensis* (d'Orbigny), SIDDALL and BRADY, 1879, Cat. Brit. Rec. Foram., p. 4. BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 310, pl. 35, figs. 1–5.

*Haplophragmoides canariensis* (d'Orbigny), CUSHMAN, 1910, U.S. Nat. Mus. Bull. 71, pt. 1, p. 101, fig. 149.

This is a very rare species in this fauna.

## Family Miliolidae

### Subfamily quinqueloculininae

### Genus **Pyrgo** Defrance

**Pyrgo denticulata** (Brady).

*Biloculina ringens* Lamarck var. *denticulata* Brady, 1884, Rep. Voy. *Challenger,* Zoology, vol. 9, p. 143, pl. 3, figs. 4, 5.
*Biloculina denticulata* Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 80, pl. 33, fig. 1.
*Pyrgo denticulata* Cushman, 1929, U.S. Nat. Mus., Bull. 104, pt. 6, p. 69, pl. 18, figs. 3, 4.

This species is relatively scarce here but exhibits the distinguishing features of the species as figured by Cushman (1910–1917).

**Pyrgo subsphaerica** d'Orbigny.

*Biloculina subsphaerica* d'Orbigny, 1839, De la Sagra. Hist. Fis. Pol. Nat. Cuba, "Foraminifíeres," p. 162, pl. 8, figs. 25–27.
*Pyrgo subsphaerica* d'Orbigny, Cushman, 1929, U.S. Nat. Mus., Bull. 104, pt. 6, p. 68, pl. 18, figs. 1, 2.

Among the few specimens of this species found there is considerable variation in size.

### Genus **Triloculina** d'Orbigny

**Triloculina inflata** d'Orbigny.

*Triloculina inflata* d'Orbigny, 1836, Ann. Sci. Nat., Paris, Ser. 1, tome 7, p. 300. Natland, 1950, Geol. Soc. America, Mem. 42, pt. 4, p. 10, pl. 3, figs. 11 a–c.

Several specimens of this robust species were found. What appears to be a variation of the form has a sharp angle on one or both sides of the larger chamber and in a few, a similar angle on the side of the smaller chamber.

**Triloculina oblonga** Montagu.

*Vermiculum oblongum* Montagu, 1803, Test. Brit., p. 522, pl. 14, fig. 9.
*Triloculina oblonga* d'Orbigny, 1826, Sci. Nat. Paris, vol. 7, p. 300, no. 16, Modeles no. 95; in De la Sagra, Hist. Fis. Pod. Cuba, 1839, "Foraminifères," p. 175, pl. 10, figs. 3–5.
*Trioculina oblonga* (Montagu), Cushman and Valentine, 1930, Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 16, pl. 4, figs. 5a, b, c, 6a, b, c.

**Triloculina circularis** Bornemann.

*Triloculina circularis* Bornemann, 1855, Zeitschr. deutsch. geol. Ges., vol. 7, p. 349. Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 67, pl. 25, fig. 4; pl. 26, fig. 1. Cushman and Valentine, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 15, pl. 4, figs. 4a, b, c.

This is one of the less common species in this fauna.

**Triloculina sidebottomi** Martinotti.

*Miliolina subrotunda* SIDEBOTTOM, 1904, Manchester Lit. Phil. Soc., vol. 6, no. 5, p. 8, text fig. 2, pl. 3, figs. 1–7.

*Sigmoilina sidebottomi* MARTINOTTI, 1920, Atti. Soc. Ital. Sci. Nat., vol. 59, pl. 2, fig. 29; text figs. 59–61.

*Triloculina sidebottomi* (Martinotti), PARKER, PHLEGER, and PEIRSON, 1953, Cush. Found. Foram. Res. Spec. Pub. no. 2, p. 14, pl. 2, figs. 25–28.

Only a few specimens of this species were found.

## Genus **Quinqueloculina** d'Orbigny

**Quinqueloculina agglutinata** Cushman.

*Quinqueloculina agglutinata* CUSHMAN, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 43, pl. 9, fig. 2. CUSHMAN and VALENTINE, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 9, pl. 1, figs. 7a, b, c.

This is one of the rare species at this locality.

**Quinqueloculina seminula** (Linnaeus).

*Quinqueloculina seminula* (Linnaeus), CUSHMAN and VALENTINE, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 10, pl. 1, figs. 8a, b, c.

This highly polished species appears to have a wide range along the Pacific Coast. It is one of the common species at Cape San Lucas.

**Quinqueloculina compta** Cushman.

*Quinqueloculina compta* CUSHMAN, 1947, Contrib. Cushman Lab. Foram. Res., vol. 23, pt. 4, art. no. 302, p. 87, pl. 19, fig. 2a, b, c. PHLEGER, 1964, In Mem. 3, Am. Assoc. Petrl. Geol., Ed. by Van Andel and Shor, p. 383, pl. 1, fig. 17.

This is one of the common species at Cape San Lucas and wherever it has been listed in the papers concerning the ecology of the Gulf of California Foraminifera it is listed as a very shallow-water form. What is probably the same species was figured by Bandy (1961). He listed it as *Q. angulosa* d'Orbigny.

This is a highly variable species, ranging between the more elongate type as figured by Bandy to very short robust forms with most characters accentuated but retaining the dull, granular surface throughout its variations.

**Quinqueloculina lamarckiana** d'Orbigny.

*Quinqueloculina lamarckiana* D'ORBIGNY, 1839, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminifères," p. 189, pl. 11, figs. 14, 15. CUSHMAN and VALENTINE, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 10, pl. 1, figs. 9a, b, c, and 10a, b, c.

Not a common form here but well defined. Only the larger ones appear to be typical.

**Quinqueloculina flexuosa** d'Orbigny.

*Quinqueloculina flexuosa* d'Orbigny, 1839, Voy. Am. Merid., "Foraminiferés," p. 73, pl. 4, figs. 4–6. Cushman and Valentine, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 11, pl. 2, figs. 3a, b, c. Natland, 1950, Geol. Soc. America, Mem. no. 43, pt. 4, p. 7, pl. 1, figs. 6a, b, c.

This is one of the commoner forms here and one which is fairly constant in character.

**Quinqueloculina costata** d'Orbigny.

*Quinqueloculina costata* d'Orbigny, Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 49, pl. 15, fig. 1. Cushman 1922, Carnegie Inst. Washington, vol. 17, publ. 311, p. 66, pl. 11, fig. 5. Natland, 1950, Geol. Soc. America, no. 43, pt. 4, p. 8, pl. 2, figs. 4a, b, c.

A common form at Cape San Lucas, many specimens were found.

**Quinqueloculina catalinensis** Natland.

*Quinqueloculina catalinensis* Natland, 1938, Calif. Univ., Scripps Inst. Oceanogr., Bull. Tech. Ser., vol. 4, no. 5, p. 142, pl. 4, fig. 3a, b, c. Bandy, 1961, Micropaleo. vol. 7, no. 1, p. 16, pl. 2, fauna 2, figs. 12a, b, c.

This is quite a common but highly variable species here. The more mature ones have 14 to 16 transverse, sinuous, ripple-like ridges or welts, some branching or discontinuous with many continuing over the usually acute angle of the test, rounding it off. This more highly ornamented type of the species might easily be considered a different species but the less ornate ones, which are associated with them, are like the typical *Q. catalinensis.*

**Quinqueloculina** species.

Test elongate, more than twice as long as broad, compressed, surface dull white, rough and pitted, short neck and phialine lip, aperture oval. A number of specimens were found, most of them perfectly preserved.

Subfamily NODOBACULARIINAE

Genus **Vertebralina** d'Orbigny

**Vertebralina striata** d'Orbigny.

*Vertebralina striata* d'Orbigny, Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 187, pl. 12, figs. 14–16. Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 38, pl. 22, figs. 3, 4.

Of fairly common occurrence here at Cape San Lucas.

**Vertebralina insignis** Brady.

*Vertebralina insignis* Brady, Flint, 1899, U. S. Nat. Mus., Rept., p. 302, pl. 47, fig. 4.

Only a few of this species were found in the Cape San Lucas collection.

### Subfamily TUBINELLINAE Rhumbler

### Genus **Parrina** Cushman

**Parrina bradyi** (Millett).

*Nubecularia inflata* Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 135, pl. 1, figs. 5–8.
*Parrina bradyi* (Millett), Cushman, Contrib. Cush. Lab. Foram. Res., vol. 7, pt. 1, p. 20.

This rather small form is variable in shape, number, and type of apertures. It is of the porcelaneous variety and quite abundant in the Cape San Lucas dredging.

### Subfamily MILIOLINAE

### Genus **Hauerina** d'Orbigny in De la Sagra

**Hauerina bradyi** Cushman.

*Hauerina compressa* Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 190, pl. 11, figs. 12, 13.
*Hauerina bradyi* Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 62, pl. 23, fig. 2.

This is one of the more common forms at Cape San Lucas.

## Family Soritidae

### Subfamily PENEROPLINAE

### Genus **Spirolina** Lamarck

**Spirolina arietina** (Batsch).

*Nautilus* (Lituus) *arietinus* Batsch (part), 1791, Conch. Seesandes, p. 4, pl. 6, fig. 15c.
*Peneroplis arietinus* Parker, Jones and Brady, 1865, Ann. Mag. Nat. Hist., ser. 3, vol. 16, p. 26, pl. 1, fig. 18.
*Peneroplis pertusus* var. *arietinus* Woodward, 1893, The *Observer*, vol. 4, p. 77. Cushman, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 88, pl. 36, fig. 2; 37, fig. 5.
*Spirolina arietinus* (Batsch), Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 43, pl. 15, figs. 4, 5.

This species is fairly abundant here and quite variable in form.

### Subfamily SORITINAE

### Genus **Amphisorus** Ehrenberg

**Amphisorus hemprichii** Ehrenberg.

*Amphisorus hemprichii* Ehrenberg, 1838, Abhandl. k. Akad. Wiss. Berlin, p. 134, pl. 3, fig. 3.
*Orbitolites duplex* Carpenter, 1883, Rep. Voy. *Challenger*, Zoology, pt. 21, p. 25, pl. 3, figs. 8–14; pl. 4, figs. 6–10; pl. 5, figs. 1–13.
*Amphisorus hemprichii* Ehrenberg, Cushman, 1930, U.S. Nat. Mus., Bull. 104, pt. 7, p. 51, pl. 18, figs. 5–7.

Of occasional occurrence here with a variety of growth stages.

### Family Nonionidae Schultze

### Subfamily nonioninae

### Genus **Florilus** de Montfort

**Florilus japonicus** (Asano) var. **mexicanus** (Cushman and McCulloch).

*Pseudononion japonicum* Asano, 1936, Jour. Geol. Soc. Japan, vol. 43 (512), p. 347, figs. a–c.
*Nonionella japonica* (Asano) var. *mexicana* (Cushman and McCulloch), 1940, Allan Hancock Pac. Exped., vol. 6, no. 3, p. 160, pl. 17, fig. 10.

This is one of the less common species found here.

**Florilus pizarrensis** (Berry) var. **basispinatus** Cushman and Moyer.

*Nonion pizarrense* (Berry) var. *basispinatum* Cushman and Moyer, 1930, Contrib. Cush. Lab. Foram Res., vol. 6, pt. 3, p. 54, pl. 7, figs. 18a, b.

Not of common occurrence in this fauna.

