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I
EXPEDITION TO THE REVILLAGIGEDO ISLANDS,
MEXICO, IN 1925

GENERAL REPORT

BY
G. DALLAS HANNA
Curator, Department of Paleontology

INTRODUCTION

Early in January, 1925, at a conference of the Director and curators of the various departments of the Academy, it was decided that suitable and desirable field work for the ensuing season could be done on the Revillagigedo Islands, Mexico, if arrangements could be made to go there with a reasonable degree of economy. A tentative plan of organization was drawn up which met the approval of all concerned and steps were taken to secure a suitable means of transportation.

The Revillagigedo Islands lie about 840 miles a little east of south from San Diego, California, and 240 miles a little west of south from Cape San Lucas, Lower California. They are several degrees south of the Tropic of Cancer; they extend in an east west line about 250 miles and close to the nineteenth parallel of north latitude. The group consists of four islands in order of size as follows: Socorro (with the small detached Oneal Rock); Clarion; San Benedicto; and Roca Partida.

March 30, 1926

Obviously, to reach these far distant and widely separated islands and make a proper exploration of them, a very substantial and reliable vessel would be needed. This, the Academy does not possess, and all agreed that present charter rates for such a ship would more than exhaust the limited amount of funds which could be allotted each year to such purposes.

Two possibilities were suggested as means for the provision of the necessary transportation. The first was to invite the interest of some friend of the Academy who possessed a suitable vessel. But in the absence of any definite information regarding such a proposition it was dismissed as offering little hope.

Knowing the willingness of the Navy Department to cooperate in legitimate undertakings of scientific and public interest, it was thought possible that, if the situation were fully explained, a vessel might in that manner be secured for the proposed exploration. Application was therefore formally made on January 15, 1925, to the Secretary of the Navy, Hon. Curtis D. Wilbur by Dr. Barton Warren Evermann, Director of the Academy. The following letter gave the essential details of the proposition:

SAN FRANCISCO, CALIFORNIA,
January 15, 1925.

HON. CURTIS D. WILBUR,
Secretary of the Navy,
Washington, D. C.

My dear MR. SECRETARY:

The California Academy of Sciences has for many years been deeply interested in the fauna, flora, and geology of the islands off the coast of California, Mexico and South America. It has sent out in past years a number of expeditions to various ones of these islands. In 1905-6, nearly two years were devoted to a study of the Galapagos which added greatly to the knowledge of those classic islands. In 1920 another party studied the fauna and flora of the southern end of Lower California. In 1921 a study extending over several months was made of all the islands in the Gulf of California. In 1922, a similar expedition was sent to Guadalupe, Cedros and other islands off the Pacific coast of Lower California. The 1921 and 1922 expeditions were made possible by the very helpful cooperation of the Mexican Government, and did much toward establishing pleasant relations between the scientific men and local officials of that country and the scientific men of this country.

The Academy is now ready to enter upon a study of the Revillagigedos, a group of four islands (Clarion, Socorro, San Benedicto and Roca Par-

tida), lying off the coast of Mexico, about 360 miles nearly due west from San Blas, or 240 miles southwest from Cape San Lucas, or about 840 miles south of San Diego.

These islands are the most isolated group on the coast and a study of their fauna and flora and a comparison with the species found on the mainland, should enable us to arrive at the origin of the island fauna and flora, and their relationships to the mainland.

The Academy is very anxious to send an expedition to these islands to make a comprehensive and thorough biological and geological survey of them. Special attention would be given to the botany, land mollusks, insects, reptiles, birds and mammals.

The requirements for the expedition would be:

1. *A suitable vessel.* One of the Eagle boat type would be best. A vessel such as the *Tanager* or the *Whippoorwill* recently detailed to the Bishop Museum at Honolulu for expeditions to various Pacific Islands would be ideal.

As there is no water on any of these islands, the investigators would not be able to remain on shore longer than a day or two at a time, but would ordinarily have to return on board each evening. The vessel would therefore have to keep in daily touch with the shore party or parties.

2. It is estimated that the work on the various islands will require a total of six to eight weeks.
3. The best time would be from late in April to about June 30.
4. A scientific (civilian) staff of seven to nine men, two of whom, it is hoped, will be scientific men from the Museo Nacional de Mexico, who would virtually represent the Mexican Government.

Knowing that it is the policy of our Government to assist public scientific and educational institutions such as the California Academy of Sciences in projects of this kind, by detailing vessels of the Navy for the purpose, I wish to ask, on behalf of the Trustees, Council, and members Academy of Sciences if the United States Navy would be disposed to assist the Academy in carrying on this proposed investigation by detailing a vessel suitable for the purpose. The Academy has no vessel suitable for such an expedition, nor has it funds for chartering a vessel.

It is thought that one of the boats now, or that may be, at the San Diego station might be available. It is also believed that such an expedition would yield results not only of great scientific interest and value but of interest and value to the Navy, as there would be opportunity to do a great deal of hydrographic work, such as soundings, ocean temperatures, ocean currents, and plankton studies.

While the income of the Academy is small, we would expect to meet such of the expenses of the expedition as can not properly be paid by the Navy.

Hoping this suggestion may receive your early and favorable consideration, I have the honor to be,

Very respectfully yours,

(Signed) BARTON WARREN EVERMANN,
Director.



In due time and coincident with the taking of the necessary steps for the detail, Secretary Wilbur advised Dr. Evermann in the letter quoted below that the mine-sweeper, *Ortolan*, would be allotted to the work.

WASHINGTON, D. C.,
March 2, 1925.

Dear Sir:

For the biological and geological survey of the Revillagigedo Islands the Navy Department will be able to provide a mine sweeper similar to that used in the surveys of islands south of the Hawaiian group.

The *Ortolan* has been designated for this duty. The Commanding Officer of the *Ortolan* has been directed to report to the Commandant, Navy Yard, Mare Island, not later than April 16, for such preparation for the expedition as is deemed necessary.

It will be necessary for the Navy Department to inform the Mexican Government through the State Department of the intended visit of the *Ortolan* to the Revillagigedo Islands; but before doing this it is requested that you state definitely the number of scientific men you desire to have accompany the expedition from Mexico and whether or not you desire to limit the invitation to men from the Museo Nacional de Mexico. This information is desired in order that the invitation may be extended to them at the same time that authority is obtained for sending the expedition.

Dr. Chas. D. Walcott, of the National Museum, has requested a set of the specimens collected for deposit in the National Museum at Washington, D. C. Will you please communicate with him on this question and the question of freight for shipment of specimens collected, as the Navy Department has no authority for payment of freight. However, the Navy Department could transport specimens from San Francisco to Hampton Roads via Naval transport, with the idea that the National Museum would pay the freight from that point and would defray the expenses of packing.

For further details and for arrangements concerning the expedition you will please communicate with the Commandant, Navy Yard, Mare Island. The *Ortolan* may leave on the expedition as soon after April 16th as ready, and should arrive at Navy Yard, Mare Island, for scheduled overhaul on June 22.

Respectfully,

(Signed) CURTIS D. WILBUR.

DR. BARTON W. EVERMANN,
Director of the Museum,
California Academy of Sciences,
San Francisco, Calif.

The actual organization of the expedition then proceeded rapidly under the guidance of Dr. Evermann and the essential details will be found in the pages following. Before proceeding, it is desired to express the great appreciation of the Acad-

emy and all of its integral departments for the fine spirit of cooperation shown by every one in the Navy Department directly concerned. It is realized by all of us that considerable sacrifice was necessary in the withdrawal of the *Ortolan* from the proposed maneuvers in the Pacific and the detail of the vessel to other duty.

Appreciation is also due to the hearty cooperation of the representatives of the Government of Mexico who accompanied the expedition.

And lastly, it should be stated that the responsibility for the smooth-working, machine-like organization which left San Francisco on April 15, 1925, rests with Dr. Evermann, Captain M. M. Nelson of the *Ortolan*, the members of his crew, and the scientific staff. I am sure that all participants will long cherish happy memories of the two months spent on virgin islands in a tropical sea.

PURPOSE OF THIS REPORT

The purpose of this report is to give as briefly as possible the details pertaining to the organization of the expedition; an itinerary; and a running narrative with general information and facts of interest. The detailed studies based upon the large collections obtained will naturally follow in separate reports by various specialists. The reader is therefore referred to these latter for definite data pertaining to the species of animals and plants inhabiting the region.

ORGANIZATION

The arranging of the details of the expedition consisted largely of selecting a scientific personnel and the requisite equipment. The first was a relatively simple matter, and after due consideration of all conditions which could be foreseen the following persons were chosen to represent the various departments:

1. *Botany*: Mr. H. L. Mason, then Professor of Botany at Mills College, California.

2. *Entomology*: Mr. Hartford H. Keifer, Assistant Curator, California Academy of Sciences.

3. *Herpetology*: Mr. Joseph R. Slevin, Assistant Curator, California Academy of Sciences.

4. *Ornithology and Mammalogy*: Mr. Frank Tose, Chief Taxidermist and Mr. John Wright, Assistant Taxidermist; California Academy of Sciences. It was recognized that the collection and preparation of birds, eggs and mammals in the tropical climate would be one of the most difficult tasks of all. Therefore, not only were two men selected to do the work, but a large amount of special equipment was taken to lighten the labors and insure the making of a representative collection. Most important of this equipment was the installation on the after deck of the *Ortolan* by the Navy Department, of a special ice machine for the preservation of specimens which could not be immediately cared for. This machine was removed from a Destroyer in San Diego for the purpose, and proved to be a most valuable addition to the equipment. Numerous birds were brought back to San Francisco in a frozen condition, there placed in cold storage, and finally prepared in the usual manner as opportunity offered.

5. *Paleontology*: Dr. G. Dallas Hanna, Curator, and Mr. Eric K. Jordan, Assistant Curator, California Academy of Sciences. In addition to the regular collection of fossils and living shells, these two representatives were expected to make general collections of marine life including invertebrates and fishes. For the latter purpose two seines, a small beam-trawl, two dredges, two hoop-nets, hooks, lines, dip-nets and a liberal supply of nitrogelatin were taken along. Also four "live tanks" were installed on the deck of the *Ortolan* and there provided with facilities for circulating sea water in order that some fishes might be brought back alive for exhibition in the Steinhart Aquarium. The taking of a series of still camera pictures throughout the trip devolved upon one of us and for the purpose a 4x5 Graflex camera was used almost exclusively. As a result approximately 400 pictures suitable for reproduction were obtained.

6. *Motion Picture Photography*: Mr. Raymond Duhem, of San Francisco. The desirability of securing a series of

motion pictures was apparent to all. Mr. Duhem was provided with two cameras and about 10,000 feet of excellent negative was produced.

Lieutenant Neil B. Musser of the Construction Corps of the U. S. Navy, then stationed at the Mare Island Yard, took a very active part in the preparation and outfitting of the *Ortolan* and was so impressed with the plans that he obtained leave and accompanied the ship during the cruise as a detached observer. He rendered valuable aid to the collectors in many ways and secured a large collection of still pictures which he has presented to the Academy for its records.

The Academy has been engaged for many years in making explorations in Mexican territory chiefly among the western islands and has always enjoyed the heartiest cooperation from the authorities of that country. Whenever possible it has been the policy to invite scientific representatives from there to accompany its expeditions. Therefore, Dr. Alphonso Herrera, Director of the National Museum of Mexico was asked to name two or three men to join the Revillagigedo Islands Expedition and the following gentlemen joined the ship at San Diego: Professor Francisco Contreras, Assistant Director of the National Museum of Mexico; Professor Jose M. Gallegos, Explorer of the Department of Fomento and Agricultura; and Señor Octavio Solis, Director of the Botanical Garden of Chapultepec, Mexico.

These men grasped the opportunity to secure large collections of natural history from some of their least known territory and proved to be most delightful companions throughout the work. Through them the expedition was able to enjoy exceptional privileges at various places.

Before departure Dr. Evermann drew up a set of instructions which gave some further details of operation and organization of the expedition. To this was appended some detailed plans and instructions prepared by the various curators. It was not expected that every condition to be encountered could be anticipated in advance and these thoughts were inspired by a desire to outline in general terms only the plans to be followed.

INSTRUCTIONS FOR GUIDANCE ON THE EXPEDITION

SAN FRANCISCO, CALIFORNIA,
April 11, 1925.

DR. G. DALLAS HANNA,
California Academy of Sciences,
San Francisco, California.

DEAR SIR:

Referring to the proposed expedition of the California Academy of Sciences to the Revillagigedo Islands, the following instructions are issued for your information and guidance:

1. *Purpose of the Expedition:* As comprehensive and thorough biological and geological survey of the islands as time and equipment permit.
2. *Vessel:* At the request of the California Academy of Sciences the Secretary of the Navy has detailed the U. S. S. mine-sweeper *Ortolan*, Lieutenant M. M. Nelson commanding, to the Academy for use on the expedition.
3. *Personnel of scientific staff:* [See above.]
4. *Itinerary:*

a. The *Ortolan* will depart from Mare Island Navy Yard on April 15. The first stop will be at San Diego where certain supplies for the ship will be taken aboard. At that time a supply of bottles for water and plankton samples desired by the Scripps Institution will be received. From San Diego the expedition will proceed to Clarion Island, stopping *en route* at Guadalupe Island long enough to make a census of the elephant seal herd which is found there, and to do such collecting as at the time may seem desirable. If tide conditions are favorable a search should be made for fur seals, a few of which may still occur there.

The survey of the Revillagigedos will begin with Clarion Island unless, perchance, Captain Nelson should, for ship's reasons, think best to begin elsewhere. The order in which the different islands will be visited will be determined by the Commanding Officer after consultation with you. The time that will be devoted to the work on and about each island and the sequence will be determined by you, always, of course, after conference with the Commanding Officer. It is of vital importance that as much time as possible be devoted to these islands that the survey may be final in its results so far as the Academy is concerned.

It is expected that, during the time the expedition remains at these islands, the Commanding Officer will take advantage of the opportunity to do hydrographic work of importance to the Navy and to science. In this work you will, of course, render any assistance desired.

- b. *Tres Marias Islands*: Upon completion of the investigations at and about the Revillagigedos, if time permits, it is expected the vessel will visit Mazatlan, which will afford an opportunity to do some work at the Tres Marias Islands which will be of great importance to a proper interpretation of the fauna and flora of the Revillagigedos.
 - c. *Magdalena Bay, etc.*: On the return northward it is hoped that time will permit stops at San José del Cabo, La Paz, Magdalena Bay, and elsewhere on the Lower California coast. It is believed some very valuable information can be secured at these places, especially at Magdalena Bay.
 - d. The *Ortolan* is expected to be at the Mare Island Navy Yard on June 22.
5. *Detailed collecting instructions*:
- a. That the purposes of the expedition may be realized, it is essential (1) that very large collections of specimens be obtained in all departments and (2) that full and carefully prepared notes be kept. It is suggested that the various members of the party confer with reference to this matter and that a uniform system be agreed upon, so far as the diversity of subjects permits.
 - b. *Birds*: While ample collections will be made both of land and sea birds, special attention will be given to the land birds. As many specimens as possible should be secured of each species except in cases where the life of it would be endangered by so doing. A hundred specimens of a species is none too many.
Mr. E. W. Gifford very much desires a few live Socorro doves and every effort should be made to get them. Full directions will be supplied by Mr. Gifford. Notes on the actual and relative abundance of the different species, their habits, behavior, food and feeding habits, breeding habits, nests and eggs, enemies, etc., should be made. The weights of the larger birds should be recorded.
 - c. *Nests and eggs*: Collect in abundance. Prepare very carefully and make careful and complete records.
 - d. *Mammals*: A few specimens of every species and *many* specimens of small land mammals if there be any. A very careful and thorough search should be made for fur seals of which it is believed a few still remain about those islands, particularly Socorro. The caves should be explored thoroughly. Search should be made for fur-seal skulls. This is one of the most important investigations that can be made at these islands. Any data regarding whales and other cetaceans should be recorded in detail.
 - e. *Reptiles*: As many specimens as possible of every species should be collected and very full and careful notes taken as to their abundance, habits, etc., etc.

- f. *Fishes*: It is desired that large collections be made of every obtainable species, and that careful notes be made as to their abundance, distribution, habits, food value, etc. Any data that may be secured regarding the presence of tuna and other scombroid fishes in the waters visited will prove of value. Every specimen should be carefully tagged or labeled.
- g. *Mollusks and other marine invertebrates*: These constitute important desiderata; very extensive collections should be made.
- h. *Insects, spiders, scorpions, etc.*: There is no limit to the number of specimens desired in each group. Field notes on distribution, habits, etc., should be carefully recorded.
- i. *Botany*: Ample series of specimens of each obtainable species of plant (including phanerogams, vascular cryptogams, algæ (marine, freshwater and land), fungi, etc., should be preserved. Full ecological notes should be kept.
- j. *Meteorology*: Weather and climatic data—wind, rain, fog, temperature of air and water, ocean currents, etc., should be recorded. It is expected that Captain Nelson will arrange to have these observations made and properly recorded.
- k. *Geology and paleontology*: It is expected that you and Mr. Jordan will make a careful study in these fields on each island visited.
- l. *Photography*: Photography of animals, plants and general scenery will constitute an important part of the results of the expedition. These will include still and moving pictures of birds and other animals, plants, scenery, etc. Special attention should be given to the bird rookeries.
- m. Great care should be taken that the specimens of whatever kind collected shall be as perfectly prepared, preserved and authenticated as possible. In this matter every member of the staff should take special pride.
- n. Detailed collecting directions prepared by the respective curators are attached hereto.
- o. Finally, each and every member of the expedition must keep constantly in mind that the success of the expedition will depend largely upon observance of the following principles of conduct: (1) whole hearted interest in the success of the expedition as a whole, willingness and readiness to cooperate with and assist others, and patience and forbearance under difficult or trying circumstances; (2) courtesy and gentlemanly conduct at all times; (3) careful observance of rules of health; and (4) the taking of no unnecessary risks to life or limb, so that the expedition may return without any serious accident having occurred and with every member in excellent health and spirits.

DETAILED DEPARTMENTAL DIRECTIONS

For the Botanist, Mr. H. L. Mason

Collect mosses, hepatics, fungi, and algæ according to directions from Dr. W. A. Setchell. If possible make six or more sets of each.

In Phanerogams and vascular Cryptogams collect six sets or more when possible. Number each collection, keep record of date, place of collection, environmental conditions and notes of general appearances, color of flowers or any other noticeable peculiarities, so as to give a good general description in your report whereby the plant could be recognized in the field by an intelligent observer.

Collect seeds for planting as well as for specimens.

Dr. Rose of the National Museum wants good series of live specimens of every kind of cactus.

(Signed) ALICE EASTWOOD
Curator.

For the Entomologist, Hartford H. Keifer

As representative of the Department of Entomology it will be your duty first to collect insects of all orders, then the spiders, scorpions and myriopods, when that can be done without prejudice to the work on the insects. In collecting insects it is of first importance to secure as many species as possible and second, to take series. In collecting, watch for the varying ecological conditions and endeavor to cover all as fully as circumstances will permit. Where there are trees or bushes use the umbrella; if there be grass or suitable bushes use the sweep-net; where there are stones turn them or enough of them to secure their peculiar fauna; dead cactus stems can be turned or opened and some interesting forms will be found there. Many insects hide among rubbish at the base of trees or under bushes and cactus and can be raked out; loose stones about the roots of trees and cacti yield some good beetles. If there are flowers use the butterfly-net for insects frequenting them. Some good things are to be found under kelp and other drift along the sea shore, and sandy areas will yield interesting Diptera, Coleoptera and Hymenoptera, and possibly some Hemiptera. Should there be freshwater pools or streams look for aquatic insects of all orders. Dragonflies and grasshoppers will usually be taken with the butterfly-net. Dead wood can be cut for boring beetles. At night, work with the lantern will secure insects of many orders, and if practicable the trap-lantern and sugaring might be tried for moths. Your own judgment will tell you which method of collecting will be most productive in each locality. Notes on the food habits of the species can be placed in the boxes with the specimens or attached to their pins. Note in day-book or journal where work was done each day and any other items of interest regarding any species of insect taken. Be careful that correct locality, and especially date, be placed with each catch of specimens.

In preparing material for shipment pin up all moths except the micros which may be placed in pill-boxes; butterflies should be papered.

Diptera should be pinned in so far as possible, if large enough for No. 1 pins; those too small for these pins can be placed in pill-boxes for mounting on points. Place insects of other orders in pill-boxes, except certain beetles such as Tenebrionidæ, Carabidæ and some large smooth beetles and Staphalinidæ which should be put into alcohol, as should all spiders, scorpions and myriopods.

While collecting insects save for the other departments such land shells, lizards and snakes as you may capture without undue loss of time. In all your work take no unnecessary risks of accident by carelessness in climbing about cliffs or over rocks; a moment's carelessness might seriously cripple the work under your charge and seriously affect the whole expedition.

(Signed) E. P. VAN DUZEE,
Curator.

For the Herpetologist, Mr. Joseph R. Stevin

The following details are submitted as covering the work of the Department of Herpetology.

Every effort will be made to collect a very large series of lizards and all the snakes possible from Clarion Island, as specimens from this island are very rare in collections and a sufficient series should be obtained for various exchanges. It is also important to discover whether there is more than one species of lizard as reported by the Webster-Harris Expedition.

As the collection from Socorro Island is represented by only a small series of the one known lizard, it is important to increase this series in order to have sufficient material for comparison and exchange. As much night work as possible will be done in an effort to discover whether any of the nocturnal lizards and snakes found in the tropics inhabit the island. The higher elevations where so little work has been done will be given as much attention as possible.

As the department has no material whatever from the Tres Marias Islands, as large a series as possible of all the species found there should be collected. Particular attention will be paid to the smaller islets which often prove to be the best collecting grounds.

While all specimens possible will be collected on the stops made along the peninsula and adjacent islands, it is important to secure the species not in the Academy's collections at present and to secure larger series of some of the rarer lizards and snakes.

Ample field notes for work with the collections will be kept. Records will be kept of the localities and abundance of sea turtles and a sharp lookout kept for sea snakes which have been reported as far north as La Paz.

The policy of the department in general will be to secure sufficient material to have good series of all the species after a representative collection is donated to the United States National Museum and a sufficient number saved for exchange.

(Signed) JOSEPH R. SLEVIN
Assistant Curator.

*For the Ornithologists and Mammalogists
Mr. Frank Tose and Mr. J. T. Wright*

In addition to the general instructions for the work to be carried on during this expedition, the following detailed instructions are given:

While collecting specimens, the fact must ever be borne in mind that the National Museum and the Mexican Government each expects to receive a set of duplicates, and also that specimens of insular forms will have a high exchange value. In consequence, it is especially desirable to obtain large series of such forms and of all the shearwaters, etc., as well. If heretofore unrecorded species are encountered every effort must be made to obtain specimens thereof.

Juvenile and immature birds of any and all kinds are particularly desired, and a reasonably limited series of such should be secured when possible.

A few of the stomachs and hearts of specimens collected should be preserved in formaldehyde solution, with each stomach and heart tied up in a piece of cheese cloth, with the field number of the specimen on an attached label.

A few alcoholics of entire bodies should be made of as many species as space and opportunity may permit, but not, of course, at the expense of regularly prepared specimens.

It is possible that well-preserved skeletons or skulls of various species of birds or mammals may be found along the shores where there are beaches, and such should be preserved.

As far as can be done, birds and mammals secured should be made up into the usual study skins, but, when time will not permit of this, specimens that otherwise would be lost must be skinned and preserved with salt, with proper data attached, until the rush of work is over. Some skins of commoner species should be placed in a *brine pickle*, after being first well washed in freshwater to remove blood from feathers or hair.

Especial care must be taken to see that labels with the proper data are attached to each bird and each mammal collected, whether made up or salted. The labels furnished have upon them the field numbers, in chronological order, of the collector, and in addition to this must have the date of taking, the sex, the initial of the collector, all of which must be entered fully in the regular note book.

A reasonable number of sets of eggs of each species of bird should be collected.

Examples of the food of the different species of seed-eating birds should be saved and, when possible, specimens should be obtained of the trees or bushes from which came seeds found in the stomachs of birds. This is additional to the matter of saving crops or stomachs as before mentioned in these instructions.

Traps for mammals, on islands where such occur, should be kept set, and as many mammals obtained as opportunity permits; and, if time is pressing, these may be preserved in any manner that your judgment may suggest when it is impossible to make regular skins of them.

Some hearts of mammals should be preserved as well as those of birds.

As alcoholics of the smaller rodents (bats, mice, etc.) admit of softening and making over into skins, this method of preservation may be used in some cases, if there is space for such in the containers in use.

The bare parts of different species of freshly killed birds should be sketched in true colors by Mr. Tose.

As full notes as time may permit should be made of all matters of importance concerning abundance, habits, peculiarities, food, as far as observed and the habitat of the birds and mammals met with.

A thorough investigation should be made as to the presence of bats on islands favorable to the habits of these mammals, whether heretofore recorded from such islands or not. If present, every effort must be made to capture as many specimens as may be possible. When captured alive they may be kept in this condition for a number of days and prepared as specimens when time permits.

(Signed) JOSEPH MAILLIARD,
Curator.

*For the Paleontologists and Ichthyologists
Dr. G. Dallas Hanna and Mr. Eric Knight Jordan*

The Department of Paleontology will be represented on the expedition by G. Dallas Hanna and Eric K. Jordan. It is expected that at every stop where fossils of any kind are preserved, ample collections will be obtained. Since there are no known deposits of this character on Guadalupe, Alijos Rocks or any of the Revillagigedo Islands and none will likely be found, special study should be given to other phases of geology, particularly the volcanism which has produced the islands and its bearing on adjacent bodies of land. The distribution of land animals and plants on oceanic islands is due, at least in part, to phenomena belonging in the province of geology and special study should be given to place yourselves in a position to be able to give expert advice on this problem to students in the other branches. Sufficient collections of rocks should be made so that identifications can be made of any which may be later discussed in detail.

It is reported that there are deposits of fossils on the Tres Marias Islands which will be visited. If these are found, as complete collections as possible should be obtained. The same applies to any places on the peninsula or adjacent islands of Lower California. Since it is expected that stops will be made at several places on the way north, possibly enough of value will be obtained to offset the lack of fossils and it is expected that many species new to science will be brought to light.

In the collection of marine mollusks many other invertebrates will inevitably be secured. These should be preserved with as great care as possible.

It is expected that the members of this department will give considerable attention to the collection of fishes wherever stops are made. These,

as well as the marine invertebrates, should shed much light on the former history of the islands and the currents of the waters surrounding them. Reasonable care must be exercised in the selection of specimens to be preserved. It is desired that a sufficient number should be kept of each species to determine the distribution and to enable the identification to be made; rarities should be obtained in quantity. Fishes too large to be preserved in the containers provided should be measured, weighed and photographs of them taken. In some cases fins, heads or other parts can be preserved for identification.

Tanks have been provided for the transportation of live fishes for exhibition in the Steinhart Aquarium. These should be filled before departure from tropical waters and as many specimens as possible brought back alive. A good supply of sea horses in particular, is greatly desired.

It is expected that Dr. Hanna will take most of the official photographs on the expedition with still cameras. He should be prepared to photograph interesting or desirable specimens in all groups which may be needed for future illustration or which may be called to his attention by the other collectors.

In the motion picture work he will be assisted by Mr. Raymond Duhem who accompanies the expedition for this particular purpose. Every possible opportunity should be afforded for Mr. Duhem to secure a valuable and interesting series of films.

Make stops and observations wherever and whenever you think results of interest may be obtained.

No private collections are permitted. All specimens must be brought to the Museum from which distribution will be made.

No interviews are to be given out except by or through you and the Captain.

Very respectfully,
BARTON WARREN EVERMANN,
Director.

ITINERARY

It was contemplated that the expedition would be out a little over two months, April 15 to June 22. My own connection with the Geological Department of the Pacific and Associated Oil Companies as Microscopist was such that Mr. J. A. Taff, Chief Geologist permitted my absence for the period indicated. Practically nothing was known previous to our visit of the geology and oil possibilities of many of the places where we expected to call. Through the kindly interest taken in the work by Mr. F. B. Henderson, Vice President of the Associated Oil Company, a supply of gasoline for the small, detachable boat engine was furnished without cost.



The exceptional facilities afforded by the *Ortolan* and the willingness of the Navy Department to cooperate in every way possible made it seem desirable to visit a few other places than the Revillagigedo Islands. Full details and reasons will be found set forth in later pages and it will suffice here to enumerate the points visited. They are: Guadalupe Island; Alijos Rocks; Revillagigedo Islands; Tres Marias Islands; Mazatlan; Cape San Lucas; Magadena Bay; San Bartolome Bay; Cedros Island; and San Quintin Bay.

DATE	LOCALITY	ARRIVED	DEPARTED	REGION VISITED
APRIL 15	San Francisco.....		1.00 PM	.....
17	San Diego.....	8.00 AM		.....
18	San Diego.....		1.00 PM	.....
19	Guadalupe Island.....	2.30 PM		Northeast Anchorage and South end
22	Guadalupe Island.....		10.00 AM	.....
24	Alijos Rocks.....	8.00 AM	11.00 AM	.....
26	Clarion Island.....	7.30 AM		Various parts
MAY 1	Clarion Island.....		5.00 PM	.....
2	Roca Partida.....	8.00 AM	11.00 AM	.....
2	Socorro Island.....	4.00 PM		Various parts
12	Socorro Island.....		2.00 AM	.....
12	San Benedicto Island..	5.30 AM	5.00 PM	.....
13	Maria Madre Island..	6.00 PM		.....
14	Maria Madre Island..			Established shore camp
15	Maria Madre Island..			<i>Ortolan</i> left for San Diego at 9.30 AM
19	Maria Madre Island..		5.30 AM	.....
19	Magdalena Island....	7.30 AM		.....
22	Magdalena Island....		6.30 PM	.....
22	Maria Madre Island..	8.30 PM		.....
23	Maria Madre Island..			<i>Ortolan</i> arrived from San Diego at 1.30 PM
24	Maria Madre Island..		2.00 AM	.....
24	Isabel Island.....	6.00 AM	5.00 PM	.....
25	Mazatlan.....	9.00 AM		.....
27	Mazatlan.....		7.30 PM	.....
28	Cape San Lucas.....	2.00 PM	4.30 PM	.....
29	Magdalena Bay.....	11.00 AM		.....
30	Magdalena Bay.....		7.00 PM	.....
JUNE 1	San Bartolome Bay...	9.30 AM		South side
3	San Bartolome Bay...		4.00 AM	North side
3	Cedros Island.....	9.30 AM		Bernstein's abalone camp
5	Cedros Island.....			Center of east side
6	Cedros Island.....		1.00 AM	.....
7	San Quintin Bay.....	3.00 AM		Across plain to Santo Domingo
8	San Quintin Bay.....		5.00 AM	.....
8	San Martin Island....	7.00 AM	2.00 PM	.....
9	San Diego.....	8.45 AM		.....
10	San Diego.....		7.00 AM	.....
12	San Francisco.....		6.30 PM	.....

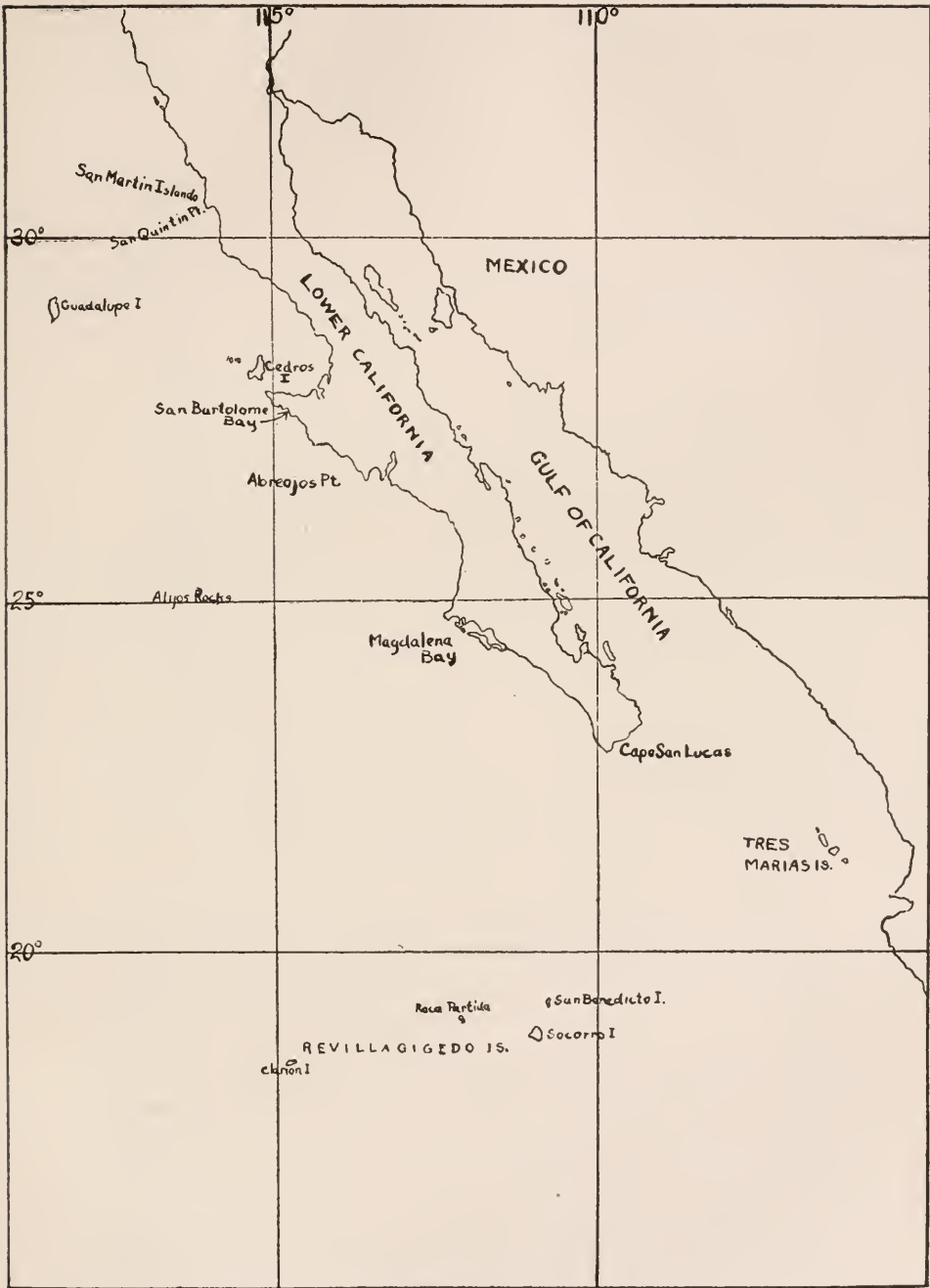


Fig. 1. Sketch map of region west of Mexico visited by the expedition of 1925.

March 30, 1926

The general region visited is covered by the map herewith (fig. 1) and detailed island charts are found in appropriate places in the text. These have been taken from the charts published by the U. S. Hydrographic Office.¹

The charts to which special reference is made in the work of the present expedition are as follows:

<i>Title</i>	<i>Chart Number</i>
Cape San Lazaro to Cape San Lucas.....	621
Revillagigedo Islands.....	622
(Tres Marias Islands).....	622
General West Coast Sailing Chart.....	1006
General West Coast Sailing Chart.....	1007
Mazatlan Harbor.....	1024
San Quintin Bay and approaches.....	1043
San Diego to San Quintin Bay.....	1149
San Martin Island to Cedros Island.....	1193
San Bartolome Bay.....	1204
Abreojos Point to Cape San Lazaro.....	1493
Magdalena Bay.....	1636
Cape San Lazaro to Cape San Lucas.....	1664
San Lucas Bay.....	1666
Guadalupe Island.....	1681
Hassler Cove.....	1686
Roca Partida.....	1687
Alijos Rocks.....	1687
Socorro Island.....	1687
San Benedicto Island.....	1687
Clarion Island.....	1688

NEW GEOGRAPHIC NAMES

During the progress of the expedition it was found that some physiographic features of considerable importance were without names. Some of these will be referred to on later pages of this report and others will appear in the technical reports. In order that the new names which we proposed to bestow might receive official sanction before their adoption by us, Mr. C. E. Grunsky, President of the Academy, addressed the following letter to the Ambassador of Mexico at Washington.

¹A full list of the charts published by the Hydrographic Office of Western Mexico and Central America may be found in the publication "H. O. No. 84 Mexico and Central America Pilot (West Coast)" sixth edition, Washington, Government Printing Office, 1920, and the supplement to the same published in 1923.

SAN FRANCISCO, CALIFORNIA,
November 14, 1925.

SEÑOR DON MANUEL C. TELLEZ,
2829 Sixteenth Street, N. W.,
Washington, D. C.

My Dear Sir:

In 1922 and 1925 the California Academy of Sciences sent expeditions out to explore certain islands off the west coast of Mexico. In each case most pleasant collaboration was enjoyed with scientific representatives of your country. The islands had not previously been very well explored and in the preparation of the scientific reports on the collections obtained, we find we need names for a few important topographic features which have heretofore been without designation.

The names which have been proposed for adoption by our scientists and which meet the approval of the Academy, are listed below with some information pertaining to each one. They have all been entered in red ink on copies of the U. S. Hydrographic Office charts which have been mailed to you today, under separate cover.

Angulo Rock.—This name is proposed for a small, outlying, flat-topped rock immediately northeast of Asuncion Island, Lower California. It is named in honor of Captain Victor Angulo, in 1922 Commander of the Fisheries Patrol Boat *Tecate*, now Commander of the Mexican National Patrol Vessel *Presidente*. Several species of insects entirely new to science were collected on this rock and a name for it is badly needed.²

Mount Gallegos.—This name is proposed for the highest mountain on Clarion Island of the Revillagigedo Group. Chart No. 1688 (U. S. Hydrographic Office) gives the elevation as 1100 feet. The name is proposed to honor the late Professor José M. Gallegos, an indefatigable explorer for the Government of Mexico, and whose recent death in British Honduras is sincerely mourned by all who knew him. Prof. Gallegos was a member of the party which, in 1925, explored the mountain for which his name is proposed.

Mount Evermann.—This name is proposed for the central peak of Socorro Island of the Revillagigedo Group. It has been selected in honor of Dr. Barton Warren Evermann, the distinguished Director of the California Academy of Sciences and the organizer of so many expeditions in which this institution has actively cooperated with the Government of Mexico.

Grayson's Cove.—This name is proposed for the little cove at the west end of Cornwallis Bay, Socorro Island, as shown on the U. S. Hydrographic Office Chart No. 1687. It was in this cove in 1867 that Colonel A. S. Grayson's sloop was wrecked and where the only known supply of fresh water on the island is found. It is suggested that beneath the name and in parenthesis the words "Fresh Water" be printed on United States' charts and "Aqua dulce" on those printed in Mexico. The account of the

² See Hanna and Anthony, National Geographic Magazine, Vol. 44, July 1923, p. 95. Hanna, Proc. Calif. Acad. Sci., Vol. 14, No. 12, 1925, p. 261. Blaisdell, Proc. Calif. Acad. Sci., Vol. 14, No. 14, 1925, pp. 321-343.

wreck and discovery of the spring may be found in Proceedings of the Boston Society of Natural History, Vol. 14, 1871, pp. 288-290.

Point Old Man of the Rocks.—This name was given by Colonel Grayson to the point of rocks which formed the eastern boundary of the little cove herein proposed to be called "Grayson's Cove."

Ash Heap.—This name is proposed for the highest elevation on San Benedicto Island. It is at the south end of the island, 975 feet high, and is composed almost entirely of soft volcanic ashes. It was explored by the expedition of 1925.

Herrera Crater.—This name is proposed for the central peak of San Benedicto Island indicated on U. S. Hydrographic Office Chart No. 1687, as being 683 feet high. The name is selected in honor of Prof. Alphonso Herrera, the distinguished Director of the National Museum of Mexico who took a large part in the organization of the expedition of 1925 which explored the island. The crater is one of the most perfect the explorers had ever seen.

Before the above names are adopted by the United States and used in our maps and in our scientific reports, it is very desirable that they receive the approval of the Government of Mexico.

Our reports are almost ready to be printed; therefore, it will be a great favor to the Academy if due consideration of the subject may be given by you at an early date and, if approved, you will be kind enough to advise The Secretary, U. S. Geographic Board, Washington, D. C.

With sentiments of highest respect, I have the honor to be, my dear Sir,

Your obedient servant,

(Signed) C. E. GRUNSKY,
President.

In due time Señor Tellez advised by telegraph that his government had approved the proposed names.

C. E. GRUNSKY,
President, California Academy of Sciences,
San Francisco, California.

Have received communication from Mexican Government approving the geographical names Revillagigedo Islands proposed in your letter of November 14.

MANUEL TELLEZ,
Mexican Ambassador.

Copies of the above correspondence having been furnished to the U. S. Geographic Board, the U. S. Coast and Geodetic Survey, the National Geographic Society, and the U. S. Hydrographic Office, it is expected that the proposed names will be incorporated in future issues of maps and charts of the region.

NARRATIVE

April 15 to 17—The *Ortolan* with all of the party, except Messrs. Contreras, Gallegos, Jordan, Solis and Hanna, left Mare Island Navy Yard in San Francisco Bay at one in the afternoon of April 15. Mr. Jordan and I reached San Diego the next evening. The ship arrived on the morning of the seventeenth at eight o'clock and immediately went to the Destroyer Base where the installation of a second refrigerator machine was begun at once.

The placing of this machine on the ship was done at the suggestion of the Academy and was primarily for the benefit of the Department of Ornithology. It was foreseen by all that Messrs. Tose and Wright would have great difficulty in preparing all of the specimens of birds and eggs in standard museum manner which could be profitably taken on the cruise. To do so each specimen of sea bird would require at least one hour of straight taxidermy and it was believed that any arrangement which would lessen this time would enable a larger collection to be obtained.

The officials of the Navy Department deserve the highest commendation for the readiness with which they undertook the installation of the refrigerator because it involved a very considerable amount of trouble. It was placed on the right side of the after deck and proved to be one of the greatest aids to bird collecting ever taken into the tropics. Specimens in large numbers were taken in favorable places and with the excellent working facilities already provided for the purpose, preparation of the specimens could proceed at any time, even days or weeks afterwards. As a matter of fact a large consignment of birds and eggs was sent to San Diego when the vessel had to replenish fuel on May 15, and was there transhipped to San Francisco in cold storage. Likewise on the final return of the *Ortolan* the refrigerator was filled with unprepared specimens. The equipment undoubtedly enabled the party to bring back some hundreds of specimens which could not have been collected at all had it been necessary to complete the taxidermy work in the field. So successful was the venture that it seems to me every expedition which can possibly do so should be equipped with cold storage facilities.



April 17—April 17 at San Diego was spent in assembling a few additional supplies such as nitrogelatin for use in the collection of fishes. An assortment of bottles, thermometers and nets was placed on board by the Scripps Institution for Biological Research at La Jolla, California; these were to be used in the collection of a series of samples of water and surface plankton as was done by the Guadalupe Expedition of 1922.³ This work was continued until we reached Clarion Island, after which it was found impossible to detail any member of the party to it without unduly hampering other assigned duties.

April 18—On April 18, the installation of the refrigerator having been completed the previous evening, the ship was moved to La Playa, the Navy coal and oil station near Point Loma, San Diego Bay. All who were on shore joined the vessel there and at 1 p. m. departure was taken for Guadalupe Island. Before leaving Mr. Lawrence M. Huey of the San Diego Society of Natural History took a photograph of the party on the dock. (See plate 1.)

April 19—The sea became very rough during the night of April 18 and a very uncomfortable time was spent by all; many of the party were seasick. Our quarters on the bridge deck had been enclosed and covered with canvas by the Naval officials at Mare Island, but even with the excellent facilities provided some of the heavy seas broke over the top and wet some of the supplies. Fortunately the mine-sweepers of the *Ortolan* class are exceedingly seaworthy and many a larger vessel would have been more uncomfortable in the weather which prevailed.

This first night out proved to be the worst of the entire cruise, and we were all glad to get in the lee of Guadalupe Island; anchor was cast at 2:30 p. m. under the towering lava cliffs at Northeast Anchorage.

The object of our visit to Guadalupe Island was to obtain a census of the herd of elephant seals for comparison with counts of previous years and also to secure an additional series of motion pictures of these strange beasts of the sea. In 1922 we had visited the herd in July after all the animals except the males had left the beach, but by making this early trip we had

³ See Hanna, Proc. Calif. Acad. Sci., 4th ser., Vol. 14, No. 12, 1925, p. 226.

hopes of getting some data on the breeding habits of the species. It was also expected that the collectors would be able to add greatly to the collections from this island by this early visit, particularly in the groups of plants, insects, fishes and birds, all of which could progress while the work on the elephant seal beach was being carried on. Therefore, we had planned to establish a camp on shore at Northeast Anchorage.

Soon after we reached that place, a landing party went ashore for a short time. A fierce gale was blowing directly off shore and the high precipitous mountains and cliffs produced swirling eddies of wind of almost tornado violence. Clouds of spray were actually picked up from the surface of the sea and scattered hither and yon. When one of these sudden gusts of wind, known in the sailors' parlance as a "will-a-waw" the world over, would strike the ship it would surge violently against the anchor or swing suddenly from side to side. At this point a vessel must come in very close to shore in order to get "holding bottom" on account of the great steepness of the submarine slopes of the mountain. A projecting lava reef adds to the dangers of the place. Under the circumstances Captain Nelson very wisely considered the anchorage unsafe for the night and those who had landed were called back.

With the wind which was blowing there was only one possible place to stay at anchor at Guadalupe and this was at South Bay. Investigation showed that here the ship would be very safe and comfortable as long as the storm continued from the northwest, and the anchor was dropped late in the evening, too late for further shore work on the 19th.

At Northeast Anchorage it was noticed that the goats were just as abundant as in 1922. The lowlands were quite green with new vegetation showing conclusively that some rain had fallen at no very distant date. However, as we sailed down the east side of the island the landscape became progressively more barren and at the south end it was as parched as any desert could be.

Professor Gallegos told us that the soldiers who had been stationed at the Northeast Anchorage had been removed a few months prior to our visit owing to transportation difficulties, but that as soon as a vessel, for which negotiations were in progress, was secured it was expected that they would

be returned. It will be recalled that as a result of recommendations made by the members of the expedition of 1922 the President of Mexico declared Guadalupe Island a government reservation. The soldiers had been stationed there to enforce the regulations which had been prescribed and from all we could learn they have performed their duty well.⁴

During the evening of April 19 three murrelets and a shearwater flew aboard the ship, attracted by the lights. And over the side, around a submerged light brought for the purpose, a very considerable number of fishes was taken for the collection.

April 20—The gale continued all night from the north-north-west with full force and there was no indication that it would cease soon. At daybreak it was evident that a landing on the elephant seal beach would be impossible at that time and other plans were made accordingly.

Early in the morning Messrs. Slevin, Jordan and I visited the old South fur seal rookery but found no seals. We landed for a short time and collected some insects, shells and plants and on the way back across South Bay to the ship we made four successful dredge hauls from sandy bottom.

At 10 a. m. we sailed for Northeast Anchorage again and landed Messrs. Tose, Mason, Wright and Keifer, equipped to spend the night on shore. They set out at once up the cañon back of the barracks for the top of the island, although the weather was very threatening and a fierce, cold wind was blowing.

The rest of the party returned with the ship to South Bay for the night. The motor boat was launched upon arrival and about 20 men of the crew went ashore at the old rookery for "liberty." Messrs. Slevin, Jordan, Musser and some of the crew collected fishes on the lava reef but had poor success on account of the high surf which was breaking. Professor Gallegos secured a few birds and Señor Solis secured some plants, one being a cactus of the genus *Mammillaria*, the species being the same as I had found at the same place in 1922.

Captain Nelson, Mr. Duhem and I went with the motor boat around Inner and Outer Islands. Some pictures were taken of these remarkable rocks. Inner Island is composed largely of

⁴ See Hanna, Proc. Calif. Acad. Sci., Vol. 14, No. 12, 1925, pp. 232-233.

a yellow volcanic sand with a cap of black lava and several dykes extending downward from it to the water line. The walls are sheer and landing is impossible. There is a little vegetation on top but with the field glasses we were not able to make out any species except a "cholla" similar to the one that grows on Guadalupe.

Outer Island is composed wholly of lava and inside there is a bowl-shaped crater containing water. A shelf of rock on the west side affords a possible place to land in calm weather, and from it a person might climb over the rim to the inside; we could not attempt it with the sea running as it was that day. On a narrow shelf just above the surf on the south side of the island 34 California sea lions were found. Cows and bulls were present but no pups. We suspected that the water on the inside of the crater might be fresh because the slopes of the walls afford a considerable drainage area. These are composed of hard black lava weather-cracked all over, giving the appearance, suggested by Captain Nelson, of a railroad map of Illinois.

At 5:30 p. m. the Captain picked up all of the men who had landed except six who were inland away from the beach without water or food and poorly clad. Naturally we felt considerable anxiety for them and at 9 p. m. Captain Nelson and I with one member of the crew started with the "dinky" for the landing to see if they had arrived. When halfway there we saw the light of a fire they had started inside the walls of one of the old Russian sealer's houses but it took us nearly an hour to get there from the ship against the gale of wind. All of the men were safe. They had captured a young black kid which they brought on board for a mascot. (Next day they tried to kill the fleas on it with creosote, and killed the goat also.)

Many showers of rain fell during the afternoon and continued in increased quantity into the night. During one squall we had a fine rainbow, the ends of which almost met in a circle in our boat.

April 21—I think fully half an inch of rain fell where the ship was anchored during the night, undoubtedly a very considerable amount for this section of the island. It is to be

regretted that two or three weeks later we might not have been able to make another visit for the benefit of the botanists—desert plants, as a rule, respond very quickly to showers and Guadalupe Island should be no exception in this respect.

We had fully intended to get under way at 5:30 a. m., but the north-north-west gale continued and we knew it was useless to try to land on the elephant beach. Therefore, we remained at anchor on good sand bottom at South Bay for most of the day.

Messrs. Jordan, Duhem and I went with the skiff and demountable engine along the eastern shore where we could remain close in under the cliffs for protection from the wind. Our object was the collecting of fishes and we were very successful in this. Some taken were allied to genera found only in tropical waters although the water at Guadalupe Island was 61° F.

We were on the way back to the anchorage when the *Ortolan* was seen coming around one of the headlands, so we joined her at sea and proceeded directly to Northeast Anchorage. There we found the shore party on the beach ready to come aboard. In rowing in for them I found it almost impossible to make headway when a "will-a-waw" struck us. Once the boat was spun around and headed in exactly the opposite direction I wished to go and that against a back-watered oar.

Messrs. Tose, Mason, Wright and Keifer had a hard trip overland. They did not reach their objective, the cypress grove on top of the island, owing to fog and rain, but chased a dozen or more goats out of a lava cave and camped there for the night. One of the animals furnished food and fuel was secured from a nearby oak tree. Most of the night was spent cooking goat meat, drinking tea and recalling the comforts of civilization, but they returned with an excellent collection of birds, insects and plants. Among the latter were some ferns and other species not previously recorded from the island.

The anchor was dropped at Northeast Anchorage but it would not hold the ship in the violent wind eddies, so we returned to South Bay for the night.

April 22—The incessant wind continued unabated throughout the night and on the morning of April 22 we gave up all hope of being able to take the census of the elephant seals. Landings were so very difficult to make, even on the lee shore and travel to the highlands so nearly impossible that all of us thought we would better proceed to the main objective of the expedition, the Revillagigedo Islands. Therefore, at 10 a. m. the ship was headed in the direction of Clarion Island 660 miles distant and the westernmost of the group. Guadalupe Island was hardly out of sight when we entered calmer seas and less wind; this seemed to indicate what we had already come to suspect—that this huge volcanic mass rising from deep waters is its own storm center.

April 23—We continued to take water and plankton samples throughout the day as the ship proceeded southward. The course was laid so that we would pass close by Alijos Rocks and we expected to sight them at noon, but a low-hanging haze prevented their being found before dark. The rocks themselves are not high and therefore are not visible from any great distance, but Captain Nelson was anxious to get a check on his instruments and we were likewise anxious to investigate the animal life about them. Therefore, after he had determined the position of the ship by star sights, we steamed ahead slowly during the night.

Very little life of any kind was seen during the day. Two blue-faced boobies, two petrels of some kind and some flying fish comprised the total.

April 24—Alijos Rocks were sighted at 6:30 a. m. and at 8 a.m. while the ship lay to, Messrs. Wright, Jordan and I rowed in as close as we could safely, to make collections.

The group consists of three main rocks, North, South and East, all volcanic in origin. All are pinnacles with vertical or overhanging walls. North Rock is 72 feet high, slopes steeply to the eastward on top, like a roof and is about 25 feet in diameter.

South Rock, the largest of the group, is 112 feet high and about 35 feet in diameter. It stands on five legs, the sea having eaten away the remainder of the base. On the south side

there is a large rock, just awash on which a seal might land in calmer weather than we saw. Between North and South Rocks, a distance of about 150 yards, there is a reef, just awash. This forms a barrier over which the northwest swells broke with tremendous violence.

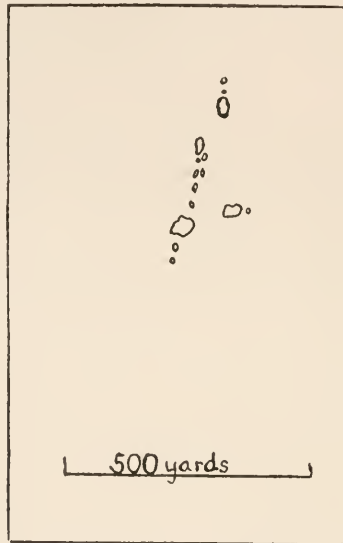


Fig. 2. Alijos Rocks.

East Rock is 60 feet high and about 30 feet in diameter. Its top is jagged and has two lava pinnacles. South of it but close by there is a rock just awash.

The three main rocks form an approximately equilateral triangle with shallow water enclosed between. Shoals also extend about 100 feet to the south of East Rock.

In this shallow water we succeeded in placing six shots of dynamite and got five species of fishes. All but one had tropical Indo-Pacific affinities. One other species was taken on a line from the ship and ten miles to the north of the rocks we caught an ocean bonito. A few seaweeds which came up from the shots were collected.

Mr. Wright succeeded in shooting and recovering 13 birds. East Rock had only sooty terns on it and it is probable that they nest there. South Rock had sooty terns and blue-faced

boobies. North Rock had red-billed tropic birds and blue-faced boobies. Both appeared to be nesting but positive proof could not be obtained.

Not a plant of any kind could be seen on the rocks. It is not likely that seals ever stop at the place and except for the birds enumerated and a limited fauna and flora of marine animals and plants, they are excessively barren. Very unfortunate indeed would be the ship which would run aground upon them; we could not find a single place where a man could scramble on shore, even in calm weather.

We left the rocks at 11 a. m. on the course for Clarion Island and took water samples to 6 p. m. After leaving Alijos, the atmosphere suddenly became warmer, the sky cloudless and only a gentle tropical breeze was blowing. From Guadalupe to Alijos the water gradually became warmer from 61° to 67° and south of the latter it became warmer still.

April 25—On the way to Clarion Island, all hands were busily engaged in making preparations for work immediately upon arrival. A final overhaul was given to equipment in general and everything possible was done in advance to facilitate collecting operations the moment we arrived at this distant, westernmost outpost of Mexico's possessions.

April 26—When we looked to the southward at dawn we could see directly ahead, the black forbidding cliffs on the north side of Clarion Island. Some little trouble with the machinery made it necessary for us to stop the engines and drift for a little while when we were still about three miles away and this gave us an opportunity to glimpse the wonderful array of marine life which swarmed all about. Man-o-war birds by hundreds sailed gracefully out to inspect us while boobies constantly passed back and forth from their feeding grounds and rookeries. In the sea, sharks, porpoises, whales, and flying fishes were frequently seen. Soon after we started, a school of giant swordfish carried away all of the trolling gear we had out, with no more concern than if our lines had been spider webs.

The anchor was dropped in Sulphur Bay on the south side of the island at 7:30 a. m. and collecting began at once. No

sooner had the ship come to rest than hand lines over the side began pulling in fishes of various kinds.

A compliment must here be paid to the personnel of the *Ortolan* for the very efficient manner in which both ship and boats were handled throughout the cruise. On a great many occasions it was demonstrated that they were thorough masters of the machines they operated. For instance, it was very

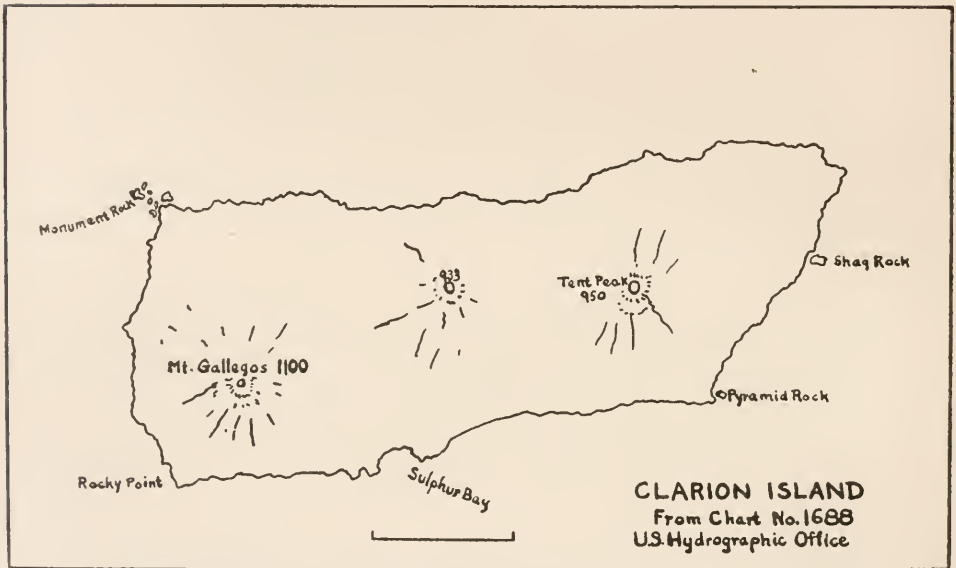


Fig. 3. Clarion Island.

seldom indeed that more than two minutes would elapse after the anchor was dropped until motor boat and row boat were in the water and the engine of the former started and ready to go.

Sulphur Bay is named for the British Survey ship *Sulphur*, which cruised in west Mexican waters at an early date. The landing place, marked on the Hydrographic office chart, is located on a lava wall in a narrow tongue-shaped indentation of the shore line just west of the coral beach about one-fourth mile. Except in favorable weather the beach is unsafe on account of the surf and, while we did land there many times before we left, our first party was put ashore at the indicated

place. This was soon after we had anchored and the party consisted of all of the scientific staff, except those to be mentioned later, and some of the members of the crew of the *Ortolan*.

Sr. Gallegos and I were very anxious to learn if there be any truth in the rumors we had received from time to time that fur seals were found on Clarion Island. It seemed desirable to investigate the matter as soon as possible after our arrival so that in case none was found, this could not be attributed to any disturbance caused by our presence. Therefore, we set out as soon as the landing party was on shore, with Captain Nelson, Chief Engineer Lot and Mr. Musser in the motor boat. We went completely around the island on the trip and examined the shores from as close as it was feasible to go with the boat. We never saw a seal of any kind, and no shore line which appeared to be very favorable rookery ground exists on the island. In view of the fact that no seals were seen at all during our stay at Clarion, it seems safe to conclude that they are absent.

It must not be assumed from this that our trip around the island was lacking in interest. Several humpback whales were seen at close range and hundreds of sharks and porpoises were noted. About 30 green sea turtles were observed, two males having been captured and put aboard the ship before we started. These were later used for food but it must be said that they did not appeal strongly to any of us. With a good supply of fresh meat in the refrigerator and excellent fish swarming all about, and to be had on a moment's notice, the turtles were not needed and we molested them no more on the trip.

Much of the way around the island we passed over growing coral reefs and for several of us it was our first opportunity to witness this magnificent sight. As usual the chief objects to attract attention were the gaily colored fishes, moving jewels in an azure sea. The Captain and Messrs. Lot and Musser used the trolling lines until their hands were sore from pulling in the fishes. Those most in evidence in the catch were two species of caranx and a large speckled form allied to the bass.

One of the caranx was a most brilliant blue trimmed with lemon-yellow.⁵

Passing close under the northern cliffs the Clarion Island doves were often seen passing from point to point while high up on the crags man-o-war birds and boobies were resting complacently. Occasionally a red-billed tropic bird would fly swiftly overhead, the long streaming tail feathers so resembling the "marlin spike" that sailor-men call it "bosun bird."

When the party assembled that night on board ship there was much to be told of the experiences during the day. Those on shore had the pleasant (or unpleasant) task of cutting trails with machetes through the otherwise impenetrable thickets of cactus and vines. A species of *Opuntia* similar to the common cactus known as "prickly pear" grows very luxuriantly in a broad zone around the shore line and more or less in patches to the top of the island. Intertwined in it everywhere are dense growths of vines. We had been forewarned of this condition, fortunately, and had provided long knives to aid in making trails. But even with the best that could be done in this line every one received many painful thorns before the work on the island was finished.

Messrs. Mason and Solis returned to the landing heavily laden with plants. They had found collecting exceptionally good although it was very evident we were on hand during the dry season. Very few annuals were to be had and the most of the vegetation had the appearance of late fall in a temperate climate. This condition indicated that August to November would be the best months for a botanist to visit the island.

Many of the perennial plants were in bloom, nevertheless. One of the most conspicuous was a brilliant, blue morning-glory which grew in greatest profusion. Three species of beans were collected, one of which seemed to do so well in spite of the dry season that it should prove a desirable addition to the list of agricultural products in those sections where there are pronounced wet and dry periods. Seeds of almost all

⁵ At the time of writing, the collection of fishes has not been entirely identified; therefore, I am not able to give names of species found. The reader who may be interested in the subject is asked to consult the report on the fishes which is expected to follow this without great delay.

plants in fruit at the time of our visit were brought back for study and experimentation.

Mr. Slevin found only two species of land reptiles on the island, a snake and a lizard. He proceeded to make his collection forthwith because, although both had been known before from a very few specimens, they were practically unrepresented in the museums of the world. He wished to secure enough to supply this deficiency, at least in part.

One question every one asked but no one could answer was: "How did the snake and lizard ever get to Clarion in the first place?" The original stock could not possibly have gotten there by swimming the 500 or more miles of intervening water to the mainland. It seems equally incredible that they could have lived on a floating object long enough to have made the passage. That they were introduced by man is unthinkable; there is too much other life in the same category. No bird would be likely to carry these reptiles as passengers. The most plausible suggestion we heard made was that when they arrived there was intervening land where there is water now. This theory is not in conflict with the known geologic data.

No mammals of any kind were found on the island. Fortunately, the place has never been inhabited, even by temporary residents; hence those curses of isles to the northward, mice, cats and goats, have not become established. In fact, Clarion Island is one of the few places remaining which has not been modified in some way through the agency of man. The original "balance of nature" still obtains. We know of only one case of the introduction of any kind of life. In 1903 the California Academy of Sciences sent an expedition to these islands and during the course of work on Socorro Island some paroquets were captured alive. Mr. E. W. Gifford, a member of the expedition, told us that some of these birds were liberated on Clarion Island. We saw no sign of them during our stay and it is supposed that they perished through lack of fruit which constitutes their chief food on their native island.

Mr. Keifer took a great many insects during the day on shore and there is little doubt that most of the species will be found to be new to science. He is the first entomologist ever to set foot on the island.

March 30, 1926



Mr. Jordan worked along shore, about the lava cliffs and on the coral reef. A large collection of mollusks, some fishes and other life was the result. Messrs. Tose and Wright found many birds to interest them. The resident forms of land birds are a species of wren, a ground owl, a dove and a raven. Brewster's and blue-faced boobies nest in large numbers and red-billed tropic birds are present but not common. The man-o-war birds were found resting on the cliffs and in the cañons in large numbers but no nests were observed during our stay. Turnstones, curlews and wandering tattlers, all migrants, were collected and Mr. Tose saw a single western gull.

Huge ocean swells whipping around both ends of the island made disembarking from the rock wall very difficult and in getting aboard the skiff, Mr. Wright dropped his shotgun overboard. Efforts of Mr. Duhem to recover it by diving were unsuccessful and it was feared that this serious loss at the beginning of the trip would be a great handicap. But next day Captain Nelson, always resourceful, got out a diving apparatus which was carried aboard the *Ortolan* and the bosun's mate went down safely and recovered the gun. It apparently suffered no injury.

April 27—Most of the party worked on shore in spite of the fact that a greatly increased sea made landing very difficult. Mr. Mason covered the west end of the island pretty well and collected about 60 species of plants. He went to the top of Mt. Gallegos, the highest point on the island (1100 feet), but found practically the same character of vegetation there as at sea level. There are evidently no altitude zones of life on Clarion.

The island is about five miles long, two miles wide and is divided by passes into three separate hills. All rocks and cliffs seen are volcanic. The hills are rounded by erosion and there are few cañons worth noting. Over most of the island there is deep reddish brown soil, all indicating a very considerable geologic age. In gathering trash from beneath the bushes to be brought back to the museum for the purpose of picking out the land shells, a few fragments of fossil-bearing rock were unwittingly collected. The matrix has the appearance of a hard, calcareous clay-shale and it is believed from this and the

few fossils taken that the rocks are at least as old as Pliocene. The specimens were obtained on the sloping land immediately back of the landing place where all exposed rocks are volcanic.

The largest bushes are not over 15 feet high. Scattered among the cactus and vine-tangles there is a stiff bush with excessively strong, sharp, hooked spines. This gave considerable difficulty in getting about. A species of *Euphorbia* grows in thickets and in these the Webster's boobies build their nests. Mr. Duhem and I visited one of these colonies and took a series of pictures. Some of the nests had fresh eggs, others young birds. One egg is a full set. The birds of the previous year were abundant on the rookery.

The blue-faced booby was found in considerable numbers but does not colonize. The individual nests were found here and there on the ground and usually contained two eggs each. Many had hatched and a few of the birds were almost half grown. Mr. Tose assisted by Mr. Lot, the chief engineer, took about thirty sets of eggs of each of the species of booby. Doves were very abundant but showed no sign of nesting. Several of the birds were captured alive. The wrens were rather scarce and the only nest found had four half-grown young. An open nest which was rather common in the bushes looked very much like that of a towhee or large sparrow. We know of no bird from Clarion which could possibly have made such a nest. The builders certainly must have migrated at the time.

One of the most interesting birds studied was the little ground or burrowing owl. They were found in considerable numbers beneath the tangles of vines and cactus. Usually one or two or an entire family would be standing nonchalantly about the entrance to the burrow. The smallest ones were well able to fly, so the nesting season was evidently long since past. Several of the burrows were excavated for eggs but without success, much to our regret.

The presence of this owl on this far distant island was the cause of considerable speculation. I believe it has been called the same species that lives in Lower California where the food normally is small mammals, in part at least. But here we saw no evidence that any thing but insects had been eaten.

Ravens were common everywhere and their nests were found in the cliffs. Messrs. Mason, Keifer, and Musser the

next day succeeded in collecting one with one fresh egg. The food of the birds was found to be land crabs and the fruit of the cactus. Possibly other articles may be eaten at times.

Land crabs were not much in evidence, presumably because this was the dry season. But remains of carapaces and the burrows they had made were common.

Mr. Keifer added a large number of insects to the collection. Wasps, bumblebees, and grasshoppers were common. Some hawk moths and three species of butterflies were taken.

Mr. Jordan and the chief machinist's mate collected fishes along the tide pools and secured about 30 species we had not previously taken. Many of these were close relatives of the gaily-colored coral reef fishes of the south seas and Hawaii.

April 28—Clarion Island is surrounded by a coral reef but this is not so well developed as those of the south seas. On the south side, at Sulphur Bay, there is a large area over which the heads of the coral project at low tide and in the caverns and interstices of this reef we found collecting excellent. Much of the coral has been pounded to pieces by the waves and at this point it is piled in great ridges back from the beach, white as snow in the sun. Marine shells of many kinds and sea urchins and starfishes have been washed up with the coral.

When the ship was anchored in Sulphur Bay, Captain Nelson was able to determine that the bottom was sand. We therefore could not lose this opportunity to dredge the bottom and April 28 was largely given to this work by several of us. It is exceedingly difficult to use any kind of dragging apparatus on bottom which is composed of large rocks or growing coral. Our method of procedure here was to take the dredge and a coil of rope in the motor boat out seaward, one end of the line having been made fast on the ship. When the line was all out the dredge was dropped. After a sufficient time had elapsed for it to reach bottom it was slowly hauled in with one of the winches on the ship. In this way it was possible to proceed slowly and not unduly strain the line or dredge bag.

We used a dredge about two feet wide made of heavy band iron, sharpened on the edges so that it made no difference which side fell on the bottom. In addition, our little beam

trawl, about six feet wide, was used with excellent results. In the construction of this we departed radically from usual procedure and built the frame of galvanized pipe entirely. This made an exceedingly strong frame, yet it was demountable and took up very little space.

These pieces of apparatus brought up enormous quantities of broken coral, coral sand, and seaweeds. The latter belongs chiefly to one species which grows as long slender stalks, round in cross section and bright green in color. The sailors called it "spaghetti." All of this material contained large numbers of shells, starfishes, sea urchins, crustaceans, and some fishes and octopuses. It was exceedingly interesting work for all hands because no one ever knew what strangers the next dredge haul would produce. With this equipment we could not work where the water was more than about 200 feet deep but we looked forward to much of such work about the Revillagigedos. In this we were disappointed because at no other place about the group did we find a suitable bottom for the use of the apparatus.

On shore the various workers continued to add largely to the collection. Messrs. Tose, Wright and Gallegos seemed to have the most difficult task of all in trying to keep their collections of birds prepared up to date. In a short time in the field each day more specimens could be collected than could be prepared, even by working far into the night.

In a full day of collecting in various parts of the island, Mr. Mason secured only two species of plants he had not previously found. He did collect about two pounds of beans of the species which grows so prolifically in the semi-desert climate. These have a hard shell, are about half an inch long and would be well worth cultivating if found palatable.

Messrs. Keifer, Tose, Gallegos and Musser prepared to stay on shore overnight. It was especially desired that some of the night-flying moths be secured if possible and Mr. Keifer took all the necessary apparatus with him for an attempt.

April 29—Mr. Jordan and I continued the collection of fishes and succeeded in getting about 12 species we had not previously taken. Some of the shells looked like species found on the Galapagos Islands while others unquestionably are

found along the shores of Lower California. The collectors who stayed ashore overnight got few specimens and the day was spent largely in taking duplicates of rarer forms previously taken.

April 30—Messrs. Mason, Keifer, and Musser went to the top of the island and to the cliffs of the north shore. One species of plant was found which had not been taken before, a shrub about 15 feet high and the nearest approach to a tree thus far found. Mr. Keifer found numerous insects he had not taken before and remained for the night in the highlands, hoping for better success than he had during his previous stay on shore.

Everyone who goes on shore to work gets his clothes stained black with the juice of a species of *Euphorbia*. This plant grows in dense thickets about three feet high. The branches are brittle and it is easier to force a way through than to fight the intolerable cactus which covers so much of the surface.

Messrs. Slevin, Tose and Gallegos went to the top of the island to the west of the center and in some large grass-covered areas on top they found numerous tunnels of Townsend's shearwater. One egg, two young, and five adult birds were secured after excavating a great many burrows. The soil there is soft and reddish-brown, easy to dig but very dry. We knew beforehand that this bird nested on Clarion Island but the exact locality could not be learned. We had almost despaired of finding it until today.

Mr. Duhem, with the aid of two young men from the ship, continued to add to his series of motion pictures and today worked to the westward from the landing and along the coral beach. Several green sea turtles were found and photographed. In one place on a solid, elevated part of the beach, Captain Nelson found some pot-holes about three feet deep and three to five feet wide. The sides were straight and very jagged. Many of the holes contained turtle bones and he was at a loss to account for the occurrence until in one of them he found an unfortunate turtle alive. Its flippers and the edge of its carapace were greatly lacerated from constant and long continued attempts to climb out of the natural trap. It was in an

advanced stage of starvation when found, but showed no definite sign of appreciation when liberated.

I went to the top of the easternmost peak on the island, but found no shearwaters. Two golden plovers, two western gulls and four curlews were noted, but I saw no signs of mammals or land birds other than those already mentioned.

Above high tide and at the east end of the westernmost sand beach there was a pool of foul water, six feet wide and 20 feet long. It is in what is evidently a drain from a level flat area between the beach and the base of the mountain, an area indicated as a lagoon or lake on some maps. During the rainy season freshwater does stand on the flat, a fact demonstrated by the presence of a space devoid of vegetation and covered with mud cracks. Marsh grass, rank in growth, surrounds the area.

I tasted the water and found it heavily charged with mineral but possibly potable in an emergency. The doves were flocking to the place in large numbers and seemed to enjoy the water as well as if it had been perfectly sweet. I have no doubt fairly good drinking water could be had in a shallow pit or well sunk almost any place on the flat, preferably back as close to the hills as possible. This pool contained a considerable number of water beetles which Mr. Keifer stated offered positive proof that the water was essentially fresh and that its impurities were collected by leaching through the soil.

When I returned to the beach from the hot, dry, cactus-chopping trip to the top of the mountain I found a beautiful little tide pool about five feet deep, five feet wide and eight feet long. The temptation to take a bath was irresistible and I was enjoying myself immensely when I noticed beside me in the lava walls, the wicked, snake-like head of a large moray. The fish was moving about in various directions as if in search of food. Tide pools thereafter did not possess the same attraction for bathing.

May 1—Messrs. Tose, Gallegos, Wright and three men from the ship went to the top of the island again today to dig further in the burrows of Townsend's shearwaters and after much labor they returned with a few more birds and eggs. Many of the young birds are half-grown; it is therefore likely the

eggs which still remain are infertile. They were packed in such a way that they could be taken back to San Francisco for final preparation.

During the night on shore Mr. Keifer secured an excellent lot of insects, chiefly of species which could not be taken otherwise, such as night flying moths. Just before he joined the last shore-boat at 3:30 p. m. he turned over a brush pile he had made as a natural retreat or trap for beetles and there was a fine species he had not found before. In dry hot climates this seems to be an excellent way to capture beetles, a method, I believe, suggested by the esteemed coleopterist, Dr. E. C. Van Dyke.

Before noon, Captain Nelson, Mr. Duhem, Mr. Jordan, Mr. Musser and I went to the west end of the island to collect fishes and get photographs of the strange Monument Rocks. The water about these rocks was exceedingly rough and on account of the shallow bottom being blocks of lava, we thought some new fishes might be obtained, but we were disappointed. In the afternoon Chief Engineer Lot did catch on a hook a labroid fish we had not previously found. At the time we were working over some shallow sand bottom between beds of coral in Sulphur Bay, searching for flounders. Some of the men from the ship had reported seeing the latter at that point but we did not find them. An examination of the sand of the bottom showed that it contained enormous numbers of Foraminifera and minute Mollusca. A good supply of it was saved.

Messrs. Mason and Solis collected cacti and seaweeds close to shore and Mr. Contreras did the same with shells. Everybody came aboard ship at 3:30 p. m. and the ship headed toward Socorro Island soon after. As we drifted out to deep water a final cast of the trawl was made but we had little success because we could not control the movements of the ship well enough.

All members of the party believed that they did a very creditable piece of work on Clarion Island. No doubt a longer stay would have resulted in the acquisition of a few more species but this would be true irrespective of the length of our stay.

Quite obviously we arrived at the wrong season for the best work among the plants, insects and birds; but since we had no

data upon which to compute the periods of rain, we had to take this chance. One of the objects of this expedition was to supply this deficiency, in so far as possible from a brief visit.

Bright sunshine which greeted us throughout our stay had evidently prevailed for a long time. Most of the vegetation looked to be autumnal; leaves had fallen, seeds were ripe, and apparently the perennials were the only ones in bloom to any great extent.

It is my belief that the rainy season begins in September or October, and ends in January. The land birds were not nesting and the young ground owls were fully grown and flying. It would seem that fresh eggs could not be had later than February. The same is true of the wrens.

The suggestion is therefore made that future expeditions try to arrange to reach Clarion about January.

May 2—At 8 a.m. we were at Roca Partida, a strange pinnacle about 60 miles west of Socorro Island. This rock is about 100 yards long; the two ends, about 100 feet high, are connected by a low isthmus not over 20 feet above the sea. At

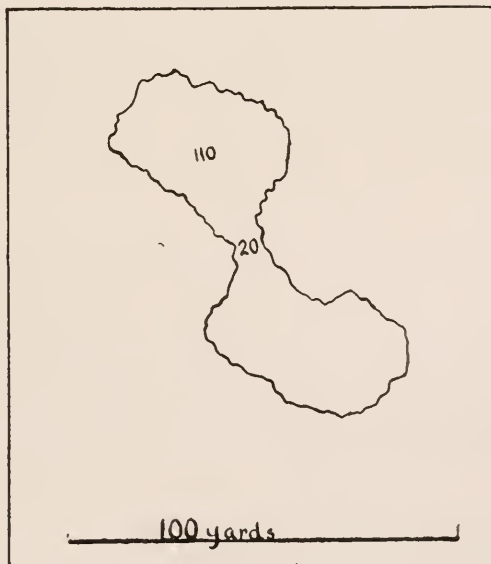


Fig. 4. Roca Partida.

a distance the object looks like a schooner under sail. We stopped and lowered a boat to make collections of fishes and birds. Of the latter we found Brewster's boobies, noddy terns, sooty terns and man-o-war birds. The sooty terns were nesting as was evidenced by a young bird picked up in the water beside the rock. Possibly the noddies also nest but it is not likely that the others do; there is no vegetation on the rock for the construction of nests.

Six shots of dynamite beside the rock wall produced seven species of fishes, and a shark was caught on a hook from the deck of the ship. Giant rays swam lazily about the ship but defied all of our efforts with the harpoon.

The walls of the rock extend straight down into the water to a great depth; 50 feet away, Captain Nelson found the depth to be 210 feet. Coraline algæ (red and pink in color) grows on the walls in the wash of the sea and some crabs were seen crawling about like flies above the water line. This species appeared to be the same that had been found on Clarion Island in similar situations. Likewise, the fishes were species which had been taken on the western island.

This rock did not appear to be composed of volcanic material but from the boat close by it seemed to be composed of a granitic rock, very resistant to weathering. Rocks of this class are usually associated with continental areas and its presence here, far out in the Pacific, led to some interesting speculation as to the possible former existence of a Pacific Continent.⁶

The high central peak of Socorro was in sight soon after we left Roca Partida and as we coasted along the south side of the island the topography was eagerly scanned with the glasses. At 4 p. m. the anchor was dropped in Braithwaite Bay, an indentation of the coast line at the southeast end of the island which afforded quiet water with the wind and sea coming from the northwest as they were then. Sheep were seen on shore near the beach and as the larder was getting low in fresh meat, it was thought best to send a rifle party ashore first and secure a supply before the animals were frightened

⁶ Some of the data bearing on this subject have recently been published by the author in "Science," n. s. Vol. 62, No. 1613, Nov. 27, 1925, pp. 491-492.

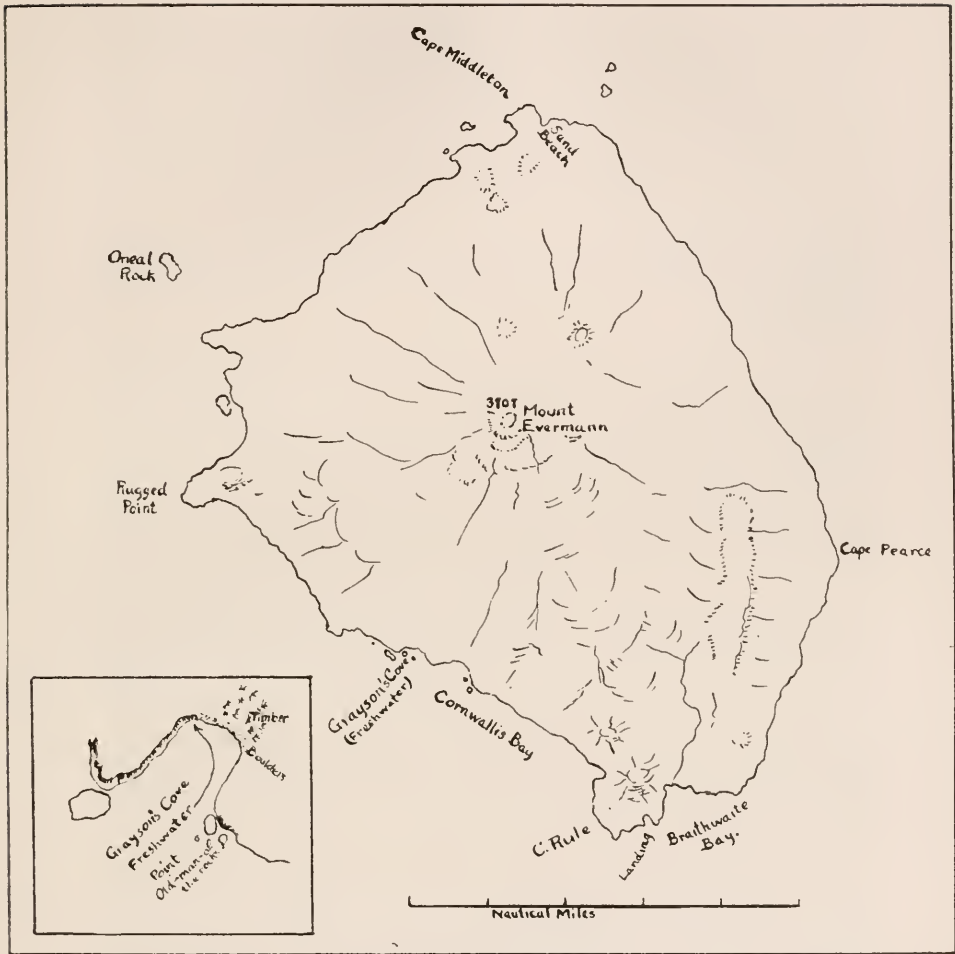


Fig. 5. Socorro Island

away by the collectors. Eight were taken before dark, six being the result of Mr. Wright's skill with the rifle.

During the evening several species of fishes were taken about the ship, and preparations were made for intensive collecting at the break of dawn.

May 3—Messrs. Slevin, Wright, Keifer, Mason, Solis, Contreras and Musser worked out from the regular landing at Braithwaite Bay all day but in the main had rather poor suc-

cess. This southeast end of the island is quite barren and the surface is mostly excessively rough with a confusion of lava blocks. Mr. Mason took only 15 species of plants. Mr. Slevin got 25 specimens of a beautiful lizard, the only reptile known from Socorro; in 1905 he and another man took 80 of them in one day. Mr. Keifer went inland farther than any one else but found few insects. In a lava cave he found some water dripping slowly from the roof. Mr. Slevin also found a slight seepage of water near Binner's Cove where birds were drinking.

Mr. Wright took about 40 birds among which were warblers, towhees, mocking-birds, night herons, and three elf owls. Two of the latter were not quite full grown. This is said to be the smallest owl in existence and we were particularly pleased with the catch because the records indicated that only four specimens were known in the museums of the world. Mr. Keifer saw a flock of parrots where he went but none was captured. Likewise no doves were taken but with these exceptions all land birds previously known from Socorro were captured the first day. One of the men from the ship shot a red-tailed hawk. This is a fair commentary on the thoroughness and industry of the various collectors.

Messrs. Jordan and Duhem collected a very considerable number of fishes along the shores. They accompanied Captain Nelson and me around the south side of the island where we went in search of Grayson's Spring.

In 1869 Colonel A. S. Grayson sailed from Mazatlan for the Revillagigedo Islands on a private expedition for the study of birds and his vessel was wrecked on the south side of Socorro Island. At the landing place a spring of freshwater was found. Undoubtedly after his return to Mexico, news of this discovery spread but from that day to this the spring was never relocated. Around Mazatlan and San Blas it had come to be regarded as a sort of myth handed down from earlier days.

It so happened that Grayson's notes on his experiences were forwarded to Dr. Geo. N. Lawrence with a collection of birds and in describing the latter in the Proceedings of the Boston Society of Natural History he quoted the notes in full.⁷

⁷ See Proc. Boston Soc. Nat. Hist., Vol. 14, 1871, pp. 288-290.

Through the knowledge of ornithological literature possessed by Miss Mary E. McLellan of the Academy we were acquainted with the account and had no trouble in going directly to the spot as Grayson had described it. His notes are so lucid that they are well worth quoting in full since the original publication is very rare in western libraries.

"For four days, the wind headed us off from the Island most provokingly, or rather from a landing place. We first endeavored to go around the north side, but found it too difficult on account of head winds; we then tried the south and, after beating against the wind and a strong current, finally reached the cove marked on the chart as Cornwallis Bay. In this cove, I had been two years previously.

"Although it is a very unsafe anchorage, yet it is the only place we could find fit to come to anchor, in which we might lay with any show of safety. The shores of this cove are rough and rocky, upon which the sea breaks in the calmest weather. There is no beach to land upon, instead of which, at its head, are heaped up round water-worn stones, and its sides are bold and precipitous. We did not see when sailing nearly all around this island, any beaches or a better place to land than this little cove, which opens broadly to the southwest.

"On the 19th of May, seventeen days from Mazatlan, we ran into this little bay with a fair breeze, and delighted with the green trees at the head of the cove and the song of birds among them. But the captain appeared to feel a great deal of uneasiness at the general appearance of things. He let go the anchors, as he thought, a little too near the shore, and the breakers so near and all around, filled him with fear; and just when we felt that all was safe and our voyage at an end for the present, he ordered the anchor to be hauled up and at the same time the main sail hoisted, with the intention of beating out against a head wind; his excuse was that the anchor would not hold. But this movement proved fatal to our craft. Before headway could be made, she was driven in by the wind and swells among the breakers near the shore; both anchors were again 'let go,' but it was too late, her doom was sealed. We made every effort to haul her out by kedging with the small anchor, this being taken ahead with great difficulty in the little skiff and dropped—we would then pull upon the chain; but futile was the effort. Her centre-board had already struck and broken off and her keel was thumping on the rocks as she surged heavily at her chains, which threatened every moment to part.

"We now turned our attention to saving the water and provisions; the former giving me the most anxiety. As for the latter I had no fears, as fish of excellent quality swarm around the shores and are easily taken with hook and line. We still had hopes of saving the sloop when the sea became a little smoother, as she was not yet much damaged. We, however, made preparation for landing everything we could. A rope was fastened to a point of rocks about twenty-five yards distant, to facilitate our landing, and the skiff was pulled back and forth just when the sea

would give us an opportunity of jumping ashore; much caution had to be used in this exploit, the sea breaking furiously at times upon this rock.

"Mr. Anderson being seasick, from which malady he suffered the entire voyage, was first put on shore, afterwards my son and the boy Cristobal were landed, in order to receive the different articles as they were thrown to them from the skiff. The water casks were all hoisted on deck in order that, should the sloop break up, they would float ashore; the provisions, guns, ammunition, and other articles most needed for the expedition were all soon safely landed.

"I remained on board till all these things were on shore. Cristobal, who had gone a few steps up the cove, suddenly cried out to me with demonstrations of the most lively joy, 'aqua, aqua-dulce,' pointing at the same time to an ugly pile of rocks upon which he was standing.

"There indeed we found a small spring of warm water gushing out of a seam in the solid rock that forms a precipice on the western side of the cove; it was partly concealed by a pile of rocks and boulders, which is often covered by the tide, and the spring so low down would naturally be taken for tide water running back into the sea.

"The uncertainty of the length of time we would have to remain before being rescued from our exile, for it is well known that vessels seldom pass near this island, rendered this discovery of the highest importance. The contemplation of the hardships, toil and intense suffering in search for water in a locality where it seemed extremely doubtful of success, filled my mind with the greatest anxiety, but it was now dispelled by this unexpected discovery, and I felt pretty certain that the preservation of our lives depended upon it. This I became more and more convinced of, as we made frequent and laborious excursions without being able to find it elsewhere."

The spring was found exactly as he had described it and birds in large numbers were still going there to drink. It is believed that enough water flows out of the lava wall to supply at least 100 men in emergency. This is very important because, so far as we were able to determine, there is no other place on the island where drinking water may be had in the dry season.

Since we resolved to return to the spring on a later date and mark it we remained on shore there only a few minutes. We did find some weather worn planks, the last remnants of Grayson's boat, and back under the trees were some rusted iron bands, apparently parts of the bird cages he was obliged to abandon.

May 4—All hands returned to Grayson's Cove and the Captain chiselled a large "W" on the rock wall above the spring; the letter was filled with white cement and the following inscription was made: ORTOLAN—4 May 1925—Grayson Cove—AGUA DULCE.

The location, at the west end of Cornwallis Bay, was marked on the chart and after our return the Hydrographic Office of the Navy was notified so that future editions can contain this important information.

Grayson's camping place was found to be a little paradise under the dense shade of a very peculiar tree. The fruit of this tree is about the size of a walnut and contains numerous seeds in a hard tough shell. The seeds taste much like a walnut. The sap is milky and the leaves are bright green and polished. A great many birds, including parrots and red-tailed hawks, were found in the grove and the collectors made the best of their opportunity. Under the bark of some of the dead trees some fine beetles were collected and several species of land shells, all minute, were found under the dead leaves on the ground. Lizards were very scarce and apparently in hiding. None of the birds showed any evidence of nesting. Two sea cliffs were found where Brewster's boobies were roosting but they do not appear to nest on the island. Petrels were common at sea and noddy terns seemed to be going back and forth to Oneal Rock in large numbers.

May 5—Messrs. Duhem, Jordan and I collected fishes all day in the vicinity of Braithwaite Bay and secured several species we had not previously taken. We tried to use a seine but found this impracticable on account of rocky bottom everywhere. There certainly is an opportunity for the development of some kind of fish collecting apparatus for use in just such situations and although we had no time to experiment in the construction of such here, we were able to suggest some features it should contain. Thus it should be a net with small meshes and capable of being operated from a small motor boat over excessively rough bottom. Probably no apparatus can be used directly on such ground, but it should approach it as nearly as possible because the most desired fishes live among the interstices of the rocks. Probably a net to be towed could

be kept down and spread by the use of metal plates or vanes called "kites."

Collecting marine Mollusca was found to be exceptionally disappointing about the shores of Socorro. No sand beaches and no sand bottom was found; the rise and fall of the tide is slight and all shores are exposed. Therefore the only fauna available is that known as "littoral."

Messrs. Tose, Gallegos, and Wright remained on board ship all day preparing specimens of birds.

Messrs. Mason and Keifer went inland and eventually penetrated the fog of the higher ground to a distance estimated to be within 500 feet of the top of the central mountain.

It should be explained that Socorro Island is roughly circular in outline and a little more than eight miles in diameter. The surface rises to a central peak, stated by the U. S. Hydrographic Office to be 3707 feet high. This mountain appeared to be without a name, but we needed one for the proper designation of positions where specimens were collected. After some consideration it was thought that the logical designation for this important landmark is "Mt. Evermann" after Dr. Barton Warren Evermann, Director of the Museum and the Steinhart Aquarium of the California Academy of Sciences, to whom credit is due for the organization of the expedition.

Knowing in advance, of difficulties of ascending the mountain, chiefly on account of the brush of the lowlands, it was thought desirable for Messrs. Mason and Keifer, two of our best travelers, to prospect for a feasible route to the summit.

After crossing an area very difficult to traverse on account of brush and lava they entered a heavily timbered cañon, which was a regular botanists' paradise. Many new plants were found, among which were a wild cherry and a fruit afterwards determined to be a new species of "Bumelia." This was a dark purple fruit about three-fourths of an inch long and with a delicious flavor. Birds were eating it in large quantities. Mr. Mason ventured to follow and no ill effects resulted.

In the cañon were many strange trees, flowers, epiphytic plants and orchids. Birds were excessively abundant and droves of sheep were met with here and there all the way.

May 6—This day was set for a number of us to begin the ascent of the central mountain of the island. We had the reports of Messrs. Mason and Keifer to indicate the best probable approach from the east side.

So far as Mr. Slevin and I had been able to determine the only previous time the mountain had been climbed was in 1903 when Messrs. E. W. Gifford and Sterling Bunnell went up and back in two days. They were members of the Academy's expedition of that year. Mr. Gifford had kept a diary of the journey and was kind enough to let us make notes therefrom before our departure from San Francisco. They likewise had ascended from the east (their camp being at Binner's Cove) and excessive hardships were endured. These were chiefly caused by the cold fog at night and the almost impenetrable brush in many parts. They had discovered some volcanic vents emitting great quantities of steam near the top, and on top they buried a bottle which contained their names and the date of their visit.

Therefore, knowing something of the difficulties to be encountered, we knew a little of the best methods of providing for ourselves for the gruelling trip. The actual distance and elevation to be traversed were not great. The center of the mountain as indicated on the Hydrographic Office chart was placed only about five miles from Braithwaite Bay, our anchorage, and the elevation was given as 3707 feet. But we knew from experience that the heat inland was excessive at this season and added to the other difficulties. Accordingly we cut our rations to the almost irreducible minimum and loaded ourselves with all the water we could carry in addition to the collecting equipment we necessarily must have. Thus equipped Messrs. Slevin, Wright, Jordan, Musser, Smith (pharmacist's mate from the ship) and I set out from the beach at 8:30 a. m. Mr. Duhem with two men from the ship started with us to go up into the foothills with the motion picture camera but it was not expected that this heavy equipment could be taken the entire distance. Nevertheless they went far up into the heavy timber before camping for the night and succeeded in getting some excellent pictures. Their water gave out this first day and on the way down all they had to quench a burning thirst was some canned fruit.

We set out northwest at first, up a small rocky gulch to escape as much as possible the stiff brush of the lowlands. This took us to a series of bare red hills which we followed toward the mountain. Several gullies and ridges were crossed with great difficulty on account of the heavy brush. This was excessively fatiguing and half an hour after we left the beach all of us were drenched with perspiration. Before noon we could have drunk our entire supply of water and not had enough, but we all realized that safety demanded that we keep at least half of our quantity for the morrow.

We had some hope of being able to locate a source of drinking water inland. Such an occurrence would enable us to carry on extensive and valuable explorations which would otherwise be utterly impossible. We thus examined every likely spot with considerable care but were entirely unsuccessful.

On the way across the Red Hills (foothill section) we were impressed by some areas which were entirely barren of vegetation and at first we were at a loss for an explanation. Some parts were covered with dead brush, all flattened on the ground and pointing in the same direction. This indicated the action of water and we decided that the small section of the island had been visited by a great cloudburst at some previous time but probably subsequent to 1903. This supposition was fully proved next day when we found a box cañon leading down from the area to the sea. This was scoured out completely to bed rock while in front of the mouth there was an enormous quantity of boulders piled up. Such downpours as this must be of rare occurrence on Socorro because evidence elsewhere was lacking; in fact, most of the cañons indicated the passage of very insignificant quantities of water at any season.

In the dense brush of the valleys and ridges we had expected to find some sheep trails which would make our labor lighter but, while we found these animals from the shore line to the very top of the mountain, their trails through the brush were too low for us. Considerable speculation was engaged in as to who had planted the sheep and when. We knew Col. Grayson had left pigs on the island in 1864,⁸ and three years later they were still there. We saw no evidence of these animals and it appears that they have completely disappeared.

⁸ Proc. Bost. Soc. Nat. Hist., Vol. 14, 1871, pp. 292-293.

One of the men from the ship found a skull on the lowlands which he thought was from a pig but he failed to bring it in and on a subsequent occasion could not find it. But we had found no trace in any report of a record of the introduction of the sheep. Mr. Gifford found them there in 1903 and so did Mr. Slevin in 1905, but earlier records seemed to be entirely lacking. At Mazatlan, however, the U. S. Consul, Mr. Wm. E. Chapman, had the full details in his files and very kindly had a copy of the following report made for us.

THE REVILLAGIGEDO ISLANDS

*By Edward R. del Rip, Clerk, American Consulate,
Manzanillo, Mexico, April 18, 1923*

The Revillagigedo Islands comprise a group of four islands situated between latitude $18^{\circ} 20'$ and $19^{\circ} 20'$ north and longitude $110^{\circ} 48'$ west. They lie off the coast of the state of Colima about 410 miles. Of this group the principal island is known as "La Isla del Socorro." The others, with the exception of Clarion Island are very small and of less importance. They are, viz: Isla de Benedicto, Roca Partida, and Isla de Clarion. There is little known at the present time of these islands. Information obtained from various sources at this port regarding the largest island of this group, namely "Socorro" is given below:

Socorro Island is situated in Lat. $18^{\circ} 43'$ north, and Long. $110^{\circ} 57'$ west. The island emerges from the ocean to a height of about 3,707 feet, according to information from the Central American West Coast Pilot of 1920, published by the Hydrographic Office of the United States Navy Department. The island is visible in clear weather at a distance of about seventy miles.

HISTORY

Historians, like Sr. Mata Padilla, describe this island as having belonged at one time to the territory known long ago as Nueva Galicia, which formerly was composed of the Mexican States known today as Aguascalientes, Jalisco, Michoacan and Colima. At that time, as now, it has been under the jurisdiction of the State of Colima. The Island of Socorro was discovered some time during the year 1608 by a gallant Spaniard known as Captain Martin Yanez de Armida, who, having been lured by tales of the Toltecas Indians, that a rich treasure of gold was buried on the island, set out to find this treasure in a small boat accompanied by his wife, six mariners and a woman servant. The captain believed this old tradition about the rich treasure buried on the island, until he reached it and began his unsuccessful search. The party abandoned the quest for the treasure and, upon departing from the island, Captain Armida gave it the name of Socorro, in honor of his wife whose name was Socorro.

In the year 1869, under authority of the Mexican Government, an Englishman by the name of John Smith, attempted to exploit these islands, and brought with him and his party from Australia, about twenty-five head of cattle and one hundred head of sheep of the very best breed from Cobu. The cattle very soon died and the few remaining were killed for meat. It is said that the heat on the island killed the cattle but had no effect upon the sheep which thrived and multiplied in great numbers. Mr. Smith died soon after his arrival on the island and his comrades returned to their homes in Australia and Canada. The sheep were left upon the island, and, according to recent reports it is said that there are great numbers of them there. Several expeditions have been made to the island and each time someone has carried away many sheep hides and salted dried goat meat. [The data here unquestionably refer to Guadalupe Island, G. D. H.]

In 1882, the late Governor of the State of Colima made a visit to Socorro Island and upon his return made a very extensive report to the Mexican Government of the richness of the island and the possibilities there for development of the sheep industry. However, to the present time the government has never derived any revenue from these islands. It is interesting to learn that since the first time the sheep were placed upon the island in the year 1869, they have increased in great numbers and are no doubt being smuggled to this day into Mexican and American ports. The pasturage is said to be excellent as the islands are covered with a very good grade of grass. The vegetation and soil is of the same kind found along the west coast of Mexico: very sandy, loamy soil and rich vegetation. The ground everywhere on the island is covered with a thick growth of flat cactus and sage-like brush. [This must refer to Clarion Island.] Much the same growth is found along the coast of Mexico.

For several years it has been stated that the island of Socorro was without water, but, because of the vegetation and animal life reported, the theory is advanced that there is a considerable supply. The pilot of the port of Manzanillo advises the writer that during his visit to the island he located several very good natural freshwater springs of excellent drinking water.

The shores of the islands of the Revillagigedo group abound in fish, turtle, crabs and crawfish and the surrounding vicinity with whales, sharks and porpoises, while the animal life on the islands is composed of birds such as swallows, robins, canaries, parrots, pelicans, sea-gulls, the frigate birds, orioles, and numerous others besides the sheep now on the island.

Of the poisonous reptiles on the island it is said that there are such as the rattlesnake, the "alacran" (scorpion) as are generally found along the coastal sections of the west coast of Mexico.

Doubtless the Mexican Government would welcome the development of these islands by reliable and constructive enterprises, composed of American and English capital.

Unfortunately there are no photographs available of these islands and if one could make a visit there and make a thorough investigation no doubt very interesting data could be obtained and disclosed to the public.

Equally as important as Socorro Island, is Clarion Island of this same group. Its vegetation and animal life is identical with Socorro. This island lies next to Socorro from which it bears 263°, 214 miles.

In spite of the fact that some of the data in the above report is unquestionably mixed, it possesses a very considerable value and enlightened us upon the one point we could not even theorize, the mode of introduction of the sheep.

It will be seen that the historical matter relating to the discovery of the Revillagigedo group differs notably from what appears to be the facts as related by Miss McLellan.⁹

The possibility of making Socorro into a profitable sheep ranch was discussed considerably by our party and it did not seem to those intimately familiar with such work that it could be made to pay. The chief obstacles are the remote distance from ports where wool would be manufactured and the lack of safe landing places on the island. Nevertheless there is a possibility that these difficulties could be overcome and the island is certainly well worthy of investigation by trained sheep men. It was our belief that so far as native fauna and flora is concerned the exploitation of the sheep would do no more damage ultimately than to leave them as they are.

About 11 a. m. we passed out of the zone of brush on the lower slopes of Mt. Evermann and entered the cañons which were densely forested with many kinds of strange trees. The travelling here was much easier and, to all of us, far more interesting. The trees were teeming with bird life, and the "Bumelia" trees afforded great quantities of delicious fruit, which we ate with a relish. It served most to quench our thirst and thus permitted us to conserve the precious supply of water in our canteens.

Occasionally we would lie down to rest under the trees and then the curiosity of the mockingbirds was uncontrollable. They would hop up and peck, jay-like, at our knapsacks or boots, uttering all the time a most non-thrush-like sound. We did not hear them attempt a song at all and would believe they

⁹See Science, n. s. Vol. 62, No. 1599, Aug. 21, 1925, p. 172.

have none except for Grayson's brief note saying that he heard them "mock" on rare occasions.