### Genus **Cushmanella** Palmer and Bermudez

**Cushmanella primitiva** Cushman and McCulloch.

*Cushmanella primitiva* Cushman and McCulloch, 1940, Allan Hancock Pac. Exped., vol. 6, no. 3, p. 163, pl. 18, figs. 6–10.

One of the rare species in this varied fauna.

### Genus **Elphidium** Montfort

**Elphidium articulatum** (d'Orbigny).

*Elphidium articulatum* (d'Orbigny), Cushman and Valentine, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 21, pl. 5, figs. 10a, b.

This is one of the common forms in the Cape San Lucas material.

**Elphidium crispum** (Linnaeus).

*Polystomella crispa* (Linnaeus), Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 736, pl. 110, figs. 6, 7. Cushman, 1914, U.S. Nat. Mus., Bull. 71, pt. 4, p. 32, pl. 18, fig. 1.

Only a few individuals of this species were found.

### Superfamily Buliminacea Jones

### Family Turrilinidae Cushman

### Subfamily turrilininae Cushman

### Genus **Buliminella** Cushman

**Buliminella parallela** Cushman and Parker.

*Buliminella parallela* Cushman and Parker, 1931, U.S. Nat. Mus., Proc., Washington, D.C., vol. 80, no. 2903, art. 3, p. 13, pl. 3, fig. 15. Cushman and McCulloch, 1948, Allan Hancock Pac. Exped., vol. 6, no. 5, p. 239, pl. 29, figs. 7a, b, c.

Only a few of this species were found here.

### Genus **Buliminoides** Cushman

**Buliminoides williamsoniana** Cushman.

*Buliminoides williamsoniana* Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 408, pl. 51, figs. 16, 17.

*Buliminoides williamsoniana* Cushman, 1911, U.S. Nat. Mus., Bull. 71, pt. 2, p. 90, fig. 144 (text).

This is a very rare species here.

### Family Buliminidae Jones

### Subfamily pavonininae Eimer and Fickert

### Genus **Reussella** Galloway

**Reussella aequa** Cushman and McCulloch.

*Reussella aequa* Cushman and McCulloch, 1948, Allan Hancock Pac. Exped., vol. 6, no. 5, p. 251, pl. 31, figs. 7 a–d.

This species occurs rather sparingly but is by no means rare.

### Genus **Chrysalidinella** Schubert

**Chrysalidinella spectabilis** Cushman and McCulloch.

*Chrysalidinella spectabilis* Cushman and McCulloch, 1948, Allan Hancock Pac. Exped., vol. 6, no. 5, p. 256, pl. 32, figs. 1–7.

The vertical striations are very faint and not discernible on some specimens. It is a rare species here.

### Family Uvigerinidae

### Genus **Trifarina** Cushman

**Trifarina** species.

This small, variable species does not appear to have been described or it may be a varient of *Angulogerina occidentalis* (Cushman).

### Genus **Siphogenerina** Schlumberger

**Siphogenerina costata** Schlumberger.

*Siphogenerina costata* Schlumberger, 1883, Feuille. Jeunes Nat., ann. 13, p. 117, text fig. B (Recent Gulf of Gascony) = *Uvigerina* (*Sagrina*) *raphanus*. Parker and Jones, 1865, Phil. Trans. Roy. Soc. London, vol. 155, p. 346, pl. 18, figs. 16, 17.

*Siphogenerina raphanus* Cushman, 1913, U.S. Nat. Mus., Bull. 71, pt. 3, p. 108, pl. 46, figs. 1–5.

*Siphogenerina costata* and *S. raphanus* have been placed in synonymy by Galloway, Cushman, and more recently, Bandy. This synonymy is discussed by Loeblich and Tappan in the Treatise (pt. C, Protista 2, vol. 2, p. C571) as follows, "We examined the types of *S. raphanus* in the British Museum (Natural

History), and regard it as distinct from *S. costata*. *Siphogenerina* is here regarded as including only species which are triserial in the microspheric early stage and biserial in the megalospheric stage. As *S. raphanus* is biserial to uniserial in the microspheric form and only uniserial in the megalospheric stage it has been transferred to *Rectobolivina*."

Since the Cape San Lucas species is triserial, it would have to be considered as *Siphogenerina* but as *S. raphanus* is now classed as *Rectobolivina* our present species would more logically be called *S. costata*.

Superfamily NODOSARIACEA

Family NODOSARIIDAE

Subfamily NODOSARIINAE

Genus **Dentalina** Risso

**Dentalina communis** (d'Orbigny).

*Nodosaria communis* d'Orbigny, BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 504, pl. 62, figs. 21, 22. CUSHMAN, 1913, U.S. Nat. Mus., Bull. 71, pt. 3, p. 54, pl. 28, figs. 1, 2.

Very rare, only one perfect specimen found.

Genus **Lagena** Walker and Jacob

**Lagena hexagona** (Williamson).

*Lagena hexagona* (Williamson), BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 472, pl. 58, figs. 32, 33. CUSHMAN, 1913, U.S. Nat. Mus., Bull., 71, pt. 3, p. 17, pl. 6, figs. 2, 3.

This is one of the very rare forms in this fauna.

Family GLANDULINIDAE

Subfamily OOLININAE

Genus **Fissurina** Reuss

**Fissurina lacunata** (Burrows and Holland).

*Lagena castrensis* BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 485, pl. 60, figs. 1, 2.

*Lagena orbignyana* (Seguenza) var. *lacunata* (Burrows and Holland), CUSHMAN, 1913, U.S. Nat. Mus., Bull. 71, pt. 3, p. 43, pl. 20, fig. 1.

*Fissurina lacunata* (Burrows and Holland), PARR, 1945, Proc. Roy. Soc. Victoria, n.s., vol. 56, p. 203.

This very small form is most nearly like the variety figured by Cushman but differs from it in the surface pitting which is limited to the convex portion of either face, and in having more abbreviated tricarinate edges. In this variety the carinae are nothing more than raised edges, the neck only slightly expressed. This is a rare form in the Cape San Lucas dredgings and its small dimensions (.2 mm to .25 mm.) render it somewhat inconspicuous.

### Family CASSIDULINIDAE

### Genus **Cassidulina** d'Orbigny

**Cassidulina** species.

This very small (.2 mm.) and transparent form is scattered very sparingly through the finer material. It could not be identified with any of the described species from this general area.

### Superfamily MILIOLACEA

### Subfamily CYCLOGYRINAE

### Genus **Cyclogyra** Wood

**Cyclogyra involvens** (Reuss).

*Cornuspira involvens* (Reuss), BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 200, pl. 11, figs. 1–3. CUSHMAN, 1917, U.S. Nat. Mus., Bull. 71, pt. 6, p. 25, pl. 1, fig. 2; pl. 2, fig. 2.

Loeblich and Tappan have indicated in the Treatise (1964), that the genus *Cyclogyra* has precedence over *Cornuspira.*

The specimens referred to here, while exhibiting the true characteristics of the species, are somewhat smaller than usual, ranging in size from .21 mm. to .27 mm. in diameter. Only a few were found.

### Superfamily SPIRILLINACEA

### Family SPIRILLINIDAE

### Subfamily SPIRILLININAE

### Genus **Spirillina** Ehrenberg

**Spirillina denticulata** Brady.

*Spirillina limbata* var. *denticulata* BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 632, pl. 85, fig. 17.

*Spirillina denticulata* Brady, PARR, 1950, Brit. Antarct. New Zealand Antarctic Res. Expend. 1929–31, Rept. Ser. B, vol. 5, pt. 6, p. 351.

Not a common species here.

**Spirillina vivipara** Ehrenberg.

*Spirillina vivipara* Ehrenberg, BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 630, pl. 85, figs. 1–5. CUSHMAN, 1915, U.S. Nat. Mus., Bull. 71, pt. 5, 1915, p. 3, pl. 1, figs. 1–2; in text, fig. 1.

The few specimens of this species found in the Cape San Lucas dredgings are characteristically hyaline and porous. The larger one measures .3 mm. in diameter.

Family BOLOVINITIDAE

Genus **Brizalina** Costa

**Brizalina paula** (Cushman and Cahill).

*Bolivina paula* Cushman and Cahill MS., CUSHMAN and PONTON, 1932, Florida State Geol. Surv., Bull. 9, p. 84, pl. 12, figs. 6a, b. CUSHMAN and MCCULLOCH, 1942, Allan Hancock Exped., vol. 6, no. 4, p. 202, pl. 24, figs. 9–12.

In this fauna there are a number of specimens which correspond to the figures in the Cushman and McCulloch paper but there are others which might more correctly be called *B. striatula* Cushman and it appears to be an intergrading series.

**Brizalina compacta** (Sidebottom).

*Bolivina robusta* Brady, var. *compacta* SIDEBOTTOM, 1905, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, no. 5, pl. 3, fig. 7.
*Bolivina compacta* CUSHMAN, 1911, U.S. Nat. Mus., Bull. 71, pt. 2, p. 36, text fig. 58.
*Bolivina compacta* SIDEBOTTOM, CUSHMAN, and MCCULLOCH, 1942, Allan Hancock Pac. Exped., vol. 6, no. 4, p. 190, pl. 23, fig. 4.

There are a number of specimens which are, with some hesitation, referred to this species but they are included with a few which appear to definitely belong here.

Genus **Bolivina** d'Orbigny

**Bolivina pseudoplicata** Heron-Allen and Earland.

*Bolivina pseudoplicata* HERON-ALLEN and EARLAND, 1930, Roy. Micros. Soc. Jour., London, pt. 1, ser. 3, vol. 50, p. 51, pl. 3, figs. 36–40. CUSHMAN and MCCULLOCH, 1942, Allan Hancock Pac. Exped., vol. 6, no. 4, p. 204, pl. 25, figs. 4–7.

A few well preserved specimens of this species were found.

**Bolivina torqueta** Cushman and McCulloch.

*Bolivina torqueata* CUSHMAN and MCCULLOCH, 1942, Allan Hancock Pac. Exped., vol. 6, no. 4, p. 215, pl. 27, figs. 5, 6.

A half dozen of this very distinctive species were found, all well preserved. The species was reported from a number of stations off the Mexican coast and the Galápagos Islands by the Allan Hancock Expedition.

Family ANOMALINIDAE

Subfamily ANOMALININAE

Genus **Hanzawaia** Asano

**Hanzawaia nitidula** (Bandy).

*Cibiocidena basiloba* (Cushman) var. *nitidula* BANDY, 1953, Jour. Paleo., vol. 27, no. 2, p. 178, pl. 22, fig. 3.
*Hanzawaia nitidula* (Bandy), 1961, Micropaleo., vol. 7, no. 1, p. 16, pl. 2, fig. 2a, b, c.

This is one of the less common forms in this material. It was listed by Bandy as one of the characteristic species of the inner shelf biofacies.

Family GLOBOROTALIIDAE

Subfamily GLOBOROTALIINAE

Genus **Globorotalia** Cushman

**Globorotalia menardii** (d'Orbigny).

*Pulvinulina menardii* (d'Orbigny), BRADY, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 690, pl. 103, figs. 1, 2. CUSHMAN, 1921, U.S. Nat. Mus., Bull. 100, vol. 4, p. 333, pl. 6, figs. 1 a–c.

*Globorotalia menardii* CUSHMAN, 1927, Bull. Scripps Inst. Ocean. Tech. Ser., vol. 1, p. 176.

This is one of the more common and well defined species here and one that is generally wide spread in this tropical Pacific Coast area.

Superfamily ROTALIACEA

Family ROTALIIDAE

Subfamily ROTALIINAE

Genus **Rotalia** Lamarck

**Rotalia avalonensis** Natland.

*Rotalia depressa* NATLAND, 1938, Bull. Scripps Inst. Ocean. La Jolla, Calif., Tech. Ser., vol. 4, no. 5, p. 147, pl. 5, figs. 15a, b, c.

*Rotalia avalonensis* NATLAND, new name, 1950, Geol. Soc. America, Mem. 43, 1940 E. W. Scripps Cruise Gulf Calif., pt. 4, p. 30, pl. 8, figs. 4 a–c.

The small species which I have referred to the above name appears to be the same as that figured by Natland from the Carmen Island locality. Only a few were found at Cape San Lucas.

Superfamily DISCORBACEA

Family DISCORBIDAE

Subfamily DISCORBINAE

Genus **Rosalina** d'Orbigny

**Rosalina obtusa** d'Orbigny (?).

*Rosalina obtusa* D'ORBIGNY, 1826, Ann. Sci. Nat. Paris, ser. 1, vol. 7.

*Discorbis obtusa* (d'Orbigny) (?), CUSHMAN, 1931, U.S. Nat. Mus., Bull. 104, pt. 8, p. 27, pl. 6, figs. 2a, b, c.

This is one of the commoner forms found at the Cape.

## Genus **Discorbis** Lamarck

**Discorbis nitida** (Williamson).

*Rosalina nitida* WILLIAMSON, 1858, Rec. Foram. Great Britain, p. 54, pl. 4, figs. 106–108.
*Rotalia nitida* BRADY, 1864, Trans. Linn. Soc. Zool., vol. 24, p. 474.
*Discorbina nitida* WRIGHT, 1889, Ann. Mag. Nat. Hist., ser. 6, vol. 4, p. 449.
*Discorbis nitida* (Williamson), CUSHMAN, 1931, U.S. Nat. Mus., Bull. 104, pt. 8, p. 26, pl. 6, figs. 1a, b, c.

Only a few of this species were found here.

**Discorbis hannae** Church, new species.

Test rotaliform, calcareous, perforate, plano-convex, coarsely perforate on dorsal, convex side, smooth, translucent and finely perforate on the flattened, ventral side, sutures directed back in gentle curves, slightly indented near the umbilicus, sutures on the dorsal side, narrow, dark lines flush with the surface and extending back at a steep angle of more than 50 degrees, outer edge acutely angled but rounded and only slightly thickened, no carina, seven chambers in the final whorl, all visible on the dorsal side, only those of the last formed whorl visible from the ventral side, the dorsal side elevated into a short, rounded, nipple-like cone somewhat thickened near the apex and projecting above the lower angled final whorl as a more steeply angled knob, color dark brown in top part of spire and fading to a pale brown in last whorl, aperture a low arch or slit at the base of the last formed chamber and extending from the periphery to the small umbilicus which is partially filled with a small depressed plug of dark, clear shell material, the inner points of the chambers project as thin, pointed teeth, partially concealing the opening and plug.

Height of type .28 mm., breadth .25 mm., thickness .15 mm.

HOLOTYPE no. 13034, California Academy of Sciences, Department of Geology Type Collection, from Locality 1309 (CAS), dredged from 28 fathoms off Cape San Lucas, Baja California, Mexico.

The generic designation of this species is somewhat doubtful as it has characters common to both *Discorbis* and *Rosalina*. It is a fairly common species at Cape San Lucas. It is named in honor of Mrs. Margaret M. Hanna, illustrator of many Foraminifera.

**Discorbis** species.

A few specimens of this unidentified species were found. It has very coarse but few scattered pores over the dorsal chambers where the test is thick and rugose and practically none on the ventral side where the test wall is thinner and of clear shell material. The umbilical area is very slightly depressed and obscured by a thin over-growth.

**Discorbis rosea** (d'Orbigny).

*Rotalia rosea* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 272, no. 7, Modeles, no. 35. Cushman, 1931, U.S. Nat. Mus., Bull. 104, pt. 8, p. 62, pl. 13, figs. 5 a–c.

*Truncatulina rosea* (d'Orbigny), Cushman, 1922, Publ. 311, Carnegie Inst., Washington, D.C., p. 46, pl. 14, figs. 3–5.

*Discorbina rosea* (d'Orbigny), Barker, 1960, "Taxonomic Notes," on Brady's *Challenger* Report of 1884. Soc. Econ. Paleon. Min., Spec. Pub. no. 9, p. 198, pl. 96, fig. 1.

Three good specimens were found and like those figured from the Atlantic Ocean by Cushman, they have numerous, short spines or tubercules over most of the highly domed dorsal side but more pronounced toward the base. All specimens have the delicate pink color characteristic of the species.

**Discorbis isabelleana** d'Orbigny.

*Discorbis isabelleana* d'Orbigny, Cushman and Valentine, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 23, pl. 6, figs. 6; 7 a–c; 8 a–c.

This is one of the less common species here.

Genus **Neoconorbina** Hofker

**Neoconorbina concinna** (Brady).

*Discorbina concinna* Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 646, pl. 90, figs. 7, 8.

*Tretomphalus concinnus* (Brady), Cushman, 1934, Contrib. Cushman Lab. Foram. Res., vol. 10, pt. 4, no. 149, p. 96, pl. 12, figs. 13–15.

*Rosalina concinna* (Brady), Barker, 1960, Spec. Publ. no. 9, Soc. Econ. Paleon. Min., Taxonomic Notes in Brady, Rep. Voy. *Challenger*, pl. 90, figs. 7, 8.

This small species is quite common at Cape San Lucas.

**Neoconorbina rosacea** (d'Orbigny).

*Rotalia rosacea* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 273, no. 15; Modeles no. 15; Modeles no. 39.

*Discorbis rosacea* Brady, 1864, Trans. Linnean Soc. London. vol. 25, p. 473, no. 69; 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 644, pl. 87, fig. 1 (4 ?).

*Discorbis rosacea* Cushman, 1915, U.S. Nat. Mus., Bull. 71, pt. 5, p. 13, figs. 13a, b, c (in text).

**Neoconorbina terquemi** (Rzehak).

*Rosalina orbicularis* Terquem, 1876, Essai Class., Anim. Dunkerque, pt. 2, p. 166, pl. 9, figs. 4 a–b.

*Discorbina orbicularis* (Terquem), Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 647, pl. 88, figs. 4–8.

*Discorbina terquemi* Rzehak, new name, 1888, Geol. Reichsanst., Verh., Wien, p. 228.

*Discorbis orbicularis* (Terquem), Cushman, 1915, U.S. Nat. Mus., Bull. 71, pt. 5, p. 16, text figs. 18 a–c, pl. 11, figs. 1 a–c.

*Rosalina terquemi* (Rzehak), Graham and Militante, 1959, Stanford Univ. Pub. Geol. Sci., vol. 6, no. 2, p. 98, pl. 14, figs. 13, 14a, b, c.

*Neoconorbina terquemi* (Rzehak), Barker, 1960, Taxonomic Notes on species figured by Brady, *Challenger* Rep. 1884, Soc. Econ. Paleon. Min., Spec. Rep. no. 9, p. 182, pl. 88, figs. 4–8.

This is one of the commoner species found in the Cape San Lucas material as is *Neoconorbina rosacea* (d'Orbigny) and it requires careful examination to distinguish one from the other.

### Genus **Tretomphalus** Möbius

**Tretomphalus bulloides** (d'Orbigny).

*Cymbalopora bulloides* (d'Orbigny), Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 638, pl. 102, figs. 7–12; text figs. 20 a–c.

*Tretomphalus bulloides* (d'Orbigny), Cushman, 1915, U.S. Nat. Mus., Bull. 71, pt. 5, p. 26, pl. 14, figs. 3, 4.

This is one of the more common forms in the Cape San Lucas fauna.

**Rosalina natlandi** Church, new species.

Test rotaliform, plano-convex, calcareous, all chambers visible from the dorsal side, only those of the final whorl visible from the ventral side, dorsal side rounded into a low arch, ventral side concave in the umbilical area, six moderately inflated chambers on the final whorl, test uniformly thin, transparent, with very fine, uniformly distributed pores on both sides, all chambers equally inflated, the sutures moderately incised, gently curved on the dorsal side, less so on the ventral side, chambers enlarge rather rapidly and evenly, outer edge of test gently rounded without a carina or any noticeable thickening, aperture a low arch at the base of the last formed chamber about half way between the umbilicus and the periphery of the test and extending into the umbilicus, a thin, transparent plate extending from the inner margin of each chamber into the umbilical opening but not so far as to close it, the secondary sutural openings are not fully developed. Dimensions: maximum diameter .35 mm.; thickness .18 mm.

Holotype no. 13035, California Academy of Sciences, Department of Geology Type Collection, from Locality 1309 (CAS), dredged in from 2 to 8 fathoms off Cape San Lucas, Baja California, Mexico.

This species differs from *Ammonia beccarii* (Linné), to which it has been compared, in having fewer, broader and more inflated chambers, more deeply incised sutures with less apparent thickening on the dorsal side and without dendritic development on the ventral side, test more compressed and more concave on the ventral side, aperture open, without umbilical plug, pillars or granules.

This species is named in honor of Dr. M. L. Natland, author of many papers on the living and Tertiary Foraminifera of this area.

### Family Acervulinidae

### Genus **Acervulina** Schultze

**Acervulina inhaerens** Schultze.

*Acervulina inhaerens* Schultze, 1854, Organismus Polythal., p. 68, pl. 6, fig. 12.
*Gypsina inhaerens* Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 718, pl. 102, figs. 1–6.
*Acervulina inhaerens* Schultze, Galloway, and Wissler, 1927, Jour. Paleo., vol. 1, no. 1, p. 67, pl. 11, fig. 3.

This encrusting species takes many shapes depending on the shape of the object to which it attaches itself. It is quite common at this locality.

### Family Cymbaloporidae

### Genus **Cymbaloporetta** Cushman

**Cymbaloporetta squammosa** (d'Orbigny).

*Rotalia squammosa* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 272, no. 8.
*Cymbaloporetta squammosa* Cushman, 1922, Carnegie Inst., Washington, D.C., Publ. 311, p. 41, pl. 6, figs. 4–6.

A number of this species were found so it is not uncommon in the Cape San Lucas dredgings.

### Subfamily bagginINAE

### Genus **Cancris** de Montfort

**Cancris aricula** (Fichtel and Moll).

*Nautilus auricula* var. A, Fichtel and Moll, 1803, Test. Micr., p. 108, pl. 20, figs. a–c; var. B, pl. 20, figs. d–f.
*Cancris auricula* (Fichtel and Moll), Cushman, 1931, U.S. Nat. Mus., Bull. 104, pt. 8, p. 72, pl. 15, figs. 1 a–c. Natland, 1950, Geol. Soc. America, Mem. 43, pt. 4, p. 32, pl. 8, figs. 7 a–c.

This is one of the rare species in this fauna.

### Family Glabratellidae

### Genus **Glabratella** Dorreen

**Glabratella pulvinata** (Brady).

*Discorbina pulvinata* Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 650, pl. 88, figs. 10 a–b.
*Discorbis pulvinata* (Brady), Cushman, 1915, U.S. Nat. Mus., Bull. 71, pt. 5, p. 19, pl. 7, fig. 2; in text, fig. 22.