During such rest periods Mr. Slevin succeeded in capturing some living specimens of the beautiful Socorro Island dove (Grayson's dove) which Mr. Gifford desired for his aviary in Oakland, California. The birds were captured with an ordinary fisherman's landing net tied on the end of a stick about six feet long. Altogether 13 of these doves were brought back alive.

Warblers were very abundant in the trees and the beautiful green paroquets kept up a continual screech, amounting in some cañons, almost to a roar. Red-tailed hawks were abundant and very tame; ornithologists will fully understand this when it is stated that one was shot with a .410 ga. gun using No. 12 shot. This fearlessness of the birds is one of the most striking features of far away, uninhabited islands such as this.

Search among the dead leaves by several of us revealed about a dozen species of minute land snails, an assemblage totally different from any I had ever seen elsewhere. Probably most striking was a member of the genus *Strobilops*, a group which reaches its greatest development in central and eastern United States. We did not find on Socorro the beautiful and gaudily colored *Orthalicus undatus* mentioned by Brewer as having been collected by Grayson.¹⁰ The species is abundant on the Tres Marias Islands which Grayson visited on his way to and from Socorro and I cannot help but feel that he made a mistake in labelling his specimens.

Considerable time was given to searching for insects but these were exceedingly scarce under stones and logs where beetles would usually be expected. The ground was very dry, however, and possibly any which may live there had retreated beneath our reach.

One of the trees with white bark like a sycamore was about 40 feet high, one foot in diameter and bore long spikes of cream-white flowers. The fruit was about half an inch in diameter, pale green in color, and was not eaten by the birds. Therefore, we did not try it. The forests in the cañons were so dense that the sunlight rarely penetrated to the ground; hence mosses, lichens, ferns and orchids were abundant on the

¹⁰ Proc. Bost. Soc. Nat. Hist., Vol. 14, 1871, p. 303.

trees and branches. Some of the *Bumelia* fruit trees were fully 50 feet high and although the larger trunks were irregular in growth they were at least five feet in diameter. What appeared to be the canes of a species of blackberry grew to the extreme length of 200 feet but it had neither fruit nor flowers and the identification could not be made with certainty. There was almost no underbrush in these cañons but the ridges and "hog-backs" were practically impassable, we learned through bitter experience during the afternoon. This was rather disconcerting to the experienced travellers who were in the habit of following the elevations in an unknown country in order to obtain a better view of the region being traversed. All of these observations and experiences made a day of hard labor and terrible thirst pass pleasantly.

Early in the evening as the fogs of the mountain top closed in we made our camp at the head of a heavily timbered cañon and a fortunate choice this was indeed. The fog passed over at each side and below us but our camp was dry. This was a great relief because we had no bedding and the night was cold. A fire was kept up most of the night and we were fairly comfortable. The camp was made at an elevation, indicated by our barometer, as 2300 feet, seemingly an insignificant climb but the excessive heat and heavy brush wore us down. The temperature was only 82° to 88° F. during the day but it seemed much warmer than that.

For dinner we each had a dove, roasted over the camp fire, and not long thereafter we were all asleep.

May 7—Next morning at six we were up and getting ready to continue the climb to the top of the mountain. Breakfast was a simple matter. Two men ate a can of beans. Another ate a sandwich and another some cookies. We could not waste much water washing down dry food; hence we did not eat.

After breaking camp we climbed the obsidian ridge ahead of us, 200 feet and into the fog. Then we realized how fortunate we had been to select a dry camp site. The vegetation all about was drenched with mist, yet there was not a drop of water to drink. We followed the ridge upward until we came to an abrupt declivity and we could see no further; therefore we did the only natural thing under the circum-

stances. We stopped for an hour to collect land shells, insects, land crabs and plants, and to await the rising of the fog. All of the time we could hear a steady roar like a railroad train straight to the west of us.

Finally, about 9 a. m., the fog lifted a little and we saw directly ahead a huge jet of steam rising 200 feet in the air. We knew then that we were on the right trail to the top because it issued from a large white area (a mud flow) on a spur on the north side of the mountain. We had headed toward it for a marker the day before.

While waiting for the fog to further dissipate we spent the time investigating the system of fissures, fumaroles and steam vents. These occur in a zone about 500 yards long in a narrow cañon on the northeast flank of the top of the mountain. It is not over 500 feet up from there to the top and the distance is perhaps half a mile. The whitish mud flows out on the side of the gulch and makes a marker which is visible for a long distance.

The fissures are very active. We had no means of measuring the temperature of the steam issuing therefrom but the rush due to the high pressure produced a great roar. Around the vents there was much crystallized sulphur and the odor of hydrogen sulphide was very apparent. The largest vents were about eight inches in diameter. In the upper part of the gulch some of the fumaroles contained water but this was found to be highly acid and entirely undrinkable. These particular vents escaped our notice but were found two days later by Mr. Lot of the *Ortolan*. All of the rocks seen in the vicinity were rather porous lavas and tuffs.

Around the rim of this zone of activity there were found numerous burrows of Townsend's shearwaters, the identification being based upon a portion of a carcass left by a red-tailed hawk at a recent date. Some of the burrows were opened but were empty. The investigation could not be carried very far because we had no digging tools and the soil was very hard and filled with volcanic ejectamenta.

The night before while lying awake listening to the various night sounds of the strange forest, I had heard birds chattering as they passed overhead at irregular intervals and was entirely unable to account for them among the known resi-

dent bird population of the island. The discovery of the burrows confirmed the suspicion that shearwaters actually nest upon Socorro.

From the steam vents we had a steady climb up a steep ridge 500 feet to the top, or what we thought was the top, still enshrouded in fog. After a short time Mr. Slevin saw the shore line and identified Grayson's Cove, from the position of which we were certain we had attained the highest point. Not long afterwards all the fog disappeared and we were treated to a grand panoramic view of the entire island and shore line.

Our barometer showed an elevation of 3373 feet, or 334 feet less than the altitude given on the chart. Search was made for the bottle left by Messrs. Gifford and Bunnell in 1903 but we did not find it. Upon our return we learned that it had been buried beneath the surface, not in a cairn as we had supposed.

We erected a cairn and, following custom, left a bottle in it with the name of the ship, commander, expedition, date and our six names.

Evidently sheep frequent the open, brush-free summit because well beaten trails lead away in every direction. Some charred brush was found nearby in a position which indicated that a fire had passed through. Probably this was a remnant of the fire started by Grayson and which led to his rescue. He spoke of its having spread far and wide over the mountain-side before he was out of sight on his homeward journey. Even today the south side of the mountain is remarkably free of brush and is principally grown over with grass and some cactus. For some strange reason the sheep do not seem to range over this area as we saw no sign of trails near Grayson's Cove.

From the top we were able to study the best means of approaching the mountain and found it unquestionably to be from Grayson's Cove. But that route does not pass through any such interesting country as we had traversed on the ascent. Wooded cañons are absent on the south side but are abundant on the north, east and west. Between them brush-covered ridges radiate outward like spokes in a wheel.

Careful search was made from the top in every direction for evidence of water but not a sign could be seen. To the eastward in one cañon there was a dry lake bed which unquestionably does contain a small amount of water during the rainy season. Up to this time we had thought there might be some reason for the supposition of Captain Colnett, that a freshwater lake existed on the island "because of the teal ducks" found flying down to the sea.¹¹ But with the unobstructed view we had we were thoroughly convinced that no permanent lake now exists on the island. It is barely possible that this dry lake bed did hold water throughout the year at the time of Capt. Colnett's visit and has silted up in the meantime. From what we saw of the erosion produced by a cloudburst on the east side of the island it seemed entirely possible for a small lake to be entirely filled with sediment in one rainstorm.

At 11 a.m. we ate a little chocolate, tasted a little water and started down. The trip was made as rapidly as feasible without excessive fatigue but we did not reach the beach until nearly 5 p. m. Choke cherries and Bumelia fruit, picked on the way down helped us to forget our thirst.

Mr. Duhem and his party arrived several hours before we did. Those members of the expedition who did not go inland were profitably engaged in making further collections in the lowlands.

May 8—Messrs. Tose, Mason, Keifer, Solis, Gallegos, Lot and two men from the ship started early for the interior of the island and the top of Mt. Evermann. The climbing party of the previous day remained aboard until after noon when collecting was done near the shore line. Many marine shells and fishes were taken but nothing very striking was found by those working on the land.

May 9—The party returned from the top of Mt. Evermann this afternoon, and, having profited by the mistakes made by those who had gone up before, they managed to endure the hardships somewhat better. Fortunately they took all the water that they could carry and not very much food. The fruit of the Bumelia proved a great help to all of them.

¹¹See McLellan, *Science*, N. S., Vol. 62, No. 1599, August 21, 1920, p. 172.

Messrs. Mason and Lot went to the top of the mountain and added their names to the bottle which had been left. They passed by the cañon which contains the fumaroles, and, from their description, it appears that some changes took place overnight. Some of those which were most active on the day before had completely quieted down. In others there appeared to be a larger quantity of mud and boiling water than we had noted. They brought back samples of some of this mud and an examination of it disclosed nothing of importance beyond fragmentary volcanic debris. The party camped overnight in one of the timbered cañons on the northeast side of the mountain and at 2:23 and 2:25 a.m. everyone in the party was suddenly awakened by severe earthquakes—gentle reminders of the deep internal forces which have built the entire island of Socorro.

We saw no evidence anywhere on the island that there had been any greater volcanic activity than at present, probably for many centuries, but there is no question but that there is a semblance of activity still and it cannot be said that it may not become more severe at any time.

The party brought back many live doves and parrots and the ship began to look like an aviary. Both species live on the fruit of the *Bumelia* and a considerable amount of this was brought along for food. A nest of a red-tailed hawk was found with one young bird about half-grown. This was the third nest of this species so far seen by our party and, from the indications which they afforded, we were apparently about two months too late to secure fresh eggs.

After our experiences on Clarion Island and on San Benedicto later, we were wholly unable to explain the absence of ravens on Socorro. The presence of the sheep, long stretches of rocky shore lines, and much edible fruit, would seem to make this an ideal situation for these birds, but so far as we were able to learn no one has ever seen one there.

Mr. Mason added a great many more plants to his collection from the highlands of the island and believed that he had most of the perennial species. Mr. Keifer carried his gasoline lantern to the night camp on the mountainside and succeeded in securing some very desirable insects, although he was surprised at the scarcity of night-flying forms.

Messrs. Jordan, Duhem, Musser and I collected fishes and other marine organisms all day. Many kinds of fishes were taken which we had not previously secured, the success being largely due to the fact that we used poison in the tide pools. We had brought along some sodium cyanide and chloride of lime for this purpose and found that both chemicals worked well. The cyanide particularly was very efficacious, even in small quantities and in pools which had more or less drainage from the beat of the surf.

A check of the fuel supply of the *Ortolan* showed that it would be necessary for the ship to return to San Diego within a few days for an additional quantity. There was some indecision at first as to whether the scientific party should remain on the Revillagigedos while this was being done, or whether they had better go to the Tres Marias Islands and establish a shore camp there. After due consideration of all the phases of the problem and a review of each collector's acquisitions thus far, the latter course was decided upon. In no branches probably, except herpetology and ornithology, could we be certain that we had specimens of every species on the islands, but this might likewise be said irrespective of the time of our sojourn. It was apparent to everybody that we were too late in the season for the collection of great numbers of the plants and insects which undoubtedly exist on Socorro. Nevertheless, the collectors felt that they had about as good a representation as they would be able to get even if we remained there while the ship made the passage to San Diego and return.

May 10—Messrs. Jordan, Duhem, one man from the ship, and I collected shells and fishes and other marine organisms in the tide pools along shore all day, and a few good things, but not many, were taken. We failed to get two fishes we saw there—one a bright blue species about four inches long, apparently perch-like; the other a little labroid two inches long, purple below and grass-green above. They are the only species we know positively are at Socorro and which we have not collected. At night the submarine light suspended from the deck of the ship has furnished us with a very considerable number of desirable forms.

For a while in the early morning I helped Mr. Keifer collect insects in a cactus patch just to the north of the landing at Braithwaite Bay. Large quantities of a very rank grass grow among the cactus and we felt certain insects must be there, but we had no way of getting them until we hit upon the idea of setting fire to small sections at a time. In this manner a good series of katydids and a large species of grasshopper, which we had not seen before, were taken. At the same time we flushed several night herons and found that they had nested among this thorny *Opuntia*. The young ones were able to fly and this would indicate that the season of fresh eggs would be not later than March. Before we had arrived at Socorro there had been some speculation as to what the food of the night heron might be in such a place as this. The question was settled today and we found that they subsist on crabs and other crustaceans secured along the rocky shore-line.

Mr. Slevin took a few more lizards today and is entirely unable to explain the scarcity of these reptiles at this season. By working energetically for many days he has amassed a very considerable collection, but the single species found is far from as common as he found it in 1905. He made up for the lack of reptiles today, however, in securing two more specimens of the little elf owl.

Another question which no one has been able to satisfactorily answer pertains to the mosquitoes on the island. When parties have camped high up on the mountain-side overnight, not a single one of these insects has been found, but when anyone has been near the shore-line after sunset, he has been pestered unmercifully. This would seem to imply that there are some pools of stagnant water somewhere in the lowlands, but repeated search by many men has failed to disclose them.

May 11—All of the scientific party and the Captain left the ship at 6 a.m. in the motorboat to go around the island. At Braithwaite Bay it seemed calm and an ideal day to make the trip, a day for which we had been waiting ever since we had arrived at Socorro. As we rounded Cape Rule, we found conditions far from pleasant. There was a strong head wind with a heavy sea and so much water came aboard that it was necessary for us to stay close in shore on the south side of the



island. We passed Grayson's Cove and proceeded as far as Cape Henslow; O'Neal Rock was in the distance and we had high hopes of really being able to reach it and investigate the colony of noddy terns which Mr. Slevin had found there in 1905. He had noted then that the nests of boobies on the rock were decorated with dead seahorses. We had made careful search for this strange fish ever since we had left Guadalupe Island but had failed to find a single one. We were very desirous of getting a large collection of them alive to ship back to San Diego in the tanks on board the *Ortolan* and from there they could be trans-shipped to the Steinhart Aquarium in San Francisco.

We were therefore greatly disappointed when, at Cape Henslow, we found we could not make further headway against the wind and sea. Everyone on board was soaking wet with the spray when we reluctantly turned back.

Although the surf was very bad in Grayson's Cove, we did succeed in landing safely on the rock wall on the west side of the cove. Again large collections of birds, insects, plants and shells were made. While Messrs. Jordan and Duhem were landing a fish with a hand-line and dip-net, a shark came up and bit the bamboo handle of the net off clean. The net was saved and a moment later the fish was taken, cut in two.

Late in the day we returned to the ship and all hands made preparations for sea. Quite obviously we must give up hope this time of being able to explore the north and west sides of the island. Throughout our stay the wind persisted from the northwest, thus making a landing on those desirable portions impossible. The island is so rough and the absence of known water makes it impossible to explore very far away from the landing places.

May 12—The ship got under way at 2 a. m. and we reached San Benedicto Island soon after daylight. It was very rough even on the east side of the island where the only anchorage is indicated on the sailing charts. For a while it seemed rather doubtful if we would be able to get on shore at all. Mr. Slevin and I in a rowboat prospected the whole of the east side but not a place was found where a boat could be landed. We did succeed in getting ashore, however, with most of the party,

by casting a grapnel upon a projecting spur. The first man scrambled up the perpendicular lava wall and with a heaving line hauled up and secured a Jacob's ladder. Going ashore and back aboard later in the day was dangerous work, but we managed to do it without an accident. A man overboard there who could not swim would almost certainly have been lost. Consequently it was thought that the two or three in the party in that category had better stay on board. San Benedicto was the most inhospitable place any of us had ever seen. The south end rises in an Ash Heap to an elevation of about 900 feet, the highest point on the island. The ashes are white and the sides of the hill are deeply scored with water channels. Connecting the Ash Heap with the northern part of the island is a low isthmus. Much of the northern part is a high plateau with, in one place, the most perfect crater many of us had seen. After due consideration of this beautiful bowl, it was decided that it should bear a name and it seemed entirely proper that it be called after Dr. Alphonso Herrera, the honorable Director of the National Museum of Mexico.

The shore line of the island has been gradually eroded away by the beating of the waves of the Pacific and on the west side some outlying pinnacle rocks have been left standing.

Messrs. Mason and Solis, with the help of others, took eight species of plants on the island. Three were grasses and one was a morning glory which is found on Clarion Island. One species of grass covers most of the accessible area and grows five to six feet high in places. It is exceedingly rank and dense and very hard to break through. The only other plant present in any abundance is a *Euphorbia*, the brush of which is used exclusively by the man-of-war birds and blue-faced boobies for nests. No cactus was found.

Whenever we went on shore a cloud of grasshoppers advanced in front of us. Some of these were at least three inches long and two species were found, which, with a few small ground beetles, are the only conspicuous insects other than a great many carrion flies about the carcasses of dead birds. Also around the necks of the live birds there were enormous numbers of parasitic flies belonging to the family Hippoboscidae. Some birds had as many as fifty flies each and they seemed to produce considerable discomfort to the host because

they select a position around the bird's neck where they cannot be reached with the bill. A favorite place for them to perch was around the pouches of the male man-of-war birds. When one of these flies would light on a man it would cling with utmost tenacity and could hardly be brushed off.

No lizards or land shells were found on the island.

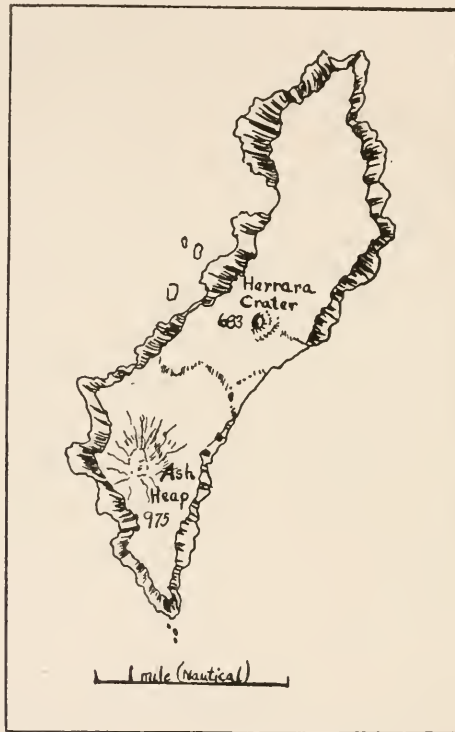


Fig. 6. San Benedicto Island.

On top of the high plateau in the center of the island was a large colony of man-of-war birds and last year's young still remained at the nest although they could fly. Large numbers of dead were strewn over the rookery. Presumably when the new nesting season arrives, the young of the previous year are deserted by the parent birds and if they are not able to take care of themselves by that time they perish on the rookery. Several fresh eggs of the 1925 season were taken. In some

cases the male, in others the female, was on the nest. Sometimes both birds sat side by side crooning each other, the male occasionally filling his enormous pouch with air to its capacity. The nest was placed on the ground or on rocks, and consisted of a sort of platform, flat on top, occasionally being built to a height of two feet. At a distance the "whoo-hoo-hoo" of the males does not greatly differ from the call of the screech owl in the east. The birds were very tame and allowed us to approach the rookery with almost no disturbance.

The three species of boobies—Webster's, blue-faced, and Brewster's—were nesting in abundance in about the order named. The blue-faced booby was closest to the shore line and the nest was placed in the center of an open circle in the grassy areas. A few stems of grass composed the nest. Two eggs were laid and all that were found appeared to be heavily incubated. Some half-grown young of all three species were found. The Webster's nested chiefly in the grassy areas and built a platform one to two feet high of grass stems. Only one egg was found in a nest and all those seen were heavily incubated. There were numerous birds of this species on the cliffs, but they seemed to be only resting. Brewster's boobies were found along the washes of the isthmus, the nest being much like blue-faced and two eggs being the usual number.

Ravens were present, but not very abundant. I saw six. Rock wrens were likewise not very common, but between us we took thirteen. Red-tailed tropic birds were seen circling along high cliffs and the deep cuts of the Ash Heap. Nests were not found, but probably occurred in the latter place. Wedge-tailed shearwaters completed the avifauna. Thousands of their burrows were found in the Ash Heap on the south end and on the higher parts elsewhere on the island. Mr. Wright succeeded in getting seven birds but they were not nesting. He found a way to call them out of the burrows without the usual amount of excavating which is necessary. This he said he did by imitating as nearly as he could two cats fighting. He said whenever he did this shearwaters all about would come to the entrances of their burrows.

While the ship was anchored beside the island, one of our parrots from Socorro got loose and flew ashore. The man-of-war birds chased the poor creature shamefully, each one trying

to force it down into the water and it barely reached land. We did not recapture it and it was not believed that it would survive very long.

The men on board the ship took 42 large sharks over the side in two hours, some being eight feet long. Other fishes were very scarce.

At 4:45 p. m. all hands were aboard satisfied with the results obtained and the ship got under way for Maria Madre Island.

May 13—When daylight came this morning the ship was gliding through a sea as smooth and calm as glass. We could hardly believe our eyes, because this was the first real calm weather we had experienced since we left San Diego. Unquestionably we had passed out of the region where northwest trade winds prevailed and were entering a new climatic zone which would be occupied by many different kinds of plants and animals than those to which we had become accustomed. We cruised all day through the oily sea, enjoying the sensation of freedom from the wind and roll. An occasional petrel or shear-water glided silently past to relieve the monotony of the situation.

At 10 o'clock of the preceding night when we were 55 miles east of San Benedicto Island a wandering wayfarer, a red phalarope, flew aboard and was captured by Mr. Duhem.

A little after noon the Tres Marias Islands were sighted to the eastward and not long thereafter the Captain found that he was headed straight for the passage between Maria Madre and Maria Magdalena islands. We anchored close in front of the Mexican Federal Penitentiary on the east side of Maria Madre Island and at 6 p. m. Messrs. Gallegos, Solis, Contreras, Nelson and I went ashore to learn what arrangements might be made for making natural history collections on the group while the ship returned to San Diego for fuel.

We were most hospitably received by the acting director, Sr. Gallindo, and the commandante, Sr. Sanchez. They very generously offered us a house which we might occupy as headquarters during our stay, a building very well equipped for our needs. They likewise offered to give us any assistance which we might require, such as guides and saddle horses.

All of this was very much appreciated because we had rather expected before our arrival that it would be necessary for us to camp in tents.

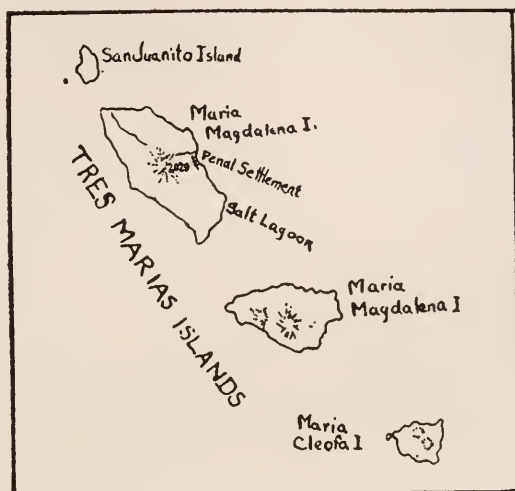


Fig. 7. Tres Marias Islands.

The penal settlement on Maria Madre is quite a large institution. There were 281 prisoners there at the time of our visit and everything about the place looked exceedingly well kept. Buildings were nicely painted, streets were graded and kept constantly watered to settle the dust. It was gratifying to see so well-kept an institution on this far distant isle.

May 14—The twelve of us of the scientific party moved ashore with all of our outfit, prepared for a stay of eight to ten days. The Captain very kindly detailed a cook and mess boy to serve us and with most pleasant surroundings we looked forward to a very successful sojourn. Most of the day was occupied in the moving operations but in the late evening some of us walked south on the beach to Lighthouse Point and we were very deeply impressed with the profusion of life of the tropical forest, even on a semi-arid island. Five species of cacti were seen along this short trail and a beautiful Bougainvillea, orange in color and with a flower $\frac{3}{8}$ of an inch in diameter, was a most delightful sight. Lizards, crabs and

insects swarmed in the intense struggle for existence which seemed to be taking place on all sides.

Parties from the ship enjoyed the day on shore and in the afternoon the crew had a ball game. Sr. Gallegos, a most delightful companion at all times, was here invaluable to us because of his ability to speak English almost as fluently as his native tongue.

May 15—At 9:30 a. m. when most of us were out in the forest making collections in our various groups, we heard three blasts from the whistle of the *Ortolan* announcing her departure for San Diego. We felt that we were in a paradise from a collector's standpoint and looked forward to the days to come with a great deal of pleasure.

Messrs. Slevin and Musser went south from the village as far as the Saltworks Lagoon and collected many lizards during the day. Two snakes were found, one being a racer about seven feet long. Mr. Musser shot a rabbit and also collected a few birds.

Messrs. Tose, Wright and Gallegos collected birds within half a mile of the village for a while during the early afternoon and spent the rest of the day preparing them. Some traps had been put out the night before, but no animals were taken in them. Among the most conspicuous birds were tanagers, flycatchers, orioles, warblers, wrens, cardinals, woodpeckers and caracaras. Three kinds of doves were seen and red-tailed hawks, vultures, parrots, swallows and hummingbirds were not uncommon.

There were so many kinds of plants to be collected and pressed that Messrs. Mason and Solis were not able to wander more than a half a mile from the village. It was quite apparent to all of us that our visit was made in the midst of the dry season. We were told that no rain had fallen for several weeks and the forest had the appearance of autumn in the eastern United States. Most of the trees had shed their leaves and there were but few annual plants in bloom. Careful observation, however, enabled the collectors to find flowers of most of the perennial plants which they encountered.

On account of the dryness of the season insects were probably not as abundant as they would have been at a later date.

Nevertheless, Mr. Keifer succeeded in taking a large series and the acquaintance which he made with the conditions in the forest undoubtedly enabled him to make the best of his opportunities on other days.

Mr. Jordan and I visited some rock exposures in the cliffs, one mile southwest of the village. Numerous species of fossil mollusks were collected and large numbers of Foraminifera were taken in bulk. Many strata of the formation are composed of Foraminifera to the extent of at least 95 per cent. We had no difficulty in the field in placing these rocks in the Pliocene and the equivalent of exposures on Cedros Island and at San Diego.

The center of the mountain mass which forms Maria Madre Island was found to consist of granite chiefly, with a rim of diorite around the edges. This whole mass was land during part of the Pliocene because many boulders of granite are in the sediments of that age. The main cañons have cut into this granite about 300 feet or more. Near the top of the island the Pliocene sediments are only about 50 feet thick, but they increase to about 300 feet toward the shore. The prevailing dips seem to be away from the center of the island. During a portion of Pliocene time large coral reefs existed around this old land mass and large blocks of the fossiliferous material, firmly cemented, have fallen down from the exposures and have rolled indiscriminately far out into the forest.

North of the town a large wash comes into the sea from the westward and in the bed of this we found float pieces of Pliocene conglomerate and large blocks of pure coral several feet square. Also some float pieces of diatomaceous shale were picked up and these indicated very conclusively that some Miocene was exposed to the westward.

May 16—The day began at 4:30 a.m. for the collectors and they all labored industriously in the region about the village of Maria Madre Island. A great many additions were made to the collections which cannot be enumerated or even mentioned here, but we all had come to the realization that in order to make a fair showing of the fauna and flora of this island we would have to work as rapidly as possible. As an illustration I need only cite the experience of Mr. Mason who collected

plants toward the top of the east side of the island. He found a great many epiphytes (such as orchids, cactus, etc.), which he had not seen before. Mr. Mason collected one fresh egg of a night-flying bird which resembles a night hawk in habits and has been called *parauque*. This is the only evidence we have thus far obtained to indicate that any of the resident birds of Maria Madre Island are nesting.

May 17—Sr. Contreras went south in a boat with two pearl divers and made a large collection of marine life. He brought back some very beautiful specimens of living coral and he also took many sea urchins, starfishes, worms, shells and some fishes.

The rest of the party went in a motorboat to the north end of the island at a point past San Juanito Island and ascended a large creek called Arroyo Hondo. The mouth of this is at a point about six miles north of the village. On the beach there are the remains of several buildings and two and one-half miles inland there are three abandoned ranch houses. A guide named Antonio accompanied us and demonstrated many times his intimate knowledge of this densely forested island. Our main objective was a water-hole in Arroyo Hondo.

Along the shore line blue-footed boobies, man-of-war birds, brown pelicans and oystercatchers were very common. Our greatest treat to bird life, however, was far up in the Arroyo toward the running freshwater. In that vicinity one could be reminded of nothing for comparison except a swarm of bees. Doves, robins, orioles, tanagers and warblers were exceedingly abundant. Among them all the red-tailed hawks must have had an easy time capturing their prey. The hawks were so tame that some of them were shot with a collecting pistol loaded with dust shot. Very often in the green foliage, present here because of underground water conditions, we were treated to the sight of the gorgeous trogon. Males of this species are more brilliantly colored than the female and they are held in especial esteem by the Mexican people because they are tri-colored like the national flag—red, white and green.

About three miles from the sea in the Arroyo a diorite dyke crosses the cañon and the water unquestionably backs up behind this because it is at this point that the creek flows on the

surface. Running water is exposed for about 100 feet in the bed of the stream and it is then lost beneath the sand and gravel of the wash. This creek is a very important topographic feature of Maria Madre Island and heads on the north side of the central mountain. Very large quantities of water have been carried at times because granite boulders twelve feet across have been washed far down from the exposure. Under a dead log in the water Mr. Slevin found a specimen of the native Maria Madre Island terrapin, a very rare species in collections.

The exposures of rock in the Arroyo and along the seacoast from the village north were very excellent indeed and they gave us an opportunity to study the geological relationships very satisfactorily. Summarized they are as follows:

The uppermost formation on the north end of the island consists of about 300 feet of Pliocene limestone and sandstone dipping away from the center of the island at angles of approximately 15° . These sediments are very fossiliferous and are underlain by about 1000 feet of diatomaceous Miocene shales. Some of this is very pure diatomite and in it fish remains were found abundantly in two or three places. Miocene shales lie directly on diorite or rhyolite and this in turn rests upon the granitic core of the island.

May 18—The bird collectors needed a day to prepare the specimens collected at Arroyo Hondo so no long trip was attempted. Mr. Jordan and I dredged off shore with the motorboat in the morning, getting a great many things in water 50 to 100 feet deep. Taking advantage of the low tide in the afternoon we made collections of littoral forms along shore.

Messrs. Mason, Solis, and Keifer took saddle horses and went north a few miles into the forest. Among many excellent specimens collected there were two species of cactus of the genus *Mammillaria*.

May 19—At 5:30 a. m. we left the dock at Maria Madre Island in the motorboat and headed across the strait toward Magdalena Island, eight miles away. All of the members of the expedition made the trip and we were accompanied by Sr. Alfredo Sanchez, the Commandante of the Prison, and

Antonio Olmedo, his foreman of the salt works. The latter was brought along by Sr. Sanchez because of his intimate knowledge of Magdalena Island and before our return we had much cause to be thankful for the foresight of Sr. Sanchez.

We left without breakfast, but Mr. Mason, who had had much experience in out-of-doors cooking in France and elsewhere, volunteered to attend to the commissary. Therefore he and the Philippino mess boy, Rosales, were landed first. By the time I had transferred the rest of the party from the boat to shore, breakfast was ready.

Camp site was chosen at the mouth of a small dry creek near the center of the north side of the island, because we thus had access to every part and we had safe anchorage for the motorboat behind the long submerged reef which projects from the north side. This did not give perfect protection from the huge northwest swells of the Pacific but it was the best we could get, according to Antonio, and we learned afterwards he was correct.

The work of the various men in the dense forest was soon under way. Mr. Wright went toward the top of the island up our little creek in hopes of securing a specimen of mainland deer. These animals were "planted" on Maria Magdalena about 1903 and were said by Antonio to have increased somewhat. Mr. Wright was prepared to remain overnight if necessary. He returned to camp next day without having seen any fresh signs of either deer or goats, the latter having been introduced also about 1903. Mr. Jordan and I kept to the creek beds and shore line all day in order to study the exposures of rock formations. Notes on the geology will appear in a later paper, so it is only necessary here to remark that Maria Magdalena Island has had an entirely different history from Maria Madre. Basement rocks are volcanic and are overlain by a great series of cherts, sandstones and mud shales. These we took to be Cretaceous in age but definite paleontologic proof was not found. Miocene appeared to be absent and Pliocene was not positively identified. Pleistocene, however, is exposed near the sea and on the beach at the creek mouth and the flat eastern end of the island is probably an

elevated terrace of this age. The dangerous reefs projecting from the north side of the island are composed of resistant layers of the supposed Cretaceous rocks, the softer shale layers having been eroded away. Many of these resistant layers weather out as huge flagstones. The high western end of the island, the Pacific side, with its enormous sea cliffs, is composed of highly altered cherts with volcanic rocks in many places. No evidence of granite, such as composes the central core of Maria Madre Island was found. Mr. Jordan and I made a large collection of marine shells and corals along the beach and land shells inland.

Messrs. Tose, Gallegos and Antonio went at once to the only water-hole in our part of the island, located about $1\frac{1}{2}$ miles back of our camp and in the next creek bed to the west. There they succeeded in getting a large collection of birds.

Messrs. Mason and Keifer collected in the various cañons leading inland and secured many specimens. At the close of the day's work, all agreed that the fauna and flora of the Maria Madre and Maria Magdalena were almost identical. Evidently transference of individuals from one to the other occurs frequently, a belief that was strengthened by the finding of various drift on the beaches of the latter island which unquestionably came from the former.

Mr. Slevin found no different species of reptiles, nor did any of us find one of the rattlesnakes which the natives maintain live on Maria Magdalena. I did collect for him a large boa which almost caused me to have heart prostration. I was helping Mr. Keifer at the time, late in the evening; we were prying the dead bark from a tree on the bank of one of the dry washes. I suddenly broke through the little pile of rubbish and roots on which I was standing and landed squarely upon the coils of a huge snake. In the dim light I could only see the light diamonds on its back, and my thoughts naturally turned to rattlesnakes. After some teasing, we succeeded in getting the reptile out of its cover and a noose made of a vine over its head. In this manner it was brought to camp and was found to be almost nine feet long. Mr. Keifer went on with his insect collecting.

May 21—While awaiting the return of the scouting parties, some interesting collections were made. Sr. Gallegos, while watching the birds at the water-hole, captured a fine black snake, a racer we had not previously taken. According to Sr. Gallegos, the snake has most interesting habits. Thousands upon thousands of flycatchers, vireos, hummingbirds, cardinals and thrushes come to the water-hole to drink and catch insects. The snake submerges with only its forked tongue above water. This is easily mistaken for an insect and if a bird attempts to capture it, the snake suddenly strikes with deadly effect.

In traveling the beach yesterday, Mr. Wright and I found a sea snake, dead and dried, but otherwise in good condition:

We also collected a set of oystercatcher eggs and noted the following other water birds: great blue heron; yellow-crowned night heron; brown pelican; blue-footed booby. The pelicans roost in the trees near shore, the boobies on outlying rocks.

Late in the evening the collections were taken aboard the motorboat and the party returned to Maria Madre Island.

May 22—Messrs. Slevin, Jordan, Keifer, Duhem and I went in the motorboat to the salt-works four miles south of the village. There we found a very considerable industry in active operation. It is made possible by there being a completely enclosed lagoon separated from the sea by a narrow neck of land. The natural presumption is that sea water seeps through this embankment and, through evaporation, concentrates in the lagoon; and it may explain the presence of the highly concentrated brine. Two facts, however, tend to indicate that the saltwater has a different origin. In the first place, the brine is carried in buckets to a large number of shallow concrete vats where it is allowed to evaporate to complete dryness. The resulting salt is said to be very pure. This procedure could not be followed with sea-water, but a certain amount of "mother liquor" containing calcium and magnesium salts would have to be eliminated. Moreover, in the bottom of the lake and under about one foot of mud, there is an 18-inch layer of calcium sulphate (gypsum) in huge magnificent crystals. The presence of this material certainly indicates a subterranean source for the salt water, it having at one time been

charged with that sulphate. On account of these facts, there was some doubt in my mind as to the sea-water origin of the lagoon brines.

At the time of our visit, the brine was very concentrated. Salt crystals grew rapidly upon any partially submerged object. The water was deep red in color, due to the usual brine inhabiting organisms.

About fifty prisoners are employed in the salt-works. A local lime-kiln is maintained for the burning of Pleistocene, highly fossiliferous rocks to make cement for the vats. The salt was sold to a contractor for a price said to be \$7.00 per ton and he carried it in small vessels to Mazatlan, San Blas and elsewhere.

Investigation of the near vicinity showed flat lying Pleistocene rocks immediately back of the salt-works and, because the entire southern end of Maria Madre is level and not very high, we were led to believe the entire exposed formation of that end to be of that age. The difference between the southerly and easterly dipping Pliocene rocks and the flat plateau was very marked at the line of contact. The rocks were not well consolidated in most part. Corals, mollusks and Foraminifera were so exceedingly abundant that a good grade of lime is produced.

May 23—Messrs. Slevin, Mason and I went into the hills of Maria Madre today, chiefly for the purpose of taking a series of photographs. Many of the exposures secured turned out later to be very good. Numerous pictures of local plants in bloom were very desirable and we also got a series of the iguanas which were so abundant everywhere. Mr. Duhem had discovered in taking his moving pictures of the animals that they would follow him like a dog if shown a cactus fruit. Undoubtedly this fruit forms one of the chief articles of diet and, by offering them some on the end of a stick, we were able to get some good pictures, close up.

Mr. Slevin came across an exceedingly thin, vine-like arboreal snake on this trip, a well known mainland species but one which had not previously been found on the Tres Marias Islands.

The *Ortolan* arrived with a new supply of fuel at 1:30 p. m. and the rest of the day was spent getting equipment and supplies aboard and sorted. In the evening we bade all of our friends on Maria Madre Island goodbye, after having thanked them most heartily for the help they had given us. Our stay had been exceedingly pleasant and no one had other than praise to offer for the orderly, business-like way the institution there was handled and governed.

May 24—After a general conference regarding the work yet to be done by the expedition with the fuel on hand, it was decided that Maria Cleofa Island would better be eliminated from the schedule. The contour of that island is such that, with the northwesterly sea which had been running for weeks, our chances of making a landing without a long wait were very small. Likewise, the waters about the little island of San Juanito contain such dangerous reefs that it seemed unwise to proceed there with a vessel the size of the *Ortolan*. Moreover, our visit to the Tres Marias Group was admittedly for reconnaissance purposes and all agreed that from this standpoint we had been quite successful. A stay of two or three months would be needed to make a thorough exploration of the group.

Therefore, at 2 a. m., the ship got under way for Isabel Island, 40 miles northeast of Maria Madre. We reached our destination at 6 a. m. and the usual activities of the party began at once.

Collecting was good in some groups, very poor in others. Mr. Slevin took over 200 specimens of lizards, three species being represented. There was no great assemblage of species of plants. Two small stunted species of trees cover most of the island, the remainder being overgrown with grasses. The trees have a maximum diameter of about eight inches and a height of not over ten feet.

The place is a paradise for sea birds and some outlying rocks were covered with pelicans and Brewster's and blue-footed boobies. The latter nest underneath the small trees near shore but the young birds had either hatched or were well grown. They roost in large numbers on the cliffs at night and when Captain Nelson blew the whistle prior to our

departure, the ship was deluged with birds. The boobies lost all sense they may have ever had and flew at our lights with utter abandon.

On the north side of the island there is a grassy area covering perhaps 10 acres. Each little hummock was the location of a nest of a sooty tern. The young birds were well grown and had flocked to the shade of the bushes nearby for shelter from the sun. One or two infertile eggs were collected. Noddies nest on the bare rocks of the north shore line and a few eggs of this beautiful tern were collected.

Man-o-war birds nest in considerable numbers in the center of the island on weak platforms built on top of the low trees. Most of the eggs had hatched showing that a much earlier nesting season exists on Isabel Island than on San Benedicto Island. Brown pelicans occupy a small rocky area near the highest part of the island and the young were almost as large as the parents. Red-billed tropic birds were constantly circling about the shore lines and in holes in the cliffs of soft scoriaeous rock of the southwest side numerous nests were found. One speckled, reddish-brown egg is laid in the dark recesses of a cave and is guarded jealously by the parents. They literally had to be pulled from their nests before the eggs could be collected. Mr. Wright and I succeeded thus in taking 14 of these rare specimens in the afternoon. Young, from newly hatched to almost full grown, were found in the various nests examined, indicating a greatly prolonged nesting season. The raucous note, powerful flight, fighting proclivities and long, slender tail feathers certainly make this the most striking sea bird of these parts of the tropical Pacific.

Close to shore and on the northwest side of the island, there is a breeding colony of Heermann's gulls and they may occupy some of the outlying rocks. Young were fully fledged and almost able to fly.

The landing place on Isabel is on the south side and with northwest winds is safe for small boats. We found that the island had been occupied until very recently by shark fishermen. A large number of sharks had been caught and dragged out upon the beach. Evidently the only parts saved were the

livers and a crude try-works for the extraction of oil from these was hardly cold. The stench from the rotting carcasses was almost unbearable about the landing place.

We learned on Maria Madre Island that a concession had been recently granted for prospecting for oil on Isabel Island and I was curious to learn what had been the cause for supposition that petroleum might exist there. We found the island to be wholly volcanic. Lavas and scoria make up the entire land surface. Back of the landing place a few yards, there is a small pool of foul water possibly derived in part from surf driving through the coral rock dam between it and the sea, but certainly in large part derived from subterranean sources. The water is very bitter to the taste and does not contain a very large amount of common salt. Beetles which belong to a family that inhabits alkaline waters were abundant on the bottom and at the west end there is a seepage of water from the bank into the pool. The mud at this seepage was so hot I could not bear my hand in it.

A crater a fourth of a mile across occupies the southeast corner of the island and is filled to about sea level with alkaline water similar to that of the pool just described. A lava rim separates the lake from the sea on all sides, the lowest point being about 200 yards from the landing place and about 30 feet high.

Apparently the water of these two pools is made very foul from the birds, at least in part, and it is entirely conceivable that a film of oil may spread over the surface at times from this cause. Mr. Wright and I found some black tar-like seepages from the excrement of the birds under some of the shelves of the sea cliff of the southwest corner. Only by mistaking some such fact as this could anyone be induced to suspect the presence of petroleum, a deposit of which in such a situation is of course practically impossible.

While working over these southwest cliffs, Mr. Wright and I found a small seepage of apparently drinkable water coming from a seam in the scoria-rock. If an excavation were made there, it is possible that enough might be collected to be used in emergency. The place is on a shelf about 25 feet below the

top of the cliff on the southwest corner of the island. The shelf is easily reached from the north and can be followed along for a considerable distance. In the caves extending back from this shelf we found the colony of nesting tropic birds.

The day was considered very successful by all of the party and the work having been completed, the ship was headed toward Mazatlan at the proper time to reach that port after daybreak next day.

May 25-27—We were very hospitably received in Mazatlan by the local officials and our stay there was very pleasant indeed. Sr. Gallegos had been stationed at the port once for three years and acted as our guide. The Academy party was particularly anxious to become acquainted with local conditions in order that proper preparations could be made in due time for collecting work in that vicinity. They were aided in this by the guidance and counsel of Mr. Wm. E. Chapman, the American Consul. We attended an exposition which was being held there jointly by the States Sinaloa, Sonora and Nayarit and all of us were greatly surprised at the wide variety and fine quality of articles manufactured. The exhibition of natural products was very instructive to us. We went by automobile from Mazatlan to Roble, 30 miles away, where the Haas people have a plantation, the chief product being sugar.

Since Mazatlan is on the main line of the Southern Pacific Railroad of Mexico, and is a regular port of call for many ships, space will not be taken to record data about the ancient and picturesque city. Tourist guide books should be consulted for such information; our duties were outside of the beaten paths. Therefore, on the evening of May 27, we were again under way, anxious to continue with work we had outlined.

May 28—We reached Cape San Lucas at 2 p. m. and went ashore at once to collect as much as possible at this classical locality during our brief stay. The place is famous in biological literature through the activities of John Xantus de Vesey, an industrious naturalist who was stationed there about the middle of the nineteenth century.



At the cape we met one of Prof. John N. Cobb's students from the fisheries school of the University of Washington, Mr. T. Suzuki, a Japanese. He knew Dr. Evermann and had collected a live hawk-bill turtle for him. It had been kept in a wicker trap for several days and when we went to get it, it was dead. This was a misfortune because, being of small size, it would have made a very desirable specimen for the Steinhart Aquarium. The turtle was not lost, however, because Mr. Slevin made a museum specimen of it.

The cape region is evidently becoming of considerable importance from a fisheries standpoint. Besides a Japanese refrigerator steamer which was being loaded with frozen fish, a sailing ship fully equipped as a refrigerator was anchored close in shore and was in full operation.

The extreme tip of the peninsula of Lower California is a narrow granitic promontory. Behind this is the harbor protected from northwest winds only. Evidently a strong current eddies around the cape because the *Ortolan* had to go within 200 yards of the beach before finding soundings to indicate suitable anchorage.

The next stop on our schedule was Magdalena Bay on the west side of the peninsula and in order that our arrival there might be timed properly, it was necessary to leave Cape San Lucas at 4 p. m.

May 29—At 3:30 this morning as we were cruising along peacefully about 20 miles south of the entrance to Magdalena Bay and several miles off shore, the ship's engine suddenly began to race and the vessel was subjected to the most violent vibration therefrom. The officers knew at once that the cause was the loss of a blade of the propeller, a prediction which was verified after we anchored in the bay. This accident, we foresaw, would handicap us considerably, but it was thought to be safe to proceed to San Francisco under a speed of not more than six miles per hour. The remaining stops which we wished to make, except Guadalupe Island, lay practically on our course, so it was decided that we might make them providing we did not remain so long as to endanger our fuel

supply. The plan to revisit Guadalupe for the census of elephant seals had to be abandoned, much to our regret.

We could not think of a possible cause of the accident to the propeller until after we had inquired into the activities of a whaler who was operating from a floating factory in Magdalena Bay. The operations had consisted of killing the whales at sea, towing them in to the "plant" where the blubber was stripped off for the manufacture of oil, and then towing the carcasses out to sea to be cast adrift. Apparently our propeller had struck one of these carcasses. At the time of the accident, nothing could be found floating on the sea and there are no known submerged rocks in the region. Nevertheless, not only was one blade completely lost, but the tip of another was knocked off.

We did not reach the anchorage abreast of the village in the north arm of Magdalena Bay until 11 a. m. but work was begun immediately thereafter. Captain Nelson proceeded to "swing ship" and check up on his compasses. Mr. Mason collected about 45 species of plants in bloom and Mr. Keifer took many fine insects. Mr. Jordan collected fossils in the bed just north of the village which I had investigated in 1922 and his careful search was rewarded by the finding of several species I had not taken. Mr. Slevin captured a snake which was not previously known from the vicinity. Mr. Duhem and I suffered the greatest disappointment of all. We rowed into the eel-grass of the lagoons in the north arm of the bay in order to search for live sea horses to take back to the Aquarium. Up to this time as well as later on the trip we devoted much time to this search, but except for the one specimen taken by the submarine light at Maria Madre Island, we were unsuccessful. The species is probably common enough in certain favorable localities wherever we went, but we were not able to find these places.

In the evening we were visited by Captain Bryde in charge of the floating whaling station. He belonged to a Norwegian company which had extensive plants in the antarctic region. His was the second vessel from the company to have come to Magdalena Bay and he said that since December, 1923, they

March 30, 1926

had taken 750 whales. Of these he said they were divided about as follows:

California Gray	130
Humpback	310
Blue (<i>Ballena sieboldi</i>)	310

This classification seemed so unusual to me that I raised the question of accuracy of identification, but he assured me that it was correct. We had come to the conclusion from other data that the California Gray whale was almost extinct, but if Captain Bryde's figures are correct, there are some still left. I was also inclined to doubt the accuracy of the identification of the blue whale, but he stated it was a species with which he had become very well acquainted in the antarctic and he knew its characters well. Nevertheless, I was not convinced, but repeat the records here for what they may be worth.

Captain Bryde told us he had recently paid Socorro Island one visit with his harpoon steamers and had killed three whales there but they had so decomposed on the long tow to Magdalena Bay that they could not be used in the factory. I cite the incident merely to show what little regard some commercial interests have for the utilization or actual continuation of that life from which they derive their revenue.

The region about the Revillagigedo Islands has long been known as the "cow pasture" in whaling parlance because so many whales go there to rear their young. Professor Contreras stated that the same was true of the Gulf of California above Carmen Island. It is hoped that, in view of these circumstances, these localities may be made into a reserve where the young whales may live for a little while without molestation.

May 30—Messrs. Slevin, Mason, Jordan, Wright, Duhem, Musser and I went south of the village about four miles in the motorboat in the early morning and walked back along the beach, making many valuable collections. Fortunately, there had been rain at a recent date and most of the desert plants were in bloom. This of course made Mr. Mason very happy because it has been said that several years have passed at a

stretch at this locality without a measurable quantity of rainfall. Many of the elephant trees were gorgeous masses of pink blooms and some had leaves.

Mr. Jordan and I succeeded in collecting some species of Pleistocene fossils which were not found in the deposit north of the village, and also, during the low tide some very desirable living species were found. A species of land shell, a *Bulimulus*, was found under the rocks on the hillside; this is apparently the same one which is found on Margarita Island to the southward and marks the extreme northward extension of the remarkable "Cape Region" land shell fauna in Lower California.

The village of Magdalena Bay is located near the north end of a series of hills which form a ridge separating the bay from the ocean and in position being comparable to Marin County, California. It was in and along these hills that we collected today. At the point four miles south of the village where we began operations, the rocks are old schists dipping to the west-south-west at an angle of about 60°. The beds are crossed in every conceivable direction by dykes and stringers of quartz, some being two feet thick in places. Some of the quartz veins have copper stains, and to the northward, back of the village where they are eight feet thick or more, they have evidently been prospected sporadically; we saw several shallow pits which had been dug along contacts but with what success we were unable to learn. There have apparently been some intrusions of granite and diorite and the locality would seem to warrant the attention of an expert mineralogist.

Along the beach south of the village there are late Pleistocene deposits, composed chiefly of coarse detrital matter, firmly cemented. Many fossils were found therein, the dominant forms being such as would live among coarse gravel, and large rocks as *Chama*, *Spondylus*, and large clams. North of the village the sediment was finer, Mollusca were more abundant and no cement has been formed. Thus it is one of the finest fossil collecting localities in western North America. We have taken almost 400 species from the deposit.

The captain of the whaling establishment paid us another visit in hopes of being able to borrow \$4,000. It appeared

that his concession was to expire on May 31, and he needed that amount to meet his taxes to avoid forfeiture of bond. We were not in a position to offer any aid to such an enterprise and, since we left Magdalena Bay that night, we did not hear how he fared later.

May 31—The day was spent at sea cruising northward toward San Bartolome Bay at slow speed owing to our injured propeller.

June 1—At 9:30 a. m. we had anchored in San Bartolome Bay and went ashore in the south arm known as Turtle Bay. It is well named, too, because we saw there on the beach the remains of a great many turtles which had been killed in the past and about a dozen live ones were on hand awaiting slaughter or transportation to some other fishing camp. We had succeeded in getting one turtle alive in Magdalena Bay and here added another to take back to the Aquarium. In transporting them it is customary to turn them on their backs and we tried this but after witnessing the obvious distress in which they constantly appeared to be, the officers constructed a deck tank of timbers and sail cloth; in this the animals appeared to be very happy during the remainder of the voyage.

A Japanese, Mr. Condu, has a concession for drying abalones at Turtle Bay and he had many racks filled with the meats. The process is essentially the same as that followed on Cedros and the San Benito islands described in the report of the Guadalupe Island Expedition.¹² Mr. Condu also has the concession for lobster fishing on this part of the coast, the work being carried on during the winter months.

Most of the collectors had a very disappointing day due to the excessive aridity which has prevailed for a long time. Five small sparrows, a thrasher and a few ravens were all of the land birds seen by the party. Pelicans, gulls and cormorants were common on the bay. Mr. Mason took only 15 species of plants, contrasting with 45 taken in one day at Magdalena Bay.

¹² See Hanna, Proc. Calif. Acad. Sci., Vol. 14, No. 12, Sept. 5, 1924, pp. 248-249-272.

Mr. Jordan and I were more successful. We went east about three miles into the hills and collected a large number of fine Pliocene fossils. Below the obviously Pliocene beds there was a thick deposit of light, gray-colored shale and at the base of this a sandy layer in which we found numerous shark teeth, some sea lion teeth and pectens. It was believed that this layer could be correlated with the famous deposit of shark teeth in Kern County, California, usually referred to the Upper part of the Miocene. Below this fossiliferous layer, heavily bedded conglomerate, probably Cretaceous in age, extended downward an unknown distance.

June 2—All of the party except Messrs. Gallegos and Solis went ashore in the north arm of San Bartolome Bay and the day of collecting was marked with only fair success. The ornithologists took about a dozen birds but none appeared to be of special importance. Mr. Slevin got several lizards and a rattlesnake; the latter was killed by Messrs. Mason and Keifer. Mr. Keifer found some very desirable insects and Mr. Mason took four or five species of plants he did not get the day before. Elephant trees thrive and grow to almost as large size as on Cedros Island. Two specimens of giant cactus were found, both in flower. The country, in the main, is excessively barren. An old lobster fisherman, living alone in a tent on the beach, stated that during the previous winter there had been only two slight sprinkles of rain. Nevertheless, coyotes, woodrats, kangaroo rats, pocket mice and two species of rabbits do well. The old fisherman catches lobsters in the winter time and exists alone in his tent the remainder of the year. Most of the freshwater used in the vicinity is shipped in from San Diego; a small quantity comes from Cedros Island.

June 3—We left Turtle Bay at 4 a. m. and arrived at Bernstein Bros. abalone plant on Cedros Island at 9 a. m. All of the party went ashore and had a very successful day, collecting.

Mr. Slevin, in addition to other things, took one of the rare alligator lizards, one of which was caught in 1922 in a mouse trap. A rattlesnake and a gophersnake were taken by other members. Messrs. Mason and Solis filled their presses with

desirable plants, having collected up the cañon back of the camp, but they did not reach the spring. Messrs. Tose and Keifer went to the spring in the late evening prepared to camp overnight.

Messrs. Jordan, Duhem and I collected fossils in the Pliocene beds south of the camp and got a great many very desirable things. These strata dip in part toward the island mass, 20° west; again they dip 15° east; then they lie flat, all within a half mile on the strike. This great discordance shows that there has been much faulting and thrusting. Fossils, especially pectens, are excessively abundant and, in the main, well preserved. The beds are white or buff sands and conglomerates, the light colors being due to coralline algæ.

In the afternoon I visited some shale hills up the main cañon back of the plant. These were composed of muddy shales with occasional layers of thin, hard sandstone. They dip to the westward at an angle of about 30° . I had looked these over for fossils in 1922 and failed to find any, but this time I was more fortunate. I found one layer which contained Foraminifera, Inoceramus and Ammonites. The formation was thus proved to be of Cretaceous age and since it resembles some rocks found about Turtle Bay and Abreojos Point so closely, I have no hesitation in classing them as the same.

June 4—Collections were again made from Bernstein's camp as a base and numerous desirable things were found. Members of the party collected five rattlesnakes and Mr. Mason and I took another specimen of the alligator lizard.

Messrs. Tose and Keifer took nothing of importance at the spring during the night. Mr. Mason and I went up today and Mr. Keifer went back with us. Many desirable specimens were taken which are found only at that place. I carried the camera and took some excellent photographs of this little oasis and the plants thereabout. The agaves were beautiful objects to behold, the long stems being crowned by brilliant golden-waxy clusters of blooms. Each blossom was filled with a sweetish liquid, slightly fermented for the purpose of attracting insects, apparently. We visited the giant cactus plant Mr. Slevin and I found in 1922 and Mr. Mason pronounced it the

same species as that found at Turtle Bay. Two other cacti were found, making a total of six species from the south end of the island.

Some of the beauty of the oasis about the spring had been marred by fire since 1922, but it still stands as a gem in this barren and parched desert. A very large volume of water comes out of the supposedly Jurassic schist, 2500 feet above sea level and two or three acres are covered with a dense growth of grasses. Many flowers were in full bloom. The juniper trees were laden with dark colored fruit and the *Rhus lentii* trees were covered with masses of pink fruit. Little green tree frogs hopped from leaf to leaf as we passed through the dense vegetation and an occasional katydid gave us a feeble song.

In 1924 some date palms were planted about the spring and along the creek leading from it. They were found to be about a foot high and seemingly doing well.

Messrs. Jordan and Wright went south into the Pliocene country again and came back with another excellent collection. They found 500 feet of Miocene rocks dipping northwest beneath the Pliocene. In the lower beds were found shark teeth, whale bones and other fossils which appeared to identify the deposit with that previously found at Turtle Bay.

June 5—During our stay at Cedros Island, Captain Nelson continued the checking of his compasses, the water off the east coast being comparatively calm. Before proceeding with that today he took us to the Grand Cañon near the center of the east side of the island.

Messrs. Mason, Keifer and Tose went to the pine forest on the north rim of the cañon. Several plants were found which had not previously been taken, the most conspicuous, aside from the pines being the California Christmas berry, an oak-like shrub. Mr. Tose saw a flock of goldfinches and took one; no other birds were seen.

Messrs. Slevin, Solis, Contreras, Wright and Duhem worked up the main cañon as far as the old stone house used by the mining company's prospectors years ago.

Messrs. Jordan and I gave the day to the study of the rather complicated geology in the vicinity. It was found that a fault line crosses the island following approximately the course of the cañon. To the south only, Jurassic cherts, supposedly Franciscan in age, were found. To the north there is a block of Cretaceous shales, 2000 or more feet thick, with a general westerly dip of about 30° . On the east coast this extends northward about three miles where it is again abruptly cut off by a cross fault, the rocks to the north being apparently Jurassic, but they were not closely examined.

On the eastern shore about two miles north of the Grand Cañon, there is a small block, 100 feet thick, of Miocene cherty shale, and this in turn is overlain by Pliocene sands and conglomerates, very fossiliferous. All dip to the eastward or northeastward at angles up to 20° and are overthrust by the Cretaceous block, the line of contact dipping westerly at an angle of about 30° . Many fine fossils were collected from the Pliocene, among them being *Pecten cerrosensis* and *Pecten veatchii*, two long-lost but remarkably fine species not found since they were originally collected on Cedros Island by Dr. Veatch about 1860.

Our studies convinced us that Cedros Island is in a zone of intense block faulting and disturbance. At the present time, except for a comparatively recent post-Pleistocene uplift of little significance, the island is in a period of depression. In other words, at no very distant period geologically, the island was a part of a very much higher land mass. This probably accounts for the presence of so many freshwater springs in so arid a region.

June 6—We left our anchorage at Cedros Island at 1 a. m. A gale had been blowing from the northwest all of the previous day, so when we got out of the protection of the east side of the island, a terrific sea was running, causing the ship to roll and toss considerably. It gave the party an excellent opportunity to discover all the loose ends not properly secured for sea,—and there were many. Fortunately no specimens or equipment were injured.

Captain Nelson desired to proceed to a point westward from Cedros and about two miles west of the San Benito Islands to sound out a shoal supposed to be there. He also wished to investigate a patch of breakers north of those islands. The position and size of the first and the existence of the last are marked as doubtful on the sailing charts. The departure from Cedros was timed so that we would be near the supposed positions at dawn, but when daylight came, it was quite obvious that survey work in that tempestuous sea was impossible. The course was changed toward San Quintin Point and this headed the ship directly into the wind and sea; owing to the injured propeller, slow progress was made. A little over five miles per hour was the best that could be made. It was too rough to accomplish any useful work on board so a holiday of rest was enjoyed by all.

June 7—Anchor was dropped back of San Quintin Point at 3 a.m. and at six Messrs. Gallegos, Jordan, Mason, Keifer, Duhem, Wright and I left the ship in the motorboat, bound for the village of San Quintin, 12 miles inland. I had been through the tortuous lagoon channels twice in 1922 and remembered enough of their course so that we managed to get through safely. The chief danger with small boats lies in crossing the lines of breakers at the outer bar. It is necessary to keep well over toward the shore on the left side going in to avoid them. Some black lava rocks outcrop on the beach where it is necessary to go closest. Once inside the bay, or lagoon as it is called on the charts, it was glassy smooth and a fairly deep channel meanders down the center line with broad mud flats on either side. Part of the channel is marked with piling but the outer portion must be navigated with considerable care to keep from grounding.

The chief object of our trip to San Quintin village was to give me an opportunity of making a geological investigation of a large tract of land on the "Plains of San Quintin." An automobile was obtained at the village and Sr. Gallegos and I, accompanied by two local residents, Messrs. Cannon and Green, spent the day travelling. We went as far as "Red Rock



Ranch" owned by Miss Hamilton and there we found Mr. Laurence M. Huey, of the San Diego Society of Natural History. Mr. Huey was busily engaged in making a collection of birds and mammals of the region. The ranch is irrigated with water from the Santo Domingo River which at that point flows out of the high mountain to the eastward upon the plain. Above the ranch a few miles is the old settlement of Santo Domingo with the ruins of the mission built by the padres.

The Plain of San Quintin is about four miles wide and 20 to 30 miles long. It is gently rolling throughout and the topography is not due to erosion but to uneven sea bottom or to folding such as has exposed the Pleistocene sediments at the village about 12 feet above sea level. Far out in the center of the plain marine fossils of Pleistocene age were found on or near the surface.

East of the Plain there is a long straight escarpment or terrace 50 to 75 feet high, the top being a mesa from one to four miles broad. This is deeply eroded with stream channels and is unquestionably older than the Plain. There is no appreciable development of alluvial fans on the Plain in front of the streams which is practically certain indication that the Plain was under the sea when the channels were being cut. The escarpment, therefore, is an ancient shore line. I was unable to find any fossils in the sediments exposed in the escarpment where we crossed it, but it could hardly be expected to be older than Pliocene.

There is a possibility that the escarpment might be a fault line, antedating the deposition of the Pleistocene of the Plain. This, however, does not seem to be a plausible explanation of the observed features.

Back of the mesa there is a range of rugged hills cut with deep cañons. The exposed rocks noted were all metamorphic, schists and slates predominating. These have a steep dip toward the Plain near the mouth of Santo Domingo River and if this generally prevails along the western side, it should certainly increase the possibilities of getting artesian water on the Plain. In view of the large area of excellent farming land

which could be brought into cultivation if artesian water exists within reasonable depths, this development would seem to be worthy of serious attempt.

In this connection it is worth recording that the deepest well of which I learned was put down to 68 feet on the Rancho Escoras on the Plain. Excellent water was obtained in sufficient quantity to supply domestic needs and irrigate the ranch garden.

At Red Rock Ranch I saw two beautiful specimens of Cretaceous ammonites with most of the pearly shell preserved. They were reported to have been collected at Ekatarina Landing in the vicinity of Rosario Bay by a Mr. Moody, petroleum geologist who located a well which was being drilled. No details of the well or the fossil occurrence were available, but it was stated by Miss Hamilton that some of the ammonites there were nearly three feet across.¹³

We returned to the village of San Quintin at 4:30 p. m., where the other members of the party ashore had made some important collections. The ship was reached at 6:30 p. m.

June 8—We left the San Quintin Point anchorage at 5 a. m. and reached San Martin Island at 7 a. m. We desired to make as complete collections as possible from this remarkable volcanic islet in the time available because of the number of species found there and no place else.

The island is almost circular, one mile in diameter and with a boulder spit on the southeast side. The western part is 400 feet high and composed of scoria and other volcanic ejectamenta. This makes a cone with a beautiful and perfect crater in the top. Lava flows form the remainder of the island (except the spit) and make the surface excessively rough and difficult to travel over.

Four or five species of land shells were found among the blocks of lava and numerous insects and spiders were taken by Mr. Keifer, assisted by Mr. Wright and me.

¹³ One magnificent specimen brought back by Mr. Moody came into the possession of Mr. Charles H. Sternberg, the veteran collector, and has been acquired by the San Diego Society of Natural History; it is fully 18 inches across. Another is in the possession of Mr. David Goldbaum of Ensenada, Lower California.

The land birds consist of a sparrow and a wren, neither one abundant. Pelicans, western gulls and cormorants nest in very large numbers.

Mr. Wright and I went back 100 yards into a lava cave and found a pile of at least five bushels of bones of small mammals. A few barn owl features gave a clue to the cause of the accumulation.

California sea lions occupy the beaches of the west side.

No recent rain had fallen and as a consequence annual plants were not available, but Messrs. Mason and Solis succeeded in getting about 25 species of perennials. Among these were the beautiful endemic *Dudleya* and four or five species of cactus. One of the latter forms a carpet over some large areas and is very difficult to walk over.

Mr. Duhem captured one of the snakes belonging presumably to the species we had seen on San Martin in 1922 but failed to get. According to Mr. Slevin, this was a very desirable addition to our collection.

The little harbor (Hassler Cove) formed by the boulder spit is a haven for small motor-driven fishing craft. Some Japanese had a camp on shore where they were drying and baling seaweed to be shipped to San Diego, presumably for the manufacture of agar-agar.

Piled high on the beach was a portion of a wreck of a motorboat which had burned to waterline at no very distant date.

June 9—The work at San Martin Island completed the modified program we had outlined after the accident to the *Ortolan* and San Diego was reached at 8:45 a. m. Our reduced speed and increased fuel consumption had left us only about one day's steaming supply when we went to the oil dock at La Playa.

I proceeded to San Francisco by rail from San Diego.

June 10-12—The *Ortolan* left San Diego at 7 a. m. June 10 and the last lap of the journey was completed at 6:30 p. m. June 12 when the ship tied up at the pier in San Francisco and the party disbanded. Much to the pleasure of all of us, Messrs.

Contreras, Gallegos and Solis came on to San Francisco with the ship and spent several days visiting points of interest thereabout.

Little did we think that when we said goodbye upon their departure it would be our last opportunity to see our most congenial companion of two expeditions, Professor José M. Gallegos. He returned to San Diego for a brief period, then went to Mexico City to prepare for aiding in the eradication of the grasshopper plague of certain sections of his country. Investigations were necessary in Guatemala and while on his way there he was stricken with fever in Beliz, British Honduras, where he died on September 24, 1925. Words cannot express the sorrow felt by all of his Academy friends upon the receipt of this sad news.*

* On March 10, 1926, after the foregoing pages were in final proof, another member of the expedition was taken from us. In an automobile accident near Gilroy, California, Mr. Eric Knight Jordan received injuries which resulted fatally a few hours later. Mr. Jordan and an assistant, Mr. Leo G. Hertlein, had just started upon a field trip for paleontological work in southern California, when the accident occurred.

On October 1, 1924, Mr. Jordan, at the age of 20, became connected with the California Academy of Sciences as a scientific assistant in the Department of Paleontology, and on April 1, 1925, he was appointed Assistant Curator of that department, which position he held at the time of his death.

Eric Jordan was a young man of unusual promise and, had he lived, would undoubtedly have attained eminence in paleontological science. In his death science and the California Academy of Sciences have suffered irreparable loss.

PLATE I

Fig. 1. The members of the expedition at the oil dock in San Diego before departing. Reading from left to right they are:

Prof. Francisco Contreras	Mr. Eric Knight Jordan
Mr. Frank Tose	Captain M. M. Nelson
Dr. G. Dallas Hanna	Mr. Hartford H. Keifer
Mr. Raymond Duhem	Mr. H. L. Mason
Prof. José M. Gallegos	Sr. Ing. Octavio Solis
Mr. Joseph R. Slevin	Mr. John L. Wright

Photograph by Laurence M. Huey.

Fig. 2. U. S. Navy Mine-sweeper No. 45, the *Ortolan*, anchored at Sulphur Bay, Clarion Island.

Fig. 3. A Clarion Island dove resting on a mass of vines; these birds were very tame.



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PLATE II

- Fig. 1. Outer Island at the south end of Guadalupe Island. This mass of lava has a crater in which there is water but whether this is fresh or salt has not been ascertained.
- Fig. 2. Two of the ground owls of Clarion Island at the entrance to their burrow beneath the dense vegetation.
- Fig. 3. A beautiful blue morning glory was in full bloom on Clarion Island at the time of our visit.
- Fig. 4. Starving young man-o-war birds, the brood of 1924, on the high grass-covered plateau of San Benedicto Island. Photograph by Neil B. Musser.
- Fig. 5. Method of landing on a lava shelf in a small bight just west of Sulphur Bay, Clarion Island. Photograph by Neil B. Musser.



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PLATE III

- Fig. 1. Pink fruit of *Rhus lentii* on Cedros Island: this fruit was very sour, and in the thick gummy substance on the surface there were many insects apparently belonging to the family Aphidæ.
- Fig. 2. Mr. Duhem photographing a turtle at low tide on the coral reef of Sulphur Bay, Clarion Island.
- Fig. 3. Prof. Gallegos with a fine specimen of the yellow-headed, Tres Marias parrot.
- Fig. 4. Monument Rock at the west end of Clarion Island.



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PLATE IV

Fig. 1. The beautiful blooms of a species of cactus found growing on San Martin Island.

Fig. 2. A view of the excessively barren landscape at San Bartolome Bay, Lower California.



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PLATE V

Fig. 1. A forest scene on Maria Madre Island.

Fig. 2. A huge nest of termites on Maria Madre Island.



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PLATE VI

Fig. 1. The Ash Heap, a deeply scored mass of volcanic debris at the south end of San Benedicto Island.

Fig. 2. One of the outlying bird-covered rocks at Isabel Island.



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PLATE VII

- Fig. 1. Young sooty terns on Isabel Island.
- Fig. 2. Adult sooty terns on Isabel Island.
- Fig. 3. The red-billed tropic birds were more numerous on Isabel Island than elsewhere and we found them nesting in deep caves on the cliffs.



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PLATE VIII

- Fig. 1. Noddy tern and egg on Isabel Island.
- Fig. 2. One of the few individuals of giant cactus found growing in the excessively arid region about San Bartolome Bay.
- Fig. 3. Male man-o-war bird on nest made of Euphorbia sticks, San Benedicto Island.



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PLATE IX

- Fig. 1. Roca Partida; this appeared to be a granitic pinnacle projecting upward from very deep water.
- Fig. 2. Alijos Rocks; the one on the right is North Rock, the center one is East Rock and the one on the left is South Rock; the latter two are adjacent in the picture but the three form an almost equilateral triangle.
- Fig. 3. Webster's booby on nest at Clarion Island.



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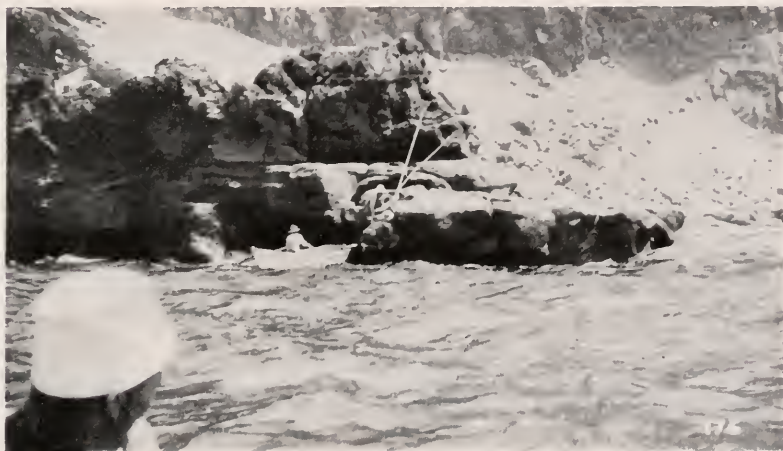
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PLATE X

- Fig. 1. Curiously sculptured rocks on the west side of San Benedicto Island.
Photograph by Neil B. Musser.
- Fig. 2. A landing on San Benedicto Island was made under considerable
difficulty. Photograph by Neil B. Musser.
- Fig. 3. One of the steam vents near the top of Mt. Evermann on Socorro
Island.



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II
**EXPEDITION TO THE REVILLAGIGEDO ISLANDS,
MEXICO, IN 1925, II**

MIOCENE MARINE DIATOMS FROM MARIA
MADRE ISLAND, MEXICO

BY
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AND
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The diatoms described in the following paper were collected in May, 1925, by G. Dallas Hanna and Eric K. Jordan, members of the expedition sent out by the California Academy of Sciences. The collection consists of many samples of diatomite of high purity, obtained in the east bank of Arroyo Hondo, a large wash which empties into the sea on the north end of Maria Madre Island, one of the Tres Marias Group, off the west coast of Mexico. The exposures are about two to three miles inland from the shore.

The diatomaceous shales outcrop here and there for a considerable distance along the creek and it was estimated that the thickness of the deposit was close to 1000 feet, the dips being from 15° to 30° and in general northerly direction. Above the diatomite, Pliocene sandstones and limestones with a thickness of approximately 400 feet have the same northerly

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dip but the angles are only 5° to 10° . The diatomite rests directly upon a diorite base and this in turn upon massive granite.

On account of its stratigraphic position and the organisms it contained, the diatomite is believed to be Miocene in age. Many of the diatoms belong to species which have previously been found only in Monterey Shale of California. Others are characteristic of the Miocene deposits of Maryland and Virginia. This mingling of floras might be expected to occur in the Miocene when the Isthmus of Panama did not exist.

The Maria Madre Island deposit has little in common with the famous beds of Barbados and Trinidad which have yielded so many strange forms. They are probably older.

The collection of slides upon which this report is based has been prepared according to the methods used by Dr. Albert Mann of Washington, D. C. One species only is mounted upon a slide. All type material is segregated in the Type Collection of the Department of Paleontology, California Academy of Sciences.

Other organisms found in the shales but which have not as yet been studied are fishes, radiolarians and silicoflagellates.

An alphabetical arrangement of genera and species has been adopted, thus obviating the need of an index. Names of genera in common use among diatomists have been retained even though some of them might be replaced in accordance with the rule of priority adopted by many botanists and zoologists. Because of their refusal to foist this rule upon themselves it is believed that the generic nomenclature of the diatoms is more stable than in most other groups of organisms.

We are under deep obligations to Dr. Barton Warren Evermann, Director of the California Academy of Sciences, for unremitting generosity in the provision of instruments and library facilities whereby this study has been made possible. The literature on the diatoms is extensive and much of it is rare and expensive; in spite of this the Academy has succeeded in securing all of the most important books and papers on the subject from a taxonomic standpoint.

1. *Actinocyclus allinearius* Hanna & Grant, new species

Plate 11, figure 1

Valve large, circular, regularly convex in the center; border narrow; pseudonodule circular, hyaline and very distinct; surface markedly coscinodisciform, there being a small group of rather heavy closely-set beads in the center without definite arrangement; remainder of disk covered with closely-set radial rows of beads the size being such that a fairly accurate quinquex arrangement is maintained; close to the margin the radial lines of beads become striæ, difficult to resolve because of the sloping surface of the valve; a definite and accurate radial and quinquex arrangement of the beads is interrupted by pairs of rows extending outwardly varying distances and maintaining a considerably larger size to the termination, after which three rows of usual size continue outwardly; this difference in size of the beading and a small hyaline space left unfilled between the two rows immediately before they end produce a pyrotechnic effect seen in the common and well known *A. pyrotechnicus* Deby¹ from the Monterey Shale of California. Also under low magnifications and in oblique light the diatom presents a mottled effect, especially when slightly out of focus; this appears to be due to irregularities of the inner surface of the valve; at least no outward structure could be detected from which it could be formed. Diameter .1131 mm.

Type: No. 1871, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This species would seem to be little apt to be confused with any other although it bears a general resemblance to *A. pyrotechnicus* Deby. It lacks the hyaline central pore of the latter, and the shape is decidedly distinct as shown by the figures herewith. Fortunately we have a perfect specimen of *pyrotechnicus* from the Maria Madre Island deposit for comparison.

2. *Actinocyclus canestrus* Hanna & Grant, new species

Plate 11, figure 2

Valve with wide margin composed of closely-crowded beads in diagonally curved rows running in two directions at angles

¹ In Rattray, Journ. Quek. Micr. Club, ser. 2, Vol. 4, 1890, p. 144, pl. 11, fig. 15.

of about 60° to the radii; the beads of this zone are very minute near the margin and increase gradually in size inwardly and without a definite boundary; disk with 17 radial rows of round, large, closely-set beads, a short spine being at the marginal end of each row; remainder of the disk uniformly dotted with beads the same size as those of the rows but not arranged in any definite formation; a very small central blank area; ocellus very distinct and set a considerable distance from the actual margin of the valve. Diameter .0690 mm.

Type: No. 1872, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This species is definitely related to *A. ralfsi* but differs notably in the uniform beading on the disk and the absence of a definite boundary, inwardly, of the marginal zone of small beading.

3. *Actinocyclus cubitus* Hanna & Grant, new species

Plate 11, figure 3

Valve small, broadly but uniformly convex; surface divided into four parts; each 90° sector with rows of heavy beads uniformly spaced and parallel to those radii which bisect the sectors; boundary of each sector with a conspicuous spine at the margin; the center of one of the sectors marked with an ocellus; border wide and radiately striated. Diameter .030 mm.

Type: No. 1873, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This beautiful little species has no close relative that we have been able to find in the literature; the above is a description of the type specimen which is figured. Another in the collection is exactly the same in all details except that it is divided into six sectors instead of four. Since variation in number of sectors is a common occurrence among the *Actinocykli*, no significance is assumed to be represented by this difference.

4. *Actinocyclus pyrotechnicus* Deby

Plate 11, figure 4

Actinocyclus pyrotechnicus DEBY in RATTRAY, Journ. Quek. Micr. Club, ser. 2, Vol. 4, 1890, p. 144, pl. 11, fig. 15; "Santa Monica," California, from a piece of Miocene float.

One perfect specimen of this common California Miocene species was found in the Maria Madre Island deposit. This is fortunate because it affords an opportunity to compare with it *A. allinearicus* n. sp. Rattray stated that the pseudonodule was "inconspicuous or problematical"; we can find no trace of the structure in our specimen. And this leads to speculation as to whether Schmidt's *Coscinodiscus micans*² from Oamaru, New Zealand, may not be the same. His figures show no pseudonodule and the structure otherwise is very similar to *A. pyrotechnicus*. If they should be the same then *micans* must take precedence because it was published a year earlier. We are not inclined to unite the two names because Rattray must have had Schmidt's plate in hand when he was preparing his paper, and if they were the same it seems very unlikely that he would have overlooked it. It is believed that Rattray's figure was drawn from the Hungarian specimen mentioned in the description of *pyrotechnicus* because there is seen a decidedly distinct pseudonodule, and this is inconsistent with his statement that the structure is "inconspicuous or problematical."

Diameter of specimen figured .2268 mm. (No. 1874, C.A.S. coll.)

5. *Actinocyclus rosoleo* Hanna & Grant, new species

Plate 11, figure 5

Valve circular, flat, very slightly depressed around the margin; margin narrow, smooth, bordered inside with a beaded zone twice the width of the margin; the beads are arranged in two rows as usual in this zone in many *Actinocyclus* such as *ralfsi*; from the beaded zone 62 rows of sparse set beads extend toward the center, the beads decreasing in size as the distance increases from the margin; in an indefinite central area

² Atlas Diat., pl. 139, figs. 2, 3, 1889.

the smallest beads become sparsely and irregularly arranged; pseudonodule very distinct and almost as wide as the border beaded zone. Diameter .080 mm.

Type: No. 1875, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The distinct and sparse radial rows of beads set this species off from any we have ever seen. The characters are so different from other forms that, although the specimens found are not perfect, they are believed to be sufficiently important to warrant description.

6. *Actinoptychus gallegosi* Hanna & Grant, new species

Plate 11, figure 6

Valve almost circular but very slightly flattened on three sides; border narrow and succeeded by an annular, beaded zone, in width almost equal to one-third the radius; sectors six, three being slightly wider than the others and these latter each have in one outer corner a short spine and in the other corner a hyaline area; each of the larger group of three sectors has in each outer corner a large hyaline area, pointed toward the center and outwardly forming the inner boundary of the marginal, annular, beaded zone; on the zone and radially very close to one of these hyaline areas is an ocellus similar to what is found in *Actinocyclus*; central area hyaline with border jagged; markings consist of sharp beads set in rows at right angles to each other on the sectors; beads of marginal annular zone slightly smaller than those of the sectors. Diameter .0928 mm.

Type: No. 1876, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species is exactly intermediate between *A. gründeri* A. Schmidt³ and *A. pfitzeri* Gründler.⁴ Both of these species are described from California and presumably from the Monterey Shale at Monterey. It is possible all three forms are variations of a single species, but, in the absence of material to prove this,

³ Atlas Diat., pl. 1, fig. 22, 1874.

⁴ Op. cit., pl. 29, fig. 1, 1875.

its assumption is unwarranted. Schmidt devoted plate 90 of his Atlas to other modifications of the same group, but none of those figured approaches our specimens as closely as those named. In his form *A. gründleri minor*⁵ from "Santa Monica" Monterey Shale, he illustrates the fact that alternating segments even in the same diatom may bear one or two spines. The presence of the ocellus on the marginal zone is of important significance.

We take pleasure in naming this diatom after the late Professor José M. Gallegos, a distinguished naturalist of Mexico and a member of the Academy expedition of 1925.

7. *Actinoptychus glabratus* Grunow

Plate 11, figure 7

Actinoptychus glabratus GRUNOW, VAN HEURCK, Syn. Diat. Belg., Pl. 120, fig. 6, 1881.—SCHMIDT, Atlas Diat., pl. 153, figs. 7, 12, 1890.

A complete frustule,⁶ divided and mounted on one slide was found in the material from Maria Madre Island. We have hesitated somewhat in referring it to the above species although it is very close to Schmidt's figure 12, cited above, of a specimen from Guano in Peru; he made the identification questionably. The specimens bear a decided resemblance to *A. janischii* Grunow, (Van Heurck Syn. Diat. Belg., pl. 122, fig. 6, 1881; Schmidt, Atlas Diat. pl. 153, figs. 8-10, 21, 1890) and there seems no reason why they might not very properly come under that name if it be valid. We doubt the validity if *janischii* and *glabratus* has precedence; therefore we have used the latter name. The species from the Monterey Shale of California, originally figured under three varietal names by Grunow, is believed to be distinct. Dr. Mann,⁷ in 1907 recognized *janischii* as distinct and put *glabratus* as a synonym under *A. splendens*, but all available figures of the latter which he cited seem to be distinct from the other two names. Diameter of specimen figured, No. 1877 (C.A.S. coll.), .1376 mm.

⁵ Op. cit., pl. 100, 1886, figs. 3, 4.

⁶ The splitting of this frustule gives us an opportunity to state that the two valves are identical and there was no trace of an internal accessory plate.

⁷ Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, pp. 270, 271.



8. *Actinoptychus maculatus* Grove & Sturt

Plate 11, figures 8, 9

Actinoptychus vulgaris SCHUMANN var. *maculata* Grove & Sturt, Journ. Quek. Micr. Club, Ser. 2, Vol. 3, 1887, p. 64, pl. 5, fig. 5; Oamaru, New Zealand.—SCHMIDT, Atlas Diat., pl. 132, fig. 17, 1888.

Individuals of this species are not uncommon in the Maria Madre Island deposit. They have the heavy secondary beading, large spines as shown by Schmidt and ten sectors. He figures two other specimens from Oamaru, New Zealand (the type locality), one with eight rays and a much larger one with fourteen. Our specimen figured, No. 1878 (C.A.S. coll.), is .0338 mm. in diameter; another is .0368 mm. The photograph on plate 11 was taken with the focus so adjusted that the large maculations on the out-of-focus sectors do not show. Therefore the drawing has been added to indicate this feature.

9. *Actinoptychus perplexus* Hanna & Grant, new species

Plate 11, figures 10, 11

Valve circular, divided into six equal segments and a hexagonal hyaline area in the center; under moderate magnification the divisions between the segments appear as black bars and the disk is covered with an irregular mottling of black on light ground; with immersion objectives of N. A. 1.20 or more the disk is found to be covered uniformly with two layers of beads; one of these, the uppermost in the type specimen, consists of comparatively large rounded beads, rather indefinitely arranged in two sets of rows set diagonally to the radii; in the other set the beads are about half as coarse and are much more crowded, being poorly arranged in rows parallel to the radii; the outer margin of each segment bears a short spine in the center and one of the segments has a comparatively large ocellus. Diameter .0622 mm.

Type: No. 1879, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The photographs show the markings of this species well and they appear to be thoroughly diagnostic; they require considerable manipulation of the microscope for proper study.

10. *Actinoptychus solisi* Hanna & Grant, new species

Plate 12, figures 1-3

Valve circular with 14 to 18 sectors, each alternating one being provided with a short spine at the outer end; central area blank; markings in two series; first a set of large rounded protuberances, too massive to be called beads, arranged apparently in no very definite form and scattered uniformly but sparsely throughout the valve, the smooth central area excepted; the other set of markings consists of a series of small but distinct, round beads set in two series of rows at angles of about 50° with the radii and uniformly distributed over the ornamented area; outer ends of non-spine bearing sectors raised out of the plane of the remainder and therefore appearing as blank spaces in photographs. Diameter of type .1352 mm.; of paratype No. 1881 .0654 mm.; of paratype No. 1882 .190 mm.

Type: No. 1880; *paratypes* Nos. 1881, 1882, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species belongs to a group of which *A. incisa* Grunow is the form most familiar to western students, on account of its being a common species in the upper part of the Monterey Shale. But in no specimen of that species we have seen has there been more than a faint indication of the system of large secondary markings so evident on *A. solisi*. Moreover, *A. incisa* invariably has blank spaces of greater or less extent following the median lines of alternating sectors from the central hyaline area; *A. solisi* has none.⁸

The species is large and very handsome and we take pleasure in naming it for Sr. Ing. Octavio Solis, Director of the botanical garden of Chapultepec and a member of the Academy expedition of 1925.

⁸ See SCHMIDT, Atlas Diat., pl. 154, figs. 2, 3, (1890)—HANNA & GAYLORD, Bull. Am. Assoc. Petrol. Geol., Vol. 9, No. 2, 1925, pl. 4, fig. 1, (*A. incisa*.)

11. *Actinoptychus undulatus* (Bailey)

Plate 12, figure 4

Actinocyclus undulatus BAILEY, Amer. Journ. Sci. Arts, 1842, pl. 2, fig. 11. Richmond, Virginia.—KÜTZING, Kieselshaligen Bacillarien, 1844, p. 132, pl. 1, fig. 24.

Actinoptychus undulatus RALFS in PRITCHARD, Hist. Infusoria, 1861, 4th ed., p. 839, pl. 5, fig. 88.—SCHMIDT, Atlas Diat., pl. 1, figs. 1-6, 1874.

The most common diatom in the Maria Madre Island deposit is an *Actinoptychus* which we have considered to be *undulatus*. The specimen figured is characteristic of the forms, and, although great variation was noted, this average-sized one is .0553 mm. in diameter. It is No. 1883 (C.A.S. coll.).

12. *Amphora crassa* Gregory

Plate 12, figure 5

Amphora crassa GREGORY, Diat. Clyde, p. 524, pl. 14, fig. 94.—SCHMIDT, Atlas, Diat., pl. 28, fig. 16, 1875.

Our specimens from Maria Madre Island Miocene do not seem to differ from the above sufficiently to warrant specific separation. The one figured, No. 1884 (C.A.S. coll.), is .1174 mm. in length and .0192 mm. in breadth.

13. *Amphora maria* Hanna & Grant, new species

Plate 12, figure 6

Valve asymmetrical, crescentic, ends rounded knob-like; concave margin gently convex in the region of the central nodule; convex side with a zone of heavy, transverse, costæ, easily resolvable into beads under proper illumination; between this zone and the raphe there is a blank space followed by a row of coarse beads close to the raphe; on the concave side a row of heavy transverse costæ starts with each end but these decrease in length to finer and finer beads toward the central nodule which they do not reach. The type is .1080 mm. in length and .020 mm. in breadth.

Type: No. 1885, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The only species with which this striking form needs comparison is one illustrated by Schmidt⁹ from Campeche Bay, Gulf of Mexico, and which he stated was "perhaps a new species," but he did not name it. His figure 14, in particular, is very close to the specimen figured herewith. He compared these figures with *A. egregia* Ehrenberg,¹⁰ but an examination of the original figure of that species shows a hopelessly indeterminate diatom in zonal view. Wolle,¹¹ however, copied Schmidt's figures and referred them unconditionally to *A. egregia*. Under such circumstances no course is possible for us but to give our fossil a new name and recommend that the name *A. egregia* be put in the list of indeterminates.

14. *Arachnoidiscus manni* Hanna & Grant, new name

Plate 12, figures 7-9

- Arachnoidiscus ornatus montereiiana* SCHMIDT, Atlas Diat., pl. 73, figs. 7-9, Jan. 28, 1882; type loc. "Monterey," California, Miocene. Not
A. ehrenbergii montereyana SCHMIDT, Atlas Diat., pl. 68, fig. 2, July 20, 1881; type loc. "Monterey," California, probably living.
Arachnoidiscus ornatus montereiianus HANNA & GAYLORD, Bull. Am. Assoc. Petrol Geol., Vol. 9, No. 2, 1925, pl. 5, fig. 2.

This is a common fossil diatom in the Miocene Monterey Shale of California and has often been referred to as *A. ornatus*. Schmidt detected the differences and named it but unfortunately the name he gave had been used for a different form on an earlier plate and *montereiiana* must pass into synonymy. Since it is a very important species and will unquestionably be often referred to we take pleasure in naming it after Dr. Albert Mann, the foremost diatomist of the United States.

It is believed that the photographs reproduced herewith give a better picture of this fossil form than any previous illustrations with the possible exception of those of Schmidt. As usual in the genus there is considerable variation but the minuteness of the beads is a distinguishing feature. The specimens figured from Arroyo Hondo, Maria Madre Island (Tres

⁹ Atlas Diat., pl. 28, 1875, figs. 13-15.

¹⁰ Abhand. Kon. Acad. Wiss. Berlin, 1872, fig. 20.

¹¹ Diat. N. Amer., pl. 3, figs. 20, 21, pl. 4, fig. 1.

Marias Group) are as follows: No. 1886 (type) diam. .1720 mm.; No. 1887, diam. .1840 mm.; No. 1888, diam. .100 mm.; (C.A.S. coll.).

15. *Asterolampra marylandica* Ehrenberg

Plate 13, figure 1

Asterolampra marylandica EHRENBURG, Ber. Akad. Wiss. Berlin, 1845, p. 76, f. 10.—BAILEY, Amer. Journ. Sci., Vol. 48, 1845, pl. 4, fig. B.—GREVILLE, Trans. Micr. Soc. London, n. s. Vol. 8, 1860, p. 108, pl. 3, figs. 1-4; Vol. 10, 1862, p. 44, pl. 7, figs. 1-3.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 273.

Individuals of what appears from the published figures to be this variable species occur not infrequently in the Maria Madre Island deposit. A few minor differences have been noted, but they do not appear to be of sufficient importance to warrant specific separation. *A. marylandica* originally was described from the Miocene deposit at Nottingham, Maryland, but has since been found widely distributed. The specimen figured, No. 1889 (C.A.S. coll.), is .0790 mm. in diameter.

16. *Asteromphalus dubius* Hanna & Grant, new species

Plate 13, figure 2

Valve divided into ten equal sectors with division ribs approximately equal in size; beaded zone equal to one-half the radius; the beads of each sector arranged in three rows 60° apart; rosette divided into 10 parts with heavy ribs between; these ribs are not radially straight and near the outer ends there are angular turns in various directions; two divisions of the rosette are larger than the others and these two meet in the center of the valve. Diameter .060 mm.

Type: No. 1890, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species is distinct from all others known to us although closely approaching *A. moronensis* Greville,¹² from a deposit in Spain. That species has nine sectors, one of the dividing ribs

¹² Schmidt, Atlas Diat., pl. 38, fig. 24, 1876.

being narrower than the others, and the parts of the rosette are differently arranged. But the similarity of the rosette of both these and some other species to typical asymmetrical *Asteromphalus* has led us to include ours in that genus. It was unquestionably such intermediate forms as these that caused Greville to unite *Asteromphalus* and *Asterolampra* in one genus.

17. *Aulacodiscus margaritaceus* Ralfs

Plate 13, figures 3, 4

Aulacodiscus margaritaceus RALFS, PRITCHARD, Infusoria, 4th ed. 1861, p. 844; type locality, Potos Island guano, Gulf of California.—SCHMIDT, Atlas Diat., pl. 37, 1876, figs. 1-8; pl. 105, 1886, figs. 1, 4, 5.—WOLLE, Diat. N. Am. 1894, pl. 82, figs. 1-2.—EDWARDS, Trans. San Francisco, Micr. Soc. pt. 1, 1893, p. 13, 14; "Santa Monica," California, Miocene.

This species has been listed from the Miocene shales of California more than once; in fact, Schmidt's first figures (pl. 37, figs. 1-4) are from "California" and were published in 1876. We cannot find that Ralfs illustrated the species, and, if not, California should be considered the type locality because, without figures, the best descriptions of diatoms are almost worthless. At the date the Atlas was published European workers had received comparatively little material from California other than fossil and it seems fairly safe to assume that Schmidt's was the latter. Therefore, we are inclined to consider Monterey Shale as the original type material of this species, rather than that of Ralfs from the Gulf of California.

We have two perfect specimens from the Miocene deposit of Arroyo Hondo, Maria Madre Island. One has eleven spines and the other three, yet they seem to be the same; the number of spines in this genus is a dangerous criterion for the separation of species. The smaller specimen with three spines has practically no umbilicus, but specimens similar in this respect have been figured heretofore. The species is very convex in the center.

The specimen with three spines, No. 1891 (C.A.S. coll.), is .1114 mm. in diameter; the one with 11 spines, No. 1892, is .1476 mm. in diameter.

18. *Aulacodiscus rellæ* Hanna & Grant, new species

Plate 13, figures 5, 6

Valve circular, typically with five spines; each spine set in a hyaline area and this surrounded by a raised, convex ridge on which there are ridges, radial from the spine; central area circular and hyaline, with narrow, hyaline, radial areas to each spine; disk uniformly dotted with fine closely-set beads. The area enclosed by the spines and a narrow marginal zone between the spines have sparsely, irregularly, arranged beads about twice as large as those covering the disk; neither more nor fewer than five spines have been seen. Diameter .0539 mm.

Type: No. 1893, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

Only three species are known to us with which this strange diatom needs comparison; *A. barbadensis* Ralfs¹³ is closest, but it has four spines only, the large, secondary beads are uniformly distributed over the disk and the spaces around the spines are radially marked only on the outer sides; in *A. rellæ* these spaces are marked completely around. *A. circumdatus* Schmidt,¹⁴ from the Monterey Shale of California, likewise has four spines, large secondary beads only in the center of the disk, and the marginal zone is marked with some heavy dark spine-like projections of silica. Another similar species is *A. notatus* Grove & Sturt,¹⁵ from the fossil deposit at Oamaru, New Zealand; this has four hyaline spaces, each with a spine and, like *A. rellæ*, with radial markings all around; some heavier beading is found in the central area but not elsewhere.

All three of the above mentioned species and *A. petersi* Ehrenberg, form a group in *Aulacodiscus*, set apart by the presence of large secondary beads on the disk.

The species is named for Mrs. Rella Grant in recognition of much assistance rendered in the preparation of the illustrations of this and other papers.

¹³ Schmidt, Atlas Diat., pl. 146, fig. 5, 1890.

¹⁴ Schmidt, Atlas Diat., pl. 35, fig. 5, 1876.

¹⁵ Journ. Quek. Micr. Club, Ser. 2, Vol. 3, 1837, p. 9, pl. 3, fig. 11.

19. *Auliscus caballi* Schmidt

Plate 13, figure 7

Auliscus caballi SCHMIDT, Atlas Diat., pl. 32, figs. 1, 2, 1875; Puerto Cabello.

We have picked out several valves of an *Auliscus* with three ocelli each and these are certainly very close to the form named by Schmidt. No differences which would warrant specific separation can be detected. This form appears to differ chiefly from *A. elaboratus* Ralfs¹⁶ in the presence of spines between the ocelli in *A. caballi* which are lacking in Ralfs' species from Barbados. Otherwise they are very similar indeed. The specimen figured, No. 1894 (C.A.S. coll.), is .0366 mm. in diameter.

20. *Auliscus cælatus* Bailey

Plate 13, figure 8

Auliscus cælatus BAILEY, Smith. Contr. Knowl., Vol. 7, 1854, p. 6, pl. 1, fig. 3-4.—SCHMIDT, Atlas Diat., pl. 32, 1875, fig. 15; "Monterey."—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 282.

Individuals which agree in almost every detail with the figure, cited above, by Schmidt and which he stated was typical *cælatus* of Bailey, are numerous in the Maria Madre Island deposit. Others tend to show some of the great variability described by Dr. Mann. The specimen figured, No. 1895 (C.A.S. coll.), is .10 mm. in greatest diameter; .0908 mm. in least diameter.

21. *Auliscus grunovii* Schmidt

Plate 13, figure 9

Auliscus grunovii SCHMIDT, Atlas Diat., pl. 30, 1875, fig. 14.—WOLLE, Diat. N. Am., 1893, pl. 79, fig. 11.

This coarsely-marked species is present in considerable numbers in the Maria Madre Island deposit. The original locality given by Schmidt is "Rio, Brasil." On a later plate¹⁷ he listed as a subspecies of it, "Californica" Grunow and in the index

¹⁶ Schmidt, Atlas Diat., pl. 67, 1881, fig. 4.

¹⁷ Schmidt, Atlas, pl. 89, 1886, fig. 8.

to the atlas Fricke says to compare both with *A. elegans* Greville, but it seems to us that Schmidt's original figure represents a distinct species. Our specimens could hardly be expected to agree more closely than they do, yet none of them indicates intergradation with either *elegans* Greville or *californica* Grunow or *californicus* Brun. The specimen figured, No. 1896 (C.A.S. coll.) is .0660 mm. in diameter and practically circular.

22. *Auliscus pruinosus* Bailey

Plate 13, figure 10

Auliscus pruinosus BAILEY, Smith. Cont. Knowl., Vol. 7, 1854, p. 5, pl. 1, fig. 5-8.—SCHMIDT, Atlas, Diat., pl. 31, 1875, figs. 6, 7, 11, 13-15; pl. 32, 1875, fig. 5, pl. 108, fig. 10.—MANN, Cont. U. S. Herb., Vol. 10, No. 5, 1907, p. 283.

Auliscus punctatus BAILEY, Smith. Cont. Knowl., Vol. 7, 1854, p. 5, pl. 1, fig. 9.—SCHMIDT, Atlas Diat., pl. 31, 1875, figs. 8, 9; pl. 67, 1881, figs. 7-8; pl. 89, 1886, figs. 14-17.

The figures cited above show considerable variation but, as Dr. Mann has pointed out, there seems to be no useful purpose served in attempting to divide them as Bailey did. So many intergradations occur that numerous specimens cannot be assigned to either form, *pruinosus* or *punctatus*, and under such circumstances union seems to be the logical course to take. The species in common in the deposit at Arroyo Hondo, Maria Madre Island. The specimen figured, No. 1897 (C. A. S. Coll.) is .0932 mm. in greatest diameter and .0860 mm. in least diameter.

23. *Biddulphia consimile* (Grunow)

Plate 13, figures 11, 12

Triceratium (Odontella) consimile GRUNOW, VAN HEURCK, Syn. Diat. Belg. 1885, pl. 108, fig. 2; "Santa Monica," California; from a piece of Miocene float.—EDWARDS, Trans. San Francisco Micro. Soc. pt. 1, 1893, p. 16, "Santa Monica."

Triceratium consimile GRUNOW, SCHMIDT, Atlas Diat., pl. 84, 1885, figs. 13, 14; "Campeche Bay," Gulf of Mexico.—WOLLE, Diat. N. Am. 1894, pl. 106, fig. 6; "Santa Monica," California.

We have one beautiful specimen and saw several others, somewhat fragmentary in the Miocene material from Arroyo

Hondo, Maria Madre Island. These agree fairly well with this species, originally described from the Miocene of California. The presence of the large spines at the corners makes it necessary to place it in the genus *Biddulphia*. In Grunow's original figure the cells are larger than in our specimens and the sides are a very little straighter. Each cell or bead is surrounded by a row of minute dots as Grunow showed. The specimen figured, No. 1899 (C. A. S. Coll.) is .1236 mm. long on each side.

24. *Biddulphia deodora* Hanna & Grant, new species

Plate 14, figures 1, 2

Valve quadrangular, sides concave, corners acutely rounded; border narrow and marked by numerous short spines; spinous corner processes marked with about six coarse dots; surface with numerous large square beads arranged in radial rows; a central circular area having a much fewer number. Length of each side of type .0340 mm.

Type: No. 1900, *paratype* No. 1901, Mus. Calif. Acad. Sci., from Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico; collected by Hanna & Jordan, May, 1925; Miocene.

The above is a description of the type specimen. A paratype containing five points and smaller marginal spines has been selected because the two appear to be the same species. These come closest to a small pentagonal form figured by Schmidt¹⁸ as *Triceratium antillarum* Cleve, but we do not find the definitely bounded circular space indicated for it.

25. *Biddulphia jordani* Hanna & Grant, new species

Plate 14, figure 3

Valve very small, triangular, margins almost straight, angles bluntly rounded; border zone very heavy as in *B. montereyi* (Brightwell)¹⁹; surface with sparse, very heavy beads, irregularly arranged except over the border zone where there are rows of three, each pointing toward center of valve; corners

¹⁸ Atlas Diat., pl. 99, 1886, fig. 14.

¹⁹ Schmidt, Atlas Diat., pl. 94, figs. 1-3, 1886.

without spines and ornamented with beads similar to the valve but growing progressively smaller, outwardly. Length along one margin, .0337 mm.

Type: No. 1898, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species is apparently closest to *B. montereyi* but is much smaller and has far fewer markings on the valve. It is named for the late Mr. Eric Knight Jordan, at the time of his death assistant curator of paleontology, California Academy of Sciences, and a member of the Academy's expedition of 1925.