Cushman described this species as having a diameter of .28 mm., those from Cape San Lucas are about the same size, ranging from .24 mm. to .32 mm. in diameter. They are quite common here.

### Family Cibicididae

### Subfamily cibicidinae

### Genus **Cibicides** de Montfort

**Cibicides mayori** Cushman.

*Truncatulina mayori* Cushman, 1924, Carnegie Inst. pub. 342, p. 39, pl. 12, figs. 3, 4.

Only one specimen was found here.

**Cibicides conoideus** Galloway and Wissler.

*Cibicides conoideus* Galloway and Wissler, 1927, Jour. Paleo., vol. 1, no. 1, p. 63, pl. 10, figs. 7a, b, c.

Only the small specimens from the type material compare with our present living examples.

**Cibicides concentrica** (Cushman).

*Truncatulina concentrica* Cushman, 1918, U.S. Geol. Surv., Bull. 676, p. 64, pl. 21, fig. 3 a–c.
*Cibicides concentrica* (Cushman), 1931, U.S. Nat. Mus., Bull. 104, pt. 8, p. 120, pl. 21, figs. 4, 5; plate 22, figs. 1, 2.

This is a rare species in the Cape San Lucas fauna but the few found are well preserved. They are most like the one figured by Cushman on plate 21, in Bulletin 104 of the U.S. National Museum.

**Cibicides** species.

This is a rather large, coarsely perforate species of which only two specimens were found. It appears not to have been described.

### Genus **Dyocibicides** Cushman and Valentine

**Dyocibicides biserialis** Cushman and Valentine.

*Dyocibicides biserialis* Cushman and Valentine, 1930, Contrib. Dept. Geol. Stanford Univ., vol. 1, no. 1, p. 31, pl. 10, figs. 1, 2a, 2b.

Numerous good specimens of this highly variable species were found.

### Family Hantkeninidae

### Subfamily hastigerininae

### Genus **Hastigerina** Thomson

**Hastigerina murrayi** Thomson.

*Hastigerina murrayi* Thomson, 1876, Proc. Roy. Soc. London, vol. 24, p. 534. Bolli, Loeblich, and Tappan, 1957, U.S. Nat. Mus., Bull. 215, p. 29, pl. 3, figs. 1–4b.

This is one of the less common species in the Cape San Lucas material.

Family Globigerinidae

Subfamily globigerininae

Genus **Globigerina** d'Orbigny

**Globigerina bulloides** d'Orbigny.

*Globigerina bulloides* d'Orbigny, Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 593, pl. 77; pl. 79, figs. 3–7. Cushman, 1914, U.S. Nat. Mus., Bull. 71, pt. 4, p. 5, pl. 2, figs. 7–9; pl. 9.

This worldwide species is not a common form at this locality.

**Globigerina inflata** d'Orbigny.

*Globigerina inflata* d'Orbigny Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 601, pl. 79, figs. 8–10. Cushman, 1914, U.S. Nat. Mus., Bull. 71, pt. 4, p. 8, pl. 4, figs. 4–8.

This species is classified as *Globorotalia inflata* (d'Orbigny) by Frances L. Parker (Jour. Paleo., 1964).

It is quite rare in the Cape San Lucas fauna as only two were found and while they are not typical they have been referred to this species.

**Globigerina quinqueloba** Natland.

*Globigerina quinqueloba* Natland, 1938, Bull. Scripps Inst. Ocean., La Jolla, Tech. ser., vol. 4, no. 5, p. 149, pl. 6, figs. 7a, b, c. Parker, 1964, Jour. Paleo., vol. 38, no. 4, p. 630, pl. 101, figs. 15, 16.

This is one of the rarer species in this fauna.

**Globigerina conglomerata** Schwager.

*Globigerina conglomerata* Schwager, 1866, Novara, Exped., Theil., pt. 2, p. 255, pl. 7, fig. 113. Cushman, 1927, Bull. Scripps Inst. Oceanog., Tech. Ser., vol. 1, no. 10, p. 172. Natland, 1950, Geol. Soc. America, Mem. 43, pt. 4, p. 36, pl. 10, figs. 1 a–c.

*Globigerina eggeri* Rhumbler, Brandt, 1901, K. Nordischis Plankton, Lief. 1, Nr. 14, p. 19, 20, tf. 20.

Natland considered *G. conglomerata* and *G. eggeri* to be equivalent species.

This is a fairly common species here and a number of the specimens have thin bullae covering the apertures on which younger specimens are attached as if budding off from the parent test. Others are normally open at the umbilicus but there are indications that such bullae may have been present and later resorbed.

Genus **Globigerinoides** Cushman

**Globigerinoides conglobata** (Brady).

*Globigerina conglobata* Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 603, pl. 80, figs. 1–5; pl. 82, fig. 5. Cushman, 1914, U.S. Nat. Mus., Bull. 71, pt. 4, p. 10, pl. 3, figs. 3–5; pl. 10, figs. 1, 6.

*Globigerinoides conglobata* (Brady), Cushman, 1927, Bull. Scripps Inst. Ocean., Tech. Ser., vol. 1, no. 10, p. 173.

This species, while quite common in the Cape San Lucas material, is much smaller than the usual occurrence and the final chambers are not so flattened as some of the larger specimens from other localities.

**Globigerinoides sacculiferus** (Brady).

*Globigerina sacculifera* Brady, 1884, Rep. Voy. *Challenger*, Zoology, vol. 9, p. 604, pl. 80, figs. 11–17. Cushman, 1914, U.S. Nat. Mus., Bull. 71, pt. 4, p. 11, pl. 2, figs. 4–6; pl. 5, pl. 10, fig. 4.

*Globigerinoides sacculiferus* (Brady), Natland, 1950, Geol. Soc. America, Mem. 43, pt. 4, p. 37, pl. 10, fig. 5a, b, c.

Only two of this species were found in the material examined and they are of the smaller type with more restricted chambers and apertures.

Family Caucasinidae

Subfamily Fursenkoininae

Genus **Fursenkoina** Loeblich and Tappan

**Fursenkoina** species.

Only one specimen of this genus was found and it is not complete.

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# THE DIGUET-MABILLE LAND AND FRESHWATER MOLLUSKS OF BAJA CALIFORNIA

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In 1895, Jules Mabille published a rather large list of mollusks collected in the Gulf of California and on the peninsula of Baja California by Léon M. Diguet. The latter is known to have travelled extensively in that area and to have made collections in the fields of botany, zoology, and anthropology, as well as conchology. Because the results of Diguet's work in Baja California are not well known we have included two of his published papers in our list of references at the end of this report. A rather complete list has been compiled by Barrett (1957, 1967).

The Mabille list contains the names of 134 marine species and subspecies of mollusks. In addition, there are names of 26 land and freshwater forms. Eight of the marine and 18 of the land and freshwater species were described as new. Not one was illustrated.

Although the land and freshwater forms were described rather fully, the identification of Mabille's species has given a great deal of trouble. This arises chiefly in most instances because no comparisons were made with species that already had been described and illustrated. When Dr. H. A. Pilsbry prepared the volume on the American Bulimulidae in the Manual of Conchology he commented on his inability to verify Mabille's names; about all he attempted was to publish English translations of the original descriptions in French. When the senior author worked on the large collection brought back from Baja California as a result of the California Academy of Sciences' 1921 Expedition to the Gulf of California the same difficulties were encountered; there were grave doubts whether some of the species that were then described as new (Hanna, 1923) were not actually some that Mabille had described previously.

Therefore, when it became possible for the senior author and Mrs. Hanna to visit some European museums during the summer of 1966, arrangements were made in advance to work at the Paris Museum of Natural History August 2 to 4. Through the kindness of Dr. Edouard Fischer-Piette and Dr. H. Chevallier, the collection in question had been segregated in order that the specimens might be photographed. They were most courteously received by Dr. and Mrs. Bernard Salvat and Miss Anne Marie Testud of the Department of Malacology. As a result of this pleasant visit it is now possible to illustrate Mabille's new land and freshwater species for the first time, which is the primary purpose of this report.

In addition to the 18 new species of land and freshwater shells covered in Mabille's list, there are eight named previously that were recognized and correctly identified by him; these need not be considered further. Two species—*Helix (Polygyra) solidens* and *H. (P.) triangularis* (and var. *minor*)—are from Guaymas, Sonora, on the west Mexican mainland and not from Baja California. These are also illustrated.

Unfortunately, the type lots of three species of *Bulimulus* could not be found among Diguet's Baja California shells in the Paris Museum. These are *Bulimulus (Leptobyrsus) lapidovagus, B. (L.) dentifer*, and *B. (Thaumastus) digueti.* Mabille's published paper contains brief locality information, which helps somewhat in placing the species. This is especially true of *Bulimulus (Leptobyrsus) dentifer* recorded from Isla Tortuga, a volcanic island in the Gulf of California. A large series of specimens was collected on this island during the Academy's 1921 Expedition and only a single species could be found. Some of these shells have been deposited in the Paris Museum for comparison in the event the original lot of *B. dentifer* is found later.

Although Mabille did not publish designations of types with his descriptions, labels in his handwriting do have the word "type" or "types" on them, leaving no doubt that type lots are represented. Notes were made of this in each instance and measurements were made at the time the shells were photographed for a check with those included by Mabille in his descriptions.

Without a direct comparison of pertinent type material in various museums with Mabille's type specimens in the Paris Museum (N. H.), any attempt to determine the validity of his new names must be speculative; in most instances decisions must be based on subjective evidence. Although the opportunity for direct comparisons seems remote, we believe some contribution can and should be made now toward settling the confusion caused by Mabille's new names by a study of the photographs and an evaluation of these and other available information. Our opinions and conclusions, contained in the following systematic list, may be summarized as follows:

| Mabille, 1895 | Probable Equivalent |
|---|---|
| *Planorbis mysarus* | *Planorbella tumida* (Pfeiffer, 1839) |
| *Helix indigena* | *Micrarionta indigena* (Mabille, 1895); syn. *M. peninsularis* (Pilsbry, 1916) |
| *Helix steganella* | *Micrarionta lohrii* (Gabb, 1868) |
| *Helix invecta* | *Micrarionta lohrii* (Gabb, 1868) |
| *Helix digueti* | A *nomen inquirendum* |
| *Helix (Polygyra) solidens* | *Polygyra anilis* (Gabb, 1865) |
| *Helix (Polygyra) triangularis* | *Polygyra behri* (Gabb, 1865) |
| *Helix (Polygyra) triangularis* var. *minor* | *Polygyra behri* (Gabb, 1865) |
| *Bulimulus (Leptobyrsus) lapidovagus* | A *nomen inquirendum* |
| *B. (Leptobyrsus) dentifer* | *Rabdotus (Leptobyrsus) dentifer* (Mabille, 1895) |
| *B. (Leptobyrsus) subspirifer* | *Bulimulus (Leptobyrsus) subspirifer* Mabille, 1895 |
| *B. (Leptobyrsus) dismenicus* | *Bulimulus (Hannarabdotus) beldingi* Cooper, 1892 |
| *B. (Scutalus) acholus* | *Bulimulus (Puritanina) acholus* Mabille, 1895 |
| *B. (Scutalus) cosmicus* | *Bulimulus (Puritanina) species inquirendum* |
| *B. (Scutalus) cacotycus* | *Bulimulus (Hannarabdotus) excelsus* (Gould, 1853) |
| *B. (Thaumastus) digueti* | A *nomen inquirendum* |
| *B. (Globulus) recognitus* | *Rabdotus (Rabdotus) sufflatus* (Gould, 1859) |
| *Berendtia digueti* | *Coelocentrum (Spartocentrum) digueti* (Mabille, 1895) |
| *Berendtia minorina* | *Coelocentrum (Spartocentrum) minorina* (Mabille, 1895) |

## Family PLANORBIDAE

**Planorbis mysarus** Mabille.

*Planorbis mysarus* MABILLE, 1895, pp. 63, 64. GERMAIN, 1921, p. 54.