26. *Biddulphia penitens* Hanna & Grant, new species

Plate 14, figures 4, 5

Valve quadrangular, apices rounded, sides gently concave; margin narrow, hyaline; markings consist of rows of beads radiating from margin toward center, the rows being widely spaced and beads decreasing in size on the corners; about 15 rows of beads of uniform size on each side; the beads become much scarcer in the center of the valve where they form an indistinct rosette. Length of one side of type .0435 mm.; of paratype .070 mm.

Type: No. 1902, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species is marked similarly to *B. parallela* (Greville) and its triangular forms,²⁰ but that species has convex margins instead of concave. The form named *B. parallela coloniensis* (Grunow), by Schmidt²¹ from Colon, Panama, comes closest to our specimens but the latter have much heavier beads and there is a decided break between the beading of the central zone and the remainder of the valve; such a division does not appear in Schmidt's figure.

27. *Biddulphia riedyi* Hanna & Grant, new species

Plate 14, figure 6

Valve, triangular, sides straight, angles acutely pointed; each corner is occupied by a blunt projection, densely but

²⁰ See Schmidt, Atlas Diat., pl. 75, 1882, figs. 3-5 and 11-12.

²¹ Atlas, pl. 81, 1885, fig. 1.

minutely beaded on top; border zone of each side with several dense, siliceous bars, irregular in shape, projecting inwardly; surface of valve sparsely covered with round, heavy beads; from the center of each side, a rounded elevated ridge projects inwardly, all three meeting in the center. Length of each side .140 mm.

Type: No. 1904, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This large and handsome species is related to few others that we can find. *Biddulphia tabellaria* (Brightwell) and the subspecies *diplosticta* Grunow²² are similarly constructed but differ greatly in details, particularly in the fine beading found on the surface of the valve and the lack of the three radiating ridges mentioned above at the end of the description. The two fossils, *B. dobreana novæ-scelandiæ* (Grove & Sturt) and *B. majus* (G. & S.²³) from the deposit at Oamaru, New Zealand, are likewise similar in general construction but differ even more in detail.

The species is named for Messrs. Charles and Frank Riedy of San Francisco, in recognition of their long continued interest in microscopy and the former San Francisco Microscopical Society.

28. *Biddulphia tuomeyii* (Bailey)

Plate 14, figure 7

Zygoceros tuomeyii BAILEY, Amer. Jour. Sci. Arts, Vol. 46, 1843, p. 138, pl. 3, figs. 3-9.

Biddulphia tuomeyii (BAILEY) RALFS in PRITCHARD, Hist. Infus. 4th ed. 1861, p. 848, pl. 6, fig. 10.—SCHMIDT, Atlas Diat., pl. 118, figs. 1-7; pl. 119, figs. 1-7, 15-17, 1888.

If all of the various forms figured by Schmidt as *B. tuomeyii* are that species, then our Maria Madre Island ones are also, unquestionably. And since ours resemble those he gives from eastern north America, the type locality, more than any others, it is very likely that our identification is correct even though the assemblage be broken up into several species, ultimately.

²²Schmidt, Atlas Diat., pl. 77, 1882, figs. 1-5.

²³Schmidt, Atlas Diat., pl. 168, figs. 2, 5, 1891.

The specimen figured, No. 1905 (C.A.S. coll.), is .080 mm. in length, and .040 mm. in width when in the position in which it was placed when the photograph was taken.

29. *Campylodiscus prentissi* Hanna & Grant, new species

Plate 14, figure 8

Valve broad, almost circular in vertical view; deeply saddle-shaped; divided on each side of a median section into 10 wide compartments separated by simple bars of silica, curved toward each end of the valve and each one bifurcate on the outer end; median section with parallel sides formed by breaks in the transverse bars, which, however, continue across the middle; between each pair of bars at the side of the median section there is an oblong bead; no fine markings could be discovered with a numerical aperture up to .95. Length along median line of type .0426 mm.; breadth at right angles to median line .0422 mm.

Type: No. 1906, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This coarsely marked species is not recorded in any of the literature at our command, and is not closely approached by any other. It has been named for Mr. Charles W. Prentiss of San Francisco, California, an enthusiastic preparer of diatoms.

30. *Cerataulus imperator* Hanna & Grant, new species

Plate 14, figure 9

Valve broadly oval, very convex, border narrow; horns long cylindrical, blunt and hyaline on top; spines absent; disk covered with heavy beading arranged radially near the margin but irregularly elsewhere; the beads over the greater portion are grouped in such a manner that the valve has a disorderly reticulate network-appearance under low magnification, markings similar in many ways to those of *Eupodiscus rogersii*. Length .1264 mm.; breadth .0936 mm.

Type: No. 1907, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

Individuals of this huge, coarsely-marked species were rarely found in the Maria Madre Island deposit; they seem to require no close comparison with other forms for recognition.

31. *Cocconeis contrerasi* Hanna & Grant, new species

Plate 14, figure 10

Valve broadly oval with raphe greatly sigmoid; central and terminal nodules minute; densely and uniformly beaded over the disk, the beads arranged in somewhat radial rows; border narrow. Length .0391 mm.; breadth .0340 mm.

Type: No. 1908, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This beautiful species belongs to the group of which *C. dirupta* Gregory is perhaps the most common representative, but the differences are very evident upon comparison with such figures as Schmidt's.²⁴

The species is named in honor of Professor Francisco Contreras, a distinguished naturalist of Mexico and a member of the Academy's expedition of 1925.

32. *Cocconeis triumphis* Hanna & Grant, new species

Plate 14, figures 11-13

Valve broadly ovate with narrow hyaline border; raphe, a narrow lanceolate blank area reaching to the ends and crossed at the center with a transverse and narrower blank strip; otherwise the disk is covered with fine beads uniformly distributed in rows, radiating irregularly from the median area toward the margin, but, before reaching the latter, the beads assume positions in diagonal rows of various angles and directions producing chiefly a wavy appearance. Length of type specimen .0620 mm.; breadth .0461 mm.; length of paratype (No. 1910) .0347; breadth .0270 mm.

Type: No. 1909, *paratypes* Nos. 1910, 1911, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

²⁴ Schmidt, Atlas Diat., pl. 197, figs. 31-34, 1895.



The characters in general are the same as those of a fossil from Sendai, Japan, called *C. formosa* Brun by Schmidt,²⁵ but the beading of the Maria Madre Island species is very much finer and the rows radiate from the central area only part way to the border; the outer zone has the beads in rows which take various diagonal directions.

33. *Coscinodiscus curvatus* Grunow

Plate 15, figure 1

Coscinodiscus curvatus GRUNOW; SCHMIDT, Atlas, Diat., pl. 57, 1877, Fig. 33; "Monterey," California; probably from a Miocene fossil deposit.

Apparently the fossil deposit at Monterey, California, is the type locality of this species and our specimens from the Miocene of Maria Madre Island could hardly come closer to perfect agreement with the figure in Schmidt's Atlas than they do, although his figures from other localities are not so close. The curved radial rows of beads dividing the disk into sectors and the additional rows in each sector parallel to the division row are very characteristic features, possessed by no other diatom than this group. Differences in living specimens from other localities pertain to width of border and size of beads, both characters of relatively little value in this group.

Diameter of specimen figured (No. 1912, C.A.S. coll.) .0658 mm.

34. *Coscinodiscus elegantulus* Greville

Plate 15, figure 2

Coscinodiscus elegantulus GREVILLE, Trans. Micr. Soc. London, Vol. 9, n. s. 1861, p. 42, pl. 4, fig. 8.—SCHMIDT, Atlas Diat., pl. 58, 1877, figs. 3-5; Barbados.

This remarkable diatom is not uncommon in the Miocene deposit on Maria Madre Island. Its chief distinguishing feature is the excentrically placed central area. Diameter of specimen figured (No. 1913, C.A.S. coll.) .0558 mm.

²⁵ Schmidt, Atlas Diat., pl. 193, fig. 47, 1894.

35. *Coscinodiscus evermanni* Hanna & Grant, new species

Plate 15, figure 3

Valve circular, large and heavy; central area depressed below a huge rounded marginal zone the diagrammatic cross section being as shown in figure 1; there is no suture between



Fig. 1. Diagrammatic cross section of *Coscinodiscus evermanni*, n. sp.

central and marginal areas as in *Craspedodiscus* and no break in the arrangement of the markings as in *Creswellia*; coarse markings arranged essentially as in *C. radiatus*, these being a group of slightly larger beads in the center but no central pore; each bead on the marginal zone has a circle of fine punctae or secondary markings as in *C. asteromphalus* and many other species, but no such structures could be found on the beads of the central area with a 4 mm. (N. A. .95) objective; the hoop connecting the valves is marked with beads of uniform size set in diagonal rows, at 90°. Diameter of type .1556 mm.; width of central area about .10 mm.; diameter of largest paratype .1564 mm.; diameter of smallest paratype .1176 mm.

Type: No. 1914, *paratypes* Nos. 1915, 1916, Mus. Calif. Acad. Sci., from Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico; collected by Hanna & Jordan, May, 1925; Miocene.

This robust species is very common in the deposit on Maria Madre Island but perfect specimens are hard to find; the large size causes most of the valves to be broken, either in the bedding or in the cleaning processes. Hoops are abundant but almost always detached from the valves. The species is a connecting link between *Coscinodiscus* and *Craspedodiscus* and is much like *Craspedodiscus coscinodiscus* Ehrenberg²⁰ but the central zone in that form is much narrower. We have included it in *Coscinodiscus* because of the lack of a definite

²⁰ Schmidt, Atlas Diat., pl. 66, 1881, figs. 3, 4.

suture between central and marginal zones which is typically developed in *Craspedodiscus*. The edge of the valve is turned down at right angles to the disk as in *Endyctia*; thus a complex of characters is displayed which makes a correct generic assignment almost impossible.

The type slide contains three fairly complete specimens, which show approximately the variation in size.

The species is named for Dr. Barton Warren Evermann, Director of the California Academy of Sciences, who was responsible for the organization and despatch of the expedition of 1925 to West Mexican Islands.

36. *Coscinodiscus fasciculatus* Schmidt

Plate 15, figure 4

Coscinodiscus fasciculatus SCHMIDT, Atlas Diat., pl. 57, 1877, figs. 9, 10; "Cuxhaven."

This species, according to Schmidt's figures, has the beading arranged in radial rows and also there is produced a "watch case milled" effect similar to *C. radiatus*; in addition, there are some radial "pyrotechnical" markings as in *Actinocyclus pyrotechnicus*, thus making an exceedingly beautiful diatom. The species appears to be rare in the Maria Madre Island deposit. Diameter of specimen figured, No. 1917 (C.A.S. coll.), .0687 mm.

37. *Coscinodiscus hertleini* Hanna & Grant, new species

Plate 15, figure 5

Coscinodiscus concavus EHRENBERG, SCHMIDT, Atlas Diat., pl. 59, 1877, fig. 16; "Monterey," California; probably from a Miocene fossil deposit. This figure, Dr. Mann stated, does not belong to *C. concavus* of Ehrenberg (Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 248).

Valve flat, coarsely marked with a network of hexagons, the size of these decreasing slightly at the margin; the disk is roughly divided into sectors by a few almost straight radial rows, the remaining rows in the sector being approximately parallel to the central radial; this makes a secondary series of rows of beads in parallel arcs which cut the margin of the

valve; border narrow and transversely marked. Diameter of type .0480 mm.

Type: No. 1918, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

In the arrangement of the details of markings this species falls in with *C. denarius* Schmidt²⁷ from the fossil deposit of Barbados, West Indies. The markings of that form, however, are much finer and no described species in the same group can be found which is so coarse as the Maria Madre Island one. The markings of the new species are as coarse as in *C. heteroporus* or *C. radiatus*, but these appear never to have the peculiar arrangement of beads of the *C. denarius* group.

The species is named for Mr. Leo G. Hertlein, of the Department of Paleontology, California Academy of Sciences.

38. *Coscinodiscus lineatus* Ehrenberg

Plate 15, figure 6

Coscinodiscus lineatus EHRENBURG, Phys. Abhl. Akad. Wiss. Berl. 1838, p. 129 [1840].—EHRENBURG Microg. 1854, pl. 18, fig. 33; pl. 22, fig. 6 a-b; pl. 35 A, group 16, fig. 7.—SCHMIDT, Atlas Diat., pl. 59, 1877, figs. 26-32.—WOLLE, Diat. N. Am. 1894, pl. 87, fig. 10.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, p. 253.

This species is found frequently in the Miocene deposit on Maria Madre Island, but the valves are so delicate that perfect specimens can hardly be found. The width of the border and the development of the marginal spines in the species is subject to considerable variation as Dr. Mann has pointed out. Diameter of specimen figured, No. 1919 (C.A.S. coll.), .100 mm.

39. *Coscinodiscus marginatus* Ehrenberg

Plate 15, figure 7

Coscinodiscus marginatus EHRENBURG, Phys. Abhl. Akad. Wiss. Berl. 1841, p. 142 (1843).—EHRENBURG, Microg. 1854, pl. 18, fig. 44; pl. 13, group 12, fig. 13; pl. 38 B, group 22, fig. 8.—SCHMIDT, Atlas Diat., pl. 62, 1877, figs. 1-5, 9, 11, 12.—WOLLE, Diat. N. Am. 1894, pl. 94, fig. 21; pl. 112, fig. 8.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 253, pl. 49, fig. 2.

²⁷ Atlas Diat., pl. 57, 1877.

Although some of our specimens from the Miocene deposit of Maria Madre Island have narrower borders than Schmidt and others have usually shown in their figures, agreement otherwise is so close that we feel justified in making the identification. This is particularly true in view of the confusion so often pointed out in this group of *Coscinodiscus*. Diameter of specimen figured (No. 1920, C.A.S. coll. smaller than average) .0357 mm.

40. *Coscinodiscus masoni* Hanna & Grant, new species

Plate 15, figure 8

Valve circular, very convex, margin rather broad; markings consist of small, closely-set beads arranged in 13 sectors; each sector has a central radial row of beads extending from the center of the valve to the margin; all the other rows of beads in each sector are parallel to this central one; in the center of each sector and just inside of the border there is a blunt spine, shown as a white spot in the photograph. Diameter .1154 mm.

Type: No. 1930, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This strange species does not seem to resemble very closely any other that has been found. The arrangement of the beads in definite sectors is a very striking feature and so is the great convexity of the valves.

The species is named for Mr. H. L. Mason, the botanist of the Academy's Expedition of 1925.

41. *Coscinodiscus nitidus* Gregory

Plate 15, figure 9

Coscinodiscus nitidus GREGORY, Trans. Roy. Soc. Edinburgh, Vol. 21, 1857, p. 27, pl. 2, fig. 45.—SCHMIDT, Atlas Diat., pl. 58, 1877, figs. 17-19; Campeche Bay, Gulf of Mexico.

We have a beautiful specimen from the Maria Madre Island deposit that appears to be this coarsely-marked species from the Gulf of Mexico. It is hardly to be confused with any other *Coscinodiscus* except the one Rattray has named *C. sub-*

*nitidus*²⁸ from the Barbados fossil deposit. This latter does not appear to deserve separation from *C. nitidus*. Diameter of specimen figured (No. 1921, C.A.S. coll.) .0314 mm.

42. *Coscinodiscus nitidulus* Grunow

Plate 15, figure 10

Coscinodiscus nitidulus GRUNOW, SCHMIDT, Atlas Diat., pl. 58, 1877, fig. 20; "Campeche Bay," Gulf of Mexico.

A single specimen of this delicate diatom was found in the Maria Madre Island Miocene material. It differs from Schmidt's figure only in having the beads roughly arranged in radial rows while in his they are more or less in zones, there being three radial rows in each. But since the arrangement is not well marked in either form it is believed to be unimportant. Diameter of specimen figured (No. 1922, C.A.S. coll.) .0475 mm.

43. *Coscinodiscus oculus-iridis* Ehrenberg

Plate 15, figure 11

Coscinodiscus oculus-iridis EHRENBURG, Phys. Abh. Akad. Wiss. Berl. 1839, p. 147 (1841).—EHRENBURG, Microgeologie 1854, pl. 18, fig. 42, pl. 19, fig. 2.—SCHMIDT, Atlas Diat., pl. 60, 1877, fig. 17; pl. 63, 1877, figs. 4, 6-9; pl. 113, 1888, figs. 1, 3-5, 20.—MANN, Cont. U. S. Nat. Herb., Vol. 10 No. 5, 1907, p. 256.

A few typical specimens of this widely-spread species were found in the Maria Madre Island Miocene deposit. They appear to be identical with the form Grunow called *C. oculus-iridis morsiana*²⁹ but for which there seems to be little reason for acceptance. The subspecies originally came from Miocene material from Santa Monica, California. Diameter of specimen figured, No. 1923 (C.A.S. coll.), .1454 mm.

²⁸ See Schmidt, Atlas Diat., pl. 58, 1877, fig. 16, and Fricke's Index to same, 1902, p. 7.

²⁹ Schmidt, Atlas Diat., pl. 60, 1877, fig. 7; see Fricke, Index to Atlas, 1902, p. 7.

44. *Coscinodiscus pacificus* Grunow

Plate 16, figure 1

Coscinodiscus pacificus GRUNOW, SCHMIDT, Atlas Diat., pl. 60, 1877, fig. 13; the identification of this figure from Barbados is by Fricke in the Index to the Atlas, 1902, p. 7.

Specimens from the deposit on Maria Madre Island agree perfectly with Schmidt's figure named above by Fricke. Four rather large beads form a slight rosette in the center and this seems to be the only distinguishing feature between *C. pacificus* and *C. radiatus* Ehrenberg. This group of *Coscinodiscus* is difficult to understand and there can be no doubt but that too many names have been and are still being used. Diameter of specimen figured (No. 1924, C.A.S. coll.) .1296 mm.

45. *Coscinodiscus radiatus* Ehrenberg

Plate 15, figure 12

This and various other so-called species of this section of the genus are very difficult to decipher, but under *C. radiatus* we have placed those coarsely-marked specimens from Maria Madre Island with radial rows of beads, a "watch case milled" effect, and no central pore or rosette of large beads in the center. When this rosette is present and the "milling" still perfect the diatoms appear to have been placed under *C. oculus-iridis*; *C. pacificus* appears to differ from the latter only in the imperfect "milling" arrangement of the markings. Diameter of specimen figured (No. 1924, C.A.S. coll.) .0628 mm.

46. *Dicladia pylea* Hanna & Grant, new species

Plate 16, figures 4, 5

Valve view of frustule a regular, elongated oval, with one conical projection in the center of one valve, this projection being rounded on the tip; the other valve has two conical projections equal in size and with some irregular branches of silica at the tops. Major diameter .0678 mm.

Type: No. 1928, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species occurs frequently in the Maria Madre Island deposit; all other members of the genus known to us are much longer in zonal view than this one.

Mangin³⁰ has stated that the various forms of *Dicladia* are only *stato-spores* of diatoms, normally belonging to other genera. In a fossil deposit, however, the determination of the parent species becomes problematical and it seems best, for the present at least, to record the *Dicladia* as distinct.

47. *Dictyoneis marginata* (Lewis)

Plate 16, figure 8

Navicula marginata LEWIS, Proc. Acad. Nat. Sci. Phila, 1861, p. 64, pl. 2, fig. 1.

Dictyoneis marginata (LEWIS), CLEVE, Le Diatomiste, Vol. 1, 1890, p. 16.—SCHMIDT, Atlas Diat., pl. 160, 1890, fig. 1.—CLEVE, Kongl. Sv. Vet. Akad. Hand., Vol. 26, 1894, p. 30.—VAN HEURCK, Treat. Diat. 1896, p. 157, fig. 29.

Several specimens of this elegant diatom were found in the Maria Madre Island deposit. They are very similar in every way to what Cleve and Schmidt have called "form *typica*." Cleve placed nine species in the genus *Dictyoneis* and under *marginata* he placed seven named subspecies; the species must therefore be very variable although our specimens do not indicate this. For *typica* he gives the following widely separated localities: Mediterranean Sea; Levant; Delaware (type locality); Florida; West Indies; Colon; Gulf of Mexico; Java; all living; and fossil at Szakal, Hungary. Other named forms were listed from the fossil deposits of New Zealand and Japan, but this is apparently the first record of any member of the genus from the eastern Pacific. Although the general dismemberment of the genus *Navicula* as proposed by Cleve is not acceptable to most diatomists, *Dictyoneis* is so different from the usual form that the retention of that name seems to be justified. Length of specimen figured (No. 1929, C.A.S. coll.) .1240 mm.; breadth .030 mm.

³⁰ Rev. Sci. 1912, pp. 481-487.

48. *Endyctia robustus* (Greville)

Plate 16, figures 2, 3

Coscinodiscus robustus GREVILLE, Trans. Micr. Soc. London, n. s., Vol. 14, 1866, p. 3, pl. 1, fig. 8.—SCHMIDT, Atlas Diat., pl. 62, 1877, figs. 16, 17.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 258, pl. 48, fig. 4.—MANN, U. S. Nat. Mus. Bull. 100, Vol. 6, pt. 1, 1925, pp. 67, 68.

Dr. Mann has stated in his 1925 paper on Philippine Diatoms that this species belongs to *Endyctia* and not *Coscinodiscus*. A study of specimens from the Miocene fossil deposit at Monterey, California, the type locality, leaves little room for doubt as to the correctness of this disposition. Our specimens from Maria Madre Island Miocene are unquestionably the same as those from Monterey in our collection. Great variation in size is shown. The smaller specimen figured (No. 1926, C.A.S. coll.) is .0974 mm. in diameter; the larger (No. 1927) is .100 mm. in diameter.

49. *Eupodiscus rogersii* (Bailey)

Plate 16, figures 6, 7

Podiscus rogersii BAILEY; Amer. Journ. Sci. Arts, Vol. 46, Dec. 1843, p. 138, fig. 12.
Eupodiscus rogersii (BAILEY), EHRENBERG, Abh., Berlin Akad., 1844, p. 81.—SCHMIDT, Atlas Diat., pl. 92, 1886, figs. 2-6.—WOLLE, Diat. N. Am. 1894, pl. 76, fig. 3.

Individuals of a species we believe to be this are common in the Maria Madre Island deposit and have four to six spines. The form was originally described from the Nottingham, Maryland, fossil deposit. Diameter of specimen figured with four spines (No. 1931, C.A.S. coll.) .1242 mm.; diameter of specimen figured with six spines (No. 1932) .1646 mm.

50. *Glyphodesmus driveri* Hanna & Grant, new species

Plate 16, figure 9

Valve elongate, naviculoid in shape, rounded terminally and gently convex medially; terminal and central nodules rounded knobs, the latter being the larger; two rows of large quadrangular beads on each side of the pseudo-raphe; these may

be considered as transverse costæ divided in two parts longitudinally, with three or four on each side of the central nodule divided into three parts (in another specimen the longitudinal rows number three through the valve on each side of the central area); pseudo-raphe very distinct and almost equal in width throughout. Length of type .0962 mm.; breadth .0117 mm.

Type: No. 1933, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This elegant species is similar to only one known to us, *G. marinum* (Ralfs), which has the transverse costæ broken into four beads, is more pointed terminally and less convex medially.

The species is named for Mr. Hershel L. Driver, of Los Angeles, California, an enthusiastic student of microorganisms.

51. *Glyphodesmus sigmoideus* Hanna & Grant, new species

Plate 16, figure 10

Valve slightly asymmetrical, swollen at each end and slightly convex in the center; central and terminal nodules distinct; pseudo-raphe distinct and sigmoid in shape corresponding to the asymmetry of the valve; markings consist of about 50 heavy transverse costæ on each side of the pseudo-raphe, each one being broken irregularly into beads. Length of type .0520 mm.; breadth at end .0079 mm.; at center .0061 mm.

Type: No. 1934, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

G. williamsoni W. Smith²¹ appears to be the closest related species to this, but that form is much less swollen terminally, is not convex in the center, and lacks the slight but constant sigmoid outline of the form being described. Very few valves were found, but probably most of them were lost in the cleaning operations due to their small size.

²¹ Wolle, *Diat. N. Am.*, 1894, pl. 45, figs. 23, 24.

52. **Grammatophora merletta** Hanna & Grant, new species

Plate 16, figures 11, 12, 14

Valve elongate, sides approximately parallel, very slightly swollen in center; ends expanded, somewhat capitate; border heavy, and greatly thickened at each end; central area oval with the long axis parallel to the sides; markings consist of parallel, horizontal rows of dots, 35 in .01 mm., on each side of an exceedingly thin median line; the dots are also arranged in quinquex; these markings are exceedingly minute and difficult to resolve, the best optical equipment and monochromatic green or blue light being required to bring them well into view in styrax mounts; in girdle view the long bars of silica are straight throughout most of their length, there being one slight curve at each end. Length of type .0763 mm.; breadth .1010 mm.

Type: No. 1935, *paratype* No. 1970a, Mus. Calif. Acad. Sci., from Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico; collected by Hanna & Jordan, May, 1925; Miocene.

This species is abundant in the Maria Madre deposit and retains its distinctive characters constantly. These consist chiefly in the capitate ends and the excessively fine beading. It is undoubtedly closely related to *G. macilenta* and *G. maxima*³² but neither of these have capitate ends. Of all species of the genus known to us only *macilenta* or its relative *subtilissima* has such excessively fine markings.

53. **Hemidiscus niveus** Hanna & Grant, new species

Plate 17, figure 1

Valve very large, thin and delicate, broadly cuneiform; ends bluntly rounded; median portion of short margin convex, space between this and ends slightly concave; girdle very thick on one side in zonal view; disk uniformly marked with small beads arranged like the milling on a watch case but with irregular separation into radial sectors from the center; a distinct ocellus near the center of the short margin and with a

³² See Van Heurck, Syn. Diat. Belg., 1881, pls. 53, 53 bis.

row of small spines on each side extending to the ends but not around the long, rounded margin. Length of type .1516 mm.; breadth .1030 mm.

Type: No. 1936, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This huge species is exceedingly abundant in the Maria Madre Island deposit but the valves are so delicate that perfect specimens are very difficult to secure. It belongs to the group once named *Palmeria* Greville,³³ but which is not believed to be separable from *Hemidiscus* proper.³⁴

54. *Hemidiscus simplicissimus* Hanna & Grant, new species

Plate 16, figure 13

Valve with margin convex throughout, greatly thickened on one (dorsal) side; ends not produced; ventral side regularly rounded, with an ocellus near the margin but no spines; disk covered with close-set beading, which is largest in the center and decreases in size gradually to the margins; beads not arranged in radial rows but somewhat like watch case milling; border zone narrow and crossed by fine radial lines. Length of type .050 mm.; breadth .0366 mm.

Type: No. 1937, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

In the absence of radial rows of beads and projecting (gibbous) ends this species differs from the well-known *Euodia gibba* Bailey (*H. cuneiformis* Wallich); it is found commonly in the Maria Madre Island deposit. A species found in the Monterey Shale of California is very similar to this and may be the same; it has been referred to *H. gibba* or *H. cuneiformis* in the past, but an examination of the original figures of these³⁵ shows that, while they are probably one and the same as most authors³⁶ have contended, they can hardly be the same as these fossils unless an enormous amount of variation from the type be admitted.

³³ Ann. Mag. Nat. Hist., 1865, p. 2, figs. 1-4.

³⁴ For a discussion of the relationship of this group see Mann, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 316.

³⁵ Bailey in Pritchard, Hist. Infus. ed. 4, 1861, p. 852, pl. 8, fig. 22; Wallich, Trans. Mic. Soc. London, 1860, p. 42, pl. 2, figs. 3, 4.

³⁶ See Mann, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, pp. 316, 317.

55. *Melosira sulcata* Kützing

Plate 17, figure 2

There appears to be no adequate means for the separation of the many variations of *Melosira* which center around the name *sulcata*. No two valves ever appear to be exactly alike and it has been said that even in the same chain of individuals there are differences. Our Maria Madre Island specimens are exceedingly beautiful and differ from the published figures in certain details, but they differ among themselves just as much. Diameter of specimen figured (No. 1938, C.A.S. coll.) .0856 mm.

56. *Navicula ardua* Mann

Navicula ardua MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 336, pl. 53, figs. 2, 3; 864 fms. off Central California.

Our specimens agree precisely with the description and figures of this species from Campeche Bay, Gulf of Mexico, we can find no other described form with which it can be united. As he pointed out, the costæ are strictly unbeaded and therefore the specimens are not admissible with such as *N. pennata* or *N. longa*. One of our Maria Madre Island specimens is .0529 mm. long and .010 mm. wide.

57. *Navicula californica* Greville

Plate 17, figures 3, 4

Navicula californica GREVILLE, Edinburgh 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. Am. 1894, pl. 14, fig. 17.

Specimens which agree in general with the above figures are not rare in the Maria Madre Island deposit. The zones of beading shown in our figure are there represented as lines, but this may perhaps have been due to imperfections in the early objectives. Also the figures cited show the hyaline area stippled with dots; we do not see structures subject to such interpretation on specimens mounted in styrax. In spite of these differences it seems that our specimens are very probably *californica*. Length of specimen figured (No. 1939, C.A.S.

coll.) .0856 mm.; breadth .0548 mm.; (No. 1949) length .0732 mm.; breadth .0488 mm.

The original material described by Greville was reported as from "California Guano." This could hardly mean other than from some of the islands of the Gulf of California or off the west coast of Lower California.

58. *Navicula campylodiscus* Grunow

Plate 17, figures 5, 6

Navicula campylodiscus GRUNOW, SCHMIDT, Atlas Diat., pl. 70, 1881, figs. .64, 65; "Campeche Bay," Gulf of Mexico.—WOLLE, Diat. N. Am. 1894, pl. 12, fig. 15.

Our specimens are believed to be identical with this coarsely-marked form. A feature not shown by Schmidt or Wolle is the depressed central area below the level of the ends; this fortunately is well illustrated in our photograph of a specimen which became accidentally dislodged in mounting. Length of specimen figured (No. 1940, C.A.S. coll.) .0459 mm.; breadth .0285 mm.

59. *Navicula clavata* Gregory

Plate 17, figure 7

Navicula clavata GREGORY, Trans. Micr. Soc. Lond. n. s., Vol. 4, 1856, p. 46, pl. 5, fig. 17.—SCHMIDT, Atlas Diat., pl. 3, 1874, fig. 13; pl. 70, 1881, fig. 50; pl. 129, 1888, fig. 16.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 340.

Navicula hennedyi W. SMITH, VAN HEURCK, Treat. Diat. 1896, p. 204.

Navicula lyra EHRENBERG, SCHMIDT, Atlas Diat., pl. 70, 1881, fig. 47.

Dr. Mann stated in 1907 that this species stands intermediate between *N. lyra* and *N. hennedyi*. The specimens from the deposit on Maria Madre Island, as shown by the figure herewith, fully confirm this view. His specimens from near the Galapagos Islands had the space between marginal and median striations strongly granulated; ours appear to be entirely hyaline. In the deposit concerned the species is very constant in its characters, showing no tendency toward intergradation with others. Length of specimen figured (No. 1941, C.A.S. coll.) .050 mm.; breadth .0315 mm.

60. *Navicula densistriata* Schmidt

Plate 17, figures 8-10

Navicula bombus var. *densistriata* SCHMIDT, Atlas Diat., pl. 13, 1875, figs. 11, 12; "California."

Specimens from the Maria Madre Island deposit are very similar to the figures cited above which were drawn from diatoms, presumably from the Monterey Shale some place in California. If the bars with cross lines represented in the figures may be interpreted to be beads the identity is assured and this seems to be a justifiable assumption because we have numerous specimens from various Monterey Shale localities and all are beaded. It does not seem that there is certain intergradation of these fossils with *N. bombus* Ehrenberg and the form appears to be entitled to specific rank.

Specimen Number	<i>Measurements</i>	
	Length	Breadth
1942	.0820 mm.	.0364 mm.
Not figured	.0660 mm.	.0278 mm.
1943	.090 mm.	.0348 mm.
1944	.0688 mm.	.0288 mm.

61. *Navicula eastwoodi* Hanna & Grant, new species

Plate 17, figure 11

Valve lanceolate, attenuate at the ends, very convex; raphe narrow and straight with slight flexure at each end; surface marked with transverse rows of small beads, not arranged in longitudinal or diagonal rows; central nodule very small, circular, the valve not uniformly convex but with a median area higher than the sides, this area being widest at each end. Length of type .1082 mm.; width .0326 mm.

Type: No. 1945, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

No species of *Navicula* close to this has been found after an extensive search of the literature. Unfortunately the only complete valve found was slightly broken, but it hardly detracts from the remarkable beauty of the specimen.

The species is named for Miss Alice Eastwood, Curator of Botany of the California Academy of Sciences, in recognition of much assistance rendered in securing necessary literature of Diatomaceæ.

62. *Navicula hennedyi* W. Smith

Plate 18, figure 1

Navicula hennedyi W. SMITH, Syn. Brit. Diat., Vol. 2, 1853, p. 93.—SCHMIDT, Atlas Diat., pl. 3, 1874, figs. 17, 18.—WOLLE, Diat. N. Am. 1894, pl. 14, fig. 30.—VAN HEURCK, Treat. Diat. 1896, p. 204, pl. 4, fig. 160, pl. 27, fig. 755.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 345.

The Maria Madre Island fossils agree almost exactly with Schmidt's fig. 17 (Wolle's fig. 30) cited above. Schmidt called his fig. 17 "*Var. manca*" and fig. 18 "typical," but the differences seem insufficient for segregation. If, however, they should be, ours would take the name *manca*. Length of specimen figured (No. 1950, C.A.S. coll.) .100 mm.; breadth .0468 mm.

63. *Navicula impressa* Grunow

Plate 18, figure 2

Navicula impressa GRUNOW in SCHMIDT, Atlas Diat. pl. 6, 1875, figs. 17, 18, 35, 36, 39.—CLEVE, Sv. Vet. Akad. Handl., Vol. 26, 1894, p. 50.—WOLLE, Diat. N. Am. 1894, pl. 14, figs. 25, 26.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, p. 345.

The specimens from the Maria Madre Island deposit agree so well with those in the Atlas, cited above, that no adequate basis for separation can be found. The name *impressa* was originally intended to cover the coarsely-beaded forms (figs. 17, 18), which ours resemble closest, because Schmidt called figs. 35, 36, 39 a "n. sp." Dr. Mann stated, however, that the differences in the figures were not sufficient to admit maintaining two species. Length of specimen figured (No. 1946, C.A.S. coll.) .0888 mm.; width .060 mm.; number of transverse rows of beads in .01 mm. in center of valve 7.

64. *Navicula longa* (Gregory)

Plate 18, figures 3, 4

Pinnularia longa GREGORY, Trans. Mic. Sci. London, Vol. 4, 1856, p. 47, pl. 5, fig. 18.

Navicula longa (GREGORY), DONKIN, British Diatoms, 1871-72, p. 55, pl. 8, 3a, 3b.—SCHMIDT, Atlas Diat., pl. 47, 1876, figs. 8-10.—WOLLE, Diat. N. Am. 1894, pl. 12, fig. 23.

Navicula directa W. SMITH, CLEVE, Kongl. Sv. Vet. Akad. Hand., Vol. 27, No. 3, 1895, p. 27.

Individuals of this coarsely-marked species are common in the Maria Madre Island deposit. The number of short transverse ribs at the stauros varies from two to four. Cleve placed this form under *N. directa* questionably and stated that he had not seen such a diatom as Gregory figured with radial striæ. Length of specimen figured (No. 1951, C.A.S. coll.) .1018 mm.; width .0178 mm.

65. *Navicula lyra* Ehrenberg

Plate 18, figure 5

Numerous specimens of this protean and widely distributed species occur in the Maria Madre Island deposit. The range of variation is much more circumscribed in the series studied than is the rule among living specimens. The specimen figured is representative of the series and corresponds very closely with what Schmidt called "subtypical."³⁷ Numerous variations have been named, based on differences of shape and sculpture, but it appears that our specimens may remain satisfactorily under the species name.³⁸ Length of specimen figured (No. 1952, C.A.S. coll.) .1170 mm.; width .040 mm.

66. *Navicula madræ* Hanna & Grant, new species

Plate 18, figure 6

Valve elongate, indented on the sides with a gentle concave curve; roundly pointed terminally; heavily marked throughout; raphe spindle shaped, rounded at both ends and with a row of 15 beads on each side; margins with 35 heavy costæ,

³⁷ Schmidt, Atlas Diat., pl. 2, fig. 25, 1874.

³⁸ See in this connection, Mann. Cont. Nat. Herb., Vol. 10, pt. 5, 1907, pp. 347-348.

each terminating inwardly in a knob; each rib is marked with a double row of faint beads. Length .080 mm.; width .0270 mm.

Type: No. 1953, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species is similar to the one figured by Schmidt from the Moron Deposit of Spain³⁹; that form, however, has a greater number of beads along the raphe, more ribs along the margins and more secondary beads on each rib. The Maria Madre species is common in the deposit and does not agree in detail with several allied forms from the Monterey Shale of California, such as *N. vagabunda* Brun, *N. sideralis* Brun, etc.

67. *Navicula ortolanæ* Hanna & Grant, new species

Plate 18, figure 7

Valve broadly oblong, rounded on the ends, sides almost straight; raphe narrow and straight; central nodule circular; surface marked with slightly radiating lines of beads, those nearest the margin being largest; in the center of the valve the dots are also so arranged as to make arcs of circles, the convex sides outermost; the valve is decidedly convex but unevenly so. Length .0743 mm.; width .0379 mm.

Type: No. 1954, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

A search of the literature has failed to disclose any species comparable to this. It is very rare, and long search failed to disclose a more perfect specimen than the figured type, but it is believed to be worth describing since all the essential characters are preserved.

³⁹ Schmidt, Atlas Diat., pl. 70, 1881, fig. 74; Fricke, in the index to the Atlas, 1902, stated that this Moron diatom was *Navicula gemmata fossilis* Pantocsek.

68. *Navicula pandura* Brebisson

Plate 18, figure 8

Navicula pandura BREBISSON, SCHMIDT, Atlas, pl. 11, 1875, figs. 1, 2, 4, 8, 9.

Coarsely-marked diatoms with double rows of minute beads on the costæ are common in the Maria Madre Island deposit. They agree in shape and sculpture with the figures cited, but it must be said that some uncertainty attends the identification of any diatom belonging to this group. Cleve⁴⁰ was not able to make satisfactory distinctions and united a great many names, including *pandura*, as "varieties" under *N. crabro*. Length of specimen figured (No. 1948, C.A.S. coll.) .1280 mm.; width .040 mm.

69. *Navicula pelagi* Schmidt

Plate 18, figure 9

Navicula pelagi SCHMIDT, Atlas Diat., pl. 7, 1875, figs. 25, 26.
D. (iploneis) fusca var. *pelagi* A. S., CLEVE, Kongl. Sv. Vet. Akad. Hand., Vol. 26, No. 2, 1894, p. 93.

Specimens which agree almost exactly with the original figures of this species from Campeche Bay, Gulf of Mexico, are common in the Maria Madre Island fossil deposit. They show no indication of intergradation with *N. smithii* in the same deposit.

70. *Navicula prætexta* Ehrenberg

Plate 18, figures 10-12

Navicula prætexta EHRENBURG, Ber. Akad. Wiss. Berl. 1840 (1841), p. 214.—EHRENBURG, Microgeologie, 1854, pl. 19, fig. 28.—SCHMIDT, Atlas Diat., pl. 3, 1874, figs. 30-34; pl. 129, 1888, figs. 7-8.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 352.

This beautiful diatom is one of the most common of the naviculoid forms in the Maria Madre Island deposit. Cleve recognized two fossil subspecies, *abundans* Schmidt⁴¹ from

⁴⁰ Kongl. Sv. Vet. Akad. Handl., Vol. 26, 1894, p. 100.

⁴¹ Atlas Diat., pl. 129, 1888, fig. 8.

Monterey and Santa Monica, California, fossil deposits, and *haytiana* Truan & Witt, from Hayti. The value of these names seems problematic.

Specimen number	Measurements	
	Length	Width
1956	.0910 mm.	.0584 mm.
1957	.0910 mm.	.0496 mm.
1958	.0886 mm.	.0550 mm.

71. *Navicula regata* Hanna & Grant, new species

Plate 18, figure 13

Valve small, slightly constricted in the middle, roundly pointed at each end; marked with a double row of transversely elongated beads or bars on each side of the median area, the latter with a faint row of dots on each side of the raphe which is not placed on a heavy bar of silica. Length .0418 mm.; width .020 mm.

Type: No. 1959, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This minute species seems to be closest to one from Campeche Bay, Gulf of Mexico, figured by Schmidt⁴² and questionably referred to *N. donkini* Schmidt. But the latter and all other constricted diatoms of this section of *Navicula* appear to have the raphe placed on a heavy rounded bar of silica; details of markings are likewise very different in the new species.

72. *Navicula smithii* Brebisson

Plate 19, figure 1

Navicula smithii BREBISSEON in W. SMITH, Brit. Diat., Vol. 2, 1856, p. 92.—SCHMIDT, Atlas Diat., pl. 7, 1875, fig. 19.—CLEVE, Kongl. Sv. Vet. Akad. Handl., Vol. 26, No. 2, 1894, p. 96.

Schmidt said that his figure, cited above, was a typical valve of the highly variable *N. smithii* and our Maria Madre Island fossils are closer to it than any other we have found. The

⁴² Atlas Diat., pl. 12, 1875, fig. 63.

identification is, therefore, reasonably certain to be correct. Length of specimen figured (No. 1960, C.A.S. coll.) .090 mm.; width .0476 mm.

73. *Navicula spectabilis* Gregory

Plate 19, figure 2

Navicula spectabilis GREGORY, Trans. Royl. Soc. Edinb., Vol. 21, 1857, p. 481, pl. 9, fig. 10.—SCHMIDT, Atlas Diat., pl. 2, 1874, fig. 31, pl. 3, figs. 20-21, 29.—VAN HEURCK, Treat. Diat. 1896, p. 202, pl. 27, fig. 757.—WOLLE, Diat. N. Am. 1894, pl. 16, fig. 3 (very poor).—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 356.

This species approaches both *N. lyra* and *N. hennedyi*, the Maria Madre Island fossils agreeing almost exactly with Schmidt's fig. 20, pl. 3, cited above. Length of specimen figured (No. 1961, C.A.S. coll.) .0636 mm.; width .0384 mm.

74. *Navicula splendida* Gregory

Plate 19, figure 4

Navicula splendida GREGORY, Trans. Micr. Soc. London, Vol. 4, p. 44, pl. 5, fig. 14.—VAN HEURCK, Syn. Diat. Belg., pl. 9, fig. 4.—SCHMIDT, Atlas Diat., pl. 13, 1875, figs. 31-34.

Like *N. pandura*, there are a great many coarsely-marked, constricted diatoms in the Maria Madre Island deposit which have the costæ divided into single beads by longitudinal furrows. Many variations have been named which have this general form of sculpture, but it appears that for the present it would be best to follow Cleve⁴³ as nearly as possible and group them under *N. splendida*. Length of specimen figured (No. 1948a, C.A.S. coll.) .1216 mm.; width .0334 mm.

75. *Navicula stippi* Hanna & Grant, new species

Plate 17, figure 12

Valve ovate, flat, almost twice as long as broad; raphe straight, narrow, bordered on each side almost to the central nodule by a band of fine transverse striæ; margin bounded by a narrow zone of fine radial striæ of uniform length; remain-

⁴³ Naviculoid Diatoms, Kongl. Sv. Vet. Akad. Handl., Vol. 26, 1894, pp. 85-86.

der of disk sparsely covered with beads irregularly arranged except for a short space near the center of each side where they seem to be in short radial rows. Length .0859 mm.; width .0474 mm.; width of zone of striæ bordering raphe .0038 mm.; width of zone of striæ at margin and in the center of the valve .0034 mm.

Type: No. 1947, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This delicate species partakes of the characters of *N. californica* in shape and arrangement of border and raphe zones but the striæ are very much finer, in fact an oil immersion lens is required to resolve them into beads. It also has scattered beads over the disk somewhat as in *N. pratexta* but is likewise much more delicate than that species.

The species is named for Mr. Thomas F. Stipp of San Francisco, California, in recognition of his interest in microscopy.

76. *Navicula subspectabilis* Hanna & Grant, new species

Plate 19, figure 3

Valve broadly ovate, rounded at the ends, similar to *N. spectabilis*; zone of beading at the margin with only 50 transverse rows of beads (*spectabilis* has 70 to 80 rows); large lyri-form blank space, unmarked, broad, and with only a faint indication of projections medially of the marginal beaded zones. Length .0445 mm.; width .0267 mm.

Type: No. 1962, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

We regret the necessity of adding a new name to the overburdened group of which *N. spectabilis* is a member, but we have been unable to find a figure or description which appears to be sufficiently close to these small specimens to include them. Besides the small size, the sparseness of the bead-rows is the chief distinguishing feature.

77. *Navicula vidovichii* Grunow

Plate 19, figure 5

Navicula vidovichii GRUNOW, Verh. K. K. Zool. Bot. Ges. Wein 1863, p. 150, pl. 4 (13), fig. 4; Adriatic Sea.

Caloneis powellii vidovichii (GRUNOW), CLEVE Kongl. Sv. Vet. Akad. Handl., Vol. 26, No. 2, 1894, p. 63.

Ostrupia powellii vidovichii (GRUNOW), SCHMIDT, Atlas Diat., pl. 264, 1906, figs. 8, 9; "Hafen von Pola (Adria)."

Our specimen, which agrees in minute detail with the original figure of Grunow as well as the one in Schmidt's Atlas, was picked out of the Maria Madre Island deposit and others were seen. It would seem to have very little in common with *N. powellii* Lewis,⁴⁴ although Cleve united it subspecifically. Likewise, there appears to us to be no substantial reason for placing the species in a new genus as Heiden has done in Schmidt's Atlas. It is a striking species of *Navicula* but does not seem to differ basically from many others of that genus. Length of specimen figured (No. 1963, C.A.S. coll.) .1140 mm.; width .0190 mm.

78. *Nitzschia hondoensis* Hanna & Grant, new species

Plate 21, figure 5

Valve slightly sigmoid in outline; with a longitudinal row of heavy quadrangular beads near but not adjacent to the superior margin; surface otherwise covered with minute dots in transverse rows and at the same time in irregular, diagonal rows toward the inferior margin. Length .1522 mm.; width .010 mm.

Type: No. 1964, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species belongs to a group of which *N. sigma* Smith is the most familiar,⁴⁵ but the Maria Madre Island fossil is broader, and the row of coarse beading is set away from the margin a perceptible distance, not adjacent to the margin as in

⁴⁴ Proc. Acad. Nat. Sci. Phila. 1861, p. 65, pl. 2, fig. 6.

⁴⁵ Schmidt, Atlas Diat., pl. 336, 1921, figs. 1-6.

N. sigma. Moreover, the beading of *N. hondoensis* forms wavy diagonal lines toward the inferior margin as well as transverse lines; *N. sigma* only has the latter.

79. *Nitzschia nelsoni* Hanna & Grant, new species

Plate 21, figures 6, 7

Valve long and slender, straight on one side, curved on the other; ends bluntly rounded; markings consisting solely of two rows of heavy, elongated bars, largest in the center of the valve and tapering gradually to each end. Length of type .1162 mm.; width .0135 mm.; length of paratype .1336 mm.; width .0127 mm.

Type: No. 1965, *paratype* No. 1966, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This diatom has excessively robust markings for a *Nitzschia* and in this respect does not resemble closely any other form known to us. It is named for Captain M. M. Nelson of the U. S. S. *Ortolan*, whose cooperation in 1925 was largely responsible for the success of the Academy's expedition to west Mexican islands.

80. *Nitzschia princeps* Hanna & Grant, new species

Plate 21, figure 8

Valve large, robust, elongated, constricted in the middle on both sides; superior margin greatly thickened and bearing about 70 large costæ; surface marked with transverse rows of minute beads, close-set except in the center of the valve where they are "patchy." Length .1384 mm.; width .0328 mm.

Type: No. 1967, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This species resembles *N. bilobata* Smith and *N. panduriformis* Gregory in general, bilobed form, but the beading on



the surface is not broken irregularly in patches in those species as in this. *N. plana* Smith⁴⁶ does have irregular beading somewhat similar to *princeps* in a general way but is entirely different in shape. The new species occurs frequently in the Maria Madre Island deposit.

81. *Orthonais splendida* (Gregory)

Plate 19, figure 6

Cocconeis splendida GREGORY, Trans. Roy. Soc. Edinburgh, Vol. 21, 1857, p. 493, pl. 9, fig. 29.—MANN, Cont. U. S. Nat. Herb., Vol. 10, pt. 5, 1907, p. 332.

Orthonais splendida VAN HEURCK, Treat. Diat. 1896, p. 283, fig. 62.

Specimens of this species from the Maria Madre Island deposit agree in minute detail with the figure of Van Heurck, cited above. The one figured (No. 1968, C.A.S. coll.) is .0468 mm. long and .0368 mm. wide.

82. *Plagiogramma fascinatum* Hanna & Grant, new species

Plate 19, figure 7

Valve regularly oval, a little more than twice as long as broad; ends rounded; terminal spaces almost circular, central area transversely oval, all hyaline; between the central area and each terminal area there are four transverse rows of huge circular beads, six in each row and close set. Length .040 mm.; width .0127 mm.

Type: No. 1969, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

In outline the species is much like *Glyphodesmis exima* Greville,⁴⁷ but the Maria Madre Island form is a true *Plagiogramma*, having a large central stauros and not merely a central nodule as in *Glyphodesmis*. No other species of *Plagiogramma* is known to us which has beads so large and heavy in proportion to the size of the valve.

⁴⁶ Schmidt, Atlas Diat., pl. 330, 1921, fig. 3.

⁴⁷ Schmidt, Atlas Diat., pl. 210, 1897, figs. 13-17.

83. *Plagiogramma hymenoptera* Hanna & Grant, new species

Plate 19, figure 8

Valve deeply constricted in the center, swollen on each side of this constriction and again between this and the ends, thus making three constrictions on each valve; central stauros broad and square with a pyriform central nodule; surface covered with rounded beads, sparsely but uniformly arranged in transverse and longitudinal rows except at the ends where the beads are still sparse but irregularly arranged; a spatula-shaped projection at each end, in place of a spine or stauros. Length .1009 mm.; width .0162 mm.

Type: No. 1970, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

Schmidt⁴⁸ has figured some specimens from Macassar Strait which resemble the present species in general form; he referred these questionably to *P. constrictum* Greville, a heavily-ribbed species which they hardly resemble at all; our specimens have a larger stauros than those of Schmidt, which also lack the spatula-shaped terminal stauros.

84. *Plagiogramma insolito* Hanna & Grant, new species

Plate 19, figure 9

Valve small, broad, sides straight, ends pointed; central area oval, terminal areas pointed; no internal septæ; beads roundly rectangular, in horizontal and longitudinal rows; terminal areas marked with fine radial striations. Length of type .0675 mm.; width .020 mm.

Type: No. 1971, *paratype* No. 1972, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This heavily-marked species appears to have no close relative except *P. tessellatum*, a comparison with which shows the distinction at once.

⁴⁸ Atlas Diat., pl. 210, 1897, figs. 28-30.

85. *Plagiogramma tessellatum* Greville

Plate 19, figure 10

Plagiogramma tessellatum GREVILLE, Quart. Journ. Mic. Sci., Vol. 7, 1859, p. 208, pl. 10, fig. 7.—WOLLE, Diat. N. Am. 1894, pl. 45, figs. 18, 19.—SCHMIDT, Atlas Diat., pl. 209, 1897, figs. 42-50.

Except for the slight constriction medially (and this is not constant), the fossils referred to this species are typical *tessellatum* as figured by Schmidt (fig. 48). It is the most common form of the genus in the deposit on Maria Madre Island and, from the published records, seems to be almost wholly confined to the east coast of North America, and especially the Caribbean region. Dr. Mann,⁴⁹ however, lists it from the Galapagos Islands, although he stated that the central area was round in the specimens instead of rectangular as usual. In our specimens the area is rectangular as are, likewise, the coarse beads. Length of specimen figured (No. 1973, C.A.S. coll.) .1160 mm.; width .0180 mm.

86. *Pleurosigma manni* Hanna & Grant, new species

Plate 19, figure 11; plate 20, figure 1

Valve narrowly lanceolate, not sigmoid, very thin and delicate; raphe almost straight; rows of beads in two series set at about 120° to each other; dots heavy, easily seen with an eight millimeter apochromatic objective and 15x ocular. Length .2272 mm.; width .0454.

Type: No. 1974, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

A few other straight diatoms belonging to *Pleurosigma* are known, but apparently none combines the characters of this one. Although fragments are very abundant in the Maria Madre Island deposit, this diatom is so excessively delicate that it is almost impossible to secure perfect examples. Some have even been deformed by pressure in the bedded material.

The species is named for the distinguished diatomist, Dr. Albert Mann of Washington, D. C.

⁴⁹ Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 326.

87. *Podosira adriatica* (Kützing)

Plate 20, figure 2

Specimens which agree with Van Heurck's⁵⁰ figure of this species are not rare in the Maria Madre Island deposit. The California fossil, *P. febigerii* Grunow, is similar in structure but appears from the figures to be more heavily marked and uniformly convex. Diameter of specimen figured (No. 1975, C.A.S. coll.) .060 mm.

88. *Podosira clarki* Hanna & Grant, new species

Plate 20, figure 3

Valve minute, strongly convex; border wide and radiately striated; surface except central zone marked by numerous elevated protuberances; also a series of minute beads uniformly dispersed in a series of imperfectly radiating sectors; these beads also have an imperfect "watch case milling" arrangement; central rosette small but distinct. Diameter .0360 mm.

Type: No. 1976, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This minute species is so distinct from other *Podosira* with its many large protuberances that comparison can hardly be made with any. A lens with high numerical aperture is necessary properly to resolve the beautiful markings.

The species is named for Dr. Bruce L. Clark, Professor of Paleontology, University of California, who has often aided in work with the diatomaceæ of California.

89. *Podosira ovoidea* Hanna & Grant, new species

Plate 20, figure 4

Valve oval very convex, apparently hyaline throughout; central area less elongate ovate than the valve and bordered by a single row of long, sharp spines; margin narrow and crenulated. Length .0247 mm.; width .0171 mm.

⁵⁰ Treat. Diat., 1896, p. 447, fig. 171.

Type: No. 1977, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

So far as we can determine no ovate *Podosira* has heretofore been described, yet in the absence of characters which would ally this little diatom with any other genus, we prefer to leave it here for the present. Possibly it belongs to a group which has not been generically segregated, yet warrants such disposition. Specimens of the species are rare in the deposit.

90. *Podosira polita* Hanna & Grant, new species

Plate 20, figure 5

Valve circular, convex, densely covered with minute beading except for a ragged, rugose, area in the center; the beads have an imperfect watch case milled arrangement and are in radial rows which form distinct zones, the rows of each zone set at an acute angle to those adjacent. Diameter .0362 mm.

Type: No. 1978, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This beautiful species seems to be related to *P. subtilis* (Bailey) but has much coarser beading than that species. Moreover, *subtilis* has a perfect watch case milled arrangement of beads, this has not.

91. *Porpeia quadriceps* Bailey

Plate 20, figures 6, 7

Individuals of this protean species are common in the Maria Madre Island deposit. Several variations have received names such as *quadrata*, *ornata*, *robusta*, and *inflexa*, but, as Mann⁵¹ has pointed out, they have little to distinguish them and may best all be united under the earliest name, *quadriceps*. Dr. Mann also gave numerous references to the literature where

⁵¹ Cont. U. S. Nat. Herb., Vol. 10, pt. 5, 1907, p. 315.

figures of the various forms may be found. The specimens figured herewith are mounted on one slide, No. 1979, C.A.S. coll.; height in side view .0256 mm.; length in end view .070 mm.; width in end view .0169 mm.

92. *Rhaphoneis ampiceros* Ehrenberg

Plate 20, figure 8

Rhaphoneis ampiceros EHRENBURG, SCHMIDT, Atlas Diat., pl. 269, 1911, figs. 45, 46, 50-55.—WOLLE, Diat. N. Am. 1894, pl. 37, figs. 18-22.

Typical specimens of this variable species are not uncommon in the Maria Madre Island deposit. Length of specimen figured (No. 1980, C.A.S. coll.) .050 mm.; width .0248 mm.

93. *Rhaphoneis cocconeiformis* (Schmidt)

Plate 20, figure 9

Coscinodiscus cocconeiformis SCHMIDT, Atlas Diat., pl. 58, 1877, figs. 23, 28; Monterey [California, type locality, probably Miocene deposit].

Our specimens from the Maria Madre Island Miocene deposit are identical with the figures Schmidt drew from specimens from "Monterey." These are circular forms with markings precisely as in *Rhaphoneis* and wholly unlike any other *Coscinodiscus*; therefore it seems inconsistent to retain them in the latter genus. The total absence of raphe or pseudo-raphe definitely excludes them from *Cocconeis*. Diameter of specimen figured (No. 1981, C.A.S. coll.) .0730 mm.

94. *Rhabdonema adriaticum* Kützing

Rhabdonema adriaticum KÜTZING, Bacill. 1844, p. 127, pl. 18, fig. 7.—SCHMIDT, Atlas Diat., pl. 217, 1899, figs. 17-29; pl. 221, 1900, fig. 14.—MANN, Cont. U. S. Nat. Herb., Vol. 10, pt. 5, 1907, p. 321.

A single group of valves firmly attached was found in the Maria Madre Island deposit. In side view, all that can be seen, the specimen resembles the figures of *adriaticum* more than any other species.

95. *Stephanogonia pretiosa* Hanna & Grant, new species

Plate 20, figure 10

Valve circular, pyramidal with 11 slightly unequal and unmarked facets; top truncate and this portion with a very few irregularly scattered dots of minute size; the flat angular faces bordering the central area are separated by heavy bars of silica. Diameter .0214 mm.

Type: No. 1982, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

Van Heurck⁵² stated that the genus *Stephanogonia* comprised a very few species, all fossil. We have examined figures of apparently all that have been described but find nothing very closely approaching the form here treated. It is possibly closest to *S. actinoptychus* Ehrenberg as figured by Van Heurck,⁵³ but that species is ovate in shape and heavily spinose around the margin; moreover it is punctate throughout the valval area.

96. *Stephanopyxis corona* (Ehrenberg)

Plate 20, figure 11

Systephania corona EHRENBURG, Ber. Akad. Wiss. Berl. 1844, p. 272.—

EHRENBURG, Microg., pl. 33, group 15, fig. 22.

Stephanopyxis corona (EHRENBURG), GRUNOW in VAN HEURCK, Syn.

Diat. Belg., pl. 83 ter., figs. 10, 17, 1881.—SCHMIDT, Atlas Diat., pl. 123, 1888, figs. 10-17, 19, 20; pl. 130, 1888, figs. 13, 16, 17, 36.—

WOLLE, Diat. N. Am. 1893, pl. 62, figs. 1, 6; pl. 67, fig. 20.

A very few specimens which seem to be referable to the above species were found in the fossil material from Maria Madre Island. The one figured, No. 1983 (C.A.S. coll), is .0565 mm. in diameter.

⁵² Treat. Diat., 1896, p. 437.

⁵³ Ibid., fig. 163.

97. *Stictodiscus californicus* Greville

Plate 20, figure 12

Stictodiscus californicus GREVILLE, Trans. Micr. Soc. London, n. s., Vol. 9, 1861, p. 79, pl. 10, fig. 1.—SCHMIDT, Atlas Diat., pl. 74, 1882, figs. 4, 5.—WOLLE, Diat. N. Am. 1894, pl. 75, figs. 5-8 (not well drawn).

This common west American species, first described from the Miocene Monterey Shale, is also common in the deposit on Maria Madre Island. It has not, apparently, been found living on the west coast, but has been considered to be one of the best markers of the widespread Miocene diatomaceous shale. Diameter of specimen figured (No. 1984, C.A.S. coll.) .0908 mm.

98. *Surirella newmani* Hanna & Grant, new species

Plate 21, figure 1

Valve ovate, narrowly rounded on the ends with a narrow lanceolate median hyaline area bordered by 10 heavy, radiating, flat-topped ribs; each of these in the median section bears two or three bars parallel to the rib; border undulating, very heavy and with some transverse striations; with a lens of 2 mm. equivalent focus and N. A. 1.32 it was barely possible to resolve the beads on the bars mentioned. Length .060 mm.; width .030 mm.

Type: No. 1985, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This species comes close to an unnamed figure of Schmidt⁵⁴ from Campeche Bay, Gulf of Mexico, and which Fricke⁵⁵ stated was a doubtful "variety" of *S. comis* Schmidt. We cannot agree to that identification and, even if correct, our specimens differ sufficiently to be recorded as distinct. It is not uncommon in the deposit on Maria Madre Island.

The species is named for Mr. P. E. Newman, a microscopist of great skill of San Francisco, California.

⁵⁴ Atlas Diat., pl. 4, 1874, fig. 7.

⁵⁵ Index to Atlas, 1902, p. 61.

99. *Surirella patens* Schmidt

Plate 21, figure 2

Surirella patens SCHMIDT, Atlas Diat., pl. 4, 1874, figs. 16, 17; "Carpenteria Bai."

Specimens which agree essentially with those of Schmidt are common in the Miocene deposit on Maria Madre Island. The central hyaline space in his figures is bordered on each side with a longitudinal row of dots which extend from end to end; in our specimens these rows are not continuous, there being a blank space in the center. This would hardly seem sufficient difference to warrant specific separation. Each of the large transverse bars of silica has three rows of minute beads, which, except under proper magnification and illumination, appear as striæ. Our photograph shows the true character of these markings. Length of specimen figured (No. 1986, C.A.S. coll.) .0946 mm.; width .0375 mm.

100. *Synedra duhemi* Hanna & Grant, new species

Plate 21, figure 3

Valve long and slender, subrostrate truncate at the ends; very convex, the cross section being as shown at *a* in figure 3; longitudinally the valve is also very convex in the center; markings consist of heavy transverse rows of beads which leave a narrow longitudinal hyaline line through the center; this line, however, does not reach to the ends of the valve but tapers out to nothing at about .01 mm. from the ends; the rows of beads are not uniformly placed as in *S. ulna* (Nitzsch) but they often bifurcate. Length .2236 mm.; width .01492 mm.; number of rows of beads in .01 mm. at center of valve, 8.

Type: No. 1987, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The great convexity of the valve in cross and longitudinal sections and the coarse, close-set lines of beads separate this

species from any other known to us. Its outline is similar to *S. ulna*, but that species is almost flat, has fine rows of dots and usually a stauros in the center.

The species is named for Mr. Raymond Duhem, the photographer of the Academy's expedition to West Mexican islands in 1925.

101. *Trachyneis aspera* (Ehrenberg)

Plate 21, figure 4

Navicula aspera (EHRENBERG), SCHMIDT, Atlas Diat., pl. 48, 1876, figs. 2-6.

Individuals which we have referred to this species occur frequently in the Maria Madre Island deposit; they show some variation in the size of the valves but in details of markings they are very close to those Schmidt figured. Many diatomists have placed this distinctive group in *Navicula*.⁵⁶ Cleve⁵⁷ separated it under *Trachyneis*, and Van Heurck in 1896⁵⁸ recognized its distinctness but kept the species, which he treated, under *Navicula* in order to conform with a previous publication. It would seem to us that the group is sufficiently distinct to be separated in almost if not all cases. Length of specimen figured (No. 1988, C.A.S. coll.) .0878 mm.; width .0276 mm.

102. *Xanthiopyxis cingulata* Ehrenberg

Plate 21, figure 9

Xanthiopyxis cingulata EHRENBERG, Microgeologie, 1854, pl. 33, group 17, fig. 18; Rappahannock, Virginia.

This species is circular and has spines uniformly distributed over the disk and projecting outwardly from the margin. The species occurs abundantly in Maria Madre Island deposit. The

⁵⁶ See Mann, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 337.

⁵⁷ Sv. Vet. Akad. Hand., Vol. 26, 1894, p. 191, pl. 3, fig. 37.

⁵⁸ Treat. Diat., 1896, p. 205.

common species of the genus in the Monterey Shale of California, *X. umbonata* Greville, lacks the marginal spines. Van Heurck⁵⁹ stated that the genus contains 12 "curious species," all fossil. It was at one time believed by some diatomists that members of the group were sporangial cases of species belonging to the genus *Chatoceros*, but if that be admitted it is difficult to explain the great abundance of *Xanthiopyxis* in some deposits where a trace of *Chatoceros* cannot be found. Our experience in dealing with fossil forms leads us to believe that *Xanthiopyxis* is probably a valid generic assemblage of species. Diameter of specimen figured (No. 1989, C.A.S. coll.) is .0418 mm.

103. *Xanthiopyxis hirsuta* Hanna & Grant, new species

Plate 21, figure 10

Valve broadly ovate, convex, border narrow; densely covered with a series of short, sharp spines; spines even cover the border and project outwardly therefrom; with dry lenses the surface has an irregularly stippled effect, but with the greater numerical aperture of immersion objectives the dots are resolved into spines. Length .0298 mm.; width .020 mm.

Type: No. 1990, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

Some difficulty was experienced in the assignment of this species to a suitable genus and even now we are somewhat undecided if it should be placed in *Xanthiopyxis*. Certainly all other members of that group with which we are familiar have much heavier and fewer spines than this one. The species is very common in the deposit on Maria Madre Island.

104. *Xanthiopyxis oblonga* Ehrenberg

Plate 21, figure 11

Xanthiopyxis oblonga EHRENBURG, *Microgeologie*, 1854, pl. 33, group 17, fig. 17.; Rappahannock, Virginia.—CLEVE, *Journ. Quek. Micr. Club*, ser. 2, Vol. 2, 1885, p. 175, pl. 13, fig. 18; Brun Tegel (Marl) Moravia.

⁵⁹ *Treat. Diat.*, 1896, p. 512.

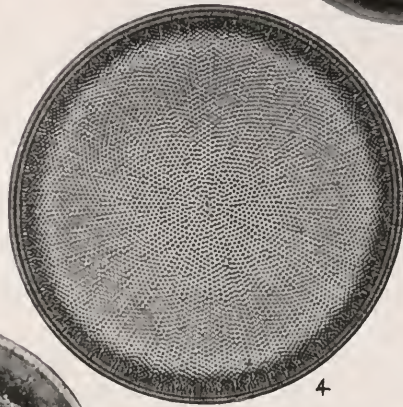
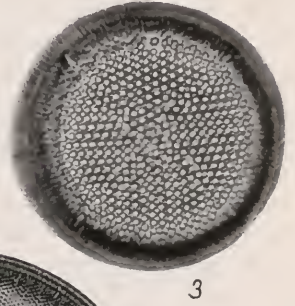
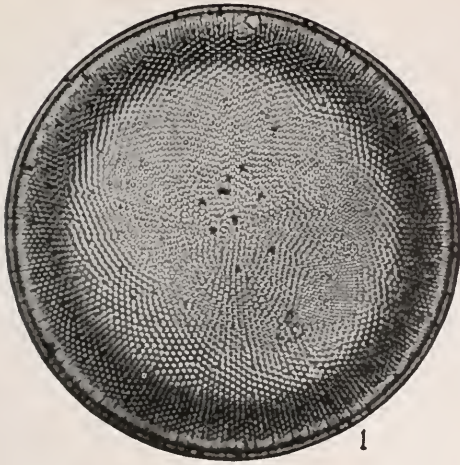
Cleve remarked that there was a possibility of this being an auxospore stage of some diatom like *Hemialus*, but, in view of the great abundance of it in the Maria Madre Island deposit and the rarity of *Hemialus*, this interpretation seems doubtful. Cleve also stated that the species was closely related to *Stephanopyxis limbata* Ehrenberg.⁶⁰ The specimen figured (No. 1991, C.A.S. Coll.) is .035 mm. long, .0183 mm. wide, exclusive of spines and in no important manner seems to differ from the figures cited above.

⁶⁰ Van Heurck, Syn. Diat. Belg., 1880-1885, pl. 83, ter. figs. 13-14.

PLATE 11

- Fig. 1. *Actinocyclus allincarius* H. & G., n. sp. x 380.⁶¹ Type, No. 1871, C.A.S. coll. P. 117.
- Fig. 2. *Actinocyclus canestrus* H. & G., n. sp. x 400. Type, No. 1872, C.A.S. coll. P. 117.
- Fig. 3. *Actinocyclus cubitus* H. & G., n. sp. x 1200. Type, No. 1873, C.A.S. coll. P. 118.
- Fig. 4. *Actinocyclus pyrotechnicus* Deby. x 450. Plesiotype, No. 1874, C.A.S. coll. P. 119.
- Fig. 5. *Actinocyclus rosolco* H. & G., n. sp. x 400. Type, No. 1875, C.A.S. coll. P. 119.
- Fig. 6. *Actinoptychus gallegosi* H. & G., n. sp. x 540. Type, No. 1876, C.A.S. coll. P. 120.
- Fig. 7. *Actinoptychus glabratus* Grunow. Plesiotype, No. 1877, C.A.S. Coll. P. 121.
- Fig. 8. *Actinoptychus maculatus* Grove & Sturt. x 1200. Plesiotype, No. 1878, C.A.S. coll. P. 122.
- Fig. 9. *Actinoptychus maculatus*, G. & S. Diagram of same specimen as fig. 8, to show maculations when the diatom is in a slightly different focus. P. 122.
- Fig. 10. *Actinoptychus perplexus* H. & G., n. sp. x 840. Type, No. 1879, C.A.S. coll. P. 122.
- Fig. 11. *Actinoptychus perplexus*. Portion of same specimen as fig. 10 enlarged x 1600 to show details of sculpture. P. 122.

⁶¹The magnifications indicated in the explanations of the plates are only approximately correct due to certain processes of lithography; the reader is referred to the descriptions for actual dimensions of the objects.



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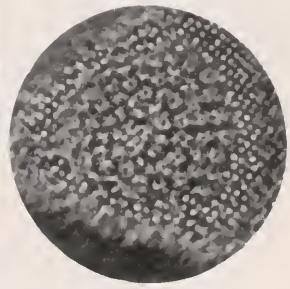
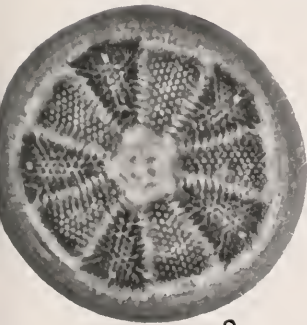
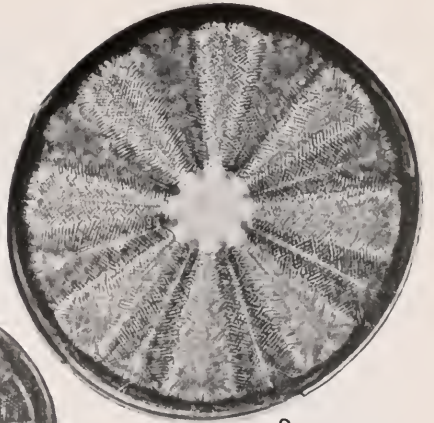


PLATE 12

- Fig. 1. *Actinoptychus solisi* H. & G., n. sp. x 420. Type, No. 1880, C.A.S. coll. P. 123.
- Fig. 2. *Actinoptychus solisi* H. & G., n. sp. x 570. Paratype, No. 1881, C.A.S. coll. P. 123.
- Fig. 3. *Actinoptychus solisi* H. & G., n. sp. x 380. Paratype, No. 1882, C.A.S. coll. P. 123.
- Fig. 4. *Actinoptychus undulatus* (Bailey.) x 960. Plesiotype, No. 1883, C.A.S. coll. P. 124.
- Fig. 5. *Amphora crassa* Gregory. x 630. Plesiotype, No. 1884, C.A.S. coll. P. 124.
- Fig. 6. *Amphora varia* H. & G., n. sp. x 600. Type, No. 1885, C.A.S. coll. P. 124.
- Fig. 7. *Arachnoidiscus monni* H. & G., n. sp. x 315. Type, No. 1886, C.A.S. coll. P. 125.
- Fig. 8. *Arachnoidiscus manni* H. & G., n. sp. x 300. Paratype, No. 1887, C.A.S. coll. P. 125.
- Fig. 9. *Arachnoidiscus manni* H. & G., n. sp. x 600. Paratype, No. 1888, C.A.S. coll. P. 125.



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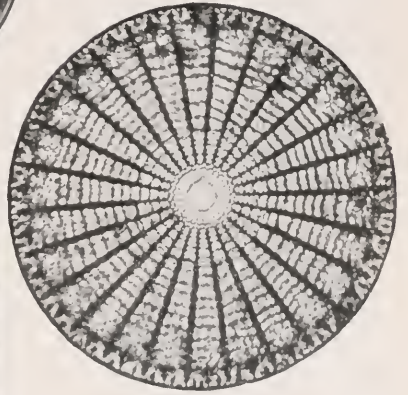


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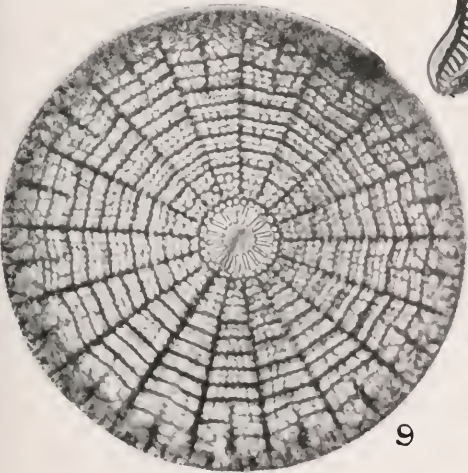


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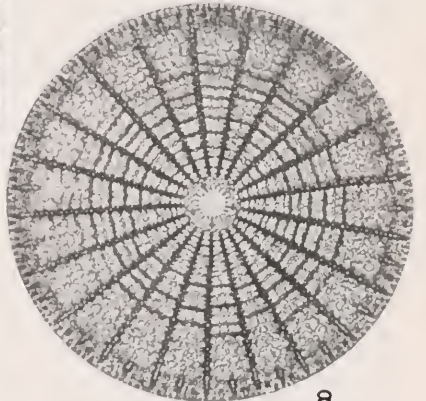
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PLATE 13

- Fig. 1. *Asterolampra marylandica* Ehrenberg, x 540. Plesiotype, No. 1889, C.A.S. coll. P. 126.
- Fig. 2. *Aterompholus dubius* H. & G., n. sp., x 800. Type, No. 1890, C.A.S. coll. P. 126.
- Fig. 3. *Aulacodiscus margaritaceus* Ralfs. x 400. Plesiotype, No. 1891, C.A.S. coll. P. 127.
- Fig. 4. *Aulacodiscus margaritaceus* Ralfs. x 300. Plesiotype, No. 1892, C.A.S. coll. P. 127.
- Fig. 5. *Aulacodiscus rella* H. & G., n. sp. x 720. Type, No. 1893, C.A.S. coll. P. 128.
- Fig. 6. *Aulacodiscus rella* H. & G., n. sp. x 800. Same specimen as fig. 5 but under slightly altered focus to show secondary markings.
- Fig. 7. *Auliscus caballi* Schmidt. x 1000. Plesiotype, No. 1894, C.A.S. coll. P. 129.
- Fig. 8. *Auliscus calatus* Bailey. x 480. Plesiotype, No. 1895, C.A.S. coll. P. 129.
- Fig. 9. *Auliscus grunovii* Schmidt. x 600. Plesiotype, No. 1896, C.A.S. coll. P. 129.
- Fig. 10. *Auliscus pruinosus* Bailey. x 540. Plesiotype, No. 1897, C.A.S. coll. P. 130.
- Fig. 11. *Biddulphia consimile* Grunow. x 300. Plesiotype, No. 1899, C.A.S. coll. P. 130.
- Fig. 12. *Biddulphia consimile* Grunow. x 800. Same specimen as fig. 11, enlarged to show secondary markings.

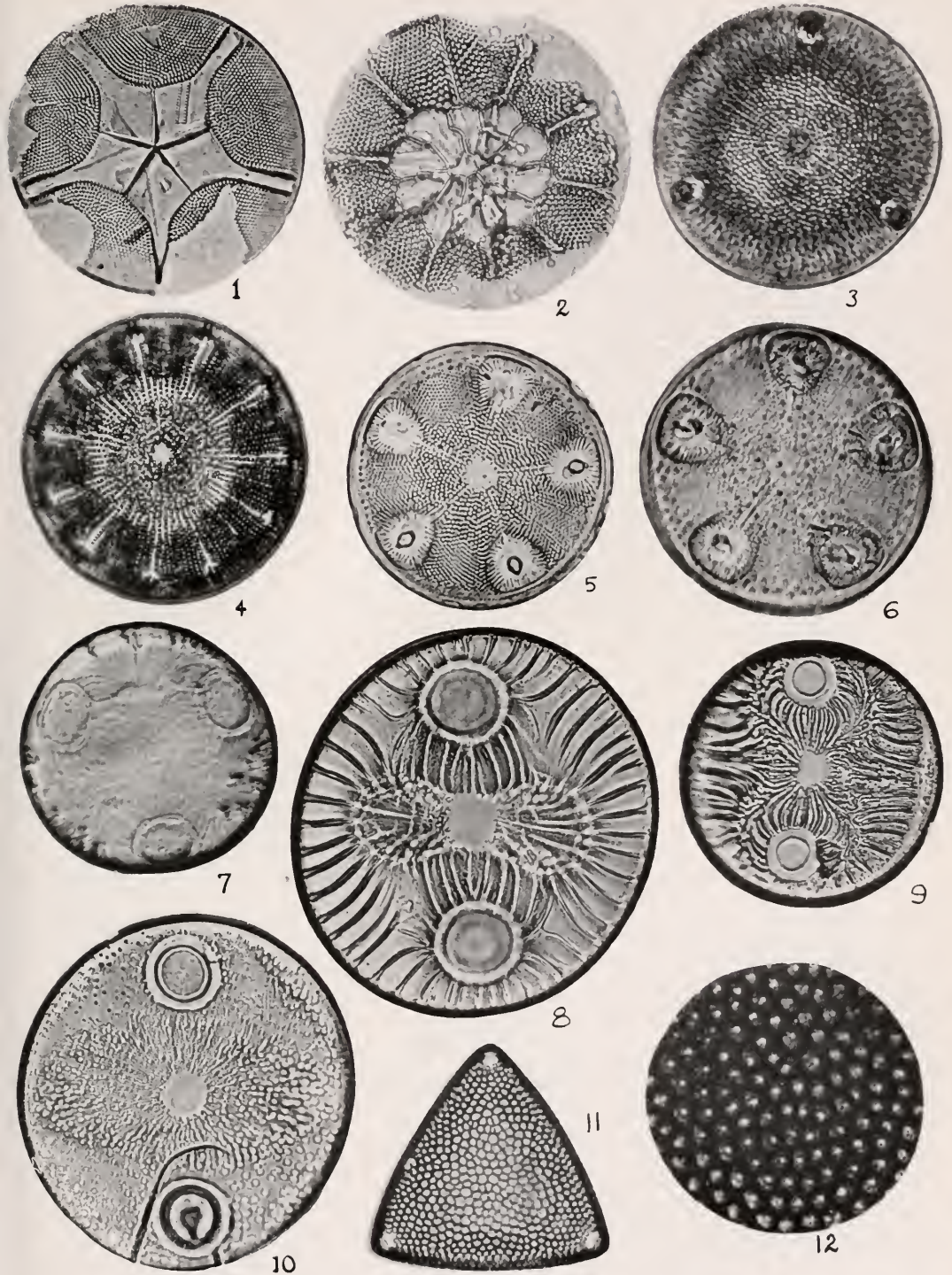


PLATE 14

- Fig. 1. *Biddulphia deodora* H. & G., n. sp. x 800. Type, No. 1900, C.A.S. coll. P. 131.
- Fig. 2. *Biddulphia deodora* H. & G., n. sp. x 920. Paratype, No. 1901, C.A.S. coll. Five pointed form; in the focal adjustment had at the time the picture was taken only a faint trace of the marginal spines could be seen, the development is practically the same in both forms. P. 131.
- Fig. 3. *Biddulphia jordani* H. & G., n. sp. x 960. Type, No. 1898, C.A.S. coll. P. 131.
- Fig. 4. *Biddulphia penitens* H. & G., n. sp. x 600. Type, No. 1902, C.A.S. coll. P. 132.
- Fig. 5. *Biddulphia penitens* H. & G., n. sp. x 540. Paratype, No. 1903, C.A.S. coll. P. 132.
- Fig. 6. *Biddulphia riedyi* H. & G., n. sp. x 300. Type, No. 1904, C.A.S. coll. P. 132.
- Fig. 7. *Biddulphia tuomeyii* (Bailey.) x 450. Plesiotype, No. 1905, C.A.S. coll. P. 133.
- Fig. 8. *Campylodiscus prentissi* H. & G., n. sp. x 1000. Type, No. 1906, C.A.S. coll. P. 134.
- Fig. 9. *Cerataulus imperator* H. & G., n. sp. x 200. Type, No. 1907, C.A.S. coll. P. 134.
- Fig. 10. *Cocconcis contrerasi* H. & G., n. sp. x 1200. Type, No. 1908, C.A.S. coll. P. 135.
- Fig. 11. *Cocconcis triumphis* H. & G., n. sp. x 600. Type, No. 1909, C.A.S. coll. P. 135.
- Fig. 12. *Cocconcis triumphis* H. & G., n. sp. x 1000. Paratype, No. 1910, C.A.S. coll. P. 135.
- Fig. 13. *Cocconcis triumphis* H. & G., n. sp. x 810. Paratype, No. 1911, C.A.S. coll. P. 135.

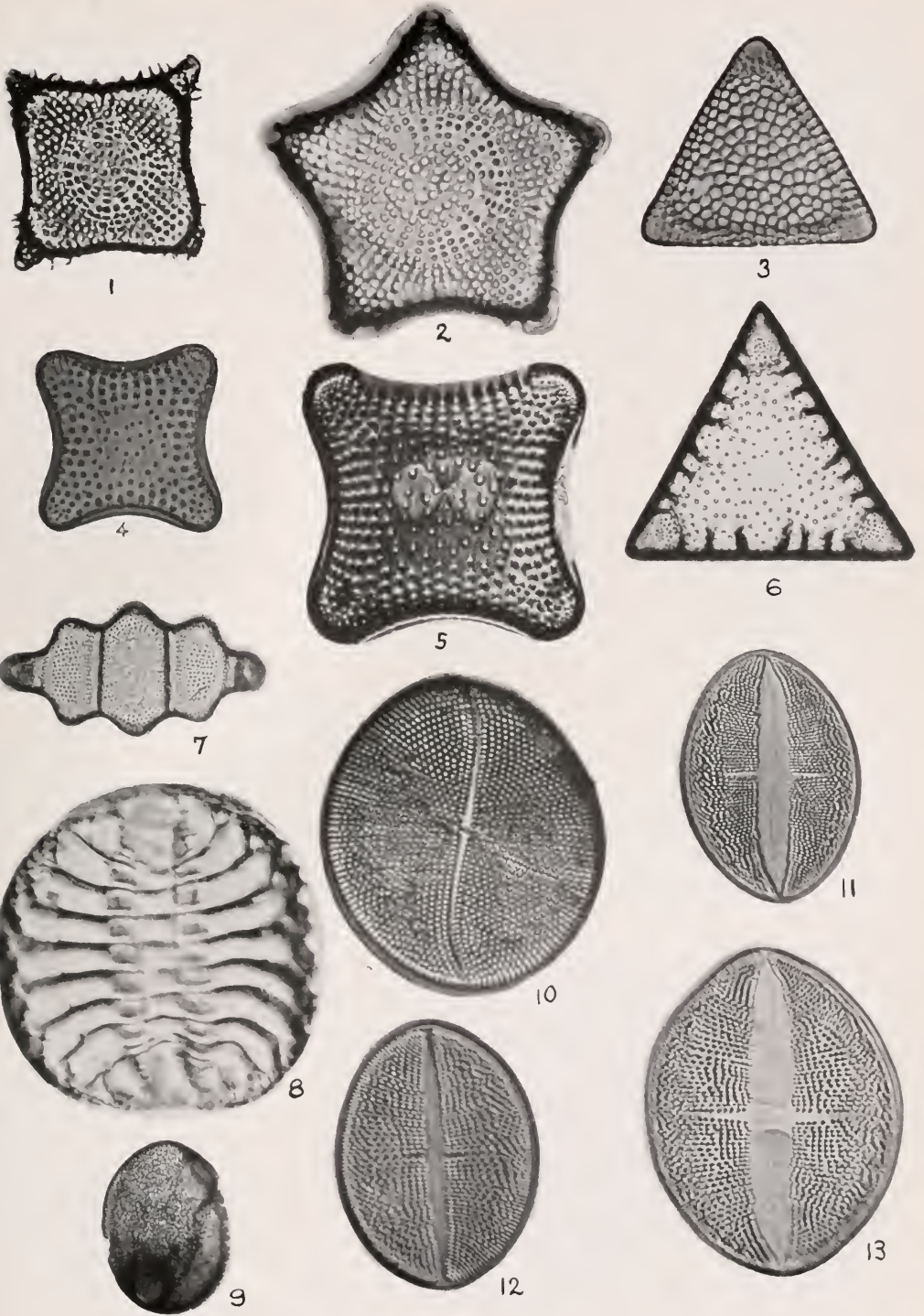
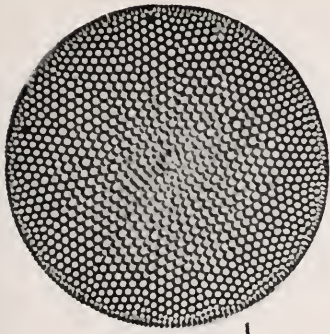


PLATE 15

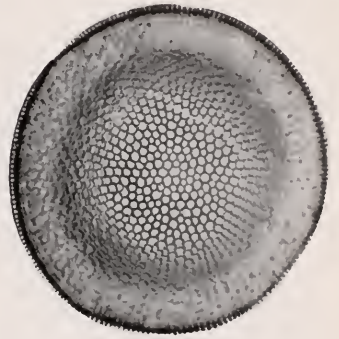
- Fig. 1. *Coscinodiscus curvatus* Grunow. x 690. Plesiotype, No. 1912, C.A.S. coll. P. 136.
- Fig. 2. *Coscinodiscus elegantulus* Greville. x 800. Plesiotype, No. 1913, C.A.S. coll. P. 136.
- Fig. 3. *Coscinodiscus evermanni* H. & G., n. sp. x 270. Type, No. 1914, C.A.S. coll. P. 137.
- Fig. 4. *Coscinodiscus fasciculatus* Schmidt. x 690. Plesiotype, No. 1917, C.A.S. coll. P. 138.
- Fig. 5. *Coscinodiscus hertleini* H. & G., n. sp. x 800. Type, No. 1918, C.A.S. coll. P. 138.
- Fig. 6. *Coscinodiscus lineatus* Ehrenberg. x 270. Plesiotype, No. 1919, C.A.S. coll. P. 139.
- Fig. 7. *Coscinodiscus marginatus* Ehrenberg. x 400. Plesiotype, No. 1920, C.A.S. coll. P. 139.
- Fig. 8. *Coscinodiscus masoni* H. & G., n. sp. x 350. Type, No. 1930, C.A.S. coll. P. 140.
- Fig. 9. *Coscinodiscus nitidus* Gregory. x 800. Plesiotype, No. 1921, C.A.S. coll. P. 140.
- Fig. 10. *Coscinodiscus nitidulus* Grunow. x 800. Plesiotype, No. 1922, C.A.S. coll. P. 141.
- Fig. 11. *Coscinodiscus oculus-iridis* Ehrenberg. x 400. Plesiotype, No. 1923, C.A.S. coll. P. 141.
- Fig. 12. *Coscinodiscus radiatus* Ehrenberg. x 400. Plesiotype, No. 1925, C.A.S. coll. P. 142.



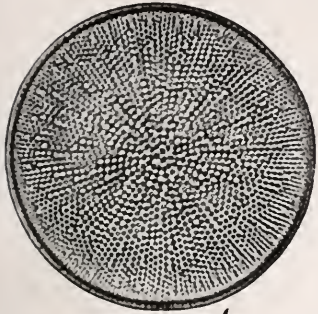
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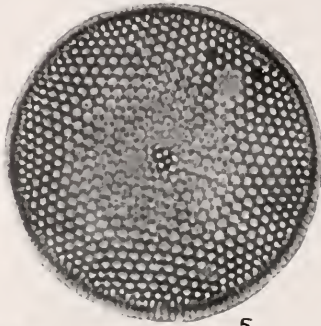
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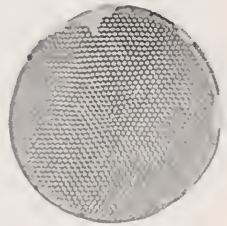
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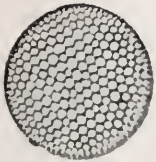
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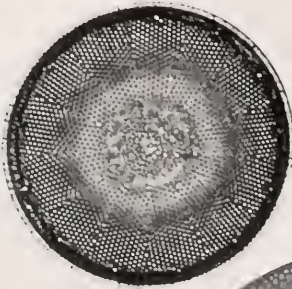
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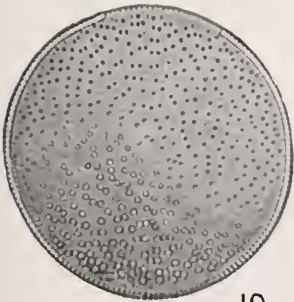
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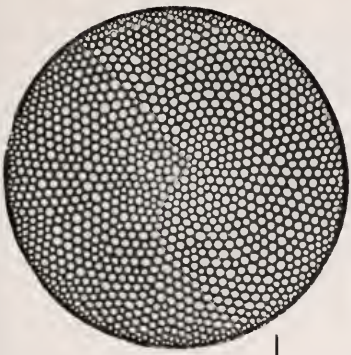
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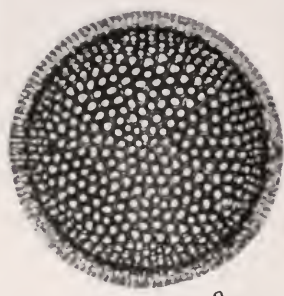
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PLATE 16

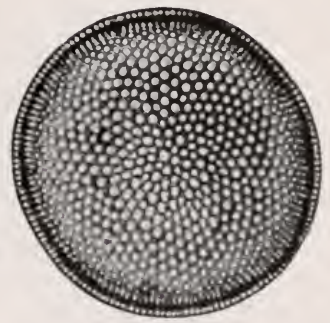
- Fig. 1. *Coscinodiscus pacificus* Grunow. x 400. Plesiotype, No. 1924, C.A.S. coll. P. 142.
- Fig. 2. *Endyctia robusta* Greville. x 375. Plesiotype, No. 1926, C.A.S. coll. P. 144.
- Fig. 3. *Endyctia robusta* Greville. x 400. Plesiotype, No. 1927, C.A.S. coll. P. 144.
- Fig. 4. *Dicladia pylea* H. & G., n. sp., x 565. Type, No. 1928, C.A.S. coll. P. 142.
- Fig. 5. *Dicladia pylea* H. & G., n. sp. x 565. Side view of type, No. 1928, C.A.S. coll. P. 142.
- Fig. 6. *Dictyoncis marginata* (Lewis.) x 570. Plesiotype, No. 1929, C.A.S. coll. P. 143.
- Fig. 7. *Eupodiscus rogersii* (Bailey.) x 350. Plesiotype, No. 1931, C.A.S. coll. P. 144.
- Fig. 8. *Eupodiscus rogersii* (Bailey.) x 330. Plesiotype, No. 1932, C.A.S. coll. P. 144.
- Fig. 9. *Glyphodesmus driveri* H. & G., n. sp. x 600. Type, No. 1933, C.A.S. coll. P. 144.
- Fig. 10. *Glyphodesmus sigmoides* H. & G., n. sp. x 1100. Type, No. 1934, C.A.S. coll. P. 145.
- Fig. 11. *Grammatophora merletta* H. & G., n. sp. x 930. Type, No. 1935, C.A.S. coll.; focused so as to show beading. P. 146.
- Fig. 12. *Grammatophora merletta* H. & G., n. sp. x 930. Same specimen as fig. 11 but in slightly different focus and with diagram of side view of interior silica-bars.
- Fig. 13. *Hemidiscus simplicissimus* H. & G., n. sp. x 960. Type, No. 1937, C.A.S. coll. P. 147.
- Fig. 14. *Grammatophora merletta* H. & G., n. sp. x 2100. A portion of paratype No. 1970a, C.A.S. coll. highly magnified to show sculpture.



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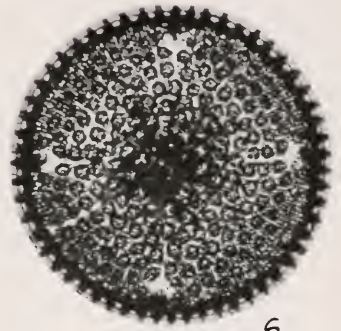
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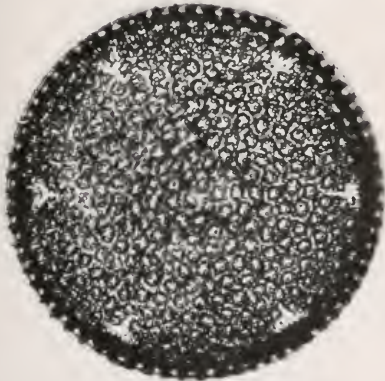
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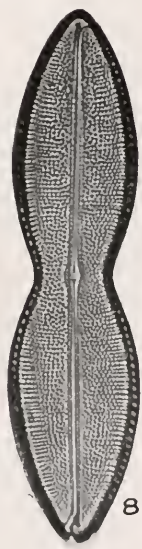
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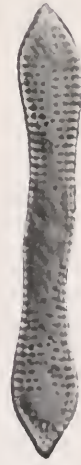
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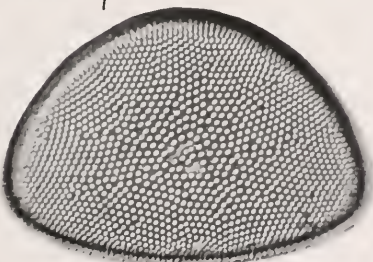
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PLATE 17

- Fig. 1. *Hemidiscus niæcus* H. & G., n. sp. x 400. Type, No. 1936, C.A.S. coll. P. 146.
- Fig. 2. *Melosira sulcata* Kützing. x 485. Plesiotype, No. 1938, C.A.S. coll. P. 148.
- Figs. 3, 4. *Navicula californica* Greville. x 790. Plesiotypes Nos. 1939, 1949, C.A.S. coll. P. 148.
- Fig. 5. *Navicula campylodiscus* Grunow. x 540. Plesiotype, No. 1940, C.A.S. coll. P. 149.
- Fig. 6. *Navicula campylodiscus* Grunow. x 540. Another specimen mounted on same slide as No. 1940, C.A.S. coll.
- Fig. 7. *Navicula clavata* Gregory. x 1275. Plesiotype, No. 1941, C.A.S. coll. P. 149.
- Fig. 8. *Navicula densistriata* Schmidt. x 600. Plesiotype, No. 1942, C.A.S. coll. P. 150.
- Fig. 9. *Navicula densistriata* Schmidt. x 600. Plesiotype, No. 1943, C.A.S. coll. P. 150.
- Fig. 10. *Navicula densistriata* Schmidt. x 630. Plesiotype, No. 1944, C.A.S. coll. P. 150.
- Fig. 11. *Navicula castwoodi* H. & G., n. sp. x 400. Type, No. 1945, C.A.S. coll. P. 150.
- Fig. 12. *Navicula stippi* H. & G., n. sp. x 630. Type, No. 1947, C.A.S. coll. P. 156.

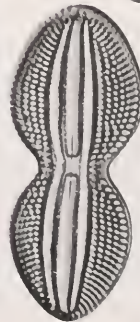
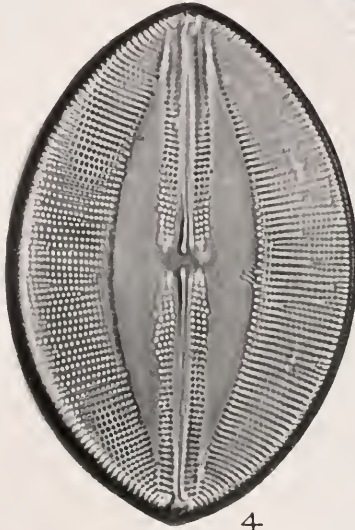
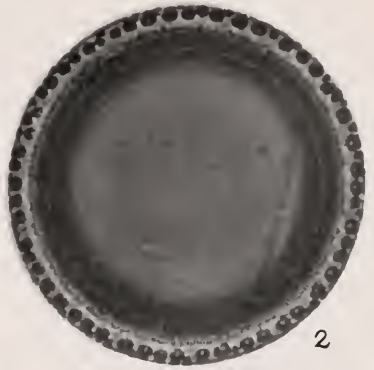
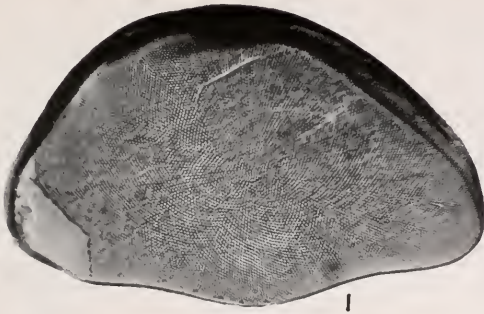


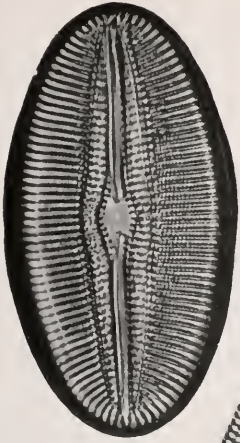
PLATE 18

- Fig. 1. *Navicula hemedyi* W. Smith. x 400. Plesiotype, No. 1950, C.A.S. coll. P. 151.
- Fig. 2. *Navicula impressa* Grunow. x 600. Plesiotype, No. 1946, C.A.S. coll. P. 151.
- Fig. 3. *Navicula longa* (Gregory.) x 540. Plesiotype, No. 1951, C.A.S. coll. P. 152.
- Fig. 4. *Navicula longa* (Gregory.) x 540. Mounted with No. 1951 showing variation in shape.
- Fig. 5. *Navicula lyra* Ehrenberg. x 600. Plesiotype, No. 1952, C.A.S. coll. P. 152.
- Fig. 6. *Navicula madrae* H. & G., n. sp. x 650. Type, No. 1953, C.A.S. coll. P. 152.
- Fig. 7. *Navicula ortolanae* H. & G., n. sp. x 540. Type, No. 1954, C.A.S. coll. P. 153.
- Fig. 8. *Navicula pandura* Brebisson, x 280. Plesiotype, No. 1948, C.A.S. coll. P. 154.
- Fig. 9. *Navicula pelagi* Schmidt. x 940. Plesiotype, No. 1955, C.A.S. coll. P. 154.
- Fig. 10. *Navicula prae-texta* Ehrenberg. x 600. Plesiotype, No. 1956, C.A.S. coll. P. 154.
- Fig. 11. *Navicula prae-texta* Ehrenberg. x 600. Plesiotype, No. 1957, C.A.S. coll. P. 154.
- Fig. 12. *Navicula prae-texta* Ehrenberg. x 500. Plesiotype, No. 1958, C.A.S. coll. P. 154.
- Fig. 13. *Navicula rcygate* H. & G., n. sp. x 1125. Type, No. 1959, C.A.S. coll. P. 155.

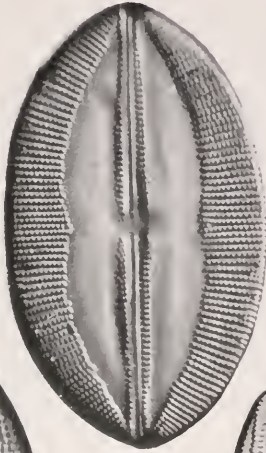


PLATE 19

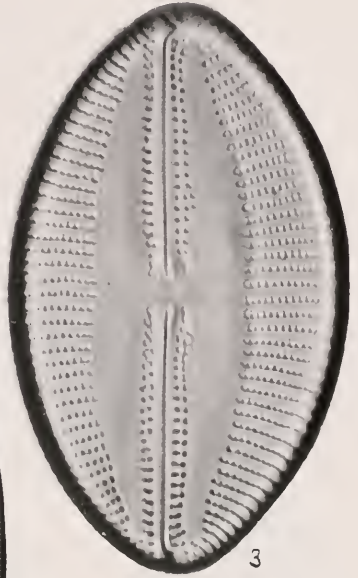
- Fig. 1. *Navicula smithii* Brebisson. x 630. Plesiotype, No. 1960, C.A.S. coll. P. 155.
- Fig. 2. *Navicula spectabilis* Gregory. x 920. Plesiotype, No. 1961, C.A.S. coll. P. 156.
- Fig. 3. *Navicula subspectabilis* H. & G., n. sp. x 1530. Type, No. 1962, C.A.S. coll. P. 157.
- Fig. 4. *Navicula splendida* Gregory. x 530. Plesiotype, No. 1948a, C.A.S. coll. P. 156.
- Fig. 5. *Navicula vidovichii* Grunow. x 600. Plesiotype, No. 1963, C.A.S. coll. P. 158.
- Fig. 6. *Orthoncis splendida* (Gregory.) x 880. Plesiotype, No. 1963, C.A.S. coll. P. 160.
- Fig. 7. *Plagiogramma fascinatum* H. & G., n. sp. x 1520. Type, No. 1969, C.A.S. coll. P. 160.
- Fig. 8. *Plagiogramma hymenoptera* H. & G., n. sp. x 640. Type, No. 1970, C.A.S. coll. P. 161.
- Fig. 9. *Plagiogramma insolito* H. & G., n. sp. x 720. Type, No. 1971, C.A.S. coll. P. 161.
- Fig. 10. *Plagiogramma tessellatum* Greville. x 380. Plesiotype, No. 1973, C.A.S. coll. P. 162.
- Fig. 11. *Pleurosigma manni* H. & G., n. sp. x 800. Type, No. 1974, C.A.S. coll. Central portion photographed to show sculpture; see next plate for outline of valve. P. 162.