TYPE LOCALITY. Lower California (Diguet).

TYPE LOT. Problematical. See remarks.

There were no specimens in the Paris Museum collection under the name *Planorbis mysarus* Mabille. There were, however, other lots of *Planorbis* collected by Diguet in Baja California. We are indebted to Drs. Fischer-Piette and Chevallier for the following information:

Diguet's shells were studied and identified later by Germain (1921), who placed Mabille's new species in the synonymy of *Planorbis (Pierosoma) tumidus* Pfeiffer, 1839. There are five lots, as follows:

Lot 1. The label, in Germain's handwriting, reads: "*Planorbis* voisins du *tumidus* Pfr., riviére de San Jose del Calvo [= Cabo]. Sud de la Basse Californie."

Lot 2. Germain's label reads: "*Planorbis tumidus* Pfr., Sud de la B. C."

Lot 3. A similar label reads: "*Planorbis tumidus* Pfr., San Jose del Calvo."

Lot 4. The label reads: "*P. tumidus* Pfr.,—*P. caribaeus* d'Orb.—*P. guatemalensis* Clessin, S. Jose."

Lot 5. The label in Mabille's handwriting reads: "*Planorbis tenuis* Phil., Basse Californie, Diguet, 1893"; an accompanying label by Germain reads: "*Planorbis tumidus* var. *major*." One of these specimens has the following dimensions: maximum diameter, 23.2 mm.; height, 8.4 mm.; height of aperture, 9.1 mm. The largest, (fig. 24a–c), measures: maximum diameter, 23.9 mm.; aperture height, 9.3 mm.

Lot 5 is perhaps the significant one. The name "var. *major*," preoccupied at least once by Gassies, 1863 (see Germain, 1923, p. 148), appears only on a

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FIGURE 1. *Bulimulus (Scutalus) cosmicus* Mabille. Lectotype. Length, 46.7 mm.; maximum diameter, 25.7 mm.

FIGURE 2. *Bulimulus (Scutalus) cosmicus* Mabille. Paralectotype. Length, 50.3 mm.; maximum diameter, 29.7 mm.

FIGURE 3. *Bulimulus (Leptobyrsus) dismenicus* Mabille. Lectotype. Length, 31.3 mm.; maximum diameter, 15.0 mm.

FIGURE 4. *Bulimulus (Leptobyrsus) subspirifer* Mabille. Lectotype. Length, 46.9 mm.; maximum diameter, 19.7 mm.

FIGURE 5. *Bulimulus (Scutalus) cacotycus* Mabille. Lectotype. Length, 58.0 mm.; maximum diameter, 26.4 mm.

FIGURE 6. *Bulimulus (Scutalus) cacotycus* Mabille. Paralectotype. Length, 53.0 mm.; maximum diameter, 24.9 mm.

FIGURE 7. *Bulimulus (Scutalus) cacotycus* Mabille. Paralectotype. Length, 48.5 mm.; maximum diameter, 23.8 mm.

FIGURE 8. *Bulimulus (Scutalus) acholus* Mabille. Lectotype. Length, 45.1 mm.; maximum diameter, 25.0 mm. Figure 8a, entire shell. Figure 8b, enlarged portion of body whorl to show sculptural detail.

FIGURE 9. *Bulimulus (Globulus) recognitus* Mabille. Lectotype. Length, 24.0 mm.; maximum diameter, 16.4 mm.


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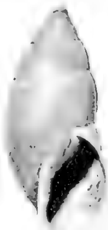
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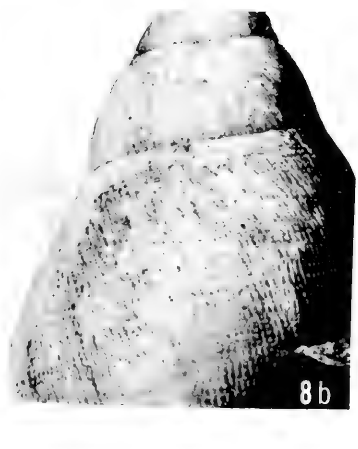
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9

museum label and thus has no taxonomic significance. These specimens (or others like them) possibly represent what Mabille used in describing *Planorbis mysarus*, although the dimensions he gave (maximum diameter, 28 mm.; minimum diameter, 20 mm.; height, 8 mm.) call for a much larger shell than the largest one of "var. *major*" in lot 5.

Although Mabille's *P. mysarus* evidently cannot be related to a particular specimen with any certainty, we follow Germain in relegating it to the synonymy of *P. tumidus*.

## Family Helminthoglyptidae

**Helix indigena** Mabille.
(Figures 22, 23.)

*Helix indigena* Mabille, 1895, p. 64. Pilsbry, 1916, p. 99.

Type locality. Found above 800 meters on the peaks of the Sierra, throughout most of the central part of the Peninsula of California (Diguet).

Type lot. Nine specimens marked "Types" on the label. All except one subadult (fig. 22) are dead, bleached shells. The shell designated here as the lectotype (fig. 23) is fully adult measuring: maximum diameter, 19.4 mm.; height, 10.2 mm. The other eight shells become paralectotypes. Pilsbry (1916), stated that these shells evidently belonged to the group of *Sonorella* [= *Micrarionta*] *lohrii* (Gabb). That *H. indigena* is different from *H. lohrii* is evident from an examination of Mabille's type lot, supported by the accompanying illustrations (figs. 22, 23). It is doubtless the same as *Micrarionta peninsularis* (Pilsbry, 1916) described and illustrated in the same paper.

The senior author discussed *M. peninsularis* in some detail in a later report (Hanna, 1923, pp. 503, 504), placing the locality of the original specimens collected by Gabb as being about 30 miles south of the Mission San Borja in the foothills of the Sierra de Calmalli. This is the same general area where Diguet probably collected *M. indigena*. Two large series of these snails were collected in this same area by the junior author during a Vizcaiño Desert Expedition of the California Academy in 1961, the station locations being 5 miles northwest and 1 mile south of Rancho Mesquital on the main road not far north of the southern border of Baja California del Norte, which is 28° N. latitude. The species was also collected by Hanna and Wiggins about a mile north of the Mission San Borja in 1959.

Several named Baja California species of *Micrarionta* seem closely related to *M. indigena*. Although a determination of their validity is beyond the scope of this report, a list of them is included for the benefit of those interested in this desert group:

| Name | Type Locality |
|---|---|
| *Micrarionta inglesiana* Berry, 1928 | North slope of Red Rock, 3 miles from the sea and ½ mile from Hamilton Ranch, West of Santo Domingo (Berry) |
| *M. merrilli* (Bartsch, 1904) | Below San Quentin (Bartsch) |
| *M. evermanni* Pilsbry, 1916 | Bahia Tortuga (Hanna & Jordan) |
| *M. ellipsostoma* (Pilsbry, 1894) | San Juan del Norte (Gabb)[1] |
| *M. ultima* (Pilsbry, 1916)[2] | Sinaloa, Mexico (Gabb) |

While available evidence points to the fact that *M. indigena* and *M. peninsularis* are conspecific (Mabille's name taking precedence over Pilsbry's), this can be determined with finality only by a detailed comparison of the type specimens of both species.

**Helix steganella** Mabille.

(Figures 16a–c.)

*Helix steganella* MABILLE, 1895, pp. 64, 65. PILSBRY, 1916, pp. 98–100.

TYPE LOCALITY. Same as for the preceding species (Diguet).

TYPE LOT. A single specimen, marked "Type" on the label, becomes the lectotype. It measures: maximum diameter, 24.0 mm.; minimum diameter, 19.0 mm.; height, 9.8 mm.

There is no doubt that this species is the same as *Micrarionta lohrii* (Gabb, 1867). According to Dr. Chevallier, an anonymous worker subsequently added the following note to the tray holding Mabille's shell: "C'est *Sonorella lohrii* Gabb." Pilsbry (1916) came to the same conclusion based on his analysis of Mabille's description which he translated into English, and placed *H. steganella* in the synonymy of *M. lohrii.*

Mabille evidently had more than one specimen; his measurements show ranges in diameter and height of shell. The dimensions of the lectotype lie within these ranges except for shell height, which is 9.8 mm., the range being stated as 7.5 to 8 mm., a relatively minor discrepancy. It seems likely from our present knowledge of the geographic range of *M. lohrii* that Diguet must have collected his specimens in an area well over 100 miles south of the spot where he found *M. indigena.*

**Helix invecta** Mabille.

*Helix invecta* MABILLE, 1895, p. 65. PILSBRY, 1916, p. 100.

TYPE LOCALITY. Lower California (Mabille).

TYPE LOT. A single dead shell marked "Type" on the label, which becomes

[1] Gabb's "San Juan del Norte" is on the east side of the peninsula about 20 miles north of Loreto.

[2] *M. ultima* was reported from the mainland where no species of *Micrarionta* of the *M. indigena* group have been collected subsequently.

the lectotype. It measures: maximum diameter, 22.3 mm.; height, 9.8 mm., which compares with Mabille's dimensions of 21 mm. and 7 mm. respectively.

Pilsbry (1916) allocated this species to his "Group of *Sonorella lohrii*" and said it "seems nearer to *S. lohrii* than any other species I have seen." His view is certainly correct. The unique type specimen is so little different from the lectotype of *Micrarionta steganella* that no illustration of it seems necessary. *Helix invecta* Mabille, therefore, becomes a synonym of *Micrarionta lohrii* (Gabb, 1868).

**Helix digueti** Mabille.

*Helix digueti* MABILLE, 1895, p. 65. PILSBRY, 1916, p. 100.

TYPE LOCALITY. Not stated by Mabille.

TYPE LOT. Not found in the Paris Museum.

Mabille's description, rendered into English by Pilsbry (1916), gives little or no information that might help to recognize the species. It calls for a shell measuring 20.0 mm. to 20.5 mm. in maximum diameter and 8 mm. to 9 mm. in height. Pilsbry thought it might be allocated to his "group of *Micrarionta lohrii*" but the statement that the reflexion of the basal part of the peristome nearly covers the umbilicus places it more closely to *M. indigena* (Mabille, 1895), *M. lohrii* having a large, wide-open umbilicus.

*Helix digueti*, therefore, must remain a *nomen inquirendum* until Mabille's type material can be found.

Family POLYGYRIDAE

**Helix (Polygyra) solidens** Mabille.

(Figure 21.)

*Helix (Polygyra) solidens* MABILLE, 1895, pp. 65, 66.

TYPE LOCALITY. South of the village of Guaymas, Sonora, Mexico (Mabille).

TYPE LOT. A single dead shell labeled "Type." This becomes the lectotype. Measurements are: maximum diameter, 14.0 mm.; height, 5.7 mm.

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FIGURES 10, 11. *Berendtia digueti* Mabille. Figure 10. Lectotype. Length, 32.5 mm.; maximum diameter, 4.3 mm. Figure 11. Paralectotype. Length, 31.5 mm.; maximum diameter, 5.1 mm.

FIGURES 12, 13. *Berendtia minorina* Mabille. Figure 12. Lectotype. Length, 20.2 mm.; maximum diameter, 3.9 mm. Figure 13. Paralectotype. Length, 20.1 mm.; maximum diameter, 3.9 mm.

FIGURES 14, 15. *Berendtia minorina* Mabille. Two paralectotypes from a series of four specimens. Figure 14. Length, 15.5 mm.; maximum diameter (not including body whorl), 3.8 mm. Figure 15. Length, 20.0 mm.; maximum diameter, 4.0 mm.

FIGURES 16a–c. *Helix steganella* Mabille. Lectotype. Maximum diameter, 24.0 mm.; minimum diameter, 19.0 mm.; height, 9.8 mm. Figure 16a, dorsal; figure 16b, apertural; figure 16c, ventral view.


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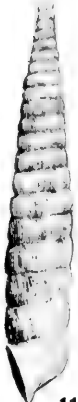
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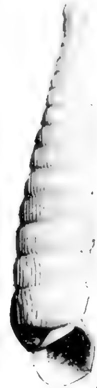
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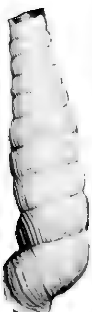
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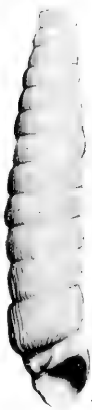
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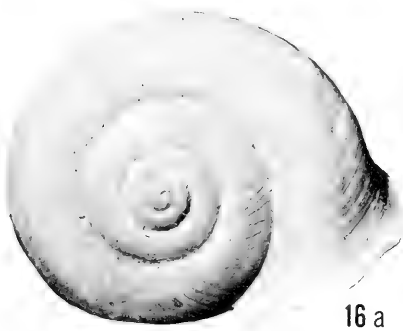
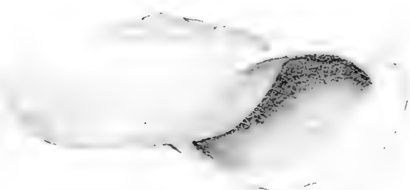

16 a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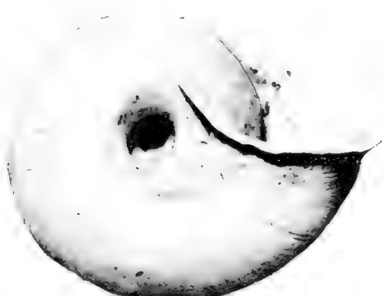
16 c

This species belongs to the typical section of the genus *Polygyra*, as now restricted. It has a simple, single, columellar tooth. The "anonymous worker" mentioned earlier identified this shell as *Polygyra anilis* (Gabb, 1865), which also has Guaymas as its type locality, and there seems to be no doubt that this identification is correct. Gabb gave the dimensions of *P. anilis* as being 0.55 inch in greatest diameter, with a height of 0.23 inch, or 14.0 mm. × 5.8 mm. Mabille's shell is almost exactly this same size. The single columellar denticle distinguishes *P. anilis* from *P. behri*, which has a more complicated set of apertural denticles.

**Helix (Polygyra) triangularis** Mabille.

(Figures 17a–c.)

Type locality. Sandy plains at the edge of the sea south of the village of Guaymas, Sonora (Diguet).

Type lot. Six specimens labeled "Types." The largest one is designated as the lectotype; the remaining 5 as paralectotypes. Measurements of the lectotype are: maximum diameter, 17.5 mm.; minimum diameter, 14.9 mm.; height, 6.9 mm.

These shells were identified as "*H. behri* Gabb" by the later "anonymous worker," which can be accepted as correct, the type locality of *Polygyra behri* (Gabb, 1865) also being at Guaymas. Mabille's shells compare well with specimens of *P. behri* in the Academy's collection from coastal localities farther south on the Mexican mainland.

**Helix (Polygyra) triangularis minor** Mabille.

(Figures 18, 19, 20.)

*Helix (Polygyra) triangularis* var. *minor* Mabille, 1895, p. 66.

Type locality. Same as for the preceding species.

Type lot. Two specimens labeled "Types." An apertural view of the larger shell, selected as the lectotype, is shown in figure 18. It measures: maximum diameter, 14.2 mm.; minimum diameter, 11.9 mm.; height, 5.2 mm. The other shell becomes a paralectotype.

Considering the amount of individual variation that may occur in species of this group of polygyrids, a difference of 3 to 4 mm. in maximum diameter is not unusual. As no other important differences are apparent in the sculpture or denticle configuration within the aperture, Mabille's subspecies or "variety" *minor* has no biological significance.

## Family Bulimulidae

**Bulimulus (Leptobyrsus) lapidovagus** Mabille.

*Bulimulus (Leptobyrsus) lapidovagus* Mabille, 1895, pp. 66, 67. Pilsbry, 1898, vol. 11, p. 161. Hanna, 1923, p. 492.

Type locality. Sierra de Cacachila, south of La Paz (Diguet).

Type lot. Not found in the Paris Museum.

The lack of type material of this species makes it practically impossible to determine whether the snails Diguet collected are new or whether they should be referred to a species already described. Pilsbry (1897) did not include it in his key to species in the subgenus *Sonorina* [= *Leptobyrsus*], not knowing the details of the internal characters. Hanna (1923) included it in the group represented by peninsular species *B. spirifer, B. lamellifer*, and others, including several endemic Gulf island species. Mabille's mention of a "columella obliquely straight, thickened, passing into a twisted, profoundly entering lamina" is not definitive enough to differentiate it from several other species.

The Sierra de Cacachila, according to Gerhart and Gulick's "Lower California Guidebook" (3rd ed., 1962, p. 175), is a barren range of mountains between La Huerta (about 15 miles southeast of La Paz) and Los Planes, which reach an elevation of 2000 feet. So far as known, only *Bulimulus sufflatus* (Gould) and *B. excelsus* (Gould) have been collected in this general area. Mabille's shell measurements call for a snail of fairly large size, 40 to 43 mm. in length, which approximates the length of *B. excelsus*. Until more specimens are collected in the Sierra de Cacachila, *B. lapidovagus* Mabille must remain as a *nomen inquirendum*.

**Bulimulus (Leptobyrsus) dentifer** Mabille.

*Bulimulus (Leptobyrsus) dentifer* Mabille, 1895, p. 67. Pilsbry, 1898, vol. 11, pp. 161, 162. Hanna, 1923, pp. 492–494, pl. 8, figs. 16–20 and text fig. 1 (genitalia and jaw).
*Rabdotus (Leptobyrsus) dentifer* (Mabille). Emerson and Jacobson, 1964, pp. 319–321.

Type locality. Volcanic island of La Tortuga, in the middle of the Gulf of California (Diguet).

Type lot. Not found in the Paris Museum.

As already mentioned, this endemic island species can be identified readily from its locality; loss of the original shells collected by Diguet is unfortunate but not a serious calamity.

In order to fix the species permanently for taxonomic purposes a series from over 1000 shells collected during the Academy's 1921 Expedition to the Gulf of California is designated as the neotype lot, this being the next available authentic series from the type locality. California Academy of Sciences Geology Type Collection plesiotype no. 1048 is selected as the neotype (Hanna, 1923, pl. 8, fig. 16; nos. 1049–1052 become neoparatypes). No. 1048 includes the mounted radula; no. 1052 has genitalia and jaw preserved in alcohol.

**Bulimulus (Leptobyrsus) subspirifer** Mabille.

(Figure 4.)

*Bulimulus (Leptobyrsus) subspirifer* Mabille, 1895, p. 67. Pilsbry, 1898, vol. 11, pp. 162, 163. Hanna, 1923, p. 492.

Type locality. Lower California (Diguet).

TYPE LOT. A single shell, which becomes the lectotype. It measures: length, 46.9 mm.; maximum diameter, 19.7 mm.

Mabille's unique specimen has the general aspect of *Bulimulus excelsus* (Gould) although it is somewhat more slender in outline. As there seems to be no sure way of identifying it with any described species, *B. subspirifer* will stand as a valid species until similar snails can be collected in Baja California that will assist in a final determination of its validity.

**Bulimulus (Leptobyrsus) dismenicus** Mabille.

(Figure 3.)

*Bulimulus (Leptobyrsus) dismenicus* MABILLE, 1895, pp. 67, 68. PILSBRY, 1898, vol. 11, p. 162. HANNA, 1923, p. 492.

TYPE LOCALITY. Sierra de la Puna, Lower California, at 1800 meters elevation (Diguet).

TYPE LOT. A single specimen labeled "Type," which therefore becomes the lectotype. It measures: length, 31.3 mm.; maximum diameter, 15.0 mm.

This species, represented by Mabille's single shell, agrees well with *Bulimulus beldingi* Cooper, 1892. We consider it to be a synonym of this latter species. The illustration of the lectotype of *B. dismenicus* (fig. 3) compares well with the illustration in the Manual of Conchology of *B. beldingi* (Pilsbry, 1898, vol. 11, pl. 25, fig. 56).

The location of the Sierra de la Puna is not known to us; probably it is one of the subsidiary ranges of mountains either in the Sierra Laguna or the Sierra de la Victoria in the Cape Region of the Baja peninsula. *Bulimulus beldingi* belongs to the group of *B. inscendens* W. G. Binney. Cooper reported it as having been collected near San Jose del Cabo, in the Sierra Laguna, and at Punta Arenas, the latter stated to be on the east coast of the peninsula at about latitude 25°30′ N., which is the present general location of Punta Marcial.

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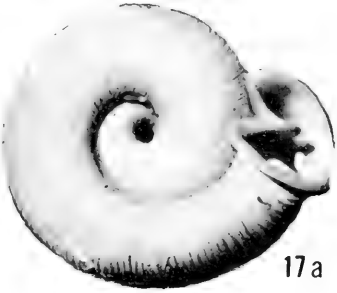
FIGURES 17a–c. *Helix (Polygyra) triangularis* Mabille. Lectotype (largest of 6 specimens). Maximum diameter, 17.5 mm.; minimum diameter, 14.9 mm.; height, 6.9 mm. Figure 17a, ventral; figure 17b, dorsal; figure 17c, side view.

FIGURES 18, 19, 20. *Helix (Polygyra) triangularis* var. *minor* Mabille. Figure 18, apertural view of lectotype. Maximum diameter, 14.2 mm.; minimum diameter, 11.9 mm.; height, 5.2 mm. Figures 19, 20, ventral views of two paralectotypes.

FIGURE 21. *Helix (Polygyra) solidens* Mabille. Lectotype. Maximum diameter, 14.0 mm.; height, 5.7 mm. Ventral view.

FIGURES 22, 23. *Helix indigena* Mabille. Dorsal views of two of nine shells. Figure 22, lectotype. Maximum diameter, 19.4 mm.; height, 10.2 mm. Figure 23, paralectotype. Maximum diameter, 16.8 mm.; height, 8.2 mm.