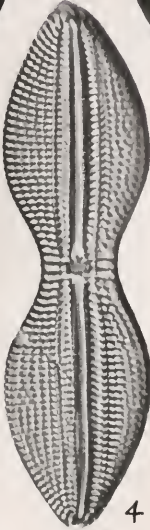
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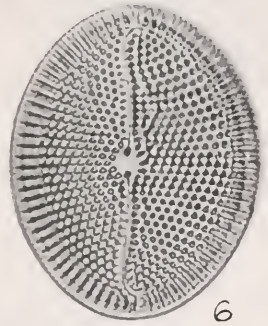
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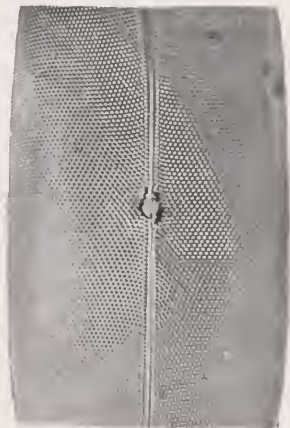
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PLATE 20

- Fig. 1. *Pleurosigma manni* H. & G., n. sp. x 450. Type, No. 1974, C.A.S. coll. Outline of valve; see preceding plate for details of sculpture.
- Fig. 2. *Podosira adriatica* (Kützing.) x 800. Plesiotype, No. 1975, C.A.S. coll. P. 163.
- Fig. 3. *Podosira clarki* H. & G., n. sp. x 800. Type, No. 1976, C.A.S. coll. P. 163.
- Fig. 4. *Podosira ovoidca* H. & G., n. sp. x 800. Type, No. 1977, C.A.S. coll. P. 163.
- Fig. 5. *Podosira polita* H. & G., n. sp. x 960. Type, No. 1978, C.A.S. coll. P. 164.
- Fig. 6. *Porpeia quadriceps* Bailey. x 400. Plesiotype, No. 1979, C.A.S. coll.; side view. P. 164.
- Fig. 7. *Porpeia quadriceps* Bailey. x 400. End view of another individual mounted on same slide as No. 1979.
- Fig. 8. *Rhaphoneis amphiceros* Ehrenberg. x 1200. Plesiotype, No. 1980, C.A.S. coll. P. 165.
- Fig. 9. *Rhaphoneis cocconeiformis* (Schmidt.) x 1200. Plesiotype, No. 1981, C.A.S. coll. P. 165.
- Fig. 10. *Stephanogonia pretiosa* H. & G., n. sp. x 400. Type, No. 1982, C.A.S. coll. P. 166.
- Fig. 11. *Stephanopyxis corona* (Ehrenberg.) x 400. Plesiotype, No. 1983, C.A.S. coll. P. 166.
- Fig. 12. *Stictodiscus californicus* Greville. x 570. Plesiotype, No. 1984, C.A.S. coll. P. 167.

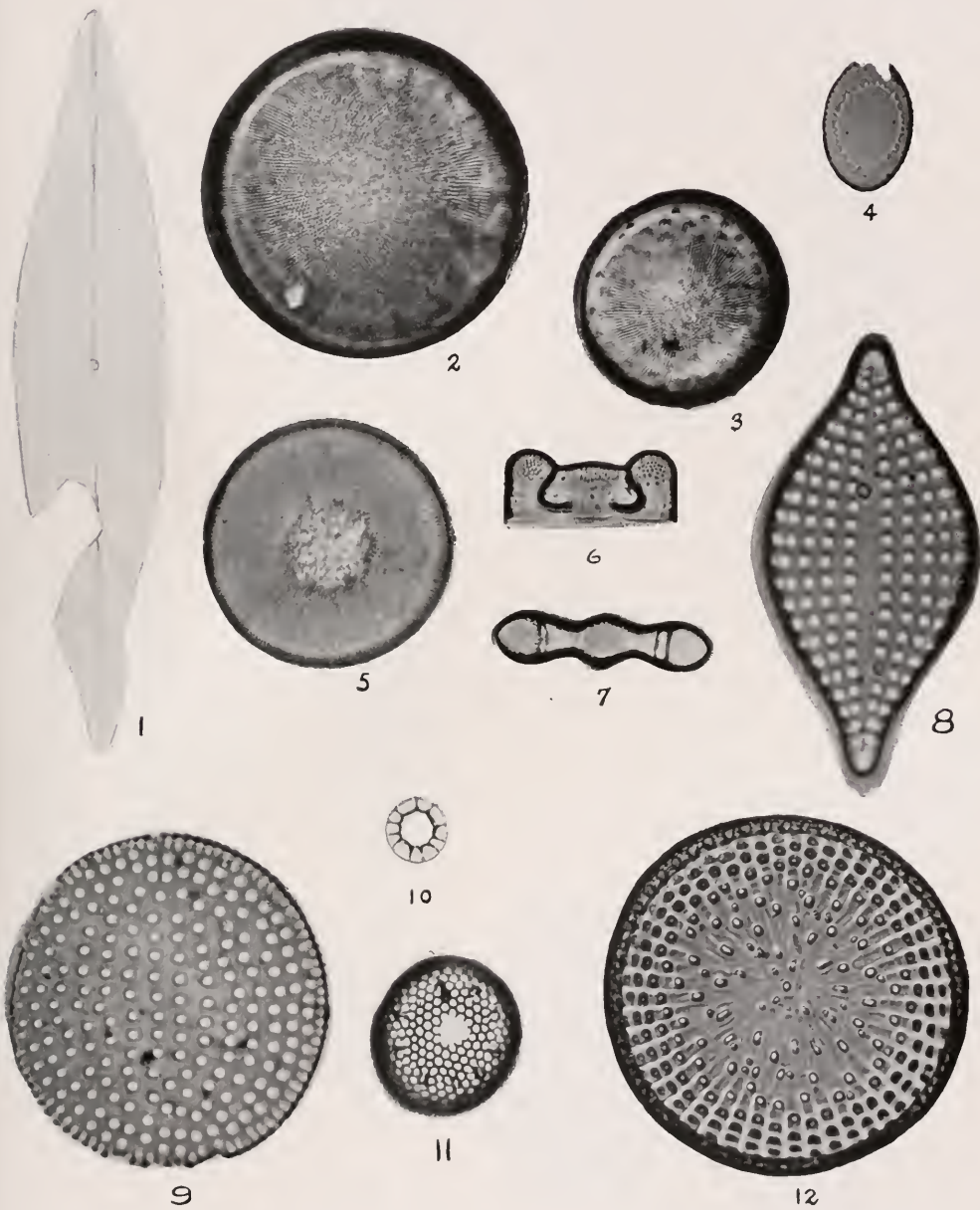


PLATE 21

- Fig. 1. *Surirella newmani* H. & G., n. sp. x 790. Type, No. 1985, C.A.S. coll. P. 167.
- Fig. 2. *Surirella patens* Schmidt. x 790. Plesiotype, No. 1986, C.A.S. coll. P. 168.
- Fig. 3. *Synedra duhemi* H. & G., n. sp. x 480. Type, No. 1987, C.A.S. coll.; diagrammatic cross section at *a*. P. 168.
- Fig. 4. *Trachyncis aspera* (Ehrenberg.) x 600. Plesiotype, No. 1988, C.A.S. coll. P. 169.
- Fig. 5. *Nitzschia honoensis* H. & G., n. sp. x 450. Type, No. 1964, C.A.S. coll. P. 158.
- Fig. 6. *Nitzschia nelsoni* H. & G., n. sp. x 600. Type, No. 1965, C.A.S. coll. P. 159.
- Fig. 7. *Nitzschia nelsoni* H. & G., n. sp. x 450. Paratype, No. 1966, C.A.S. coll. P. 159.
- Fig. 8. *Nitzschia princeps* H. & G., n. sp. x 400. Type, No. 1967, C.A.S. coll. P. 159.
- Fig. 9. *Xanthiopyxis cingulata* Ehrenberg. x 1000. Plesiotype, No. 1989, C.A.S. coll. P. 169.
- Fig. 10. *Xanthiopyxis hirsuta* H. & G., n. sp. x 1200. Type, No. 1990, C.A.S. coll. P. 170.
- Fig. 11. *Xanthiopyxis oblonga* Ehrenberg. x 800. Plesiotype, No. 1991, C.A.S. coll. P. 170.



PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES
FOURTH SERIES

VOL. XV, No. 3, pp. 195-207, plate 22

APRIL 26, 1926

III
**EXPEDITION TO THE REVILLAGIGEDO ISLANDS,
MEXICO, IN 1925, III**

NOTES ON A COLLECTION OF REPTILES AND
AMPHIBIANS FROM THE TRES MARIAS AND
REVILLAGIGEDO ISLANDS, AND WEST
COAST OF MEXICO, WITH DESCRIP-
TION OF A NEW SPECIES
OF TANTILLA

BY
JOSEPH R. SLEVIN
Assistant Curator, Department of Herpetology

The following notes are based on a collection of reptiles and amphibians made on the Academy's expedition to the Tres Marias and Revillagigedo islands, in the spring of 1925, on board the United States Ship *Ortolan*, Lieutenant M. M. Nelson, U. S. Navy, commanding.

The expedition besides making investigations among the Tres Marias and Revillagigedo islands, also made stops along the west coast of Lower California, and some of the adjacent islands.

As larger series of specimens from these regions than have heretofore been available for study were gathered, and as a new species and new records were obtained, it was thought advisable to publish the following notes in hopes that they may be of use to future students who may be interested in the herpetology of western Mexico.

April 26, 1926



I

REVILLAGIGEDO ISLANDS

1. *Uta clarionensis* Townsend

An abundant species about the lowlands and rocky ridges in the vicinity of Sulphur Bay, Clarion Island. This lizard was found among the outcroppings of lava in the brushy areas and seemed to be confined strictly to the lower levels as none were observed on the plateau or higher parts of the island.

A male (No. 58190) was colored in life as follows: Body with irregular dorsal and lateral black markings; tail and limbs cross-banded with black; ground color a rich cobalt green. Females are brown above, show less of the black markings of the male, and have a yellowish lateral stripe extending from the ear opening to the hind limb. Under surfaces are whitish. Both Van Denburgh¹ and Townsend² speak of the coloring as bluish, similar to *Uta auriculata* from Socorro Island, but these descriptions are evidently from alcoholic specimens as all those now in the Academy's series have lost the green coloring and have changed to a light blue.

The femoral pores in twenty specimens vary from ten to fourteen; being 10 four times, 11 ten times, 12 sixteen times, 13 eight times, and 14 once. Males have enlarged postanal plates.

2. *Coluber anthonyi* (Stejneger)

A common species about the sea bird colonies and cactus patches in the vicinity of Sulphur Bay, Clarion Island. It was found mostly in the dense thickets and appeared to be confined chiefly to the area close to and encircling the sand beach. Of the sixteen specimens taken none were found to contain any food.

¹ The Reptiles of Western North America, Vol. I, 1922, p. 196.

² Proc. U. S. N. M., Vol. 13, 1890, p. 143.

The color above in living specimens varies from pale to dark brown, and sometimes shows a reddish tinge; a few scattered black dots on top of the head; under surfaces yellowish or whitish, with gular region sometimes clouded or marbled with black.

The scale counts are given below. All have 17 scale rows.

Number	Sex	Gastro- steges	Uro- steges	Supra- labials	Infra- labials	Pre- oculars	Post- oculars	Loreal	Temporals
58173	♀	186	98+	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58174	♀	188	90+	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58175	♂	191	100+	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58176	♂	190	54+	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58177	♀	189	94+	8-8	8-8	2-2	2-2	1-1	2+2-2+3
58178	♂	193	107c	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58179	♂	191	92+	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58180	♂	191	103c	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58181	♂	189	104c	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58182	♀	189	75+	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58183	♂	197	82+	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58184	♂	192	90+	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58185	♂	194	105c	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58186	♂	196	76+	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58187	♂	189	103c	8-8	8-8	2-2	2-2	1-1	2+2-2+2
58188	♂	186	94+	8-8	8-8	2-2	2-2	1-1	2+2-2+2

3. *Uta auriculata* Cope

This species, the only one found on Socorro Island, ranged from sea level to about 2,500 feet, but only one or two specimens were found at this elevation. It was found to be generally confined to the arroyos and small flats back of the numerous little coves along the shore line. A common but not an abundant species.

Color in life bluish, with irregular black dorsal markings; tail and limbs cross-banded with black; under surfaces dotted or marbled with black. Females are sometimes brown above.

The femoral pores in twenty specimens vary from ten to thirteen; being 10 twelve times, 11 seventeen times, 12 seven times, and 13 four times. Males have enlarged postanal plates.

II

TRES MARIAS AND ISABEL ISLANDS

1. *Phyllodactylus tuberculosus* Wiegmann

Four specimens (Nos. 58950-58953) were taken on Maria Madre Island May 16-23, 1925. These were found under the bark of trees, and on walls of deserted houses where they were found at night while searching for insects.

2. *Anolis nebulosus* Wiegmann

Taken on Maria Madre and Magdalena islands. This little lizard was found on the trees, vines, and stones in the ravines and cañon bottoms. It was not found to be a common species on either island.

The color in living specimens may be gray or light brown, with irregular dorsal markings of black or orange, sometimes forming bands on the tail. The limbs are cross-banded with black. The under surfaces are whitish. Males have a large dark red or yellow gular pouch extending along the belly to a point midway between the hind limbs. One specimen (No. 59004) has a wide light dorsal stripe edged with black.

3. *Uta lateralis* Boulenger

Common on both Maria Madre and Maria Magdalena islands. It inhabits the area back of the beach line where it is found among the driftwood and fallen trees.

A male (No. 59049) was colored in life as follows: Upper surfaces grayish, with four regular rows of black oval blotches between the limbs; limbs barred with black; a yellow streak along the side of the head from the snout to the fore limb; throat light blue; belly blue with obscure black spots.

The femoral pores in twenty specimens vary from ten to thirteen; being 10 eight times, 11 nineteen times, 12 seven times, and 13 six times. Males have enlarged postanal plates.

4. *Sceloporus boulengeri* Stejneger

Abundant on Isabel Island and found mostly on the small trees back of the landing place. It is strictly an arboreal species and in habits resembles *Sceloporus clarkii*, its northern relative.

An adult male (No. 59083) was colored in life as follows: Light gray above with scattered scales of pale blue; lower front and hind limbs cross-banded with black; gular region blue, edged anteriorly with black; a large black shoulder patch extending on to the throat and connecting on the median line. The belly is blue with a central streak of black two to three scales wide.

The ear opening is large protected by very small scales. Dorsal scale rows in twenty specimens vary from 22 to 26, femoral pores from eight to eleven; being 8 ten times, 9 seventeen times, 10 twelve times, and eleven once.

5. *Cnemidophorus mariarum* Günther

A very abundant species about the lower levels of Maria Madre Island, where it was found along the roads, trails, and in the brush thickets. This species was found to be rare on Maria Magdalena Island, where it was also taken.

A large male (No. 58846) was colored in life as follows: Grayish above, with two longitudinal rows of black blotches on the sides; top of head light olive; top of limbs grayish with small yellowish dots; belly bluish black with some scales of light blue along the edges; lower surfaces of limbs bluish black; lower surface of tail salmon; gular region salmon, clouded with black.

Femoral pores in twenty specimens vary from nineteen to twenty-four; being 19 three times, 20 twelve times, 21 nine times, 22 ten times, 23 five times, and 24 once.

6. *Cnemidophorus gularis mexicanus* (Peters)

Found very abundant on the beach at Isabel Island. Hundreds of them were observed feeding on the insects gathered about an immense pile of dead sharks left on the sand beach by Mexican fishermen.

A typical specimen (No. 59259) was colored in life as follows: Brownish above, with three longitudinal yellowish lines on each side. The ground color between these lines is marked with a series of small yellowish spots. The top of the head is brown; upper surfaces of the limbs spotted with black and yellow; lower surfaces whitish, spotted with black; gular region reddish. In some specimens the belly is nearly uniform black with a few white spots.

The femoral pores in twenty specimens vary from eighteen to twenty-three: being 18 two times, 19 seven times, 20 seventeen times, 21 five times, 22 eight times, and 23 once.

7. *Ctenosaura teres* (Harlan)

A very abundant species on Maria Madre, Maria Magdalena, and Isabel islands. On Maria Madre where it was found most abundantly it lived among the rock piles, and in the hollow tree stumps. They were noticed feeding on the leaves of the various trees and plants, and seemed to be particularly fond of the fruit of the cactus. They were so tame that they would sometimes take the cactus fruit from one's hand when it was offered to them.

The ground color of adult specimens is black, marbled or mottled with reddish or yellowish; throat black or whitish, with black reticulations; belly whitish, clouded or spotted with black. Very young specimens are a light green with black markings. Intermediates are sometimes cross-banded with greenish or reddish between the limbs.

The femoral pores in twenty specimens vary from two to seven; being 2 once, 3 once, 5 seven times, 6 twenty-one times, and 7 ten times.

8. *Tantilla nelsoni* Slevin, new species

Diagnosis.—Rostral small, a little broader than deep, scarcely visible from above; frontal large, a little longer than broad; nostril in a single nasal; symphyseal in contact with anterior genials; anterior genials twice as long as posterior. Scales smooth, in 15 rows, gastrosteges 130, urosteges 39c, anal single, supralabials 7—6, infralabials 8—8, preoculars

1—1, postoculars 2—2, temporals 1+2—1+2. Color black, with eleven complete white bands four to five scales wide encircling the body; three encircling the tail; tip of tail white; a narrow white band crosses the back of the head touching the posterior tips of the parietals; snout and top of head, uniform black; anterior labials black, edged with white; posterior labials white; throat white.

Type: No. 58680, Mus. Calif. Acad. Sci., **Maria Madre Island, Tres Marias Islands, Mexico**, collected by a native, May 18, 1925.

Named for Lieutenant M. M. Nelson, U. S. Navy, commanding officer of the U. S. S. *Ortolan*.

9. *Oxybelis acuminatus* (Wied)

A male of this species (No. 58682) was taken on Maria Madre Island, May 23, 1925. It has 17 scale rows, gastrosteges 190, urosteges 195c, anal divided, supralabials 8—8, infralabials 11—10, preoculars 1—1, postoculars 2—2, loreal absent, temporals 1+2 and 1+2.

Color grayish above, with a few scales black-edged, and a few small scattered black spots; under surfaces grayish.

10. *Drymobius boddærtii* (Seetzen)

Found to be the most common of any of the snakes collected on the Tres Marias. Specimens Nos. 58676-58679 from Maria Madre Island, and Nos. 58990-58991 from Maria Magdalena Island have the following scale counts:

Number	Sex	Scale rows	Gastrosteges	Urosteges	Supralabials	Infralabials	Preoculars	Postoculars	Loreal	Temporals
58676	♀	17	198	117c	8-8	8-8	1-1	2-2	1-1	2+2-2+2
58677	♂	17	195	114+	8-8	9-9	1-1	2-2	1-1	2+3-2+3
58678	♀	17	196	105c	8-8	9-9	1-1	2-2	1-1	2+2-2+2
58679	♂	17	185	110c	8-8	10-10	1-1	2-2	1-1	2+2-2+2
58990	♀	17	202	80+	8-8	10-9	1-1	2-2	1-1	2+2-2+3
58991	♀	17	194	131c	x-8	10-9	1-1	x-2	1-1	x-2+2



11. *Drymarchon corais melanurus* (Duméril & Bibron)

An adult male (No. 58993) was taken late in the afternoon, May 21, 1925, in the bottom of a creek bed on Maria Magdalena Island. It has 17 scale rows, gastrosteges 201, urosteges 78+, anal 1, supralabials x—8, infralabials 7—6, preoculars 1—1, postoculars 2—2, loreal 1—1, temporals 2+2 and 2+2.

Color above black; a few scattered scales brownish, mottled with black; top of head uniform black; 58 posterior gastrosteges and under surface of tail black; anterior gastrosteges white, spotted or edged with black; gular region white.

12. *Boa imperator* Daudin

A male of this species (No. 58681) taken on Maria Madre Island May 21, 1925, has the following scale counts: Scale rows 77, gastrosteges 258, urosteges 66c, anal 1, supralabials 19—20, infralabials 23—24.

This species was also collected on Maria Magdalena Island.

13. *Pelamydrus platurus* (Linnæus)

A dead specimen (No. 58992) was picked up on the beach at Maria Magdalena Island, May 21, 1925.

14. *Kinosternon integrum* Leconte

A single specimen (No. 58675) was found half buried in the mud under an old stump in the creek bottom at Arroyo Hondo, Maria Madre Island, May 17, 1925.

Length of carapace.....	290 mm.
Length of plastron.....	270 mm.
Width of carapace.....	192 mm.
Width of plastron.....	161 mm.

III

PENINSULA OF LOWER CALIFORNIA AND
ADJACENT ISLANDS

The reptiles and amphibians of this region have been studied at length by Van Denburgh,¹ but inasmuch as there are now new records to be added to the fauna, the following data are given in order to bring the list of the known species to date, and to complete the report on the herpetology of the expedition.

1. *Hyla regilla* Baird & Girard

Fifty-two specimens (Nos. 59626-59677) were collected on Cerros Island, June 3, 1925. This little tree-toad was found to be abundant along a small stream at the southeast end of the island.

2. *Coleonyx variegatus* (Baird)

One specimen (No. 59625) was found under a large stone in the bottom of a dry wash on Cerros Island, June 4, 1925.

3. *Crotaphytus wislizenii* Baird & Girard

One specimen was taken on Cerros Island, June 4, 1925. This species was also taken on previous expeditions of the Academy to Cerros Island but was found to be very rare.

4. *Callisaurus crinitus* Cope

One hundred and sixty-one specimens (Nos. 59396-59556) were collected at Turtle Bay, June 1, 1925. This lizard was found to be very abundant along the sand beaches at the south end of the bay. It was found mostly about the piles of debris just at the high tide line, where it was seen feeding on the swarms of kelp flies about the dead seaweed.

5. *Callisaurus draconoides draconoides* (Blainville)

Twelve specimens (Nos. 59296-59307) were collected at Cabo San Lucas, May 28, 1925. This lizard is common in the brushy areas back of the sand beach.

¹ Proc. Cal. Acad. Sci., Ser. 4, Vol. IV, 1914.
The Reptiles of Western North America, Vols. I-II, 1922.

6. *Uta martinensis* Van Denburgh

Twenty-one specimens were taken in the vicinity of Hassler's Cove, San Martin Island, June 8, 1925. Found sparingly among the low-growing shrubs at the back of a small sand beach.

7. *Uta nigricauda* Cope

Thirteen specimens (Nos. 59331-59343) were collected on Magdalena Island, May 29-30, 1925. Found most commonly upon the large rocks in the bottoms of the dry washes.

8. *Uta stansburiana elegans* (Yarrow)

Nine specimens (Nos. 59344-59352) were taken on Magdalena Island, May 29, 1925, three (Nos. 59393-59395) at Turtle Bay, June 1, 1925, three (Nos. 59560-59562) at San Bartolome Bay, June 2, 1925, and thirty-seven specimens on Cerros Island, June 3-4, 1925. Generally an abundant species when met with.

9. *Sceloporus rufidorsum* Yarrow

Nine specimens (Nos. 59569-59577) were collected on Cerros Island, June 3-5, 1925. Found sparingly among the dense brush thickets in the bottoms of the dry washes.

10. *Sceloporus zosteromus* Cope

Fourteen specimens were taken on Magdalena Island, May 29, 1925, and one specimen (No. 59392) was taken at Turtle Bay, June 1, 1925. A very shy but common species among the cactus patches and brush thickets.

11. *Phrynosoma coronatum* Blainville

A single specimen (No. 59703) was taken at San Quintin, June 7, 1925.

12. *Gerrhonotus scincicauda webbii* (Baird)

Two specimens were collected on Cerros Island, June 3-5, 1925, and two specimens on San Martin Island, June 8, 1925. Of the two from Cerros Island, both have the temporals feebly

keeled and the longitudinal dorsal series of scales in 14 2/2 rows. This species was found to be very rare on Cerros Island. On a previous expedition of the Academy a specimen was caught in a mouse trap.

13. *Verticaria hyperythra beldingi* (Stejneger)

Twenty-one specimens (Nos. 59310-59330) were collected on Magdalena Island, May 29-30, 1925. All these specimens have the four supraocular plates and the large collar scales. Eighteen are typical *V. h. beldingi* having the double dorsal line, while only three (Nos. 59317, 59318, and 59323) have the single dorsal line characteristic of *V. h. schmidti*.

14. *Cnemidophorus bartolomas* Dickerson

Two specimens (Nos. 59558-59559) were collected at San Bartolome Bay, June 2, 1925. Neither of these specimens agree with the description of the type¹ in dorsal coloration, showing none of the alternating of the spots in the dorsal rows. Van Denburgh² was doubtful as to the distinctness of this species from *C. rubidus*. Of the two specimens before me the dorsal coloration of No. 59558 resembles that of *C. t. stejnegeri*, while that of No. 59559 resembles *C. rubidus*. The gular region of the former shows less of the black markings characteristic of *C. t. stejnegeri*, while the latter has the black throat markings found in specimens of *C. rubidus* from Magdalena Island. More material and further study may prove this species to be an intergrade between *C. rubidus* and *C. t. stejnegeri*.

15. *Cnemidophorus multiscutatus* (Cope)

Eight specimens were taken on Cerros Island, June 4-5, 1925. All show the black spotting on the lower surface of the tail.

16. *Cnemidophorus rubidus* (Cope)

A single specimen (No. 59389) was taken on Magdalena Island, May 30, 1925. It has the black throat markings of specimens from this locality.

¹Bull. Amer. Mus. Nat. Hist., Vol. XLI, Art. X, p. 476.

²The Reptiles of Western North America, Vol. 1, 1922, p. 525.

17. *Coluber flagellum piceus* (Cope)

A male of this species (No. 59391) from Magdalena Island, collected on May 30, 1925, has 17 scale rows, gastrosteges 199, urosteges 121c, anal divided, supralabials 8—8, infralabials 10—10, preoculars 2—2, postoculars 2—2, loreal 1—1, temporals 2+3—2+3.

18. *Pituophis catenifer annectens* (Baird & Girard)

Specimens Nos. 59390 from Magdalena Island, May 29, 1925, 59568 from Cerros Island, June 4, 1925, and 59678-59679 from San Martin Island have the following scale counts:

Number	Sex	Scale rows	Gastrosteges	Urosteges	Supralabials	Infralabials	Pre-oculars	Post-oculars	Loreal	Temporals
59390	♂	33	245	61c	9-9	12-12	1-1	3-3	1-1	3-3
59568	♂	31	231	61c	9-9	12-12	2-2	3-4	1-1	4-5
59678	♂	33	234	75+	8-9	12-12	1-1	4-4	1-1	4-4
59679	♂	33	227	71c	9-8	12-12	1-1	4-4	1-1	4-4

19. *Crotalus exsul* Garman

A male of this species (No. 59557) was taken at San Bartolome Bay, June 2, 1925. It has 27 scale rows, gastrosteges 191, urosteges 24c, anal 1, supralabials 15—16, infralabials 16—16, preoculars 2—2, postoculars 3—3, loreal 1—1. Five specimens (Nos. 59563-59567) taken on Cerros Island, June 3-4, 1925, have the following scale counts:

Number	Sex	Scale rows	Gastrosteges	Urosteges	Supralabials	Infralabials	Pre-oculars	Post-oculars	Loreal
59563	♂	27	195	19c	17-17	16-17	2-2	3-3	1-1
59564	♀	27	194	17c	16-16	16-16	2-2	3-3	1-1
59565	♂	27	191	21c	15-14	15-15	2-2	3-3	1-1
59566	♂	27	190	22c	16-16	x-16	2-2	3-3	1-1
59567	♂	27	189	23c	17-17	16-16	2-2	3-3	1-1

20. *Eretmochelys squamosa* (Girard)

A small female (No. 59704) was secured. This specimen was caught by some Japanese fishermen close to Cabo San Lucas, May 27, 1925.



Photo. by G. Dallas Hanna



Photo. by G. Dallas Hanna

Fig. 1. *Uta auriculata*
Grayson's Cove, Socorro Island, Revillagigedo Islands, Mexico, May 11, 1925.

Fig. 2. *Ctenosaura teres*
Maria Madre Island, Tres Marias Islands, Mexico, May 15, 1925.

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IV
EXPEDITION TO THE REVILLAGIGEDO ISLANDS,
MEXICO, IN 1925, IV

A PLIOCENE FAUNA FROM MARIA MADRE
ISLAND, MEXICO¹

BY
ERIC KNIGHT JORDAN AND LEO GEORGE HERTLEIN
Department of Paleontology

In the course of the expedition of the California Academy of Sciences to the Revillagigedo and Tres Marias islands, Mexico, a marine Pliocene formation was found on the island of Maria Madre, of the Tres Marias group, and from it a small fauna was obtained. The collection was made by Dr. G. Dallas Hanna, curator of Paleontology, and the present senior author. The limited time available permitted only rather superficial collecting, and observation of no more than the most general geologic relations.

Maria Madre Island lies off the west coast of Mexico in approximately 21° 35' north latitude, almost directly west of San Blas. It is about 55 miles from the nearest point on the mainland. The island is the largest of the Tres Marias group, which forms a chain having a general northwest and southeast trend.

Maria Madre Island consists essentially of a core of igneous rocks, chiefly granite, with some diorite and rhyolite, over-

¹This paper is No. 4 of the Revillagigedo Islands Expedition of 1925. No. 1 contains the General Report; No. 2 gives an account of the Diatoms collected; and No. 3 is devoted to the Reptiles obtained. See pages 1-208 of this volume.

April 26, 1926



lain unconformably by marine Tertiary sediments in which both Miocene and Pliocene are definitely recognized. A considerable development of Marine Pleistocene is found at the southern end of the island.

Miocene beds, according to Dr. Hanna, are well exposed in the Arroyo Hondo several miles upstream from its mouth near the northeast corner of the island. According to his statement, the section consists of about 1000 feet of soft white diatomite, almost pure, and superficially in every way similar to the Miocene diatomites of California. Fish remains are abundant in these beds, but no other megascopic fossils were found.

Pliocene beds apparently cap the greater part of the island. Along the eastern shore these attain a thickness of possibly 300 to 500 feet. In the central, higher regions the older rocks are commonly exposed in the cañons, but thin residual masses of Pliocene remain on the mountain tops. The beds appear to be moderately folded, with a general dip away from the central mountain core.

According to Dr. Hanna, an angular unconformity exists between the Miocene and Pliocene beds in the Arroyo Hondo; the dip of the Miocene beds is about 30° , and that of the Pliocene beds about 15° .

Lithologically, the Pliocene rocks exhibit considerable variation. They are most commonly represented by a loosely consolidated calcareous rock composed of a mixture of coarse sand and pebbles, and excessively abundant tests of foraminifera. Fossils are generally distributed in these beds, but the preservation is rarely very good. Finer grained sandstones and shales are found in lesser amounts, which are likewise rich in foraminifera but contain few larger fossils. Large blocks of reef coral are irregularly distributed in the formation. The general character of the Pliocene sediments indicates that they were, in greater part, deposited in distinctly shallow water, possibly under truly littoral conditions.

Pleistocene sediments apparently compose the low flat near the salt works at the southern end of the island. These consist of beds of calcareous, very fossiliferous sandstone. The beds are nearly flat-lying and in vertical section are about one hundred feet thick.

Pliocene fossils were collected at the following points. The numbers refer to the catalogue of localities of the department of Paleontology of the California Academy of Sciences.

- Loc. 937—Maria Madre Island, Tres Marias, Arroyo Hondo, near northeast corner of island; first exposure in stream bed upstream from mouth.
- Loc. 938—Maria Madre Island, Tres Marias. Beach cliffs 200 yards south of mouth of Arroyo Hondo; dark gray shales.
- Loc. 939—Maria Madre Island, Tres Marias. Cliffs about one mile south of and above village.
- Loc. 940—Maria Madre Island, Tres Marias. Lighthouse Point, on shore about one mile southeast of village.
- Loc. 941—Maria Madre Island, Tres Marias. Float in arroyo, three quarters of a mile north of village.
- Loc. 942—Maria Madre Island, Tres Marias. Miscellaneous collections from Pliocene.

The following fauna was recognized from the above localities:

Foraminifera

Numerous species,
All localities.

Anthozoa

Solenastrea sp.,
Loc. 941.

Brachiopoda

Terebratalia sp.,
Loc. 941.

Mollusca

Leda sp.,
Loc. 938.

Ostrea chilensis Philippi,
Locs. 939; 940.

Ostrea conchaphila Carpenter,
Locs. 939; 940.

- Ostrea cumingiana* Dunker,
Locs. 937; 939; 942.
- Ostrea megodon* Hanley,
Locs. 939; 942.
- Ostrea vespertina* Conrad,
Locs. 937; 939.
- Pecten (Pecten) stearnsii* Dall,
Loc. 937.
- Pecten (Chlamys) dallasi* Jordan & Hertlein,
new species,
Loc. 937.
- Pecten (Patinopecten)* near *caurinus* Gould,
Loc. 939.
- Pecten (Lyropecten) subnodosus* Sowerby,
Locs. 937; 939.
- Pecten (Plagioctenium) circularis* Sowerby,
Loc. 937.
- Pecten (Plagioctenium) abietis* Jordan & Hertlein,
new species,
Locs. 937; 939.
- Pecten (Plagioctenium) invalidus* Hanna,
Locs. 937; 939; 942.
- Placuanomia cumingii* Broderip,
Locs. 939; 942.

Cirripectida

Coronula cf. *diadema* Linnæus

This faunal list, while not large and unquestionably not complete for the formation, is extremely important, since its affinities are western North American, and Maria Madre Island is the southernmost point from which such a fauna has yet been reported. A large majority of the species occur in the Pliocene of Southern or of Lower California. None shows relations with either the Caribbean,² Panamanian, or Peruvian provinces.

The composition of the fauna indicates an upper Pliocene age, certainly no older than the Pliocene of Cedros Island, Lower California, and the San Diego formation of Southern

²*O. megodon* of the present fauna has been reported from the Tertiary of the Caribbean region.

California. The beds are not far removed in age from the upper Pliocene of Loreto, San Antonio Point, San José Island, and San Marcos Island, in the Gulf of California region, although the exact stratigraphic position of those beds is not yet known.

By far the greater part of the fauna is composed of Pectens, which, as a whole, indicate a warm temperate climate at the time of deposition of these beds.

1. **Pecten (Chlamys) dallasi** Jordan & Hertlein, new species

Plate XXIII, figures 2, 5, 6, 8

Shell of medium size, moderately thick, in several specimens with strong lines of restricted growth; valves mildly arched, and slightly extended posteriorly; hinge line a little over half the total length of the disk. Right valve ornamented by about 15 to 19 almost flat-topped radiating ribs, separated by slightly rounded interspaces almost as wide as the ribs, the summit of the ribs smooth, the sides and interspaces sculptured by fine, sharp, subequal radiating ridges and grooves, the shoulder of each rib on either side marked by a deeper groove; anterior dorsal and posterior dorsal areas of disk smooth; ears unequal, the anterior with a well developed byssal notch and sculpture consisting of about six radiating riblets crossed by concentric lines of growth; posterior ear obliquely truncated behind, and ornamented by four or five radiating riblets between which the interspaces bear fine incised radiating lines. Left valve sculptured much as right; anterior dorsal and posterior dorsal margins of disk sloping more abruptly to base of ears than on right valve; anterior ear indented by a rounded byssal notch and ornamented by five radiating riblets between which are minute sharp radiating grooves; posterior ear obliquely truncated and sculptured much as anterior, the radiating riblets, however, much more subdued and less prominent. Height 42 mm.; length 43 mm.; diameter 13 mm.; apical angle approximately 105° .

Type: No. 1862, *paratypes* Nos. 2072, 2073, 2074, 2075, 2076, and 2077, Mus. Calif. Acad. Sci., from Loc. 795 (C.A.S. coll.), Cañons one or two miles from San Antonio Point, east coast of Lower California; upper Pliocene; Fred Baker col-



lector; also No. 2078, Mus. Calif. Acad. Sci., from Loc. 937 (C.A.S. coll.), Arroyo Hondo, Maria Madre Island, Mexico; upper Pliocene; G. Dallas Hanna and Eric K. Jordan collectors.

Pecten dallasi is easily recognized by the peculiar minor radiating sculpture superimposed on the major ribs and interspaces. The number of ribs varies considerably, as does the obliquity of the valves.

This species is abundant in the upper Pliocene of the Gulf of California region, and, as we have specimens from there in better state of preservation than those from Maria Madre Island, the type is selected out of a lot from Lower California. The collection from Maria Madre contains three specimens of the species. The writers wish to express their obligation to Dr. Fred Baker, who collected the type specimen.

The species is named in honor of Dr. G. Dallas Hanna, whose work on the Pliocene of Imperial County, California, and on Lower California has added to our knowledge of the region.

2. *Pecten (Plagiocentrum) circularis* Sowerby

Plate XXIII, figure 9

A specimen of this species, from the Pliocene of Maria Madre Island, is illustrated to show the characteristic narrow ribs with broad interspaces, in contrast with the ribbing of *P. abietis*.

3. *Pecten (Plagiocentrum) abietis* Jordan & Hertlein, new species

Plate XXIII, figures 1, 3, 7

Shell averaging about 45 millimeters in altitude, about as long as high, fairly thick and solid, somewhat produced posteriorly. Right valve ornamented by 19—21 subtriangular ribs, in adults becoming flattened toward the margin, separated by sharp, narrow-bottomed interspaces, the sides of the ribs and interspaces decorated by sharp, close-set fringing lamellæ; hinge line about two-thirds the length of disk; ears about equal in length, rather large, the anterior ear ornamented by about four rather faint radial ribs crossed by concentric lines of growth, the byssal notch well defined; posterior ear faintly

radially and concentrically sculptured. Left valve with the ribs more pronouncedly triangular in cross-section, the sides densely fringed with lamellæ; ears similar to those of right valve, but the byssal notch on anterior ear less developed; hinge strong; cardinal crura well developed. Altitude 45 mm.; longitude 46 mm.; diameter of left valve about 32 mm.; apical angle about 100°.

Type: Left valve, No. 2079, *paratypes* Nos. 2080, 2081, 2082, and 2083, Mus. Calif. Acad. Sci., from Loc. 937 (C.A.S. coll.), **Arroyo Hondo, Maria Madre Island, Mexico**; upper Pliocene; Hanna & Jordan, collectors.

This species is closely related to *P. circularis*, but is distinguishable by the character of the ribbing. The ribs of *P. abietis* are wide at the base, and are triangular or subtriangular in cross-section. The interspaces are very narrow, and the sides of the ribs and interspaces are covered by a dense fringe of concentric lamellæ. The ribs of *P. circularis* are distinctly rounder and much narrower in cross section, and the interspaces are much wider.

Examination of a large series of specimens from Maria Madre Island, where this species is very abundant, and also from various localities in the upper Pliocene of the Gulf of California region, shows the angularity of the ribs to be a constant characteristic. The writers realize that intergradation with *P. circularis* proper may ultimately be proved, but as yet the present species is known only from the subtropical Pliocene.

The name (*abietis*,—of the fir) refers to the dense fringes of lamellæ, like needles of a conifer.

4. *Placuanomia cumingii* Broderip

Plate XXIII, figure 4

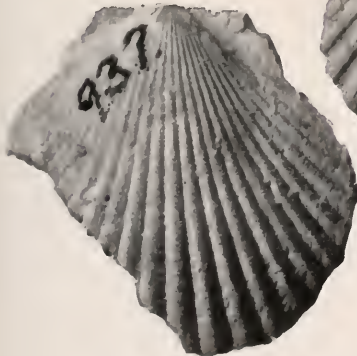
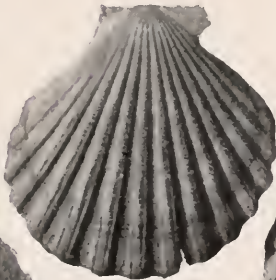
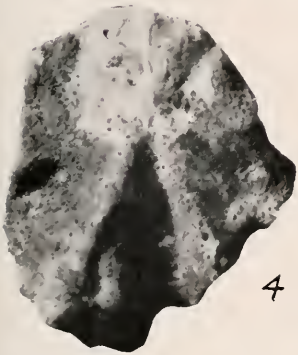
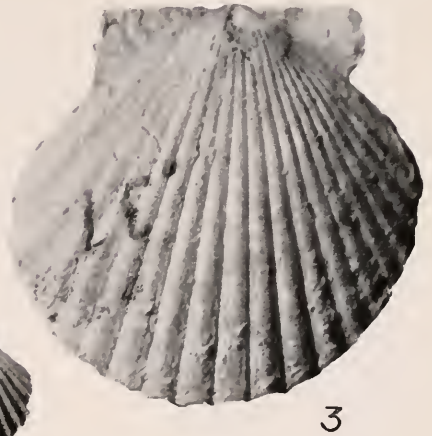
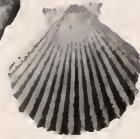
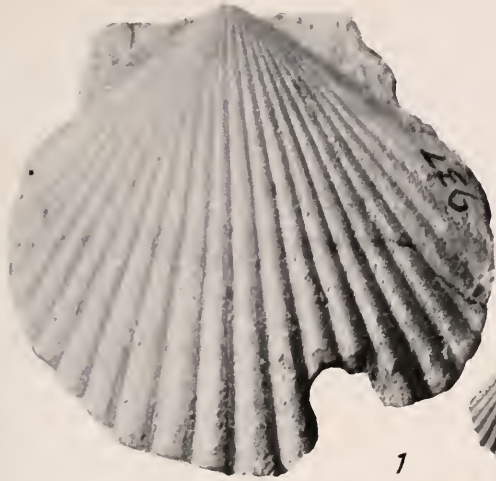
Placuanomia cumingii Broderip, Proc. Zool. Soc., 1832, p. 29.—Reeve, Conch. Icon., Vol. 11, 1859, *Placuanomia*, pl. 1, figs. 3a, 3b.

This species has never previously been figured in any generally accessible publication. It has not heretofore been reported from the Pliocene.

P. plicata Tuomey & Holmes, from the Pliocene of South Carolina, is hardly distinguishable from this species.

PLATE XXIII

- Fig. 1. *Pecten (Plagiocentrum) abietis* Jordan & Hertlein, new species; natural size; type, left valve, No. 2079, Mus. Calif. Acad. Sci.
- Fig. 2. *Pecten (Chlamys) dallasi* Jordan & Hertlein, new species; natural size; paratype, right valve, No. 2072, Mus. Calif. Acad. Sci.
- Fig. 3. *Pecten (Plagiocentrum) abietis* Jordan & Hertlein, new species; natural size; paratype, right valve, No. 2080, Mus. Calif. Acad. Sci.
- Fig. 4. *Placuanomia cumingii* Broderip; natural size; plesio-type, No. 2084, Mus. Calif. Acad. Sci., from Loc. 939 (C.A.S. coll.), Cliffs about one mile south of and above village, Maria Madre Island, Mexico; upper Pliocene.
- Fig. 5. *Pecten (Chlamys) dallasi* Jordan & Hertlein, new species; natural size; type, right valve, No. 1862, Mus. Calif. Acad. Sci..
- Fig. 6. *Pecten (Chlamys) dallasi* Jordan & Hertlein, new species; natural size; type, left valve. Same specimen as Fig. 5.
- Fig. 7. *Pecten (Plagiocentrum) abietis* Jordan & Hertlein, new species; natural size; paratype, left valve, No. 2081, Mus. Calif. Acad. Sci.
- Fig. 8. *Pecten (Chlamys) dallasi* Jordan & Hertlein, new species; natural size; paratype, right valve, No. 2073, Mus. Calif. Acad. Sci.
- Fig. 9. *Pecten (Plagiocentrum) circularis* Sowerby; natural size; plesio-type, left valve, No. 2085, Mus. Calif. Acad. Sci., from Loc. 937 (C.A.S. coll.), Arroyo Hondo, Maria Madre Island, Mexico; upper Pliocene.





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APRIL 26, 1926

V

EXPEDITION TO THE REVILLAGIGEDO ISLANDS,
MEXICO, IN 1925

THE BEMBICINI (Digger Wasps)

BY

CHARLES L. FOX

San Francisco, California

Report on the bembicine wasps taken by Mr. H. H. Keifer while with the 1925 Expedition of the California Academy of Sciences to the Revillagigedo Islands.

1. *Steniolia duplicata* Provancher

Cedros Island, Lower California, June 3, 1925. One male.

2. *Stictia signata* Linnæus

Arroyo Hondo, Maria Madre Island, Tres Marias Islands, Mexico, May 17, four females.

3. *Stictiella bifurcata*, var. *albicerca* C. L. Fox

Cedros Island, Lower California, June 3, two males and three females.

Female: In general appearance similar to the male except that the clypeus is not entirely yellow, the basal half being black divided by a narrow yellow medial streak; dorsum of tergites yellow, not soiled white.

April 26, 1926

4. *Bembix magdalenæ* C. L. Fox, new species

A short and robust species; labrum unusually long and narrow; clypeus large; ocelli not obliterated; ultimate tergite with lateral notches, its dorsal surface strongly rugose apically; sixth sternite with a square process apically bituberculate. Length 15-17 mm.

Male: Mandibles long and narrow, having an inconspicuous tooth on inner margin; labrum (fig. 1) extremely long and slender, sometimes reaching half way between anterior and intermediate coxæ; clypeus (fig. 1) three-quarters as long as wide, prominent, its anterior margin truncate at apex, behind which is a slightly flattened area; scape (fig. 4) short, strongly widened towards apex, hirsute; segment II of flagellum (fig. 3) slender, its width increasing perceptibly towards apex; segments 8-11 with inner apical angles slightly produced; 9-11 bearing elongated glabrous excavations; apical segment curved and somewhat compressed. Inner margins of compound eyes almost parallel, slightly divergent at clypeus and at vertex. Ocelli peculiar in that they are well developed, probably functional (a character not uncommon in Mexican species of this genus); posterior pair almost round, anterior ocellus transversely oval. Anterior femora (fig. 8) much narrowed apically, becoming terete; intermediate femora unarmed below. Ultimate tergite (fig. 2) with basal half broad, abruptly notched on either side at base of the triangularly produced apical portion; basal half finely, closely punctured, these punctures becoming coarser and wider until drawn out into conspicuous longitudinal rugæ and apically into submarginal carinæ; margins at notches armed with few short bristles. Second sternite bearing a prominent median process (fig. 7), laterally compressed, rounded and very slightly hooked; sixth bearing a nearly square process occupying apical two-thirds of sternite, and elevated posteriorly into two blunt tubercles with a slight depression between them; seventh with a shallow abbreviated median groove; eighth ending in a single long, slender, decurved spine. Pubescence on head, thorax, median segment, base of abdomen, and basal joints of legs, long, dense and white, somewhat shorter on dorsum of thorax, elsewhere on abdomen very short, rather dense and semi-erect. Wings hyaline; nervures brown, costa fulvous towards base; first cubital cross vein (fig. 6) less strongly bent near its posterior end than in most species of this genus. Genital stipites (fig. 5) long, narrow, arcuately converging at apex, more or less hirsute.

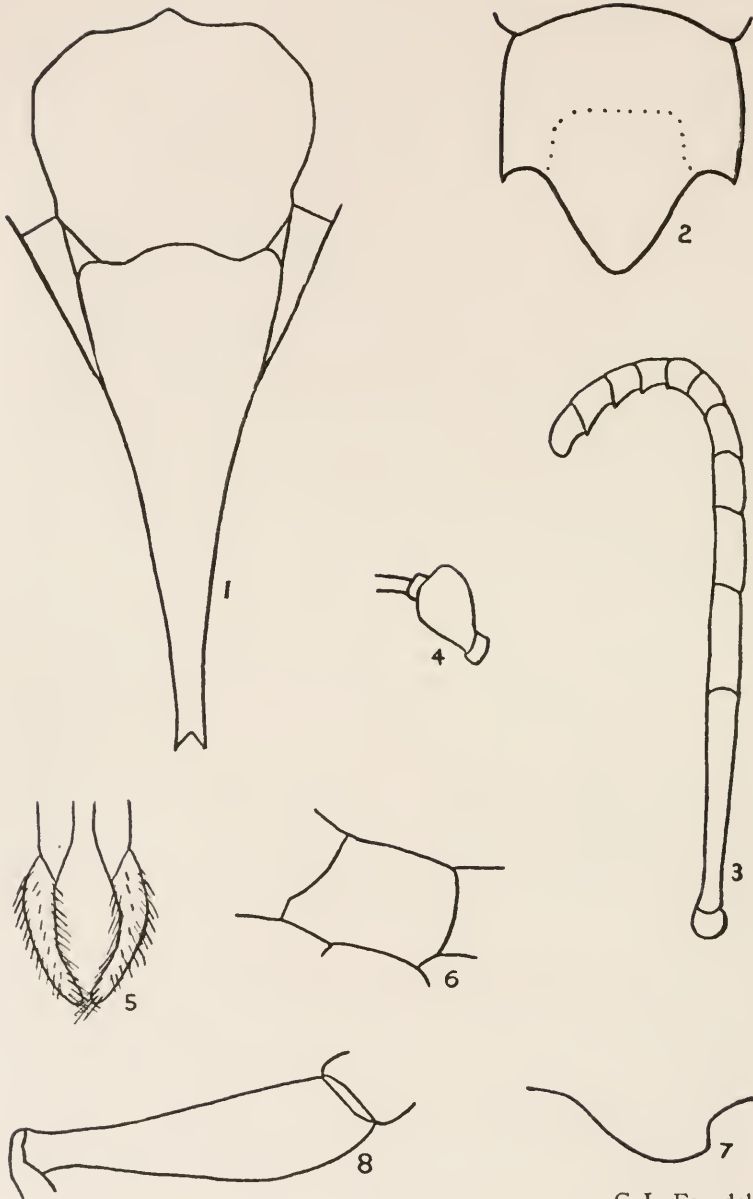
Color black with the following soiled white, or yellow maculations: labrum; mandibles except apex; clypeus, except pair of small black (sometimes orange) spots on basal third below antennæ; scape below,

first and second segments of flagellum below; lower part of frons; inconspicuous spot in front of anterior ocellus; broad anterior orbits reaching line of anterior ocellus; broad posterior orbits, gradually narrowing to a point at vertex; narrow irregular band on posterior margin and deflexed sides of prothorax, the latter enclosing a large black spot on and before tubercles; tegulæ almost entirely; lateral margin on scutum above the tegulæ, sometimes produced anteriorly; two small medial approximated spots on posterior border of scutum (wanting in six specimens); fascia on border of scutellum; sides of median segment almost entirely; metapleuræ; irregular broad stripe on mesopleuræ, extending from tegulæ to base of intermediate coxæ, and anterior spots, variable in size; broad continuous fasciæ on tergites 1-6, reaching the posterior margin on 5-6 and on 1-4 separated only by extremely narrow black line; fasciæ on 1-5 bi-emarginate, medially notched and sinuate laterally on anterior border, sixth almost triangular with medial notch on anterior border, apical half of seventh tergite as in fig. 2; first sternite entirely except lateral black spots; second and third with broad continuous fasciæ, undulate and narrowed more or less medially on the anterior border; fourth with large square lateral spots; apex of sixth and seventh; coxæ and trochanters in part; femora except a more or less broad black stripe above, not reaching the apex; tibiæ except inconspicuous narrow stripe below (wanting in four specimens), and tarsi entirely. Fasciæ on tergites soiled white over black, other markings more or less yellow (in places reddened by cyanide). Segments 3-12 of flagellum fusco-piceous, lighter below. Described from twelve males.

Type: Male, No. 1829, Mus. Calif. Acad. Sci., collected May 30, 1925, at **Magdalena Bay, Lower California**. *Paratypes*, same data in the collections of the Academy, U. S. National Museum, Washington, D. C., and of the author.

5. *Microbembex monodonta* Say

Cape San Lucas, Lower California, May 28, 1925. One male.



C. L. Fox del.

EXPLANATION OF FIGURES

Fig. 1. Clypeus and labrum.

Fig. 2. Outline of ultimate tergite, dotted line to show base of apical maculation.

Fig. 3. Flagellum.

Fig. 4. Scape, viewed from below.

Fig. 5. Genital stipites.

Fig. 6. Second cubital cell, showing bend in first cubital cross vein.

Fig. 7. Process on second sternite.

Fig. 8. Anterior femora.



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VI*
**EXPEDITION OF THE CALIFORNIA ACADEMY OF
SCIENCES TO THE GULF OF CALI-
FORNIA IN 1921**

MOLLUSCA OF THE FAMILY TRIPHORIDÆ

BY
FRED BAKER

Owing to the inability of Dr. G. Dallas Hanna, Curator of Paleontology of the California Academy of Sciences, to accompany this Expedition, the writer was chosen to take charge of the collecting of mollusks. He joined the party on the S. S. *Masatlan* at San Pedro, California, and left it over three months later at Yuma, Arizona. For the itinerary of the Expedition reference should be made to the General Account¹ by Mr. Joseph R. Slevin, in charge of the Expedition. Dr. Hanna has already reported on the land and fresh water mollusks taken by the Expedition.² The Polyplacophora were referred to Dr. S. Stillman Berry for study and report and it is expected that his papers will appear in due time.

It was originally planned to make a single report on the marine mollusks, but unavoidable delay has made it seem better to treat one or more families in separate papers in order to get the results in the hands of specialists as early as possible. The present paper is the first of this series.

* No. 34 of the Gulf of California Expedition papers.
¹ Proc. Calif. Acad. Sci., 4th ser., Vol. XII, pp. 55-72.
² L. c. pp. 483-527.

This Expedition visited more of the islands of the Gulf than had been visited by any previous scientific expedition. As some of the visits were rather hurried, and as most of them could not be timed to correspond with the lowest tides, the collections are somewhat irregular in quality and character. The tidal movement of the southern part of the Gulf of California is moderate in degree, while in the northern part the variation between lowest low tide and highest high tide exceeds thirty-one feet in certain seasons. At such times the water rushes through the mouth of the Colorado River in a great bore which is dangerous to small boats for some distance up. As a result of this greater tidal movement, collections made in the more northern localities were rather more representative than those made farther south, although the fauna is not so varied. Certain islands were visited only at the time of high tide so that only worn and weathered beach shells were taken at these points.

On the whole, dredging was unsatisfactory, although the total result of this part of the work is considerable. No preparation was made for deep dredging and the launch *Silver Gate* could not be slowed down sufficiently to yield satisfactory results in shallow water. Therefore, practically all dredging was done from rowboats or by carrying the dredge to a distance from the larger vessel at anchor and hauling in. Just at the time the Expedition was in the field most of the bottom in shallow water was closely covered by a broad-leaved marine alga commonly known as "sea lettuce." The growth was sufficiently heavy to prevent the dredge reaching the sea bottom satisfactorily and it filled the dredge completely in a very short haul. Only on the rare occasions when it was possible to locate patches of clear bottom with the water telescope was dredging really satisfactory. Unfortunately, it was not until just about the time the Expedition left the Gulf that this marine growth matured and began breaking away from the sea and bay bottoms.

The writer's sincere acknowledgments are due to Dr. Barton Warren Evermann, Director of the California Academy of Sciences, who placed him in charge of the mollusk collecting of the Expedition; to all the members of the Expedition for many courtesies and for much help in collecting

whenever their own work could be so arranged as to make it possible; and in very large measure to Dr. G. Dallas Hanna, who not only photographed the shells here figured, but also aided in planning and formulating this report.

Triphora (Deshayes) Blainville, 1828

Five species have been reported from the Gulf of California and from Cape St. Lucas, under the generic name *Triphoris*, three originally described by C. B. Adams,³ *alternatus*, *inconspicuus* and *infrequens*, and two by Bartsch,⁴ *excolpus* and *stearnsi*. Of these, *Triphoris infrequens* is a dextral shell, therefore not to be considered in this group. None of the remaining four species was taken by the Expedition. The eight species and two subspecies described in this paper seem to be new.

1. **Triphora hannai** Fred Baker, new species

Plate 24, figure 1

Shell sinistral, elongate-conic, large and robust for the genus, shining, everywhere marked by minute growth lines and spiral striæ; tubercles and spiral keels, except the basal keels, light, grayish-brown, the intervening channels, sutures, basal keels and columellar region dark chocolate-brown; first one or two nuclear whorls decollated, the next one and a half globose, with very fine retractive axial threads only, followed by two with two rather widely separated spiral cords rendered tuberculate by the crossing of numerous fine, retractive axial threads, of which there are about twenty-six on the last nuclear whorl; transition to postnuclear whorl not well-defined, the two spiral cords continuing and the retractive axial threads being replaced irregularly by protractive series of tubercles, of which there are about fourteen on the first postnuclear whorl, about twenty-two on the sixth, and about twenty-four on the penultimate; postnuclear whorls eleven and three-quarters, the first four with two very distinct spiral keels separated by a shallow channel nearly twice as wide as the deeply channeled sutures; median spiral keel appearing on the fifth whorl, closer

³ Ann. Lyc. Nat. Hist., Vol. 5, pp. 382, 383.

⁴ Proc. U. S. Nat. Mus., Vol. 33, pp. 254-255, pl. 16, figures 2 and 8.

to the posterior than the anterior keel, and enlarging regularly to fully the size of the anterior keel on the last two or three turns; posterior keel larger than the others, the tubercles being elongate axially into distinct ovals on all but the first three or four postnuclear whorls and becoming twice as long as broad on the last half turn; tubercles of the posterior and middle keels largely subtruncate posteriorly, those of the anterior and peripheral keels mostly truncate; spiral keels much heavier than the axial riblets, their crossing producing rather exceptionally well-defined, rectangular pits which are generally spirally elongate; tubercles markedly clean-cut and defined; anterior channels between the keels about equal to the sutures in width and about double the width of the posterior channels; two very distinct tuberculate keels beginning on the last half turn, one on each side of the anterior keel; peripheral keel strongly tuberculate, the tubercles sharply truncate posteriorly, nearly equaling the anterior keel in size, separated from it by a channel about two-thirds as wide as the one preceding it, and continuing in the preceding sutures as a minute tuberculate cord faintly discernible for eight or nine turns; base well-rounded, subcarinate on the last half turn; basal keels two, the first lying entirely on the base, irregularly tuberculate, the tubercles not well-defined, the second entirely on the columellar region, broader than the first, tending to become double, roughened, but nowhere distinctly tuberculate; aperture subrhomboidal, with a well-rounded posterior notch; outer lip moderately sharp, slightly reflexed and effuse at its junction with the basal lip, conforming to the external sculpture, and showing the alternating colors of the spiral keels and channels by transmitted light; anterior canal nearly closed, nearly vertical; columella nearly straight, slightly revolute below, with a heavy, dark brown callus extending over the parietal wall. Length, 8.17 mm.; diameter, 2.43 mm.

Type: No. 2135, Mus. Calif. Acad. Sci., from **San Francisco Island, Gulf of California**, in shallow water; a well preserved paratype, No. 2136, with two-and-a-half nuclear whorls and nine-and-a-half postnuclear whorls, was taken at San Marcos Island, Gulf of California. An immature and weathered specimen from San Francisquito Bay, Lower California, probably belongs here.

This species more closely resembles *Triphora panamensis* (Bartsch) than any other from this coast, but it is a strikingly marked species, differing from *panamensis* in the number of nuclear whorls, in the distinctness and greater width of the spiral channels and sutures, in the very definite variegation of the spiral keels and channels, in the occurrence of the intercalated keels on the last turn, and in the extension of the peripheral keels into the preceding sutures.

The species is named for Dr. G. Dallas Hanna, Curator of Paleontology of the California Academy of Sciences.

2. *Triphora evermanni* Fred Baker, new species

Plate 24, figure 9

Shell sinistral, small, elongate-conic above, tending to become spindle-shaped; nuclear whorls light brown, postnuclear whorls dull yellowish white; nuclear whorls four, increasing rapidly, the first eroded, the second rounded, nearly smooth, the others with two closely spaced spiral cords, the posterior near the middle of the whorl, the other close to the suture, crossed by many discrete, rather sharp, slightly retractive axial threads, of which there are about 26 on the last whorl, producing indistinct tubercles at the points of intersection and enclosing shallow, squarish depressions; transition to postnuclear whorls rather abrupt, the two nuclear spiral cords forming the anterior keel and a posterior keel beginning almost at once near the preceding suture; postnuclear whorls eight and a quarter, the first four with two moderately sharp spiral keels, the anterior the larger, rather widely spaced, crossed by strong, but narrow, axial ribs, producing small, prominent tubercles at their intersections, which are quite generally subcuspidate, especially on the anterior keel, which is subtruncate posteriorly, and enclosing proportionately large, irregular pits which tend to become squarish on the lower whorls; beginning rather abruptly on the fifth postnuclear whorl a median keel separates from the anterior keel, soon taking a median position which it maintains to the aperture, becoming nearly equal to the other two keels in about two turns, all the keels from that point, with slight variations, continuing nearly equal; axial ribs slightly protractive, varying little in number from



about 16 on the first postnuclear whorl to about 20 on the penultimate turn; sutures very broadly channeled, crossed very conspicuously by the axial riblets, which decrease in size below the peripheral keel and terminate abruptly on the last basal keel; peripheral keel about two-thirds the width of, and less distinctly tuberculate than, the anterior keel, separated from it by a channel nearly equal to the one preceding it, and showing for two turns in the preceding sutures as a narrow band adnate to the posterior keel; aperture subrhomboidal, the outer and basal lips conforming to the external sculpture, with a well-rounded posterior canal and a broad anterior canal which is rather more nearly vertical than transverse; base shortly rounded, with two strong basal keels beginning rather close together at the callus of the parietal wall, but finally separated from each other and from the peripheral keel by rather broad, deep channels; posterior basal keel distinctly tuberculate, the anterior nearly smooth; columella strong, sharply revolute. Length, 2.77 mm.; diameter, 1.20 mm.

Type: No. 2137, Mus. Calif. Acad. Sci., from **Amortajada Bay, San José Island, Gulf of California**, in about two fathoms; a paratype, No. 2138, was taken in another dredge haul in the same general locality. In this specimen the subcuspidation of the tubercles is even more marked than in the type.

This species differs from all others described from this coast in the small, discrete, subcuspidate tubercles with proportionately wide interspaces. It is somewhat similar in shape to *Triphora galapagensis* (Bartsch), but differs from that species in most other respects.

The species is named for Dr. Barton Warren Evermann, Director of the California Academy of Sciences.

3. *Triphora vanduzeei* Fred Baker, new species

Plate 24, figure 8

Shell sinistral, elongate-conic above, becoming cylindrical below, faded, dull yellowish-white, showing a slight tendency to a reddish-brown color on the posterior keels and base; nuclear whorls decollated; postnuclear whorls eight and a half, the first four with two tuberculate spiral keels widely separated

by a rather shallow channel, an intercalated keel beginning nearly in the center of this channel on the fifth whorl which never quite reaches the size of the other two; axial riblets narrower than the spiral keels, about twelve on the first post-nuclear whorl, eighteen on the sixth, and twenty-three on the last, nearly vertical, crossing the broadly channeled sutures, the channels separating the peripheral and basal keels and becoming obsolete on the anterior basal keel; tubercles of the anterior spiral keel subtruncate posteriorly, rendering that keel less prominent than the posterior one which is armed with fully rounded tubercles; pits enclosed by the axial riblets and spiral keels generally squarish and exceptionally large; last half turn with distinct keels intercalated between the posterior and middle, the middle and anterior, and the anterior and peripheral keels; peripheral keel markedly tuberculate, nearly equaling the preceding keel in size, and extending prominently for nearly four turns in the preceding sutures as a narrow, sharp, tuberculate ridge; basal keels four; the first nearly equal to the peripheral keel, the others decreasing in size towards the umbilical region, the peripheral and first three basal keels being broadly spaced, the last two lying close together; base roundly shouldered at the periphery, rather elongate; aperture elongate, subrhomboidal, with a well marked posterior canal-notch and a long, broad, open anterior canal, which is more vertical than transverse; outer lip sharp, conforming to the external sculpture; columella very strong, slightly revolute below, with a heavy callus reflexed on the right side and extending over the parietal wall. Length, 5.10 mm.; diameter, 1.80 mm.

Type: No. 2139, Mus. Calif. Acad. Sci., from **Amortajada Bay, San José Island, Gulf of California**, in about four fathoms; paratype, No. 2140, from La Paz, Lower California, in about four fathoms.

This species somewhat resembles *Triphora evermanni* in general appearance and in the wide separation of the spiral keels, but the tubercles show no tendency to cuspidation, the median spiral keel is persistently small. The shape of the base is very different, having four keels instead of two, and the intercalation of spiral keels on the last turn is a distinctive character which shows also on the paratype. In the combina-

tion of these criteria with the wide interspaces and the persistence of the peripheral keel in the preceding sutures it differs from all other species described from this coast.

The species is named for Mr. E. P. Van Duzee, Curator of Entomology of the California Academy of Sciences and a member of the Academy Expedition of 1921.

4. *Triphora contrerasi* Fred Baker, new species

Plate 24, figure 7

Shell sinistral, large, elongate-conic, shining, everywhere covered with minute growth lines and spiral striæ; posterior, peripheral and basal keels, sutures and columella dark brown, the rest of the shell glistening white; nuclear whorls decolated; remaining postnuclear whorls thirteen, separated by rather narrow, deeply channeled sutures, with two moderately spaced tuberculate spiral keels on the earlier turns; beginning on the third remaining whorl, a thin tuberculate middle keel, increasing rapidly, soon equals and finally exceeds the size of the anterior keel; posterior keel much more prominent than the others, especially on the last two or three turns; axial ribs very strongly protractive, the riblets narrower, but more prominent than the spiral keels, producing prominent tubercles at their intersections, dipping into all sutures and reaching nearly to the umbilical region; about twenty on the first and sixth whorl and twenty-six on the penultimate; axial ribs and spiral keels enclosing deep, subrhomboidal pits; tubercles prominent, shining, those on the posterior and middle keels sloping gradually anteriorly and subtruncate posteriorly, those of the anterior keels rather sharply truncate posteriorly; last half turn showing a tuberculate keel intercalated on each side of the middle keel and between the anterior and peripheral keel; peripheral keel nearly equal to the anterior one, separated from it by a channel about equal to the one preceding it, and extending into the preceding sutures for several turns as a narrow, brown tuberculate band; base rounded, marked by two broadly spaced, prominent, narrow basal keels rendered tuberculate by the crossing of the radial riblets, the posterior channel narrower than the anterior; aperture subpyriform, entire, outer lip sinuous, basal lip rounded, both conforming to the

external sculpture; posterior canal well marked, anterior canal entirely closed, nearly vertical; columella stout, revolute, heavily calloused, the callus extending over the parietal wall. Length, 8.00 mm.; diameter, 2.13 mm.

Type: No. 2141, Mus. Calif. Acad. Sci., from **San Evaristo Bay, Lower California**; paratype, No. 2142, dredged in Coyote Bay, Concepcion Bay, Lower California. Four much weathered and worn specimens taken at Isthmus Bay, Espiritu Santo Island, Gulf of California, and a young specimen dredged in Amortajada Bay, San José Island, Gulf of California, seem to be the same but are too worn for positive identification.

The distribution of color in this species is somewhat like that on *Triphora alternata* (C. B. Adams), but it is almost double in size in all dimensions, the axial ribs are strongly protractive, the base is proportionately shorter and the general appearance of the shell is different.

The species is named for Professor Francisco Contreras, Director of the National Museum of Natural History of the City of Mexico, who was detailed by the Mexican Government to accompany the Academy Expedition of 1921.

5. *Triphora slevini* Fred. Baker, new species

Plate 24, figure 5

Shell sinistral, very small, very broadly elongate-conic, everywhere marked by minute growth lines and spiral striæ, dark brown and shining throughout except the first nuclear whorl which is whitish, the posterior and peripheral spiral keels being slightly darker than the others; nuclear whorls five, the first nearly smooth, the others with two delicate convex cords close together on the most prominent portion of the whorls, crossed by nearly vertical, discrete, radial threads of which there are about thirty-two on the fourth whorl, producing minute tubercles at the points of crossing and enclosing shallow, squarish pits; postnuclear whorls five and a half; change from nuclear to postnuclear whorls gradual, beginning with the enlarging of occasional axial threads and tubercles and the separation of the spiral cords so that the first postnuclear whorl comes to be marked by two distinct, coarsely tuberculate spiral keels; beginning on the third postnuclear whorl, a median spiral keel

appears about in the middle of the channel, enlarging gradually to about the size of the other keels on the last two turns only; tubercles on all postnuclear whorls joined by axial riblets and spiral keels of about equal size, the former very protractive, these enclosing series of irregular shallow pits which are indefinitely marked but tend to be more squarish than round; axial ribs about fourteen on the second postnuclear turn and about twenty-two on the last; periphery subcarinated by the anterior keel; peripheral keel lying on the basal edge, tuberculate, about half the width of the preceding one, the intervening channel being crossed by the radial riblets; base nearly flat or slightly concave, marked by distinct growth lines and fine spiral threads which become obsolete on the columellar region; distinct basal keels wanting; sutures channeled, but broken by the prominent axial riblets; aperture broadly and irregularly subovate, the outer and basal lips conforming to the external sculpture; anterior canal short; columella short, stout, slightly revolute and calloused, nearly vertical. Length, 2.14 mm.; diameter, .955 mm.

Type: No. 2143, Mus. Calif. Acad. Sci., dredged in shallow water at **Northeast Anchorage, Monserrate Island, Gulf of California.**

This species is shaped somewhat like *Triphora chathamensis* (Bartsch), but varies in color, in having a much wider apical angle, in a slight truncation of the tubercles posteriorly, in its smaller size, and in the later and more limited development of the middle spiral keel.

The species is named for Mr. Joseph R. Slevin, Assistant Curator of Herpetology of the California Academy of Sciences, who was in charge of the Expedition of 1921.

6. *Triphora oweni* Fred Baker, new species

Plate 24, figure 10

Shell sinistral, of medium size, rudely spindle-shaped, rather stout, everywhere marked by close growth lines, especially on the base, slightly shining, the first whorl and the posterior spiral keels white, median, anterior, peripheral and basal keels very light brown; nuclear whorls decollated; remaining post-nuclear whorls eight and a half, separated by moderately chan-

neled sutures; first five postnuclear whorls marked by two tuberculate spiral keels of approximately the same size, rather narrowly spaced, with an intercalated median keel beginning feebly on the sixth turn and increasing in size very gradually until it equals the anterior keel on the last half turn, partly because that keel narrows slightly on the last two turns; all tubercles rather large, with broad bases, those on the median keel being subtruncate posteriorly on the lower turns; axial ribs protractive, about fourteen on the first whorl, sixteen on the fifth and twenty on the penultimate; periphery of the last whorl marked by a narrow, tuberculate keel about half as wide as the one preceding it; base rather long, rounded, marked by two rather narrow, indefinitely tuberculate spiral keels beginning together on the edge of the parietal callus, but separating until they are about equally separated from the peripheral keel and from each other; outer and basal lips broken; aperture probably suboval; anterior canal large, nearly vertical; columella stout, revolute, covered by a heavy callus which extends over the parietal wall. Length, 4.55 mm.; diameter, 1.69 mm.

Type: No. 2144, Mus. Calif. Acad. Sci., dredged in **Puerto Escondido, Lower California**, in three to six fathoms.

The general color pattern of this species resembles that of *Triphora inconspicua bicolor* (Bartsch) but the shell seems to differ from that species and from all others described from this coast. It is a much stouter shell than *T. inconspicua*, with coarser tubercles and fewer axial ribs, these being more protractive than is shown in Bartsch's figure. The space between the initial keels is much less and there are two basal keels instead of three.

The species is named for Mr. Virgil Owen, Ornithologist and Mammalogist of the Expedition of 1921.

7. *Triphora johnstoni* Fred Baker, new species

Plate 24, figures 3, 4

Shell sinistral, rather stout, elongate-conic, shining, everywhere marked by minute growth lines and spiral striæ, light brown; type with one nuclear and ten and a half postnuclear whorls, about two-fifths of a turn being broken from the aperture; change from nuclear to postnuclear whorls very abrupt,

the two spiral cords being replaced by two tuberculate spiral keels of about equal size at first, the tubercles arranged in protractive series, the keels rapidly diverging until the channel between them is double the width of the channeled sutures, with a very indistinct intercalated median keel dividing from the posterior keel on the sixth or seventh turn, continuing close to it throughout its course, enlarging gradually, but always narrow and showing a tendency to doubling on the last turn and to an elongation of the tubercles spirally; tubercles of the posterior keel becoming larger than those of the anterior after the third postnuclear whorl and finally twice as large; all tubercles united spirally by rather strong keels and by less distinct axial riblets, these enclosing irregular, but generally roundish pits; first postnuclear whorl with about fourteen, sixth with about sixteen and penultimate with about twenty-two axial ribs, the tubercles quite generally subtruncate posteriorly; peripheral keel narrow, about as wide as the median one, with indistinct tubercles elongated spirally; base very slightly concave, with no basal keels on the type; aperture badly fractured but probably subquadrate; anterior canal very transverse; columella very stout, nearly vertical, slightly revolute below.

An immature paratype shows the following characters of the nucleus:

First nuclear whorl papillæform, smooth, followed by four-and-a-half globose, double-carinated whorls, the carinæ close together on the most prominent part of the whorls, slopingly shouldered posteriorly, more abruptly anteriorly, the posterior carina slightly heavier and nearer the middle of the whorl; whorls separated by rather deep, channeled sutures, the channels between the carinæ being about equal in width to the sutures; whorls everywhere crossed by very fine, sinuous, nearly vertical axial threads, of which about twenty-eight appear on the last nuclear whorl; carinæ rendered tubercular by the crossing of the axial threads which enclose rather deep, squarish pits. Other partly grown paratypes show under high power two very narrow, slightly squamose basal keels. Length of type, 4.81 mm.; diameter, 2.00 mm. Length of immature paratype, 2.36 mm.; diameter, 1.19 mm.

Type: No. 2145, Mus. Calif. Acad. Sci., and three immature paratypes, Nos. 2146, 2147, and 2148, dredged in **Amortajada**

Bay, San José Island, Gulf of California. A worn specimen taken at Isthmus Bay, Espiritu Santo Island, Gulf of California, seems to be the same.

This species is shaped like *Triphora catalinensis* (Bartsch), but differs from that species in the markedly protractive arrangement of the tubercles, in coloration, and especially in the wider spaces between the spiral keels, this feature being very marked in the paratypes and being more pronounced than in any species described from the coast.

The species is named for Mr. I. M. Johnston, Botanist of the Expedition of 1921.

8. *Triphora johnstoni pazensis* Fred Baker, new subspecies

Plate 24, figure 6

Type: No. 2149, Mus. Calif. Acad. Sci., dredged near the main wharf at **La Paz, Lower California**, in about four fathoms. It has remaining two-and-a-half nuclear and six-and-a-half postnuclear whorls. It accentuates the broad channels between the spiral keels as in the type, but varies in the earlier incidence of the median keel and its more rapid enlargement, and in having a small basal keel near the peripheral keel. Length, 2.75 mm.; diameter, 1.40 mm.

9. *Triphora chamberlini* Fred Baker, new species

Plate 24, figure 2

Shell sinistral, large, elongate-conic, shining, everywhere marked by minute growth lines and spiral striæ, dark wax-yellow, variegated irregularly with white; nuclear whorls decollated; remaining postnuclear whorls ten-and-a-half, the first four-and-a-half marked by two tubercular spiral keels only moderately separated, the tubercles large, low, with broad bases; a narrow, tuberculate keel beginning on the fifth whorl, separating from the posterior keel and enlarging very slowly, only equals the anterior keel on the last half turn; axial riblets and spiral keels low and ill-defined, enclosing irregular pits which are generally squarish on the lower turns; axial ribs definitely protractive, about sixteen on the third remaining whorl and about twenty on the penultimate; tubercles of the

anterior and posterior keels not varying greatly in size until the last whorl where those of the posterior keel are nearly double the size of those of the anterior; sutures rather broad, with a very narrow channel at the bottom which is nowhere distinctly crossed by the axial riblets; tubercles on the summits of the whorls subtruncate, forming a narrow, rounded shoulder most marked on the lower whorls; peripheral keel overlaid at first by the parietal callus but soon enlarging to equal the anterior keel, its tubercles rather distinctly truncate posteriorly, separated from the preceding keel by a channel almost as wide as the one preceding it, and persisting for several turns in the sutures as a very thin band adnate to the posterior keel; riblets from the peripheral keel dipping into, but not crossing the next basal channel; base moderately rounded, with two nearly smooth, broad, rounded keels beginning at the edge of the parietal callus, nearly parallel throughout, separated by a channel narrower than the keels themselves; columella stout, revolute, covered by a very heavy callus extending over the parietal wall and a small portion of the peripheral keel; aperture? fractured, anterior canal large, rather vertical than transverse. Length, 7.45 mm.; diameter, 2.40 mm.

Type: No. 2150, Mus. Calif. Acad. Sci., dredged at the **Northeast Anchorage, Monserrate Island, Gulf of California**, in about two fathoms; no other specimens found.

The species more closely resembles *Triphora panamensis* (Bartsch) than any other described from this coast, but it is a more robust shell, wider in proportion to its length and with proportionately wider whorls. The lighter color and irregular variegation also distinguish it from that species.

The species is named for Mr. Joseph C. Chamberlin, who accompanied the Expedition of 1921 as Assistant in Entomology.

10. *Triphora escondidensis* Fred Baker, new species

Plate 24, figure 11

Shell sinistral, rather slender, elongate-conic, everywhere marked by minute growth lines, shining, very light brown; nuclear whorls decollated; remaining postnuclear whorls nine,

separated by moderately channeled sutures, the first four marked by two tuberculate keels divided by a rather broad channel; a very slender tuberculate, median keel appearing on the fifth turn, lying slightly closer to the posterior than the anterior keel, and attaining the size of the anterior keel on the eighth and succeeding turns; tubercles of the posterior keel slightly larger than those of the other keels after the third turn; axial ribs slightly protractive, the riblets crossing the sutures indistinctly and continuing as far as the first basal keel; axial riblets and spiral keels enclosing moderate pits which are generally squarish; second whorl with about sixteen axial ribs, penultimate with about twenty-four; peripheral keel well developed, tuberculate, about three-fourths as large as the one preceding it; base moderately elongate, marked by two tuberculate basal keels nearly equaling the peripheral one; peripheral and basal keels commencing close together near the parietal callus, separating rather rapidly at first, then slowly to the end of the turn; aperture? outer and basal lips fractured; anterior canal large, rather vertical than transverse; columella stout, revolute, heavily calloused, the callus extending over the parietal wall. Length, 4.50 mm.; diameter, 1.62 mm.

Type: No. 2151, Mus. Calif. Acad. Sci., dredged in Puerto Esccondido, Lower California, in three to five fathoms.

As this shell somewhat resembles *Triphora hemphilli* (Bartsch), from the opposite side of the Peninsula of Lower California, it is probable that more material will show it to be only a subspecies of that species.

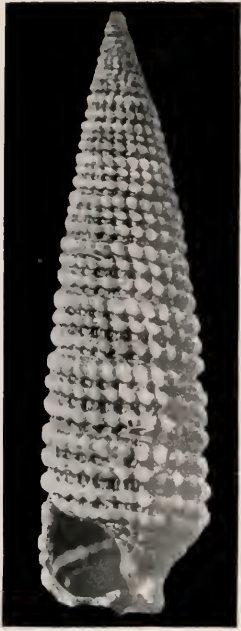
11. *Triphora peninsularis* (Bartsch)

Triphoris peninsularis BARTSCH, Proc. U. S. Nat. Mus., Vol. 33, p. 255, pl. 16, fig. 2. Type locality, Point Abreojos, Lower California, Henry Hemphill, coll.

A single specimen dredged near the main wharf at La Paz, Lower California, differing somewhat in size, but corresponding with Bartsch's figure and very exactly with his description, seems to represent this species, taken by Hemphill on the opposite side of the Peninsula of Lower California. It is too worn for positive diagnosis.

PLATE 24

- Fig. 1. *Triphora hannaï*, new species; type, No. 2135 (C.A.S. Type Coll.) from San Francisco Island, Gulf of California; length, 8.17 mm.; diameter, 2.43 mm.; p. 225.
- Fig. 2. *Triphora chamberlini*, new species; type, No. 2150 (C.A.S. Type Coll.) from Northeast Anchorage, Monserrate Island, Gulf of California; length, 7.45 mm.; diameter, 2.40 mm.; p. 235.
- Fig. 3. *Triphora johnstoni*, new species; type, No. 2145 (C.A.S. Type Coll.) from Amortajada Bay, San José Island, Gulf of California; length, 2.36 mm.; diameter, 1.19 mm.; p. 233.
- Fig. 4. *Triphora johnstoni*, new species; immature paratype, No. 2146 (C.A.S. Type Coll.) from same locality; length, 2.36 mm.; diameter, 1.19 mm.; p. 233.
- Fig. 5. *Triphora slevini*, new species; type, No. 2143 (C.A.S. Type Coll.) from Northeast Anchorage, Monserrate Island, Gulf of California; length, 2.14 mm.; diameter, .955 mm.; p. 231.
- Fig. 6. *Triphora johnstoni pazensis*, new subspecies; type, No. 2149 (C.A.S. Type Coll.) from La Paz, Lower California; length, 2.75 mm.; diameter, 1.40 mm.; p. 235.
- Fig. 7. *Triphora contrerasi*, new species; type, No. 2141 (C.A.S. Type Coll.) from Amortajada Bay, San José Island, Gulf of California; length, 8.00 mm.; diameter, 2.13 mm.; p. 230.
- Fig. 8. *Triphora vanduzeci*, new species; type, No. 2139 (C.A.S. Type Coll.) from Amortajada Bay, San José Island, Gulf of California; length, 5.10 mm.; diameter, 1.80 mm.; p. 228.
- Fig. 9. *Triphora evermanni*, new species; type, No. 2137 (C.A.S. Type Coll.) from Amortajada Bay, San José Island, Gulf of California; length, 2.77 mm.; diameter, 1.20 mm.; p. 227.
- Fig. 10. *Triphora oweni*, new species; type, No. 2144 (C.A.S. Type Coll.) from Puerto Escondido, Lower California; length, 4.55 mm.; diameter, 1.69 mm.; p. 232.
- Fig. 11. *Triphora csecondidensis*, new species; type, No. 2152 (C.A.S. Type Coll.) from Puerto Escondido, Lower California; length, 4.50 mm.; diameter, 1.62 mm.; p. 236.



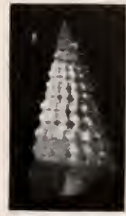
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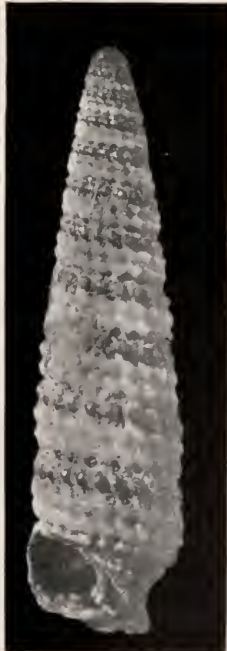
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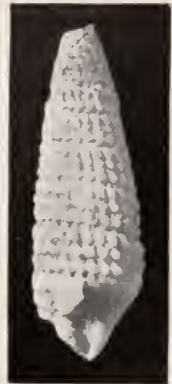
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PROCEEDINGS
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VII
EXPEDITION TO GUADALUPE ISLAND, MEXICO,
IN 1922—No. 4¹

MOLLUSCAN FAUNA OF THE PLEISTOCENE OF
SAN QUINTIN BAY, LOWER CALIFORNIA

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A large Pleistocene fauna from northern Lower California, at a considerable distance to the south of the well-known deposits of San Pedro and San Diego, is of interest inasmuch as it forms a step in the southward extension of our knowledge of the Tertiary and Quaternary of the west coast. In the following paper it is intended to present a list, as complete as possible, of the known Mollusca of the marine Pleistocene of San Quintin Bay, together with a discussion of the stratigraphic relations of the assemblage. Four new species are described.

The material which forms the basis of this report was secured by Dr. G. Dallas Hanna, Curator of Paleontology in the California Academy of Sciences, as a member of the 1922 expedition to Guadalupe Island. Four days were spent by him

¹ The preceding numbers of this series are:

- No. 1. General Report, by G. Dallas Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 12, 1925, pp. 217-275.
No. 2. Birds and Mammals, by A. W. Anthony, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 13, 1925, pp. 277-320.
No. 3. The Coleoptera, by Frank E. Blaisdell, Sr., Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 14, 1925, pp. 321-343.

April 26, 1926



in collecting. The locality has since been briefly visited by the writer, but the list of species is founded solely on the collection made by Dr. Hanna.

The writer is greatly indebted to Mrs. Ida S. Oldroyd, of Stanford University, for aid in the identification of species, and to Dr. J. P. Smith, Professor of Paleontology in that institution, for free access to the University's collections and library. Acknowledgment is due to Dr. Hanna for the collection of the material, for preparation of the figures, and for other assistance. Finally, the writer wishes to thank Mr. Leo G. Hertlein, of the Department of Paleontology, California Academy of Sciences, for helpful criticism of the manuscript.

San Quintin Bay is a shallow and tortuous inlet on the west coast of Lower California about 150 miles south of San Diego. It is surrounded by level plains, elevated but a few feet above the sea, and extending for several miles inland to the foot of the mountains. It is protected from the ocean on the west side by a chain of low hills. The geology of the immediate vicinity of the bay has been briefly outlined by Hanna² in the general report on the expedition to Guadalupe Island. The following statements are quoted from his account:

"I found it profitable to visit some low cliffs, not over 20 feet high, on the east side of the bay and just south of the village. Here I succeeded in getting a very large collection of fossil shells consisting of several thousand specimens.

"The geology in the vicinity of San Quintin is comparatively simple. In late Pleistocene the present bay was a broad indentation of the sea and ocean-living species were very abundant. Subsequent elevation raised the bottom on the east side in a broad fold. The preservation of the fossil shells is excellent, many of them retaining some of the original coloration. How far back toward the foothills this embayment extended cannot be determined but probably it went to the first terrace, the beginning of a long series of rolling hills or mesa. This terrace is said also to contain fossils, but none were secured. It is probably much older than the outcrops on the bay. The mountainous country to the east of this terrace is metamorphic, the age not having been determined.

² Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 12, 1925, pp. 246-247.

“On the west side of the bay there is a chain of low volcanic cones not over 300 feet high. Lava has spread outward from these as far as the bay shore, and on top of a broad shelf of this there are other Pleistocene marine sediments, but with a different set of fossils. Among those collected were some huge *Schizotherous* clams, fully eight inches long.”

The only discussion of the paleontology of these deposits, previous to this, is found in a report by Dall³ on collections made at San Quintin Bay by C. R. Orcutt. The species recognized were listed, several new species were described, and brief notes were included by Orcutt on geologic and other conditions at San Quintin. While the number of species listed was relatively small, some were noted by Dall that are not recognized in the present collection; these, however, are added to the following list for the sake of completeness.

With one exception, the species obtained by Hanna were taken from a series of low cliffs of soft, fossiliferous sand on the east shore of the bay immediately to the south of the village of San Quintin (Loc. 910, Calif. Acad. Sci. coll.). The specimens of *Schizothærus nuttallii* were found at Loc. 929 (C.A.S. coll.), on the west side of the bay, directly opposite the village. Those species recorded by Dall, but not recognized in the present collection are included in the list in brackets. They were apparently taken from several points about the bay, but as all the collecting stations are very close together, and as all belong without question to one horizon, the exact localities are not here differentiated in the listing of species. The list, while large and as complete as can be made with the material at hand, is known not entirely to exhaust the fauna, for in the collection there are a number of species that can not be positively identified, and doubtless more extensive work about the bay would discover a few more forms not yet noted. Mere generic determinations of fragmentary material are omitted from the list. In addition to the Mollusca the deposits contain a few species of Bryozoa, Echinodermata, and Crustacea; also Foraminifera of many species which have not as yet been identified.

³ West American Scientist, Vol. 19, 1921, pp. 17-24.

LIST OF SPECIES OF MOLLUSCA FROM THE PLEISTOCENE OF
SAN QUINTIN BAY, L. C.

PELECYPODA

- Nucula exigua* Sowerby
Leda acuta Conrad
 [*Leda oxia* Dall]
Leda penderi Dall
Leda taphria Dall
 [*Glycymeris corteziana* Dall]
 [*Glycymeris multicostata* Sowerby]
Arca multicostata Sowerby
Ostrea lurida Carpenter
 [*Ostrea megodon* Hanley]
Pecten cataractes Dall
Pecten circularis Sowerby
Pecten latiauritus Conrad
Hinnites giganteus Gray
 [*Lima dehiscens* Conrad]
Anomia peruviana Orbigny
Pododesmus macroschisma
 Deshayes
Mytilus californianus Conrad
Modiolus modiolus Linnæus
Modiolus rectus Conrad
Periploma planiuscula Sowerby
Periploma sulcata Dall
 [*Thracia quentinensis* Dall]
 [*Cyathodonta dubiosa* Dall]
Pandora punctata Conrad
Lyonsia californica Conrad
Crassinella branneri Arnold
Cardita subquadrata Carpenter
Chama buddiana C. B. Adams
Chama pellucida Sowerby
Diplodonta subquadrata Carpenter
 [*Phacoides annulatus* Reeve]
Phacoides approximatus Dall
Phacoides californicus Conrad
Phacoides nuttallii Conrad
Phacoides richthofeni Gabb
 [*Kellia laperousii* Deshayes]
Aligena cerritensis Arnold
Rochefortia tumida Carpenter
 [*Lasæa rubra* Montagu]
Cardium biangulatum Sowerby
Cardium procerum Sowerby
Cardium quadrigenarium Conrad
Curdium substriatum Conrad
Dosinia ponderosa Gray
Tivela stultorum Mawe
 [*Transnella tantilla* Gould]
Amiantis callosa Conrad
 [*Macrocallista aurantiaca* Sowerby]
Pitaria newcombiana Gabb
Saxidomus nuttallii Conrad
Chione succincta Valenciennes
Paphia staminea Conrad
Paphia staminea laciniata Carpenter
Paphia tenerrima Carpenter
Psephidia cymata Dall
 [*Cooperella subdiaphana* Carpenter]
Tellina bodegensis Hinds
Tellina buttoni Dall
Tellina carpenteri Dall
 [*Tellina idæ* Dall]
Metis alta Conrad
 [*Macoma acolasta* Dall]
Macoma indentata Carpenter
Macoma nasuta Conrad
Macoma secta Conrad
Macoma yoldiformis Carpenter
Semele decisa Conrad
Semele pulchra Sowerby
 [*Semele quentinensis* Dall]
Semele rubropicta Dall
Cumingia densilineata Dall
Donax californica Conrad
 [*Donax gouldii* Dall]
Sanguinolaria orcutti Dall
Heterodonax bimaculata Linnæus
Tagelus subteres Conrad
Solen rosaceus Carpenter
Solen sicarius Gould
 [*Siliqua lucida* Conrad]
Mactra californica Conrad
Mactra dolabriformis Conrad
 [*Spisula camaronis* Dall]
 [*Spisula catilliformis* Conrad]
 [*Spisula longa* Dall]

Spisula planulata Conrad
Schizothærus nuttallii Conrad
Cryptomya californica Conrad
 [*Cryptomya magna* Dall]

Corbula luteola Carpenter
Panope generosa Gould
Saxicava arctica Linnæus
 [*Zirfæa gabbi* Tryon]

SCAPHOPODA

Dentalium neoheptagonum
 Pilsbry & Sharp
Dentalium semipolitum

Broderip & Sowerby
Cadulus tolmei Dall

GASTROPODA

Acteon punctocoelata Carpenter
Acteon traski Stearns
Acteocina carinata Carpenter
Acteocina culcitella Gould
Cylichnella diegensis Dall
Bullaria gouldiana Pilsbry
Melampus olivaceus Carpenter
Terebra pedroana Dall
Terebra pedroana phillippiana Dall
Conus californicus Hinds
Cryptoconus tremperianus Dall
Elæocyma arbela Dall
Elæocyma hemphilli Stearns
 [*Clathrodrillia halcyonis* Dall]
Clathrodrillia incisa ophioderma
 Dall
Pseudomelatoma moesta Carpenter
Mangilia arteaga roperi Dall
Mangilia barbarena Oldroyd
Cytherea branneri Arnold
Cytherea densilineata Dall
 [*Cytherea quentenensis* Dall]
Olivella biplicata Sowerby
Olivella boetica Carpenter
Olivella pedroana Conrad
Olivella porteri Dall
Marginella californica Tomlin
Marginella jettettii Carpenter
Marginella oldroydæ Jordan, n. sp.
Marginella regularis Carpenter
Cypræolina pyriformis Carpenter
Strigatella catalina Dall
Mitromorpha aspera Carpenter
Mitromorpha filosa Carpenter
Kellettia kelletii Forbes

Marcron athiops Reeve
Alectrion californiana Conrad
Alectrion cerritensis Arnold
Alectrion cooperi Forbes
Alectrion fossata Gould
Alectrion mendica Gould
Alectrion perpunguis Hinds
Alectrion tegula Reeve
Columbella gausapata Gould
Columbella tuberosa Carpenter
Amphissa versicolor Dall
Murex festivus Hinds
 [*Murex gemma* Sowerby]
Purpura nuttallii Conrad
Tritonalia foveolata Hinds
Tritonalia interfossa Carpenter
Tritonalia lurida munda Carpenter
Tritonalia poulsoni Carpenter
 [*Tritonalia squamulifera*
 Carpenter]
 [*Acanthina lugubris* Sowerby]
Forreria belcheri Hinds
Epitonium acrostephanum Dall
Epitonium fallaciosum Dall
Epitonium tinctum Carpenter
Melanella berryi Bartsch
Melanella draconis Bartsch
Melanella lastra Bartsch
Melanella loleta Jordan, n. sp.
Melanella micans Carpenter
Melanella oldroydi Bartsch
Melanella rutila Carpenter
Melanella thersites Carpenter
Turbonilla (Turbonilla) gilli
 Dall & Bartsch

- Turbonilla (Strioturbonilla) asser* Dall & Bartsch
Turbonilla (Strioturbonilla) attrita Dall & Bartsch
Turbonilla (Strioturbonilla) stylina Carpenter
Turbonilla (Pyrgolampros) gloriosa Bartsch
Turbonilla (Pyrgolampros) gouldi Dall & Bartsch
Turbonilla (Pyrgiscus) almo Dall & Bartsch
Turbonilla (Pyrgiscus) antestriata Dall & Bartsch
Turbonilla (Pyrgiscus) hertleini Jordan, n. sp.
Turbonilla (Pyrgiscus) tenuicula Gould
Turbonilla (Pyrgiscus) vexativa Dall & Bartsch
Turbonilla (Mormula) catalinensis Dall & Bartsch
Turbonilla (Bartschella) laminata Carpenter
Odostomia (Chrysallida) dallasi Jordan, n. sp.
Odostomia (Ividella) navisa delmontensis Dall & Bartsch.
Odostomia (Ividella) pedroana Dall & Bartsch
Odostomia (Iolæa) cucosmia Dall & Bartsch
Odostomia (Evalea) minutissima Dall & Bartsch
 [*Trivia californiana* Gray]
Erato columbella Menke
Bursa californica Hinds
 [*Cymatium vestitum* Hinds]
Triphora catalinensis Bartsch
Triphora pedroana Bartsch
Triphora stearnsi Bartsch
Cerithiopsis alcima Bartsch
Cerithiopsis antefilosa Bartsch
Cerithiopsis diegensis Bartsch
Cerithiopsis grippi Bartsch
Cerithiopsis halia Bartsch
Cerithiopsis montereyensis Bartsch
Seila montereyensis Bartsch
Bittium interfossa Carpenter
Bittium rugatum Carpenter
Cerithidea californica Haldeman
Cæcum californicum Dall
Cæcum dalli Bartsch
Micranellum crebricinctum Carpenter
Micranellum pedroëense Bartsch
Fartulum bakeri Bartsch
Fartulum hemphilli Bartsch
Fartulum occidentale Bartsch
Aletes squamigerus Carpenter
Vermiculum anellum Mörch
Petalococonchus complicatus Dall
 [*Turritella cooperi* Carpenter]
Turritella jewetti Carpenter
Turritellopsis acicula stimpsoni Dall
Tachyrhynchus lacteolus subplanatus Carpenter
Littorina scutulata Gould
Lacuna unifasciata Carpenter
Alaba catalinensis Bartsch
Alaba jeanettæ Bartsch
Barlecia bentleyi, Bartsch
Barlecia dalli Bartsch
Alvania æquisculpta Keep
Alvania pedroana Bartsch
Alvania purpurea Dall
Truncatella californica Pfeiffer
Truncatella stimpsoni Stearns
Syncera translucens Carpenter
Hipponix tumens Carpenter
Crepidula excavata Broderip
Crepidula lessoni Broderip
Crepidula lingulata Gould
Crepidula nummaria Gould
Crucibulum spinosum Sowerby
Polinices lewisii Gould
Polinices reclusiana Deshayes
Phasianella compta Gould
Phasianella pulloides Carpenter
Phasianella substriata Carpenter
Phasianella typica Dall
Astræa undosa Wood
Leptothyra carpenteri Pilsbry
Leptothyra paucicostata Dall
Norrisia norrisii Sowerby
Tegula aureotincta Forbes

<i>Tegula gallina</i> Forbes	[<i>Turcica coffea</i> Gabb]
<i>Tegula ligulata</i> Menke	<i>Vitrinella eshnauri</i> Bartsch
[<i>Tegula regina</i> Stearns]	<i>Vitrinella stearnsi</i> Bartsch
<i>Calliostoma canaliculatum</i> Martyn	<i>Cyclostremella californica</i> Bartsch
<i>Calliostoma gloriosum</i> Dall	<i>Megatebennus bimaculatus</i> Dall
[<i>Calliostoma lima</i> Philippi]	<i>Diadora aspera</i> Eschscholtz
<i>Calliostoma tricolor</i> Gabb	

AMPHINEURA

<i>Callistochiton decoratus</i> Carpenter	<i>Callistochiton palmulatus mirabilis</i> Pilsbry
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The composition of the above fauna indicates that it is of upper Pleistocene age. It cannot be lower Pleistocene or upper Pliocene as suggested by Dall.⁴ Of the 255 species in the list, only 13, or about 5 per cent, are not known to be living today. Several of these are closely allied to recent forms, and our knowledge of the present day fauna of Lower California is not sufficiently complete to assume that a few others will not eventually be found in the living state. While the assemblage is essentially similar to the recent fauna of southern California and of Lower California north of Cedros Island, there are in the list a number of characteristically tropical types that do not now live in the waters about San Quintin, but are found living only in considerably warmer regions. Such species as *Glycymeris multicostata* Sby.; *Ostrea megodon* Hanl.; *Pecten cataractes* Dall; *Cardium procerum* Sby.; *Macrocallista aurantiaca* Sby.; *Macron æthiops* Rve.; *Cymatium vestitum* Hds., and certain of the smaller gastropods are true residents of the Gulf of California, and of Lower California to the south of Cedros Island. Their appearance in the fauna indicates that the climate during the time of deposition of the beds at San Quintin was notably warmer than it is at present in the region.

It has been proved by Arnold,⁵ and again brought out by J. P. Smith,⁶ that, on the basis of contrasting faunas dependent upon climatic changes, two distinct horizons may be recognized in the Pleistocene of San Pedro. The older, known as the Lower San Pedro, contains a coldwater fauna, of which

⁴West American Scientist, Vol. 19, 1921, pp. 17 and 21.

⁵Mem. Calif. Acad. Sci., Vol. 3, 1903, pp. 20 and 29.

⁶Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, No. 4, 1919, pp. 136-137.

many species now live only to the north of that district. The younger, or Upper San Pedro, contains a subtropical fauna, of which many species are today confined to the coast of Lower California, and to the Gulf. During the lower Pleistocene, then, as likewise in the uppermost Pliocene,⁷ the climate of western North America was distinctly cooler than it is at present, while later in the Pleistocene it became warmer than today.

The deposits at San Quintin, containing a fauna with several warmwater elements in a latitude where quite such a fauna no longer exists, are, therefore, to be placed in the Upper Pleistocene, as an approximate though more southern equivalent of the Upper San Pedro. In addition to the evidence deduced from climatic relations, there remains in support of such correlation the fact that, with a few exceptions, the species occurring at San Quintin are also common to the Upper San Pedro, and far fewer of them are found in older formations.

1. *Cumingia densilineata* Dall

Plate XXV, figures 1, 3, 5

Cumingia densilineata Dall, West American Scientist, Vol. 19, 1921, p. 22; Proc. U. S. Nat. Mus., Vol. 66, 1925, p. 15, pl. 8, fig. 5; pl. 11, fig. 2.

The original description is as follows:

"Shell subtriangular, equivalve, nearly equilateral, inflated, rounded in front, acutely rostrate behind; beaks inconspicuous, nearly central; surface regularly closely concentrically, minutely lamellose, the wider interspaces faintly radially striated; hinge normal, well developed; pallial sinus deep, low, almost entirely coalescent with the pallial line below; length, 29; height, 20; diameter, 12 mm.

"This differs from all the figured species, and especially the Californian recent species, by its close and regular sculpture and the straightness with which the upper and lower margins converge toward the posterior end."

The species was described from the Pleistocene of San Quintin Bay.

⁷ See Arnold, loc. cit., p. 16; Smith, loc. cit., p. 151.

There are nine specimens in the collection agreeing with the above description, and differing from the living *Cumingia lamellosa* Sowerby in the characters enumerated by Dall. These also have a thinner and more delicate shell than any other specimens examined of the recent species.



Fig. 1. *Sanguinolaria orcutti* Dall; dorsal view.

2. *Sanguinolaria orcutti* Dall

Text figure 1

Sanguinolaria (*Nuttallia*) *orcutti* Dall, West American Scientist, Vol. 19, 1921, p. 17; Proc. U. S. Nat. Mus., Vol. 66, 1925, p. 26, pl. 12, figs. 1, 2.

The original description is as follows:

"Shell large, thin, inequivalve, inequilateral, externally smooth except for incremental lines; left valve inflated, the

right valve flattish; hinge formula $\frac{L\ 1\ 0\ 1\ 0\ 1}{R\ 0\ 1\ 0\ 1\ 0}$; ligament long and strong on prominent nymphs; anterior adductor scar elongate, narrow; posterior scar reniform, large; pallial sinus subtriangular, reaching slightly in front of the vertical from the beaks, almost wholly coalescent with the pallial line below; valve margins thin, smooth, the valves slightly patulous behind. Length of shell, 130; height, 95; diameter of left valve, 22; of right valve, 13; beaks behind the anterior end, 47 mm.

"This shell is undoubtedly the ancestor of the much smaller *S. nuttallii* Conrad, which, except in size and minor details of hinge, outline and pallial sinus, it closely resembles. The anterior cardinal in the fossil is very feeble, in the recent species it has vanished altogether."

The species was described from the Pleistocene of San Quintin Bay.

This large clam is exceedingly abundant throughout the deposit. Young examples can hardly be discriminated from *S. nuttallii*, but the living species never approaches the fossil in size.

3. *Marginella oldroydæ* E. K. Jordan, new species

Plate XXV, figure 7

Shell minute, smooth and polished, evenly egg-shaped, not pyriform, the greatest width only slightly posterior to the middle; spire of about two and one-half whorls, low and broad, but evident and not covered by enamel; nucleus very small; suture appressed, not distinct; outer lip evenly rounded, not flattened, slightly thickened in the middle, internally smooth; inner lip with five rather sharp plaits including that at edge of pillar, these regularly decreasing in size posteriorly. Length, 3.21 mm.; maximum width, 2.00 mm.

Type: No. 1846, *paratypes* Nos. 1847 and 1848, Mus. Calif. Acad. Sci., from Loc. 910 (C.A.S. coll.), **San Quintin Bay, Lower California**, Pleistocene; G. D. Hanna, collector. This

little shell is not identical with any of the figured *Marginellidæ* from western America, and apparently cannot be identified with any of the species recently described, without illustration, by Dall. The evenly egg-shaped form, the low but uncovered spire, and the presence of five plaits on the inner lip are distinguishing characters.

The species is named in honor of Mrs. Ida S. Oldroyd, to whom the writer is much indebted.

4. *Melanella loleta* E. K. Jordan, new species

Plate XXV, figure 6

Shell small, rather broadly conic, smooth, brilliantly polished; spire of about eight, slightly inflated and rounded post-nuclear whorls that enlarge rapidly anteriorly; sutures slightly impressed; periphery of last whorl moderately inflated, smoothly rounded; base very short, rounded; aperture broadly ovate; outer lip thick but sharp-edged, shallowly sinuate close to junction with preceding whorl, slightly protracted just anterior to periphery, and again slightly retracted at junction with basal lip; junction of basal and inner lips slightly protracted; inner lip short, nearly straight, strongly reflected and appressed to the base posteriorly; parietal wall covered by a rather thin callus. Length, 3.69 mm.; width, 1.77 mm.

Type: No. 1849, *paratypes* Nos. 1850 and 1851, Mus. Calif. Acad. Sci., from Loc. 910 (C.A.S. coll.), **San Quintin Bay, Lower California**, Pleistocene; G. D. Hanna, collector.

Another specimen was also examined from the same locality.

The more broadly conic form, slightly inflated whorls, and shorter base of this species distinguish it from other west American *Melanellas*. In outline it recalls certain species of *Sabinella* Monterosato, but the inner lip is not of the character common to the latter genus.

5. *Turbonilla (Pyrgiscus) hertleini* E. K. Jordan, new species

Plate XXV, figure 2

Shell elongate conic; fairly thick and solid; nuclear whorls and all but last nine-and-one-half post-nuclear whorls decol-lated; remaining post-nuclear whorls flattened in the middle, forming a straight-sided spire; sutures moderately constricted, rather sharply marked; axial ribs 20 on the last whorl, strong, slightly protractively slanting, regular, well rounded, and nearly equal to the intercostal spaces in width; intercostal spaces well marked, crossed by about 13 unequal and unequally spaced incised spiral grooves, of which the second, fifth, and eighth are much the strongest, forming deep squarish pits, and the first, and the tenth to thirteenth are the weakest; periphery of last whorl well rounded, crossed by feeble continuations of the axial ribs which evanesce before they reach the middle of the base, and marked by a spiral row of deep squarish pits, that, however, do not quite appear on the anterior portion of the whorls of the spire; bottoms of peripheral pits very delicately spirally striate; base rather short, well rounded, sculptured by continuations of the axial ribs, and by seven subequal and subequally spaced lightly impressed spiral lines, the first of which is considerably anterior to the peripheral row of pits; aperture broadly oval; outer lip thick, not showing the external sculpture within, broken in type specimen; inner lip with a feeble oblique fold a little anterior to its intersection; parietal wall covered by a thin callus. Length, 6.40 mm.; width, 1.74 mm.

Type: No. 1852, *paratypes* Nos. 1853, 1854, and 1855, Mus. Calif. Acad. Sci., from Loc. 910 (C.A.S. coll.), **San Quintin Bay, Lower California**, Pleistocene; G. D. Hanna, collector.

Nine other specimens were also examined from the same locality.

Turbonilla hertleini is closely related to a number of previously described forms, but minor details of sculpture, constant in all the specimens examined, differentiate it. This species is named for Mr. Leo G. Hertlein, whose work has contributed greatly to knowledge of the paleontology of Lower California.

6. *Odostomia* (*Chrysallida*) *dallasi* E. K. Jordan, new species

Plate XXV, figure 4

Shell elongate ovate, fairly solid; nuclear whorls of moderate size, obliquely immersed in the first of the succeeding turns; post-nuclear whorls six, rather flat, considerably contracted at the sutures and narrowly shouldered at the summit, crossed by retractive axial ribs, of which 20 occur on the penultimate turn; spiral sculpture of four sharp keels, about equal to the axial ribs in strength, and rendering them strongly nodulous at their intersection; axial ribs and spiral keels enclosing deep, nearly round pits; periphery of last whorl marked by a groove equal in strength to those separating the spiral keels between the sutures, and crossed by continuations of the axial ribs which terminate at the posterior edge of the first basal cord and render it slightly nodulous; base of last whorl well rounded, marked by six or seven unequal and unequally spaced spiral cords, of which the first, second, and fourth are the strongest; the third is very weak, or practically obsolete, leaving a broad, flat channel between the second and fourth, and the cords anterior to the fourth rapidly decrease in strength toward the umbilical area; spaces between the basal cords crossed by numerous slender axial threads; aperture oval; outer lip showing the external sculpture within; columella decidedly reflected anteriorly, provided with a strong fold at its intersection. Length, 3.72 mm.; width, 1.67 mm.

Type: No. 1856, *paratypes*, Nos. 1857, 1858, 1859, and 1860, Mus. Calif. Acad. Sci., from Loc. 910 (C.A.S. coll.), **San Quintin Bay, Lower California**, Pleistocene; G. D. Hanna, collector.

Nine other specimens were examined from the same locality.

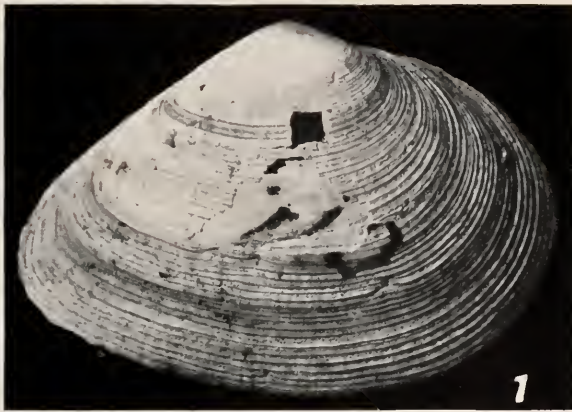
Odostomia dallasi is close to *O. nodosa* Carpenter, and to several other related species, but it is distinguished by the sculpture of the base, which is constant in all of the specimens examined, and which is different from that of any previously described form.

Named for Dr. G. Dallas Hanna.



PLATE 25

- Fig. 1. *Cumingia densilineata* Dall; length 23.0 mm.; plesiotype, right valve, No. 1845, Mus. Calif. Acad. Sci., from Loc. 910 (C.A.S. coll.), San Quintin Bay, Lower California. Pleistocene.
- Fig. 2. *Turbonilla (Pyrgiscus) hertleini* E. K. Jordan, new species; length 6.40 mm.; type, No. 1852, Mus. Calif. Acad. Sci., from Loc. 910 (C.A.S. coll.), San Quintin Bay, Lower California. Pleistocene.
- Fig. 3. *Cumingia densilineata* Dall; plesiotype, left valve, same specimen as fig. 1.
- Fig. 4. *Odostomia (Chrysallida) dallasi* E. K. Jordan, new species; length 3.72 mm.; type, No. 1856, Mus. Calif. Acad. Sci., from Loc. 910 (C.A.S. coll.), San Quintin Bay, Lower California. Pleistocene.
- Fig. 5. *Cumingia densilineata* Dall; plesiotype, right valve, same specimen as Fig. 1.
- Fig. 6. *Melanella toleta* E. K. Jordan, new species; length 3.69 mm.; type, No. 1849, Mus. Calif. Acad. Sci., from Loc. 910 (C.A.S. coll.), San Quintin Bay, Lower California. Pleistocene.
- Fig. 7. *Marginella oldroydæ* E. K. Jordan, new species; length 3.21 mm.; type, No. 1846, Mus. Calif. Acad. Sci., from Loc. 910 (C.A.S. coll.), San Quintin Bay, Lower California. Pleistocene.





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VIII

**NEW SHARKS FROM THE TEMBLOR GROUP IN
KERN COUNTY, CALIFORNIA
COLLECTED BY CHARLES MORRICE**

BY

DAVID STARR JORDAN

The two new species of shark teeth described herein are represented by specimens in the California Academy of Sciences, and were collected at Shark Tooth Hill, Kern County, California, by the veteran collector of fossils from that county, Mr. Charles Morrice of the Pacific Oil Company.

Shark Tooth Hill lies on the north side of Kern River, about six miles from Bakersfield.¹ It is a noted locality for sharks' teeth, as is also the Barker Ranch about two miles farther up on the south side of Kern River. Poso Creek (called Ocoya Creek by Agassiz) flows parallel to Kern River and is about 12 miles farther north. These Kern River deposits belong to the Temblor formation of lower Miocene age, here composed largely of decayed granite brought down from the high Sierra and carried to the sea in early times by Kern River and other streams.

¹ For a general statement concerning the occurrences of fossils on Shark Tooth Hill, see Hanna, Science, U. S., Vol. 61, No. 1568, Jan. 16, 1925, pp. 71-72.

April 26, 1926

1. *Carcharodon tembloris* Jordan, new species

Plate 26, figures 1, 3

The tooth in question is one of the largest ever found; it is rather narrowly triangular, with a somewhat thickened concave base. Its slant height, with the base, is $4\frac{2}{3}$ inches; without the base it is $3\frac{1}{2}$ inches. The vertical height, with the base is $4\frac{1}{2}$ inches, or $3\frac{1}{3}$ inches above the base. The posterior face is mildly concave, the tip incurved, the outer face convex. There is no trace of a lobe at base; both edges to the tip are provided with rather large, even, somewhat bluntish, serræ, 121 in number, the pair at the tip somewhat enlarged, those towards the base smaller than the others; width of base a little less than height including base; width of crown at base considerably more than height of crown; no suggestion of a median ridge, the middle on the flat or inner side being somewhat concave.

Type: No. 1843, *paratype* No. 1866, Mus. Calif. Acad. Sci., from Loc. 905 (C.A.S. coll.), **Shark Tooth Hill, Kern County, California**; Miocene, Temblor formation; Charles Morrice collector.

From the type of *Carcharodon branteri*, described by me in 1907² from Bolinas Bay, this species differs in its larger size, and more numerous and much stronger serrations. It is apparently identical with the fragment from Santa Ana, figured with the other on page 117.

It seems closer to the rather narrow form described by Jordan & Hannibal, *Carcharodon leviathan*, in 1924³ from the Pleistocene of Lomita. It is, however, broader than the latter, with more and larger serrations.

Teeth of this type, the largest of all fishes (the single living species being known as the Great White Shark or Man-Eater), are abundant in southern California, as well as in Miocene deposits from Maryland to Florida, and also in Europe.

Several different forms of *Carcharodon* teeth have been described as representing different species, although one can-

² Univ. Cal. Pub. Geol., Vol. 5, 1907, p. 116, fig. 16.

³ Bull. So. Cal. Acad. Sci., Vol. 22, pt. 2, 1923, p. 55, pl. 7, pl. 8.

not be sure that some of them are not based on immature teeth or teeth from other parts of the mouth. These different forms, however, correspond fairly closely to different divisions of Miocene time. The species are also divisible into two groups differing in size of the tooth, those of large size having a much greater number of serrations. It is notable that one species with large teeth and another with smaller ones have been found in each of the principal subdivisions of the California Tertiary which are accessible for study.

After the above was written, Stanford University received from Mr. L. M. Clark, a student in Geology, a very large tooth of *Carcharodon tembloris* from the Temblor formation of the Miocene at El Toro, in Orange County, California. This tooth is very much like the type. The serrations are fine, even and close-set, about 150 on the convex edge, about 130 on the concave.

Median height of crown, $3\frac{1}{2}$ inches; of entire tooth, 5 inches; slant height of crown, $4\frac{1}{2}$ inches; slant height of whole tooth, $5\frac{3}{4}$ inches.

This specimen represents a shark which was, in life, not less than 120 feet in length and therefore one of the very largest of all fishes.

2. *Carcharodon morricei* Jordan, new species

Plate 26, figure 2

In the Miocene deposits of Shark Tooth Hill, occurs another species of *Carcharodon*, distinct from all others known, unless these relatively small species of the different periods of the Miocene, Pliocene, and Pleistocene, are all regarded as variants of *Carcharodon arnoldi*.

The type of *Carcharodon morricei* is a tooth of moderate size, the crown $1\frac{1}{2}$ inches high, the total height $2\frac{2}{5}$ inches, the slant height of crown $1\frac{3}{4}$ inches, of the whole tooth $2\frac{1}{2}$ inches, its form rather narrowly triangular, the height of the crown greater than its width at base which is $1\frac{2}{5}$ inches. The thick base of the tooth is scarcely lunate, a feature in

which these smaller forms of *Carcharodon* differ from the species of larger size.

Serrations about 50, thick and blunt, the somewhat exerted tip of the tooth without serrations, a distinctive character. Front and back of the tooth with low ridges (not shown in smaller specimens).

Besides the type, three other examples, all much worn, were obtained, all smaller than the type. Two of these are broader, not at all ridged; in one of these the serrations are rather sharper than in the type. A fourth example only an inch high has the serrations still sharper and the base of the crown more widely extended at base. The most striking characters of the species lie in the rather large size of the serrations and scarcely lunate base of the tooth.

Type: No. 1861, *paratypes* Nos. 1867, 1868, 1869, and 1870, Mus. Calif. Acad. Sci., from Loc. 905 (C.A.S. coll.), **Shark Tooth Hill, Kern County, California**; Miocene, Temblor formation; Charles Morrice, collector.

This species is close to *Carcharodon arnoldi* of the California Pliocene and to *C. riversi* of the same horizon. These two are probably identical.

Probably all the Miocene specimens identified as *Carcharodon* belong to *C. morricei*, which occurs lower down in the Tertiary series than does *C. arnoldi*.

The species is named for Mr. Charles Morrice of Bakersfield, a tireless collector and discoverer of the type specimens of both *C. tembloris* and of *C. morricei*.

Each of the periods of the later Tertiary represented in southern California has a giant *Carcharodon* and one of moderate size, besides *Carcharocles rectus*, which is known by the presence of a basal denticle. The following is a list of the supposed species:

<i>Carcharodon leviathan</i>	}	.....Pleistocene of Lomita
<i>Carcharodon purplei</i>		
<i>Carcharodon branteri</i>		Pliocene of Bolinas
<i>Carcharodon arnoldi (riversi)</i>		Pliocene of Bolinas
<i>Carcharodon tembloris</i>	}	.....Miocene of Kern County
<i>Carcharodon morricei</i>		



Plate 26

- Fig. 1. *Carcharodon tembloris* Jordan, new species; three-fourths natural size; paratype, immature example, No. 1866, Mus. Calif. Acad. Sci., from Loc. 905 (C.A.S. coll.), Shark Tooth Hill, Kern County, California; Miocene, Temblor formation; Charles Morrice, collector.
- Fig. 2. *Carcharodon morricei* Jordan, new species; three-fourths natural size; type, No. 1861, Mus. Calif. Acad. Sci., from Loc. 905 (C.A.S. coll.), Shark Tooth Hill, Kern County, California; Miocene, Temblor formation; Charles Morrice, collector.
- Fig. 3. *Carcharodon tembloris* Jordan, new species; three-fourths natural size; type, No. 1843, Mus. Calif. Acad. Sci., from Loc. 905 (C.A.S. coll.), Shark Tooth Hill, Kern County, California; Miocene, Temblor formation; Charles Morrice, collector.

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IX
**THE RELATION OF FORAMINIFERA TO THE
ORIGIN OF CALIFORNIA PETROLEUM***

BY
THOMAS F. STIPP

Diatomaceæ are generally regarded by geologists as being the source of most of the petroleum of California. In 1867, J. D. Whitney, in a paper read before the California Academy of Sciences, called attention to the organic origin of the oil of the Pacific coast. The following is quoted from his paper:

"In conclusion, it may be remarked that the marine infusorial rocks of the Pacific Coast, and especially of California, are of great extent and importance. They occur in the Coast Ranges, from Clear Lake to Los Angeles. They are of no little economical, as well as scientific interest; since, as I conceive, the existence of bituminous materials in this state, in all their forms, from the most liquid to the most dense, is due to the presence of infusoria—the proofs of which statement I will, at some future time, endeavor to set before the Academy."¹

Diatomaceæ at that time were classed with the Infusoria, their distinction not then being clear, but it is evident from the context of the article that Whitney referred to the Diatomaceæ as being the source of the petroleum. Whitney's paper is

* Read before the Meeting of the Pacific Section of the American Association of Petroleum Geologists, Nov. 19, 1925, San Francisco, Calif.

¹ Whitney, J. D.—On the Fresh Water Infusorial Deposits of the Pacific Coast, and their connection with the Volcanic Rocks," Proceedings of the California Academy of Sciences, Vol. 1, 1854-1868, page 324.

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especially interesting as being perhaps the first published account of the organic origin of the oil of California.

The diatom-theory is now accepted by many geologists; several writers on California geology have, however, indicated their belief that Foraminifera have contributed to the origin of the oil. Many of the Cretaceous and Tertiary strata of California are rich in fossil Foraminifera, and their close connection in some cases with diatomaceous strata, and their proximity to producing oil fields have led geologists to the above natural conclusion.

Recent study and experiments conducted upon Foraminifera tend to show that they have contributed less to the origin of oil than has been believed.

Arnold & Anderson, discussing the origin of the petroleum of California, stated the following in their bulletin on the Coalinga District:

"The oils of the Coalinga district are believed to have been derived from two different sources, namely, the organic shales forming the uppermost member of the Chico (Upper Cretaceous) and those described as the upper portion of the Tejon (Eocene). It is believed that the oil originated from the organic matter, both vegetable and animal, once contained in these beds. The shales are composed in large part of the tests of foraminifera and diatoms, and a smaller number of other organisms, in such abundance as fully to warrant the assumption that the animal and vegetable material that must have been contained in them when deposited was adequate for furnishing a quantity of hydrocarbons and other compounds more than equivalent to the quantity of petroleum found in this field."²

Anderson & Pack, referring to the origin of oil in the foothill region north of Coalinga, indicated clearly their belief that Foraminifera contributed to the origin of the oil, although they considered the Diatomaceæ of most importance. Quoting from their writing:

"The oil-bearing zones of this region are the two diatomaceous and foraminiferal shale formations—the Moreno (Upper Cretaceous) and the Kreyenhagen (Oligocene?) and the sandy beds lying immediately above them. This fact points significantly to the two formations as the sources of the oil, and the writers firmly believe that the petroleum was derived

² Arnold, Ralph, and Anderson, Robert. *Geology and Oil Resources of the Coalinga District, California*; U. S. Geological Survey Bulletin 398, page 188, 1910.

from the organic matter once contained in the myriad shells of minute organisms of which these formations are largely composed.”³

It is further stated :

“It cannot be said whether both the diatoms and the foraminifera or only one of these types of organisms furnished the organic matter from which the oil was produced, or which was the more important, but it seems probable that both contributed, with the possible addition of ingredients from still other organisms. Owing to the fact that the organic substance of plants is less readily decomposed than animal matter and would therefore be more certain to persist within the deposit until well buried and sealed, the diatoms are believed to have been the greatest contributors.”⁴

Pack writes of the origin of the oil of the Sunset-Midway Field as follows :

“The chief reservoirs of petroleum in the Sunset-Midway District are the feebly consolidated sandy beds of the McKittrick group, but the petroleum is believed to have originated not in these beds, but in the fine-grained beds of organic origin that make up so large a part of the Maricopa shale and of the upper portion of the Vaqueros formation in certain parts of the region. These fine-grained beds are chiefly the so-called diatomaceous shales, which are composed in large part of the remains of minute plants and animals—diatoms and foraminifera—and it is from the decomposition and alteration of these organisms that the petroleum now found in the Sunset-Midway field results. In parts of the region the organic material contained originally in the fine-grained beds appears to be not so much the remains of diatoms as of larger terrestrial vegetation, and it is probable that part of the petroleum has been formed by the alteration of this coarser vegetal material. But in any case it seems clear that the ultimate source of the petroleum is the organic material originally contained in these beds.”⁵

Vander Leck writes :

“The diatoms and foraminifera lived at the surface of warm inland seas, such as were present in what is now the great valley and coast regions of California, during the various geological ages from the Cretaceous to the present. These organisms dying, dropped to the bottom of the sea and together with other plant and animal matter formed an ooze or organic mud. Then, due to low temperature and absence of oxygen

³ Anderson, Robert and Pack, Robert W. Geology and Oil Resources of the West Border of the San Joaquin Valley North of Coalinga, California; U. S. Geological Survey, Bulletin 603, page 194, 1915.

⁴ Op. cit. p. 199.

⁵ Pack, R. W., The Sunset-Midway Oil Field of California, U. S. Geological Survey Professional Paper 116, page 70, 1920.

in quantities, a very slow decomposition, or putrefication of the organic parts took place. It is, however, believed that no great quantity of liquid hydrocarbons were formed at this stage. These are believed to have formed when, due to earth movements, the mud or ooze was uplifted above the surface of the sea and by reason of the heat and pressure due to these movements and possibly aided by the action of saline waters, distillation of the shale took place, which resulted in the formation of petroleum."⁶

The above statements imply clearly the belief that Foraminifera were of considerable importance in contributing to the origin of the oil of California. This belief is based upon the following assumptions:

1. That Foraminifera were present in the Cretaceous and Tertiary seas in large numbers;
2. That the conditions of sedimentation were such as to bury a large proportion of the animal tissue along with the tests of the Foraminifera; and
3. That this animal tissue was wholly or in part converted into petroleum by the agency of pressure, heat and chemical or bacterial action.

Concerning the first and third of these assumptions, little need be said. Foraminifera were doubtless present in large numbers in the Cretaceous and Tertiary seas, as shown by the numerous fossil occurrences. Furthermore, it is reasonable to believe that a part at least of the animal tissue of Foraminifera may have been converted into petroleum by suitable reactions. That a large amount of animal tissue was actually buried in the strata, is, however, open to question. The following evidence is presented for the reason that it throws some light upon this problem.

Joseph A. Cushman, an American authority on Foraminifera, writes of their life history as follows:

"When the animal (Microspheric form) attains its adult stage, there is a great increase in the number of pseudopodia, and the entire protoplasm either leaves the test and accumulates about the exterior or is drawn into the outer chambers. Finally, each nucleus gathers a mass of protoplasm

⁶Vander Leek, Lawrence. Petroleum Resources of California; California State Mining Bureau, Bull. 89, page 13, 1921.

about itself and secretes the proloculum of a new test. The newly formed proloculum is of the larger type, and is the first chamber of the megalospheric form, instead of being of the same size as that of the microspheric parent from which it was derived. The megalospheric form differs from the microspheric in having a single nucleus. This does not divide, but moves along as new chambers are added, keeping in about the middle number numerically. Nucleoli appear in increasing numbers as the growth continues, and finally the whole nucleus breaks down and a great number of minute nuclei appear. These draw about themselves portions of the protoplasmic mass, and then divide by mitotic division. Finally, the mass leaves the test in the form of zoospores. These are then supposed to conjugate and to give rise to the small proloculum of the microspheric form, thus completing the life cycle, although the actual process of conjugation has not definitely been observed in this group. The empty tests left behind must form a large proportion of the dredged Foraminifera.”⁷

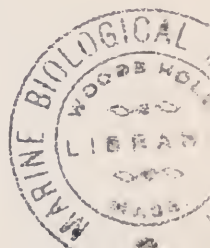
Recently Cushman conducted some experiments in the Tortugas region of the Gulf of Mexico with living Foraminifera. One observation is significant in this connection:

“One important observation was that in the case of *Iridia diaphana* taken from *Posidonia* leaves and placed in petri dishes over night. In the morning some of these were found to have left their test empty and were moving about as naked masses of protoplasm with a free and comparatively rapid movement. That the animal may leave the test and pass some time without one is very significant from the standpoint of the method of growth. Growth of the test in those species which have a single chamber has often been a subject of speculation. If the test can be abandoned at will and another secreted or made by collecting more material in the case of those which have agglutinated tests, this difficulty is solved, and we may also understand how various sedentary species can collect various materials which are not common, for their tests.”⁸

It appears from the above discussion of the life history of the Foraminifera that a very large portion of the tests preserved in the strata as fossils were empty of animal tissue at the time of burial. It is no doubt true that tidal action, ocean currents, decrease in the salinity of the waters, or other factors, impose upon Foraminifera conditions at times unfavorable for their existence, and that many may thus be killed and their tissues within their tests entombed. Some oil may have

⁷ Cushman, Jos. A., Monograph of the Foraminifera of the North Pacific Ocean. U. S. National Museum, Bull. 71, page 7, 1910.

⁸ Cushman, Jos. A., Shallow Water Foraminifera of the Tortugas Region, Carnegie Inst. of Washington, Vol. 17, page 8, 1922.



formed under these conditions. However, to account for the widespread destruction of foraminiferal life, and the accumulation and entombment of the animal tissue, such as would be necessary for the formation of oil in quantity, we must postulate unusual and extraordinary conditions of sedimentation recurring at intervals during and since Cretaceous time. Such conditions would lead to a sufficient accumulation of calcareous foraminiferal tests as to form considerable thicknesses of limestone, which are unknown in the Cretaceous and Tertiary formations of California. The fact that we do have several thousand feet of diatomaceous strata is considered strong support of the diatom theory. It appears probable from the above that Foraminifera have been of less importance than diatoms with respect to the origin of the petroleum of California.

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X

**SOURCES OF MATERIAL FROM WHICH PETRO-
LEUM MAY HAVE BEEN DERIVED**

BY
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In discussing the testimony of a witness a New York court once said: "The testimony of this witness is important, if true. We do not deem it important." That is just the way some of us feel about the theory that "practically the entire source of petroleum has been certain disintegrated and decomposed constituents of fishes."¹

This is not a purely academic question. It has a very practical bearing upon such questions as why, when and how far oil migrates, in what kinds of formations it is likely to be found, in what kinds of beds it originates, and many others. That the theory is bearing unfortunate fruit is evident from certain speeches recently made before commercial organizations by inexperienced geologists.

We may accept certain important facts presented by Professor Macfarlane, without accepting his sweeping conclusion. Undoubtedly some species of fishes do live in enormous schools and are very rich in oil, and it would be quite possible for such schools to be caught by showers of volcanic ash or in other unusual and catastrophic ways and buried, so that the

¹ Macfarlane, *Fishes, the Source of Petroleum*, 1923, pp. 5, 77, 384.

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oil derived from the breaking down of the protoplasmic mass would not be dissipated. Indeed, there are indications that something of the sort has actually happened in some instances, though that is not by any means the only possible interpretation of "fish-bone beds,"² nor are such occurrences as numerous as one may be led to believe.

On the other hand, other organisms are and always have been much more abundant than fishes, contain the essential chemical elements for the formation of oil, and are much better adapted to rapid burial. There seems to be no *a priori* reason why they, instead of fishes, may not have furnished much or most of the material from which petroleum has been derived, especially in those highly petroliferous formations rich in lower organisms and practically free from fish remains. It is asserted in support of the fish-oil theory that fishes are the only possible adequate source for all the petroleum and that fish remains are actually abundant almost wherever petroleum is found. Neither assertion is correct.

The inorganic origin of oil does not seem to be well founded. Assuming that it is of organic origin, in order to produce petroleum in great quantity the organic material in the rocks must not only have been abundant, but it must have been incorporated in the sediments under conditions which prevented the dissipation of the oil as it formed. Also, as Goldman has said, the rate of accumulation of the organic material must bear proper relation to the rate of decomposition.

One amateur geologist, in a recent pamphlet, has explained that the great weight of salt water would hold the oil down and prevent it from rising to the surface. It is unfortunate that he did not have a brief elementary course in physics before writing his pamphlet. I have forgotten whether he is the one who, mistaking oolite and pisolite grains for fossil fish eggs, declared that the oil in the Green River shales was derived entirely from fish eggs.

Fine sediments have a marked tendency to trap and hold oil. If dead organisms of any sort accumulate in sufficient quantities, under conditions providing the proper ratio be-

² Compare Goldman, Bull. Amer. Assn. Petroleum Geol., VIII, pp. 195-200, 1924.

tween accumulation and decomposition and a proper ratio between organic and inorganic sediments, a petroleum-bearing formation should be the result. These complex and varying conditions are much more likely to occur frequently and for prolonged periods in case of the lower organisms than in case of fishes.

True, algæ, diatoms, bacteria and other low plants, and protozoans and other invertebrates are not usually so rich in oil as some fishes, but their composition is such as to make them a quite possible source of petroleum under favorable circumstances, their size is such that they are easily buried by ordinary processes of sedimentation, their prodigious numbers compensate for their small size, and they are actually found to enter largely into the composition of certain formations rich in petroleum, in which fish remains are uncommon. Why, then, should we call into play wholly problematical catastrophes to overwhelm repeatedly great schools of fishes, when there are processes that have been in continuous operation from the dawn of life to the present time, daily burying vast quantities of organic material in sediments suitable for the retention of the oil derived therefrom?

Adequate, accurate statistics are not at hand to prove the assertion, but it may be safely said that the total bulk of low orders of aquatic plants and aquatic invertebrates now living very greatly exceeds the aggregate bulk of fishes now living, and that this has always been true. Furthermore, the rate of increase of some low organisms under favorable circumstances is almost unbelievable. A generation of certain species may represent only a few hours, or days, or at most weeks. A generation of fishes usually represents several years. A great many generations of the lower organisms die and their remains accumulate during a single generation of fishes.

It is difficult to make an accurate estimate of the average life period of fishes. Some species are known to be very long-lived. Jordan says most of them "apparently live until they fall victims to some stronger species." On the other hand, the Pacific red salmon has a rather definite life span of about four years, limited by its peculiar spawning habit.

In order to estimate the proportionate amounts of organic matter furnished by lower organisms and by fishes during a given year, we must indulge in multiplication and division. To ascertain the amount provided by protozoans, for example, we must multiply the quantity in the water at a given time by the number of generations which live and die during the year. To ascertain the quantity of fish material we must divide the amount in the water at a given time by a number equal to the years of the average life of fishes.

Experienced biologists assure me that there is little danger of exaggerating the excess of the total bulk of lower organisms over the total bulk of fishes. One unfamiliar with microscopic life can have but little idea of the abundance and aggregate quantity of minute organisms in the water, though one may vaguely recall having read or heard of a drop of water "swarming with animalculæ." One may, however, obtain a slight conception of the quantity in the ocean where certain species are present, by watching the flashes of phosphorescent light displayed as the water is disturbed by the dip of oars or the revolution of steamship propellers on a dark night, keeping in mind the fact that the species which produce these flashes constitute but a small fraction of all the minute life present.

Some conception of the vast quantity of organic matter furnished by minute organisms in the course of geological ages may be derived from a study of certain deposits, sometimes reaching a thickness of hundreds of feet, composed almost entirely of the siliceous skeletons of diatoms or the calcareous tests of foraminifera. No deposits of fish remains have been found at all comparable to the sometimes highly petroliferous diatomaceous and foraminiferal formations. Even that evidence, however, is wholly inadequate. A very large proportion of low organisms possess no hard parts suitable for preservation in recognizable condition as fossils in the rocks, and many others can only be so preserved under very exceptional conditions. In view of the general presence of such organisms in water, surely no biologist or geologist will assume that they were absent from the water in which a formation

was deposited, simply because their remains cannot be recognized in the rocks.

Now let us consider whether it is true that petroleum has originated only where fish remains are abundant. In the first place, it is interesting to note the artful dodging by which the leading exponent of that theory seeks to avoid the consequences of facts inconsistent with the hypothesis. Murchison's report that in the early Paleozoic rocks of Sweden "graptolites and fucoids so abound as to have given a highly bituminous character to the lower strata." is set aside as valueless because the same geologist also found bitumen disseminated through a "matted mass of bony fragments" of fishes at another horizon in England, the inference being that the presence of fish remains in the one locality proves that the bituminous material at the other locality also came from fish remains, notwithstanding their absence from the formation and the presence of the other organisms in quantity. He causes fish oil to float long distances in the sea and then to be carried down by showers of volcanic ash, in order to get it from regions in which fish remains are common to localities where none are found. He admits that petroleum occurs in formations rich in diatoms and foraminifera, but refuses to believe that the latter organisms had anything to do with the origin of oil. He explains these facts away by declaring that the geologists have overlooked or ignored the fish remains, which will ultimately be discovered. This, in face of the fact that many geologists believe fishes to have been an important source of oil in certain formations, and would have been on the lookout for such fossils. It is presumptuous to assert that numerous competent geologists and paleontologists who have examined such formations with such thoroughness as to have discovered many species of microscopic organisms and numerous small mollusks have all overlooked or ignored such an important item as fishes.

The Mowry formation is cited as a good example of the derivation of petroleum from fishes, but perhaps some writers personally unfamiliar with the formation may have obtained from the literature an exaggerated idea of the abundance of

fish remains therein. Such phrases as the "widespread and often wholesale destruction of fish life over many thousands of square miles" by "powerful volcanic activity," and the "tremendous and comparatively sudden destruction of fish life," which have been applied to this formation, are not justified by the facts. There is no evidence of such destruction. Fish scales are very abundant, as compared with most formations, but after all they are so scattered that the scales from one good-sized fish would account for all found on a slab many yards square at most localities. They are not more common than might be expected in any marine shales deposited under ideal conditions for their preservation, without assuming wholesale and repeated destruction of fishes in schools. Indeed, the wonder is not that they are so abundant in the Mowry, but that they are so few in other formations of the region. The scales are seldom or never found very close together or arranged in natural order. This is important. It shows that the fishes were not overwhelmed by volcanic ashes and quickly buried, but that they were thoroughly decomposed and their scales scattered before burial, a condition favorable for the dissipation of the hydrocarbons, rather than for their retention. However, we are told by the advocate of the fish-oil theory that the oil floated until carried down by showers of volcanic ash, for which no proof is offered.

Another very significant fact is that, though the scales are from bony fishes, their bones and teeth are exceedingly rare in this formation and apparently totally absent from many localities. No theory of Mowry sedimentation or of the origin of petroleum in this or adjacent strata can be complete and satisfactory that does not account for the scarcity of bones. The most reasonable explanation seems to be that they were dissolved by solvents in the water, probably before burial, or their casts should be common. If this be true, it indicates even more thorough decomposition of the flesh than is suggested by the scattering of the scales, which were superficial.

What were the solvents? A correct answer to that question is imperative. It does not seem likely that there could have been in the water, mineral solvents which would thoroughly

dissolve the calcium carbonates and phosphates over thousands of square miles of territory. Decomposing animal matter under certain conditions may produce solvents, but is more likely to produce an alkaline condition unfavorable to the solution of the bones. On the other hand, decomposition of plants in great quantity would have produced just the acid condition which would result in the destruction of the bones and of the shells of mollusks, which are also rare in the scale-bearing strata. The fish scales, on the other hand, would be immune to the attacks of such acids.

The most likely plants which could occur in sufficient quantity to produce enough acids to do so thorough a job for so long a period over so large an area are low forms of algæ, etc., which as a rule are not recognizable in a fossil state. Here, then, we have a suggestion of a quite possible plant source of a considerable part of the Mowry petroleum, which cannot be ignored unless some other equally satisfactory explanation of the absence of bones be forthcoming.

In the discussion of the Green River shales also there is gross exaggeration of the abundance of fish remains, perhaps due partly to misinterpretation of portions of the literature of the subject. Their abundance is confined to a limited area in western Wyoming. The great majority of the fine Green River fish skeletons exhibited in the museums of the world have been obtained in one thin stratum at one locality. Considering the formation as a whole, in both its vertical and horizontal dimensions, the fossil fishes are abundant in only a very small fraction of the formation. They are exceedingly scarce in the much richer oil shales far to the south of the fish localities, in Colorado. If fishes were the sole or even the principal source of the shale oil, the richest shale should be somewhere near the region where fish remains are abundant. A thorough search for fossils over one hundred square miles of the richest oil shales in Colorado, during which fish scales, bones and teeth were especially sought, yielded only a very few, widely scattered examples, though leaves and insects were found in abundance. Investigators in other parts of Colorado, Utah and Wyoming have reported similar results.

though some skeletons were found in the Cathedral Bluffs region, I believe, according to a personal communication from Dean E. Winchester.

On the other hand, the oil shales at the richest localities in Colorado, where fish remains are very rare, are found by microscopic examination to be filled with plant remains of various kinds, chiefly algæ and algæ-like forms, in a ground-mass of material believed by investigators to have resulted from the decomposition of vegetable material. There is no evidence that it came from fishes. This plant material certainly furnished an enormous quantity of organic compounds in the very beds which are rich in oil. Why, then, should anyone attribute the oil of these shales to fishes, rather than to the abundant plant remains? Furthermore, at the type locality of the Tipton member of this formation, referred to by Schultz as "rich in bituminous strata," myriads of fresh water mollusk shells occur, with few, if any, fish remains.

Again, Macfarlane, after quoting Schultz to the effect that oil shale in the Rock Springs district "contains an *abundance* of vegetable and animal remains and *some* well-preserved fossil leaves and small fishes," asserts that "the only group that would again explain the origin of the enormous quantities of oil sealed up in the rocks" is the fishes, thus ignoring the other abundant organisms. Such loose reasoning concerning formations with which we are familiar has made some of us fear that similar statements concerning the relation of fishes to petroleum in more remote regions are equally unreliable.

It has been strongly urged that showers of volcanic dust have been responsible for the destruction of the fishes of the Green River shales. A careful examination of many slabs from Wyoming containing fish skeletons has disclosed no evidence of such material. All samples we have tested chemically almost completely dissolved in hydrochloric acid, leaving scarcely a trace of residue.

Some writers have suggested that the hydrocarbons of the oil shales may have existed in the water in a sort of colloidal condition that prevented its dissipation until buried by sediments. During the summer of 1925 I found the water of

Hasty Lake, on Whidby Island, Puget Sound, to be just such a mass of decomposed vegetation of the consistency of thin liquid glue to a depth of from two to four feet, greatly retarding the rowing of the boat. At one end of Lake Erie, on the same island, decomposed vegetation of nearly the same consistency occurred to such a depth that an oar thrust into it failed to reach the bottom, covered by a foot or two of clear water.

Macfarlane says that the "Fort Pierre and Laramie strata were in large part laid down in fresh water" and that they "are rich in fresh water fishes and in petroleum products." Such unfounded statements do not inspire confidence in statements concerning other formations.

The arguments concerning the fish-oil origin of early Paleozoic bituminous and petroliferous formations may be left for those more experienced in dealing with formations and faunas of those ages; pausing first to say that the definitely known fish remains of the Ordovician are confined to two or three localities which have not thus far yielded oil. Macfarlane's argument for fish-origin of the Ordovician oil of the eastern United States is based upon his belief that conodonts are teeth of cyclostomous fishes, not of annelids or other invertebrates, and that they are abundant enough to account for all the oil found in rocks of that age. He also declares that the conodont beds, as well as the Devonian fish beds, are all of fresh water origin, quite distinct from and alternating with the highly fossiliferous marine beds, and that the oil has all originated in the fresh water fish beds, not in the marine beds so rich in invertebrates. Are these statements correct? One might also ask how much evidence is there of abundant fish remains in the highly petroliferous formations of Texas and Oklahoma? Here again, perhaps, the geologists have overlooked or ignored the abundant fish remains which must be there.

In conclusion: (1) The arguments for the inorganic origin of petroleum are not convincing. (2) The arguments in support of the exclusive fish-origin of petroleum are in part based upon incorrect information, in part upon misinterpretation of

facts, in part upon conclusions which may be doubted concerning early Paleozoic teeth, and in part upon illogical reasoning. (3) The supposition that petroleum has originated only in strata which contain abundant fish remains is contradicted by very definite evidence. (4) All organisms contain more or less hydrocarbons essential to the formation of petroleum. (5) The total quantity of aquatic plant and invertebrate animal matter available for this purpose vastly exceeds the total amount of fish material, and much of it is better suited for deposition under conditions favorable to the formation of oil. (6) It is quite probable that different materials in different formations have provided hydrocarbons from which petroleum has been derived, including particularly swamp plants, aquatic plants such as algæ (which include diatoms), and aquatic animals such as fishes, protozoans, mollusks, and perhaps to a less extent in some formations the bryozoans, coelenterates, echinoderms, crustaceans and so forth, microscopic forms being especially important in some formations.

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XI

**EXPEDITION TO THE REVILLAGIGEDO ISLANDS,
MEXICO, IN 1925, VI**

THE BIRDS AND MAMMALS¹

BY

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In pursuance of its long established policy of studying the fauna and flora of Lower California and the adjacent islands, the California Academy of Sciences despatched its expedition to the Revillagigedo² and Tres Marias islands in 1925. The United States government placed the mine-sweeper *Ortolan* at the disposal of the Academy for this purpose, and, under the leadership of Dr. G. Dallas Hanna, the expedition sailed from the Mare Island Navy Yard on April 16.

Clarion Island, the outermost of the Revillagigedo Islands, was reached on the morning of April 26, and the six succeeding days were devoted to securing a representative collection of land and sea birds. The natural barriers furnished by masses of *Opuntia* and dense growths of vines made traveling

¹ This paper is No. 6 of the Revillagigedo Islands Expedition of 1925. Previous papers dealing with the scientific results of that expedition are to be found in preceding papers of Vol. XV of these Proceedings, No. 1, pp. 1-113, being the General Report with itinerary.

² A note on the previous scientific expeditions which had visited this group was published by the author in *Science*, n. s., Vol. 62, No. 1599, pp. 171-173,
May 20, 1926

difficult, but both northern and southern slopes of the island were traversed, and the central ridge surmounted. In spite of handicaps, a good series of birds was obtained.

For a few hours on May 2 the *Ortolan* lay off Roca Partida, and, although it proved impossible to make a landing, the collectors obtained specimens of sea birds by approaching the rocks in a small boat.

On the afternoon of the same day the island of Socorro was reached. Land birds were found to be abundant about the spring near Grayson's Cove, and at many points in the heavy growth at higher levels. On account of the difficulties encountered in the ascent, no collections were made at elevations higher than the steam vents on the slope of Mt. Evermann. Ten days were spent on Socorro with very satisfactory results.

San Benedicto was visited on May 12, and, so far as time permitted, representatives of the resident species of birds were obtained.

The *Ortolan* arrived at Maria Madre on the evening of May 13, and the five ensuing days and the days between May 21 and 23, inclusive, were spent in securing birds from the eastern slope of the island from Arroyo Hondo at the north to the salinas at the south. Land birds were plentiful in the neighborhood of fresh water, and a good series was acquired.

Four days were allotted to the work on Maria Magdalena, but an unavoidable interruption to the labors of the collectors somewhat diminished the returns from that island.

May 24 was spent on Isabel Island, and specimens of the resident birds, as well as some stragglers, were obtained.

Incidentally to the main objectives, calls were made on the outward voyage at Guadalupe Island and Alijos Rocks, and homeward bound, the *Ortolan* visited Cape San Lucas, Magdalena and San Bartolome bays, and San Quintin on the peninsula, and Cedros and San Martin islands.

It had originally been intended that a census of the elephant seal herd on Guadalupe Island should be taken, and a thorough search of the island made for certain of the rarer endemic species of birds. Weather conditions at the time the *Ortolan*

reached the island rendered these plans abortive. It was noted, however, that the juncos had become greatly reduced in numbers since 1922, and there seems to be reason to fear that they are soon to become a matter of history. No cross-bills or nuthatches were noted; and, as no kinglets or Guadalupe Petrels have been observed in recent years, it is believed that these birds have joined the ranks of the extinct species.

The birds and mammals of Cedros Island are apparently in a fair way to follow the birds of Guadalupe. Deer, which had been fairly common on Cedros Island when the *Tecate* called there in 1922, were not seen, and few signs of them were in evidence; no rabbits, nor recent signs of them, were observed; and birds were exceedingly scarce. Feral dogs and cats, as well as destructive humans, seem to have played their part in the reduction of wild life on the island.

The *Ortolan* reached San Francisco on June 12, bringing with her for the Department of Ornithology and Mammalogy a satisfactory total of 548 bird skins, 62 sets of eggs, and 29 mammalogical specimens.

Mr. Frank Tose, chief taxidermist of the Academy's Museum, assisted by Mr. J. T. Wright, faithfully represented the Department of Ornithology and Mammalogy, and to their energy and devotion is due the very gratifying results attained. The department is also indebted to the other members of the scientific staff and the officers and crew of the *Ortolan* for the assistance they generously afforded the collectors.

The specimens thus secured, and the field notes made by Mr. Tose form the basis of the present report.

Within the bounds of the A. O. U. *Check-List* (3rd ed.) and *Supplements*, its nomenclature has been employed in this paper, and the terminology of Miller's *List of North American Recent Mammals*, 1923, has been applied to the mammals.

LIST OF SPECIES OF BIRDS

1. *Brachyramphus hypoleucus* Xantus. Xantus's Murrelet

Attracted by the lights of the fishing party, two males of this species came on board the *Ortolan* as she lay in Melpomene Cove, Guadalupe Island, on the night of April 19.

One specimen has the plumage of the upper parts quite fresh, but the other has these parts considerably worn. In neither instance is there any evidence of moult. In both examples the white of the malar region extends upward in front and above the eye to form a supraorbital stripe, and the auriculars are invaded by the white of the under parts.

2. *Cerorhinca monocerata* (Pallas). Rhinoceros Auklet

A Rhinoceros Auklet flew on board the vessel at Guadalupe Island, April 19. The plumage is greatly worn on all areas, but renewal of the contour feathers is in progress.

Another specimen, taken on San Martin Island on June 8, is a bird in much faded livery. Moult, however, is in progress on the upper parts, it being almost complete on the head. Feather replacement in this example has probably been delayed on account of the bird's physical condition, the web of one foot having been injured.

Both birds are apparently young of the previous year.

3. *Larus occidentalis* Audubon. Western Gull

Western Gulls were noted in the vicinity of the Santa Barbara Islands on April 16. They were also seen on April 18, after the departure of the vessel from San Diego.

On Clarion Island, Mr. Tose noted an immature individual on the beach at Sulphur Bay on April 26. Others were seen by Doctor Hanna on April 30.

The nesting season was over at San Martin by June 8. Many well grown young were in evidence, but no eggs were found.

4. *Larus heermanni* Cassin. Heermann's Gull

Heermann's Gulls were numerous on Isabel Island on May 24, and a breeding colony was discovered close to shore on the northwestern side of the island. The young were fully fledged and almost ready to fly.⁸

⁸ Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 77.

The six specimens (two males and four females) collected are in greatly worn plumage. Postnuptial moult is in progress. In all but one specimen, the inner primaries are being replaced, and fresh feathers are present on the mantle and breast. One individual has pin feathers appearing on the head.

5. *Sterna fuscata* Linnæus. Sooty Tern

Sooty Terns were first seen at Alijos Rocks. They appeared to be the only dwellers on East Rock, but they shared with the Blue-faced Boobies the rookeries on South Rock.⁴

Roca Partida is evidently a breeding ground for these terns, as a juvenile is among the specimens taken there. They were not noted on Socorro, but some were seen in the vicinity of Oneal Rock.

Thousands were seen on Isabel, a large number being young almost fully grown. The nesting season was probably over, and the one fresh egg taken may have been infertile.

Nine specimens (six males and three females) were obtained on Alijos Rocks, April 24; four males (one juvenile) were taken at Roca Partida on May 2; and three males, two females, and one unsexed juvenile were collected on Isabel Island on May 24.

Save for abraded rectrices, the plumage of the Alijos Rocks birds is in good condition. The examples from Roca Partida are in more worn dress. One specimen seems to have recently acquired a new inner primary and most of the secondaries. Two of the specimens from Isabel have new feathers appearing on cervix and crown, and one of them is developing new lateral rectrices. The juvenile has down still adhering to the feathers of the rump and flanks.

As the birds from Alijos Rocks seem to approach in size those from the eastern rather than the western Pacific, the measurements, in millimeters, of the series are given below:

⁴Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 28.

	<i>Wing</i>	<i>Tail</i>	<i>Exposed culmen</i>	<i>Tarsus</i>	<i>Middle toe</i>
Males	307	190	48.0	22.00	22.0
	302	...	44.2	21.00	21.0
	300	...	41.0	21.90	21.5
	298	...	43.5	22.50	21.5
	298	...	43.5	23.25	21.0
	296	188	48.5	23.00	21.5
Average	300.1	189	44.7	22.27	21.4
Females	300	178(worn)	43	23.00	22
	285	...	41	23.00	21
	302	210	43	23.00	21
Average	296.3	194	42.3	23.00	21.3

6. *Anous stolidus* (Linnæus). Noddy

Noddy Terns were first found at Roca Partida, where they were believed to be breeding. A few were noted at sea near Socorro. Upon Isabel Island these terns were very numerous, nesting on the bare rocks on the north shore.⁵

The collection includes one female from Roca Partida, May 2; and two males, two females, and one unsexed young (just passing out of natal down) from Isabel Island, May 24. Nine eggs in all stages from fresh to more than half incubated were collected on Isabel, May 24.

The wing coverts of the Roca Partida bird exhibit some wear, otherwise the plumage is in good condition. The proximal primary appears to be new, and a few of the feathers of the forehead and crown are still in the sheath. Postnuptial moult has begun in the Isabel Island birds. One male shows feather renewal on the crown and throat, and the other is developing the tenth and eleventh primaries. The females have new feathers appearing on all areas of the body plumage, and the three inner primaries are being replaced in one, and two inner primaries in the other.

The juvenile has the contour feathers fairly well developed save on the throat and abdomen. The feathers of the fore-breast, sides of neck, and under tail-coverts are still tipped with brownish-gray down, and the throat and abdomen are clad in neossoptiles of the same shade.

⁵ Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 77.

7. *Diomedea nigripes* Audubon. Black-footed Albatross

One Black-footed Albatross was seen at sea north of Magdalena Bay on May 31.

8. *Puffinus opisthomelas* Coues. Black-vented Shearwater

The lights of the fishing party brought one Black-vented Shearwater on board the *Ortolan* as she lay at anchor in Melpomene Cove, Guadalupe Island, on April 19.

The foreneck and sides of breast of this specimen are strongly suffused with gray, and the lining of wing is mottled with the same color.

A fully developed egg was found in the oviduct.

9. *Puffinus auricularis* C. H. Townsend.
Townsend's Shearwater

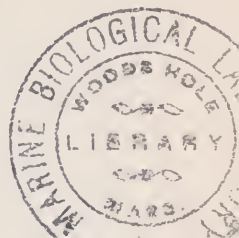
Burrows of Townsend's Shearwaters were found in great numbers at an altitude of about 800 feet under the grass hummocks on the northern slope of Clarion Island.

Not many of the burrows were occupied. A few contained eggs, but more had young nearly half grown.

This shearwater had not been previously reported as breeding on Socorro, but on May 7, Doctor Hanna⁶ discovered burrows and fragments of a recently killed bird which was believed to be one of this species. The burrows were at an altitude of about 3000 feet in the vicinity of the steam vents on the eastern slope of Mt. Evermann. The soil proved to be so exceedingly hard that few burrows were excavated and no other specimens were obtained. The birds were believed to be numerous, however, as they were heard at night flying over the camp.

Three males, four females, and two downy young were gotten on Clarion on April 30. Several eggs were obtained on April 30 and May 1, but only two were retained in the collection. One was addled, and the other was in an advanced stage of incubation.

⁶ Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 56.



In three examples the throat feathers exhibit distinct dark shaft lines, and one has the under tail-coverts largely white. The axillaries of one female have no trace of dark color.

Moult is in progress. One of the birds seems to have recently undergone a complete feather renewal, some of the greater coverts and scapulars alone showing wear. A few pin feathers are present on the throat. Two others in slightly worn plumage have new feathers appearing on the cervix, back, and breast. Two birds have the plumage much abraded, and a general renewal of the contour feathers is in progress. The remiges and rectrices are in fair condition; the secondaries appear to have been recently replaced. Of the downy young, one is in the protoptyle state and the other has the mesoptyles developed on the back.

10. *Puffinus cuneatus* Salvin. Wedge-tailed Shearwater

Thousands of Wedge-tailed Shearwaters were nesting on the Ash Heap on San Benedicto Island, and six unsexed specimens were obtained (May 12).

The specimens are all of the dark phase. The plumage is fresh, only the scapulars exhibiting signs of wear.

The average length of culmen in five specimens is 39.32 mm.; the maximum, 40.10; the minimum, 37.⁷

11. *Oceanodroma leucorhoa kaedingi* Anthony. Kaeding's Petrel

In following the nomenclature of the A. O. U. *Check-List* (3rd ed.) and *Supplements*,⁸ the name *kaedingi* has been used for the petrel which came on board the *Ortolan* at sea south of Guadalupe Island on April 23. The upper tail-coverts are extensively white, not interrupted medially by darker. The measurements are as follows: wing, 152 mm.; tail, 82.75; fork of tail, 20; culmen, 16; tarsus, 23.5; middle toe and claw, 24. Thus in regard to both color and measurements the specimen in hand differs from the typical *kaedingi*.

⁷ Cf. Mathews, *Birds of Australia*, Vol. II, p. 84.

⁸ *Auk*, Vol. XL, p. 514.

The flight feathers are in good condition, pin feathers are present on the upper tail-coverts, and only a few worn feathers are to be found among the fresh ones on the crown and back. The frontal feathers are greatly worn.

12. *Phaëthon æthereus* Linnaeus. Red-billed Tropic-bird

Red-billed Tropic-birds were first seen on North Rock (Alijos Rocks) where they were supposed to be breeding.⁹ They were not common on either Clarion or Socorro Island, but they were more numerous on San Benedicto and were believed to be nesting¹⁰ on the Ash Heap. On Isabel tropic-birds were abundant. They were noted on the shore line, and their nests were discovered in holes in the cliffs on the southwest side of the island by Doctor Hanna and Mr. Wright. Nests contained eggs, downy young, and many fully fledged immature birds.

The collection includes an adult male and female from Clarion Island, April 28; and six adult males and two adult females, two unsexed immature individuals, and two downy young from Isabel Island, May 24. Twelve eggs were obtained on Isabel. Two eggs were fresh, and others were in various stages from slightly to almost fully incubated.

The postnuptial moult of the female from Clarion Island is nearly complete. The body plumage seems to have been entirely renewed, and but two primaries and the rectrices are still to be developed. The male is undergoing a similar moult which has not advanced quite so far. Three of the Isabel Island birds are acquiring central rectrices. A few new feathers are appearing also on the under parts.

13. *Sula dactylatra* Lesson. Blue-faced Booby

Blue-faced Boobies were discovered on North and South rocks of the Alijos group, where they were believed to be breeding.¹¹ On Clarion Island they were nesting in the vicinity of Sulphur Bay. A good many nests contained fresh eggs, and newly hatched young were numerous. They did

⁹ Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 29.

¹⁰ Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 65 (red-tailed, *lapsus calami*).

¹¹ Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, pp. 28-29.

not appear to be present on Socorro, but there were breeding birds on San Benedicto on May 12.

One bird in immature plumage was taken on Alijos Rocks on April 24, and six adult males and two downy young (male and female) were collected on Clarion Island on April 27 and 28.

A postnuptial moult involving the body plumage has commenced in all the Clarion Island birds. Two of the males are also developing new rectrices. The immature bird from Alijos Rocks has the dark color of the head broken by patches of drab feathers. The young are clothed in pure white down.

In dried skins the colors of the soft parts vary considerably. The bill is horn color in some specimens and straw yellow in others. The tarsus and toes vary from dirty flesh color to mustard yellow.¹² In life, according to the color sketch made by Mr. Tose, the culmen approaches a deep chamois.

The twelve sets of eggs in the collection from Clarion Island (April 27 and 28) were in various stages from slightly to well incubated, and a few were fresh. The heavily incubated eggs discovered¹³ on San Benedicto Island (May 12) were not retained in the collection.

14. *Sula nebouxii* Milne-Edwards. Blue-footed Booby

Blue-footed Boobies were noted on the beach on Maria Madre on May 17, and on outlying rocks on Maria Magdalena¹⁴ on May 21. They were very numerous on Isabel Island where they nest under small trees. No eggs were found, but young, in nearly every state from newly hatched to almost fully grown, were present. The older ones were observed at the southwest beach learning to swim.

Two adult males were collected on Isabel Island on May 24. Postnuptial feather replacement has affected the remiges and rectrices, and also the plumage of the back.

¹² Cf. Rothschild, B. O. C., Vol. XXXV, p. 43.

¹³ Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 65.

¹⁴ Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 74.

15. *Sula brewsteri* Goss. Brewster's Booby

Brewster's Boobies were found nesting in the washes on San Benedicto. They were also seen on Roca Partida, Socorro, and Isabel, but they did not appear to be breeding.

Two adult females, and an immature male and female were collected on Roca Partida on May 2, and an adult female and three unsexed immature birds were obtained on San Benedicto on May 12.

Postnuptial moult is apparently in progress on the Roca Partida birds. Both adult females are undergoing a complete replacement of the body and flight feathers. The female from San Benedicto has some of the breast and abdomen feathers still in the sheath, otherwise there is no indication of moult. One of the immature examples from the same island is developing a new rectrix and a few white feathers on the abdomen. The immature bird from Roca Partida is acquiring fresh feathers on the upper parts, throat, and breast.

Three sets of eggs were obtained on San Benedicto, one being fresh, the others slightly and one-half incubated. The eggs measure as follows: 60.0 mm. x 39.5, 52.0 x 39.0, 59.1 x 41.4, 51.0 x 38.1, 54.5 x 36.6.

16. *Sula piscator* (Linnæus). Red-footed Booby

Large colonies of Red-footed Boobies were nesting in the Euphorbias near Sulphur Bay, Clarion Island. Some of the nests contained eggs, others well developed young. Groups of birds in immature plumage kept to themselves, and a few of such birds were found to be breeding.

On San Benedicto, Red-footed Boobies were roosting on the cliffs, but they nested in the grassy areas, building up platforms of grass culms to a height of a foot or more. The eggs found in these nests were all heavily incubated¹⁵.

Two adult males, four adult females, four immature birds (one female and three unsexed), and one downy young were taken on Clarion Island, April 27.

The contour plumage of the adult birds is but little worn, but a moult of the flight feathers is in progress in two examples.

¹⁵ Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 65.

The three immature unsexed individuals are in much worn livery. They are probably young of the previous year, for, although the under tail-coverts are white, the rump is still dark. A moult involving all areas is in progress. In all cases the new rectrices are dark colored.

The immature female is probably a bird experiencing its second postnuptial moult. The head, neck, and underparts are white, save for a slight clouding; the rump is dark, and the incoming feathers only partially white; the feathers of the back are broadly margined with white; and the newly acquired rectrices are dark.

The downy young is still in the protoptyle stage, but pure white mesoptyles are well developed.

The eggs in the collection were all obtained on Clarion Island on April 27. Some of the eggs were fresh. In others incubation had begun, and in others it was advanced.

17. *Phalacrocorax auritus albociliatus* Ridgway.

Farallon Cormorant

Cormorants were reported to be breeding in large numbers on San Martin Island on June 8. One set of half incubated eggs (said to be those of the Farallon Cormorant) was obtained.

18. *Phalacrocorax penicillatus* (Brandt). Brandt's Cormorant

The one Brandt's Cormorant in the collection was a member of a small breeding colony on the north side of Outer Island, Guadalupe. It was taken by Captain Nelson on April 21.

19. *Pelecanus californicus* Ridgway. California Brown Pelican

On the southward voyage, brown pelicans were seen off the Santa Barbara Islands, April 16. On Maria Madre they were seen on the beach to the north of the settlement, and on Maria Magdalena they were roosting in trees near shore. Pelicans with young almost as large as the adults occupied a rocky area near the highest part of Isabel Island on May 24.

An egg one-third incubated was taken on June 7 on San Martin Island, where this species was nesting in large numbers.

20. **Fregata aquila** (Linnæus). Man-o'-war-bird

The first Man-o'-war-bird observed by the *Ortolan* party was noted by Mr. Musser on April 23, when the vessel was about half way between Guadalupe Island and Alijos Rocks.

On Clarion Island many Man-o'-war-birds were seen on the cliffs, and in flight after boobies, but there was no indication of nesting. They seemed to be absent from Socorro, but they occurred about Roca Partida, and were found nesting¹⁶ in large numbers on the high central plateau of San Benedicto. Many of last year's young were seen about the nests, and the rookery was strewn with dead birds of this age. Several fresh eggs were secured from the nests, and the one preserved in the collection was only slightly incubated.

Frigate Birds were seen about Maria Magdalena, and they were found nesting on Isabel Island on May 24. The nests were weak platforms placed in the tops of low trees. Most of the eggs had hatched.

The collection comprises one immature female from Clarion (April 28); one adult and four immature males (one marked female, two unsexed), and two immature females from San Benedicto, May 12.

The adult male from San Benedicto has postnuptial moult in progress. The flight feathers are being renewed and moult is advanced on the head and back, but only slightly so on the neck and under parts.

Two immature males (one unsexed) from San Benedicto wear the plumage of the adult bird, save for the grayish feathers of the breast. Moult has commenced on both birds, but the new feathers on the breast still have a grayish cast. Two younger males (one labeled "female" and one unsexed) have the head and forebreast cinnamon, the breast and sides more or less dark colored, and the abdomen white. New

¹⁶ Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, pp. 64-65.

feathers of a darker cinnamon are appearing on the crown. Two immature females are acquiring new flight feathers and darker cinnamon plumage on the crown.

21. **Guara alba** (Linnæus). White Ibis

Two birds of this species were noted flying overhead at Magdalena Bay on May 29.

22. **Ardea herodias** subsp.

Since no specimens of great blue herons were secured during the voyage, the exact status of the birds seen must remain in doubt.

Great blue herons were noted by Mr. Wright and Captain Nelson near Sulphur Bay, Clarion Island, on April 28 and 29, but none was seen on Socorro.

Three of these herons were seen by Mr. Tose on Maria Madre on the shore north of the settlement. They were also noted on Maria Magdalena by Doctor Hanna. On Isabel Island, also, they were present.

On May 29, birds of this species were observed at Magdalena Bay.

23. **Nyctanassa violacea** (Linnæus).
Yellow-crowned Night Heron

Yellow-crowned Night Herons were present on Socorro in small numbers. They frequented a patch of *Opuntia* to the east of Braithwaite Bay, and Doctor Hanna¹⁷ found that they nested there. In the evening they visited the spring near Grayson's Cove to drink. Crabs seem to play a large part in the food of these birds.

Birds of this species were also noted on the shores of Maria Magdalena.

Four specimens were secured on Socorro on May 3 and 11.

An unsexed bird is evidently just passing into fully adult plumage. A few dark feathers are still retained on the fore-

¹⁷ Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 61.

head. An immature female is in fresh feather. Two juveniles show little feather deterioration, and exhibit no indications of moult.

24. *Phalaropus fulicarius* (Linnæus). Red Phalarope

When the *Ortolan* was about 55 miles east of San Benedicto Island on May 12, one of these birds flew on board and was captured by Mr. Duhem.

This bird has just acquired fresh remiges and rectrices, and new contour feathers are in evidence on all areas.

25. *Heteroscelus incanus* (Gmelin). Wandering Tattler

About the Revillagigedo Islands a number of Wandering Tattlers were observed. They were common on Clarion and two males and one female were secured at Sulphur Bay, April 26. They were also noted near Braithwaite Bay, Socorro.

Prenuptial moult is well advanced in one male; only the tertials and greater coverts are worn. Feather replacement has commenced in the flight feathers of the second male, but it has barely begun on the body plumage. The female is in worn dress, but the secondaries and inner primaries are apparently newly developed.

26. *Actitis macularia* (Linnæus). Spotted Sandpiper

Several birds, believed by Mr. Tose to be of this species, were noted on the beach on Socorro. No specimens were secured.

27. *Numenius hudsonicus* Latham. Hudsonian Curlew

Several Hudsonian Curlews were seen in the vicinity of Sulphur Bay, Clarion Island, and one was taken on April 26. This specimen is a female undergoing a prenuptial moult. The outer three pairs of rectrices and several of the inner primaries have been recently renewed. New feathers are present on the rump and upper tail-coverts, and pin feathers have appeared on the crown.

28. *Pluvialis dominica* subsp.

Doctor Hanna noted two golden plovers on Clarion Island, April 30.

29. *Arenaria interpres morinella* (Linnæus). Ruddy Turnstone

Turnstones were fairly numerous on Clarion Island. A male and a female were taken from a flock of about 15 on April 26.

Both birds are undergoing prenuptial moult, the remiges and rectrices (except the central ones of the male) having been recently renewed.

30. *Hæmatopus frazari* Brewster. Frazar's Oyster-catcher

Oyster-catchers were seen on the beaches of Maria Madre, Maria Magdalena, and Isabel. One male was obtained on Maria Magdalena, May 20, and a set of three eggs was taken on the same day.

31. *Columba flavirostris madrensis* Nelson.

Tres Marias Pigeon

Although these pigeons were present on Maria Madre and Maria Magdalena, they were far from common. They frequented the taller timber, and were noted at the spring at Arroyo Hondo.

Two specimens were taken on Maria Madre on May 17. The prenuptial moult of the male is somewhat more advanced than that of the female, but in both cases there are still many of the flight feathers to be replaced. Many pin feathers are present on the crown and throat of the female.

32. *Zenaidura macroura clarionensis* Townsend.

Clarion Island Mourning Dove

These doves seemed to be common on Clarion Island, and apparently were most abundant in the vicinity of Sulphur Bay.

Eleven males and six females were collected on April 27, 28, and 29. Most of the birds are in worn plumage, but feather renewal has commenced. Contour feathers are in most

instances being replaced, but flight feathers also are being developed in seven cases. One specimen has acquired fresh flight feathers, but the distal primaries and the rectrices are not fully grown.

33. **Zenaidura graysoni** Lawrence. Socorro Mourning Dove

Mourning doves were very numerous on the island of Socorro, being particularly abundant on the higher wooded levels, and ranging almost to the top of the island. They were so fearless that no difficulty was experienced in catching them alive. At the time of the visit of the *Ortolan* the fruits of *Bumelia socorrensis* and *Prunus capuli* entered very largely into the diet of these birds.

Ten males (two immature), eight females (one immature), and one unsexed juvenile were collected on May 7 and 9.

A postnuptial moult involving all areas is in progress. Two immature males are acquiring adult plumage. The unsexed juvenile (evidently a late fall bird) has new feathers appearing on the crown and throat, and new remiges are developing.

34. **Leptotila fulviventris capitalis** Nelson. Tres Marias Dove

The Tres Marias Dove seemed to be common on both Maria Madre and Maria Magdalena. It was noted particularly in the vicinity of Arroyo Hondo, and at the water hole on Maria Magdalena.

A male and three females (one immature) were collected on Maria Madre May 17 and 20.

One female has not yet begun to acquire nuptial dress, the other and the male are in an advanced state of moult, a complete one being in progress. The immature female has a few feathers of the adult present on the crown, and the inner two primaries have recently been renewed.

35. **Melopelia asiatica mearnsi** Ridgway.
Western White-winged Dove

This species did not appear to be common at any place visited. A few of the birds were noted on Maria Madre, and one male was secured on Maria Magdalena, May 21. Another

May 20, 1926

male was taken on Isabel Island, May 24, the only one seen on that island.

Both birds are assuming nuptial plumage. Pin feathers are present on nearly all the body feather tracts, the inner two primaries are new ones, and the rectrices of the Maria Magdalena bird are not fully developed. The example from Isabel Island has a central rectrix only partially grown.

36. *Chæmepelia passerina pallescens* Baird.
Mexican Ground Dove

These birds were reported to be abundant near the shore on Maria Madre, May 14; and at the water hole on Maria Magdalena, May 20; and were noted at Cape San Lucas, May 28. No specimens were taken, however.

37. *Chæmepelia passerina socorroensis* (Ridgway).
Socorro Ground Dove

No great number of ground doves was seen on Socorro. A flock of about 50 birds was noted near the spring at Grayson's Cove, and Mr. Slevin saw two other birds near Braithwaite Bay.

Five males (one immature), eight females (one immature), and one unsexed immature bird were collected on May 4 and 11.

A prenuptial moult is in progress. Two of the females are in worn plumage, but a few new feathers are appearing on the back. Other specimens show a more advanced feather replacement,—some renewing the body plumage, others undergoing a moult of the flight feathers, as well. The immature birds are assuming nuptial plumage by a complete moult.

38. *Cathartes aura septentrionalis* Wied. Turkey Vulture

39. *Coragyps urubu urubu* (Vieillot). Black Vulture

Mr. Tose records Turkey Vultures as being numerous on the beach on Maria Madre, and he also mentions the presence of "vultures" on Maria Magdalena. It seems probable that

both Black and Turkey vultures were represented on the Tres Marias at the time of the visit of the *Ortolan*, as, during the days the author spent on Maria Madre in October, 1925, the flocks haunting the beach in front of the settlement comprised both species.

40. ***Buteo borealis calurus*** Cassin. Western Red-tail

On April 19, Doctor Hanna saw two red-tailed hawks flying over the cliffs on Guadalupe Island.

41. ***Buteo borealis socorroensis*** Ridgway. Socorro Red-tail

Red-tailed hawks were fairly common and not at all wild on Socorro Island. A pair was seen near Grayson's Cove, and many others were in evidence about the steam vents. On one occasion a pair was disturbed in a feast on a three weeks old lamb. The crop of one of the examples contained nearly the whole of a Grayson's Dove. One nest was placed in the face of a cliff near Braithwaite Bay; another, discovered by members of the *Ortolan's* crew, contained a young bird about four weeks old; a third nest, in a lava bubble on the wall of an arroyo, was noted by Mr. Slevin.

Several specimens were obtained by various members of the party. The collection includes the skins of three males and one female, taken on May 3 and 11.

One of the males is in greatly abraded plumage. Two others have commenced their postnuptial moult, fresh body and flight feathers appearing. Two of the birds are melanistic ones.

42. ***Buteo borealis fumosus*** Nelson. Tres Marias Red-tail

Red-tailed hawks were said to be numerous on Maria Madre. They were quite fearless and so easily approached that one was killed by a shot from a collecting pistol. No specimens of this species are included in the collection.

43. *Cerchneis sparveria phalæna* (Lesson).
Desert Sparrow Hawk

Mr. Tose saw one sparrow hawk on Guadalupe Island, April 19.

44. *Polyborus cheriway pallidus* Nelson.
Tres Marias Caracara

Caracaras were very abundant on Maria Madre, particularly in the vicinity of the settlement. One specimen was taken on May 22, but the skin was not preserved.

45. *Pandion haliaëtus carolinensis* (Gmelin). Osprey

Although Ospreys did not appear to be as numerous as they were in 1922, they were still common on Cedros Island. No specimens were secured.

46. *Tyto alba pratincola* (Bonaparte). American Barn Owl

Doctor Hanna and Mr. Wright discovered the kitchen midden and feathers of a barn owl in a cave on San Martin Island.

47. *Micropallas graysoni* (Ridgway). Socorro Elf Owl

Socorro Elf Owls were found in the dense growth on the lower levels of the island. They appeared to be less rare than they were formerly supposed to be. Mr. Slevin obtained three in a tree at the bottom of an arroyo near Braithwaite Bay. Sailors obtained two downy young, but the location of the nest was not recorded.

Five specimens are in the collection,—an adult male and female, one unsexed bird, a juvenile female, and a downy young, all taken on May 10.

The remiges and rectrices of the adult birds are worn, and a few pin feathers are appearing on the crown and throat. The juvenile female is in the hemiptyle stage and worn filaments of down still adhere to the feathers. The plumage of this juvenile lacks the intensity of color possessed by the adult.

The upper surface is clove brown (somewhat paler and grayer on the crown and forehead), varied by pinkish cinnamon spots and margins on the feathers. The white is absent from the nuchal collar. The lower surface is deep mouse gray, banded by white, and anteriorly suffused by pinkish cinnamon.

The unfledged young is clad in grayish white down, through which the hemiptyles are appearing.

The measurements, in millimeters, of the adult birds are given below:

	<i>Wing</i>	<i>Tail</i>	<i>Culmen without cere</i>	<i>Tarsus</i>	<i>Middle toe</i>
Male	106	49.0	9.5	19.0	14.50
Female	108	47.5	10.0	19.5	15.00
Unsexed bird	105	51.0	10.5	20.0	15.25

48. ***Speotyto cunicularia rostrata*** Townsend.
Clarion Island Burrowing Owl

Burrowing owls were common on Clarion Island. They had been nesting in the cliffs, and burrows were found under vines and cacti. No eggs were discovered, and the young birds were all able to fly¹⁸. Insects seemed to be the staple food.

Three males and eight females are in the collection.

One male appears to have completed its postnuptial moult. Two females are in worn dress, and show no indications of feather replacement. The contour plumage of a male and two females is in good condition, save for that of the head, upon which pin feathers are showing. Three other birds are in worn plumage, but new feathers are appearing on crown and throat.

49. ***Aratinga brevipes*** (Lawrence). Socorro Paroquet

Large flocks of paroquets were seen in the hinterland of Socorro, and several pairs of supposedly breeding birds were observed about Grayson's Cove. No nests, however, were discovered. The fruit of *Bumelia socorrensis* seemed to be a favorite food of this paroquet.

¹⁸ Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 35.

Five males, nine females, and four unsexed birds were collected on May 4 and 9.

Feather renewal is in progress. In some cases the first pin feathers are appearing on the throat, other birds have almost completed the moult. The feather replacement experienced by the birds at this season seems to be a complete one, as the contour feathers, rectrices, remiges, and wing-coverts are all involved.

50. *Amazona oratrix tresmariaë* Nelson. Tres Marias Parrot

Tres Marias Parrots were seen in pairs and flocks in various parts of Maria Madre, and there were a number of them about the water hole on Maria Magdalena. The fruit of various species of *Ficus* was ripe at the time of the visit of the *Ortolan*, and the parrots were to be found congregated in the neighborhood of the fruit-bearing trees.

The abundance of these birds is rather surprising in view of the fact that the Tres Marias Parrot is held in high regard as a pet because it learns to talk with great fluency. The convicts at the settlement on Maria Madre have built up a flourishing trade with the mainland, and great numbers of young birds are captured each year to supply the market.

No specimens were secured.

51. *Psittacula insularis* Ridgway. Tres Marias Lovebird

Lovebirds did not appear to be very common on Maria Madre, and they were not noted at all on Maria Magdalena. Some examples were collected from a flock feeding in a fig tree in the neighborhood of Arroyo Hondo, others were found in a fig tree near the trail leading across the island.

Four males and two females were taken on May 17 and 22.

The specimens are all moulting birds. An immature male is acquiring its first nuptial dress. Some of the birds have feather renewal only well begun, others have it considerably advanced. Apparently this moult is complete, as the body plumage, remiges and wing-coverts, and rectrices are all involved.

52. *Trogonurus ambiguus goldmani* (Nelson).
Goldman's Trogon

Like most of the birds on the Tres Marias, trogons were most numerous in the vicinity of water. The Maria Madre specimens were secured at Arroyo Hondo, and in the heavy timber by the trail leading across the island. The only trogons noted on Maria Magdalena were near the water hole.

On Maria Madre four males (three adults and one immature) and one female were collected, and four males and one female were obtained on Maria Magdalena.

The plumage of most of the birds exhibited little wear. Molt, however, was in progress. In most cases only the contour feathers seemed involved, but one bird is developing new lateral rectrices and the secondaries seem new. An immature bird is just gaining its first nuptial plumage.

53. *Dryobates scalaris lucasanus* (Xantus).
San Lucas Woodpecker

The collection includes two birds of this species,—an immature male in the first contour feathers, and a female in much worn plumage. The female is acquiring a new central rectrix, the only indication of moult.

The specimens were obtained at Cape San Lucas (May 28).

54. *Dryobates scalaris graysoni* (Baird).
Tres Marias Woodpecker

The Tres Marias Woodpecker seemed to be fairly common and generally distributed on Maria Madre and Maria Magdalena.

The collection includes two immature birds (marked females, but acquiring red feathers on the pileum) from Maria Madre, May 15 and 16, and two males (one unsexed) from Maria Magdalena, May 19 and 20. New feathers are appearing on the crown, throat, and breast. The immature birds have the feathers of the under parts a good deal worn, and one has an inner primary not fully developed.

The under parts of the adult birds are streaked, not spotted.

55. *Centurus uropygialis* Baird. Gila Woodpecker

One female of this species was taken at Cape San Lucas on May 28. The plumage on all areas is a good deal worn, but there is no sign of feather renewal.

56. *Nyctidromus albicollis insularis* Nelson.

Tres Marias Parauque

Parauques are common on Maria Madre, and may be seen at any hour of the day on forest trails and in shady cañons. They were also present on the wooded slopes of Maria Magdalena.

An adult male and female were taken on Maria Madre (May 17 and 23), and an immature male was collected on Maria Magdalena (May 20). On May 16, Mr. Mason found a single fresh egg on the road south of the settlement on Maria Madre.

The adult birds have the body plumage greatly worn, but show no indications of feather renewal. In the case of the immature male, the flight feathers are also in poor condition.

57. *Calypte costæ* (Bourcier). Costa's Hummingbird

Twelve Costa's Hummingbirds were taken during the course of the voyage. An immature male and female were secured at Magdalena Bay (May 30), three males and five females were taken at San Bartolome Bay (June 2), and an immature male and female were collected on Cedros Island (June 3 and 4).

The immature male from Magdalena Bay seems to be acquiring adult plumage. Many new feathers are present among the worn ones on the back, and only a central patch of throat feathers is non-metallic. The central rectrices of the female are not fully developed, and pin feathers are present on the throat.

One male from San Bartolome Bay has five of the inner primaries just appearing, and there are pin feathers on the crown, foreneck, and breast. The other adult males are in worn feather, but moult has not commenced. The contour plumage of two females is worn, but the remiges and rectrices

are new ones. Three females with fresh wing feathers are gaining new body plumage.

The Cedros Island birds are in worn dress, but moult has not begun.

58. **Amazilia graysoni** Lawrence. Grayson's Hummingbird

This hummingbird is quite common on Maria Madre, although not so abundant about the settlement as Lawrence's Hummingbird. Many were seen at Arroyo Hondo and near the water hole on Maria Magdalena. The specimens (one male and three unsexed birds) in the collection were taken on Maria Madre on May 16, 17, and 20.

The remiges and rectrices of these specimens are fresh, and new feathers are being developed on the throat and forehead. One of the unsexed birds is of a distinctly coppery cast on the head and back. The measurements of this specimen are as follows: exposed culmen, 25.75 mm.; wing, 72; tail, 48.25.

59. **Cyanthus lawrencei** (Berlepsch).
Lawrence's Hummingbird

Lawrence's Hummingbird is abundant on Maria Madre—particularly about the settlement—and it was noted about the water hole on Maria Magdalena.

The collection includes four males (two immature), one female, and one unsexed (male) bird taken on Maria Madre on May 15, 16, and 20.

The adult males are in unworn plumage, one having a few pin feathers on the forehead. The female has pin feathers on the crown and throat, and a new fifth primary is just appearing.

60. **Tyrannus vociferans** Swainson. Cassin's Kingbird

An adult male in badly worn plumage was obtained at San Quintin on June 7. Pin feathers are present on the anterior portions of the body.

61. *Myiarchus cinerascens cinerascens* (Lawrence).
Ash-throated Flycatcher

An adult male of this species was among the birds collected on Isabel Island (May 24). Moulting is in progress. The tertials and secondaries are fresh, many new feathers are visible on the back and throat, and pin feathers are appearing on the forehead and nape. All the rectrices and upper tail-coverts on one side are being renewed at once.

62. *Myiarchus cinerascens pertinax* Baird.
Lower California Flycatcher

A female was taken at Cape San Lucas on May 28. The plumage on all areas is greatly worn, but replacement has commenced on the back, upper tail-coverts, throat, and breast.

63. *Myiarchus magister magister* Ridgway
Arizona Crested Flycatcher

This flycatcher proved to be very abundant on Maria Madre. The low growth on the eastern side of the island harbored numbers of them, and many hawked for insects at Arroyo Hondo. Four males and one female were taken on May 15 and 16. All of them had recently completed the prenuptial moult.

64. *Myiarchus lawrenceii tresmariae* Nelson.
Tres Marias Flycatcher

Tres Marias Flycatchers were common and shared with the crested flycatchers the low growth near shore and the territory in the vicinity of Arroyo Hondo.

The plumage of the four females in the collection is greatly worn. New feathers are developing on the cervix and throat of one specimen, and on the throat of another.

65. *Empidonax difficilis difficilis* Baird. Western Flycatcher

A male of this species was taken on Isabel Island, May 24. It is apparently undergoing a prenuptial moult, new and pin

feathers being present on the throat, forebreast, crown, and back. The first and third tertials have seemingly been just renewed.

66. *Myiopagis placens minima* Nelson.
Little Golden-crowned Flycatcher

One example of the Little Golden-crowned Flycatcher was secured on Maria Madre on May 23. The feathers of the crown, the primaries, greater coverts, and tertials are apparently fresh, and a few new feathers are interspersed among the worn ones of the back.

67. *Otocoris alpestris actia* Oberholser.
California Horned Lark

An adult male and an immature female were taken at San Quintin on June 7. The male has just commenced to acquire winter plumage, pin feathers being present on the interspecular region. The juvenile, in first contour feathers, has the three proximal primaries newly developed.

68. *Aphelocoma californica hypoleuca* Ridgway. Xantus's Jay

An adult female of this species was taken at Cape San Lucas on May 28. The proximal primary appears to be new, and pin feathers are present among the lesser coverts. The plumage is otherwise a good deal worn.

69. *Corvus corax clarionensis* Rothschild & Hartert.
Clarion Island Raven

Ravens were not uncommon on Clarion Island. A number were seen about Sulphur Bay, and a flock of 50 or more was seen on the northern slope of the island. They were seen hovering over the shearwater burrows, and it was thought that they feed to some extent on young shearwaters and boobies. A pair was nesting in the cliff near Sulphur Bay. Doctor Hanna¹⁹ noted ravens on San Benedicto, also.

¹⁹ Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 65.

Two males and a female were collected on Clarion. A set of two eggs (only one of which was preserved) was taken on April 30.

The birds are in somewhat worn plumage. The female is acquiring a new ninth primary.

The measurements, in millimeters, of these examples are as follows:

	<i>Wing</i>	<i>Tail</i>	<i>Culmen</i>	<i>Depth of bill</i>	<i>Breadth of bill</i>	<i>Tarsus</i>	<i>Middle toe</i>
Males	385	210	61.10	23.7	24.0	63.5	41.5
	385	215	60.75	24.2	24.2	65.7	41.0
Female	403	222	66.5	25.2	24.8	66.0	42.5

70. *Icterus spurius* (Linnæus). Orchard Oriole

At Cedros Island, June 3, there was taken a female Orchard Oriole in much worn plumage. A few new feathers are appearing on the throat and breast.

71. *Icterus graysonii* Cassin. Grayson's Oriole

Arroyo Hondo, on Maria Madre, and the water hole on Maria Magdalena were the gathering points for these orioles at the time of the visit of the *Ortolan*. The birds were abundant at those places, and they also occurred about the settlement.

With one exception, the four males and one female collected exhibit more or less wear of plumage. One male is in fairly good feather, and has a central rectrix not fully developed.

72. *Carpodacus cassinii* Baird. Cassin's Purple Finch

Mr. Tose took one Cassin's Purple Finch in a garden in the settlement on Maria Madre (May 16).

The bird is a male with the feathers of the cervix, back, and breast much worn. Fresh feathers and pin feathers are present on the throat.

73. **Carpodacus mexicanus clementis** Mearns.
San Clemente House Finch

Only a few house finches appeared to be present on Cedros Island, but a male and female were collected on June 3. Both birds are in greatly worn plumage, but lack any indications of feather renewal.

74. **Carpodacus mexicanus ruberrimus** Ridgway.
San Lucas House Finch

Although a number of house finches were observed at Cape San Lucas, no specimens were included in the collection.

75. **Carpodacus amplus** Ridgway. Guadalupe House Finch

House finches are still abundant and widely distributed on Guadalupe Island. A number were nesting in the cholla. The nests examined were lined with goats' hair. Three were found containing eggs, and one held almost fully fledged young. By dissection of the birds, it was evident that the breeding season was far from over. While some of the birds were unmistakably nesting, other females had ova practically undeveloped, and other birds were almost ready to lay.

Eleven adult and two immature males and nine females were taken on April 21. Three sets of eggs (incubation unrecorded) were obtained on the same day.

All the birds are in somewhat worn plumage, and four of the males are renewing the feathers of the head and throat.

76. **Astragalinus psaltria psaltria** (Say). Arkansas Goldfinch

This species was found to be abundant at Arroyo Hondo, on Maria Madre, and it was also present about the water hole on Maria Magdalena. An adult male and two unsexed birds (a female and an immature male) were taken on Maria Madre on May 17 and 20. A moult involving the body and flight feathers is in progress. The adult male has a few feathers on the interscapulars and rump showing indications of olive-green, and the immature male retains on the cervix and inter-



scapular region a few worn olive-green feathers among the fresh black ones.

77. *Astragalinus psaltria hesperophilus* Oberholser.
Green-backed Goldfinch

A flock of about 30 goldfinches was noted on Cedros Island, June 5. They appeared to be very wild. One specimen was secured. It is apparently an immature just passing into adult plumage, moult being in progress on the body feather tracts. The primaries have not been replaced and the white margins of the outer ones have been completely worn away.

78. *Passerculus rostratus guttatus* Lawrence.
San Lucas Sparrow

An adult male of this species was taken at Magdalena Bay on May 29. The bird is in worn plumage, but no feather renewal has commenced.

79. *Junco insularis* Ridgway. Guadalupe Junco

Juncos appeared to be scarce on Guadalupe Island, but it is possible that they were more numerous at elevations higher than those visited by the Academy's party. A male and female, taken near shore on April 21, were the only ones seen. The male is undergoing a postnuptial moult, a feather renewal involving all areas being in progress. The female is in greatly worn livery, but moult has not yet begun.

80. *Amphispiza bilineata deserticola* Ridgway.
Desert Sparrow

At Magdalena Bay, Desert Sparrows were more numerous than elsewhere. They were scarce at San Bartolome Bay, and their numbers had greatly diminished on Cedros Island since 1922. The specimens taken on Cedros were found near the spring at the top of the island.

Seven males (one juvenile), two females, and one unsexed bird were obtained at Magdalena Bay, May 30; two males,

a female, and one unsexed bird were gotten at San Bartolome Bay, June 2; and a male and female were collected on Cedros Island, June 4.

With two exceptions, the birds from Magdalena Bay are experiencing a postnuptial moult. In some cases feather renewal has affected only the plumage of the throat and crown, in others, it has progressed to include all the feather tracts. The juvenile has recently gained its definitive plumage. The birds from San Bartolome Bay are in about the same stage of moult, but those from Cedros Island are a little behind and have but pin feathers on the crown and throat.

81. *Amphispiza belli* (Cassin). Bell's Sparrow

Although Bell's Sparrow was not very abundant on San Martin Island, three males, six females (one immature), and two unsexed birds were obtained on June 8. A male and female were also taken at San Quintin on June 7.

Postnuptial moult is well under way in all but three adult birds. All areas, including the wing (coverts and remiges) and tail, are included in the feather replacement. Two immature birds in their first contour feathers show no indications of assuming winter dress.

82. *Pipilo carmani* Baird. Socorro Towhee

Towhees were very abundant on Socorro from sea level to an altitude of about 2700 feet. Most of the specimens were secured near the spring at Grayson's Cove. Twelve males and two females were collected on May 4 and 10. All the birds are in worn plumage. A few had not commenced to moult, but the remainder had feather renewal in progress on the crown and throat. In two cases moult has advanced to affect all the body feather tracts.

83. *Cardinalis cardinalis igneus* Baird. San Lucas Cardinal

Several cardinals were seen in the scrub about Cape San Lucas on May 28. One adult male was collected.

84. *Cardinalis cardinalis mariæ* Nelson. Tres Marias Cardinal

The cardinal is one of the common birds on Maria Madre. It seemed to be particularly abundant in the Arroyo Hondo vicinity.

Four adult males, one adult female, and one unsexed bird (an immature female) were secured on May 15 and 16.

In the cases of two males, the gray deciduous margins of the upper parts are still in evidence. The plumage of the unsexed bird is greatly worn on all areas, the rectrices being reduced almost to the rachises. A few pin feathers about the nostrils of this bird are the only signs of feather replacement. One male has evidently met with an accident, as the inner secondaries and the tertiaries are being renewed on one wing.

85. *Piranga ludoviciana* (Wilson). Western Tanager

The only Western Tanager seen on the Tres Marias was a male collected on Maria Madre on May 15. The first nuptial plumage is being assumed, and replacement is nearly complete.

86. *Piranga bidentata flammea* (Ridgway).

Tres Marias Tanager

This is one of the abundant birds on the Tres Marias. It is to be found most commonly in the second growth scrub near the shore. At the time of the visit of the *Ortolan*, many of them were seen near Arroyo Hondo, on Maria Madre, and at the water hole on Maria Magdalena. Four adult males and two females were taken on Maria Madre on May 15, 16, 17, and 23. The plumage of all the specimens shows wear. The "mirrors" on the tertiaries are almost completely worn away. There are no indications of feather renewal.

87. *Vireosylva flavoviridis forreri* (Madarasz).

Forrer's Vireo

Although there were many Forrer's Vireos about the water holes on Maria Madre and Maria Magdalena, their numbers were considerably less than had been expected. Three males

were taken on Maria Madre, May 15, 16, and 23, and a male and female on Maria Magdalena, May 20 and 21. The examples are apparently in nuptial plumage. One of the females has the gray of the nape still somewhat obscured by greenish margins.

88. **Vireo hypochryseus sordidus** Nelson. Tres Marias Vireo

This species appeared to be rare on the Tres Marias, and but one specimen was taken on Maria Madre, May 23. The bird is apparently in prenuptial dress.

89. **Compothlypis pitiayuma insularis** (Lawrence).
Tres Marias Parula Warbler

This warbler was probably the most abundant species on the Tres Marias. At the time of the visit of the *Ortolan*, its metropoleis were at Arroyo Hondo, on Maria Madre, and the water hole on Maria Magdalena. It was found, however, in the scrub near shore and in the various arroyos.

Five specimens (three males and two females) were collected on Maria Madre on May 15, 16, and 23. A pair was also secured on Isabel Island, May 24.

Two females taken on Maria Madre appear to be in fresh body and wing feather, the rectrices exhibiting more wear. The remainder of the specimens have the plumage more worn, but only one, which has pin feathers on the forehead, has commenced to moult.

90. **Compothlypis graysoni** Ridgway. Socorro Warbler

The Socorro Warbler was found to be very numerous, particularly in the vicinity of the spring near Grayson's Cove. It occurred, however, wherever the heavier growth extended, regardless of elevation. Twelve males, one female, and two unsexed birds were taken on May 3. About half the specimens have the feathers of the head and cervix margined with olive yellow. The remainder of the birds are in somewhat worn dress, lack the olive yellow margins to the feathers, and are acquiring new plumage on the forehead, crown, and throat.

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91. *Dendroica aestiva brewsteri* Grinnell.
California Yellow Warbler

A pair of California Yellow Warblers was taken on Maria Madre on May 16. New greater wing coverts and tertials have been acquired, and pin feathers are present on the crown and throat.

92. *Dendroica bryanti castaneiceps* Ridgway.
Mangrove Warbler

A number of these warblers were seen in and about the mangrove swamp at Magdalena Bay. Three adult and two immature males, and one female were taken on May 29 and 30. One male is in good plumage. Two other males and a female are in worn dress. The tertials, secondaries, and greater coverts of an immature male seem to be new, and pin feathers are appearing on the throat. Another male in its first (and greatly worn) contour plumage is acquiring new feathers on the throat.

93. *Dendroica auduboni auduboni* (J. K. Townsend).
Audubon's Warbler

A female and an unsexed example were obtained on Isabel Island on May 24. Prenuptial moult has affected the wing- and tail-coverts, tertials, and rectrices of the unsexed bird, but has not commenced on the female.

94. *Seiurus aurocapillus* (Linnæus). Oven-bird

One Oven-bird was secured on Maria Madre on May 16.

95. *Wilsonia pusilla pileolata* (Pallas). Pileolated Warbler

A male and female in nuptial plumage were taken on Maria Madre on May 16 and 17.

96. **Granatellus francescæ** Baird.
Tres Marias Red-breasted Chat

On May 22 two specimens of this species were taken on Maria Madre near the trail leading across the island. The skins were not preserved. Another bird was seen on the day following, but it was not secured.

97. **Mimus polyglottos leucopterus** (Vigors).
Western Mockingbird

A male in worn plumage was taken on Isabel Island (May 24). A few new feathers are appearing on the throat and upper tail-coverts.

98. **Mimodes graysoni** (Lawrence). Socorro Thrasher

The thrashers were the most abundant and most widely distributed species on Socorro. They were particularly numerous about the spring at Grayson's Cove, and in the heavily wooded cañons. Eight males (one immature) and two females were collected on May 3. Moulting is in progress in all but one of the birds. The other specimens are in all stages from initial to almost complete feather renewal, all areas (contour and flight feathers) being involved.

99. **Melanotis cærulescens longirostris** Nelson.
Tres Marias Blue Mockingbird

Mockingbirds were not seen about the settlement, and appeared to prefer the deeper woods. They were common at Arroyo Hondo and about the water hole on Maria Magdalena. The specimens collected on Maria Madre (two males and one female) on May 17 and 19, and on Maria Magdalena (one male) on May 20 were in good plumage, save for a little wear on the rectrices. One female from Maria Madre exhibited some wear on the contour feathers as well.

100. *Toxostoma cinereum cinereum* (Xantus).
San Lucas Thrasher

Three examples of this species were taken at Cape San Lucas on May 28. An adult male is in greatly abraded plumage, but no moult has begun. Two hornotines (a male and an unsexed example) have pin feathers present on the sides of breast and rump. One of them has a central rectrix still in the sheath.

101. *Heleodytes brunneicapillus affinis* (Xantus).
San Lucas Cactus Wren

An adult female was collected at Cape San Lucas on May 28.

102. *Salpinctes obsoletus guadeloupeensis* Ridgway.
Guadalupe Rock Wren

These wrens frequented the shore on Guadalupe Island and also occurred in the cañon extending inland from Northeast Anchorage.

Five adult males, three adult females, and one immature male were collected on April 21.

Two males and a female are in worn plumage, and exhibit no signs of moult. The remainder of the adult birds have commenced a postnuptial moult, which in most cases has only affected the upper contour feathers. In one case, however, a new rectrix is being developed and in another the two inner primaries are just being acquired. The juvenile is clad in its first definitive feathers.

103. *Salpinctes obsoletus proximus* Swarth.
San Martin Rock Wren

Rock wrens did not appear to be common on San Martin Island, but four males and one female were secured on June 8.

In spite of the wear exhibited by the feathers of all the specimens, moult has not begun. One bird has recently gained the fourth, fifth, and sixth primaries in one wing, but there is no corresponding replacement in the other.

A male in the collection taken on August 14, 1922, is experiencing a renewal of the wing- and tail-coverts, as well as the contour feathers. An immature in its first contour feathers, taken on July 11, 1905, is much paler than the Guadalupe bird in similar plumage. The under parts shade from white on the throat to a very pale vinaceous-cinnamon on the under tail-coverts. A female taken on July 11, 1905, is in worn plumage. A new third primary is the only indication of moult.

The measurements, in millimeters, of the Academy's series are given below.

	<i>Wing</i>	<i>Tail</i>	<i>Culmen</i>	<i>Tarsus</i>	<i>Middle toe without claw</i>
Males	68	47.75	19.00	21.20	14.1
	69	50.00	20.00	20.50	14.1
	68	50.50	17.75	19.75	14.5
	68	50.00	19.00	20.50	15.0
	68	49.00	18.00	20.50	14.7
Females	70	50.50	18.00	21.00	15.0
	66	45.00	18.00	19.75	14.4

104. *Salpinctes obsoletus exul* Ridgway.
San Benedicto Rock Wren

Rock wrens were not numerous on San Benedicto. Mr. Slevin found them on the southern slope of Mt. Herrera and a few on the western shore. According to Mr. Wright, the wrens were nesting at the time of the visit of the *Ortolan*.

Five males, three females (one immature), and one unsexed bird were secured on May 12.

Two males, two females, and the unsexed bird are in worn livery, but moult has not commenced. One male has new feathers on the crown. Another has new flight feathers, and moult on other areas is nearly complete, but many pin feathers are in evidence on the crown and wing- and tail-coverts. A third male is in fresh plumage, save for some worn lesser coverts. This bird is a partial albino. Its plumage is much grayer than that of the other fresh-plumaged male, and there are patches of white on the upper parts. The under parts of the immature bird approximate in coloration those of the San Martin specimen in similar plumage, but the upper parts are

darker. The immature bird from Guadalupe lacks the grayish cast of the upper parts possessed by the one from San Benedicto.

The measurements, in millimeters, of the series from San Benedicto are as follows:

	<i>Wing</i>	<i>Tail</i>	<i>Exposed culmen</i>	<i>Tarsus</i>	<i>Middle toe without claw</i>
Males	69	51.5	18.50	22.0	14.0
	73	52.5	17.75	20.9	13.5
	72	50.0	21.00	21.0	15.0
	66	50.0	20.00	18.5	14.1
	67	51.0	17.75	21.5	15.5
Females	68	51.0	17.25	20.1	16.0
	69	50.0	19.75	19.5	14.0

105. *Thryomanes bewicki charienturus* Oberholser.
San Diego Wren

One San Diego Wren (a male) was secured at San Quintin on June 7, and four males were taken near the spring at the summit of Cedros Island on June 4. In all cases the plumage was greatly worn, but moult had not commenced.

106. *Troglodytes tanneri* Townsend. Clarion Island Wren

These wrens were common on Clarion Island. Most of the specimens in the collection were taken in the vicinity of Sulphur Bay, where they frequented the scrubby growth and patches of cactus. Although they were most abundant near the shore, they occurred on all parts of the island. According to the notes of Mr. Tose, the specimens collected showed little indication of nesting. On April 28, however, Doctor Hanna²⁰ found a nest containing four half-grown young.

Twenty-one males (one immature), 12 adult females, and two unsexed examples were taken on April 26, 27, 28, and 29.

Postnuptial moult is well under way in these specimens. A few individuals have pin feathers just appearing on forehead and throat, others are gaining new tertials, also. Still others have renewed the contour feathers and remiges, and have

²⁰ Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 35.

moult progressing on upper and under wing-coverts and rectrices. In no case did moult appear to be complete. The one immature bird in the collection shades from mummy brown on the head to a cinnamon brown on the rump and upper tail-coverts. The under parts are suffused with tawny-olive, deepest on the under tail-coverts. The under tail-coverts are immaculate.

107. *Thryomanes insularis* (Lawrence). Socorro Wren

Socorro Wrens seemed to be abundant. Many were noted about the spring near Grayson's Cove, and they also occurred among the trees on the slopes of Mt. Evermann to an elevation of at least 2700 feet. Nine specimens (three males and six females) were collected. An adult male and female are in completely new livery. The remaining examples have the plumage somewhat worn, but show no indications of moult.

108. *Pheugopedius felix lawrencii* (Ridgway).
Lawrence's Wren

Lawrence's Wren is exceedingly abundant on Maria Madre. It is commonly a denizen of the second growth scrub.

Three adult males and an adult female are in the collection, taken on May 15 and 16. They are all in somewhat worn plumage, but exhibit no signs of moult.

109. *Auriparus flaviceps lamprocephalus* Oberholser.
Cape Verdin

A number of these birds were noted about Magdalena Bay, and four males, an adult and an immature female, and three unsexed immature birds were collected on May 29 and 30. One female was taken at Cape San Lucas on May 28.

The plumage of the adult birds shows a good deal of wear, but moult has only just commenced. Pin feathers are present on the throat and breast of two individuals, and a third has just gained a new proximal primary and two new rectrices. The bird from Cape San Lucas has a pair of fresh rectrices, and new feathers are appearing on the crown. The immature birds are wearing the first definitive feathers.

110. *Polioptila plumbea* (Baird). Plumbeous Gnatcatcher

One individual of this species was taken at Cape San Lucas May 28. The bird is in good plumage, save for the remiges and rectrices. One secondary and one tertial appear to be new, and a central rectrix is being developed.