FIGURES 24a–c. *Planorbis tumidus* var. *major* Mabille. Largest shell of the series. Maximum diameter, 23.9 mm.; aperture height, 9.3 mm. Figure 24a, ventral; figure 24b, dorsal; figure 24c, apertural view.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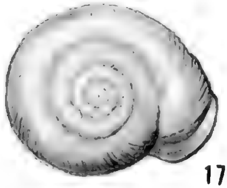
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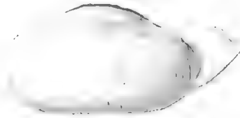
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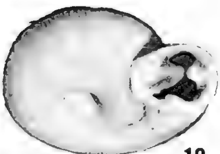
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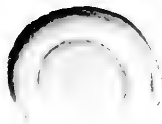
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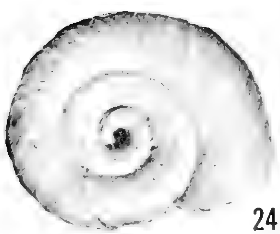
19


20


24c


24a


24b

**Bulimulus (Scutalus) acholus** Mabille.

(Figures 8a, 8b.)

*Bulimulus (Scutalus) acholus* Mabille, 1895, p. 68. Pilsbry, 1897, vol. 11, pp. 143, 144. Hanna, 1923, p. 486. Jacobson, 1958, p. 10.

Type locality. Mountains of Lower California, in company with *B. montezuma* (Diguet).

Type lot. A single shell, which becomes the lectotype. Dimensions are: length, 45.1 mm.; maximum diameter, 25.0 mm.

The granular sculpture of this species places it in the group of *Bulimulus montezuma* Dall, 1893, the type species of subgenus *Puritanina* Jacobson, 1958. *Bulimulus harribaueri* Jacobson, 1958, has the finer sculpture of *B. acholus* but the latter is a somewhat more slender, smaller shell. On the basis of present evidence Mabille's species may be accepted as valid until a sounder decision can be made from additional material showing the extent of individual variation of the three species so far assigned to the subgenus *Puritanina*.

**Bulimulus (Scutalus) cosmicus** Mabille.

(Figures 1, 2.)

*Bulimulus (Scutalus) cosmicus* Mabille, 1895, p. 68. Pilsbry, 1897, vol. 11, p. 144. Hanna, 1923, p. 486. Jacobson, 1958, p. 10.

Type locality. Sierra of the south [end] of the peninsula of Lower California (Diguet).

Type lot. Three specimens. The selected lectotype (fig. 1) is the best preserved and measures: length, 46.7 mm.; maximum diameter, 25.7 mm. One of the two paralectotypes (fig. 2) measures: length, 50.3 mm.; maximum diameter, 29.7 mm.

*Bulimulus cosmicus* is closely related to *B. montezuma* Dall, a fact recognized by both Pilsbry and Jacobson. The sculpture is more finely granular than on this species or *B. harribauri* Jacobson, 1958. According to Mabille, Diguet also collected *B. montezuma*, reporting it from "all of the southern sierra of the peninsula, and, in particular, near the Rancho San Bartolo." Thus Mabille had at least three forms for comparison, including his *B. acholus*.

There is considerable variation in the shells of snails that have been identified as *B. montezuma*, and the possible occurrence of local races, including their ecology and the extent of their geographical ranges, is not yet well known. Much more collecting in the relatively inaccessible mountain areas of the Cape Region of Baja California needs to be done before the number of valid species and subspecies in the group can be determined with confidence. For this reason and because of the lack of a precise locality for *B. cosmicus*, together with Mabille's failure to make a direct comparison between this and *B. montezuma*, his species may be allowed to stand until the availability of additional material dictates otherwise.

**Bulimulus (Scutalus) cacotycus** Mabille.

(Figures 5, 6, 7.)

*Bulimulus (Scutalus) cacotycus* Mabille, 1895, p. 69. Pilsbry, 1898, vol. 11, p. 150. Hanna, 1923, p. 502.

Type locality. Sierras of the south [end] of the peninsula (Diguet).

Type lot. Three specimens, labeled "Type." The one selected as the lectotype (fig. 5), is a full-grown shell measuring: length, 58.0 mm.; maximum diameter, 26.4 mm. A full-grown paralectotype, (fig. 6), measures: 53.0 mm. × 24.9 mm. and the second, which is subadult, 48.5 mm. × 23.8 mm.

The "anonymous worker" mentioned earlier has labeled these shells as *Bulimulus excelsus* (Gould, 1853), an identification that seems to be correct. Mabille's shells show the characteristic waxen-white and brown streaks of Gould's species; and while they are all somewhat larger than Gould's type of *B. excelsus* they agree in size with specimens from the La Paz area in the Academy's collection. Pilsbry's inclusion of *B. cacotycus* in his "group of *B. inscendens*" now turns out to be incorrect.

**Bulimulus (Thaumastus) digueti** Mabille.

*Bulimulus (Thaumastus) digueti* Mabille, 1895, p. 69. Pilsbry, 1898, vol. 11, pp. 148, 149. Hanna, 1923, p. 502.

Type locality. Sierra de la Victoria (Diguet).

Type lot. Not found in the Paris Museum.

Measurements of this species, as given by Mabille, are: length, 20 to 22 mm.; maximum diameter, 10 to 12 mm.; length of aperture (not including the peristome), 10 mm.; breadth, 7 mm. Inability to locate Mabille's type shells leaves this species in the category of a *nomen inquirendum*. We suspect it was collected at a higher rather than lower elevation in the mountains. Several species of *Bulimulus* are found in these mountains, with which authentic specimens of *B. digueti*, if located, must be compared before its validity can be determined.

Pilsbry and Hanna both include *B. digueti* in the "group of *B. inscendens*," which comprises *B. inscendens* (W. G. Binney), *B. xantusi* (W. G. Binney), and *B. beldingi* Cooper, with some possible valid subspecies of *B. inscendens*. This is as far as one can probably go for the time being.

**Bulimulus (Globulus) recognitus** Mabille.

(Figure 9.)

*Bulimulus (Globulus) recognitus* Mabille, 1895, pp. 69, 70. Pilsbry, 1897, vol. 11, p. 137. Hanna, 1923, pp. 485, 486.

Type locality. Lower California (Diguet).

Type lot. A single specimen, the lectotype, measuring: length, 24.0 mm.; maximum diameter, 16.4 mm.

Authors who have commented on the taxonomic position of *B. recognitus* agreed that it was probably conspecific with *B. sufflatus* (Gould in Binney, 1859), which is common in the La Paz area and elsewhere and which has been collected also on some of the islands of the Gulf of California. This view is confirmed by inspection of the lectotype. *Bulimulus recognitus* Mabille therefore becomes a synonym of *Rabdotus (Rabdotus) sufflatus* (Gould). Use of the genus *Rabdotus* to cover this and other Baja California *Bulimulidae* is covered by Emerson and Jacobson (1964, p. 317).

## Family Urocoptidae

**Berendtia digueti** Mabille.

(Figures 10, 11.)

*Berendtia digueti* Mabille, 1895, p. 70. Mabille, 1897, p. 79.
*Coelocentrum digueti* (Mabille, 1895). Pilsbry, 1900, pp. 550–552. Pilsbry, 1902, vol. 15, pp. 51, 56, 57. Emerson and Jacobson, 1964, p. 328.

Type locality. San Zavier [Javier] plateau, about latitude 25° N.; collected among charcoal occurring in old Indian encampments (Diguet).

Type lot. Two specimens on a small blue card indicated as "Types"; two additional specimens on another blue card (not illustrated). The selected lectotype (fig. 10) measures: length, 32.5 mm.; maximum diameter, 4.3 mm. A paralectotype (fig. 11) measures: length, 31.5 mm.; maximum diameter, 5.1 mm.

*Coelocentrum digueti*, and other species of the genus occurring in Baja California, belong to the subgenus *Spartocentrum* Dall, 1895, which takes precedence over the subgenus *Teneritia* Mabille, 1897. It differs from all other described species in the occurrence of interstitial striae between the closely spaced riblets on all of the later whorls. This feature, unfortunately, does not show up in the illustrations of two of Mabille's shells from the type lot (figs. 10, 11). According to Pilsbry, his *C. minorinum gabbi* has a shorter shell, fewer whorls, and scarcely any observable twist in the columella. Apparently no specimens referable to *C. digueti* have been collected since.

*Coelocentrum digueti* can be accepted as a valid member of the *Spartocentrum* group. The San Javier "plateau" on which the ruins of Mission San Javier are located, is nearer to 26° N. latitude than to 25° N., as given by Diguet. Some subsequent collector should be able to find the type locality without too much difficulty.

**Berendtia minorina** Mabille.

(Figures 12–15.)

*Berendtia minorina* Mabille, 1895, pp. 70, 71. Mabille, 1897, p. 79.
*Coelocentrum minorinum* (Mabille, 1895). Pilsbry, 1900, p. 551. Pilsbry, 1902, vol. 15, pp. 53, 54. Emerson and Jacobson, 1964, p. 328.

Type locality. Plateaus above the Arroyo de la Purissima (Diguet).

Type lot. Four specimens on a blue card labeled "Types." The best, a complete shell (fig. 12) is selected as the lectotype; it measures: length, 20.2 mm.;

maximum diameter, 3.9 mm. A complete paralectotype (fig. 13) measures 20.1 mm. × 3.9 mm. Both have about 17 whorls. The other two paralectotypes (figs. 14, 15) have lost their early whorls.

The main Baja California "highway" forks about 8 miles West by South of Canipolé, the upper fork going eastward across the narrow waist of the peninsula about latitude 26°20′ N. and follows the Arroyo de la Purisima for about 32.5 miles to the village of La Purisima. The type locality of *Coelocentrum minorinum* must be somewhere along this road on the western slope of the mountains. *Coelocentrum minorinum gabbi* Pilsbry, 1900 (p. 551) was collected by Gabb in the "high mountains back of Mulegé," which are on the eastern side of the peninsula approximately 40 miles to the north and east of the Arroyo de la Purisima. Until more is known about the variability of the various species of *Coelocentrum* in Baja California it will be possible only then to determine the status of *C. minorinum*. This also requires careful collecting at or near the type locality.

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# THREE LATE CENOZOIC MOLLUSCAN FAUNULES FROM BAJA CALIFORNIA, WITH A NOTE ON DIATOMITE FROM WEST OF SAN FELIPE

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Fossil mollusks of late Cenozoic age have been reported from various localities in Baja California. In the present paper three faunules are reported from fossiliferous strata at localities not heretofore mentioned in the literature. The specimens forming the basis of the lists are in the collections of the Department of Geology of the California Academy of Sciences.

A small collection of Pleistocene age was assembled by the late Walter R. Heyneman from strata exposed along the southwest coast of Baja California between Point Conejo and Arroyo Conejo. This locality is nearly straight west of La Paz on the east coast of the Peninsula.

Locality 38742 (CAS). Strata exposed along the coast between Point Conejo and Arroyo Conejo, about Latitude 24°06′ North, west coast of Baja California, Sur, Mexico, Walter R. Heyneman collector, 1963. Pleistocene.