111. *Polioptila californica* Brewster. Black-tailed Gnatcatcher

Gnatcatchers were fairly common at Magdalena Bay, and two males and a female were taken there on May 30. One adult and an immature male were also taken at San Quintin on June 7.

One male from Magdalena Bay is undergoing a postnuptial moult. The feathers are little worn, but pin feathers are present on the crown and underparts. The central rectrices and proximal secondary appear to be new. The other male is in worn plumage, but no moult has commenced. The plumage of the female is less worn, but pin feathers are appearing on the crown and upper tail-coverts. The adult male from San Quintin has a patch of pin feathers on the breast, the only indication of feather renewal. The immature bird has no replacement in progress.

In the cases of one male and female from Magdalena Bay, the black on the outer web of the outer rectrix is barely perceptible, and the colors of the upper and under parts are intermediate between those of *P. californica* and *P. plumbea*. A male and an unsexed bird, taken at Magdalena Bay, July 25, 1922, exhibit the same characters²¹.

112. *Planesticus graysoni* (Ridgway). Tres Marias Robin

Robins were common on the Tres Marias, particularly about Arroyo Hondo, on Maria Madre, and the water hole on Maria Magdalena.

Three specimens were taken on Maria Madre on May 17. The flight feathers are in good condition, but the contour plumage is somewhat worn. Moult has not commenced.

²¹ Cf. Thayer and Bangs, Condor, Vol. IX, p. 134.

LIST OF SPECIES OF MAMMALS

1. *Macrotus mexicanus bulleri* H. Allen.
Buller's Big-eared Bat

A deserted ranch house at the northern end of Maria Madre was found by Doctor Hanna and Mr. Slevin to harbor large numbers of big-eared bats. Other individuals of this species were discovered in the lime kiln near the hospital.

Twelve specimens were taken on May 17, and preserved in alcohol. Later, six of these examples (four females and two males) were made up as study skins.

The measurements, in millimeters, of the skins and skulls are given below.

Skins:

	Total length	Ear from crown	Tragus	Forearm	Thumb	Tibia	Foot	Tail
Males	96	21.00	7.50	46.25	12.75	20.5	13.0	32
	90	20.10	6.50	47.00	12.00	21.5	13.0	28
	90	19.50	6.90	47.25	12.50	20.0	12.5	27
	90	20.5	6.00	48.50	12.00	21.0	12.5	27
Females	86	21.5	6.50	49.5	12.90	21.0	12.0	30
	84	20.5	7.00	49.5	12.90	20.5	12.2	30

Skulls:

	Basal length	Palatal length	Width of braincase	Height of braincase	Interorbital width	Zygomatic breadth	Length of mandible
Males	19.00	11.0	9.25	9.00	4.5	11.50	15.50
	....	10.9	9.00	....	4.5	11.40	15.50
	19.00	11.0	8.75	9.25	4.7	11.25	15.25
Females	18.75	11.0	9.50	9.25	4.7	11.7	15.4
	18.50	11.0	9.60	8.90	4.9	11.75	15.5

2. *Rhogeëssa parvula* H. Allen. Tres Marias Rhogeëssa

The collection contains four examples of this species taken on Maria Madre on May 15 and 16. Mr. Slevin saw a number of these small bats under the tiles of the disused hospital building.

The measurements of the one study specimen are as follows:
Skin.—Total length, 73 mm.; ear from crown, 9.5; tragus, 4.5; forearm, 28.5; thumb, 6.0; tibia, 11.25; foot, 5.75; tail, 13.

Skull.—Basal length, 10.5; palatal length, 6.5; width of braincase, 6.0; height of braincase, 4.9; interorbital width, 3.0; zygomatic breadth, 8.25; length of mandible, 9.10.

3. **Felis catus** Linnæus. Domestic Cat

Mute testimony as to one force disturbing the balance of nature on Cedros Island, is the skull of a domestic cat which was found there.

4. **Zalophus californianus** (Lesson). California Sea Lion

According to Mr. Tose's notes, California Sea Lions were in evidence at sea north of Cape San Lucas, May 29, and many were seen near shore at Cedros Island, June 5.

Doctor Hanna²² counted 34 cows and bulls (no pups) on a narrow shelf of rock just above the surf line on Outer Island, Guadalupe Island. He also records²³ them as occupying the beaches on the western side of San Martin Island. At this place, one skull was collected.

5. **Phoca richardii geronimensis** Allen.
San Geronimo Harbor Seal

One skull of a harbor seal was collected by Doctor Hanna at Turtle Bay. There is no record of animals of this species having been seen alive at any of the points visited.

6. **Peromyscus maniculatus geronimensis** (Allen).
Ashy-gray White-footed Mouse

The refuse heap of an American Barn Owl domiciled on San Martin Island contained mandibles which apparently are referable to this species.

²² Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 25.

²³ Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 92.

7. **Peromyscus eremicus cedrosensis** Allen.
Cedros Island White-footed Mouse

One female of this species was taken on Cedros Island on June 4.

8. **Neotoma intermedia pretiosa** Goldman.
Matancita Wood Rat

The collection contains a male and female of this wood rat taken at Magdalena Bay on May 30.

9. **Neotoma bryanti** Merriam. Cedros Island Wood Rat

Two of these wood rats were taken in traps set close to the spring near the top of Cedros Island, June 4.

10. **Neotoma martinensis** Goldman.
San Martin Island Wood Rat

The rubbish heap of an American Barn Owl contained an almost complete skull of the endemic wood rat of San Martin Island. From the number of mandibles and other bones attributable to this species contained in the mass, it would appear that wood rats are fairly common on the island.

11. **Rattus rattus rattus** (Linnæus). Black Rat

The trapping on Maria Madre resulted in the addition of a Black Rat to the collection.

12. **Ammospermophilus leucurus peninsulae** (Allen).
Lower California Antelope Ground Squirrel

Antelope ground squirrels were noted at Cape San Lucas on May 28. No specimens were obtained.

13. **Lepus californicus magdalenæ** Nelson.
Magdalena Island Jack Rabbit

Three individuals of this species were seen at Magdalena Bay, May 30, but no specimens were taken.

14. **Sylvilagus graysoni** (Allen). Tres Marias Cottontail

Three cottontails were taken on Maria Madre, May 23, between the settlement and the salinas. Others were seen in the vicinity of the wireless station. They were said to be generally distributed over the island, but did not appear to be very abundant.

15. **Megaptera nodosa** (Bonaterre). Humpback Whale

Doctor Hanna²⁴ observed several whales of this species at close range off Clarion Island on April 26.

16. **Prodelphinus longirostris** (Gray). Long-nosed Porpoise

The skull of a Long-nosed Porpoise was picked up on the beach on Isabel Island, May 24.

²⁴ Proc. Calif. Acad. Sci., 4th Ser., Vol. XV, p. 31.

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XII

**THE ANTIRRHINOIDEÆ-ANTIRRHINEÆ
OF THE NEW WORLD**

BY

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In 1923, Miss Martha Hilend, a student at Pomona College, undertook a study of the southern California species of *Antirrhinum*. This work was carried on in the herbarium and in the field, but neither sufficient time nor material was available for any sort of conclusion regarding the status of the more confusing species. In 1924, therefore, during a stay of some months at the Gray Herbarium, I devoted considerable time to work on *Antirrhinum*. It soon became evident that an understanding of *Antirrhinum maurandioides* Gray and of *A. speciosum* (Nutt.) Gray involved the genera *Maurandya* and *Galvesia* respectively; and, finally, it was deemed best to study the other closely related genera for those species native to the New World. So far as possible, identification keys are presented also for species introduced from the Old World, but descriptions of such species are not included.

In addition to the Gray Herbarium (G), I visited and studied material in the following herbaria: New York Botanical Garden (NY), Philadelphia Academy of Natural Sciences (Ph), United States National Herbarium (US), Field Museum of Natural History (F), Missouri Botanical Garden

June 3, 1926

(M), University of California (C), California Academy of Sciences (Ca), Stanford University (S), and Pomona College (Po). The abbreviations indicated in parentheses above are those used in citing material in the various herbaria. To those in charge of the herbaria, to whose kindness I owe the privilege of examining and, in some cases, borrowing material, I hereby extend an expression of gratitude. To Miss Martha Hilend I express my thanks for color notes made in the field for several species.

KEY TO GENERA

- Leaves entire, ovate to lanceolate to linear, but not triangular-hastate, circular, reniform, cordate, nor lobed (except in 2 species of *Linaria* which have spurred corollas); corolla with definite palate more or less closing the throat, and saccate, gibbous or spurred at the base.
- Shrubs; leaves mostly opposite or in threes.....4. *Galvesia*
- Herbs; basal leaves often opposite, rarely in threes; cauline leaves mostly alternate.
- Fertile stamens 2, other 3 very rudimentary; seed with inrolled (cup-shaped) wing.....2. *Mohavea*
- Fertile stamens 4, the 5th rudimentary.
- Corolla with narrow spur at base of tube (spur very insignificant in *L. floridana* of the S. E. United States).....1. *Linaria*
- Corolla scarcely spurred, rather saccate or gibbous at base (with rather prominent but broad spur in *A. cornutum*)...3. *Antirrhinum*
- Leaves triangular-hastate, circular, reniform, or cordate, often crenate or lobed; corolla usually with internal plaits, but with true palate in one species only (*Maurandya antirrhiniflora*); corolla scarcely more than gibbous at base.
- Sepals decidedly thickened, indurated, gibbous at base, and with very evident midrib and reticulate veining; capsule thick walled, surmounted by beak-like, flattened, thickened base of style, dehiscing regularly by 2 clean, semicircular slits, one on each side of base of style; body of seed flat5. *Epixiphium*
- Sepals not much thickened, but membranaceous or foliaceous; capsule rather thin-walled, dehiscing with 2 irregular subterminal openings; style practically filiform; body of seed thick.

- Calyx herbaceous; floor of corolla throat either with plaits or two lines of hair; filaments with 2 rows of tack-shaped glands.....6. *Maurandya*
- Calyx membranous, purple; floor of corolla throat without ridges or lines of hair; filaments lacking glands.....7. *Rhodochiton*

I. LINARIA

The position of our native species in the genus *Linaria* has, I think, not been questioned. I have not gone into the generic position of some of the introduced ones, such as *L. elatine* (L.) Mill., *L. cymbalaria* (L.) Mill., and *L. minor* (L.) Desf., such a study scarcely being within the scope of this paper. Though I key these out in *Linaria*, such action should not be interpreted as an expression of opinion concerning the status of *Kicksia*, *Cymbalaria*, and *Chænorrhinum*.

KEY TO SPECIES

- Throat of corolla completely closed by palate.
 - Flowers in terminal racemes and on erect or ascending stems.
 - Seeds subcylindric, longitudinally angled, truncate; native American species.....§ *Leptoplectron* Pennell
 - Spur slender, at least 5 mm. long; pedicels shorter than corollas, glabrate; racemes strict not branching; corolla generally 7-12 mm. long.
 - Seeds smooth, not covered with minute tubercles; corollas, exclusive of spur, usually not over 7-9 mm. long; eastern North America.....
 -1a. *L. canadensis* var. *typica*
 - Seeds covered with minute tubercles; corollas 9-12 mm. long; western North America to South America
 -1b. *L. canadensis* var. *texana*
 - Spur short, blunt, scarcely 1 mm. long; pedicels longer than corollas, glandular-puberulent; racemes commonly paniculately branched; corolla 5-7 mm. long; southeastern United States.....2. *L. floridana*
 - Seeds not subcylindric, truncate nor longitudinally angled, but triangularly angled or transversely corrugate; introduced species.

Spur short, blunt, scarcely $\frac{1}{3}$ the length of the corolla; flowers nearly white, striped with blue; perennial by horizontal rootstock3. *L. repens*

Spur longer, slender-pointed, over half the length of the corolla.

Seeds winged.

Flowers yellow or yellowish.

Perennial, 3-8 dm. high; pedicels equaling or exceeding calyx; calyx-segments ovate, glabrous, ca. half as long as mature capsule....5. *L. vulgaris*

Annual, 0.5-2.0 dm. high; pedicels often shorter than calyx; calyx-segments linear-oblong, glandular-pubescent, almost as long as mature capsule.....6. *L. supina*

Flowers pale lavender with yellowish palate; leaves lanceolate to lance-linear; plant annual or biennial. Known in America only from Newfoundland....4. *x L. sepium*

Seeds not winged.

Branches of 2 sorts (basal slender short ones 5-10 cm. long, with elliptic leaves ca. 3 mm. wide; and tall erect ones with filiform leaves ca. 1 mm. wide); corolla purple, throat yellow, reticulate with purple veins; plant annual or biennial; capsule indurated, surpassed by calyx7. *L. reticulata*

Branches not dimorphic as above, but all of one sort.

Flowers purple; plant erect, coarse, several dm. high; capsule indurate, scarcely equaling sepals8. *L. purpurea*

Flowers yellow.

Annual; very slender stemmed; pedicels filiform, longer than calyx; cauline leaves linear-filiform9. *L. spartea*

Perennial; fairly coarse.

Leaves ovate to lanceolate, half clasping; pedicels equal to or exceeding calyx10. *L. dalmatica*

Leaves lanceolate to linear, merely sessile; pedicels shorter than calyx11. *L. genistifolia*

Flowers solitary in the axils of prostrate stems.

Leaf-blades entire, pinnately veined, longer than petioles; stems with spreading pubescence.

Leaves broadly ovate, rounded or subcordate at base; corolla yellowish with purple upper lip.....12. *L. spuria*

Leaves hastate; corolla yellowish, purple beneath13. *L. elatine*

Leaf-blades palmately lobed, shorter than petioles; stems glabrous.....14. *L. cymbalaria*

Throat of corolla not completely closed by palate; glandular-pubescent annual with linear to linear-spatulate leaves; flowers shorter than pedicels, bluish.....15. *L. minor*

1. LINARIA CANADENSIS (L.) Dum.-Cours. Bot. Cult. 2:96, 1802.

Glabrous, dark green annual, or biennial; stems very slender and of two kinds, fertile ones erect or ascending, 1-5 (8) dm. high, simple or branched, leafy below and ending in slender pedunculate racemes, sterile stems largely basal, spreading or procumbent, filiform, 2-10 (15) cm. long, very leafy, sometimes elongating and becoming fertile; leaves of fertile stems entire, linear to linear-oblong, opposite or in 3's at the base, alternate above, acute to obtusish, sessile, blades 5-25 mm. long, 1-3 mm. wide, leaves of sterile stems crowded, entire, ovate to elliptic to linear, obtuse to acute, blades 3-20 mm. long, 1-3 mm. wide, sessile or on petioles 1-2 mm. long; inflorescence a glabrate, spicate slender raceme, flowers fairly crowded, but fruit scattered on nodes 5-25 mm. apart, peduncles 2-12 cm. long, racemes proper 5-30 cm. long, pedicels 2-10 mm. long, filiform, glabrate to finely

glandular-puberulent, ascending to appressed, each subtended by a minute subulate bract; calyx glabrate to glandular-puberulent, 5-parted into subequal herbaceous, lanceolate segments 2-3 mm. long with scarious margins and divergent tips; corolla pale blue to purplish blue, with reticulate veinings, strongly bilabiate, closed at throat, 7-12 mm. long exclusive of spur, glabrate without, tube whitish, slightly constricted above base, 2.5-4 mm. long, 1-2 mm. wide, glabrous within, with slender spur at base, upper lip reflexed, 4-5 mm. long, lobes oblong, 2-3 mm. long, lower lip spreading, deflexed, 5-10 mm. long, with the well formed palate convex, 2-ridged, pubescent, extending to base of lobes, lobes broad, suborbicular, 3-4 mm. long, middle one projecting beyond others; stamens glabrous, didynamous, 2-3 mm. long, included, filaments slightly dilated, scarcely geniculate, anther-sacs divergent, confluent, less than 0.5 mm. long, 5th stamen very rudimentary, represented by filament-base only; pistil glabrous, 2-3 mm. long, stigma entire, style equal to ovary; capsule 2.5-3.5 mm. long, cylindrical-globose, equaling or slightly exceeding calyx, tipped by short stout persistent style, rather thin-walled and dehiscing irregularly by 2 large terminal pores; seeds subconic-cylindric, truncate, angled, not winged, less than 0.5 mm. long, smooth to tuberculate.

1a. *L. canadensis* var. *typica*, nom. nov.

Antirrhinum canadense L., Sp. Pl., 618. 1753. *Linaria canadensis* Dum.-Cours., Bot. Cult. 2:96. 1802. Chavannes, Monogr. Antirrh., 149. 1833. Pennell, Proc. Acad. Nat. Sci. Phila. 73: 501. 1922.

Corolla, exclusive of spur, from 7-9 mm. long; seeds smooth.

Type locality: Probably southern New Jersey (Pennell, *Torreyia* 19:151. 1919). Herbarium material of this and of the next variety is so abundant that no attempt is here made to cite specimens, especially as the whole matter has been so adequately discussed by Pennell (Proc. Phila. Acad., 1. c.). I have seen sheets that I would refer to the var. *typica* from N. S., Me., N. H., Vt., Mass., R. I., Conn., N. Y., N. J., Md.,

Va., N. C., S. C., Ind., Ill., Ga., Ala., and Fla. From Venezuela I have seen two sheets that apparently belong here: Colonia Tovar, Aragua, *Pittier 9953* (G); and "prope coloniā Tovar," *Fendler 836* (Ph).

The intergradation between this and the next variety is quite complete and, as shown by Pennell, the roughness of the seeds is the best character.

1b. *LINARIA CANADENSIS* var. *TEXANA* (Scheele) Pennell, Proc. Acad. Nat. Sci. Phila. 73:502. 1922. Pennell in Millsp. & Nutt., Field Mus. Pub. Bot. 5:221. 1923.

L. texana Scheele, Linnæa 21:761. 1848. Rydb., Fl. Rocky Mts., 762. 1922. Small, Fl. S. E. U. S., 1056. 1903. Schulz, 500 Wildflowers of San Antonio, 190. 1922. *L. canadensis* of H. & A., Bot. Beechey, 153 and 375. 1833. Curtis Bot. Mag. 10: pl. 3473. 1836. Gray, Bot. Mex. Bound. Survey, 111. 1859. Bolander, Pls. San Fran., 21. 1870. Coulter, Rocky Mt. Bot., 273. 1885. Behr, Fl. Vic. San Fran., 153. 1888. Brandegeee, Proc. Cal. Acad. II, 1:215. 1888. Davidson, List Pls. L. A. Co., 13. 1892. Cat. Pls. L. A. Co., 22. 1896. McClatchie, Fl. Pasadena, 642. 1895. Anderson, Nat. Hist. Santa Cruz Co., 41. 1894. Howell, Fl. N. W. Amer. 1:504. 1901. Rydb. Fl. Colo., 305. 1905. Coulter & Nelson, Rocky Mt. Bot., 438. 1909. Frye & Rigg, N. W. Flora, 343. 1912. Wootton & Standley, Contr. U. S. Nat. Herb. 19:577. 1915. Abrams, Fl. L. A., 357. 1904 and 328. 1917., Jepson, Fl. W. Mid. Calif., 397. 1901 and 371. 1912. Davidson & Moxley, Fl. So. Calif., 324. 1923. Jepson, Man. Calif., 901. 1925.

Corolla, exclusive of spur commonly 9-12 mm. long; seeds covered with minute tubercles.

Type locality: "Zwischen Houston und Austin," Texas. Of wide distribution; I have seen material from S. Car., Ga., Ala., Miss., La., Texas, N. Mex., Ariz., Colo., Kansas, Okla., Mo., B. C., Wash., Ore., Calif., Mex., Colombia, Venezuela, Peru, Bolivia, Chile, Argentine, Uruguay, Santo Domingo.

Occasionally with much reduced flowers and becoming quite cleistogamous for example, Laguna Lakes, Orange Co., *Munz 6910* (Po) with corollas 4-5 mm. long and spur 3-4 mm.; and Potrero Grade, San Diego Co., Calif., *Munz 9464* (Po) with corollas ca. 2 mm. long and spur quite lacking.

2. *LINARIA FLORIDANA* Chapman, Fl. So. U. S., 290. 1860. Gray, Syn. Fl. N. Am. 2: 250. 1888. Small, Fl. S. E. U. S., 1056. 1903. Pennell, Proc. Acad. Nat. Sci. Phila. 71:258. 1920.

Glabrate or finely puberulent annual or biennial; stems very slender, much as in the preceding species but more glandular-puberulent; leaves of fertile stems linear, 5-25 mm. long, ca. 1 mm. wide, those of sterile stems as in preceding species; inflorescence finely puberulent, the racemes frequently paniculately branched, pedicels glandular-puberulent, 5-12 mm. long, exceeding the minute flowers; calyx glandular-puberulent, 2 mm. long, 5-parted into lanceolate greenish segments with hyaline margins; corolla like that of preceding species, but smaller, light blue, 5-7 mm. long, glabrous without, with spur scarcely 1 mm. long, corolla-tube ca. 2.5 mm. long, glabrous within, upper lip of corolla reflexed, ca. 2 mm. long, lobes oblong, ca. 1 mm. long, lower lip spreading, convex, 3 mm. long, with well formed pale palate with exceedingly minute pubescence, lobes ca. 1 mm. long, oblong, middle one projecting beyond others; fertile stamens didynamous 1.5 and 2.5 mm. long, filaments dilated, arcuate above, glabrous, not geniculate, anther-sacs divergent, confluent, ca. 0.5 mm. long; pistil scarcely 2 mm. long, glabrous, style 1 mm. long, stigma entire; capsule as in preceding species, but 2-3 mm. long; seeds ca. 3 mm. long, dark, somewhat subconic-cylindric, angled, relatively smooth.

Type locality: "Drifting sands near the coast, West Florida." Material studied: MISSISSIPPI: Horn Island, *Tracy & Earle in 1894* (F, US); Petit Bois Island, *Tracy 5106* (F, M, NY); Cat Island, *Lloyd & Tracy 89* (NY); Deer Island, *Earle 1417* (G). ALABAMA: Mobile, *Mohr in 1883* (G,

M), in 1878 (Ph, US). GEORGIA: Fifteen Mile Creek, Emanuel Co., *Harper 976* (F, G, M, NY, US). FLORIDA: without locality, *Simpson in 1889* (US), *Chapman* (G, M, NY, US); Pensacola, *Baker in 1898* (NY, Po); Appalachicola, *Curtiss 1846* (F, G, M, NY, Ph, US), *Chapman* (F, G, Ph, NY), *Chapman 4106a* (G, NY, US), *Chapman in 1875* (G), *Saurman in 1867* (F, Ph); Ft. Augustine, *Smith in 1884* (F, G), St. Augustine, *Reynards* (NY); Indian River, *Palmer 352* (G, M, NY, US); Eustis, *Hitchcock in 1894* (M), *Nash 192* (F, G, C, M, NY, Ph, US), *Hitchcock 1421* (F); Leesburg, *Pennell 9681* (G, NY, US); Hernando Co., *Hitchcock 1420* (F), in 1898 (M); Polk Co., *Ohlinger 459* (F, M); Apopka, *Pennell 9679* (F, M, NY, Ph); and Jensen, *Curtiss 5835* (G, C, M, NY, US).

3. LINARIA REPENS (L.) Mill., Gard. Dict., ed. 8, no. 6. 1768.

Antirrhinum repens L. Sp. Pl., 614. 1753. *Linaria striata* DC, Fl. France 3:586. 1805. Benth. in DC, Prodrromus 10: 278. 1846. Introduced species, native to Europe; known in the New World from Newfoundland, New Brunswick, and New York.

4. x LINARIA SEPIUM J. G. Allm., Proc. Irish Acad. 2:404. 1844.

L. vulgari-repens Sowerby, Eng. Bot. 6:142. 1873.

Supposed to be a hybrid between *L. repens* and *L. vulgari*. On this continent known only from Newfoundland.

5. LINARIA VULGARIS Hill, Brit. Herb. 108. 1756.

Antirrhinum linaria L. Sp. Pl., 616. 1753. *Linaria linaria* Karst, Deutsch. Fl. 947. 1880-83.

Native to Eurasia; widely introduced in North America. I have seen material from the southern provinces of Canada and most of the states of the Union.

6. *LINARIA SUPINA* (L.) Desf., Fl. Atlant. 2:44. 1800.

Antirrhinum supinum L., Sp. Pl., 615. 1753.

Native of the Mediterranean region. Known in America from Mass., N. Y., Penn., N. J., and Calif.

7. *Linaria pinifolia* (Poiret) n. comb.

Antirrhinum pinifolium Poiret, Voy. en Barb. 2: 193. 1789.

A. reticulatum Smith, Icon. Pict. Pl. Rar. 1: pl. 2. 1790.

Linaria reticulata Desf., Fl. Atlant. 2:48. 1800.

Native of the western Mediterranean region. It has been collected in Conn. and Calif. A specimen from near San Diego has been referred to *L. reticulata aureopurpurea*; I have been unable to check the status of this variety.

8. *LINARIA PURPUREA* (L.) Mill. Gard. Dict. Ed. 8, No. 5. 1768. *Antirrhinum purpureum* L. Sp. Pl., 613. 1753.

A native of southern Europe. It has been collected in New Jersey.

9. *LINARIA SPARTEA* Link & Hoff., Fl. Port. 1:233. 1809.

Native of southern Europe and northern Africa. Has been collected in Connecticut.

10. *LINARIA DALMATICA* (L.) Mill. Gard. Dict. Ed. 8, no. 13, 1768.

Antirrhinum dalmaticum L. Sp. Pl., 616. 1753.

Native of the eastern Mediterranean region and introduced into Pennsylvania and California.

11. *LINARIA GENISTIFOLIA* (L.) Mill. Gard. Dict. Ed. 8, n. 14. 1768.

Antirrhinum genistifolium L. Sp. Pl., 616. 1753.

Native of Austria, Hungary, etc. Introduced into Mass., New York, and Pennsylvania.

12. *LINARIA SPURIA* (L.) Mill. Gard. Dict. Ed. 8, no. 15. 1768.

Antirrhinum spurium L. Sp. Pl., 613. 1753. *Kicksia spuria* Dumont, Fl. Belg. 35, 1827. *Elatinoides spuria* Wettst. in Engl. & Prantl, Nat. Pfl. Fam. 4: Abt. 3b, 58, 1891.

Widespread in Europe and western Asia. In the New World it has been introduced into New York, New Jersey, Pennsylvania, Missouri, North Carolina, South Carolina, Alabama, Florida, California, and Chile.

13. *LINARIA ELATINE* (L.) Mill. Gard. Dict. Ed. 8, no. 16. 1768.

Antirrhinum elatine L., Sp. Pl., 612. 1753. *Kicksia elatine* Dumont, Fl. Belg. 35. 1827. *Elatinoides elatine* Wettst. in Engl. & Prantl, Nat. Pfl. Fam. 4: Abt. 3b, 58. 1891.

Widespread in Europe and about the Mediterranean. In the New World it has been collected in most eastern and southern states, in Oregon and California, in Bermuda, Cuba, and Haiti.

14. *LINARIA CYMBALARIA* (L.) Mill. Gard. Dict. Ed. 8, no. 12. 1768.

Antirrhinum cymbalaria L., Sp. Pl., 612. 1753. *Cymbalaria cymbalaria* Wettst. in Engl. & Prantl, Nat. Pfl. Fam. 4: Abt. 3b, 58. 1891.

Native to western Europe. Escaped in Ontario, many eastern states, Bermuda, Missouri, Oregon, and Puebla, Mexico.

15. *LINARIA MINOR* (L.) Desf., Fl. Atlant. 2:46. 1800.

Antirrhinum minus L., Sp. Pl., 617. 1753. *Chænorrhinum minus* Lange in Wilke & Lange, Prodr. Fl. Hisp. 2:579. 1870.

Widely distributed in Europe and northern Africa. Known in America from Quebec, New Brunswick, Nova Scotia, Ontario, Vermont, Connecticut, New York, Penn., N. J., Ala., Mich., Ind., Ill.

II. MOHAVEA

- Flowers pale yellow, 2.5-3.5 cm. long; palate conspicuously purple dotted; tube and throat together ca. $\frac{1}{2}$ the length of the whole corolla; lower lip lobed to 6 or 8 mm. above the palate; stamens slightly pubescent; seeds less than 2 mm. long.....1. *M. confertiflora*
- Flowers lemon yellow, 1.5-2.0 cm. long; palate not conspicuously dotted; tube and throat together ca. $\frac{1}{2}$ length of whole corolla; lower lip lobed to within 2 or 3 mm. of palate; stamens glabrous; seeds 2-2.5 mm. long2. *M. breviflora*

1. MOHAVEA CONFERTIFLORA (Benth.) Heller Muhlenbergia 8:48. 1912.

M. confertiflora in Johnston, Proc. Calif. Acad. IV, 12: 1164. 1924. Jepson, Man. Calif., 901. 1925.

Antirrhinum confertiflorum Benth. in D. C., Prodr. 10:592. 1846. Gray, Proc. Amer. Acad. 7:372. 1868. *Mohavea viscidida* Gray, Pac. R. R. Rep. 4:122. 1857. Proc. Amer. Acad. 7:378. 1868. Bot. Ives Exped., 19. 1860. Bot. Calif., 1:552. 1876. Syn. Fl. N. Am. 2:254. 1888. Torrey, Pac. R. R. Rep. 5:363. 1857. Orcutt, Fl. So. & Lower Calif., 8. 1885. Curran, Proc. Calif. Acad. II, 1:234. 1888. Brandege, Proc. Calif. Acad. II, 2:190. 1889. Davidson & Moxley, Fl. So. Calif., 326. 1923. Tidestrom, Contr. U. S. Nat. Herb. 25: 485. 1925.

Erect annual, simple or usually diffusely, corymbosely branched from below; stems viscid-villous to viscid-pubescent throughout, 8-45 cm. high; leaves ovate-lanceolate to lance-linear, entire, mostly heavily glandular-pubescent, blades 1-6 cm. long, gradually narrowing at base into short winged petiole 3-15 mm. long, acuminate above, lower leaves subopposite, upper ones alternate, narrowed, rather crowded; flowers borne singly in upper axils, somewhat clustered during anthesis; pedicels 5-10 mm. long in flower, elongating somewhat in fruit, heavily glandular-pubescent, ascending; calyx deeply 5-parted, herbaceous, viscid-villous, campanulate, somewhat oblique, calyx-lobes lanceolate to lance-linear, subequal,

9-13 mm. long, 1.5-2.5 mm. wide, in fruit suberect and 12-20 mm. long and up to 5 mm. wide; corolla strongly bilabiate, slightly pubescent without, 2.5-3.5 cm. long, silky, pale yellow, closed at throat, corolla-tube saccate anteriorly, very short, passing insensibly into the short narrow throat, the two together ca. $\frac{1}{3}$ the length of the whole corolla, pubescent within above the very base, flattened, corolla-limb large, expanded, dorsally compressed, not reflexed, upper lip dotted with purple, 1.5-2 cm. long, almost as wide, obscurely lobed, the 2 lobes broad, obtuse, lower lip also dotted, especially on the prominent deep-yellow, hairy palate, of about equal length to upper, with 3 lobes subapiculate, and about one-fourth as long as whole lip, middle lobe narrowest, palate coming out almost $\frac{1}{2}$ way onto lower lip; 2 lower stamens fertile, dilated, curved toward tip, slightly glandular above, somewhat pubescent at base, 9-10 mm. long, not geniculate, anther-sacs confluent, short, each ca. 0.5 mm. long; other 3 stamens aborted, ca. 1 mm. long, middle one without vestige of anther, others with it; stigma subglobular, entire, style ca. equal to the fertile stamens, filiform, persistent, slightly flattened, glandular-puberulent, ovary glandular-puberulent, 2-celled; capsule globular to slightly elongate, 10-12 mm. long, thin-walled, dehiscing by 2 subterminal, irregularly lacerate openings; seeds barely 2 mm. long, dark, rather flat, the ventral face with an emarginate, inrolled (cup-shaped) striate wing.

Type locality: Colorado Desert of California. Material studied: NEVADA: Eldorado Cañon, Lincoln Co., *Davis 61* (M); Eldorado Cañon near Colo. River, *Tidestrom 8787* (Ph). ARIZONA: Ft. Mohave, *J. G. Lemmon & wife in 1884* (US), *Cooper in 1861* (G, US); Riverside Mt., near Colorado River, *Newberry* (G, NY), *Grinnell in 1910* (C); Ehrenberg (without definite label on some sheets), *Palmer 336, in 1876* (C, F, M, NY, Ph, US); Bill Williams Creek, *MacDougal 28* (NY); Ft. Yuma, *Major Thomas* (G, NY). CALIFORNIA: So. California, *Parry & Lemmon 292* (F, M, NY, Ph); Mohave Desert, *Mrs. Curran in 1884* (G), *Mr. & Mrs. Lemmon in 1884* (C); Mohave Creek, *Bigelow on*

Whipple Exp. (G, NY); Daggett, *K. Brandegee in 1914* (C), *Munz & Keck 7848* (Po); Kane Spring, Ord Mts., *Hall & Chandler 6818* (C, M, Po); Cushenberry Cañon, *Parish 4952* (S); Calico, *Parish 9814* (S); Warm Springs, Mohave Desert, *S. B. & W. F. Parish 209* (F, M, NY, Ph, S, US); Needles, *Munz & Harwood 3638* (Po, S), *3605* (Po), *Jones 3829* (F, NY, Po, US); Eagle Mts., Colorado Desert, *Munz & Keck 4825* (Po); Mecca, *Mrs. Clemens in 1922* (Ca); Painted Cañon, *Jaeger 1025* (Po), *Spencer 591, in 1920* (Po); Indio Mt., *Hall 5778* (C, F, G, M, NY, Ph, Po, S, US); Palm Springs, *Parish in 1896* (NY), *Eastwood in 1913* (Ca), *Saunders in 1903* (Ph); Palm Creek, *Mrs. Thurber in 1895* (C); Coachella, *Greata 410* (S); Ironwood Well, *T. S. Brandegee in 1905* (C); Cathedral Cañon, *Hall 5767* (C); Santa Maria Mts., *Schellenger in 1905* (C); Near Blythe, *Jones in 1924* (Po); 40 miles north of Yuma, *MacDougal 67* (NY); Yaqui Wells, *Eastwood 2638* (Ca, G, NY, US); Rocky Cañon, Mt. Springs, *Orcutt 1515* (M, US); Cariza Creek, *Schott* (F); near Borego Spring, *Jones in 1906* (Po); San Felipe, *T. S. Brandegee in 1898* (NY), *Purpus in 1898* (Po); Signal Mt., *Abrams 3173* (G, M, NY, S), *Brandegee in 1901* (C); between Santa Ysabel and Ft. Yuma, *Schott* (F); San Diego Co., Colo. Desert, *Spencer 591, in 1917* (G, Po); Colorado Desert, *Brandegee in 1901* (US); without locality, but from Colo. Desert, *Coulter 616* (G, part of type collection); Santa Catalina Mission, San Diego Co.?, *Orcutt in 1889* (US). LOWER CALIFORNIA: without locality, *Streets* (G); Angel Island, *Streets in 1875* (US); Angel de la Guardia Island, *Johnston 4228* (Ca, G); Los Angeles Bay, *Palmer 597* (G, US); Cucupa Mts., *MacDougal in 1905* (NY); Cajon de Santa Maria, *Brandegee in 1889* (C, S).

2. *MOHAVEA BREVIFLORA* Coville, Contr. U. S. Nat. Herb. 4:168, pl. 17. 1893.

M. breviflora of Tidestrom, Contr. U. S. Nat. Herb. 25: 485. 1925. Jepson, Man. Calif., 901. 1925.

Erect, usually widely branching annual, viscid glandular-villous practically throughout (upper surfaces of leaves sometimes glabrate), 5-15 cm. high; leaf-blades 1-4 cm. long, ovate-lanceolate, entire, acuminate, tapering at base into winged petioles 5-10 mm. long, upper leaves somewhat reduced, crowded, each with single axillary flower; pedicels slender, ascending, 3-8 mm. long; calyx 5-parted almost to base, calyx-lobes in flower oblong-linear, obtuse or bluntly acute, subequal, ca. 10 mm. long, 2-3 mm. wide, in fruit ca. 12 mm. long; corolla 17-20 mm. long, lemon-yellow, strongly bilabiate, pubescent without, corolla-tube saccate anteriorly, 2-3 mm. long, corolla-throat 5-6 mm. long, ca. 5 mm. wide, strongly flattened, pubescent within on lower side, corolla-limb scarcely reflexed, flattened, the upper lip 7-8 mm. long, ca. 6 mm. wide, with 2 rounded lobes divided ca. one-third the way down, lower lip ca. same length, with prominent pubescent yellow palate for half its length, its 3 lobes divided for ca. 3 mm., middle one slightly narrower; fertile stamens 2, scarcely dilated, practically glabrous, anther-sacs confluent, the 2 together scarcely 1 mm. across; sterile filaments as in the preceding species; pistil ca. 9 mm. long, glandular-puberulent; stigma globose, style persistent, ovary glandular-puberulent; capsule 2-celled, globular, rather thin-walled, included in calyx, dehiscing as in *M. confertiflora*; seeds dark 2-2.5 mm. long, body flattened with emarginate inrolled, cupulate, striate, subentire wing.

Type locality: Johnson Cañon in Panamint Mts., Inyo Co., California. Material seen, from CALIFORNIA: Panamint Mts., *Coville & Funston 547*, type collection (G, M, NY, Ph, US); Wild Rose Cañon, Panamint Mts., *Ferris, Scott, & Bacigalupi 3944* (S), *Parish 10085* (S); Pleasant Cañon, Panamints, *Hall & Chandler 6937*; Emigrant Cañon, Panamints, *Ferris, Scott & Bacigalupi 4016* (S); Funeral Mts., *Jones in 1907* (Po); Furnace Creek, *Parish 9865* (C, S); Greenwater Flats, *Parish 10051* (C, S); Shepherd Cañon, *Hall & Chandler 7063* (C); *Darwin, Jones in 1897* (M, Po, US); *Keeler, Brandegee in 1891* (C); Lone Willow Spring, *Parish 10178* (C, S); Salt Wells Cañon, on Trona Road,

Ferris, Scott & Bacigalupi 3919 (S); Amargosa Desert, *Jones in 1907* (Po); Kelso, *Jones in 1906* (Po); Saratoga Spring, *Jones in 1924* (Po); Mohave Desert, without locality, *Mrs. Curran in 1884* (G). NEVADA: Moapa, *Tidestrom 8684* (Ph); Mica Spring, *Jones 5045ag* (US).

This species, which has received very little attention, is not only a very distinct one in characters, but also in distribution, being found for the most part north of the middle portion of San Bernardino Co., Calif., while *M. confertiflora* extends largely from its southern limit south into Lower California.

III. ANTIRRHINUM

Capsule more or less oblique, dehiscent by fairly definite terminal or subterminal pores.

Seeds not cup-shaped.

Throat of corolla quite closed by palate.....

.....§ *Antirrhinastrum*. Chavannes.

Corolla 3-5 cm. long; perennial, with purple, red, white or yellow flowers in dense terminal glandular-pubescent racemes; naturalized from Europe.....3. *A. majus*

Corolla not over 2 cm. long; usually annuals; native to western North America.

Stems self-supporting, lacking filiform tortile branchlets.

Plants stout; flowers reddish, 16-19 mm. long; corolla-tube merely saccate at base; hair on calyx, if present, merely glandular and short, not villous and long.

Glabrous throughout (except in the flower), perennial; leaves linear4. *A. virga*

Glandular-pubescent throughout; annual or biennial; leaves lanceolate5. *A. glandulosum*

Plants slender; flowers 10-12 mm. long, bluish with yellow palate; corolla-tube with large spur at base almost half the length of the tube itself; calyx glandular-villous, the

longer hairs $\frac{2}{3}$ the length of the calyx-segments.

Filaments all strongly oblique-dilated and pubescent toward tips; style in fruit about 5 mm. long and at least as long as capsule6a. *A. cornutum* var. *typicum*

Filaments glabrous toward tips, only longer pair strongly oblique-dilated; style in fruit ca. 4 mm. long and scarcely equaling the capsule6b. *A. cornutum* var. *leptaleum*

Stems in mature plants largely supporting themselves on surrounding vegetation by tortile branchlets, or at least possessing such.

Plant simple below, erect, glabrous except for the glandular-villose, dense, spicate raceme; leaves of inflorescence reduced to minute bracts; flowers whitish with the lower lip forming a large part of the whole7. *A. coulterianum*

Plant usually branching below and pilose or glandular-pubescent along base of stem (if this is glabrate, then dorsal sepal is conspicuously enlarged); inflorescence lax or fairly dense but not set off sharply by its pubescence and leaflessness from the upper part of the stem.

Palate and corolla-tube with 2 bands of hairs, the tips of which are conspicuously enlarged and tack-shaped; pedicels 5-20 mm. long, exceeding calyx; corolla-tube merely gibbous at base, about as long as lower lip.....8. *A. nuttallianum*

Palate and corolla-tube only minutely and rather uniformly glandular-puber-

- lent or puberulent; pedicels mostly shorter than calyx (except in *kingii*).
- Corollas 16-18 mm. long; dorsal segment of calyx 10-20 mm. long, several ribbed; coarse herb, frequently 7-8 dm. high and densely leafy9. *A. subcordatum*
- Corollas 8-16 mm. long; dorsal segment of calyx not exceeding 10 mm. in length, nor with more than 3 ribs; rather slender herbs not densely leafy, usually less than 5 dm. high.
- Flowers light purple, 10-15 mm. long, on pedicels 2-5 mm. long; stems glandular - pilose to glandular - pubescent at least above.
- Stems scatteringly pilose below, glandular - pilose in inflorescence; corolla 13-15 mm. long; calyx - segments strongly differentiated, the enlarged upper one at least two-thirds as long as corolla tube and throat, and 8-10 mm. in length
10a *A. vexillo-calyculatum*
 var. *typicum*

Stems quite glandular - pubescent throughout; corolla 10-12 mm. long; calyx - segments not strongly differentiated, the longest one-half as long as corolla - tube and throat, or 4-6 mm.

...10b. *A. vexillo-calyculatum*
var. *breweri*

Flowers largely whitish, 7-8 mm. long, on pedicels 5-20 mm. long; stems glabrate except for white-woolly base and fine glandular - pubescence among flowers.

Pedicels 4-6 mm. long in fruit; upper calyx-segment 5-7 mm. long, lateral ones 3-4 mm. Ore. to Ariz. and Calif.

...11a. *A. kingii* var. *typicum*

Pedicels 9-20 mm. long in fruit; calyx-segments subequal, 3-4 mm. long. Mexico.

...11b. *A. kingii* var. *watsoni*

- Throat of corolla widely open; corolla ca. 20 mm. long; upper lip pink, lower white; corolla-tube subarcuate; longer filaments well dilated and glandular-puberulent toward tip.
Eastwoodiella sect. nov. One species.....12. *A. ovatum*
- Seeds appearing cup-shaped because of broad incurved wing; slender erect annual with narrow leaves; flowers purple or white, ca. 12 mm. long; calyx-segments linear.....§ *Orontium*. 1. *A. orontium*
- Capsule not oblique; dehiscence by irregular bursting.
Seeds strongly cup-shaped; erect, viscid-pubescent annual with bluish flowers 11-13 mm. long; stamens not dilated toward tips.....§ *Pseudorontium*. 2. *A. cyathiferum*
- Seeds not at all cup-shaped; glabrate annuals at first erect and becoming climbers by the very long capillary pedicels.....§ *Maurendella* Gray, in part
Flowers yellow, 11-13 mm. long; stems very slender; corolla-tube saccate at base; desert plants13. *A. filipes*
- Flowers blue, 13-15 mm. long; lower part of stem fairly stout; corolla-tube gibbous at base; coastal plants.....14. *A. strictum*

1. ANTIRRHINUM ORONTIUM L., Sp. Pl., 617. 1753.

Native of the Old World, where widely distributed. Occasionally naturalized in America: Prince Edward Island, *Fernald & St. John 11176* (G); Buffalo, N. Y., *Clinton* (Ph); Hayfield, Ky.?, *Short in 1855* (Ph); Mobile, Ala., *Mohr in 1888* (US); Brownsville, Ore., *Hasken 9* (S); Havana, Cuba, *Curtiss 681* (NY); St. Helens Gap, Jamaica, *Britton 75* (NY); *Maxon & Killip 592* (US); Furey, Haiti, *Leonard 4293* (NY, US).

2. ANTIRRHINUM CYATHIFERUM Benth., Bot. Sulph., 40. pl. 19. 1844.

A. cyathiferum Benth. in D. C., Prodr. 10:290. 1846. Gray, Proc. Am. Acad. 7:372. 1868. Bot. Calif. 1:548. 1876. Proc. Am. Acad. 12:81. 1876. Syn. Fl. N. A. 2:251. 1888. Curran, Proc. Calif. Acad. II, 1:234. 1888. Brandegee, Proc. Calif.

Acad. II, 2:190. 1889. Vasey & Rose, Contr. U. S. Nat. Herb. 1:74. 1890. Johnston, Proc. Calif. Acad. IV, 12:1159. 1924. *A. chytospermum* Gray, Proc. Am. Acad. 12:81. 1876. Syn. Fl. N. A. 2:251. 1888.

Erect, rather coarse annual, 5-45 cm. high, commonly branching from base, viscid glandular-pubescent throughout; branches ascending and very leafy; leaves alternate, or lower opposite, rather thick, ovate, entire obtuse to acute, leaf-blades 5-25 mm. long, 3-14 mm. wide, narrowed at base into winged petioles, these 5-13 mm. long, leaves gradually reduced up the stem; flowers axillary, solitary, occurring from near base of plant, pedicels filiform, strongly recurved after anthesis, 3-5 mm. long; calyx herbaceous, campanulate, somewhat oblique, glandular-pubescent without and within, 5-parted into lanceolate, subequal segments 4-5 mm. long, bulging in fruit and 6-7 mm. long; corolla bluish, bilabiate, glandular-puberulent without, apparently closed at throat, 11-13 mm. long, tube and throat not distinguishable, scarcely saccate at base, not strongly inflated upward, 5-6 mm. long, 2.5 mm. wide, pubescent within on floor except at very base, upper lip ca. 4 mm. long, suberect, arched, glabrous within, the 2 lobes oblong-ovate, ca. 1.5 mm. long, lower lip ca. 5 mm. long, spreading, with large yellowish, glandular-villous palate extending to base of the oblong-ovate lobes, these ca. 2 mm. long, the middle one narrowest; fertile stamens slightly didynamous, 7 and 8 mm. long, filaments not dilated, quite geniculate, weakly pubescent at genicula; anther-sacs ca. 2 mm. long, divergent, confluent, deltoid-oblong, fifth stamen very rudimentary; pistil about as long as stamens, stigma entire, slightly enlarged, style 4.5-5 mm. long, persistent, glandular-puberulent in lower half, ovary globose, glandular-puberulent; capsule globose, not oblique, thin-walled, 7-8 mm. long, somewhat puberulent, the 2 valves projecting slightly beyond base of style, each dehiscing irregularly at apex; seeds straw-colored, body barely 1 mm. long, plano-convex in cross-section, with several irregular ridges on convex side and a broad incurved cupulate wing around margin of plane side, giving whole seed a cupulate appearance.

Type locality: Magdalena Bay, Lower California. Material studied: ARIZONA: Ehrenberg, *Palmer in 1876* (G, US, type collection of *chytrospermum*); Maricopa, *Parry in 1881* (F, G, M), *Parish in 1881* (S). SONORA: N. W. Sonora, *Pringle in 1884* (F, G, M, NY, US); Papago Tanks, Pinacate Mts., *MacDougal 44* (US); Tiburon Island, *Johnston 4414* (Ca); Guaymas, *Palmer 1211* (US), *Brandegee in 1893* (Po, US), *Palmer 152* (G, NY, US). LOWER CALIFORNIA: Cucupa Mts., *MacDougal 132* (NY); Santa Gertrudis, *Orcutt* (C); Calamahue, *Nelson & Goldman 7138*; Calmalli, *Purpus in 1898* (C, NY); Santa Maria Bay, *Rose 16281* (NY, US); Angel de la Guardia Island, *Johnston 3386* (Ca, G), *4202* (Ca, G); San Francisquito Bay, *Johnston 3575* (Ca); San Nicolas Bay, *Johnston 3730* (Ca); Arroyos San Pablo, *Purpus in 1898* (F, S), *208* (US); La Paz, *Palmer 91* (F, G, NY, US), *Brandegee 427* (NY); Magdalena Island, *Brandegee in 1888* (C), *in 1889* (G, Ph, US); Margarita Island, *Nelson & Goldman 7302* (US); San Jose del Cabo, *Purpus 453* (M, US), *Brandegee 427* (C).

Some plants have calyx-segments slightly wider than do others, but the differences given by Gray (*Syn. Fl.*, 2:251. 1888) as distinguishing *cyathiferum* of Mex. from *chytrospermum* of Ariz. are not tenable (Vasey & Rose, l. c.). I am unable to find characters that will maintain even varietal distinction.

3. ANTIRRHINUM MAJUS L., Sp. Pl., 617. 1753.

Native of Mediterranean region. Occasionally becoming naturalized in America: Bridgeport, Conn. *Eames 8827* (G); Philadelphia, *Parker in 1877* (G); Evanston, Ill., *Shipman in 1874* (Ph); Salem, Ore., *Nelson 3202* (Ph); Santiago de las Vegas, Cuba, *Van Hermann 846* (F, NY), *5154* (NY, Po); Oaxaca, Mex., *Conzatti & Gonzalez 1267* (G); Puebla, *Arsène 1973* (US); Querétaro, *Arsène 10520* (NY, US), *10479* (US); Volcan de San Salvador, *Calderon 541* (US), *Standley 22853* (US).

4. *ANTIRRHINUM VIRGA* Gray, Proc. Am. Acad. 7:373. 1868.

Bot. Calif. 1:549. 1876. Syn. Fl. N. Am. 2:252. 1888. Greene, Man. Bot. San Fran. Bay, 270. 1894. Jepson, Fl. West. Mid. Calif., 370. 1911 and 396. 1901. Armstrong, West. Wildflowers, 468. 1915. Jepson, Man. Calif., 898. 1925.

Erect perennial, glabrous throughout and with many coarse virgate stems from a single base, 6-15 dm. high, occasionally branching above; leaves thickish, alternate, rather crowded, linear, sessile, acute, 2-9 cm. long, 3-7 mm. wide, gradually reduced up the stem, becoming linear-subulate bracts less than 1 cm. long in the inflorescence, midrib of leaf ending in rather obscure gland-tip; inflorescence a secund, spicate rather crowded raceme 1-7 dm. long, pedicels ascending, 3-7 mm. long, slender; calyx herbaceous, oblique-campanulate, 5-parted into subequal, ovate-lanceolate, acuminate segments (the 2 lower slightly wider and shorter than the others), 6-7 mm. long, not much enlarged in fruit, though somewhat distended by the capsule, but still with connivent tips; corolla "red-purple," 16-18 mm. long, closed at throat, corolla-tube and throat scarcely distinguishable, tubular with broad saccate spur which is 1.5-2 mm. long, tube slightly constricted above ovary, 10-12 mm. long, 3-3.5 mm. wide, slightly ampliate at throat, pubescent within from base of palate downward, upper lip reflexed, 5-6 mm. long, pubescent, lobes ovate to suborbicular, 2 mm. long, lower lip spreading, 6-7 mm. long, with prominent villous palate, the 3 lobes deflexed, suborbicular, ca. 2.5 mm. long; fertile stamens didynamous, 12 and 13 mm. long, filaments glandular-villous throughout, very dilated toward the tips, geniculate and especially hairy above the base, anther-sacs divergent, confluent, each ca. 0.5 mm. long; pistil equaling stamens, glabrous, curved, slightly bifid at apex; capsule rather thin-walled, strongly oblique, 7-8 mm. long, 4-5 wide, subovoid, somewhat truncate above, with 4 tuberculate umbos about base of persistent, often deflexed or geniculate style, dehiscing apparently by a slit on edge of each umbo; seeds

dark, ovoid, ca. 1.5 mm. long, with several fimbriate, wing-like longitudinal ridges.

Type locality: "California." Material studied: CALIFORNIA: without locality, *Bridges 191*, type collection (G, NY, US); Mendocino Co., *Vasey in 1875* (US), *in 1876* (G); Calpella, *Blankenship in 1893* (M); Ukiah, *Purdy* (C), *Chestnut 376* (US), *Eastwood in 1894* (G), *11364* (Ca); Allen Springs, *Cleveland in 1882* (G, S); Witters Springs, *Rattan in 1885* (G); Houghs Springs, *Heller 12376* (Ca, F, G, M, NY, Ph, Po, S, US); Adams Springs, *Tracy 2251* (C); Sonoma Creek, *Heller 5775* (F, G, M, NY, Ph, Po, S, US); Hoods Peak, *Michener & Bioletti 6194* (NY), *in 1893* (F, C, M, Ph, Po, US); Mt. St. Helena, *Greene in 1894* (C), *Jepson in 1893* (C); Cazadero, *Carruth in 1901* (Ca); Howell Mt., *Tracy 368* (C); Atlas, *Mrs. Wilson in 1920* (Ca).

5. ANTIRRHINUM GLANDULOSUM Lindl., Bot. Reg. 22: pl. 1893. 1836.

Benth. in D. C., Prodr. 10:291. 1846. Torrey, Pac. R. R. Rep. 7, pt. III, p. 15. 1856. Hooker & Arnott, Bot. Beechey, 375. 1840. Gray, Proc. Am. Acad. 7:373. 1868. Syn. Fl. N. Am. 2:252. 1886. Bot. Calif. 1:549. 1876. Rattan, Pop. Calif. Fl., 90. 1880. Greene, Man. Bot. San Fran. Bay, 270. 1894. Anderson, Nat. Hist. of Santa Cruz Co., 41. 1894. McClatchie, Fl. Pasadena, 642. 1895. Davidson, List Pls. L. A. Co., 13, 1892. Cat. Pls. L. A. Co., 22. 1896. Jepson, Fl. West. Mid. Calif., 396. 1901. 370. 1912. Abrams, Fl. L. A., 358. 1904. 329. 1917. Armstrong, Western Wildflowers, 468. 1915. Davidson & Moxley, Fl. So. Calif., 325. 1923. Jepson, Man. Calif., 898. 1925.

Stout widely branched annual or short-lived perennial, viscid glandular-pilose throughout. 6-15 dm. high; branchlets spreading, non-tortile; leaves numerous, thickish, entire, acute, lanceolate, sessile, 1-6 cm. long, 3-15 mm. wide, gradually reduced up the stem to leafy bracts, the mid-rib ending in more or less evident gland-tip; inflorescence a terminal subsecund,

dense spicate raceme, 0.5-5 dm. long, pedicels fairly stout, appressed, 5-7 mm. long; calyx oblique, herbaceous, 5-parted, segments unequal, lanceolate to ovate-lanceolate, upper one 10-13 mm. long, others 7-9 mm., acute to acuminate, not much enlarged in fruit; corolla rose-red except for the cream-colored to yellowish palate, 17-19 mm. long, glandular-pubescent without, corolla-tube and throat scarcely distinguishable, saccate at base, cylindrical, 10-11 mm. long, 4-5 mm. wide, glabrate within, whitish with rose-colored lines, upper lip reflexed, 6-7 mm. long, the 2 broadly-oblong lobes scarcely 2 mm. long, and folded back against each other, lower lip erect, 7-8 mm. long, with prominent hairy palate, lobes deflexed, rounded, 2-3 mm. long, middle one largest; fertile stamens didynamous, dilated, ciliate-pubescent, geniculate, heavily bearded at genicula, longer ones ca. 12 mm. long, widely dilated at base, shorter ones ca. 11 mm. long, genicula rather high, glabrous below, anthers divergent, confluent, ca. 5 mm. long, 5th stamen very reduced; pistil almost as long as stamens, glandular-pubescent except at deflected, slightly 2-lobed tip; capsule glandular-pubescent, erect, oblique, ovoid, 8-9 mm. long, 5-7 mm. wide, with persistent style bent forward, about base of which are 4 lobes, the 2 posterior ones close together and tending to dehisce by one pore, the 2 anterior ones farther apart and each dehiscing by its own pore; seeds brown, ovoid, ca. 1 mm. long, with numerous broken fimbriate, wing-like ridges.

Type locality: "California." Material studied: CALIFORNIA: without locality, *Douglas*, presumably type material (G), *Hartweg* (G), *Palmer in 1876* (G, M), *Anderson 296* (M), *Lemmon 33* (M); Murphys, Calaveras Co., *Davy 1607* (C); Calaveras Valley *K. Brandegee* (C); Santa Clara, *Bolander* (F, G, M); Loma Prieta Peak, *Elmer 4384* (Ca, M, NY, Po, S, US); Mt. Hamilton Range, *Abrams 6639* (NY, Ph, S), *Greene in 1891* (NY), *Williamson in 1906* (Ph), *Smith in 1906* (S); Madrone Springs, *Dudley in 1895* (Ph, S, US); Santa Cruz, *Hartweg 1887* (NY); Santa Cruz Mts., *Kellogg & Harford 659* (M, NY, US), *Pendleton 401* (C), *Davis 105* (C); Los Gatos, *Cannon in 1894* (Ca); Santa

Cruz, *Pringle in 1882* (F, M, Ph, US); Big Basin, *Pendleton in 1908* (C); the Pinnacles, *Mrs. Sutcliffe in 1920* (Ca, Ph), *Eastwood 6747* (Ca), *Bacigalupi in 1922* (S); Carmel River, *Clemens in 1910* (Po), *McGregor 62* (S), *McMurphy in 1906* (S); Paraiso Springs, *Congdon in 1881* (S); Tassajara Hot Springs, *Elmer 3361* (M, S, US); Gavilan Range, *Brewer 745* (C, M, US); Santa Lucia Mts., *Plaskett 146* (G, NY, US), *K. Brandegee in 1909* (C), *Vasey 447* (Ph, US), *Jepson 1689* (M); Blochman Ranch, Santa Maria, *Eastwood 475* (Ca, US); San Luis Obispo Co., *Summers* (C); Santa Barbara Co., *Baker in 1895* (NY); Santa Barbara, *Nuttall* (G), *Brewer 745* (G), *Lemmon* (F), *Franceschi in 1894* (C); Zaca Lake, *Eastwood 576* (Ca, US); Montecito, *Bingham* (NY); Santa Inez Mts., *T. S. Brandegee in 1888* (C); Painted Cave Ranch, near Santa Barbara, *Eastwood 112* (US); Mt. Piños, *Dudley & Lamb 4803* (S), *4763* (S); Ojai, *Peckham in 1866* (G, US), *Bidwell in 1889* (M); Matilija, *Kendall in 1922* (Po); Fillmore, *Hall 3125* (C); Nordhoff, *S. Fautleroy in 1919* (Ca); Oakgrove Cañon, *Abrams & McGregor 383* (C, NY, S, US); Newhall Mts., *Nevin 16* (G); Topatopa Mts., *Abrams & McGregor 153* (NY, S, US); Newhall, *Parish 1938* (F); Sespe Creek, *Munz 9403* (Po); Verdugo Cañon, *Macbride & Payson 751* (G); Mt. Lowe, *Williamson in 1901* (Ph), *Drushel in 1915* (M), *Dudley in 1900* (S); Pasadena, *Jones in 1902* (Po), *McClatchie in 1893* (NY); San Gabriel Mts., near Pasadena, *Grinnell in 1916* (Ca); Soma Cañon, L. A. Co., *Barber in 1898* (C, M, Po); Covina, *Grant in 1904* (C, F, M, Ph, S); Little Santa Anita Cañon, *Abrams 2630* (G, M, Ph, Po, NY, S, US); San Antonio Cañon, *Johnston in 1917* (C, S); Cajon Pass, *Parish 436* (C, M, US); Arrowhead Springs, *Fudge 89* (Po); San Bernardino, *Parish in 1880* (M); Cucamonga Mt., *S. B. & W. F. Parish 436* (F, M, Ph); Keller Creek, San Bernardino Mts., *Smith 2* (C).

6. ANTIRRHINUM CORNUTUM Benth., Pl. Hartw., 328. 1848.

Erect, rather slender annual, viscid-villous throughout, simple or with few ascending branches, 1-5 dm. high; leaves

alternate, linear-oblong to linear-lanceolate to oblong-ovate, obtuse to emarginate at apex, the midrib ending in rather evident gland, leaf-blades 1-2.5 (5) cm. long, 3-10 (20) mm. wide, narrowed at base into slightly winged petioles 4-8 (12) mm. long, leaves not conspicuously reduced up the stem; flowers borne singly in axils of all but lowest leaves, subsessile; calyx herbaceous, glandular-villous with some hairs at least half as long as calyx-segments, which are 5, separate almost to base, linear-oblong to oblong-lanceolate, acute to obtuse or rarely emarginate; corolla bluish, with yellow palate, villous without, corolla-tube and throat scarcely distinguishable, cylindrical, 6-7 mm. long, 2-3 wide, glabrous within, except just below palate, with spur prominent, rounded, 2.5 mm. long, upper lip reflexed, 4-5 mm. long, lobes blunt, ca. 2.5 mm. long, bent back almost against each other, lower lip ca. 6 mm. long, erect, with large villous palate, lobes deflexed, rounded, ca. 3 mm. long; fertile stamens didynamous, ca. 5 and 6 mm. long, somewhat oblique-inflated toward the tips, geniculate and with heavy pubescence at genicula, anther-sacs confluent, divergent, 5th stamen very reduced; pistil about length of stamens, glandular-pubescent except at subentire, bent tip; capsule somewhat oblique, ovoid, 6-7 mm. long, glandular-pubescent, tipped with stout persistent, somewhat deflexed style, ca. 5 mm. long, dehiscing by 2-4 small openings; seeds ovoid, ca. 0.6 mm. long, echinate-favose.

6a. *Antirrhinum cornutum* var. *typicum*, nom. nov.

A. cornutum Gray, Proc. Am. Acad. 7:373. 1868. Bot. Calif., 1:549. 1876. Jepson, Man. Calif., 898. 1925, in part. *A. leptaleum* of Howell, Fl. N. W. Am. 1:504. 1901. *A. leptopetalum* of Frye & Rigg, N. W. Flora. 343. 1912. *A. cornutum* var. *venosum* Jepson, Man. Calif., 898. 1925.

Fertile filaments all strongly oblique-dilated and ciliate-pubescent toward tip; style ca. 5 mm. long, equal to or slightly exceeding in length the capsule.

Type locality: Probably Sacramento Valley. Specimens seen; CALIFORNIA: without locality, but without doubt

from Sacramento Valley, *Hartweg 1888*, type collection (G, NY); California, *Bridges 192a* (NY, US); Mt. Shasta, *Grant 5271* (C, S); Pitt to Baird, *Eastwood 1406* (Ca, G, NY, US); Kennet, *Eastwood 727* (Ca, US); Redding, *Jones & Alexander in 1902* (C); Red Bluff, *Nickes in 1917* (Ca); Chico, *Bidwell in 1878* (G), *Eastwood in 1913* (Ca, US), *Heller 11562* (C, Ca, F, G, Mo, NY, Ph), *Green in 1890* (NY, US), *Austin 1833* (Po, US); South Fork, *K. Brandegee* (C); Stony Creek, Colusa Co., *Rattan 49* (G), *in 1882* (S); Scott Creek, Lake Co., *Tracy 2377*, type of var. *venosum* (C); Butts Cañon, Napa Co., *K. Brandegee in 1911* (C); Placer Co., *Jones in 1882* (Po); Placerville to Eldorado, *Abrams 6850* (S); Mt. Auburn, *Gross 231* (S); Doxtaters, *Gross 118* (Ph).

A. cornutum var. *typicum* occurs mostly in the Sacramento Valley while the var. *leptaleum* is in the San Joaquin Valley. The characters given by Gray in his description of *leptaleum* scarcely seem sufficient for specific distinction, especially since various intermediate conditions are to be found. The South Fork specimen cited above has the small filaments narrow for *typicum*, but the large ones are pubescent toward the tips. A collection at Mariposa, *Congdon in 1898* (C) has the short filaments broad but all glabrous. A collection from Big Tree Grove, Yosemite *Lemmon* (F), which comes from the region for *leptaleum*, has the the large filaments pubescent. Another intermediate is from Rush Creek Mill, Fresno Co., *McCardle in 1895* (Ca).

A. emarginatum Eastw. is, I am confident, merely an ecological form with wider leaves than normal. Even narrow-leaved plants tend to have some emarginate leaves and the tendency becomes quite marked when the leaves widen. I have seen but two specimens that had been referred to *emarginatum*: the type from Fresno, *Jenney 216* (Ca), which has the flowers of *leptaleum*, with the shorter filaments narrow and with all quite glabrous. The other plant was a single one mounted on the same sheet with several plants of *typicum*. Chico, *Bidwell in 1878* (G). This plant had been labelled

"*emarginatum*" by Miss Eastwood. But it has the flowers of *typicum*, with all fertile filaments dilated and pubescent.

6b. **A. cornutum** var. **leptaleum** (Gray), n. comb.

A. leptaleum Gray, Proc. Am. Acad. 7:373. 1868. Bot. Calif. 1:549. 1876. Syn. Fl. N. Am. 2:252. 1888. Eastwood, Sierra Club Pub. 27:58. 1902. *A. emarginatum* Eastw., Bull. Torrey Bot. Club 32:214. 1905. Jepson, Man. Calif., 901. 1925. *A. cornutum* of Dur. & Hilg., Pac. R. R. Surv. 5:11, pl. 10. 1855, Jepson, Man. Calif., 898. 1925, in part.

Filaments glabrous except at genicula, shorter ones scarcely dilated toward tip; style ca. 4 mm. long and scarcely equal to length of capsule.

Type locality: Clarks Ranch, Mariposa Co., Calif. Material studied; all from CALIFORNIA: Clarks, *Bolander 4983*, type collection, (F, G, US), *Sullivan & Gray in 1872* (G); Mariposa, *Lemmon 1* (C), *35* (M), *Congdon 459* (G); Merman Bar, *Congdon in 1903* (M); Darrah, *Congdon 35* (S); Sequoia Mills T. S. *Brandegge in 1892* (F, rather broad leaves); Pohona Trail, Yosemite, *Michaels in 1922* (Ca); Wawona, *Kelly in 1916* (C); Toll House, Fresno Co., *Hall & Chandler 2* (C); Pose Creek, *Hermann* (Ph, US).

7. ANTIRRHINUM COULTERIANUM Benth. in D. C., Prodr. 10:592. 1846.

Gray, Proc. Am. Acad. 7:374. 1868. Bot. Mex. Bound. Survey, 111. 1859. Bot. Calif. 1:549. 1876. Syn. Fl. N. Am. 2:252. 1888. Abrams, Fl. L. A., 358. 1904 and 329. 1917. Armstrong, W. Wildflowers, 468. 1915. Davidson & Moxley, Fl. So. Calif., 325. 1923. Davidson, List Pls. L. A. Co., 13. 1892. Cat. Pls. L. A. Co., 22. 1896. McClatchie, Fl. Pasadena, 642. 1895. Parsons & Buck, Wildflowers Calif., 42. 1921. *A. nivenianum* Gray, Bot. Gaz. 9:53. 1884. *A. nevianum* Gray, Syn. Fl. Am. Suppl., 438. 1888. Davidson & Moxley, Fl. So. Calif., 325. 1923. *A. coulterianum* var. *nevianum* Jepson, Man. Calif., 899. 1925.

Erect annual, 3-12 dm. high, glabrous except in inflorescence, with fairly coarse main stem, simple below and with numerous slender tortile branchlets above, these 5-15 cm. long, often supporting itself on adjacent vegetation, larger branches sometimes ascending and floriferous; leaves very scattered, with midrib ending in glandular swelling, lower ones opposite, ovate to ovate-lanceolate, obtuse, lower leaf-blades 1-3 cm. long, petioles 1-2 cm. long, main cauline leaves lanceolate, alternate, obtusish, 2-9 cm. long, 3-10 mm. wide, short-petioled to subsessile, upper cauline gradually reduced, linear; inflorescence a dense spicate raceme, 5-30 cm. long, subsecund, densely glandular-villous, with herbaceous glandular-pubescent lanceolate or linear bracts, pedicels 2-3 mm. long, glandular-pubescent; calyx herbaceous, glandular-villous, especially without, 5-parted, the segments subequal in length, 3-4 mm. long, swollen-glandular at the tips, the dorsal segment linear-lanceolate, the others lanceolate to lance-ovate; corolla white to bluish, often with darker reticulate veining, with yellowish palate, pubescent without, 9-14 mm. long, corolla-tube cylindrical, 5-7 mm. long, 1.5-2 mm. wide, glabrate within, with broad saccate spur ca. 1 mm. long, upper lip 3.5-6 mm. long, reflexed, with its edges bent back, and with the ovate lobes ca. half as long as the lip itself, lower lip forming large part of the flower, spreading and deflexed, 4-7 mm. long, the great palate minute glandular-puberulent, the 3 lobes subequal, rounded, slightly over one-third length of the lip and somewhat wider than long; stamens didynamous, ca. as long as corolla-tube, strongly dilated toward tip, glabrous except for short pubescence at genicula, anther-sacs confluent, divergent, 5th stamen very rudimentary; pistil about as long as stamens, glandular-villous except near somewhat swollen entire stigma; capsule 6-8 mm. long, glandular-pubescent, cylindric-ovoid, tipped with persistent style 3-4 mm. long, dehiscing by 2 well-formed anterior subterminal pores; seeds dark, ovoid, almost 1 mm. long, with many high ridges passing almost unbroken from one end of seed to other and parallel to each other, or anastomosing and forming a reticulate condition.

Type locality: California. Material studied; CALIFORNIA: without locality, *Coulter 607* (G, type collection), *Parry & Lemmon 289* (F, G, M, NY, Ph), *Vasey 448* (F), *Palmer 321* (US); Blochmans near Santa Maria, *Eastwood 486* (Ca); Gavilan Mts., *Hall 579* (C); Simi, Ventura Co., *Hall 3243* (C, F, Po); Oakgrove Cañon, Liebre Mts., *Abrams & McGregor 396* (G, NY, S, US); Kings Cañon, *Dudley & Lamb 4394* (Po, S); Ojai, *Peckham in 1866* (G, US); Elizabeth Lake, *Grinnell 455* (US); Saugus, *K. Brandegee in 1909* (C); Cahuenga Mts., *Braunton 263* (US); San Fernando, *Eastwood 3126* (Ca, US); Los Angeles, *Wallace* (G), *Hasse in 1888* (US), *in 1890* (US), *4067* (NY); Sherman, *Braunton 4* (US); Tujunga Wash, *Grinnell 504* (US); Redondo, *Braunton 262* (US); Ballona Harbor, *Abrams 1674* (Po, S); Monta Vista, *Abrams 1394* (Po, S); Sierra Santa Monica, *Hasse in 1889* (M); Laurel Cañon, *Grant 2530* (S); Garvanza, *Eastwood 63* (Ca, G, US); Pasadena, *McClatchie in 1893* (NY), *Jones in 1904* (Po); Oak Knoll, *Braunton 746* (US); Eaton Cañon, *Grinnell in 1907* (F), *Mrs. Thurber in 1890* (F); Rubio Cañon, *Peirson 188* (G); Eagle Rock Cañon, *Moxley 222* (Ca); San Gabriel Cañon, *Munz 9449* (Po), *Eastwood 8975* (Ca, G); Glendora, *Grant 4973* (S); Covina, *Grant 49, July 1904* (F, G, M, Ph); Claremont, *Chandler in 1897* (C), *Baker 5244* (C, Po, S); Santiago Mt., *Abrams 1790* (Po, S); Santa Ana Mts., *Munz 7106* (Po); Santa Ana River Cañon, *Munz, Street & Williams 2623* (Po, S); Lytle Creek Cañon, *Hall 1410* (C, M, Po, S), *Street in 1918* (Po); Mohave Desert, *Saunders in 1906* (Ph), *Palmer 321* (M); Cajon Pass, *Jones in 1903* (Po); Deep Creek, San Bernardino Mts., *Abrams & McGregor 720* (NY, S); San Bernardino Mts., *Vasey 448* (Ph, US); Clarks, San Bdn. Mts., *Jones in 1900* (Po); Arrowhead Springs, *Fritchey 57* (M); San Bernardino, *Parish 3658* (C, G, M, US), *Parish 5261* (F), *in 1898* (NY), *Wright* (M), *S. B. & W. F. Parish in 1888* (M, NY), *257, in 1886* (C, F, M, S, US), *in 1890* (M), *Parish 11145* (C), *Orcutt in 1882* (M); Colton, *Jones 3199* (Ca, M, NY, Ph, Po, US), *Pringle in 1882* (F, M, Ph, NY, US); Mentone, *Eaton* (G), *Williamson in 1904* (Ph);

Reche Cañon, *Hall in 1899* (NY); Idyllwild, Riverside Co., *Spencer in 1921* (Po), *in 1923* (Po); Poppet Flat, San Jacinto Mts., *Munz & Johnston 8839* (Po); Whitewater, *Munz & Keck 4999* (Po), *Jones in 1903* (Po); Lakeview, *Johnston in 1920* (Po); San Jacinto Valley, *Reinhardt in 1897* (C); Box Springs Mt., *Reed 1293* (F); Menifee, *King in 1893* (C); Elsinore, *McClatchie in 1892* (NY); Jurupa Hills, *Wilder 183* (Po); Oak Grove, San Diego Co., *Jones in 1900* (Po); Palomar, *Hall 1956* (C, US), *Chandler 5408* (NY), *Munz 8215* (Po); Warners Springs, *Coombs in 1911* (Ca, G, M, NY, US); San Felipe Valley, *Hill, Keck, McCully 61* (Po), *Brandegee in 1894* (C); Banner, *Hill, Keck, & McCully 142* (Po); Witch Creek, *Alderson in 1894* (G, S); Santa Ysabel, *Antisell 168* (NY), *Collins & Kempton 252* (US), *Munz 9812* (Po); San Luis Rey River, *Street in 1917* (Po); Aguanga, *Munz 9844* (Po); Dripping springs, *Munz 9835* (Po); Fallbrook, *Davidson 3594* (Po); Escondido, *Parish 9115* (S); Descanso, *T. S. Brandegee* (C); San Pasqual, *Thurber 592* (G, NY); Del Mar, *T. S. Brandegee in 1894* (C), *Angier 161* (M); Soledad, *Angier 27* (M); Mesa, *Collins & Kempton 65* (US); San Diego, *Orcutt 139* (G), *Orcutt in 1883*, part of type of *Orcuttianum* (G), *Cleveland in 1884* (G, S), *Spencer 7, in 1916* (C, G, Ph, US), *Cleveland in 1874* (G), *Spencer & Woodcock 2320* (G); 40 mi. n. of San Diego, *Orcutt 140*, part of type of *Orcuttianum* (G); Talleys Palmer in 1875 (G); Lions Valley, *Munz & Hilend 7967* (Po); Tecate Mt., *Munz & Hilend 8025* (Po); Potrero, *Orcutt in 1890* (US), *in 1882* (G); Chollas Valley, *Orcutt in 1884* (F, NY, US), *Cleveland in 1884* (C), *Orcutt 998* (G, M, Ph), *Stokes in 1895* (S); Alpine, *Collins & Kempton 117* (US), *K. Brandegee in 1905* (C), *Parish 4427* (F, G, M, NY, S, US); Campo, *Abrams 3588* (F, G, M, NY, S); Jacumba. *Schoenfeldt 3357* (US), *Munz 9617* (Po); Buckmans Springs, *Munz 9643* (Po), *Campbell 25* (Ca, US); Laguna Mts., *Spencer 7, in 1920* (Po), *Mearns 3660* (S, US), *McGregor 106* (S), *896* (S); Cuyamaca Mts., *Palmer 270* (F, M, NY), *Eastwood, 9158* (Ca); *Brandegee in 1894* (C), *in 1896* (C, NY);

LOWER CALIFORNIA: Nachoguero Valley, *Mearns* 3398 (US), 3476 (US), 3495 (US); Burro Cañon, *Brandegee in 1893* (F); Tecate, *Munz* 9488 (Po), 9507 (Po).

In general, there are some slight geographic tendencies to variation in this species, but they are so poorly defined as hardly to merit taxonomic recognition. For instance, in the valleys south of the San Gabriel and San Bernardino Mts., occur plants with the largest flowers, 13-15 mm. long, and with the largest, thickest capsules, 8-9 mm. long. To the north and especially to the south of this general region, the flowers are smaller, 8-10-12 mm. long, and the capsules slightly more slender and 7-8 mm. long. And, from the Cuyamaca Mts. south and west, there is a definite tendency for bluish flowers, while, to the north of the Cuyamacas and Fallbrook and Del Mar, the flowers are mostly whitish. In the material cited above, such collections as *Johnston's* at Lakeview, *Munz* 9835, 9844, 9617 are quite intermediate. The most of the specimens cited above from Fallbrook, Escondido, Soledad, San Diego, Alpine, Tecate, Potrero, etc., are quite blue-flowered and may be referred to *A. coulterianum* forma *orcuttianum** (Gray) n. comb. To my way of thinking *orcuttianum* cannot deserve more than such rank; I have spent much time trying to work out characters that would enable me to maintain *orcuttianum* as a concept of higher rank. Flower-size as used by Gray is of small consequence, *Munz & Hilend* 8025, for example, having blue but much larger flowers than do many of the white-flowered plants. The relative lengths of upper and lower lips vary widely. Nor do the seed-characters used by Gray help. At the time that Gray died there was at the Gray Herbarium only one sheet of the large and white-flowered plants that had seeds of any maturity (*Parry & Lemmon* 289); this particular specimen has the seeds less deeply pitted than usual. The bulk of the large white flowered more northern plants have seeds quite indistinguishable from the blue-flowered more southern ones. The *Nevin* specimen from Capistrano, for which Gray

* *A. orcuttianum* Gray, Bot. Gaz. 9: 53. 1884. Syn. Fl. N. Am. Suppl., 438. 1888. Bailey, Cyclopedia Hort. 1: 304. 1914. Orcutt, Fl. So. & Lower Calif., 8. 1885. Parsons & Buck, Wildflowers Calif., 42. 1921. Davidson & Moxley, Fl. So. Calif., 325. 1923.

made the species *nevianum*, seems to differ only in the seeds being ridged instead of pitted. This condition is to be found in many other plants, usually both kinds of seeds coming from the same capsule: *Eastwood 8975, Hall 1410, Abrams 1394, Spencer 2165, Wilder 183, Muns 7106, and Abrams 1674*. The tendency is so indefinite and so poorly correlated with any definite flower-size, geographic distribution, or other matter, that I cannot accept it as of any value.

8. ANTIRRHINUM NUTTALLIANUM Benth. in D. C., Prodr. 10:592. 1846.

Gray, Proc. Am. Acad. 7:374. 1868. Syn. Fl. N. Am. 2:253 and 438. 1888. Bot. Calif. 1:550. 1876. Mex. Bound. Survey, 111. 1859. Greene, Bull. Calif. Acad. 1:226. 1885. 2:408. 1887. Brandegee, Proc. Calif. Acad. II, 1:215. 1888. Orcutt, Fl. So. and Lower Calif., 8. 1885. Davidson, List Pls. L. A. Co., 13. 1892. Cat. Pls. L. A. Co., 22. 1896. McClatchie, Fl. Pasadena, 642. 1895. Pennell, in Field Mus. Pub. Bot. 5:222. 1923. Davidson & Moxley, Fl. So. Calif. 325. 1923. Abrams, Fl. L. A. 358. 1904. 329. 1917. Jepson, Man. Calif., 899. 1925. *A. nuttallianum* var. *effusum* Gray. Bot. Calif. 1:622. 1876. Syn. Fl. N. Am. 2:253. 1888. Davidson & Moxley, l. c. Jepson, l. c. *A. subsessile* Gray, Bot. Gaz. 9:53. 1884. Syn. Fl. N. Am. 2:432. 1888. Brandegee, Proc. Calif. Acad. II, 2:190. 1889. Orcutt, Fl. So. and Lower Calif., 8. 1885. Vasey & Rose, Contr. U. S. Nat. Herb. 1:18. 1890. Abrams, l. c. Davidson & Moxley, l. c. *A. nuttallianum* var. *subsessile* Jeps., Man. Calif., 899. 1925.

Annual or biennial, erect and simple, or erect and with ascending branches, or ascending and clambering through adjacent plants by the tortile, more or less horizontal branchlets, generally diffusely branched, stems leafy, softly viscid glandular-pubescent to glandular-pilose, 1-10 (12) dm. high; leaves mostly alternate (lowest frequently opposite), entire, ovate to subcordate, acute to obtuse, glandular-pubescent, blades 0.5-4 cm. long, 2-20 mm. wide, gradually reduced up the stem and becoming ovate bracts in the inflorescence, petioles glandular-

pubescent, 1 or 2 to 8 or 10 mm. long; inflorescence glandular-pubescent throughout, 5-30 cm. long, varying from simple lax raceme to fairly dense paniculately branched raceme, bracts green, ovate, acute, sessile or petiolate, 2-12 mm. long, pedicels 5-20 mm. long, mostly capillary, ascending, spreading, or tortile; calyx oblique, herbaceous, glandular-pubescent, 3-5 mm. long, 5-parted into lanceolate or ovate segments, these subequal or the dorsal one longest, slightly enlarged in fruit; corolla violet-blue, tube deep lavender, palate bright yellow and more or less reticulate, corolla 10-12 mm. long, glandular-pubescent without, corolla-tube cylindrical 4.5-6 mm. long, 2.5-3.5 mm. wide, merely gibbous at base, glabrous within except along 2 lines extending downward from palate, upper lip 4-5 mm. long, suberect, arched, the 2 lobes oblong ovate, ca. 1.5 mm. long, bent upward back to back, lower lip 5-6 mm. long, erect, with depressed oblong-ovate lobes ca. 2 mm. long, palate large and with 2 bands of yellowish tack-shaped hairs running into throat; stamens didynamous, filaments somewhat dilated, glabrous except at short-pubescent genicula 7 and 8 or 8 and 9 mm. long, anther-sacs divergent, confluent, scarcely 0.5 mm. long, 5th stamen very rudimentary; pistil equaling stamens, glandular-pubescent except at glabrous, pointed, slightly curved, simple stigma; capsule cylindric-ovoid, narrow above, glandular-pubescent, oblique, 6-8 mm. long, 3.5-4.5 mm. wide, tipped with persistent inclined style, dehiscence by 2 well formed pores at front of base of style (sometimes additional one back of style); seeds ca. 0.6 mm. long, subcylindrical, dark, alate- or cristate-costate.

Type locality: San Diego. Material studied from CALIFORNIA: without locality, *Coulter 599* (G), *Parry & Lemmon 291* (F, M, NY), *Armstrong 744* (NY); Santa Barbara, *Nuttall* (Ph); Santa Cruz Island, *Ford in 1887* (G), *Brandegee in 1888* (C), *Niedermueller in 1908* (C), *Eastwood 6398* (Ca); Santa Monica Mts., *Hasse 4635* (NY), *in 1890* (Po, US); Los Angeles, *Wallace* (G), Los Angeles Cañon, *Bolander in 1860-67* (US), *in 1873* (G); Ballona, *Braunton 435* (C, NY, US) *in 1902* (S), *Abrams 1681* (NY, Po, S); Catalina Island, *Trask in 1901* (NY, US), *Trask in 1898*

(US), *Schumacher in 1874* (G), *K. Brandegee in 1916* (C), *Smith 5084* (F), *Nuttall 240* (F), *491* (F), *697* (F), *Reed in 1909* (F); Playa del Rey, *Abrams 2496* (C, G, M, NY, Ph, Po, S, US); San Bernardino, *Parish 4757* (NY, S, US), *4746* (S, Po), *4190* (C, G, M, NY, US); San Bernardino foothills, *S. B. & W. F. Parish 258* (C); Highland, *Parish 4615* (C, F, NY, Ph, Po, S), *2056* (S); City Creek, San Bdn. Mts., *Smith 1* (C); Box Springs Cañon, Riverside Co., *McClatchie in 1892* (NY), *Reed 801* (US), *Johnston in 1920* (Po); Lakeview, *Johnston in 1920* (Po); Riverside, *Hall 1709* (C), *Hall in 1897* (C); Whitewater, *Jones in 1903* (Po); Menifee, *King in 1893* (C); Murietta, *Munz & Johnston 5352* (Po); Fallbrook, San Diego Co., *Munz & Harwood 3901* (Po, S); San Luis Rey, *Street 1931* (Po); Santa Ysabel, *Munz & Harwood 7308* (Po); *Henshaw 5* (US), *8* (US); Lakeside, *Hall 7441* (C), *T. S. Brandegee in 1888* (C), *in 1906* (C); Del Mar, *Parish 1833* (M, NY), *4433* (C, G, M, S, US), *T. S. Brandegee in 1894* (C), *Street in 1917* (Po); Ramona, *Brandegee in 1894* (C); Soledad, *Engelmann in 1880* (M); La Jolla, *F. E. & E. S. Clements 112, 113, 114, 115* (F, G, M, NY, Ph); Torrey Pines, *Spencer 908, in 1918* (G, Ph, Po); San Diego, *Orcutt in 1884* (F, G), *Cleveland in 1874* (G), *Cooper in 1862* (G), *501* (US), *Orcutt 164* (G), *Jones 3150* (F, NY, US), *Palmer 268* (C, M, NY), *288* (US), *Pringle in 1882* (F, NY, Ph, US), *Parry in 1850* (NY), *Vasey 449* (Ph, US), *in 1880* (US), *Brandegee in 1903* (US), *Hall 3928* (C, M), *Evans 20* (M), *Parish 6801* (S), *Grant 6801* (S), *Nuttall* (Ph), *K. Brandegee* (M, Ph, US), *Thurber 567* (G, NY); Bernardo, *Abrams 3383* (F, G, NY, S); Foster, *T. S. Brandegee in 1894* (C, S); El Cajon, *T. S. Brandegee in 1904* (C), Lemon Grove Road, *Chandler 5296* (S); Chula Vista, *Collins & Kempton 53* (US); Pacific Beach, *Collins & Kempton 61* (US); Coronado, *Collins & Kempton 106* (US), *Dunn in 1891* (S); Agua Hedionda, *Peirson 3415* (Po); Mission Beach, *Street 1930* (Po, S), *Millsbaugh 4426* (F); Point Loma, *T. S. Brandegee in 1895* (C); *Mearns 4039* (US); Dulzura, *T. S. Brandegee in 1904* (C); Barrett Dam, *Munz & Hilend 7992* (Po); Pala Grade,

Munz 8200 (Po); Tecate Mt., *Munz & Hilend* 8006 (Po), 8025 (Po); Jamul Valley, *Palmer in 1875* (F, G, Ph), *Mearns* 3830 (G, NY, US); Chollas Valley, *Orcutt* 997 (G, M), in 1884 (F, C); San Miguel Mt., *Chandler* 5276 (NY); Carizo Creek, *Brandegee in 1893* (C); San Clemente Island, *Newin & Lyon* 16 (G), *Trask* 243 (US), 244 (NY, US), *Munz* 6766 (Po).

ARIZONA: Santa Catalina Mts., *Lemmon* 257 (G); Tucson, *Lemmon* 167 (G), Tucson & Lowell, *W. F. Parish* 177 (F, G, S); Hot Springs, *Toumey* 220 (S); Sierra Tucson, *Pringle in 1884* (F, M), 4834 (NY, Ph); Sabenio Cañon, *Griffiths* 2528 (NY).

LOWER CALIFORNIA: San Telmo, *Orcutt in 1886* (F, M, US), *T. S. Brandegee in 1893* (C); Ensenada, *Jones in 1882* (NY); San Pedro Martir, *T. S. Brandegee in 1893* (C); San Quentin, *Palmer* 735 (F, G, NY, Ph); San Martin Island, *Stewart in 1906* (Ca); Guadalupe Island, *T. S. Brandegee in 1897* (C), *Brown* 24 (G), 25 (G), 38 (G), in 1906 (C), *Drent in 1898* (C), *Palmer* 56 (G, M, NY, Ph); Caysito, *Orcutt in 1883* (G).

So far as I can see *subsessile* and var. *effusum* are ecological and of no taxonomic value. Plants growing among shrubs and other vegetation become very effuse, especially in the second year of growth. Plants in rather exposed conditions tend to have thickened, short-petioled leaves. There is a tendency toward cleistogamy especially in the southern part of the range; plants having this condition are Brandegee's *pusillum*, which is nothing more than a small-flowered, depauperate form of *Nuttallianum* and which may be known as *A. nuttallianum* forma *pusillum** (Brandegee) n. comb. Here are to be referred the following: Todos Santos Island, *Brandegee in 1897* (C); San Martin Island, *Anthony* 225 (C, F, S, US); Guadalupe Island, *Brandegee in 1897* (C); Cedros Island, *Palmer* 725 (US); Point Loma, *Brandegee in 1895* (C).

* *Antirrhinum pusillum* Brandegee, Univ. Calif. Pub. Bot. 6:360. 1916.

9. *ANTIRRHINUM SUBCORDATUM* Gray. Proc. Am. Acad. 20:306. 1884.

Syn. Fl. N. Am. 2:438. 1888. Jepson, Man. Calif., 900. 1925.

Coarse, diffusely branched, annual, bright green herb, at least 3 to 7-8 dm. high, pilose-hispid below, glandular-pubescent above, main branches up to 4 dm. long, secondary and minor ones numerous, filiform, tortile; leaves numerous, close, ovate, subcordate, sessile to subsessile (lowest apparently petioled), glabrate, entire, obtuse or emarginate, with conspicuous glandular swelling at end of midrib, 10-45 mm. long, 5-35 mm. wide, with 3-several main longitudinal veins, leaves reduced upward; lower flowers solitary and axillary, upper in a leafy spicate raceme and in same axils with spreading tortile branches, subsessile; calyx sparsely glandular-villous, herbaceous, 5-parted, the upper segment ovate to elliptic-orbicular, truncate to emarginate, 10-20 mm. long, several ribbed, the middle rib ending in a gland, lateral and ventral segments subequal, linear-lanceolate, 6-10 mm. long, acuminate; corolla 16-18 mm. long, glandular pubescent without, corolla-tube 9-10 mm. long, subcylindric, with basal saccate spur 1.5-2 mm. long, pubescent within from base of lower lip, upper lip reflexed, ca. 6 mm. long, with slight palate-like enlargement, the 2 lobes rounded, ca. 1.5 mm. long and 2.5 wide, lower lip ca. 7 mm. long, the middle lobe ca. 2.5 mm. long, ovate, others shorter and wider, palate large and glandular-pubescent; fertile filaments didynamous, glabrous except for sparse coarse pubescence at genicula, longer filaments widely dilated, ca. 10 mm. long, shorter less so and 9 mm. long, anther-sacs divergent, confluent, each ca. 1 mm. long, 5th stamen very rudimentary; pistil about as long as shorter stamens, glandular-pubescent except at pointed, unequally and slightly bifid tip; capsule ca. 8 mm. long, 4.5 wide, ovoid, with deflexed style, glandular-pubescent, dehiscent by 2 pores; seeds ovoid, ca. 1 mm. long, reticulate-favose.

Type locality: Stony Creek, Colusa Co., California. Material studied, from CALIFORNIA: Alder Springs, Glenn Co., Heller 11462 (Ca, G, F, M, NY, S); Stony Creek, Colusa Co.,

Rattan 47, type collection (C, G, S); Calaveras Valley, *Brandege* (C); without locality, *Klee* (C). The last two named are somewhat intermediate with *A. vexillo-calyculatum* Kell. More material may show that *A. subcordatum* is only a variety of that species.

10. ANTIRRHINUM VEXILLO-CALYCVLATUM Kellogg, Proc. Calif. Acad. Sci. 1 (ed. 1) :27. 1855. Curran. Bull. Calif. Acad. 1:144. 1885.

Erect or ascending annual, simple below, diffusely branched above, the main branches floriferous, 1.5-4.5 dm. long, the smaller branchlets filiform and tortile, 3-10 cm. long, main stem sparsely hispid-pilose below, increasingly so upward, glandular-pilose in the inflorescence (or even throughout); lowest leaves opposite, others alternate, most not crowded, glabrous to glandular-pilose, entire, ovate to lanceolate, to oblong-lanceolate, blades 1-6 cm. long, 0.5-2 cm. wide, obtuse to almost truncate, 3-5 veined, midrib ending in a glandular swelling, leaves gradually reduced in inflorescence, petioles glabrous to glandular-pilose, 2-35 mm. long, leaves of tortile branchlets ovate to orbicular-ovate to orbicular, less than 1 cm. long, subsessile; flowers of smaller plants borne singly in fairly low axils, but mostly in terminal more or less leafy and often branching, glandular-pubescent, spicate racemes 5-30 cm. long, pedicels ascending, 2-5 mm. long, more or less glandular-pubescent; calyx glandular-pubescent, herbaceous, in flower 4-12 mm. long, 5-parted, segments variable, from almost subequal to the upper broad and much exceeding others, truncate to obtuse to acute, slightly enlarged in fruit; corolla "light-purple," 10-16 mm. long, glandular-pubescent without, corolla-tube with basal saccate spur 1-2 mm. long, subcylindric, 8-10 mm. long, 2-3 wide, glabrate within, upper lip reflexed, arched, 2.5-4 mm. long, lobes oblong-ovate to oblong-lanceolate, lower lip erect, 4-6 mm. long, the high palate slightly glandular-pubescent, the 3 lobes oblong-ovate, 2-3 mm. long; fertile filaments didynamous, very oblique-dilated, weakly glandular-puberulent toward tips, ca. 7 and 8 or 8 and 9 mm. long, some-

what coarsely pubescent at genicula, dilated below as well as at tip, 5th stamen very rudimentary; pistil equal to shorter stamens, glandular-pubescent except at very tip, stigma unequally bifid; capsule oblique, ovoid, glandular-pubescent, with deflexed persistent style, 4-6 mm. long, 2-3 wide, dehiscing by 2 pores; seeds ovoid, ca. 1 mm. long, the winged ridges fimbriate and anastomosing to form reticulate-favose condition.

10a. ***A. vexillo-calyculatum* var. *typicum***, nom. nov.

A. vexillo-calyculatum Kell., l. c. *A. vagans* Gray, Proc. Am. Acad. 7:375. 1868. Syn. Fl. N. Am. 2:253. 1888. Bot. Calif. 1:549. 1876. Wats., Bot. King Exp., 216. pl. 21, fig. 5. 1871. Bolander, Cat. Pls. San Fran., 21. 1870. Rattan, Pop. Calif. Fl., 90. 1880. Behr, Fl. Vic. San Fran., 153. 1888. Anderson, Nat. Hist. Santa Cruz Co., 41. 1894? Jepson, Fl. West. Mid. Calif., 371. 1912. 396. 1901. Man. Calif., 900. 1925. Parsons & Buck, Wildflowers Calif., 326. 1921. Greene, Man. Bot. San Fran. Bay, 271. 1894. Armstrong, Western Wildflowers, 470. 1915. *A. vagans* var. *bolanderi* Gray, Proc. Am. Acad. 7:375. 1868. Bot. Calif., 1:550. 1876, in part. Syn. Fl. N. Am. 2:253. 1888, in part. Bolander, l. c. Rattan, l. c. Jepson, Fl. West Mid. Calif., l. c. *A. coulteri-anum* var. *appendiculatum* Dur. & Hilg. Pac. R. R. Rep. 5:11. pl. 11. 1855. *A. vagans* var. *rimorum* Jepson, Man. Calif., 900. 1925.

Stems generally glabrate at base, with scattering pilose hairs, glandular-pilose in inflorescence; flowers 13-15 mm. long; calyx-segments strongly differentiated and at least two-thirds as long as corolla-tube, dorsal segment 8-12 mm. long, broadly elliptic to narrowly ovate, others 7-8 (10) mm. long, linear-lanceolate.

Type Locality: Point Reyes, Marin Co., California. Material studied, CALIFORNIA: without locality, *Fremont 495* (G, M, NY); *Bridges 192* (G, NY, US); Santa Rosa, *Kuntze 23130* (NY); between Knights Valley and Mark West Springs. *Heller 5788* (F, G, M, Ph, NY, S, US); Knights

Valley, *Edwards in 1877* (NY); Sonoma Creek Cañon, *Baker in 1904* (C); Russian River near Duncans Mills, *Baker in 1899* (US); Ukiah, *Eastwood 3393* (Ca, US); Cloverdale, *Rattan in 1877* (S); Kenwood, *Davy 867* (C); Petaluma, *Congdon in 1880* (C); Calistoga, *Wright in 1921* (Ca); Atlas, *Wilson in 1920* (Ca); Marin Co., *Bolander 2479* (G, US) is Gray's var. *Bolanderi*; Mill Valley, *Eastwood in 1894* (G); Tamalpais, *Michener & Bioletti 74* (G), *Sutcliffe in 1920* (Ca, Ph); K. *Brandegee in 1905* (C), *Eastwood 11500* (Ca); Lily Lake, *Sutcliffe in 1923* (Ca); Paper Mill Creek, *Congdon in 1880* (C); between Ross Valley and Bolinas Ridge, *Eastwood in 1898* (F); Kentfield, *Moore 389* (Ca); Alameda, *Vasey in 1875* (US); Oakland Hills, *Kellogg & Harford 658* (G, M, NY, US), *Torrey 360a* (G, NY), *Davy 7784* (C); Niles, *Jepson in 1897* (G); Rag Cañon, *Brewer 1319* (G, US); New Almaden, *Torrey in 1868* (NY); Berkeley, *Walker 402* (C); Oakland, *Drew in 1888* (C); Tiburon, K. *Brandegee* (C); Concord, *Elmer 4937* (US); Port Costa, *Elmer 4937* (S); Mt. St. Helena, *Jones in 1921* (Ca); Calaveras Valley, *Brooks in 1878* (Ca); San Francisco, *Wilkes Exped., 1439* (US), *Vasey in 1876* (G); Santa Clara, *Bolander 47* (G); Penitence Cañon, *Bush in 1874* (G, US); Gilroy Springs, *Edwards in 1874* (NY); Loma Prieta Peak, *Elmer 4983* (M, NY, S, US), *Dudley in 1893* (S); Black Mt., *Randall 376* (S), *Baker 1543* (Ca, Po); Santa Cruz, *Bolander 47* (M); Saratoga, *Pendleton 218* (C); Congers Springs, *Williamson in 1905* (Ph); Cholame Valley, *Lehman* (F); San Juan Baptista Hills, *Dudley in 1895* (C, Ca, M, G, NY, S); Posa Creek, *Heermann in 1853* (Ph, US), the *A. Coulterianum* var. *appendiculatum* of Dur. & Hilg.; Saugus?, T. S. *Brandegee* (C).

Although no specimen or drawing is extant for original material of Kellogg's *vevillo-calyculatum* from Point Reyes, his detailed description fits very closely the species that has so long gone under the name of *vagans*. The only thing with which it could possibly be confused is *subcordatum*, but I have seen no specimens of that species from the same region. There is a tendency for shade plants of *vevillo-calyculatum* to have

the calyx somewhat enlarged. This is especially true in the region of Marin Co., for example, *Bolander 279* and the *Eastwood* specimen from Mill Valley. Such plants constituted Gray's var. *bolanderi*, but so far as I have seen such, they seem to be shade plants and not worth nomenclatorial recognition.

10b. **A. vexillo-calyculatum** var. **breweri** (Gray), n. comb.

A. breweri Gray, Proc. Am. Acad. 7:374. 1868. Syn. Fl. N. Am. 2:253. 1888. Gray, in Bot. Calif. 1:550. 1876. Bolander, Pls. San Fran., 21. 1870. Rattan, Pop. Calif. Flora, 90. 1880. *A. vagans* Gray, var. *breweri* Jepson, Fl. W. Mid. Calif., 371. 1912. 396. 1901. Man. Calif., 900. 1925. *A. breweri* var. *ovalifolium* Gray, Proc. Am. Acad. 7:375. 1868. *A. vagans* var. *bolanderi* Gray, Syn. Fl. N. Am. 2:253. 1888 in part. Gray, in Bot. Calif. 1:550. 1876, in part.

Stems generally quite glandular-pubescent throughout; flowers 10-12 mm. long; calyx-segments not strongly differentiated and often scarcely more than half as long as corolla-tube; dorsal calyx-segment 4-6 (7) mm. long, ovate-lanceolate, the others 3-5 mm. and linear-lanceolate.

Type locality: "Below Mt. Shasta". Material studied: OREGON: Illohe, *Nelson 1376* (G); Ashland, *Sheldon in 1889* (M); Glendale, *Howell 769* (G), *Howell in 1887* (C, F, M, NY, Ph, US). CALIFORNIA: Valley of the Sacramento, *Wilkes 1629* (US); without locality, *Vasey in 1875* (US); Hornbrook, Siskiyou Co., *Abrams 9897* (S); Ft. Jones, Scott Valley, *Butler 2* (Po); Humbug Mts., *Butler 1569* (C, M, Po); Snow Mt., *T. S. Brandegee in 1891* (F); Mt. Shasta, *Brown 547* (M, NY, US), below Mt. Shasta, *Brewer 1343* (G); Craggy Peak, *Dudley in 1899* (S); Mad River, Humboldt Co., *Rattan* (S), *Tracy 4327* (C, US); Willow Creek, *Tracy 3482* (C), *Abrams 7171* (S); ridge between Van Duzen & Mad Rivers, *Tracy 2790* (C, G, US); Yreka, *Greene 901* (G, M, Ph); Dunsmuir, Trinity Co., *Abrams 6159* (NY, S); Pitt River, Shasta Co., *Smith in 1913* (Ca); Pitt to Kennett, *Eastwood 1473* (Ca, G, NY, US);

Burney Butte, *Eastwood 1041* (Ca, G, NY, US); Mt. Bullion, *Bolander 4849* (C, G, US); Delta, *Heller 11697* (Ca, F, G, M, NY, S, US); Genessee, Plumas Co., *Heller & Kennedy 8836* (F, G, M, NY, Ph, S, US); Plumas Co., *Ames in 1874* (G), *in 1876* (G, M, Ph); Genessee Valley, *Hall & Babcock 4444* (C, NY, US), *Clemens in 1920* (Ca); Spanish Ranch, *Eggleston 7691* (US); Sierra Co., *Lemmon in 1874* (G); Sierra Nevada Mts., *Lemmon in 1875* (US); Colfax, Placer Co., *Jones 3426* (M, NY, Po, US); Sweetwater Creek, Eldorado Co., *K. Brandegee in 1908* (C); Ione, Amador Co., *Braunton 1041* (C, M, NY, US); Long Valley, Mendocino Co., *Rattan in 1882* (S), *Kellogg & Harford 657* (M, NY, Ph, US), *659* (G); Twin Rocks, *Eastwood 10639* (Ca); Orr's Springs, *McMurphy 290* (S); Newville-Covella Road, *Heller in 1914* (M, NY, S); Hullville, Lake Co., *Heller in 1902* (M, NY, Ph, US); Allens Springs, *Cleveland in 1882* (C); Coast Mts. of Lake Co., *Rattan in 1882* (S); Clear Lake, *Torrey 360* (G, NY); Lake Co., *Torrey 359* (G, NY); Rose Springs, *Gates in 1879* (C); Little Chico Creek, *Leiberg 5005* (US); Rawhide, Tuolumne Co., *Williamson 225* (S); Stockton Creek, Mariposa Co., *Congdon 134* (S); Coulterville Road, *Congdon in 1895* (C), *in 1897* (S); Cazadero, Sonoma Co., *Congdon in 1901* (US).

While *typicum* inhabits the "Bay Region", *breweri* is found to the north and east, and is not always well distinguished from *typicum*. Such specimens as *Heller 11697*, *Bridges 192*, *Torrey 360*, and *Congdon* from Cazadero are quite intermediate in the calyx-condition, flower size and other characters. The type specimen of Gray's *breweri* var. *ovalifolium* [with *Brewer 1343* (G)] from Mt. Shasta is a shade form.

11. ANTIRRHINUM KINGII Wats., Bot. King Exped., 215. pl. 21. 1871.

Annual, 1-5 dm. high, erect or ascending, simple at base or with ascending branches, slender, mostly glabrate except for the sparsely tomentose base; inflorescence glandular-puberulent with filiform tortile branchlets usually present in the upper

part; leaves lanceolate to linear, blunt, with a glandular swelling at end of midrib, rather scattered, glabrous, blades entire, 5-35 mm. long, 1-5 wide, upper sessile, reduced to linear bracts, lower narrowed into petioles 3-10 mm. long; flowers axillary even from near base of plant, forming above a lax, racemose inflorescence, usually in same axils with branches, pedicels filiform, glabrate to finely glandular-puberulent, 4-20 mm. long; calyx 3.5 to 4.5 mm. long, glandular-puberulent, 5-parted; corolla 7-8 mm. long, white with purple veins to "violet, white-veined", glandular-puberulent, corolla-tube merely gibbous at base, 3-4 mm. long, 2-2.5 wide, slightly pubescent within from base of palate downward, upper lip 3-3.5 mm. long, suberect, with the 2 rounded lobes ca. 1 mm. long and reflexed, lower lip erect, ca. 4 mm. long, with prominent pubescent palate and deflexed lobes ca. 1 mm. long; fertile stamens didynamous, ca. 4 & 5 mm. long, moderately dilated, pubescent only at genicula, anther-sacs divergent, confluent; pistil equaling shorter stamens, sparsely glandular-puberulent except toward entire tip; capsule oblique, glandular-puberulent, subglobose, ca. 4 mm. long, ending in persistent style which is ca. 3 mm. long, dehiscing by 1 posterior and 2 anterior pores; seeds ca. 0.5 mm. long, ovoid, deeply fimbriate-costate or with irregularly fimbriate wings, or almost alate-tuberculate.

11a. *A. kingii* var. *typicum*, nom. nov.

A. kingii Wats., Bot. King Exped. 215. pl. 21, 1871. Gray, Bot. Calif. 1:550. 1876. Howell, Fl. N. W. Amer. 1:505. 1901. Rydb., Fl. Rocky Mts., 762. 1922. Frye & Rigg, N. W. Flora, 343. 1912. Tidestrom, Contr. U. S. Nat. Herb. 25:485. 1925.

Pedicels 4-6 mm. long in fruit; upper calyx-segments 5-7 mm. long in fruit, oblong-lanceolate, lateral ones 3-4 mm. long, lanceolate; corolla "white".

Type locality: By inference, Washoe Valley, Nevada. Material studied, UTAH: Milford, *Jones in 1880* (F); Salina Cañon, *Jones 5419* (C, NY, Po, US); Leamington, *Jones in 1880* (NY), (Po); Riverside, *Jones in 1880* (Ph, Po, US); Deep Creek, *Jones in 1891* (Po). NEVADA: Candelaria,

Shockley 294 (C, G, S, US); Regans Valley, *Watson 767* (G, NY, US); Reno, *Hillman in 1895* (Po); Unionville Valley, *Watson 767* (G); Trinity Mts., *Watson 767* (NY, US); Goldfield, *Heller in 1913* (G, M, S); Rhyolite, *Jones in 1907* (Po); Reese River Pass, *Watson 767* (NY, US); Hawthorne, *Jones in 1882* (Po); Steamboat Springs, *Stretch in 1865* (NY); Curries, *Jones in 1906* (Po); Hot Springs S. of Reno, *Stokes in 1903* (US); Nevada Basin, *Lemmon* (F); Pyramid Lake, *Lemmon 1130½* (G); without locality, *Lemmon in 1878* (G). CALIFORNIA: Bishop Creek, *Hall & Chandler 7248* (C, Po); Sierra Nevada Mts., *Lemmon in 1875* (US); Argus Mts., *Purpus 5419* (C, G, M, US); White Mts., *Heller 8341* (C, Ca, F, G, M, Ph, NY, S, US), *K. Brandegee* (C); Panamint Mts., *Hall & Chandler 6977* (C); Mammoth, *T. S. & K. Brandegee* (C); Emigrant Springs, *Parish 10635* (S). OREGON: Malheur, *Cusick 1243* (G, Ph, US); Narrows, Harney Co., *Peck 2677* (G). IDAHO: Blue Lakes, Snake Plains, *Palmer 70* (US).

11b. **A. kingii** var. **watsoni** (Vasey & Rose), n. comb.

A. kingii var., Wats., Proc. Am. Acad. 24: 66. 1888. *A. watsoni* Vasey & Rose, Proc. U. S. Nat. Mus. 11:533. 1889. Contr. U. S. Nat. Herb. 1:18. 1890. Brandegee, Proc. Calif. Acad. II, 2:190. 1889.

Pedicels 9-20 mm. long in fruit; calyx-segments subequal and 3-4 mm. long, narrowly lanceolate to linear; corolla "violet, white-veined".

Type locality: By inference, Los Angeles Bay, Lower California. Material studied, SONORA: Northwestern Mts., *Pringle in 1884* (F, G, NY, Ph, US). LOWER CALIFORNIA: San Quentin, *Palmer 657* (F, G, Ph, US); Magdalena Island, *Orcutt 44* (US); San Benito Islands, *Rose 16060* (NY, US); Cedros Island, *Brandegee in 1897* (C, G, M, S, US), *Palmer 714* (G, US); Los Angeles Bay, *Palmer 589* (G, US).

With its more southern range, its longer pedicels and more nearly equal calyx-segments, *watsoni* can be considered a good variety of *kingii*.

12. ANTIRRHINUM OVATUM Eastw., Bull. Torrey Bot. Club 32:213. 1905. Jepson, Man. Calif., 900. 1925.

Erect annual, simple or branching from base as well as above, 1-4 dm. high, stems glandular-villous throughout, upper branches slender, few, and not very tortile; rather leafy throughout, leaf-blades ovate, glandular-pubescent or almost glabrate, entire, obtuse to truncate to emarginate, 8-28 mm. long, 6-22 wide, with translucent glandular swelling at end of midrib, main longitudinal veins several, cauline leaves sessile or subsessile, lowest ones narrowed into petioles 1.5-2 cm. long; flowers axillary in a leafy raceme, pedicels 2-3 mm. long; calyx herbaceous, 5-parted, glandular-pubescent, upper segment elliptical, 10-12 mm. long, 5-7 mm. wide, obtuse to emarginate, others subequal, 4-5 mm. long, 1 mm. wide, linear, acute; corolla ca. 2 cm. long. "upper lip pink, lower white", glandular-pubescent without, corolla-tube subarcuate, 7-10 mm. long, with saccate spur at base 2 mm. long and 3 broad, glabrous within and widening abruptly into a broad throat ca. 5 mm. long and widely gaping, upper lip reflexed, ca. 6 mm. long, lobes rounded-truncate, ca. 2.5 mm. long, lower lip reflexed, 7-8 mm. long with smooth low palate and 3 rounded, obscure, deflexed lobes; fertile stamens didynamous, the 2 shorter ca. 10 mm. long, slightly dilated above, glabrous, others ca. 12 mm., more dilate toward tips, glandular-puberulent, all with short hairs at genicula, anthers divergent, somewhat confluent; pistil equaling shorter stamens, glandular-pubescent except at pointed entire tip; capsule oblique, glandular-pubescent, ovoid, 8-9 mm. long, 4-5 wide, style slender, 10-11 mm. long; seeds 1 mm. long. "cuneate, rugose and the rugae muricate".

Known only from the type collection, Carisa plains, McDonald's Ranch, near boundary between Santa Barbara and San Luis Obispo Counties, California, *Eastwood in 1902* (C,

Ca). It is a most remarkable species in its widely gaping corolla.

13. *ANTIRRHINUM FILIPES* Gray, in Bot. Ives Exped., 19. 1860.

A. filipes Gray, Proc. Am. Acad. 7:376. 1868. Bot. Calif. 1:551. 1876. Syn. Fl. N. Am. 2:254 & 439. 1888. Coville, Contr. U. S. Nat. Herb. 4:169. 1893. Orcutt, Fl. So. & Lower Calif., 8. 1885. Tidestrom, Contr. U. S. Nat. Herb. 25:485. 1925. Jepson, Man. Calif., 898. 1925. *A. cooperi* Gray, Proc. Am. Acad. 7:376. 1867. Bot. Calif. 1:551. 1876. Syn. Fl. N. Am. 2:253. 1888. Parry, Amer. Nat. 9:346. 1875. Rydb., Fl. Rocky Mts., 762. 1922. Davidson & Moxley, Fl. So. Calif., 326. 1923.

Climbing, filiform, bright green annual, 3-8 dm. high, glabrous except for slight tomentum at base, diffusely branched below, with branches at first ascending then climbing mostly by the capillary twisting pedicels; lower leaves somewhat clustered, blades ovate, entire, obtuse, 0.5-2 cm. long, on petioles 5-15 mm. long, becoming narrower (lanceolate) and longer (3 cm.) above the base of plant, most cauline leaves reduced to lance-linear sessile green bracts, 5-15 mm. long and at nodes 5-10 cm. apart; flowers solitary, axillary, pedicels 3-8 cm. long; calyx scarcely oblique, herbaceous, obscurely glandular-puberulent, 5-parted into subequal lanceolate lobes ca. 4 mm. long and 1 wide; corolla bright yellow, 11-13 mm. long, glandular-puberulent without, corolla-tube saccate at base, subcylindric, ca. 6 mm. long and 3 wide, pubescent within from base of palate downward, upper lip 5-6 mm. long, erect, with broadly ovate-truncate lobes ca. 2 mm. long, lower lip ca. 6 mm. long, erect, with the 3 lobes deflexed, narrowly truncate-ovate and ca. 2.5 mm. long, palate prominent, hairy, yellow with dark spots; fertile stamens ca. 6-8 mm. long, the longer pair dilated, all glabrous except for the coarsely pubescent genicula, anther sacs divergent, confluent; pistil slightly longer than shorter stamens, closely glandular-puberulent except at very tip, this entire and slightly enlarged; capsule globose, 3-5

mm. long, slightly exceeding calyx, very finely glandular-puberulent, tipped with rather persistent geniculate style (6 mm. long), apparently dehiscent irregularly; seeds scarcely 1 mm. long, tuberculate, with corky wing-like outgrowths.

Type locality about thirty-five miles north of Needles, but on the Arizona side of the Colorado River. Material studied. SOUTHERN UTAH: *Parry in 1874* (G). NEVADA: Rhyolite, *Heller 9648* (S); Good Springs, *Jones in 1905* (Po); Charleston Mts., *Jones in 1906* (Po); Lincoln Co., *Davis 53* (M); Amargosa Desert, *Jones in 1907* (Po). ARIZONA: Ft. Mojave, *Cooper in 1861*, type collection of *A. Cooperi* (G, US), *Almendinger* (G); Camp 49, *Newberry* type collection of *filipes* (G, US); Yucca, *Jones in 1884* (Ph, Po). CALIFORNIA: Darwin, *Jones in 1897* (Po); Panamint Mts., *Coville & Funston 525* (G, NY, S, US); Fremonts Peak, Mohave Desert, *Hall & Chandler 6854* (C); Salt Wells Cañon on Searles-Trona Road, *Ferris et al 3903* (S); Randsburg, *Heller in 1905* (Ph); Funeral Mts., *Coville & Funston 459* (US); Providence Mts., *Munz & Harwood 3443* (Po); Needles, *Jones in 1904* (Po); Kelso, *Jones in 1906* (Po); Barstow, *Parish 19232* (C), *Munz 2604* (Po, S), *Spencer in 1922* (Po); Kane Spring, *Hall & Chandler 6822* (C); Colorado Desert, *Spencer 1466* (G, Po); Cottonwood Spring, *Hall 6014* (C, S, US); Ironwood Well, *Brandege in 1905* (C); Chuckwalla Mts., *Munz & Keck 4868* (Po); Shavers Well, *Munz & Keck 4756* (Po); Coachella, *Hall 5815* (C, S); Yaqui Wells, *Eastwood 2749* (Ca, G, NY, US); Agua Caliente, now Palm Springs, *S. B. & W. F. Parish 1224* (G, S), *1224a* (G); Banner, *Dunn* (C); Mission Cañon, San Diego?, *Orcutt 1046* (G, M).

14. *ANTIRRHINUM STRICTUM* (H. & A.) Gray, Proc. Am. Acad. 7:375. 1868.

Maurandia stricta H. & A., Bot. Beechey, 375. 1840. *Antirrhinum strictum* Gray, Bot. Calif. 1:550. 1876. Greene, Bull. Calif. Acad. Sci. 2:409. 1887. Man. Bot. San Fran. Bay, 271. 1894. Yates, 9th Ann. Rep. State Mineralogist, Calif., 17. Davidson, Pls. L. A. Co., 13, 1892 & Cat. Pls. L. A. Co., 22.

1896. McClatchie, Fl. Pasadena, 642. 1895. Jepson, Fl. West. Mid. Calif., 396. 1901 and 371. 1912. Abrams, Fl. L. A., 358. 1904 & 329. 1917. Heller, Muhlenbergia 3:118. 1907. Armstrong, West. Wildflowers, 470. 1915. Davidson & Moxley, Fl. S. Calif., 325. 1923. *A. hookerianum* Pennell in Millspaugh & Nuttall, Field Mus. Pub. Bot. 5:222. 1923.

Annual, glabrous except for sparse white wooliness at base, erect, 3-10 dm. high, fairly stout below, strict or branched, upper portions usually becoming vinelike and climbing by means of the slender twisting petioles; lower heavier part of stem quite leafy, with internodes shorter than leaves, leaves entire, often purplish beneath, midrib ending in glandular thickening, very lowest leaves ovate, obtuse, blades 3-20 mm. long, petioled, next ones lance-ovate to lanceolate, short-petiolate to sessile, 3-6 cm. long, petioles winged; upper vine-like portion of stem with lance-linear to linear leaves, sessile, 5-15 mm. long, and with internodes 20-30 mm. long; flowers solitary in upper axils, pedicels filiform, 3-6 cm. long; calyx slightly oblique, herbaceous or purplish tinged, 5-6 mm. long, 5-parted in lance-linear subequal segments; corolla 13-15 mm. long, blue, glabrate, corolla-tube 7-8 mm. long, gibbous at base, 3-4 mm. wide, slightly arcuate, pubescent within from base of palate, upper lip reflexed, ca. 5 mm. long and as wide, the 2 lobes suborbicular, 2.5-3 mm. long, lower lip erect, ca. 6 mm. long, the 3 lobes 2.5-3 mm. long, suborbicular, deflexed, the palate prominent, densely pubescent; stamens 4.5 & 5.5 mm. long, well dilated, glabrous except at pubescent genicula, anther-sacs confluent, divergent; pistil equaling longer stamens, style very minutely granular-puberulent, 5.5-6 mm. long; capsule globose, glabrous, 6-7 mm. long, slightly exceeding calyx, with style straight, not deflexed, dehiscence irregular; seeds scarcely 1 mm. long, tuberculate with numerous wing-like outgrowths.

Material studied: CALIFORNIA: without locality, *Douglas*, probably type collection, (G); Sequoia Cañon, Marin Co., *Michener & Bioletti in 1892* (C, US); La Honda, San Mateo Co., *Elmer 2413* (US); Los Gatos, Santa Clara Co., *Heller 7376* (C, F, G, M, NY, Ph, S. US); Santa Lucia Mts.,

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Plaskett 80 (G, NY, US); Santa Ynez Mts., Santa Barbara Co., *Brewer 314* (G, US); Zaca Lake, *Eastwood 707* (Ca, US); Painted Cave Ranch, *Eastwood 40* (US); Montecito, *Bingham* (NY); Southern California, *Parry & Lemmon 290* (F, G, NY), *Vasey in 1880* (US); Los Angeles Co., *Chamberlain* (NY); Sierra Santa Monica, *Hasse in 1890* (F, M, S, US), *4636* (NY); Santa Monica Cañon, *Barber 110* (C); Glendale to Burbank, *Braunton 911* (C, S, US); Los Angeles, *Davidson in 1890* (M), *Hasse in 1889* (M); Pasadena, *Allen in 1885* (G), *McClatchie in 1893* (NY); Verdugo Hills, *Abrams 1407* (S); Sierra Madre foothills, *Nevin 947* (G); San Dimas Cañon, *Munz & Harwood 3683* (C, Po, S); San Gabriel Cañon, *Munz 9431* (Po); San Juan Capistrano, *Nevin 679* (G); Sierra Cañon, Santa Ana Mts., *Munz & Harwood 3785* (Po); Sepulveda Cañon, *Abrams 333* (Po), *Munz & Harwood 3949* (Po); Avalon, *Trask in 1896* (M, US), *in 1897* (M), *Grant 2389* (NY), *in 1900* (S), *Nuttall 247* (F); Del Mar, San Diego Co., *Angier 144* (M), *120* (M); Red Cliff, *Angier 8* (C); San Diego, *Orcutt in 1889* (US), *in 1884* (NY); 25 mi. E. of San Diego, *Cleveland in 1878* (G); El Cajon Valley, *Orcutt in 1889* (US); Sweetwater, *Cleveland in 1878* (C); Tecate Mt., *Munz & Hilend 8018* (Po); La Costa, *Alderson 1200* (S); Cariso Creek, *Brandegee in 1893* (C); LOWER CALIFORNIA: N. Low. Calif., *Orcutt, in 1886* (F, NY, US); Vallecito, *Orcutt 1350* (G, M).

It does not seem necessary to take up for this species the name *hookerianum* proposed in 1923 by Pennell, since the *Antirrhinum strictum* of Sibth. & Smith (Fl. Graec. 6:75, pl. 594. 1826) is a *Linaria*. Moreover some of the more recent treatments, such as Halacsy (Conspectus Fl. Graecae 2:410. 1902), do not even recognize it as a species under *Linaria*, but refer it to synonymy under var. *parmassica* Bois & Heldr. of *Linaria peloponnesiaca* Bois & Heldr.

EXCLUDED OR DOUBTFUL SPECIES

1. *A. uniflorum* Sesse & Mocino, Pl. Nov. Hispan, 95. 1893 & 102. 1887. From the description certainly not an *Antirrhinum*.

2. *A. maculatum* Sesse & Mocino, Pl. Nov. Hispan., 95. 1893 & 102, 1887. Apparently also not in this genus.

3. *A. kelloggii* Greene, Bull. Torrey Bot. Club 10:126. 1883.

I have been unable to get a photograph or other information concerning this species at the Greene Herbarium. At the Gray Herbarium and at the University of California there are specimens labeled "A. Kelloggii Greene. Part of type" in Mrs. Brandegee's handwriting. This collection was referred to *A. kingii* by Gray, Suppl. Syn. Fl., but is certainly *A. strictum*. Whether this is actually part of the type of *A. kelloggii* appears doubtful, although Greene's description fits it fairly well. Greene's type was from "Summit of the Sierra Nevada, Dr. H. Kellogg, July 20, 1876". But I have seen no other specimens of *strictum* from the Sierra Nevada.

IV. GALVESIA

Leaves regularly in 3's, glabrous or pubescent, coriaceous, 2-4.5 cm. long, those in inflorescence conspicuously reduced and pubescent; palate of lower lip glabrous; filaments very evidently dilated upward; flowers ca. 25 mm. long. (§Gambelia).....1. *G. speciosa*

Leaves not constantly in 3's, or, if so, scarcely over 2 cm. long, and those of inflorescence not markedly different from others; palate of lower lip pubescent; filaments not conspicuously dilated. (§Eugalvesia)

Corolla 22-30 mm. long; palate not both glandular and pubescent; North American species.

Leaves much reduced, almost lacking up to barely 1 cm. long, narrowly lance-elliptic; stems glaucous, broom-like; calyx and pistil glabrous2a. *G. juncea* var. *typica*

Leaves well developed, 1-2.5 cm. long, oval-elliptic to broadly ovate.

Stems glaucous; leaves glabrous; calyx and pistil glabrous.....2b *G. juncea* var. *foliosa*

Stems and leaves, calyx and pistil glandular-pubescent2c *G. juncea* var. *pubescens*

Corolla 12-22 mm. long; palate both glandular and pubescent; South American species.

Flowers 12-14 mm. long; pedicels 1-2 cm. long; style 7 mm.; filaments glandular in upper part; leaves obtusish.....3. *G. fruticosa*

Flowers 14-22 mm. long; pedicels 5-10 mm.; style 11-13 mm.; filaments glabrous in upper part; leaves often acuminate.....4. *G. ballii*

1. GALVESIA SPECIOSA (Nutt.) Gray, Proc. Amer. Acad. 22:311. 1887.

G. speciosa Gray, Brandg., Zoe 5:167. 1903. *Gambelia speciosa* Nutt., Jour. Philad. Acad. Nat. Sci. (II) 1:149. 1848. Pennell, in Millsp. & Nutt., Field Mus. Pub. Bot. 5:222. 1923. *Antirrhinum speciosum* Gray, Proc. Am. Acad. 7:376. 1868. Bot. Calif. 1:551. 1876. Syn. Fl. N. Am. 2:254. 1888. Meehan, Nat. Fls. Illus. II, 2:61, pl. 15. 1880. Greene, Bull. Calif. Acad. Sci. 1:227. 1885. Bailey, Cyclop. Hort. 1:305. 1914. Abrams, Fl. Los Ang., 329. 1917. Davidson & Moxley, Fl. So. Calif., 325. 1923. Jepson, Man. Calif., 897. 1925.

Smooth or pubescent, spreading, bright green shrub, 15-20 dm. high, stems fairly stout, generally glabrous except at nodes, where there is a line of hair on base of petioles and inflorescence; leaves verticillate in 3's, coriaceous, glabrous, or pubescent, slightly bicolored, ovate, entire, obtusish, mucronulate at apex, rounded at base, with 3 principal and some smaller veins converging toward apex, blades 2-4.5 cm. long, 0.5-2.0 cm. wide, petioles ca. 5 mm. long, flattened, channeled and pubescent above, uppermost leaves reduced to narrow, lanceolate, greenish bracts, pubescent, thin, acuminate, 5-10 mm. long; flowers in a terminal lax racemose or crowded, corymbose, glandular-pubescent inflorescence, pedicels slender, ascending, glandular-pubescent, 1-2 cm. long; calyx campanulate, herbaceous, glandular-pubescent within and without, somewhat oblique, 5-parted to near base, calyx-segments lanceolate, acuminate, subequal, 7-10 mm. long in flower, slightly enlarged and thickened in fruit; corolla scarlet, tubular, 22-26 mm. long, bilabiate, nearly or quite closed at throat, heavily glandular pubescent without, corolla-tube scarlet, subcylindric,

saccate at base anteriorly, 15-17 mm. long, 5-6 mm. wide, pubescent within just above insertion of 2 anterior stamens, upper lip of corolla somewhat reflexed, 6-7 mm. long, with oblong-ovate lobes separated ca. half way, lower lip spreading, 7-8 mm. long, with large glabrous palate extending to base of lobes, these oblong-ovate, ca. 3.5 mm. long, 3 mm. wide, middle one slightly narrower; fertile stamens 4, slightly didynamous, 17-19 mm. long, filaments conspicuously dilated and weakly glandular upward, geniculate and heavily pubescent above the expanded glabrate base, anther-sacs divergent, confluent, ca. 1 mm. long; 5th stamen with rudiment of anther, inconspicuous; pistil scarcely equal to stamens, style and ovary glandular-pubescent, ovary oblique, stigma not divided, flattened; capsule subglobose, slightly oblique, thick-walled, with persistent filiform style, dehiscing by 2 irregular terminal pores; seeds oblong, dark, ca. 1 mm. long, not winged, with thin irregular broken ridges.

Type locality: Catalina Island. Material studied: CALIFORNIA: Catalina *Gambel*, type collection, (G, NY), *Trask in 1900* (NY), *in 1896* (C, M, US), *in 1897* (US), *Mills-paugh 4832* (F), *Knopf 392* (F), *Hall 8289* (C); San Clemente Island, *Nevin & Lyon 6* (G, S), *Trask in 1902* (US), *Purpus* (C), *Brandegee in 1894* (C), *Evermann in 1918* (Ca), *Peirson 3476* (S), *Munz 6685* (Po). MEXICO: Guadalupe Island, *Palmer 57* (F, G, M, NY, Ph), *Brandegee in 1897* (C).

2. GALVESIA JUNCEA (Benth.) Gray, Proc. Amer. Acad. 22:311. 1887.

Erect or spreading shrubs with many slender stems, much branched and 6-15 (20) dm. high, nodes 2-8 (10) cm. long; leaves opposite or verticillate in 3's, variable as to size and pubescence, veins converging toward tip; flowers borne in 2's or 3's near upper parts of stem, pedicels 1-3 cm. long; calyx herbaceous, campanulate, 5-parted, calyx-segments lance-ovate to oblong-ovate, subequal, 2.5-5. mm. long in flower, 5-7 mm. in fruit; corolla tubular, scarlet, 2.5-3. cm. long, glandular-pubescent without, tube saccate at base, on

anterior side, 15-25 mm. long, 3-5 mm. wide, apparently scarlet without, cylindrical, scarcely ampliate into a throat, tawny-pubescent within from near base to well formed pubescent palate, lower lip reflexed, 4-8 mm. long, the 3 lobes rounded, 1.5-2 mm. long, palate extending to their very base but not closing throat, upper lip suberect, ca. equal to lower, obscurely 2-lobed at very tip; 4 fertile stamens very slightly dilated upward, extremely variable in length (from subequal and two-thirds length of corolla, to markedly didynamous with 2 anterior equaling the corolla, to subequal and the longer slightly exceeding corolla), commonly with anthers exerted, variable also as to pubescence, but all coarsely pubescent at the slight genicula, and dilate and glabrous at base, anthers confluent and divergent; 5th stamen without vestige of anther; stigma entire, slightly flattened, style varying in length with stamens, pubescence variable, ovary oblique at base; capsule 2-celled, ovoid, firm-walled, 8-9 mm. long, 6-7 mm. thick, with persistent filiform style inserted between the 2 slightly projecting valves, each of these dehiscing by a terminal rounded, irregular opening; seeds dark, ca. 1 mm. long, oblong, wingless with numerous thin, broken and irregular ridges.

2a. *Galvesia juncea* var. *typica*, nom. nov.

Maurandia juncea Benth., Bot. Sulph., 41. 1844. D. C., Prodr. 10:296. 1846. *Saccularia veatchii* Kell., Proc. Calif. Acad. Sci. 2:17. 1860. Curran, Bull. Calif. Acad. 1:144. pl., 1885. Gray, Bot. Calif. 1:551. 1876. *Antirrhinum junceum* Gray, Proc. Am. Acad. 7:377. 1868. Syn. Fl. N. Am. 2:254,439. 1888. Bot. Calif. 1:551. 1876. 2:472. 1880. Brandegee, Proc. Calif. Acad. II, 2:190. 1889. Davidson & Moxley, Fl. S. Calif., 325. 1923. *Galvesia juncea* Gray, Proc. Am. Acad. 22:311. 1887. Vasey & Rose, Proc. U. S. Nat. Mus. 2:533. 1889. Contr. U. S. Nat. Herb. 1:19. 1890. Ball, Jour. Linn. Soc. 22:152. 1887. Goldman, Contr. U. S. Nat. Herb. 16:364. 1916. Johnston, Proc. Calif. Acad. IV, 12:1160. 1924.

Leaves reduced or almost lacking, scarcely 1 cm. long, narrowly lance-elliptic; stems glaucous, broomlike; calyx and pistil glabrous.

Type locality: "West coast of Lower California, probably at San Quentin." Material studied: LOWER CALIFORNIA: San Antonio Cañon, *Hill & Ballou in 1925* (Po); Calmalli, *Purpus 198* (C); Salada Cañon, *Brandegee in 1893* (C); San Quentin, *Nelson & Goldman 7109* (US), *Palmer 720* (G, NY, Ph); San Julio Cañon, *Brandegee in 1889* (C, Ph); Playa Maria, *Anthony 85a* (G, M, NY, Ph, S, US); San Telmo, *Orcutt 1363* (G, M, NY, Ph, US); Cedros Island, *Belding in 1881* (G). *Veatch*, type collection of *Saccularia Veatchii* (G, NY), *Streets in 1876* (G, US), *Anthony 286* (C, G, M, S, US), *85* (C, G, M, NY, Ph, S, US), *Palmer 720* (G, NY, US), *Rose 16093* (NY, US), *Pond in 1889* (US), *Greene in 1885* (F), *Stewart in 1906* ? (Ca).

Variable and intergrading with var. *foliosa*, e. g., *Palmer 720*.

2b. GALVESIA JUNCEA var. FOLIOSA Johnston, Proc. Calif. Acad. Sci. IV, 12:1161. 1924.

G. glabrata Brandg., *Zoe 5:167*. 1903.

Stems glaucous; leaves 1-2.5 cm. long, glabrous; calyx and pistil glabrous.

Type locality: San Felipe, Lower California. Material studied: LOWER CALIFORNIA: San Felipe, *Purpus 463*, type of *glabrata* (C, M, US); Saucito, *Brandegee in 1893* (C); Las Animas Bay, *Johnston 3510* (Ca); Santa Maria Bay, *Rose 16257* (NY, US); Cape San Lucas, *Rose 16370*, in part (NY, US); South San Lorenzo Island, *Johnston 3530* (Ca, G); San Pedro Nolasco Island, *Johnston 3133* (Ca, G).

2c. GALVESIA JUNCEA var. PUBESCENS (Brandg.) Johnston, Proc. Calif. Acad. Sci. IV, 12:1161. 1924.

G. juncea of Brandg., Proc. Calif. Acad. Sci. II, 3:225. 1892. *G. speciosa* var. *pubescens* Brandg., *Zoe 5:167*. 1903. *G. rupicola* Brandg., Univ. Calif. Pub. Bot. 6:360. 1916.

Leaves well developed, 1-2.5 cm. long, oval-elliptic, glandular-pubescent, as are stems, calyx, and pistil.

Type locality: "On the rocks of Cape San Lucas, Lower California." Material studied: LOWER CALIFORNIA: Cape San Lucas, *Brandegee in 1892*, type of *rupicola* (C, G), *Rose 16370*, in part (NY, US); Saucito, *Brandegee in 1893* (C); Angel de la Guardia Island, *Johnston 3420* (Ca); Espiritu Santo Island, *Johnston 3980* (Ca, G).

Intergrading with var. *foliosa*, *Rose 16370* having both sorts on one branch.

3. GALVESIA FRUTICOSA Gmelin, Syst., 937. 1791.

G. fruticosa, Juss. ex Steudel, Nomen. bot. 1:356. 1821. Stewart, Proc. Calif. Acad. Sci. IV, 1:141. 1911. *Russelia* ? *alternifolia* Pers., Syn. 2:164. 1807. *Agassizia limensis* Dombey ex Chavannes, Monogr. Antirrh., 180. pl. 11. 1833. *Galvesia limensis* Domb., Benth. in D. C., Prodr. 10:296. 1846. Weberbauer in Engler & Drude, Veg. der Erde, 12: 107, 153. 1911.

Spreading shrub, 3-10 dm. high, ultimate branches slender, glandular-puberulent; leaves opposite (especially lower ones) or alternate, somewhat fleshy glabrate or glandular-puberulent, ovate-lanceolate, with blades 5-25 mm. long, 4-15 wide, obtusish, mucronulate, petioles somewhat grooved above, glandular-puberulent, 3-7 mm. long; flowers near ends of branches, borne singly in axils of somewhat reduced and crowded upper leaves, pedicels slender, glandular-pubescent, spreading, somewhat recurved, somewhat tortuous after anthesis, 8-20 mm. long; calyx herbaceous, glandular-puberulent within and without, 5-parted, the segments subequal, lance-ovate, 2-3 mm. long, slightly enlarged in fruit; corolla "scarlet", tubular, glandular-pubescent without, 12-14 mm. long, tube slightly saccate at base, then slightly constricted, then slightly ampliate into narrow throat, within having stalked glands and sparse coarse pubescence anteriorly, 7-8 mm. long and 2-3 broad, limb bilabiate, upper lip reflexed, glandular-puberulent within, 4-5 mm. long, its 2 lobes rounded-ovate, grown together ca. half way, lower lip glandular-puberulent especially on palate, 4-5 mm. long, the 3 lobes ovate, grown together ca. half way;

4 stamens 8-9 mm. long, slightly didynamous, filaments not dilated, conspicuously glandular, with coarse short pubescence at genicula, glabrous at base, anther-sacs divergent, confluent, each pair forming almost a circle after dehiscence; 5th stamen inconspicuous, with anther not evident; pistil scarcely as long as stamens, ovary and style glabrous, or weakly glandular-puberulent, style 5-6 mm. long, persistent, flattened upward, stigma slightly 2-lobed; capsule depressed-globose, 2-celled, 4-5 mm. long, thin-walled, dehiscing by 2 irregular pores; seeds scarcely 1 mm. long, oblong, not winged, with several irregular broken ridges.

Material seen: PERU: Galapagos Islands, *Stewart 3440* (Ca, G), *3441* (Ca), *3442* (Ca); Lima, *Wilkes Explor. Exped.* (G, NY, US); Tambo de Pariocota, *Macbride & Featherstone 2540* (US).

4. *Galvesia ballii*, nom. nov.

G. limensis Domb. var. *grandiflora* Benth., in D. C. Prodr. 10:296. 1846. Ball, Jour. Linn. Soc. 22:151. 1887.

Apparently spreading shrub much like *G. fruticosa*; leaf-blades acuminate to acute, 5-25 mm. long, 5-15 mm. wide, petioles flattened, puberulent, 2-5 mm. long; pedicels glandular-puberulent, 5-10 mm. long, deflexed after anthesis; calyx-segments 3-4 mm. long; corolla tubular, glandular-puberulent without, 16-22 mm. long, upper lip 6-7 mm. long, lower lip same length; fertile stamens 12-14 mm. long, not conspicuously dilated, glabrous except at genicula; pistil 12-14 mm.

Type locality: Payta, Peru. Material seen, Payta, *Andre 4119* (NY), *Ball in 1882* (G, NY); *Rusby 2504* (NY). Ball, l. c., reports it also from Manta, Ecuador.

To be sure the amount of material available was not great and it may be that this plant is not specifically distinct from *G. fruticosa*. But such characters as pubescence of stamens, flower size, etc. seem quite fundamental. *Rusby 2504* has leaves varying from acuminate to obtusish. The name *Ballii* is proposed because of the uncertain *Galvesia grandiflora* (Kell.) Benth. of Wettstein in Engler & Prantl, Pflanzenfam. IV. Abt. 3b, p. 61. 1895, supposed to be from California. I

have been unable to find any justification whatsoever for this name, nor any indication as to what it may refer, but it seems best not to continue the use of the name *grandiflora* after this confusion.

V. EPIXIPHIMUM (Engelm.), gen. nov.

Recognized as a section by Gray (Proc. Am. Acad. 7:377. 1868) of the genus *Maurandia*, and sufficiently characterized there. Having but one species which is undoubtedly closely related to *Maurandya antirrhiniflora* but differing so widely in its capsule characters, heavily indurated sepals, and flat seeds, as apparently to deserve generic recognition.

1. *Epixiphium wislizeni* (Engelm.), n. comb.

Maurandya wislizeni Engelm. by Gray, in Torrey, Bot. Mex. Bound. Surv., 111. 1859. Gray, Proc. Am. Acad. 7:377. 1868. Syn. Fl. N. Am. 2:254. 1888. Coulter, Contr. U. S. Nat. Herb. 2:307. 1892. Hemsley, Biol. Centr. Amer. 2:442. 1882. Small, Fl. S. E. U. S., 1057. 1903. Wootton & Standley, Contr. U. S. Nat. Herb. 19:578. 1915. Johnston, Proc. Calif. Acad. Sci. IV, 12:1163. 1924.

Glabrous herb climbing by tortile petioles and pedicels; leaves thin, alternate, triangular-hastate, some obscurely 5-lobed, each lobe mucronulate, margin otherwise entire, scarcely if at all bicolored, base cordate, apex acuminate (obtuse in lowest leaves), with 3 principal veins in terminal portion, blades 1-4 cm. long, 1-3 (4) wide, petioles glabrous, fairly stout, 1-5 cm. long; flowers solitary, axillary, horizontal, pedicels slender at anthesis, less than 1 cm. long, thickened in fruit; calyx herbaceous at anthesis, slightly oblique, 5-parted almost to base, calyx-segments linear-lanceolate, subequal, 12-15 mm. long, tips somewhat spreading, calyx-segments in fruit triangular-lanceolate, indurate, especially at base, strongly reticulate, 2.5-3.5 cm. long and 1 cm. wide at base, strongly keeled at base, upper halves spreading, acuminate; corolla 3-3.5 cm. long, "pale blue", glabrous without, 2-lipped, funnelform, tube 5-6 mm. long, slightly gibbous anteriorly, glabrous within at

base, pubescent upward, throat rapidly expanding to ca. 1 cm. across, without plaits or hair within, corolla-limb suberect, ca. 1 cm. long, the 2 upper lobes well grown together, suborbicular, lower lip pubescent at base, its 3 lobes ca. 5 mm. long, the middle one narrowest; stamens didynamous, ca. 15 & 17 mm. long, anther-sacs confluent, filaments glandular above and below (just above slight genicula), heavily pubescent below genicula to glabrate expanded base; style in flower glabrous, ca. 15 mm. long, flattened below, stigma bilobed, ovary glabrous; capsule 12-15 mm. long, globose-ovate, coriaceous, surmounted by persistent beak-like, flattened style, which is ca. 4 mm. wide at base, pointed above and 12-15 mm. long, dehiscence by clean curving transverse slit on each side of base of beak; seeds tawny, with body 2-2.5 mm. long, compressed, oval, "chaffy-rugose", surrounded by an entire emarginate wing, ca. 1 mm. wide.

Type locality: "Along the Rio Grande below Dona Ana". Material studied very extensive, only a small part is here cited of all that has been seen, NEW MEXICO: Valverde, so. of Santa Fe, *Wislizenus* 45 (M); Ft. Craig, *Rusby* 314 (M, US), 320 (F); Las Cruces, *Wootton in 1893* (US), *Vasey in 1881* (F, US) Puebla Crossing, *Wootton in 1900* (US); mesa W. of Organ Mts., Dona Ana Co., *Wootton in 1893* (US); San Marcial, *Herrick* 846 (US); plains of Acoma, *Saunders in 1903* (Ph); Upper Gila, *Greene in 1880* (F, M, Ph, Po, NY); Messila, *Standley* 451 (US), *Dewey in 1891* (US), *Wootton in 1899* (Po), 25 (C, G, M, NY, Po, S, US), *in 1902* (US), *in 1904* (US); Deming, *Mulford* 1123 (M, NY), *Griffith* 3328 (US); valley of Rio Grande, *Mex. Bound. Surv.*, type (G, NY, US); without locality, *Wright in 1851* (G, NY). TEXAS: Ft. Hancock, *Mearns* 1520 (US); western Texas, *Wright* (G, NY, Ph, US). MEXICO: Laguna de Guzman, Chihuahua, *Hartman* 718 (G, US); Chihuahua, *Thurber* 762 (G, NY), *in 1852* (F); Paso del Norte, *Pringle in 1885* (G); Colonia Diaz, *Nelson* 6450 (G, US); Samalayuca, *Coville* 1698 (US); Sapio, Sierra Madre Mts., *Jones in 1903* (Po); Bolson de Mapimi, Rio Nazas, *Gregg in 1847* (NY).

VI. MAURANDYA

- Anther-sacs oblong after dehiscence, confluent or in contact; calyx-segments lanceolate, almost distinct; leaves deltoid, glabrous; seeds not winged; climbing plants; leaf-margin quite entire except for main lobes.
- Plaits within corolla developed distally into a palate, corolla not over 3 cm. long, blue, ridges light yellow; plant herbaceous..... § *Antirrhinoidea*. 1. *M. antirrhiniflora*
- Plaits not developed into a palate but distinct, corolla generally over 3 cm. long; plants somewhat woody. § *Usteria*
- Sepals glabrous; corolla lavender.....2. *M. scandens*
- Sepals conspicuously glandular-pilose; corolla deep purple3. *M. barclaiana*
- Anther-sacs circular after dehiscence, discrete; calyx-lobes ovate (ovate-lanceolate in *glabrata*); leaves circular or cordate or reniform; habit various; leaf-margin dentate or crenate or serrate..... § *Lophospermum*
- Flowers yellow; stamens well exerted; pedicels tortuous; seeds apterous.....4. *M. flaviflora*
- Flowers not yellow; stamens included or barely visible; pedicels straight or geniculate, at least not tortuous.
- Stems not climbing; corolla with 2 prominent plaits on the floor of the throat, which are thickly beset with hairs.
- Seeds apterous.
- Fruiting pedicels thickened, geniculate; leaf-margins crenate; calyx cleft to near middle, 12 mm. long, the segments oblong-ovate, obtuse.....5. *M. geniculata*
- Fruiting pedicels not thickened nor geniculate; leaf-margins dentate; calyx cleft two-thirds its length, 15-20 mm. long, the segments lance-ovate, acute.....6. *M. rosei*
- Seeds winged; fruiting pedicels spreading or ascending.
- Plant strongly pubescent; calyx-segments ovate; anterior pair of fertile stamens distinctly longer than posterior pair; sterile stamens scarcely reaching the genicula of posterior fertile ones.....9. *M. erecta*

Plant glabrate; sepals more or less cordate; fertile stamens subequal; sterile stamen almost half as long as fertile ones.....7. *M. purpusii*

Stems climbing; corolla without prominent plaits on the floor of the throat, but merely with 2 prominent lines of hairs; seeds winged.

Plant densely softly pubescent, grayish; sepals oblong-ovate; flowers rosy pink8a. *M. erubescens* var. *typica*

Plant glabrate or somewhat pubescent, green; sepals lance-ovate; flowers rose-purple8b. *M. erubescens* var. *glabrata*

1. MAURANDYA ANTIRRHINIFLORA Humb. & Bonpl. ex Willd., Hort. Berol., pl. 83. 1807 & Enum. Hort. Berol., 659. 1809.

M. antirrhiniflora of Curtis Bot. Mag. 40: pl. 1643. 1814. Benth., in D. C., Prodr. 10:296. 1846. Chavannes, Mon. Antirrh., 78. pl. 2, f. B. 1833. Nees & Schauer, Linnea 20: 712. 1847. Martens & Galeotti, Acad. Roy. Brux. 12: no. 7, p. 3. 1845. Gray, Bot. Ives Exped., 19. 1860. Gray, in Torrey, Bot. Mex. Bound. Surv., 110. 1859. Torrey, Bot. Sitgreaves Exped., 166. 1853. Armstrong, W. Wildfl., 466. 1915. Britton, Fl. Bermuda, 346. 1918. Pennell, Proc. Acad. Nat. Sci. Phila. 73:500. 1922. *M. antirrhina* Lindl., Torrey in Emory Recon., 146. 1848. Probably *M. sempervirens* Jacq. of Small, Bot. of the Bermudas, 44. 1913. *M. personata* Lag., Gen. et Sp. Nov., 19. 1816. *Usteria antirrhiniflora* Poir., Encyc. Suppl. 5:405. 1817. *Antirrhinum antirrhiniflorum* of Small, Fl. S. E. U. S., 1056. 1903. *A. antirrhiniflorum* of Hitchcock, Rep. Mo. Bot. Gard. 4:113. 1893. Schulz, Wildflowers of San Antonio, 191. 1922. Wootton & Standley, Contr. U. S. Nat. Herb. 19:578. 1915. *A. maurandioides* Gray, Proc. Am. Acad. 7:376. 1868. Syn. Fl. N. Am. 2:254. 1888. Bot. Calif. 1:551. 1876. Porter, in Bot. Wheeler Surv., 209. 1878. Hemsley, Biol. Centr. Amer. 2:441. 1882. Coulter, Contr. U. S. Nat. Herb. 2:306. 1892. Jepson, Man. Calif., 898. 1925. Bailey, Cyclop. Hort. 1:305. 1914.

Perennial herb, climbing by the tortuous petioles and pedicels, stems slender, glabrous, green; leaves thin, alternate, not strongly bicolored, glabrous, triangular, hastate to 5-lobed, each lobe mucronulate, margin otherwise entire, base cordate, 3 main veins in terminal portion of blade, tip acuminate, 5-25 mm. long, equally wide, petioles glabrous, slender, 5-25 mm. long, green; flowers solitary, axillary, horizontal, pedicels filiform, glabrous, 1-2 cm. long; calyx 5-parted almost to base, narrowly campanulate, glabrous, calyx-segments green, lance-linear, the tips spreading, the 3 upper segments straight or curving upward, 10-12 mm. long at anthesis, the 2 lower curving, 11-13 mm. long, calyx-segments bulging in fruit, but tips connivent, 12-15 mm. long, scarcely thickened; corolla 2.5-3.0 cm. long, glabrous without, tube whitish, 4-5 mm. long, ca. 3 mm. wide, mostly glabrous within, pubescent where it expands into the throat, throat whitish, tinged blue without, ca. 1 cm. wide, pubescent within and with 2 prominent plaits fusing anteriorly to form conspicuous yellow palate at base of lower lip, base of upper lip also somewhat plaited, throat not closed, limb blue to reddish, upper lobes 5-6 mm. long, blunt, lower lobes ca. 6 mm. long; stamens included, didynamous, ca. 17-19 mm. long, anther-sacs confluent, ca. 1.5 mm. long, filaments clavate, glandular above, slightly geniculate and heavily pubescent above the glabrous dilated base; 5th stamen very rudimentary; style glabrous, persistent, flattened toward tip, 12-13 mm. long, ovary glabrous, ovoid-globose; capsule globose, rather thin, glabrous, 7-8 mm. long, included in calyx, with irregular subterminal dehiscence; seeds oblong, ca. 1 mm. long, wingless, brown, with corky short broken, tuberculate ridges.

Type locality: Mexico. Some hundreds of herbarium sheets have been studied for this species and it hardly seems worth while citing so many. I have therefore selected representative ones and such as will give some indication of range. The species seems to be largely an inhabitant of lime soils. CALIFORNIA: Providence Mts., Mohave Desert, *Brandegee in 1902* (C. US), *Munz, Johnston & Harwood 4282* (Po);

Kelso, *Jones in 1906* (Po). ARIZONA: Union Pass. N. Ariz., *Wilson 28* (C, US); Grand Cañon, *Hitchcock in 1915* (US), *Gray in 1885* (G); Chiricahua Mine, *Blumer 1805* (F, G, M, NY, US); Tucson, *Toumey in 1894* (C, NY, US), *Pringle in 1884* (F, NY, Ph, US); Bisbee, *Gooding 708* (G, NY). NEW MEXICO: Silver City, *Metcalf in 1898* (US); Albuquerque, *Rusby in 1909* (NY); Lincoln, *F. S. & E. S. Earle 548* (M, NY, US). TEXAS: El Paso, *Stearns 167* (US), *Jones 4346* (F); Austin, *Hall 507* (F, M, NY, US); Laredo, *Letterman 351* (M, NY); San Marcos, *Pennell 10428* (NY, Ph); San Antonio, *Jermy 234* (G, M, NY). MEXICO: Sonora, *Hartman 858* (G); Parral, Chihuahua, *Goldman 115* (G, US); Ciudad, Chihuahua, *Stearns in 1911* (NY, Ph); La Ventura, Coahuila, *Nelson 3915* (US); Torreon, Coahuila, *Palmer 475* (C, F, G, M, NY, US); Tula, Hidalgo, *Pringle 6365* (C, F, G, M, NY, Ph, US); Tehuacan, Puebla, *Liebmann 9415* (NY, US); Sota la Marina, Tamaulipas, *Nelson 6642* (G); Vallee de Mexico, Guadalupe, *Bourgeau in 1865-66* (G, US); Tequisquiapam, Querétara, *Nelson 3872* (G, US); San Luis Potosi, *Parry & Palmer 665* (F, G, M, Ph, US); Zacatecas, Jalisco, *Coulter* (NY). Naturalized in many places east of its original range: Miami, Fla., *Tracy 9428* (G, M, NY); Grantstown, New Providence, Bahamas, *Wilson 8216* (F, NY); Bermuda, *Collins 284* (G, NY, US); Malvern, Santa Cruz Mts., Jamaica, *Britton 1302* (NY); *Harris 9660* (G, F, NY, Ph, US).

2. MAURANDYA SCANDENS (Cav.) Pers., Synopsis 2:160. 1807.

M. scandens of Bailey, Cyclop. Hort. 4:2012. 1916. Britton, Fl. Bermuda, 346. 1918. Johnston, Proc. Calif. Acad. Sci. IV, 12:1163. 1924. *Usteria scandens* Cav., Ic. Pl. 2: pl. 116. 1793. Andrews, Botanists Repository 1: t. 63. 1794. *Reichardia scandens* Roth, Catal. 2:64. 1800. *Maurandya semperflorens* Ortega, Nov. Gen. Hort. Matr. decas. 2:21. 1797. Jacquin, Hortus Schönb., 3:20, t. 288. 1798. Curtis, Bot. Mag. 13: t. 460. 1799. Willd., Enum. Pl. Hort. Berol..

659. 1801. Sp. Pl. 3:389. 1801. Spreng., Syst. Veget. 2:814. 1825. Chavannes, Monogr. Antirrh., 78. 1833. Benth. in D. C., Prodr. 10:297. 1846. Nees & Schauer, Linnea 20:712. 1847. Gray, Proc. Am. Acad. 7:377. 1868. Hemsley, Gard. Chron. N. S., 17:22. 1882. Biol. Centr., Am. 2:442. 1882. Reada, Pls. Bermudas, 67. 1883. Smith, Enum. Pl. Guat. 2:55. 1890. Urbina, Cat. Pls. Mex., 256. 1897.

Suffrutescent climber, petioles and pedicels twining, stems slender, glabrous, younger ones often reddish; leaves thin, alternate, bright green above, paler below, glabrous, triangular-cordate, sometimes obscurely 5-lobed, each lobe mucronulate, margin otherwise quite entire, somewhat hastate at base, acuminate, 3 main veins running into terminal portion, 1-5 cm. long, 1-4 wide, petioles glabrous, slender, green or reddish, 1-2 cm. long; flowers solitary, axillary, horizontal, pedicels slender, glabrous, 5-10 cm. long; calyx 5-parted, narrowly campanulate, glabrous, the segments green, lance-linear, the 3 upper straight, 13-15 mm. long, 2 lower slightly curved upward, 12-14 mm. long, in fruit the segments becoming 18-20 mm. long, tips connivent, base somewhat thickened; corolla 3.5-4.5 cm. long, finely glandular-puberulent without, broadly funnel-form, bilabiate, tube whitish, swollen at base in front, 5-8 mm. long, 6-7 mm. wide, pubescent within above the base, throat whitish, with lavender tinge, amplified, 12-15 mm. wide at its extreme, glabrous with 2 prominent plaits on floor, limb lavender, reflexed, lobes suborbicular, ca. 1 cm. long, the 2 upper slightly largest, middle lower smallest; stamens didynamous, ca. 18 & 20 mm. long, enlarged and provided with yellow glands above, glandular also just above genicula, where also heavily pubescent, flattened and glabrous at base, anthers oblong, confluent; 5th stamen very reduced; style filiform, almost equal to shorter stamens, glabrous except for few scattered glandular hairs at base, persistent, ovary very sparingly glandular-pubescent at base of style; capsule globose, glabrous, ca. 1.5 cm. long, rather firm walled, dehiscent by 2 rather irregular subterminal openings; seeds oblong, 1-1.5 mm. long, brown, with few irregular broken, corky, tuberculate ridges, not winged.

Type locality: Mexico. Material studied, MEXICO: valley of Rio Nazas, *Gregg 445* (M); Molino, Morelia, *Arsène in 1910* (F); Puebla, Molino, *Nicolas 78* (Ph); Orizaba, Vera Cruz, *Botteri 540* (G, US); Rio de San Francisco, Puebla, *Purpus 4102* (C); San Simon, *Purpus 3965* (C); Barranguito de Puebla Viejo Nochixtlan, Oaxaca, *Consatti 1850* (F, G); Dominguillo, *Nelson 1594* (G); Cuilapam, *Smith 46* (G); Oaxaca, *Scler 1582* (G); Monte Alban, *Smith 396* (US), *Pringle 4786* (C, G, M, NY, Ph, US); Cerro San Antonio, *Consatti 1409* (G), *1964* (F); Cerro San Felipe, *Consatti 2244* (F, G); De Huranchilla a Nothixllax, *Consatti 4276* (US); Valley of Oaxaca, *Nelson 1251* (US); Huajuapán, *Nelson 1969* (US); near Mexico, Bustamente y Rocha, no coll., (NY). GUATEMALA: Antigua, Zacatepequez, *Smith 2181* (G), *Kellerman 4702* (US). BERMUDA (where introduced): Pembroke, *Collins 283* (G, NY, US); Mt. Langton, *Harshberger in 1905* (G, NY, Ph, US), *Brown & Britton 412* (NY, Ph); Harrington House, *Brown, Britton & Scaver 1129* (NY, Ph, US); without locality, *Flynn 87* (M). Botanical Garden specimens: Hort. Duval, Cartigny, *in 1826* (NY); Hort. Saltzwedel, Frankfurt, *Engelmann in 1825* (M);

3. MAURANDYA BARCLAIANA Lindl., Bot. Reg. 13: t. 1108. 1827.

M. barclaiana in Lodd, Bot. Cab. 14:t. 1381. 1828? Bailey, Cyclop. Hort. 4:2012. 1916. *M. barclayana* in Martens & Galeotti, Bull. Acad. Roy. Brux. 12: No. 7, p. 3. 1845. Chavannes, Monogr. Antirrh., 77. 1833. Benth., in D. C., Prodr. 10:297. 1846. Gray, Proc. Am. Acad. 7:377. 1868. Hemsley, Gard. Chron., N. S., 17:22. 1882. Biol. Centr. Am. 2:441. 1882. Urbina, Cat. Pls. Mex., 256. 1897. Ramirez & Alcocer, Sin. Pls. Mex., 106. 1902. Britton, Fl. Bermuda, 347. 1918. Johnston, Proc. Calif. Acad. Sci. IV, 12:1163. 1924.

Suffrutescent climber of the same habit, leaves, etc. as the preceding species; leaf-blades 1-3.5 cm. long & 1-3 broad, petioles 1-2.5 cm. long; pedicels slender, glabrous, 3-5 cm. long; calyx 5-parted almost to base, conspicuously glandular-villous

on the outside with slender, several-celled hairs, glabrate within, calyx-segments linear-lanceolate, the 3 upper ones subequal, straight, 10-13 mm. long in flower, the 2 lower ones curving upward, 9-12 mm. long, in fruit sometimes up to 2 cm. long; corolla 3-4.5 cm. long, glandular-puberulent without, tube greenish white with bluish tinge, swollen at base in front, 5-7 mm. long, 5-6 wide, glabrous within at base, hairy above, throat of same color, sometimes tinged with yellow, 10-13 mm. wide, glabrous within, with 2 prominent pale plaits, limb dark purple, reflexed, lobes 7-8 mm. long, suborbicular; stamens much as in *scandens*, but more heavily villous below the genicula; pistil as in *scandens*; capsule globose, ca. 1 cm. long, the 2 valves projecting slightly beyond insertion of persistent style, dehiscence terminal, rather irregular; seeds oblong, etc. as in *scandens*.

Type locality: Mexico. Material studied, MEXICO: near Mondora, Coahuila, *Palmer 972* (G); San Luis Potosi, *Schaffner 748* (G, NY, Ph), *Parry & Palmer 664* (M, Ph); Mimas de San Rafael, San Luis Potosi, *Purpus 4911* (C, G, NY); Alvarez, San Luis Potosi, *Palmer 606* (C, F, G, M, NY, US); Sierra de la Mesa, Hidalgo, *Rose, Painter & Rose 9105* (US); San Luis Tultitlanapa, near Oaxaca, *Purpus 2575* (C, F, G, M, NY, S, US); San Felipe del Agua, Oaxaca, *Conzatti 588* (G); between Cadereyta & Visaron, Querétaro, *Rose, Painter & Rose 9747* (NY, US); Guanajuato, *Duges in 1880* (G); without locality, *Coulter 1342* (G). Introduced into other countries and escaped: Ambato, Tungurahua, Ecuador, *Pachano 87* (NY); Barbacena, Brazil, *Dorsett, Shamel, & Popenoe 307b* (US). The following cultivated material was available: Hort. Cantab., *1845* (G, NY), *1856* (G); Hort. Aupet a la Garaz prope Nevey, *1832* (NY); Hort. Haren., St. Louis, *Engelmann in 1850* (M); Philadelphia, *Redfield 5969* (M).

Lindley's description gives the length of the corolla as 3 in. and is followed by Bailey, l. c. I have seen no material with flowers more than half this length. The species is very close to *M. scandens* and may be sufficiently distinct from that species for varietal rank only.

4. MAURANDYA FLAVIFLORA Johnston, Proc. Calif. Acad. Sci. IV, 12:1162. 1924.

“Perennial (?) forming loose mat-like growths 2-5 dm. broad and about 1 dm. high; clammy-oily villous throughout, stems slender, branched mainly near the base; leaves bright green, thin, numerous, alternate, very broadly cordate or reniform, coarsely serrate, 20-25 mm. long, 25-40 mm. wide; petioles slender, non-tortuous, 1-3 cm. long; flowers axillary; pedicels slender, 20-25 mm. long, in fruit becoming coarse contorted and 5-10 cm. long; calyx 5-parted, in flower 11-12 mm. long with lobes foliaceous and the upper the longest (9 mm. long), accrescent in fruit, becoming firmer with lobes ovate and tube more developed; corolla pale yellow, cylindrical, glabrate outside, 25-28 mm. long; corolla-tube 4-5 mm. long, 4 mm. broad, glabrous within, stamens attached at about the middle and adnate to beginning of throat; corolla-throat amplified, 7-8 mm. wide at the middle, about 15 mm. long, within the lower part pubescent with numerous short flat yellow hairs (as is also the lower part of the filaments); corolla lobes broadly ovate or orbicular, not spreading, upper pair longest and united for about a third their length, lower lobes 3-4 mm. long with middle one the shortest; stamens 4, protruding 2-6 mm., fifth represented by small appendage near middle of corolla tube and between shorter pair of filaments; filaments flat, heavy pubescent below, with tack-shaped glands above, upper pair shortest being only about 25 mm. long, lower pair about 28 mm. long; anther-sacs about 1.25 mm. long, circular, discrete, divergent” after dehiscence; “pistil filiform, equalling or longer than stamens; fruit a turgid, laterally compressed, many-seeded capsule about 1 cm. broad; valves short-acuminate, above forming 2 crest-like apices in whose sinus is borne the sub-persistent style; seeds” almost black “with high irregular coarse corky longitudinal ridges, oblong, almost 2 mm. long”, not winged.

Type and only known collection: Las Animas Bay, Lower California, Johnston 3504 (Ca, G).

5. *MAURANDYA GENICULATA* Rob. & Fern., Proc. Am. Acad. 30:120. 1894.

M. geniculata of Johnston, Proc. Calif. Acad. Sci. IV, 12: 1163. 1924.

Apparently perennial herb, densely glandular-villous and viscous throughout, stems zigzag; leaves orbicular-cordate, thick, coarsely crenate, with blades 2-5 cm. broad, 2-4 cm. long, apparently not strongly bicolored, 5-nerved, petioles spreading, 1-2 cm. long; flowers not known; pedicels in fruit stout, recurved, up to 2 cm. long, solitary, axillary, calyx narrowly campanulate, subequally 5-cleft to near the middle, ca. 12 mm. long, segments oblong-ovate, obtuse, spreading at tips; style filiform, persistent, ca. 2 cm. long, slightly glandular; capsule glabrate, globular, ca. equal to calyx, irregular in dehiscence; seeds black, oblong, 1.5 mm. long, with large irregular, corky tubercles, not at all winged.

Known from a single collection on "cliffs at Nacroy, Sonora," at 3750 ft. by *Mr. Hartman No. 272*, (G. NY, US).

6. *Maurandya rosei* Munz, new species

Apparently low perennial herb, densely glandular-villous and oily throughout, stems at least 2-3 dm. high, often zigzag in fruit; leaf-blades orbicular-cordate, coarsely dentate, 2-4 cm. long, 2-4 wide, not bicolored, indistinctly 5-nerved, petioles ascending to recurved-spreading, 1-2 cm. long; flowers axillary, pedicels slender, 1-2 cm. long, contorted but scarcely elongated or thickened in fruit; calyx narrowly campanulate, subequally 5-cleft two-thirds its length, 18-20 mm. long, segments erect, ovate-lanceolate, acute; corolla apparently reddish, cylindrical, villous without, ca. 4 cm. long, tube 7-8 mm. long, 4-5 wide, glabrous within at base, throat gradually amplified, 6-7 mm. wide at its middle, ca. 30 mm. long, somewhat pubescent within especially near base and along the 2 prominent ridges on the corolla floor, lobes rounded, 5-6 mm. long, 4-5 wide, not spreading, division between upper and lower lips ca. 8 mm. deep; stamens 4, included, filaments flat, adnate for 5 mm., free parts of upper pair ca. 25 mm. long, of lower 32

mm., heavily pubescent near base and with tack-shaped glands near tips, anther-sacs ca. 1 mm. long after dehiscence, circular, discrete, divergent; sterile filament adnate to near the anther, ca. 20 mm. long; pistil filiform, glabrous, ca. 30 mm. long; capsule glabrous, globular, ca. 1 cm. long, distending the calyx, thin-walled, dehiscing apparently at first by 2 terminal openings, but soon becoming irregular; seeds brown, ca. 1.5 mm. long, oblong, with large irregular corky tubercles, but apterous.

Type locality: Bolaños, Jalisco, Mexico, Sept. 15 to Oct. 1, 1897, *J. N. Rose 2950* (U. S. No. 301903).

7. MAURANDYA PURPUSII Brandegee, *Zoe* 5:256. 1906.

M. purpusii of Curtis, *Bot. Mag.* IV, 13: t. 8697. 1917. Bailey, *Cyclop. Hort.* 4:2013. 1916. *M. erubescens* var. *purpusii* (Brandg.) Johnston, *Proc. Calif. Acad.* IV, 12:1164. 1924.

Perennial herb with thickened fleshy roots, stems ascending or prostrate, scarcely scandent, 9-12 dm. high, finely glandular-puberulent; leaves alternate, blades thin, glabrate above, puberulent below especially on veins, somewhat bicolorated, triangular-cordate, obscurely 5-lobed, remotely and shallowly mucronate-dentate to subentire, acute, 3-5 cm. long and equally wide, petioles glandular-puberulent, approaching leaf-blades in length; flowers solitary axillary, pedicels glabrous, ascending, slender, 4-5 cm. long (10 in hort.); calyx herbaceous tinged with purple, glabrate to puberulent, 5-parted, ca. 15 mm. long, segments erect, oblong-ovate, rounded and apiculate, cordate at base; corolla rose purple, funnellform, somewhat 2-lipped, 3.5-4 cm. long, glabrate without, tube slightly swollen at base in front, 12-14 mm. long, constricted ca. 5 mm. above base, glabrous within except on 2 yellow prominent plaits which continue into the rapidly ampliate throat, limb 2-lipped, lobes reflexed, subequal, suborbicular, almost 1 cm. long; fertile stamens subequal, barely exerted, filaments glandular above, densely coarsely pubescent below, anthers discrete, circular after dehiscence, each sac ca. 1 mm. long; sterile stamen half as long as fertile ones, heavily pubescent below; style almost

equal to stamens, glandular-pubescent below, filiform, persistent, stigma scarcely bilobed, ovary ovate, glandular-pubescent; capsule "ellipsoid", ca. 12 mm. long, glabrate, included in slightly spreading calyx; seeds brown, coarsely corky-tuberculate, body ca. 1 mm. long, with emarginate striate, irregular light-colored wing.

Material seen, the type collection, San Luis Tultitlanapa, Puebla, near Oaxaca, *Purpus 2567* (C, F, G, M, NY, S, US). The presence of the two prominent plaits in the floor of the corolla certainly distinguishes this plant sufficiently to make it a species distinct from *M. erubescens* which lacks such folds but has merely two lines of hair.

8. MAURANDYA ERUBESCENS (Don) Gray, Proc. Am. Acad. 7:377. 1868.

Frutescent, slender, branching freely, climbing by the twining petioles and pedicels, stems glandular-puberulent to pilose throughout; leaves thin, triangular-lanceolate or -cordate to obscurely 5-lobed, glabrate to soft-pubescent, coarsely dentate, somewhat bicolored, lower ones opposite, blades up to 15 cm. long and equally wide, subcordate, acuminate at tip, petioles up to several cm. long, glabrate to glandular-pilose, upper leaves reduced, alternate; flowers solitary, axillary, spreading horizontally, pedicels 2-6 cm. long, ebracteate, pubescent; calyx 5-parted, glabrate or pubescent without and within and tipped with minute glands, green or with purplish tinge, segments subequal, 15-20 mm. long, erect in anthesis, spreading in fruit; corolla 4-7 cm. long, tubular for 1.5-2 cm., constricted ca. 1 cm. above base, glabrous within below constriction, coarsely yellowish pubescent at narrow part, gradually ampliate upwards especially on the lower side, subarcuate, glabrate to finely pubescent without, limb with 2 upper lobes reflexed, & 3 lower ones somewhat erect, subequal, ca. 1 cm. long, 1.5 cm. wide, finely glandular, throat whitish with 2 plaits with bright yellow hairs; stamens connivent at outer extremities, scarcely dilated except at very base, not exerted, glandular toward tips, geniculate and heavily bearded toward base,

anther-sacs discrete, ca. 1.5 mm. long, circular after dehiscence; 5th stamen reaching about to genicula of others; pistil equaling stamens, ovary finely glandular-pubescent, stigma usually bifid; capsule pubescent, subglobular, 1.5 cm. long, surmounted by slender persistent base of style, dehiscing by 2 irregular slits; seeds having body ca. 1 mm. long, brown, oblong, coarsely corky tuberculate, and with a broad, paler, emarginate and lacerated wing.

8a. **Maurandya erubescens** var. **typica**, nom. nov.

Lophospermum erubescens Don in Sweet, British Fl. Gard. (II) 1: t. 75, note. 1830. Zuccarini, Muenchen, Abhandl. 1:305. 1832. Flora, Beibl. 2:61. 1832. Lindl., Bot. Reg. 17: t. 1381. 1831. Benth. in D. C., Prodr. 10:297. 1846. *L. scandens* Don, in Sweet, Brit. Fl. Gard. (II) 1: t. 68. 1830. Graham, in Curtis, Bot. Mag. 57: tt. 3037, 3038, 1830. Chavannes, Monogr. Antirrh., 75. t. 11. 1833. *Maurandya erubescens* (Don) Gray, Proc. Am. Acad. 7:377. 1868. Hemsley, Gard. Chron. (N. S.) 17:22. 1882. Biol. Centr. Am. 2:441. 1882. Gard. Chron. (2) 20:500., f. 81. 1883. Urbina, Cat. Pls. Mex., 256. 1897. Bailey, Cyclop. Hort., 4:2012. 1916. Johnston, Proc. Calif. Acad. Sci. (IV) 12:1164. 1924.

Plant densely soft pubescent throughout; calyx-segments pubescent, oblong-ovate, acute, to obtuse; corolla glandular-pubescent without, rose-colored, throat white with rose-colored spots on its roof.

Type locality: Jalapa, Mex. Material studied, MEXICO: Tamasopa Cañon, San Luis Potosi, *Pringle 3560* (G), *3704* (C, F, G, M, NY, Ph, US); Barrance de Tenampa, Vera Cruz, *Purpus 2952* (C, F, G, M, NY, US); Orizaba, *Bourgeau in 1865-66* (G), *Botteri 129* (G, US); Cerro del Boqueron, Chiapas, *Purpus 6696* (C, F, G, M, NY, US). COLUMBIA et ECUADOR, without definite locality, *Lehmann 5598* (US). VENEZUELA: Colonia Tovar, *Pittier 9256* (G, NY, US), *Jahn 478* (US). JAMAICA: Troy, *Perkins 1315* (G); St. Helens Gap, St. Andrews, *Maxon & Killip 574* (F, G, NY, US); Morces Gap, *Nichols 22* (F, G, M, NY,

US); Tweedside, S. St. Andrews, *Harris 6920* (F, NY); Cinchona, *Clute 198* (M, Ph, US), *Harris & Laurence C15269* (NY), *C15189* (US), *Harris 9150* (NY); Hardmere Gap, *Britton & Hollick 1784* (NY); Battersea, *Britton 3778* (NY); Mandeville, *Crawford 800* (Ph); New Haven Gap, *Maxon 2608* (US); Blue Mts., *Hitchcock* (F, M); without locality, *Parry in 1871* (US). BERMUDA: Public Garden, *Brown & Britton 919* (NY). AZORES: San Miguel, *Carreira 228A* (M). Hort. Cantab., *in 1845* (G). Hort. Basil, *in 1839* (NY).

Approaching *glabrata*, for example, *Purpus 6696*.

8b. MAURANDYA ERUBESCENS var. GLABRATA JOHNSTON, Proc. Calif. Acad. Sci. IV, 12:1164. 1924.

Lophospermum scandens Don, Trans. Linn. Soc. 15:353. 1826. Maund, Botanist, t. 17. 1837. Graham in Curtis, Bot. Mag. 65: t. 3650. 1838. Don, in Sweet, Brit. Fl. Gard. 2: t. 401. 1837. Benth. in D. C., Prodr. 10:297. 1846. *Maurandia scandens* of Gray, Proc. Am. Acad. 7:377. 1868. Hemsley, Gard. Chron. (N. S.) 17:22. 1882. Biol. Centr. Am. 2:442. 1882. Smith, Enum. Pl. Guat. 3:57. 1893, probably of Smith, l. c., 2:55. 1890. *M. lophospermum* Bailey, Cyclop. Hort. 4:2013. 1916.

Type locality: Mexico. Material studied: MEXICO: Morelos, Cuernavaca, *Pringle 6882* (C, F, G, M, NY, Ph, Po, US); Sierra de Tepoxlan, Morelos, *Rose & Painter 7245* (Ph, US); Jalapa, Vera Cruz, *Rose & Hay 6155* (US). GUATEMALA: S. Miguel Uspantan, Guiche, *Smith 3130* (G, NY, US). Cultivated: Hort. Cantab., *in 1866* (G).

Plant finely glandular-pubescent to glabrate; calyx-segments glabrate, lance-ovate, acuminate; corolla glabrate without, "purplish rose-colored, obscurely dotted on its outside."

9. MAURANDYA ERECTA HEMSLEY, Gard. Chron. (N. S.) 17:22. 1882. Biol. Centr. Am. 2:441. 1882.

M. erecta of Johnston, Proc. Calif. Acad. Sci. IV, 12:1164. 1924.

Erect perennial herb, glandular-villous and viscous throughout, stems 3-4 dm. tall, quite unbranched, densely leafy; leaf-

blades orbicular-cordate to cordate-reniform, thick, 1-4 cm. long, 1.5-6 cm. wide, shallowly coarsely crenate, apparently bi-colored, light green, 5-nerved, petioles equaling the blades; flowers horizontal, solitary in upper axils, pedicels slender, spreading, 1-1.5 cm. long; calyx herbaceous, campanulate, 12-14 mm. long, cleft to below middle, lobes oblong, obtuse glandular-pubescent within and without, not spreading in fruit; corolla 3.5-4. cm. long, funnelform, glandular-pubescent without, tube ca. 7 mm. long, 5 mm. wide, narrowed above the ovary, glabrous within, throat gradually amplified, more so on lower side, with 2 prominent hairy plaits, hairy within at base, lobes sub-orbicular 6-8 mm. long; fertile stamens didynamous, longer ones reaching almost to base of corolla-lobes, upper ones distinctly shorter, all glandular toward apex, geniculate and heavily pubescent above the dilated glabrous bases, anthers discrete, circular after dehiscence; sterile filament scarcely reaching genicula of others; style about as long as stamens, filiform, slightly glandular, stigma somewhat bilobed, ovary globose, glandular; capsule globose, ca. 12 mm. long, scarcely shorter than calyx, glabrate; seeds light brown, body 1.5 mm. long, oblong with elongate corky irregular tubercles and broad irregular, emarginate straw-colored, striate wing.

Type locality: San Lorenzo de Laguna, Coahuila, Mex. *Material seen:* MEXICO: San Lorenzo de Laguna, Coahuila, *Palmer 966* (G, Ph, US); Sierra de Parras, Coahuila, *Purpus 1049* (C, G, F, M, NY); Viesca, Coahuila, *Purpus 540* (C, Po, US); Cuíngar, *Edwards* (NY); Ixtacuixtla ?, Tlcala, *Purpus 37* (C, M, Po, US); Cerro de San Ignacio, Durango, *Purpus 4585* (C); without locality, *Edwards* (G).

EXCLUDED SPECIES

Excluded species, *Lophospermum physalodes* D. Don, *Trans. Linn. Soc.* 15:353. 1827. equals *Gastromeria physalodes* of Sweet, *Brit. Fl. Gard. N. S.*, 75. note. 1831, or *Melasma hispidum* Benth.

VII. RHODOCHITON

1. RHODOCHITON VOLUBILE Zucc. by Otto & Dietr., Verh. Ver. Gart. Preuss. 10:152. t. 1. 1829?

R. volubile of Martens & Galeotti, Bull. Acad. Rot. Brux. 12; no. 7, p. 3. 1845. Benth. in D. C., Prodr. 10:298. 1846. Paxton, Bot. Mag. 2:27. 1836. Graham in Curtis, Bot. Mag. 61: t. 3367. 1834. Lindl., Bot. Reg. 21: t. 1755. 1835. Hemsley, Gard. Chron. (IV) 17:22. 1882. Biol. Centr. Am. 2: 442. 1882. Revue Hort., 1910:78-79. Gard. Chron. III, 53:310. 1913. Bailey, Cyclop. Hort. 5:2930. 1916. *Lophospermum atosanguineum* Zucc., Abhandl. Muench. 1:306. t. 13. 1832. *L. rhodochiton* Don, in Sweet, Brit. Fl. Gard. N. S., 3: t. 250. 1834.

Suffrutescent, slender, climbing by means of twining petioles and pedicels, stems slender, sparsely glandular-villous, younger branches purple; leaves thin, alternate, triangular-cordate, somewhat 5-lobed, remotely mucronate-dentate, acuminate, glabrate, somewhat bicolored, often purplish tinged, blades 2-8 cm. long, equally broad, petioles almost equal to leaves, sparingly villous; flowers solitary, axillary, pendulous, pedicels slender, glabrate, 8-12 cm. long; calyx campanulate, spreading, ca. 2.5 cm. long, divided to the middle into 5 ovate acute lobes, pale purple, membranous, minutely glandular-pubescent, especially within; corolla straight, funnel-shaped, glandular-pubescent without, deep purple, 4-5 cm. long, tube 5 sided, 12-14 mm. long, constricted above ovary, glabrous within at base, pubescent at constriction, throat gradually expanded to 1 cm. wide, glabrous within not plaited, limb of 5 subequal erect obtuse lobes ca. 1 cm. long and 6-7 mm. wide, glabrous within; 4 fertile stamens subequal, anthers slightly exerted, discrete, subcircular after dehiscence, filaments glabrous above, heavily expanded above the pubescent base, not strongly geniculate; 5th sterile stamen very reduced; pistil slightly exceeding stamens, ovary green, globose, finely glandular-pubescent, style filiform, persistent slightly pubescent below, stigma short, bilobed; capsule globose, glabrate, 2-celled.

bursting irregularly at top, slightly over 1 cm. long; seeds brown, the body tubercular, ca. 1.5 mm. long, with a broad lighter-colored irregular wing split at both ends.

Type locality: Mexico. Material seen: MEXICO: Camino de Escalera, de Zantla a Pápalo, Oaxaca, *Gonzalez & Conzatti 756* (G, US); Oaxaca, *Nelson in 1894* (US). Cultivated: Botanic Garden, Harvard *in 1872* (G), *in 1868* (G), *in 1878* (G); Hort. Bot. Basil, *in 1841* (NY); San Diego, *Brandege Garden in 1895* (C); *Bernhardi Herb.* (M).

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XIII

**DESCRIPTIONS OF SEVEN ANDRENIDS IN THE
COLLECTION OF THE CALIFORNIA
ACADEMY OF SCIENCES**

BY
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The Andrenids described below were received some years ago from the California Academy of Sciences through Mr. Charles Fuchs.

1. *Andrena (Trachandrena) coactifera* Viereck, new species

Related to *A. (T.) multiplicata* Cockerell.

Female: Length 10 mm.; body black, mostly covered with pale ochreous and whitish hairs; head with its facial line : transfacial line : :55:63; axial line : temporal line : :27:18; elevated portion of malar space crowded out or nearly so; malar line : joint 3 of antennæ : :2:6; head with whitish hairs, front rather indistinctly, longitudinally striate, not elevated into a welt along the fovea; fovea at most : ocellocular line : :9:12; fovea virtually contiguous to the upper end of the inner eye margin; distance between fovea and ocelli : ocellocular line : :2:12; fovea decidedly constricted near its middle where it is apparently only a little more than half as wide as the greatest width of the fovea, the latter continued below the constriction as a narrowing furrow down to a point apparently on the clypeal line; hairs of fovea pale ochreous; fovarea widest at the middle of the fovea, angulated at its widest point where it is three-fourths as wide as the fovea is wide opposite the angulation of the fovarea, the latter polished and with a few punctures; face polished, with adjoining or nearly adjoining punctures; clypeus elevated above the apical margin, convex, pol-

July 22, 1926.

ished, punctured much like the face but with some of its punctures larger; clypearea poorly developed on the lower half of the nearly bare clypeus; labrarea truncate, width at base : length down the middle ::10:3, width at apex : length down the middle ::4:3; labrarea at base : distance between lower corners of clypeus ::10:19; labrum with a fringe of pale hairs; joint 3 of antennæ: 4 + 5 ::7:8; joint 4 as thick as long, the succeeding joints a little longer than thick; antennæ blackish to brownish throughout; mandibles atypical, robust, extending to the outer edge of the labrum, black except for the apical half which is mostly clear dark reddish; palpi nearly typical; thorax above covered with an abundance of whitish thick hairs that are shorter on the dorsulum, where they are thick, than the thin hairs on the mesopleura; dorsulum with disc of the hind half set off from the margins by brownish, thick hairs; notauli represented by an impressed dullish line; mesopleura with whitish hairs that are thin except along the upper margin where the hairs are thick; scutellum hairy and sculptured much like the dorsulum except for being more closely punctured and devoid of brownish hairs; metanotum hairy and sculptured like the dorsulum except that the sculpture is less defined; tegulæ dark and pale stramineous, polished; wing base partly blackish brown; subcosta blackish brown like the stigma, rest of veins dull brownish stramineous; legs blackish brown except for the small joints of the tarsi and hind tibiæ which are more or less pale brownish; legs covered with pale whitish and golden hairs; scopa typical, its hairs whitish, and concolorous throughout with the hairs at base above slightly darkened; hind metatarsi at most apparently as wide as mid metatarsi; propodeum with its enclosure fairly well defined, bounded at apex by a trenchant carina, coarsely plicate, rest of upper face of propodeum sculptured somewhat like the mesopleura but not so coarsely, and covered with thin whitish hairs; propodeal pleura with scattered punctures recalling cutis anserinus; floccus whitish; abdomen with its tergum polished, punctured, the punctures clear cut but small and mostly adjoining or nearly adjoining on the elevated portions, sparser on the depressed portions; second tergite with its elevated portion down the middle : depressed portion ::8:16; fifth tergite with coarse adjoining punctures; pygidium convex, nearly pointed at apex; tergum with inconspicuous pale hairs, second, third and fourth tergites with a broadly interrupted whitish hair band; fimbria brownish-golden.

Type: Female, No. 1723, Mus. Calif. Acad. Sci., collected by Dr. F. E. Blaisdell, in July, at Tallack, California.

2. *Andrena* (*Parandrena*) *cuneilabris* Viereck, new species

Related to *A. (P.) parachalybea* Viereck.

Female: Length 12 mm.; body greenish, mostly covered with pale ochreous and whitish hairs; head with its facial line : transfacial line ::55:70; axial line : temporal line ::31:20; malar line : joint 3 of anten-

$n\bar{a} :: 1:10$; ocellocapital line : greatest diameter of lateral ocellus : $4:3.5$; elevated portion of malar space crowded out or nearly so; head with whitish and black hairs; front rather indistinctly, longitudinally striate, not elevated into a welt along the fovea; fovea at most : ocellocular line : $10:14$; foveal band wanting; distance between fovea and ocelli : ocellocular line : $4:14$; fovea gradually attenuated below its middle and continued to a point apparently between the clypeal and the antennal line, filled with dark seal-brown hairs; vertex and temples along the upper edge of the eye and sides of front along the foveæ with black hairs; face dullish, with distinct punctures that are as many as five puncture-widths apart; clypeus in the middle not elevated above the apical margin, nearly planate, sculptured like the face except that the punctures are smaller; clypearea wanting; clypeus thinly hairy, its sculpture not at all hidden by hairs; labrarea unituberculate, its width at base : length down the middle : $6:4$, width at apex : length down the middle : $2:4$; labrarea at base : distance between lower corners of clypeus : $6:18$; labrum with a fringe of golden hairs, without a median longitudinal crista between the labrarea and apical edge of labrum; joint 3 of antennæ : $4 + 5 :: 10:7$, joints 4 & 5 thicker than long, the succeeding joints as thick as long or little longer than thick except joint 12 which is distinctly longer than thick; antennæ blackish throughout; mandibles nearly typical, slender, extending to beyond the lower angles of the clypeus, black except for the apex which is dark reddish; palpi atypical, slender; thorax covered with an abundance of pale ochreous almost white and whitish hairs that are as long on the dorsulum, where they are pale ochreous, as are the whitish hairs on the mesopleura; dorsulum dullish, finely reticulated and distinctly punctured like the face, but not so closely; notauli represented by an impressed shining line; mesopleura densely sculptured nearly rugose, indefinitely punctured; scutel hairy and sculptured much like the dorsulum; metanotum hairy and sculptured like the dorsulum except that the sculpture is denser and less distinct; tegulæ dark brown, partly polished; wing base partly blackish brown; subcosta blackish brown; stigma pale brownish stramineous, rest of veins dull stramineous; legs blackish, except for the tarsi which are more or less brownish, covered with brownish golden and ochreous hairs; scopa typical, its hairs pale ochreous, almost white, the hairs at base above decidedly darkened; hind metatarsi at most apparently a little wider than mid metatarsi; propodeum with its enclosure poorly defined, dullish and finely reticulated and with a few basal plicæ; rest of upper face of propodeum finely reticulated, coarsely pitted and covered with fine whitish hair; propodeal pleura coarsely sculptured, wrinkled; abdomen with its tergum dullish, finely reticulated and finely punctured, the punctures from two to six or more puncture-widths apart on the first tergite, hardly closer on the succeeding tergites; second, third and fourth tergites without an apical hair band; apical edge of first, second, third and fourth tergites with a pale stramineous border, second tergite with its elevated portion down the middle : depressed portion : $12:15$; fifth tergite shining, reticulate, its coarse punctures closer together than the punctures on the other

tergites; pygidium rounded at apex, nearly planate, with a median triangular slightly embossed area and a shallow furrow on each side, tergum with inconspicuous nearly erect pale hairs, fimbria pale brownish.

Type: Female, No. 1724, Mus. Calif. Acad. Sci., collected by Dr. F. E. Blaisdell, in April, at **Mokelumne Hill, California.**

3. *Andrena (Andrena) shasta* Viereck, new species

Related to *A. (A.) pascoensis* Cockerell of which it may prove to be only a race or variety.

Female: Length 12 mm.; body black, mostly covered with tawny hairs; head with its facial line : transfacial line ::65:82; axial line : temporal line ::34:19; malar line : joint 3 of antennæ ::3:12; elevated portion of malar space nearly crowded out, ocelloccipital line : greatest diameter of lateral ocellus ::4:5; head covered with tawny hairs; front rugoso-punctate, not elevated into a welt along the fovea; fovea at most : ocellocular line ::12:14; distance between fovea and ocelli : ocellocular line ::2:14; foveal band wanting; fovea slightly gradually attenuated below its middle and continued to a point apparently on the clypeal line, filled with golden hairs; face dullish, closely punctured, the punctures adjoining or nearly so; clypeus elevated above the apical margin, convex, polished and coarsely punctured, the punctures from adjoining to three puncture-widths apart; clypearea present but poorly defined; clypeus thinly hairy its sculpture not at all hidden by hairs; labrarea truncate, its width at base : length down the middle ::10:5; width at apex : length down the middle ::7:5; labrarea at base : distance between lower corners of the clypeus ::10:20; labrum with a fringe of golden hairs; joint 3 of antennæ : 4 + 5 ::12:10; joints 4 and 5 thicker than long; first six joints of antennæ blackish excepting the apex of the scape which is dark stramineous; mandibles atypical, robust, extending to the outer edge of the labrum, dark stramineous, blackish near apex; palpi typical; thorax covered with an abundance of tawny hairs that are much shorter on the dorsulum where they are darker than the hairs on the mesopleura; dorsulum shining, with conspicuous adjoining or nearly adjoining punctures; notauli represented by a shining line; mesopleura with adjoining pits; scutel hairy and sculptured much like the dorsulum; metanotum hairy and sculptured like the dorsulum except that the sculpture is denser and less distinct; tegulæ pale stramineous, polished; wing base stramineous; subcosta blackish; stigma pale brownish stramineous, rest of veins dark stramineous; membrane uniformly tinged with brown; legs blackish except for the apex of femora and all of the tarsi and tibiæ, which are more or less yellowish stramineous; legs covered with pale ochreous and golden hairs; scopa typical, its hairs nearly golden throughout; hind metatarsi at most apparently a little narrower than mid metatarsi; propodeum with its enclosure poorly defined, coarsely sculptured as in *A.*

(*S.*) *cratægi* Rob.; rest of upper face of propodeum sculptured somewhat like the mesopleura but not so coarsely, and covered with finer golden hair; propodeal pleura with sparse pits; abdomen with its tergum shining and sculptured much like the face; the punctures from adjoining to three puncture-widths apart on the first tergite, the punctures adjoining or nearly so on the succeeding tergites; second, third and fourth tergites with an apical, golden hair band that nearly completely fills the depressed portion of those tergites; apical edge of first, second, third and fourth tergites with a stramineous border; second tergite with its elevated portion down the middle : depressed portion ::22:10; fifth tergite shining, finely reticulate, its punctures not so close but much coarser than on the other tergites; pygidium nearly planate, nearly pointed at apex; tergum with inconspicuous, pale nearly erect hairs in addition to the hair bands; fimbria golden.

Other locality, Shasta Co., Calif.

Type: Female, No. 1725, Mus. Calif. Acad. Sci., collected by Dr. F. E. Blaisdell, at San Diego, California.

4. *Andrena (Andrena) sinaloa* Viereck, new species

Related to *A. (A.) kincaidi* Cockerell.

Female: Length 11 mm.; body black, mostly covered with whitish or white hair; head with its facial line : transfacial line ::57:77; axial line : temporal line ::32:18; malar line : joint 3 of antennæ ::2.5:11; elevated portion of malar space virtually crowded out; ocelloccipital line : greatest diameter of lateral ocellus ::3:5; head covered with white hairs; front rather indistinctly rugulose and pitted, not elevated into a welt along the fovea; fovea at most : ocellocular line ::10:13; distance between fovea and ocelli : ocellocular line ::3:13; foveal band wanting; fovea attenuated below its middle and continued to a point apparently a little below the clypeal line, filled with whitish hairs; face shining, closely punctured; clypeus brownish down the middle, not elevated above the apical margin, convex, polished, with well separated distinct punctures; clypearea present but poorly defined; clypeus thinly hairy its sculpture not at all hidden by hairs; labrarea rounded, its width at base : length down the middle ::10:4; labrum with a fringe of pale hairs and without a median longitudinal crista between the labrarea and apical edge of labrum; joint 3 of antennæ : 4 + 5 :: 11 :8; joints 4 and 5 thicker than long, the succeeding joints as thick as long or little longer than thick except joints 11 and 12 which are distinctly longer than thick; antennæ blackish throughout; mandibles atypical, robust, black at base; palpi nearly typical; thorax covered with an abundance of whitish hairs that are much shorter on the dorsulum than the whitish hairs on the mesopleura; dorsulum shining, closely and deeply punctured; notauli

represented by an impressed shining line; mesopleura coarsely pitted; scutellum hairy and sculptured much like the dorsum; metanotum hairy like the dorsum, densely sculptured; tegulae dark brown, polished; wing base partly blackish brown; subcosta blackish brown; stigma pale brownish stramineous; rest of veins dull stramineous, the costal half of the wings infuscated; legs blackish except for the tarsi which are more or less brownish, covered with whitish and golden hairs; scopa typical, its hairs whitish, hairs at base above darkened; hind metatarsi at most apparently a little narrower than mid metatarsi; propodeum with its enclosure poorly defined, rugose nearly as in *A. (S.) cratægi* Rob.; rest of upper face of propodeum indistinctly sculptured; abdomen with its tergum shining to polished and sculptured much like the face, the punctures mostly from adjoining to two puncture-widths apart on the first tergite, hardly closer on the succeeding tergites; second, third and fourth tergites with an apical, whitish hair band that is interrupted in the middle of the second; apical edge of first, second, third and fourth tergites with a dark stramineous border; second tergite with its elevated portion down the middle : depressed portion : 9:17; fifth tergite shining, reticulate, its punctures coarser and sparser than on the other tergites; pygidium nearly planate; tergum with inconspicuous pale, nearly erect hairs in addition to the hair bands; fimbria brownish.

Type: Female, No. 1726, Mus. Calif. Acad. Sci., collected by Chas. Fuchs, at **Culiacan, Sinaloa, Mexico.**

5. *Andrena (Andrena) innominata* Viereck, new species

Related to *A. (A.) interrogationis* Viereck & Cockerell.

Male: Length 7 mm.; body greenish, mostly covered with white hair; head with its facial line : transfacial line : 40:48; axial line : temporal line : 21:11; temples rounded; malar line : joint 3 of antennæ : 1.5:6; elevated portion of malar space virtually crowded out; head covered with white hairs except along the inner eye margin, upper eye margin, and outer eye margin above the middle of temples and on front where the hairs are black; front with longitudinal raised line; ocellular line : ocellopituitary line : 9:4; face shining, indistinctly punctured, its punctures from one to three puncture-widths apart; clypeus nearly planate, slightly concave, dullish and more distinctly punctured than the face, elevated directly above the apical margin; clypeus wanting; sculpture of the clypeus not hidden by the mustache; labrum truncate at apex, emarginate beyond on its under side, polished, its width at base : greatest length : 5:2, width at apex : length down the middle : 4:2; labrum at base apparently half as wide as the distance between the lower angles of the clypeus, with a fringe of whitish hairs; joint 3 of antennæ : 4:6:4; joint 4 and following joints from a little longer than thick to nearly one and one-half times as long as thick, dullish; flagel, almost straight

in outline; antennæ brownish throughout; mandibles nearly typical, rather slender, extending a little beyond the lower corners of the clypeus, black except for the apical fourth which is dull dark reddish; palpi slender; thorax covered with an abundance of white hairs; hairs of dorsulum nearly as long as the hair of mesopleura; dorsulum dullish, finely reticulated and sparsely punctured, the punctures indistinct and from two to five or more puncture-widths apart, mostly the latter; notauli represented by an impressed shining line; mesopleura dullish with pale ochreous hairs throughout, finely reticulated and mostly covered with shallow pits that are mostly three or more pit-widths apart; scutel hairy and sculptured like the dorsulum; metanotum hairy and sculptured like the dorsulum except that the sculpture is denser; tegulæ dark brown, polished; wing base brownish; subcosta blackish; stigma brownish, membrane nearly colorless; legs blackish brown excepting the small joints of the tarsi which are paler, covered with whitish hairs; hind metatarsi at most hardly wider than mid metatarsi and nearly half as wide as hind tibiæ at apex of the latter; propodeum with its enclosure poorly defined, irregularly rugulose on basal half, finely granular on apical half, rounded off at apex; rest of upper face sculptured somewhat like the mesopleura but with smaller pits and covered with finer whitish hair; propodeal pleura sculptured apparently like the mesopleura; abdomen with its tergum shining, finely reticulated and indistinctly punctured, the punctures mostly three or four puncture-widths apart; first tergite, with erect whitish hairs; second and third tergites with nearly erect whitish hairs; second tergite with its elevated portion down the middle : depressed portion ::11:7; seventh sternite triangularly emarginate at apex, the emargination as deep as the distance between the tips of the processes of this sternite; apical margin of tergites brownish; process narrow, shaped as in *A. (A.) jessica* C. & C. but slenderer at base and truncate at apex; tergum without hair bands, hair at apex of abdomen of a golden hue; hypopygium somewhat as in *A. (A.) jessica* C. & C. but with the lingam nearly parallel sided and much narrower though thicker at apex; processes also slenderer.

Type: Male, No. 1727, Mus. Calif. Acad. Sci., collected by Dr. F. E. Blaisdell in April at **Mokelumne Hill, California.**

6. *Andrena (Andrena) marina* Viereck, new species

Related to *A. (A.) bisalicis* Viereck.

Male: Length 8 mm.; body black, mostly covered with ochreous hair; head with its facial line : transfacial line ::47:58; axial line : temporal line ::24:14; temples rounded; malar line : joint 3 of antennæ ::2:7; elevated portion of malar space virtually crowded out; head covered with ochreous hairs except along the inner eye margin, upper eye margin, and outer eye margin above the middle of temples and on front where

the hairs are black; front rugulose, shining; ocellular line : ocellocipital line ::11:4; face shining, rather indistinctly punctured, its punctures from one to two puncture-widths apart; clypeus convex; labrarea broad and truncate, polished, its width at base : greatest length ::7:2, nearly as wide at apex as at base; joint 3 of antennæ :4::7:4; joint 4 and following joints from a little thicker than long to a little longer than thick, dullish; flagel, almost straight in outline; antennæ brownish throughout; mandibles atypical, robust, extending beyond the outer edge of the labrarea, and nearly to end of the basal half of its fellow, black except for the apical third which is reddish; palpi slender; thorax covered with an abundance of dark, dull ochreous hairs; hairs of dorsulum seemingly a little shorter than hair of mesopleura; dorsulum dullish, finely reticulated and sparsely punctured, the punctures indistinct and from two to five or more puncture-widths apart; notauli represented by a shining line; mesopleura dullish with pale ochreous hairs throughout, finely reticulated and mostly covered with shallow pits, that are three or more pit-widths apart; scutel hairy and sculptured like the dorsulum; metanotum hairy and sculptured like the dorsulum except that the sculpture is denser; tegulæ dark brown, polished; wing base mostly brownish; subcosta blackish; stigma brownish stramineous with a blackish tinge, membrane uniformly tinged with brown; legs blackish brown excepting the tarsi which are brownish stramineous; legs covered with ochreous hairs; hind metatarsi at most hardly wider than mid metatarsi and nearly half as wide as hind tibiæ at apex; propodeum with its enclosure poorly defined, irregularly rugulose, rounded off at apex, rest of upper face sculptured somewhat like the mesopleura but with smaller pits and covered with pale ochreous hair; propodeal pleura sculptured apparently like the mesopleura; abdomen with its tergum shining, almost polished, finely reticulated and indistinctly punctured, the punctures mostly three or four puncture-widths apart; first and second tergites with long, erect, pale ochreous hairs; second tergite with its elevated portion down the middle : depressed portion ::14:7; fourth and fifth tergites with brownish appressed hairs on the elevated portion, fifth tergite with its basal blackish portion covered with poorly defined punctures that are as many as four puncture-widths apart; rest of fifth tergite and exposed portion of sixth and seventh tergites with a stramineous margin; anal process subemarginate and slenderer than in *A. (A.) geranii* Rob.; prominences of seventh sternite like an M in outline; hair at apex of abdomen of a golden hue; hypopygium of the *A. (A.) geranii* Rob. type but lobes not at all pointed outwardly and under side of ends of processes not bevelled.

Type: Male, No. 1728, Mus. Calif. Acad. Sci., collected by Chas. Fuchs in **Marin County, California.**

7. *Andrena (Andrena) chapmanæ* Viereck

Andrena chapmanæ Vier. Can. Ent., 36 (191, 223), 1904.

Type: No. 4121, The Academy Nat. Sci., Phila.

Andrena yosemitensis Cockerell, Pan-Pacific. Ent., 1, (51, 62), 1924.

Type: No. 1586, The Calif. Acad. Sci.

Type locality: Yosemite, Calif., June 24, 1902 (B. Chapman.)

Related to *A. (A.) purpurina* Vier. & Ckll.

Female: Length 10 mm.; body mostly bluish green, mostly covered all over with black hairs; head with its facial line : transfacial line :: 64 : 76; axial line : temporal line :: 31 : 19; malar line : joint 3 of antennæ :: 3 : 10; elevated portion of malar space nearly crowded out; ocelloccipital line : greatest diameter of lateral ocellus :: 6 : 5; front punctured and longitudinally striate, not elevated into a welt along the fovea; width of fovea at most : ocellocular line :: 10 : 15; distance between fovea and ocelli : ocellocular line :: 5 : 15; foveal band virtually wanting at upper end of the inner eye margin; fovea nearly parallel sided, narrowed below the middle and continued to a point apparently a little below the clypeal line, filled with dark seal brown hairs; face polished or nearly so, partly indistinctly reticulate, with distinct punctures that are as much as two puncture-widths apart; clypeus mostly black, distinctly elevated above the apical margin, convex, polished, with large scattered punctures that are as much as six puncture-widths apart down the middle, but sculptured like the face along the edges excepting the anterior edge; clypearea poorly defined; clypeus thinly hairy its sculpture not at all hidden by hairs; labrarea emarginate, its width at base : length down the middle :: 12 : 4; width at apex : greatest length :: 4 : 5; labrum with a fringe of blackish hairs, with a faint median longitudinal welt between the labrarea and apical edge of labrum; joint 3 of antennæ : 4 + 5 :: 10 : 8; joints 4 and 5 thicker than long, the succeeding joints as thick as long except joint 12 which is distinctly longer than thick; antennæ blackish throughout; mandibles atypical, robust, extending about half way to the outer edge of the labrum, dark reddish throughout; palpi nearly typical; thorax above thinly covered with hairs that are shorter on the dorsulum than the hairs on the mesopleuræ; dorsulum dullish in front, mostly shiny, finely reticulated and punctured like the face but more distinctly so and not so closely; notauli represented by a shining line; mesopleuræ shiny, sculptured somewhat like the dorsulum but not so closely or distinctly punctured; scutel hairy and sculptured much like the dorsulum but with some longer hairs and with pale hairs laterally near the edge; metanotum with some pale hairs, partly shiny, mostly dullish, densely, finely sculptured and punctured; tegulæ dark brownish stramineous, partly almost polished; wing base dark stramineous; subcosta blackish brown; stigma pale yellowish brown-stramineous with a blackish border, rest of veins dull blackish stramineous; first recurrent vein received by the second submarginal cell be-

yond the middle and nearly as near to the second transverse cubitus as the first transverse cubitus is to the stigma on the radial vein; nervulus interstitial and forming an acute angle with the first abscissa of the discoidal vein; membrane uniformly tinged with brown; legs blackish brown throughout and covered with black hairs; scopa typical, its hairs black all over; hind metatarsi at most apparently a little narrower than mid metatarsi; propodeum with its enclosure poorly defined, dullish and finely reticulated, as well as with some delicate wrinkles, rest of upper face of propodeum sculptured somewhat like the mesopleuræ but with smaller punctures, and covered with finer hair; propodeal pleuræ shiny, finely reticulated and with sparse shallow punctures, floccus well developed; abdomen with its tergum shining and sculptured much like the propodeal pleuræ but with well defined small punctures from two to six or more puncture-widths apart on elevated portion of the first tergite, the punctures hardly closer on the elevated portions of the succeeding tergites; the depressed portion of the first, second, third and fourth tergites almost impunctate; apical edge of first, second, third and fourth tergites with a stramineous edge; second tergite with its elevated portion down the middle : depressed portion :: 18 : 9; fifth tergite shining, reticulate, its punctures differing from those on the other tergites, its sculpture recalling cutis anserina; pygidium planate, truncate at apex; tergum with conspicuous, short, nearly erect black hair bands; fimbria black.