Pelecypoda
- *Anadara tuberculosa* Sowerby
- *Ostrea* cf. *O. angelica* Rochebrune
- *Ostrea* cf. *O. corteziensis* Hertlein
- *Ostrea iridescens* Gray
- *Ostrea megodon* Hanley
- *Chlamys (Argopecten) circularis* Sowerby

*Chlamys (Nodipecten) subnodosa* Sowerby
*Pecten (Oppenheimopecten) vogdesi* Arnold

GASTROPODA
*Oliva spicata* Röding in Bolten
*Polinices* cf. *P. reclusianus* Deshayes

CIRRIPEDIA
*Balanus (Balanus)* species

All except two of the mollusks in this list have been reported living in the subtropical waters along the west coast of Baja California, and all now live in the Gulf of California. The present assemblage may be considered to represent a faunule of late Pleistocene age.

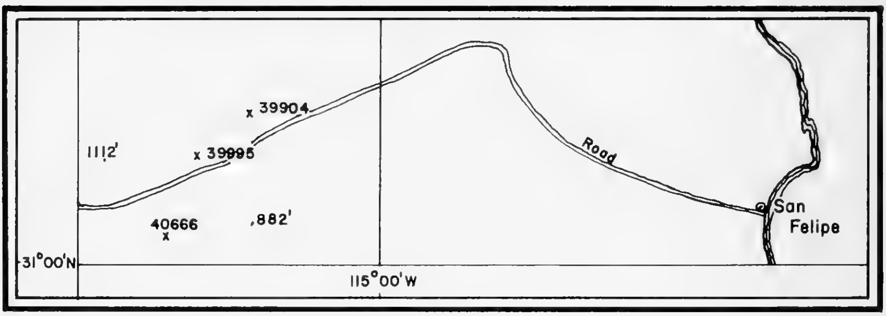


FIGURE 1. Sketch map indicating approximate locations of collecting stations west of San Felipe, Baja California.

Two collections of fossils of Pliocene age were assembled by W. Morlin Childers of El Centro, California. These fossils were collected from strata exposed about 15.5 to 18.5 miles west of San Felipe in the northeastern portion of the peninsula. According to Mr. Childers, the fossil-bearing strata are exposed in a pass where the road to Ensenada crosses and descends to San Felipe Dry Lake. The elevation of the pass is approximately 625 feet above sea level. The hill on the northwest side of the pass is shown on the San Felipe topographic sheet as 1112 feet in elevation, the hill on the southeast side of the pass is 882 feet in elevation. The strike of the strata is Northeast-Southwest except at the Southwest extremity where there are Northwest trending folds. The dip is variable up to 45° Northwest.

Locality 39995 (CAS). About 15.5 miles west of San Felipe, Baja California, along the road to Ensenada, near the northeast end of the fossiliferous outcrop in about Latitude 31°02′00″ North, Longitude 115°05′00″ West. W. Morlin Childers collector, August, 1966. Pliocene.

Locality 40666 (CAS). About three miles southwest of Locality 39995 (CAS), along the strike of the same series of strata toward the southwest end of the outcrop in approximately Latitude 31°01′00″ North, Longitude 115°06′30″ West. W. Morlin Childers collector, 1967. Pliocene.

List of Fossils from West of San Felipe.

| | 39995 | 40666 | Imperial Formation |
|---|---|---|---|
| Echinoidea | | | |
| *Agassizia scrobiculata* Valenciennes | × | | |
| *Clypeaster bowersi* Weaver (W. M. Childers, written communication) | × | | × |
| *Clypeaster* cf. *C. carrizoensis* Kew | × | | × |
| *Clypeaster deserti* Kew | × | | × |
| *Encope tenuis* Kew | × | × | × |
| Pelecypoda | | | |
| *Anadara multicostata* Sowerby | cf. | × | |
| *Chlamys (Argopecten)* cf. *C. (A.) abietis* E. K. Jordan and Hertlein | × | × | |
| *Chlamys (Chlamys) corteziana* Durham | × | | × |
| *Ostrea* cf. *O. angelica* Rochebrune | | × | |
| *Ostrea californica* Marcou | | × | × |
| *Ostrea heermanni* Conrad | × | × | × |
| *Ostrea* cf. *O. vespertina* Conrad | | × | × |
| *Pecten (Euvola) keepi* Arnold | | × | × |
| *Pecten (Pecten)* cf. *P. (P.) lunaris* Berry | | × | |
| Gastropoda | | | |
| *Bulla* cf. *B. gouldiana* Pilsbry | | × | |
| *Cantharus gemmatus* Reeve | × | | |
| *Conus* species | × | | |
| *Cypraea* species | × | × | |
| *Fasciolaria princeps* Sowerby | × | × | × |
| *Ficus ventricosa* Sowerby | × | | × |
| *Melongena patula* Broderip and Sowerby | | × | |
| *Oliva spicata* Röding in Bolten | × | | × |
| *Polinices* species | × | × | |
| *Strombus* cf. *S. granulatus* Sowerby | × | × | |
| *Turritella imperialis* Hanna | | × | × |
| Shark tooth | | | |
| *Carcharhinus leucas* Valenciennes | × | | |

This list contains 26 species of which 16 are definitely identified, 7 are compared with known species, and 3 are identified only as to genus. Of these, 12 now live in the Gulf of California and 11 are extinct. Twenty-two have been reported from strata of Pliocene age in the Gulf of California region and 9 of these were originally described from the Imperial formation in Imperial County, California.

A number of species in the present assemblage are characteristic of the Imperial fauna and one may infer that the strata containing them were deposited approximately contemporaneously with those of the Imperial formation in southeastern California.

Walker (1967, pp. 359, 361) recently reported strata bearing fossils of Pliocene age at three localities: on the west side of the Cocopah Mountains about 20 miles south of the United States-Mexico boundary; in arroyos which cross the coastal plain 35 to 40 miles south of San Felipe; and in the hills west of Gonzaga Bay. Localities 39995 and 40666 (CAS) are thus latitudinally nearly midway between the northernmost and southernmost localities reported by Walker.

## DIATOMITE

Locality 39904 (CAS). Diatomite from about 15 miles west of San Felipe, Baja California, approximately in Latitude 31°03′ North and Longitude 115°04′ West, just northeast and adjacent to figure "58" shown on road on San Felipe topographic sheet, Series F501, Sheet NH 11-3, edition 1-AMS. W. Morlin Childers collector, 1967.

A sample of well preserved, soft, white diatomite was collected by W. Morlin Childers from about 15 miles west of San Felipe. This material was examined by Dr. G D. Hanna who furnished the following information.

SPECIES OF DIATOMS FROM LOCALITY 39904 (CAS)

*Actinocylus octonarius* Ehrenberg
*Actinocyclus ralfsii* (W. Smith)
*Actinoptychus senarius* Ehrenberg
*Amphora eulensteinii* Grunow
*Asterolampra flabellata* (Greville)
*Aulacodiscus margaritaceus* Ralfs
*Aulăcodiscus thumii* A. Schmidt
*Auliscus sculptus* (W. Smith)
*Bacteriastrum furcatum* Shadboldt
*Biddulphia tuomeyii* Bailey
*Campylodiscus schmidtii* Grunow
*Clavicula* species
*Cocconeis dirupta* Gregory
*Cocconeis sparsipunctata* Brun
*Corethron* species
*Coscinodiscus apiculatus* Ehrenberg
*Coscinodiscus kützingii* Schmidt
*Coscinodiscus lineatus* Ehrenberg
*Coscinodiscus nitidus* Gregory
*Coscinodiscus pacificus* Grunow
*Coscinodiscus stellaris* Roger
*Diploneis ornata* Schmidt
*Eupodiscus californicus* Grunow
*Grammatophora maxima* Grunow
*Navicula campylodiscus* Grunow
*Navicula densistriata* Schmidt
*Navicula lyra* Ehrenberg
*Nitzschia princeps* Hanna and Grant
*Plagiogramma antillarum* Cleve
*Plagiogramma tessellatum* Greville
*Stictodiscus californicus* Greville
*Surirella patens* Schmidt
*Syndendrium diadema* Ehrenberg
*Trachyneis aspera* (Ehrenberg)
*Xanthiopyxis* species

The foregoing list contains 32 identified species and three others identified only as to genus. This however is only a small sampling of the flora.

The stratigraphic relations of the diatomite are not personally known to me. Mr. Childers suggested that it may overlie beds containing fossil mollusks of Pliocene age. However, Dr. Edwin C. Allison (written communication to L. G. Hertlein, dated October 25, 1967) stated that the diatomite lies almost horizontally on the axis of an anticline. He further stated, "The San Felipe diatomite lies beneath *Encope tenuis*-bearing strata and probably overlies some sort of volcanic sequence. . . The planktonic foraminifers of the diatomite are middle-upper Miocene (with *Globorotalia acostaensis*). The benthonic foraminifers of the diatomite also appear to be Miocene (Mohnian-Delmontian) though upper range limits of critical species are known only in California where cooling water and other changing conditions, rather than total extinction, may determine range tops."

The assemblage of species of diatoms in the present list is indicative of late Miocene age in comparison with assemblages of that age from southern California or from Rancho Refugio in Baja California del Sur. On the other hand the assemblage is not indicative of Pliocene age in comparison with diatom floras of that age in southern California. A few species such as *Aulacodiscus margaritaceus, Diploneis ornata*, and *Plagiogramma antillarum*, strongly suggest a late Miocene rather than Pliocene age.

## Acknowledgments

The writer here expresses his appreciation of the opportunity to study the collections which became available through the generosity of W. Morlin Childers and the late Walter R. Heyneman. Dr. Edwin C. Allison, Department of Geology, San Diego State College, furnished information concerning the stratigraphic relationship of the fossil-bearing beds west of San Felipe. Dr. G Dallas Hanna, Department of Geology of the California Academy of Sciences, furnished helpful criticism concerning the manuscript and contributed the information concerning the diatomite, and Mrs. Lillian Dempster, Department of Ichthyology in the same institution, furnished information concerning the identification of the shark tooth mentioned in this paper. The line drawing of the sketch map reproduced in figure 1 was prepared by Mr. Hugo H. Hawkins.

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# INDEX TO VOLUME XXX

Fourth Series

New names and principal reference in **boldface** type

# ERRATA

Page 7. Line 10 from top of page: for *montezumae* read *montezuma.*
Page 120. Line 20 from top of page: for *hesperis* read *hesperus.*
Page 185. Line 5 from bottom of page: for *splendidulum* read *splendidum.*
Page 188. Line 12 from bottom of page: for *M.* (*K.*) *dane,* read *M.* (*K.*) *danaë.*
Page 200. Line 13 from bottom of page: for **NITICACEA** read **NATICACEA.**
Page 209. Line 18 from top of page: for *hesperis* read *hesperus.*
Page 225. Line 1 in caption under figure: for *Broteus* read *Broteas.*
Page 246. Line 18 from top of page: for agreat read a great.
Line 21 from top of page: for results *of* many papers read results *in* many papers. . .
Page 247. Line 16 from bottom of page: for *S. petrina* read *E. petrina.*
Page 260. Line 13 from top of page: for (L. DIGUES ded.) read (L. DIGUET ded.).
Page 262. Line 10 from bottom of page: delete period ( . ) after word "If" at beginning of sentence.
Page 358. Line 1 in caption under figures: for *Discorbis hannai* read *Discorbis hannae.*
Page 369. Line 13 from bottom of page: for *torqueta* read *torqueata.*

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# INVESTIGATIONS IN THE NATURAL HISTORY OF BAJA CALIFORNIA

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