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XIV

**EXPEDITION TO THE REVILLAGIGEDO ISLANDS,
MEXICO, IN 1925, VII¹**

CONTRIBUTION TO THE GEOLOGY AND PALEON-
TOLOGY OF THE TERTIARY OF CEDROS
ISLAND AND ADJACENT PARTS
OF LOWER CALIFORNIA¹

BY

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Department of Paleontology

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¹ This paper is No. 7 of the Revillagigedo Islands Expedition of 1925. Previous papers dealing with the scientific results of that expedition are to be found in preceding papers of Vol. XV of these Proceedings, No. 1, pp. 1-113, being the General Report with itinerary.

July 22, 1926

INTRODUCTION

The following paper is a report on all available collections of fossils from the Pliocene beds of Cedros Island², off the west coast of Lower California, and of the general region about Turtle Bay³, opposite the island in the central part of the west coast of the peninsula. No extensive list of fossils of any of the Tertiary formations of Lower California has heretofore been published, and the fauna herein described extends our knowledge of the Pliocene of western North America southward.

The greater part of the material upon which this report is based was obtained by the expedition of the California Academy of Sciences to the Revillagigedo and Tres Marias Islands, Mexico, in the early summer of 1925. The party spent three days on Cedros Island, and two days at Turtle Bay. During that time Dr. G. Dallas Hanna and the present senior author made collections as complete as possible from the Pliocene sediments that are exposed at these places.

The writers have also examined a small collection made on Cedros Island and at Turtle Bay by Dr. Hanna in the course of the expedition to Guadalupe Island in 1922.

During a recent geological investigation of Lower California by the Marland Oil Company of California, Mr. B. F. Hake made collections from the Pliocene beds in the general region about Turtle Bay. Most of the material was deposited at Leland Stanford Junior University by Mr. Carl H. Beal, Chief Geologist of the company, and through his courtesy and that of Dr. J. P. Smith, Professor of Paleontology at the Leland Stanford Junior University, it has been available for the present study⁴. Finally, in the collections of the California Academy of Sciences, Leland Stanford Junior University, and the University of California, there are a few specimens collected on Cedros Island by Mr. Henry Hemphill and others. These have been examined in the course of the work.

A few species have already been described or listed on the basis of this material. From the fossils secured by Hanna on

² Cedros Island has been sometimes called "Cerros" Island.

³ Also known as San Bartolome Bay, Bahía San Bartolo, and Bahía Tortuga.

⁴ See *Boletín del Petróleo*, Vol. 17, No. 6, 1924, pp. 417-453; Vol. 18, No. 1, 1924, pp. 14-53, for an account of the observations of the Marland Oil Company's geologists.

Cedros Island in 1922, Israelsky⁵ described three new species of echinoids; Hertlein⁶ has already described or listed the pectens from the collections made by Hake and Hanna in 1922. Except for the information found in these two papers, and for descriptions of a few species from Cedros Island by early writers, the fauna of the Pliocene of this region has remained unknown.

The geologic occurrence of the deposits at Cedros Island and at Turtle Bay is briefly discussed in the present paper and the known fossils are listed. The relations of the fauna to those of Pliocene formations elsewhere are considered. Finally, notes are included on many of the definitely recognized species, and 10 new species are described.

The writers wish to acknowledge their indebtedness to Dr. G. Dallas Hanna, Curator of Paleontology in the California Academy of Sciences, for the collection of much of the material upon which this report is based, for advice and assistance in various ways during the preparation of the manuscript, and for preparation of the illustrations. Acknowledgment is due Mr. T. F. Stipp for assistance in the preparation of the sketch map. They also wish to thank Mr. Carl H. Beal, of the Marland Oil Company of California, for permission to publish upon the collections made by geologists of that company; and Dr. J. P. Smith, of Leland Stanford Junior University, for permission to borrow these collections and for helpful suggestions and criticism during the course of this study; acknowledgment is due Dr. B. L. Clark, of the University of California, for opportunity to examine type specimens in the collections of that institution.

OCCURRENCE AND GEOLOGY

The approximate position of the localities from which the fossils described in this report were obtained is shown on the accompanying sketch map (fig. 1). Limitation of time precluded any careful geological investigation by the senior author at either Cedros Island or at Turtle Bay. It was for the same reason impossible to cover any large area in collect-

⁵ Univ. Cal. Pub. Geol., Vol. 14, No. 11, 1923, pp. 377-396.

⁶ Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, pp. 1-35.

ing, and the large number of specimens obtained may be attributed to the extreme abundance of fossils. Members of the expedition did not visit the localities at Elephant Mesa⁷ nor at the Mesa west of Mesa de las Auras⁸, where Mr. Hake

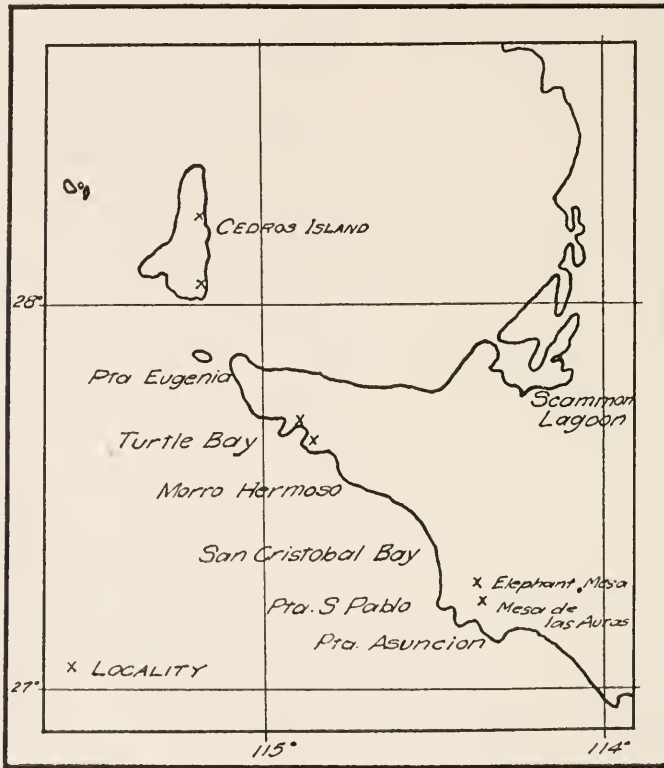


Fig. 1. Map showing collecting stations.
(Tracing from map by Rand McNally.)

made collections for the Marland Oil Company, and no information was secured as to the geology at those places.

At Bernstein's Abalone Camp, on the southeast side of Cedros Island, a tilted block of Tertiary sediments is exposed, apparently a fault block, downthrown relative to the complex

⁷ Localities 48 (L. S. J. U.), 76 (L. S. J. U.), and 77 (L. S. J. U.).

⁸ Locality 43 (L. S. J. U.)

of older sediments, and metamorphic rocks that compose the core of the island.

The Tertiary strata dip in a general northerly direction directly toward the older rocks. On the south side of the block, beneath the Tertiary beds, sandstones, conglomerates and shales⁹ are exposed; these dip northward at a high angle. Hanna has recorded the occurrence of Foraminifera, *Inoceramus* and *Ammonites* in the shale.

Unconformably overlying the older beds are several hundred feet of sediments probably of Miocene age. At the base is a layer containing bones of whales and other marine mammals and sharks' teeth which can be identified with species from the Miocene of California. A thin bed of gray siliceous shale overlies the bed containing the vertebrate fossils. The greater part of the Miocene which overlies the two beds just described, consists of strata of nearly uniform, fine grained, rather soft white sandstone, in all several hundred feet thick, and as far as known, barren of recognizable megascopic fossils.

Several hundred feet of Pliocene sediments overlie the Miocene series, probably unconformably¹⁰. These consist of fairly well consolidated sandstones and gravels in alternating layers of varying thickness. The Pliocene series is extraordinarily fossiliferous throughout, and, the preservation of certain groups of fossils is everywhere excellent. The Pliocene sediments are more resistant to erosion than are the soft Miocene beds. The higher parts of the area of Tertiary rocks are occupied by Pliocene and the Miocene-Pliocene contact is marked by a steep escarpment.

About nine miles north of Bernstein's Camp, on and close to the shore, and almost surrounded by older rocks, a small area of Pliocene beds is exposed, similar to those at Bernstein's camp. They are nearly flat lying and their occurrence at this point may or may not be ascribed to faulting.

The stratigraphy at Turtle Bay is essentially similar to that on Cedros Island. The oldest rocks exposed close to the bay are conglomerates accompanied by less abundant sandstones and shales, and the series may be several thousand feet in

⁹ Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 1, 1926, p. 86.

¹⁰ Locality 928 (C. A. S.).

thickness. These beds stand at high angles and were mapped by the Marland Oil Company geologists¹¹ as Eocene, the equivalent of the Tepe Tate formation of the southern part of the peninsula, but may be in part or all Cretaceous on the basis of similarity of lithology and stratigraphic position to the Cretaceous beds on Cedros Island, as considered by Hanna¹². Miocene and Pliocene sediments occupy old embayments of small size between low ranges of hills composed of Cretaceous or Eocene rocks. The base of the Miocene series is a layer containing bones and sharks' teeth, belonging to the species *Aetobatus smithii* Jordan & Beal, *Carcharocles rectus* Ag., *Carcharhinus antiquus* Ag., *Carcharodon* sp., *Hemipristis heteropleurus* Ag., and *Isurus hastalis* Ag., and pectens which are poorly preserved, but resemble *P. andersoni* Arnold. A bed of white siliceous shale about 30 feet thick, overlies the bone bed. The remainder of the series is soft fine grained white sandstone, ash, and impure diatomite rich in fish scales and in casts of foraminifera. The whole Miocene series is several hundred feet thick, and the beds dip in a general westerly direction at about 20°.

The Pliocene series at Turtle Bay¹³ overlies the Miocene unconformably. The beds are almost horizontal, the prevailing dip being very gently seaward. They consist of soft to moderately indurated sandstones, abundantly fossiliferous throughout. At the time of deposition these beds apparently contained a large and varied molluscan fauna, but leaching, presumably a result, in part at least, of the desert conditions of the region, has removed the shells of all but a few genera leaving of the others only casts seldom specifically determinable. As on Cedros Island the Pliocene sediments are generally more resistant to erosion than is the Miocene material, and the Pliocene stands up in prominent small mesas and hills.

The areal extent of neither the Miocene nor Pliocene beds was determined in the Turtle Bay region. East of the bay, mountains composed of conglomerates and sandstones of either Cretaceous or Eocene age rise rather abruptly above the younger sediments.

¹¹ Boletín del Petróleo, Vol. 18, No. 1, 1924. Map opposite p. 53.

¹² Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 1, 1926, p. 86.

¹³ Localities 944 (C.A.S.), 945 (C.A.S.), 47 (L.S.J.U.), 49 (L.S.J.U.), 80 (L.S.J.U.).

A thin veneer of Pleistocene sands and gravels, containing a marine fauna, overlies the Tertiary beds, some places nearly a hundred feet above the sea.

LIST OF COLLECTING STATIONS

California Academy of Sciences localities:

928 (C.A.S.). Cedros Island, off Lower California. Pliocene beds at Bernstein's Abalone Camp on southeast side of island. G. D. Hanna and E. K. Jordan collectors. This is the same as Locality 753 (C.A.S.)¹⁴.

944 (C.A.S.). Turtle Bay, Lower California. Pliocene beds exposed on shore at north end of Bay, beneath the Pleistocene. G. D. Hanna and E. K. Jordan, collectors. Locality 930 (C.A.S.)¹⁵, is in part the same as this locality.

945 (C.A.S.). Turtle Bay, Lower California. Pliocene beds exposed about a prominent monadnock, from one to two miles to southeast of bay. G. D. Hanna and E. K. Jordan collectors.

946 (C.A.S.). Cedros Island, off Lower California. Pliocene beds exposed near the shore on east side of island about nine miles north of Bernstein's Abalone Camp. G. D. Hanna and E. K. Jordan collectors.

Leland Stanford Junior University localities:

43 (L.S.J.U.). "Mesa west of Mesa de las Auras, Scammon Lagoon Quadrangle, Lower California; 27° 15' N. Lat., 114° 20' W. Long". Pliocene; B. F. Hake, collector.

47 (L.S.J.U.). "Turtle Bay, Lower California". Pliocene; B. F. Hake, collector.

48 (L.S.J.U.). "Mouth of large Arroyo, northwest of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California". Pliocene; B. F. Hake, collector.

49 (L.S.J.U.). "Slopes of Salada, three miles southeast of Turtle Bay, uppermost beds"; B. F. Hake, collector.

76 (L.S.J.U.). "Pliocene beds on white clay northwest of Elephant Mesa and west of Arroyo, Scammon Lagoon Quadrangle, Lower California"; B. F. Hake, collector.

77 (L.S.J.U.). "Pliocene beds on west side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California"; B. F. Hake, collector.

¹⁴ Israelsky, M. C., Univ. Cal. Pub. Geol., Vol. 14, No. 11, 1923, pp. 378, 379, 381.

¹⁵ Hertlein, L. G., Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, p. 3.

80 (L.S.J.U.). "Pliocene exposed in Cañon southeast of Turtle Bay, Lower California"; B. F. Hake, collector.

116 (L.S.J.U.). "Cedros Island, Lower California; Pliocene;" Henry Hemphill and other collectors.

LIST OF SPECIES

Echinoidea

1. *Astrodapsis israelskyi* E. K. Jordan & Hertlein, new species, Cedros Island, Loc. 928 (C.A.S.).
2. *Astrodapsis kewi* E. K. Jordan & Hertlein, new species, Cedros Island, Loc. 928 (C.A.S.).
3. *Clypeaster deserti* Kew, Cedros Island, Loc. 946 (C.A.S.).
4. *Calopleurus corona-formis* Israelsky, Cedros Island, Loc. 928 (C.A.S.).
5. *Dendraster cedrosensis* Israelsky, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Loc. 945 (C.A.S.); Elephant Mesa, Loc. 76 (L.S.J.U.); Mesa west of Mesa de las Auras, Loc. 43 (L.S.J.U.).
6. *Dendraster diegoensis* Kew, Cedros Island, Loc. 928 (C.A.S.).
7. *Dendraster gibbsii humilis* Kew, Cedros Island, Loc. 928 (C.A.S.).
8. *Dendraster pacificus* Kew, Cedros Island, Loc. 928 (C.A.S.).
9. *Dendraster pentagonalis* Israelsky, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Loc. 945 (C.A.S.); Elephant Mesa, Locs. 48 (L.S.J.U.); 76 (L.S.J.U.).
10. *Strongylocentrotus franciscanus* A. Agassiz, Cedros Island, Loc. 928 (C.A.S.).
11. *Strongylocentrotus purpuratus* Stimpson, Cedros Island, Loc. 928 (C.A.S.).

Brachiopoda

12. *Laqueus californicus vancouveriensis* Davidson, Cedros Island, Loc. 928 (C.A.S.).
13. *Terebratalia transversa caurina* Gould, Cedros Island, Loc. 928 (C.A.S.).
14. *Waldheimia kennedyi* Dall, Cedros Island (Dall)¹⁶.

¹⁶ Proc. Calif. Acad. Sci., 1st Ser., Vol. 5, 1874, p. 299. Not recognized in the present collection.

Pelecypoda

15. *Anomia peruviana* Orbigny, Turtle Bay, Loc. 945 (C.A.S.).
16. *Arca* sp.¹⁷, Turtle Bay, Loc. 945 (C.A.S.).
17. *Arca* sp., Turtle Bay, Loc. 945 (C.A.S.).
18. *Arca* sp., Turtle Bay, Loc. 945 (C.A.S.).
19. *Arca* sp., Turtle Bay, Loc. 945 (C.A.S.).
20. *Chama frondosa* Broderip, Cedros Island, Loc. 946 (C.A.S.); Turtle Bay, Loc. 945 (C.A.S.).
21. *Chione* sp., Elephant Mesa, Loc. 77 (L.S.J.U.).
22. *Macoma kelseyi* Dall, Turtle Bay, Loc. 945 (C.A.S.).
23. *Mactra* sp., Turtle Bay, Loc. 945 (C.A.S.).
24. *Metis* cf. *M. alta* Conrad, Cedros Island, Loc. 928 (C.A.S.).
25. *Ostrea lurida* Carpenter, Cedros Island, Loc. 946 (C.A.S.); Turtle Bay, Locs. 944 (C.A.S.), 945 (C.A.S.).
26. *Ostrea megodon* Hanley, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Loc. 945 (C.A.S.); Elephant Mesa, Loc. 48 (L.S.J.U.).
27. *Ostrea tayloriana* Gabb, Elephant Mesa, Loc. 48 (L.S.J.U.).
28. *Ostrea vespertina* Conrad, Cedros Island, Locs. 928 (C.A.S.), 946 (C.A.S.); Turtle Bay, Locs. 944 (C.A.S.), 945 (C.A.S.); Elephant Mesa, Locs. 48 (L.S.J.U.), 76 (L.S.J.U.).
29. *Pecten (Pecten) bellus* Conrad, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Loc. 49 (L.S.J.U.); Elephant Mesa, Loc. 48 (L.S.J.U.).
30. *Pecten (Pecten)* cf. *P. heimi* Hertlein, Cedros Island, Loc. 928 (C.A.S.).
31. *Pecten (Pecten) lecontei* Arnold, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Loc. 945 (C.A.S.); Elephant Mesa, Loc. 48 (L.S.J.U.).
32. *Pecten (Pecten) stearnsi* Dall, Cedros Island, Locs. 928 (C.A.S.), 946 (C.A.S.).
33. *Pecten (Patinopecten)* cf. *P. coosensis* Shumard, Elephant Mesa, Loc. 48 (L.S.J.U.).
34. *Pecten (Patinopecten) dilleri* Dall, Elephant Mesa, Loc. 48 (L.S.J.U.).
35. *Pecten (Patinopecten) healey* Arnold, Cedros Island, Loc. 928 (C.A.S.).

¹⁷ The inclusion in the list of generic determinations of casts seems in this case to be desirable, as indicating the presence in the fauna of representatives of other than the few abnormally predominant groups.

36. *Pecten (Chlamys) opuntia* Dall, Turtle Bay, Loc. 944 (C.A.S.).
37. *Pecten (Lyropecten) cerrosensis* Gabb, Cedros Island, Locs. 928 (C.A.S.), 946 (C.A.S.); Turtle Bay, Loc. 945 (C.A.S.).
38. *Pecten (Lyropecten) gallegosi* E. K. Jordan & Hertlein, new species, Cedros Island, Loc. 946 (C.A.S.).
39. *Pecten (Lyropecten) modulatus* Hertlein, Mesa west of Mesa de las Auras, Loc. 43 (L.S.J.U.).
40. *Pecten (Lyropecten) subnodosus* Sowerby, Cedros Island, Locs. 928 (C.A.S.), 946 (C.A.S.); Turtle Bay, Loc. 945 (C.A.S.).
41. *Pecten (Lyropecten) veatchii* Gabb, Cedros Island, Locs. 928 (C.A.S.), 946 (C.A.S.).
42. *Pecten (Acquiptecten) percarus* Hertlein, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Loc. 944 (C.A.S.); Elephant Mesa, Locs. 48 (L.S.J.U.), 76 (L.S.J.U.).
43. *Pecten (Leptopecten) bellilamellatus* Arnold, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Loc. 945 (C.A.S.); Elephant Mesa, Loc. 48 (L.S.J.U.).
44. *Pecten (Leptopecten) latiauritus* Conrad, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Loc. 945 (C.A.S.).
45. *Pecten (Leptopecten) pracvalidus* E. K. Jordan & Hertlein, new species, Turtle Bay, Loc. 945 (C.A.S.).
46. *Pecten (Plagiectenium) calli* Hertlein, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Locs. 944 (C.A.S.), 945 (C.A.S.).
47. *Pecten (Plagiectenium) callidus* Hertlein, Cedros Island, Locs. 928 (C.A.S.), 946 (C.A.S.), 116 (L.S.J.U.); Turtle Bay, Locs. 944 (C.A.S.), 945 (C.A.S.).
48. *Pecten (Plagiectenium) circularis* Sowerby, Cedros Island, Locs. 928 (C.A.S.), 946 (C.A.S.); Turtle Bay, Locs. 945 (C.A.S.), 47 (L.S.J.U.); Elephant Mesa, Loc. 48 (L.S.J.U.).
49. *Pecten (Plagiectenium) cristobalensis* Hertlein, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay; Locs. 944 (C.A.S.), 945 (C.A.S.), 49 (L.S.J.U.); Elephant Mesa, Loc. 48 (L.S.J.U.).
50. *Pecten (Plagiectenium) evermanni* E. K. Jordan & Hertlein, new species, Cedros Island, Loc. 928 (C.A.S.).
51. *Pecten (Plagiectenium) hakei* Hertlein, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Locs. 944 (C.A.S.), 945 (C.A.S.), 47 (L.S.J.U.).

52. *Pecten (Plagiectenium) invalidus* Hanna, Cedros Island, Loc. 928 (C.A.S.), Turtle Bay, Locs. 944 (C.A.S.), 945 (C.A.S.).
53. *Pecten (Plagiectenium) mendenhalli* Arnold, Cedros Island, Locs. 928 (C.A.S.), 946 (C.A.S.); Turtle Bay, Loc. 944 (C.A.S.).
54. *Pecten (Plagiectenium)* cf. *P. purpuratus* Lamarck, Cedros Island, Locs. 928 (C.A.S.), 116 (L.S.J.U.).
55. *Pecten (Plagiectenium) subdolos* Hertlein, Cedros Island, Locs. 928 (C.A.S.), 946 (C.A.S.).
56. *Pecten (Amusium)* sp., Turtle Bay, Loc. 945 (C.A.S.).
- 56a. *Phacoides californica* Conrad, Cedros Island, Loc. 928 (C.A.S.).
57. *Placunanomia hannibali* E. K. Jordan & Hertlein, new species, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Loc. 945 (C.A.S.).
58. *Sanguinolaria* sp. Turtle Bay, Loc. 945 (C.A.S.).
59. *Spondylus calcifer* Carpenter, Cedros Island, Loc. 946 (C.A.S.).
60. *Spondylus crassisquama* Lamarck, Cedros Island, Loc. 928 (C.A.S.).

Gastropoda

61. *Conus* aff. *C. regularis* Sowerby, Elephant Mesa, Loc. 48 (L.S.J.U.).
62. *Epitonium cedrosensis* E. K. Jordan & Hertlein, new species, Cedros Island, Loc. 928 (C.A.S.); Turtle Bay, Loc. 945 (C.A.S.).
63. *Epitonium contrerasi* E. K. Jordan & Hertlein, new species, Turtle Bay, Loc. 945 (C.A.S.).
64. *Epitonium dallasi* E. K. Jordan & Hertlein, new species, Turtle Bay, Loc. 945 (C.A.S.).
65. *Epitonium* sp., Turtle Bay, Loc. 945 (C.A.S.).
66. *Epitonium* sp., Turtle Bay, Loc. 49 (L.S.J.U.).
67. *Forreria belcheri* Hinds, Turtle Bay, Loc. 944 (C.A.S.).
68. *Forreria wrighti* E. K. Jordan & Hertlein, new species, Turtle Bay, Loc. 945 (C.A.S.).
69. *Forreria* sp. Turtle Bay, Loc. 945 (C.A.S.).
70. *Forreria* sp., Turtle Bay, Loc. 80 (L.S.J.U.).
71. *Gyrineum* sp., Turtle Bay, Loc. 945 (C.A.S.).
72. *Haliotis* cf. *H. rufescens* Swainson, Cedros Island, Loc. 928 (C.A.S.).
73. *Natica* sp., Turtle Bay, Loc. 945 (C.A.S.).
74. *Turritella* sp., Turtle Bay; Loc. 945 (C.A.S.).

Cirripedia

75. *Balanus* cf. *B. concavus* Bronn, Turtle Bay, Locs. 944 (C.A.S.), 945 (C.A.S.).
76. *Balanus tintinnabulum* cf. *B. t. californicus* Pilsbry, Turtle Bay, Loc. 944 (C.A.S.).
77. *Balanus tintinnabulum coccopoma* Darwin, Turtle Bay, Loc. 945 (C.A.S.).

CORRELATION

The inadequacy of previous collections from these deposits until recently has prevented any definite correlation or determination of their age. Veatch¹⁸ in 1860 gave a brief account of the general geology of Cedros Island and referred to "fossiliferous sandstones of a late Tertiary age". The first account of Tertiary fossils from Cedros Island is in the original descriptions of *Pecten cerrosensis*, *P. veatchii*, *Ostrea cerrosensis* (= *O. megodon*), and *O. veatchii* (= *O. vespertina*), by Gabb¹⁹ in 1869. He considered the deposits to be of Miocene age. Dall²⁰ in 1874, described *Waldheimia kennedyi* from "beds of Miocene age, Cerros Island, Lower California", and in 1898²¹ referred to the beds on Cedros Island as of either Miocene or Pliocene age. Arnold²² in 1906 considered the beds on Cedros Island to be of Pliocene age, and equivalent to the Purisima formation of central California. In 1919, J. P. Smith²³ correlated the Pliocene of Cedros Island with the Carizzo formation of Imperial County, California, and considered both to be equivalent to the Etchegoin formation of the San Joaquin valley. Kew²⁴, in 1920, described *Dendraster pacificus* from the Pliocene of Pacific Beach, California, and of Cedros Island, and apparently considered the deposits at these two localities to be equivalent, and of upper Pliocene age. Darton²⁵ in 1921 in a paper on the Geology of Lower California, described marine post-Miocene deposits exposed in the Arroyo

¹⁸ The Hesperian, Vol. 3, No. 6, 1860, pp. 531-534. See also J. A. Veatch, in J. Ross Brown, Resources of the Pacific Slope, 1869, p. 143.

¹⁹ Pal. Cal., Vol. 2, 1869, pp. 32, 34, 35.

²⁰ Dall, W. H., Proc. Calif. Acad. Sci., 1st Ser., Vol. 5, 1874, p. 299.

²¹ Dall, W. H., Trans. Wagner Inst. Sci., Vol. 3, pt. 4, 1898, p. 705.

²² Arnold, R., Prof. Paper U. S. Geol. Surv., No. 47, 1906, p. 26.

²³ Proc. Calif. Acad. Sci., 4th Ser., Vol. 9, No. 4, 1919, p. 153.

²⁴ Univ. Cal. Pub. Geol., Vol. 12, No. 2, 1920, p. 129.

²⁵ Journ. Geol., Vol. 29, No. 8, 1921, pp. 746-747.

La Salada, some distance to the south of the present region, and listed a few species found there. In 1922 Heim²⁶ published an account of the Tertiary of the southern part of Lower California in which he gave the name Salada to the beds exposed at the Cattle Ranch, La Salada. He gave no faunal list and made no mention of the occurrence of Pliocene on Cedros Island but stated that the Salada formation extended some distance to the north of the type locality. Israelsky²⁷, in 1923 described three species of echinoids from the beds on Cedros Island, and referred them to the Pliocene.

The first statement of the occurrence of Pliocene beds in the Turtle Bay region appeared in 1924²⁸, on a geological map of Lower California compiled from the results of the Marland Oil Company. On this map and in the accompanying report, all the Marine Pliocene of the peninsula was referred to the Salada formation. Hertlein²⁹ in 1925, writing on peccens from Lower California chiefly collected by the geologists of the Marland Oil Company, correlated the beds on Cedros Island with the San Diego formation of Pacific Beach; he applied Heim's name Salada to the deposits at Turtle Bay and at Elephant Mesa, and suggested the equivalence of those beds to those on Cedros Island. The writers concur entirely with Hertlein's conclusions, except that they do not accept extension of the name Salada to regions remote from the type locality of that formation, until the fauna of the type locality is more fully known. Hanna³⁰ in 1925 and in 1926, referred to the Pliocene beds on Cedros Island and at Turtle Bay.

The present study of collections far larger than those before available to Hertlein, while little altering the general correlation of these beds, furnishes a basis for a fuller discussion of the character and relations of the fauna.

In the preceding list of species the records from Cedros Island, Turtle Bay and from Elephant Mesa are combined. The deposits at these points are approximately equivalent in

²⁶ Geol. Mag., Vol. 59, No. 702, 1922, p. 529-548.

²⁷ Univ. Cal. Pub. Geol., Vol. 14, No. 11, 1923, pp. 378-380.

²⁸ Boletín del Petróleo, Vol. 18, No. 1, 1924, opposite p. 52; M. Bustamente in 1921 mapped the sedimentary rocks in the immediate region of Turtle Bay as Tertiary and Quaternary in age. Bol. del Petróleo, Vol. 11, No. 6, 1921, map opposite p. 532.

²⁹ Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, p. 6.

³⁰ Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 12, 1925, pp. 262, 264, 268 also Vol. 15, No. 1, 1926, pp. 85, 86.

age and in fauna. Community of species between the various localities is most striking and the collecting stations are in no case separated by any very great distances. In the following discussion the whole assemblage is treated as a unit.

This fauna is peculiar in that it consists of little more than echinoderms, pectens and oysters; it contains few other pelecypods and few gastropods. Pectens were evidently excessively abundant in Lower Californian waters in Pliocene time, but the extreme predominance of that genus in the present fauna may be to a considerable extent attributed to the destruction of the shells of many other forms by weathering in a desert climate. In attempting a correlation of a fauna such as this its incomplete nature must not be forgotten. It is an assemblage in which species of short range in geologic time, abnormally predominate, and the percentage of living species found is unreliable as an exact criterion for age determination. Correlation rests chiefly on community of diagnostic species with other known Pliocene formations.

The affinity of this fauna is wholly western North American. More than half of the species are common to the Pliocene of southern California; the remainder are slightly more tropical forms, still living in western Mexican waters or known only from the Pliocene of Lower California. No pronounced similarity is shown to the Tertiary of the Caribbean or Peruvian provinces.

About 40 per cent of the species in the present list are known to occur in the San Diego formation, as exposed in Pliocene sands at Pacific Beach, near San Diego, California, which lie upon the harder Eocene sandstones, shales and conglomerate with no evident discordance of dip and are unconformably overlain by nearly horizontal soft Pleistocene sand, boulders and shells.

The beds at Pacific Beach probably approximate in age the lower part of the upper Pliocene, as has been stated by J. P. Smith⁸¹. Fewer species of the Lower California fauna are found in the Saugus (Saugus of Hershey⁸², and of Kew⁸³, Ventura of Carson⁸⁴, upper Fernando of various authors) and

⁸¹ Proc. Calif. Acad. Sci., 4th Ser., Vol. 9, No. 4, 1919, pp. 149, 151, 152.

⁸² Am. Geologist, Vol. 29, No. 6, 1902, pp. 359-362.

⁸³ Bull. U. S. Geol. Surv., No. 753, 1924, pp. 81-89.

⁸⁴ Pan-American Geologist, Vol. 43, No. 4, 1925, pp. 269, 270.

Santa Barbara³⁶ formations of southern California, which are of upper Pliocene age but are a little younger than the Pliocene of Pacific Beach. Many species in the present list are found in the Pico formation (Lower Fernando of English³⁶, and of various authors, Fernando of J. P. Smith³⁷, Pico of Kew³⁸), Lower Pliocene, in southern California. The similarity of the present fauna to that of the beds at Pacific Beach is, however, more striking than to that of the Pico. Beyond community of a few wide ranging and non-diagnostic species, the present fauna is not related to that of the Jacalitos or Etchegoin formations of the San Joaquin valley region, nor similar in aspect to that of the Pliocene of Coyote Mountain, in Imperial County, California³⁹.

The writers, therefore, consider the Pliocene beds of Cedros Island and of the Turtle Bay region to be approximately equivalent to the San Diego formation of Pacific Beach, and to represent either approximately the middle of the Pliocene or the lower part of the upper Pliocene.

Considered as to climatic relations, the present fauna presents a mixture of warm and cool water types, with warm water forms in the majority, a condition similar to that today prevailing in the waters about Cedros Island and Turtle Bay. The presence of abundant *Lyropecten*, *Plagioctenium*, *Anusium*, *Pecten* ss., *Placunanomia*, *Arca*, *Spondylus*, fluted *Ostrea*, *Astrodapsis*, and *Clypeaster* indicates that when these beds were deposited the waters were at least as warm as they are at present in the region. On the other hand the effect of gradual cooling in Pliocene time in western North America, described by J. P. Smith⁴⁰, is shown by the occurrence here of many central and southern California upper Pliocene forms, particularly *Patinopectens* and such species as *Laqueus californicus vancouveriensis*. Probably at the time of deposition of these beds the climate in the region did not differ greatly from that of the present.

It is yet impossible to draw any conclusions as to distribution or relationship of Pliocene faunas in Lower California as

³⁶ J. P. Smith, Proc. Calif. Acad. Sci., 4th Ser., Vol. 9, No. 4, 1919, pp. 150-151.

³⁷ Univ. Cal. Pub. Geol., Vol. 8, No. 8, 1914, pp. 203-214.

³⁸ Proc. Calif. Acad. Sci., 4th Ser., Vol. 9, No. 4, 1919, pp. 149, 151, 152.

³⁹ Bull. U. S. Geol. Surv., No. 753, 1924, pp. 70-81.

⁴⁰ Hanna, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 18, 1926, pp. 427-503.

⁴¹ Proc. Calif. Acad. Sci., 4th Ser., Vol. 9, No. 4, 1919, pp. 123-173.

a whole. Hertlein⁴¹ has listed pectens, probably of Pliocene age, from various localities on the peninsula outside of the present region. Deposits of this age are known to occur at Santa Rosalia and at other points near the shores of the Gulf of California; their fauna as far as known is somewhat different from that found in the beds on Cedros Island and Turtle Bay. E. K. Jordan & Hertlein⁴² recently described a small Pliocene fauna from Maria Madre Island, far to the south and that assemblage shows affinities with the present one; it is not older and may be slightly younger in age than the present fauna. The Pliocene of Maria Madre Island is apparently more closely related to the Pliocene of the Gulf of California region.

NOTES AND DESCRIPTIONS OF SPECIES

1. *Astrodapsis israelskyi* E. K. Jordan & Hertlein, new species

Plate XXVII, figures 4 and 6

Test small; subcircular to suboval in outline, not greatly elevated, the upper surface rather flat; margin thick, evenly rounded and entire; apical system central, or slightly posterior, the apex of the test slightly anterior to the center of the madreporic area; madreporic area pentagonal, with four genital pores; petals narrow, slightly elevated, widely open, and extending nearly to the margin; rows of pores at first diverge, then at about half the distance to the margin they converge slightly, after which they continue toward the margin parallel or very slightly divergent; outer row of pores more pronouncedly sinuous than inner; interambulacral areas relatively broad, little depressed, flat, sloping gently from the apex toward the margin; inferior surface concave toward the center; mouth central, large, subpentagonal in outline; ambulacral furrows not distinct, but branching close to their origin at the peristome and extending nearly to the margin; periproct fairly large, situated on ventral surface and a little less than its own diameter from the margin; tuberculation prominent, the tubercles rather large and distantly spaced,

⁴¹ Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, pp. 1-35.

⁴² Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 4, 1926, pp. 209-217.

those on the inferior surface perhaps even more prominent than those above. Anteroposterior diameter 37.5 mm.; transverse diameter 35.3 mm.; greatest elevation 7.9 mm.

Type: No. 2086, *paratypes*, Nos. 2087, 2088, and 2089, Mus. Calif. Acad. Sci., from Loc. 928, **Bernstein's abalone camp, Cedros Island, Lower California**; upper Pliocene; G. D. Hanna and E. K. Jordan collectors.

Four other specimens of this species were examined from the same locality.

Astrodapsis israelskyi somewhat resembles *A. fernandoensis* Pack, but lacks the very large tubercles that are characteristic of Pack's species. It is close to *Dendraster perrini* Weaver, but the apical system of the present species is central in the type, and nearly central in all the other specimens, while in *D. perrini* it is moderately eccentric.

The species is named in honor of Mr. Merle C. Israelsky, in recognition of his work on echinoids.

2. *Astrodapsis kewi* E. K. Jordan & Hertlein, new species

Plate XXVII, figures 2 and 3

Test small, subcircular in outline, considerably elevated, the margin thick, evenly rounded, and entire; apex distinctly anterior to and higher than center of apical system; petals strongly elevated, and extending about two-thirds of the distance to the edge of the test, their extremities wide open; interambulacral areas deeply sunken, depressed in a distinct median trough; apical system nearly central; madreporic area pentagonal, with four genital pores, the one opposite the posterior interambulacral area absent; pores of petals conjugate, the inner rows not converging very rapidly outward, the outer rows converging more rapidly; anterior a little longer and narrower than others; inferior surface evenly concave; mouth subcentral, large, subpentagonal in outline; ambulacral furrows distinct, broad, branching at somewhat less than half the distance outward to the margin, becoming obsolete as the margin is approached, periproct of moderate size, situated on the under surface and distant from the margin about one and a

half times its own diameter; tuberculation prominent, the tubercles elevated, of several orders of magnitude, and the same on both surfaces, except that the ambulacral furrows on the lower surface are smooth. Anteroposterior diameter 31.6 mm.; transverse diameter 31.1 mm.; greatest elevation 8.3 mm.

Type: No. 2090, Mus. Calif. Acad. Sci., from Loc. 928 (C. A. S. Coll.), Bernstein's abalone camp, Cedros Island, Lower California; upper Pliocene; G. D. Hanna and E. K. Jordan collectors.

Astrodapsis kewi is distinguished from what is apparently its nearest relative, *A. tumidus* Rémond of the upper San Pablo Miocene of central California by the following characters: the petals in the present species do not extend to the margin of the test as they do in *A. tumidus* and the relief between the crest of the petals and the bottom of the interambulacral areas is greater in *A. kewi*; the summit of *A. kewi* is considerably anterior to the madreporite, rather than almost coinciding as in *A. tumidus*; margins in *A. kewi* are thicker than in *A. tumidus* and are entire, rather than notched by the ends of the ambulacral furrows. *A. kewi* as a whole has a thicker and more tumid test than has *A. tumidus*. *Dendraster arnoldi* Twitchell in some degree resembles this species, but it is distinguished by the excentricity of the apical system. *A. kewi* bears little resemblance to *A. fernandoensis* Pack, from the lower Pliocene of southern California.

This species is named in honor of Dr. W. S. W. Kew, in recognition of his masterly work on the fossil echinoids of western North America.

3. *Laqueus californicus vancouveriensis* Davidson

Plate XXVII, figure 7

Megerlia jeffreysi DALL, Sci. Res. Expl. Alaska, 1877, p. 48; Living, Vancouver, Id., B. C.

Not *Frenula jeffreysi* DALL, Am. Nat., Vol. 5, 1871, p. 55; Living, northeast Atlantic (= *Macandrevia cranium* Müller 1776).

Laqueus californicus var. *vancouveriensis* DAVIDSON, Trans. Linn. Soc. Lond., 2nd Ser., Vol. 4, 1887, p. 113, pl. 18, figs. 10, 11, 12, 13, 13a, 13b; Living, off Lopez Id., Wash.

Laqueus jeffreysi DALL, ARNOLD, Mem. Calif. Acad. Sci., Vol. 3, 1903, p. 93.

Laqueus californicus vancouveriensis DAVIDSON, DALL, Proc. U. S. Nat. Mus., Vol. 57, 1920, p. 348.

Laqueus californicus jeffreysi DALL, OLDROYD, Pub. Puget Sound Biol. Sta. Univ. Wash., Vol. 4, 1924, p. 205.

Laqueus californicus vancouverensis DAVIDSON, OLDROYD, Pub. Puget Sound Biol. Sta. Univ. Wash., Vol. 4, 1924, p. 206.

This wholly west American form has been confused with the *Frenula*, *Ismenia* or *Megerlia jeffreysi* of Dall, originally described from the northeast Atlantic, and now considered by Dall to be the young of *Macandrevia cranium*.

There is no basis for records of both *Laqueus californicus vancouveriensis* and *Laqueus californicus jeffreysi* from the Puget Sound region, and, as Dall has pointed out, the name *jeffreysi* is not tenable for either the Atlantic or Pacific species.

This form was found abundantly in small lenses near Bernstein's abalone camp, on Cedros Island. It is known living from southeastern Alaska to the Washington Coast, and occurs in the Santa Barbara and San Diego Pliocene formations of southern California.

4. *Chama frondosa* Broderip

Plate XXXIV, figure 1

Chama frondosa BRODERIP, Proc. Zool. Soc. Lond., 1834, p. 148; living, Id. Plata, "Western Colombia."

Chama frondosa BRODERIP, Trans. Zool. Soc., Vol. 1, p. 302, pl. 38, figs. 1, 2.

Chama frondosa BRODERIP, REEVE, Conch. Icon. Vol. 4, 1846, Chama, pl. 1, figs. 1a, 1b.

This species occurs on Cedros Island and at Turtle Bay. It is known living from San Diego, Calif., south to Peru.

5. *Ostrea megodon* Hanley

Plate XXVIII, figure 1

Ostrea megodon HANLEY, Proc. Zool. Soc. Lond., 1845, p. 106; living, Peru.

Ostrea gallus VALENCIENNES, Plates of Voy. Venus, Coq., pl. 21, 1846. According to Dall.

Ostrea cerrosensis GABB, Geol. Surv. Cal., Pal., Vol. 2, 1869, p. 35, pl. 11, fig. 61; Pliocene, Cedros Island.

Ostrea megodon HANLEY, SOWERBY, Conch. Icon., Vol. 18, Ostrea, 1871, pl. 12, fig. 24.

Ostrea megodon HANLEY, MAURY, Bull. Amer. Paleo., Vol. 5, No. 29, p. 183, pl. 34, fig. 3.

This species is found very abundantly on Cedros Island, and also near Turtle Bay and Elephant Mesa. The fossils are unquestionably identical with the living species, and examples from the Caribbean Miocene appear in no way different. *O. megodon* has also been reported from the Pleistocene of Lower California, from the Pliocene of Maria Madre Island, Mexico, and occurs in the Saugus, upper Pliocene, near Piru, California.

6. *Ostrea tayloriana* Gabb

Plate XXXIII, figure 3

Ostrea tayloriana GABB, Geol. Surv. Cal., Pal., Vol. 2, 1869, p. 34, pl. 12, figs. 60, 60a; "Miocene", San Marcos Pass, Calif.

Ostrea georgiana CONRAD, DALL, Trans. Wagner Inst. Sci., Vol. 3, pt. 4, 1898, p. 683. In part; not of Conrad.

Ostrea megodon HANLEY, DALL, Nautilus, Vol. 28, No. 1, 1914, p. 1. In part; not of Hanley.

This species, apparently not recognized in California since the discovery of the original specimens, has been recorded under various names in the literature. Our examples agree almost exactly with the figure of the type of *O. tayloriana*. They are in no wise related to *O. georgiana*, which is similar to the well known west American *O. titan* Conrad, nor do they resemble *O. megodon*. *O. tayloriana* does not differ greatly from *O. chilensis* Philippi.

7. *Ostrea vespertina* Conrad

Ostrea vespertina CONRAD, Journ. Acad. Nat. Sci. Phila., 2nd Ser., Vol. 2, 1854, p. 300; "Miocene?", near San Diego, Calif.

Ostrea vespertina CONRAD, House Doc. 129, Proj. Vol. 3, 33rd Congress, 1st Sess. 1855, p. 15, App. to Rep. of W. P. Blake.

Ostrea vespertina CONRAD, Pac. R. R. Rept., Vol. 5, 1857, p. 325, pl. 5, figs. 36, 37, 38.

- ?*Ostrea amara* CARPENTER, Proc. Zool. Soc. Lond., 1863, p. 363; living, Panama.
- Ostrea veatchii* GABB, Geol. Surv. Cal., Pal., Vol. 2, 1869, p. 34, pl. 11, fig. 60.
- Ostrea haitiensis* SOWERBY, DALL, Trans. Wagner Inst. Sci., Vol. 3, pt. 4, 1898, p. 685. In part; not of Sowerby.
- Ostrea veatchii* GABB, ARNOLD, Bull. U. S. Geol. Surv. No. 322, 1907, p. 148, pl. 23, fig. 10.
- Ostrea vespertina* CONRAD, ARNOLD, Bull. U. S. Geol. Surv. No. 396, 1909, p. 77, pl. 24, figs. 4, 5.
- Ostrea veatchii* GABB, DALL, Nautilus, Vol. 28, 1914, p. 1.
- Ostrea vespertina* CONRAD, HANNA, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 18, 1926, p. 468, pl. 26, figs. 1, 2, 3.

As first pointed out by Arnold there can be little question that the *O. veatchii* of Gabb, originally described from the Pliocene of Cedros Island, and generally common in the Pliocene of southern California, is identical with *O. vespertina* Conrad. It has not generally been recognized that the types of Conrad's species came from San Diego, where the form commonly known as *O. veatchii* is abundant.

O. amara Carpenter is also probably identical with *O. vespertina*, but absolute proof of identity cannot be given. The name was applied by Carpenter to specimens in the C. B. Adams collection of living Panama shells, and referred to other examples from Mazatlan sketchily described by Carpenter⁴³, under the title "*Ostrea* sp." As nearly as can be made out from this description, without figure, *O. amara* was meant to represent a fairly large, plicate oyster, similar in general characteristics to the present species.

O. haitensis, a species of the Caribbean Miocene is quite similar to *O. vespertina*, but not certainly identical.

O. vespertina was found abundantly on Cedros Island, around Turtle Bay, and near Elephant Mesa. It has previously been reported in the Gulf of California, from the Pleistocene of Lower California, from the Saugus, the San Diego and the Pico of southern California, from the upper Pliocene of Maria Madre Island, Mexico, and the Pliocene of Coyote Mtn., Imperial County, California.

⁴³ Maz. Cat., 1857, p. 164.

8. *Pecten* (*Pecten*) *bellus* Conrad

Plate XXXII, fig. 2; Plate XXXIII, figs. 1, 2; Plate XXXIV, figs. 2, 3, 4

Janira bella CONRAD, Proc. Acad. Nat. Sci. Phila., 1857, p. 312; "Middle Tertiary", Santa Barbara, Calif.

Janira bella CONRAD, Pac. R. R. Rept., Vol. 6, 1857, p. 71, pl. 3, fig. 16.

Janira bella CONRAD, GABB, Geol. Surv. Calif., Pal., Vol. 2, 1869, p. 105, pl. 16, fig. 20.

Pecten hemphillii DALL, Proc. U. S. Nat. Mus., Vol. 1, 1879, p. 15; San Diego formation (Pliocene); San Diego, Calif.

Pecten (*Pecten*) *bellus* CONRAD, DALL, Trans. Wagner Inst. Sci., Vol. 3, pt. 4, 1898, p. 704.

Pecten (*Pecten*) *hemphillii* DALL, Trans. Wagner Inst. Sci., Vol. 3, pt. 4, 1898, p. 706.

Pecten (*Pecten*) *bellus* CONRAD, ARNOLD, Mem. Calif. Acad. Sci., Vol. 3, 1903, p. 103, pl. 21, figs. 1, 2.

Pecten (*Pecten*) *hemphillii* DALL, ARNOLD, Mem. Calif. Acad. Sci., Vol. 3, 1903, p. 105.

Pecten (*Pecten*) *bellus* CONRAD, ARNOLD, Prof. Paper U. S. Geol. Surv. 47, 1906, p. 95.

Pecten (*Pecten*) *hemphillii* DALL, ARNOLD, Prof. Paper U. S. Geol. Surv. 47, 1906, p. 97, pl. 33, figs. 3, 3a, 3b.

Examination of a large number of specimens of both typical *Pecten bellus* Conrad and *P. hemphillii* Dall, from both Upper and Lower California, has convinced the authors that these two forms are merely extremes of an unbroken series, and belong to but one very variable species. The name *bellus* takes precedence by right of priority.

P. hemphillii has been said to differ from *P. bellus* in that the left valve is flat or concave in the former, rather than somewhat convex as in typical *P. bellus*, and in that the radiating ribs on both valves of Dall's species are more numerous and more highly elevated. In the series examined by us we find great variation in the combinations of these characters; no two adult specimens are exactly alike in appearance, and the extremes are perfectly united by intermediate forms. The number of ribs on the right valve varies from 14 to 18; the ribs vary greatly in width, elevation and prominence, and the convexity of the two valves is in no wise constant. Young examples, up to an altitude of 20 mm., are all very similar in appearance.

Six paratypes of *P. hemphillii*, out of the original lot from Pacific Beach, near San Diego, have been examined in the course of this work. On the basis of the previously enumerated distinctions, certain of these specimens can be referred to Dall's species, while others are unquestionably the *P. bellus* of Conrad. One of the latter is herewith figured, together with illustrations of two of our specimens from Cedros Island. The type of *P. hemphillii*, as indicated by the illustration furnished by Arnold, is an intermediate form not exactly similar to either extreme of the series, although it inclines toward the narrow-ribbed variants. In the original description of *P. hemphillii* no reference was made to *P. bellus*, but a comparison was drawn with *Pecten stearnsii* Dall, a quite different form. There is, furthermore, neither stratigraphic nor geographic difference in the occurrence of the two extremes of the series, and there is no doubt that they are specifically identical.

This species is excessively abundant in the Pliocene beds near Bernstein's abalone camp on Cedros Island, and it also occurs near Turtle Bay and Elephant Mesa. It is known from the Santa Barbara, Saugus and San Diego upper Pliocene formations, and from the Pico lower Pliocene formation of southern California.

9. *Pecten (Patinopecten) dilleri* Dall

Plate XXX, figure 1

Pecten (Lyropecten) dilleri DALL, Nautilus, Vol. 14, No. 10, 1901, p. 117.

Pecten (Patinopecten) dilleri DALL, ARNOLD, Prof. Paper U. S. Geol. Surv. 47, 1906, p. 62, pl. 5, fig. 2.

The left valve of this species has hitherto not been illustrated but the discovery of several in these collections enables us to supply this deficiency. We have compared our specimens with left valves from the lower Pliocene of the Santa Maria district in California, where they are associated with right valves which agree exactly with specimens from the type locality.

The left valve of *P. dilleri* is large, subcircular in outline, and slightly arched. The anterior ear is rather sharply truncated at the anterior margin, and is ornamented by about six to eight radiating ribs which are crossed by concentric lines of

growth and are roughened by raised scaly imbrications. The posterior ear slopes slightly from the posterior dorsal margin to the base; it bears about six radiating ribs and is otherwise sculptured similar to the anterior ear.

The left valve bears about 27 or 28 slightly rounded, high, prominent radiating ribs separated by interspaces that are a little wider than the ribs. The tops of the ribs are ornamented by strong, raised scaly concentric imbrications; the sides of the ribs and the interspaces are marked only by faint traces of rather widely spaced concentric lamellæ.

P. dilleri Dall is distinguished from *P. purisimænsis* Arnold and from *P. coosensis* Shumard by having a larger number of ribs which, in the left valve of Dall's species, are fairly large, slightly rounded, and more distant than in the others. The great prominence of the raised scaly imbrications on the ribs is also characteristic of *P. dilleri*.

This species was found near Elephant Mesa, and has previously been known from the Wildcat lower Pliocene of northern California, and from the lower Pliocene of the Santa Maria District, southern California.

10. *Pecten* (*Lyropecten*) *cerrosensis* Gabb

Plate XXXII, figure 4

Pecten cerrosensis GABB, Geol. Surv. Cal. Pal., Vol. 2, 1869, p. 32, pl. 9, figs. 55, 55a; "Miocene", Cerros Id.

Pecten (*Lyropecten*) *ashleyi* ARNOLD, Prof. Paper U. S. Geol. Surv. 47, 1906, p. 122, pl. 47, figs. 1, 1a, pl. 48, fig. 1; Pliocene, Cerros Id.

Not *Pecten* (*Plagioctenium*) *cerrosensis* GABB, ARNOLD, Prof. Paper U. S. Geol. Surv. 47, 1906, p. 123, pl. 44, fig. 5, pl. 49, figs. 1, 1a, 1b.

Pecten (*Plagioctenium*) *cerrosensis* GABB, HERTLEIN, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, p. 15, pl. 6, fig. 1.

A comparison of the type specimens of *P. cerrosensis* Gabb and *P. ashleyi* Arnold, both taken from the Pliocene beds on Cedros Island, together with examination of a large number of specimens in the present collection, leads the authors to the conclusion that the two so-called species both clearly belong to

the section *Lyropecten* and are identical. The name *P. cerrosensis* takes precedence by priority. The type of *P. ashleyi* is slightly less globose than the type of *P. cerrosensis*, the latter has much less pronounced radial striations than those that ornament the radial ribs of *P. ashleyi* and it lacks also the pronounced sculpture present on the ears of *P. ashleyi*; but the type of *P. cerrosensis* is an exceptionally large and old specimen, and weathering apparently has obliterated much of the finer ornamentation. The number of ribs on the two specimens is the same. A study of other *Lyropectens* such as *P. estrellanus* Conrad, which the young of *P. cerrosensis* closely resemble, shows that species of the subgenus *Lyropecten* vary greatly in globosity of valves, and in prominence of secondary radial sculpture.

The fact that the type of *P. cerrosensis* has not until recently been available for study, has, as pointed out by Hertlein, led to considerable misunderstanding of the species. The type specimen was not available at the time that Arnold described *P. ashleyi*, and the concept arose that *P. cerrosensis* Gabb belonged to the section *Plagioctenium* rather than to *Lyropecten*. As a result various species have been referred to *P. cerrosensis* in literature and in collections, particularly *P. hakei* Hertlein, *P. subdolosus* Hertlein, *P. callidus* Hertlein, *P. circularis* Sowerby (= *P. subventricosus* Dall). Most of the records of *P. cerrosensis* from the Pliocene of southern California are erroneous, but *P. cerrosensis* does occur in southern California in some cases, in the form hitherto known as *P. ashleyi* Arnold.

The original description of *P. cerrosensis* Gabb, together with the description and figure of *P. ashleyi* Arnold fully define the characters of the former. A young specimen of *P. cerrosensis* which resembles *P. estrellanus* Conrad, is herewith figured.

P. cerrosensis has been found on Cedros Island at Locality 928 (C.A.S.), abundantly at Locality 946 (C.A.S.), and a single valve was also discovered at Turtle Bay. It also occurs in the San Diego formation of southern California.

11. *Pecten* (*Lyropecten*) *gallegosi* E. K. Jordan & Hertlein,
new species

Plate XXIX, figure 1

Shell large, and of the same general outline as *P. cerrosensis* Gabb, but flatter. Right valve ornamented by 21 to 23, narrow, square, flat-topped and often T-rail shaped radiating ribs; interspaces flat-bottomed, with a well defined midrib, their bottoms and walls also finely, radially striate; ribs and interspaces crossed by concentric lines of growth; anterior dorsal and posterior dorsal margins of the valve bearing several sharp, radiating riblets; anterior ear large, with a well defined byssal notch, the ear ornamented by six to eight strong, radiating riblets which are crossed by lines of growth; posterior ear smaller than anterior, and sloping obliquely, posteriorly and downward from posterior termination of hinge line to edge of disk, the ear sculptured by 10 to 12 sharp, strong, radiating riblets crossed by growth lines. Height 125 mm.; length 138 mm.; apical angle 116° . Left valve more highly arched than right, and similarly sculptured; at intervals every fifth rib is slightly raised, as is the case on occasional specimens of *P. cerrosensis* Gabb.

Type: Right valve, No. 2096, *paratypes* No. 2097, 2098, 2099 and 2100, Mus. Calif. Acad. Sci., from Loc. 946 (C.A.S. coll.), on shore nine miles north of Bernstein's abalone camp, Cedros Island, Lower California; upper Pliocene; G. D. Hanna and E. K. Jordan collectors.

Two other specimens from the same locality were examined; all agree substantially with the type.

It is recognized that intergradation may ultimately be proved with *P. cerrosensis* Gabb, which itself is rather variable, but the type and paratypes of *P. gallegosi* present such striking characters as to merit a separate designation. From *P. cerrosensis*, the present form is distinguished mainly by having a much flatter shell, and by a greater intensity of sculpture. The slightly greater number of ribs, which are in nowise rounded, the sharp riblets on the anterior dorsal and posterior dorsal margins of the shell, and the strong sculpture on the ears are distinguishing characters. From *P. hakei* Hertlein,

P. gallegosi differs in having the strong hinge teeth characteristic of a *Lyropecten*, in the presence of a midrib between the major radial ribs, and in other less important particulars.

This shell is named in honor of the late Professor José Maria Gallegos, Explorer for the Departamento de Agricultura y Fomento, Mexico, in recognition of his work so unfortunately terminated, on the preservation of the wild life of Lower California.

12. *Pecten (Aequipecten) percarus* Hertlein

Pecten (Aequipecten) percarus HERTLEIN, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, p. 13, pl. 2, figs. 2, 5; Pliocene, Elephant Mesa, Lower Calif.

The large size, subcircular form, flatness of the right valve, and the number and even roundness of the radiating ribs crossed by concentric growth lines distinguish adults of this species from related forms. Very young examples are not easily differentiated from the young of several species of *Plagi-octenium*. Specimens of this species have been found on Cedros Island, at Turtle Bay, and near Elephant Mesa.

13. *Pecten (Leptopecten) praevalidus* E. K. Jordan & Hertlein, new species

Plate XXIX, figures 2, 3

Shell of moderate size, somewhat inflated, elongated posteriorly giving an oblique outline, the hinge line four-fifths the length of the shell. Right valve nearly flat, ornamented by about 13 or 14 flat-topped radiating ribs which are often longitudinally sculptured by one or two slight sulci; ribs separated by interspaces about as wide as the ribs, the bottoms of some of the interspaces lightly, longitudinally striate; anterior ear large, cut by a large byssal notch, and ornamented by four or five radiating ribs crossed by concentric lines of growth; left ear larger than right, sloping acutely from hinge line to posterior margin of shell, ornamented by six to nine unequal radiating riblets. Left valve somewhat more arched than right, ornamented by 15 or 16 moderately rounded radiating ribs some

of which show a fairly well defined medial sulcus; interspaces as wide as ribs; both ribs and interspaces finely longitudinally striate, and crossed by concentric lines of growth; ears much as those of right valve, and similarly ornamented, except that the anterior ear of the left, carries six or seven radiating riblets between which are intercalated minute raised lines. Length 50 mm.; height 48 mm.; diameter approximately 15 mm.; length of hinge line approximately 40 mm.; apical angle 103° .

Type: No. 2101, *paratypes* Nos. 2102, 2103, 2104, 2105, and 2106, Mus. Calif. Acad. Sci., from Loc. 945, **Southeast of Turtle Bay, Lower California**; upper Pliocene; G. D. Hanna and E. K. Jordan, collectors.

30 other specimens were examined from the same locality.

The large size, the flattish right valve, the flat-topped ribs of the right valve and the striations of the ribs of both valves characterize this large *Leptopecten*. Some specimens attain a length of about 70 mm., and a height of about 60 mm., or more.

14. *Pecten* (*Plagiopecten*) *calli* Hertlein

Plate XXVII, figure 5

Pecten (*Plagiopecten*) *calli* HERTLEIN, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, p. 16, in part, pl. 4, fig. 6; Pliocene, Santiago, Lower Calif.; not figs. 5, 7.

Pecten calli is especially abundant in the Pliocene of Turtle Bay, and after examination of a large series of specimens, certain characteristics of the species are better known than previously.

The type specimen of the species is a left valve. The writers are now convinced that the Miocene shell figured by Hertlein⁴⁴ as a paratype of *P. calli*, and from which a description of the right valve was drawn, does not belong to this species. A right valve, undoubtedly of *P. calli*, is figured in this paper.

Right valves of this species vary considerably in convexity; usually they are moderately convex, and markedly so at the umbo. The hinge line is about two-thirds as long as the shell. They bear 18-21 ribs, which are rather high and prominent,

⁴⁴ Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, pl. 4, figs. 5, 7.

squarish in early stages of growth and usually square in the adult forms, but in a few individuals later becoming slightly rounded. The ribs are separated by interspaces that are not quite as wide as the ribs and, in unweathered specimens their sides are ornamented by fine concentric lamellæ. The posterior ear is well developed, and shows a very faint, broad notch. The ear is ornamented by five or six faint radiating riblets crossed by concentric lines of growth. The anterior ear is well developed, and is cut by a well defined byssal notch; the anterior margin of the ear is rounded, and the surface is ornamented by four to six radiating riblets crossed by incremental lines.

In size, our specimens range from 5 mm. up to an altitude of 50 mm., the average is probably between 25 and 35 mm.

Pecten calli is a variable species, but it may be distinguished from its near allies *P. deserti* Con., *P. impostor* Hanna, and *P. invalidus* Hanna, by peculiarities of the left valve, with its high and sharp ribbing, subangular shape at the umbo, and distinctly notched ears slightly turned up at the umbo. The ribbing and high umbo of the right valve are also characteristic.

This species occurs in the Pliocene beds on Cedros Island, as well as at Turtle Bay, in the Pliocene of the Cape region of Lower California and the San Diego Pliocene of Pacific Beach near San Diego, California.

15. *Pecten (Plagioctenium) callidus* Hertlein

Pecten (Plagioctenium) callidus HERTLEIN, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, 1925, No. 1, p. 22, pl. 5, figs. 1, 3, 5, 6; Pliocene, Cedros Island.

From *P. subdolosus* Hertlein, this species is distinguished by having higher, squarer, flat-topped ribs. The shell of *P. callidus* is usually somewhat thicker than that of *P. subdolosus*. The right valve in *P. callidus* varies somewhat in convexity, but usually has a tendency to become flattish, with the posterior ventral margin slightly attenuated. A short hinge line, the character of the ribbing, a greater relative height of shell and a usually slight, posterior ventral attenuation distinguish this species from *P. mendenhalli* Arnold. The character of the

ribbing, a generally larger size, a tendency toward flattening of the right valve and slight posterior attenuation distinguish *P. callidus* from *P. invalidus* Hanna.

In the case of immature individuals, the above criteria are not always effective, and the young of these closely related species of *Plagioctenium* can not always be identified with certainty.

P. callidus was found generally distributed in the Pliocene beds on Cedros Island and about Turtle Bay. It is also known to occur in the Pico formation of southern California, from which it has been listed as *P. cerrosensis*. *P. callidus* also occurs in the San Diego Pliocene of Pacific Beach near San Diego, California.

16. *Pecten (Plagioctenium) circularis* Sowerby

Pecten tumidus SOWERBY, Proc. Zool. Soc. Lond., 1835, p. 109; Living, Santa Elena, Ecuador. Not Turton 1822, nor Zeiten 1830.

Pecten circularis SOWERBY, Proc. Zool. Soc. Lond., 1835, p. 110; Living, Guaymas, Mexico.

Pecten ventricosus SOWERBY, Thes. Conch., Vol. 1, 1843, *Pecten*, p. 51, pl. 12, figs. 18, 19, 26; Living, St. Elena, Ecuador.

Pecten circularis SOWERBY, Thes. Conch., Vol. 1, 1843, *Pecten*, p. 51, pl. 12, fig. 23.

Pecten (Pecten) compactus DALL, Trans. Wagner Inst. Sci., Vol. 3, pt. 4, 1898, p. 707, pl. 34, fig. 5; "Pliocene", Ventura Co., Calif.

Pecten (Plagioctenium) subventricosus DALL, Trans. Wagner Inst. Sci., Vol. 3, pt. 4, 1898, p. 707, pl. 29, fig. 8; "Pliocene", Ventura Co., Calif.

Pecten (Plagioctenium) ventricosus SOWERBY, DALL, Trans. Wagner Inst. Sci., Vol. 3, pt. 4, 1898, p. 710.

Pecten (Plagioctenium) newsomi ARNOLD, Mem. Calif. Acad. Sci., Vol. 3, 1903, p. 113, pl. 11, figs. 1, 1a; Pleistocene, San Pedro, Calif.

Pecten (Plagioctenium) ventricosus SOWERBY, ARNOLD, Mem. Calif. Acad. Sci., Vol. 3, 1903, p. 114, pl. 11, figs. 3, 3a, 6, 6a.

Pecten (Plagioctenium) cerrosensis GABB, ARNOLD, Prof. Paper U. S. Geol. Surv. 47, 1906, p. 123, pl. 44, fig. 5. In part; not *P. cerrosensis* Gabb.

Pecten (Plagioctenium) circularis SOWERBY, ARNOLD, Prof. Paper U. S. Geol. Surv. 47, 1906, p. 125, pl. 42, figs. 3, 4, 5, 6, pl. 44, figs. 6, 6a, 6b, 7.

Pecten (Plagioctenium) circularis SOWERBY, E. K. Jordan & Hertlein, Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 4, 1926, p. 214, pl. 23, fig. 9.

The considerable inflation of the valves, and the rounded ribs separated by fairly wide interspaces distinguish this species. It occurs on Cedros Island, at Turtle Bay, and near Elephant Mesa, and has previously been found living from Monterey, Calif., to Payta, Peru, in the Pleistocene of southern and Lower California, the San Diego Pliocene at Pacific Beach, near San Diego, California, and has been reported in the Saugus, upper Pliocene formation in southern California.

17. *Pecten (Plagioctenium) cristobalensis* Hertlein

Pecten (Plagioctenium) cristobalensis HERTLEIN, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, 1925, p. 19, pl. 3, figs. 1, 2, 5; Pliocene, Turtle Bay.

P. cristobalensis is easily recognized by its numerous, high, rather narrow, square ribs, separated by deep, square interspaces, and by the presence of unusually strong, sharp concentric lamellæ ornamenting the bottoms of the interspaces and the sides of the ribs. This species has been found on Cedros Island, at Turtle Bay, and near Elephant Mesa.

18. *Pecten (Plagioctenium) evermanni* E. K. Jordan & Hertlein, new species

Plate XXVII, figure 1

Shell large, thick, moderately inflated. Right valve ornamented by 30 or 31, flattish topped, equal, radiating ribs, separated by narrow, slightly rounded interspaces, both the ribs and interspaces crossed by concentric lines of growth and the sides of ribs fringed by concentric lamellæ; anterior ear sculptured by about four radiating ribs, a very prominent thickening at base of ear; posterior ear somewhat similar to anterior in ornamentation, but without any large ridge at base. Length about 125 mm.; height 115 mm.; apical angle 108°.

Type: Right valve, No. 2108, *paratype*, No. 2109, Mus. Calif. Acad. Sci., from Loc. 928, **Bernstein's abalone camp, Cedros Island**; upper Pliocene; G. D. Hanna and E. K. Jordan, collectors.

P. evermanni differs from *P. hakei* Hertlein in possessing more numerous ribs which are flatter and much closer together. From *P. purpuratus* Lamarck, *P. evermanni* can be distinguished by the much greater number of ribs in the new species.

This species is named in honor of Dr. Barton Warren Evermann, Director of the California Academy of Sciences, in recognition of his notable scientific and executive accomplishments.

19. *Pecten* (*Plagioctenium*) *hakei* Hertlein

Plate XXXI, figures 1 and 2

Pecten (*Plagioctenium*) *cerrosensis* GABB, ARNOLD, Prof. Paper U. S. Geol. Surv. 47, 1906, p. 123, in part, pl. 49, figs. 1, 1a, 1b; not pl. 44, fig. 5; not *P. cerrosensis* Gabb.

Pecten (*Plagioctenium*) *purpuratus* LAMARCK, HERTLEIN, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, p. 14, in part, pl. 4, fig. 2. Not Pl. 4, fig. 5; Pl. 1, fig. 1.

Pecten (*Plagioctenium*) *hakei* HERTLEIN, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, p. 18, pl. 4, figs. 1, 3; Pliocene, Turtle Bay.

A large number of specimens of *P. hakei*, in a much better state of preservation than the original lot, has shown that this species is closely related to *P. purpuratus* Lamarck, yet the two species are clearly distinct.

P. hakei reaches a much larger size than does *P. purpuratus*. The shell of *P. hakei* appears to be uniformly thicker than that of *P. purpuratus* of equal size, and it is neither as distinctly suborbicular nor as flattish on the umbo as are typical examples of Lamarck's species. *P. hakei* shows considerable variation in globosity. The specimen here figured tends to be flattish while the young specimen figured by the junior author (These Proceedings, Vol. 14, No. 1, pl. 4, fig. 2), is a much more globose form. Furthermore, the anterior ear of the right valve of *P. hakei* is apparently larger than it is on *P. purpuratus*; on some young individuals of *P. hakei* the anterior ear of the right valve bears only three radiating ribs, as do many of the young of *P. purpuratus*, but differences in the ribbing on

the disk serve to separate the two species; adults of both often have more than three ribs on the ear.

The ribs ornamenting the right valve of *P. hakei* vary in number from 24 to 27. These are rounded and are separated by interspaces nearly as wide as the ribs, while in *P. purpuratus* the ribs are flat-topped or almost T-rail shaped, and are set close together, with narrow and deep interspaces. On unweathered specimens of *P. hakei* the ribs are seen to be laterally fringed by fine lamellæ, but these are not as pronounced as in *P. purpuratus*.

This species was found on Cedros Island, at Turtle Bay, and is known from other Pliocene localities to the south of the present region in Lower California.

20. *Pecten* (*Plagiectenium*) *invalidus* Hanna

Pecten (*Plagiectenium*) *cooperi* ARNOLD, Prof. Paper 47, U. S. Geol. Surv., 1906, p. 124, pl. 49, figs. 2-4. Pliocene, San Diego, Calif. Not *Pecten cooperi* E. A. Smith, 1903.

Pecten invalidus HANNA, Proc. Calif. Acad. Sci., 4th Ser., Vol. 13, No. 10, 1924, p. 177.

This species is distinguished from *P. callidus* Hertlein and *P. mendenhalli* Arnold by its smaller size, usually moderately arched umbo, and by its square ribs. In some of the specimens referred to *P. invalidus* the ribs show a tendency to become rounded in later stages of growth, while *P. callidus* always possesses square ribs. The right valve of *P. invalidus* is more symmetrical and not slightly attenuated toward the posterior ventral margin as is usually shown in typical examples of *P. callidus*. Young of *P. invalidus* show few positive characters to differentiate them from several other forms; the adults, however, can be recognized.

P. invalidus was found on Cedros Island, and at Turtle Bay. It had previously been known from the San Diego upper Pliocene of southern California, the Pliocene of Maria Madre Island, Mexico, and from the Pliocene of the Cape and Gulf of California regions of Lower California.

21. *Pecten* (*Plagiectenium*) *mendenhalli* Arnold

Pecten (*Plagiectenium*) *cerrosensis* GABB var.? *mendenhalli* ARNOLD, Prof. Paper, U. S. Geol. Surv., No. 47, 1906, p. 84, pl. 25, figs. 2, 2a, 2b; Pliocene, Santa Rosalia, Lower Calif.

Pecten (*Plagiectenium*) *cerrosensis mendenhalli* ARNOLD, HERTLEIN, Proc. Calif. Acad. Sci., Vol. 14, No. 1, 1925, p. 16, pl. 1, fig. 5.

Pecten mendenhalli ARNOLD, HANNA, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 18, 1926, p. 473, pl. 25, figs. 4, 5.

A few specimens in the collection appear to belong to this species. They agree with Arnold's figure of the type of *P. mendenhalli* in possessing an unusually long hinge line, valves which are little inflated and are unusually long in proportion to their height and right valves which are evenly rounded at the umbo, and broadly rounded on the ventral margin. They can be distinguished from *P. invalidus* and *P. callidus* by these characters. None of our specimens has quite as broadly rounded ribs as is shown by Arnold's figure of the type of *P. mendenhalli*.

Examination of many specimens of true *P. cerrosensis* Gabb proves that *P. mendenhalli* is not related to that species, but it is far closer to *P. invalidus*, *P. callidus*, *P. subdolosus*, and *P. circularis*.

This species was found at Cedros Island and at Turtle Bay. It has previously been known from the Imperial Pliocene formation of Imperial County, California, from Santa Rosalia, Lower California, and from the San Diego Pliocene of Pacific Beach near San Diego, California.

22. *Pecten* (*Plagiectenium*) cf. *purpuratus* Lamarck

Pecten purpuratus LAMARCK, Hist. des Animaux sans Vertèbres (edition by Deshayes and Edwards), Vol. 7, 1836, p. 134; Recent, "Mers orientales et australes".

Pecten purpuratus LAMARCK, Dall, Proc. U. S. Nat. Mus. Vol. 37, 1910, p. 149, pl. 26, figs. 5, 6.

Pecten (*Plagiectenium*) *purpuratus* LAMARCK, HERTLEIN, Proc. Calif. Acad. Sci. 4th Ser., Vol. 14, No. 1, 1925, p. 14, in part, pl. 1, fig. 1, pl. 4, fig. 4; not fig. 2.

In the collection from Cedros Island there are a few specimens which are very similar to *P. purpuratus* Lamarck, al-

though none is exactly typical of that species. The writers are convinced that the right valve figured by Hertlein as *P. purpuratus* from Turtle Bay is *P. hakei* Hertlein (Vol. 14, No. 1, Pl. 4, fig. 2).

A suborbicular disk, moderately small anterior ear on the right valve, ornamented with three or four radiating ribs, and numerous closely spaced flat-topped or T-rail shaped ribs which are laterally fringed with lamellæ, are characteristic features of *P. purpuratus*.

P. purpuratus is now living from Coquimbo, Chile, northward to Ecuador, and is also known from the Pliocene and Pleistocene of Coquimbo.

23. *Pecten (Plagioctenium) subdolus* Hertlein

Pecten (Plagioctenium) subdolus HERTLEIN, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, p. 20, pl. 5, figs. 2, 4, 7; Pliocene, Pacific Beach near San Diego, Calif.

Pecten subdolus is distinguished by having usually a rather thin shell, with somewhat low rounded ribs, and rounded interspaces; both the ribs and interspaces in perfect specimens are usually ornamented by fine radial striæ. These characteristics easily distinguish the species from *P. callidus* Hertlein.

The specimen figured for *P. cerrosensis* by Arnold⁴⁵, but later referred to *P. subdolus* by Hertlein, can not be identified with this species and is not *P. cerrosensis* Gabb; it is apparently a variant of *P. hakei* Hertlein.

P. subdolus was found on Cedros Island, and near Turtle Bay. It is abundant in the San Diego upper Pliocene of Pacific Beach, Calif.

24. *Placunanomia hannibali* E. K. Jordan & Hertlein, new species

Plate XXVIII, figures 2, 3, and 4

Shell large, thin, subcircular to suboval in outline, usually very flat, compressed and more or less regular in growth; most specimens with no evidence of radial plication but a few

⁴⁵ Prof. Paper U. S. Geol. Surv., No. 47, 1906, pl. 49, figs. 1, 1a, 1b.

more or less profoundly, radially plicate; surface sculptured by concentric growth lines, and by very fine, wavy, minutely prickly, radial striations. Right valve slightly arched; byssal foramen closed or nearly so, but leaving an elongate oblique semi-triangular pit near the beak, which almost communicates with the interior; auricular crura very strong, diverging from the beak at an acute angle varying somewhat in different specimens. Left valve flat or concave, never convex as is the right; without byssal foramen, but usually broken slightly at the beak; interiorly with two strong ribs radiating from the umbo, but fitting outside of the auricular crura, and hence diverging at a somewhat greater angle. Length 114 mm.; width 95 mm.; thickness 15 mm.

Type: No. 2110, *paratypes*, Nos. 2111, 2112, 2113, 2114, and 2115, Mus. Calif. Acad. Sci., from Loc. 945 (C.A.S. coll.), **southeast of Turtle Bay, Lower California**; upper Pliocene.

Fourteen other specimens of this species were examined from the same locality, and one was found at Loc. 928 (C.A.S. Coll.), Bernstein's abalone camp, Cedros Island, Lower California; upper Pliocene.

Placunanomia hannibali is related to *P. californica* Arnold, from the Etchegoin lower Pliocene of central California, but is distinguished by having a generally flatter and more regular shell with very fine rather than heavy radial sculpture. *P. cumingii* Broderip, from the recent fauna of western Mexico and the upper Pliocene of Maria Madre Island is very strongly radially plicate, and lacks all radial sculpture. *P. hannibali* is most nearly related to *P. lithobleta* Dall, of the Miocene of the Caribbean region, but seems to attain a larger size than that species, and to be fitted with larger and heavier auricular crura.

This species is named in honor of Mr. Harold Hannibal, in recognition of his work on the paleontology and stratigraphy of western North America.

25. *Spondylus crassisquama* Lamarck

- Spondylus crassi-squama* LAMARCK, Hist. des Animaux sans Vertèbres, Vol. 6, 1819, p. 191; Living, "les mers de l'Inde",—"fossile a Carthagène d'Amerique".
- Spondylus princeps* BRODERIP, Proc. Zool. Soc. Lond., 1833, p. 4; Living, "Insulam Platam Columbiæ Occidentalis".
- Spondylus dubius* BRODERIP, Proc. Zool. Soc. Lond., 1833, p. 4; Living, Gulf of Tehuantepec.
- Spondylus leucacantha* BRODERIP, Proc. Zool. Soc. Lond., 1833, p. 5; Living "ad Insulam Platam".
- Spondylus limbatus* SOWERBY, Proc. Zool. Soc. Lond., 1847, p. 87; Recent, "Persian Gulf".
- Spondylus pictorum* SOWERBY (as of CHEMNITZ), Thes. Conch., Vol. 1, 1847, p. 422, pl. 85, fig. 17, pl. 86, fig. 28; Living, Island of Plata, Colombia.
- Spondylus leucacantha* BRODERIP, SOWERBY, Thes. Conch., Vol. 1, 1847, p. 423, pl. 87, figs. 35, 36.
- Spondylus limbatus* SOWERBY, Thes. Conch., Vol. 1, 1847, p. 427, pl. 88, fig. 51.
- Spondylus leucacantha* BRODERIP, REEVE, Conch. Icon., Vol. 9, 1856, *Spondylus*, pl. 2, fig. 6.
- Spondylus princeps* BRODERIP, REEVE, Conch. Icon., Vol. 9, 1856, *Spondylus*, pl. 2, fig. 9.
- Spondylus pictorum* CHEMNITZ, REEVE, Conch. Icon., Vol. 9, 1856, *Spondylus*, pl. 6, fig. 24.
- Spondylus limbatus* SOWERBY, REEVE, Conch. Icon., Vol. 9, 1856, pl. 6, fig. 34.
- Spondylus crassisquama* LAMARCK, DALL, Proc. U. S. Nat. Mus., Vol. 37, 1909, p. 256.

This species, of which many fragments but no complete specimens were found on Cedros Island, is the large, spiny, brilliantly colored *Spondylus* well known from the recent fauna of western Mexico. There can be no question that all of the so-called species enumerated above are specifically identical, although the range of variation shown is considerable.

S. calcifer Carpenter reaches a much larger size than this species, has a relatively heavier, longer and narrower shell at all stages of growth, and never bears as long and prominent spines as *S. crassisquama*.

26. *Epitonium cedrosensis* E. K. Jordan & Hertlein,
new species

Plate XXX, figure 3

Shell small, broadly conic, solid; spire turreted, of five, strongly convex, post nuclear whorls, the tip lost; sutures deeply marked; varices 13 to 15, somewhat unequal, generally strong, the terminal varix and occasional scattered varices on earlier whorls much stronger and thicker than others; all varices reflected, rounded on top, and thin edged, continuous across the suture and encircling about half of the spire, each bearing a small, broad but sharp spine at the shoulder; intercostal spaces averaging one and one-third times as wide as the varices, ornamented by about 30 subequal, rounded spiral threads that are separated by rounded grooves about as wide as the threads; no basal disk, the base of the last whorl evenly rounded, sculptured as are the whorls of the spire, the varices continuous to the umbilical area; umbilicus narrowly perforate; aperture ovate. Length 8.2 mm.; width 4.34 mm.

Type: No. 2116, *paratypes* Nos. 2117, 2118, 2119, and 2120, Mus. Calif. Acad. Sci., from Loc. 928 (C.A.S. coll.), **Bernstein's abalone camp, Cedros Island, Lower California**, upper Pliocene; G. D. Hanna and E. K. Jordan collectors.

Seventeen other specimens of this species were examined from the type locality and one from locality 945.

This species belongs to the group of *E. bellastrata* Carpenter, to which has been given the subgeneric designation of *Asperiscula* De Boury⁴⁶. From the several previously known species of the group, it is apparently well distinguished by the number and character of the varices.

27. *Epitonium contrerasi* E. K. Jordan & Hertlein,
new species

Plate XXX, figure 4

Shell rather elongate conic, of moderate size, not very thick; spire of five moderately convex and slightly shouldered whorls, the tip lost; varices about ten, nearly equal, subequally spaced,

⁴⁶ See Dall, Proc. U. S. Nat. Mus., Vol. 53, 1917, p. 475.

thin, sharp, hardly recurved, rarely directly continuous across the suture, each varix with a small, sharp spine at the shoulder; intercostal spaces perfectly smooth, about five times as wide as the varices; no basal disk, the varices continuous to the umbilical area; umbilicus imperforate. Length 21.3 mm.; width 8.6 mm.

Type: No. 2121, Mus. Calif. Acad. Sci., from Loc. 945 (C.A.S. Coll.), **one mile southeast of Turtle Bay, Lower California**; upper Pliocene; G. D. Hanna, and E. K. Jordan, collectors.

While we are unable to state that this is, without question, distinct from any of the previously described, but so far unfigured species of the genus, from western America, we have, at the same time been unable to identify it with any described species.

This species is named in honor of Prof. Francisco Contreras Assistant Director of the Museo Nacional de Mexico, conchologist and member of the expedition to Lower California, 1925.

28. *Epitonium dallasi* E. K. Jordan & Hertlein, new species

Plate XXX, figure 2

Shell small, conic, quite thick and solid; spire of four strongly convex post nuclear whorls, the tip lost; sutures sharp; varices 18 or 19, of which all except the terminal and next to terminal are moderately strong, round topped, not reflected nor much overhanging, having more the appearance of axial ribs than of true varices; terminal and next to terminal varices very wide, thick, and heavy, together occupying about one-third of the perimeter of the body whorl, fused posteriorly at the suture and anteriorly on the base, elsewhere separated by an intercostal space of a little greater than normal width; other varices partly fused at the suture but not directly continuous across it, nor in any wise produced or spiny at the shoulder; intercostal spaces about twice as wide as a normal varix, ornamented by about 20 subequal and subequally spaced impressed spiral grooves, which extend part way up on the sides of the varices but end abruptly and do not pass over the

tops; no true basal disk, the umbilical area, however, covered by a thick irregular patch of callus that is fused with the anterior ends of the last few varices; remainder of base evenly rounded, sculptured as the whorls of the spire, the varices and spiral grooves extending to the edge of the patch of callus; aperture sub-circular. Length 5-9 mm.; width 4.0 mm.

Type: No. 2122, Mus. Calif. Acad. Sci., from Loc. 945 (C.A.S. Coll.), **one mile southeast of Turtle Bay, Lower California**; upper Pliocene; G. D. Hanna and E. K. Jordan, collectors.

This species is named in honor of Dr. G. Dallas Hanna, curator of Paleontology in the California Academy of Sciences.

29. *Forreria wrighti* E. K. Jordan & Hertlein, new species

Plate XXXII, figures 1 and 3

Shell of moderate size, fairly thick and solid; spire moderately elevated, about five whorls, the tip lost, the whorls enlarging rapidly, and strongly shouldered near the summit; axial sculpture of ten to thirteen sharp varices, produced into short, sharp slightly reflexed spines at the shoulder; spiral sculpture of few to many strong and distantly spaced, or fine and closely spaced ridges, which are most intense on the earlier whorls and become less marked later; all the sculpture varying greatly in different individuals; aperture ovate; outer lip anteriorly bearing a tooth of greater or less prominence; canal moderately long, broadly open. Altitude of type with tip of spire lost 45.1 mm.; width 32.2 mm.

Type: No. 2123, *paratypes*, Nos. 2124, 2125, 2126, 2127, 2128, 2129, and 2130, Mus. Calif. Acad. Sci., from Loc. 945, **southeast of Turtle Bay, Lower California**; Pliocene; G. D. Hanna and E. K. Jordan, collectors.

Sixty other specimens have been examined from the same locality.

This species is extremely variable in form and sculpture and resembles various forms from the Miocene and Pliocene of western North America, but none of our examples agrees exactly with any other described species. From *F. coalingensis*

Arnold it is distinguished by the presence of more spiral ridges on the whorls. From *F. perelegans* Nomland, *F. wrighti* is distinguished by possessing somewhat stronger sculpture and a less recurved canal and a less prominent siphonal fasciole. From *F. carisaënsis* Anderson, it is distinguished by a more elongate outline of the shell. The prominent spiral sculpture on the early whorls distinguish *F. wrighti* from the young of *F. belcheri* Hinds, *F. magister* Nomland, and *F. ponderosum* Gabb.

This species is named for Mr. John T. Wright, collector of birds and mammals on the expedition of 1925, who frequently and generously assisted in the collection of fossils.

30. *Haliotis* cf. *rufescens* Swainson

A specimen of an abalone shell was found in the Pliocene of Cedros Island, in place and associated with Pliocene fossils. Unfortunately the friable condition of the matrix and brittleness of the shell makes complete cleaning of the specimen impossible.

The shell is a little thinner than that of typical *H. rufescens* from the recent west American fauna, and the spiral sculpture is more regular. It is not *H. fulgens* Philippi, for in that species the holes are small, more numerous, and their margins are little elevated, while on our specimen the holes are few, large, with elevated margins, and very similar to those of *H. rufescens*. The known recent range of *H. rufescens* is from Bodega Bay, California, southward to La Paz, Lower California.

PLATE 27

- Fig. 1. *Pecten (Plagiocentrum) evermanni* E. K. Jordan & Hertlein, new species; natural size; type, right valve, No. 2108 (C. A. S. Type Coll.), from Loc. 928 (C. A. S.), Pliocene beds at Bernstein's abalone camp on east side of Cedros Island. Pliocene; p. 439.
- Fig. 2. *Astrodapsis kewi* E. K. Jordan & Hertlein, new species; natural size; type, upper surface of test, No. 2090 (C. A. S. Type Coll.), Loc. same as Fig. 1; p. 425.
- Fig. 3. *Astrodapsis kewi* E. K. Jordan & Hertlein, new species; natural size; type, lower surface of test. Same specimen as Fig. 2; p. 425.
- Fig. 4. *Astrodapsis israelskyi* E. K. Jordan & Hertlein, new species; natural size; type, lower surface of test, No. 2086 (C. A. S. Type Coll.), Loc. same as Fig. 2; p. 424.
- Fig. 5. *Pecten (Plagiocentrum) calli* Hertlein; natural size; plesiotype, right valve, No. 2107 (C. A. S. Type Coll.), from Loc. 945 (C. A. S.), Pliocene beds exposed about a prominent monadnock, from one to two miles to southeast of Turtle Bay. Upper Pliocene; p. 436.
- Fig. 6. *Astrodapsis israelskyi* E. K. Jordan & Hertlein, new species; natural size; type, upper surface of test. Same specimen as Fig. 4; p. 424.
- Fig. 7. *Laqueus californicus vancouveriensis* Davidson; natural size; plesiotype, No. 2091 (C. A. S. Type Coll.), Loc. same as Fig. 1; p. 426.

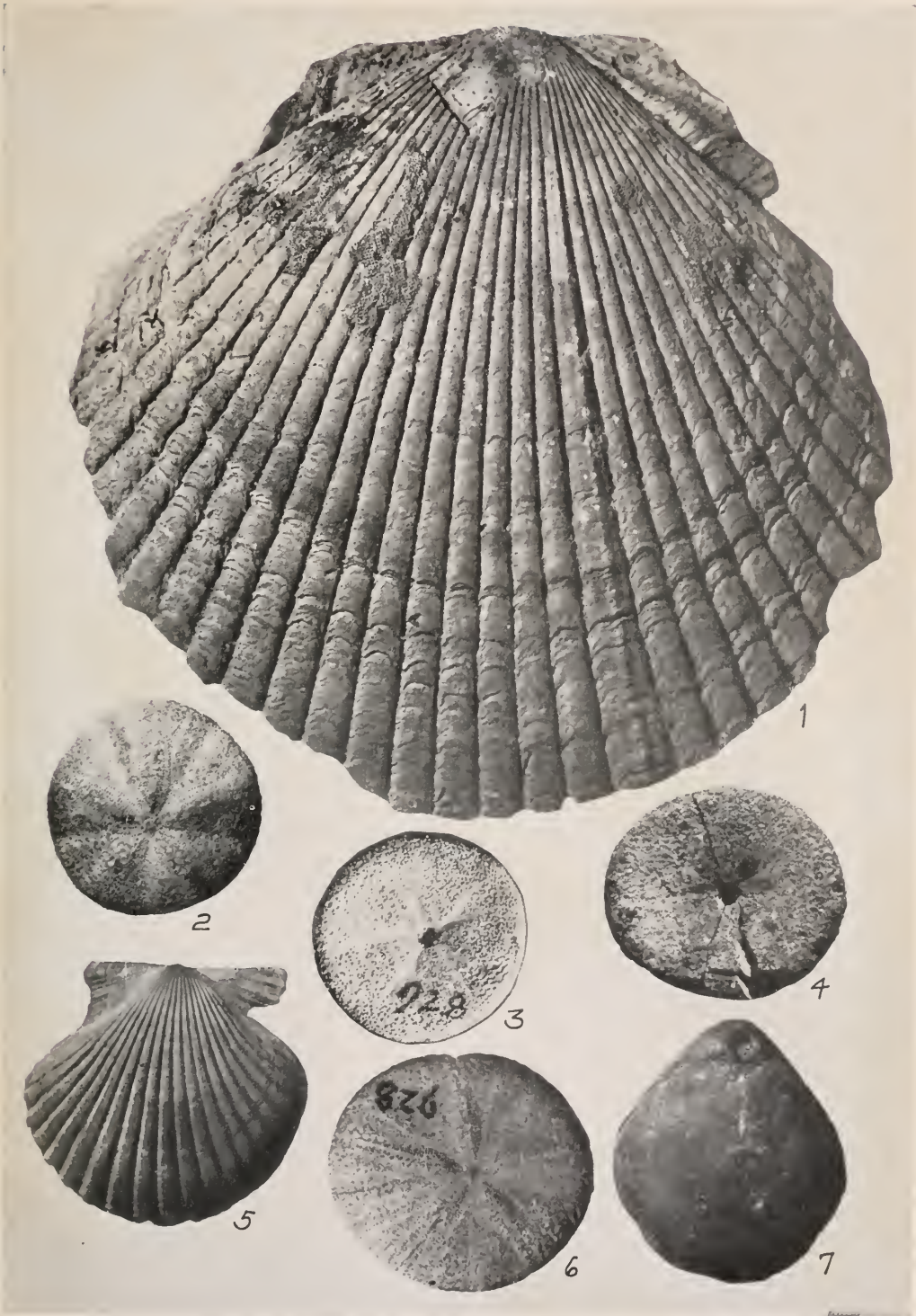


Plate 28

- Fig. 1. *Ostrea mcgodon* Hanley; natural size; plesiotype, No. 2093 (C.A.S. Type Coll.), from Loc. 928 (C.A.S.), Pliocene beds at Bernstein's abalone camp on southeast side of Cedros Island. Pliocene; p. 427.
- Fig. 2. *Placunanomia hannibali* E. K. Jordan & Hertlein, new species; natural size; type, right valve, No. 2110 (C.A.S. Type Coll.), from Loc. 945 (C.A.S.), Pliocene beds exposed about a prominent monadnock, from one to two miles southeast of Turtle Bay. Upper Pliocene; p. 443.
- Fig. 3. *Placunanomia hannibali* E. K. Jordan & Hertlein, new species; natural size; paratype, right valve showing interior of valve, No. 2112 (C.A.S. Type Coll.), Loc. same as Fig. 2; p. 443.
- Fig. 4. *Placunanomia hannibali* E. K. Jordan & Hertlein, new species; natural size; paratype, right valve, No. 2111 (C.A.S. Type Coll.), Loc. same as Fig. 2. Figure shows tendency of some forms to become plicate; p. 443.



Plate 29

- Fig. 1. *Pecten (Lyropecten) gallegosi* E. K. Jordan & Hertlein, new species; natural size; type, right valve, No. 2096 (C.A.S. Type Coll.), from Loc. 946 (C.A.S.), Pliocene beds exposed near the shore on east side of Cedros Island about nine miles north of Bernstein's abalone camp. Upper Pliocene; p. 434.
- Fig. 2. *Pecten (Leptopecten) prævalidus* E. K. Jordan & Hertlein, new species; natural size; paratype, left valve, No. 2102 (C.A.S. Type Coll.), from Loc. 945 (C.A.S.), Pliocene beds exposed about a prominent monadnock, from one to two miles south-east of Turtle Bay. Upper Pliocene; p. 435.
- Fig. 3. *Pecten (Leptopecten) prævalidus* E. K. Jordan & Hertlein, new species; natural size; type, right valve, No. 2101 (C.A.S. Type Coll.), Loc. same as Fig. 2; p. 435.

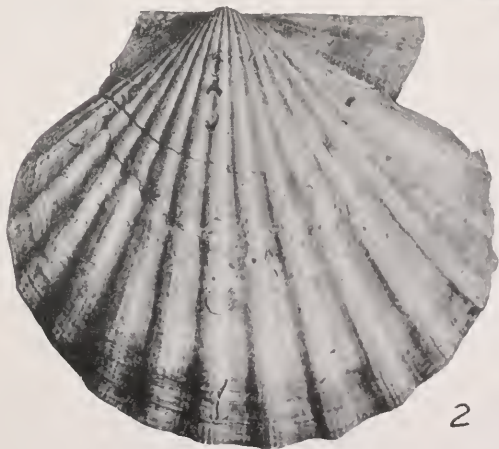
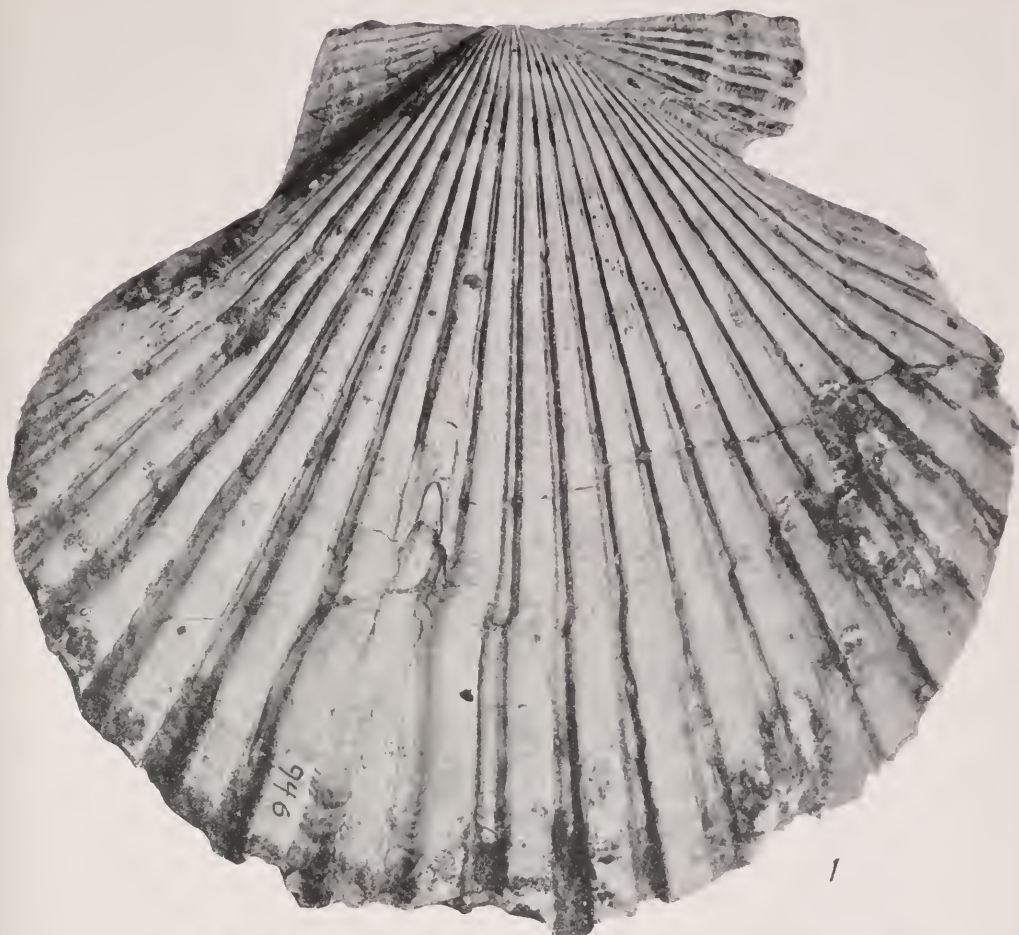


Plate 30

- Fig. 1. *Pecten (Patinopecten) dilleri* Dall; natural size; plesiotype, left valve, No. 2095 (C.A.S. Type Coll.), from Loc. 48 (L.S.J.U.), mouth of big arroyo northwest of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California. Pliocene; p. 431.
- Fig. 2. *Epitonium dallasi* E. K. Jordan & Hertlein, new species; true length of figured specimen approximately 8 mm.; width 4 mm.; type No. 2122 (C.A.S. Type Coll.), from Loc. 945 (C.A.S.), one mile southeast of Turtle Bay. Pliocene; p. 447.
- Fig. 3. *Epitonium cedrosensis* E. K. Jordan & Hertlein, new species; true length of figured specimen 8.2 mm.; width 4.34 mm.; type, No. 2116 (C.A.S. Type Coll.), from Loc. 928 (C.A.S.), Pliocene beds at Bernstein's abalone camp on southeast side of Cedros Island. Pliocene; p. 446.
- Fig. 4. *Epitonium contrerasi* E. K. Jordan & Hertlein, new species; true length of figured specimen 21.3 mm.; width 8.6 mm.; type, No. 2121 (C.A.S. Type Coll.), from Loc. 945 (C.A.S.), one mile southeast of Turtle Bay. Pliocene; p. 446.

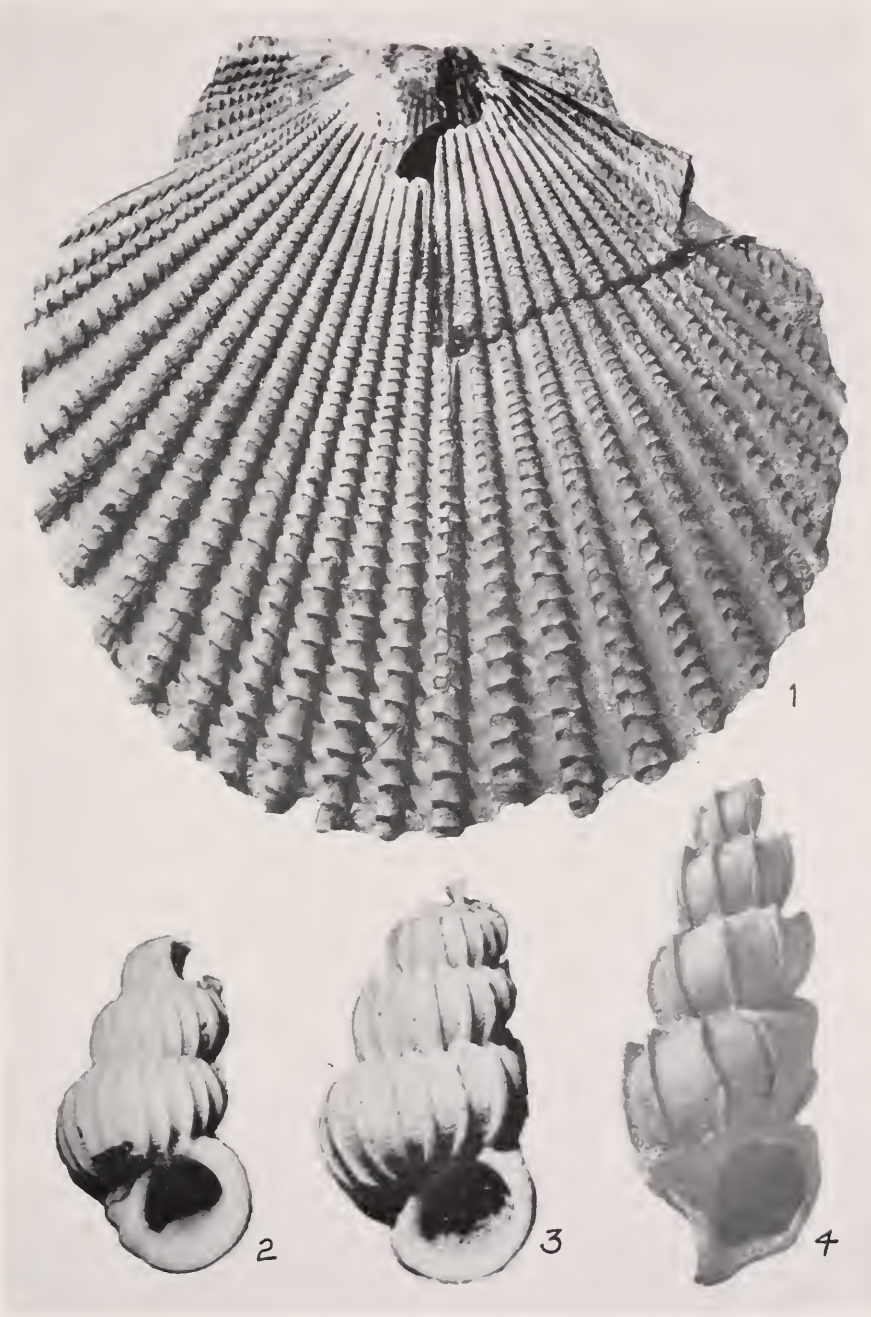


Plate 31

Fig. 1. *Pecten (Plagiectenium) hakei* Hertlein; natural size; plesiotype, right valve, No. 2131 (C.A.S. Type Coll.), from Loc. 928 (C.A.S.), Pliocene beds at Bernstein's abalone camp on south-east side of Cedros Island. Pliocene; p. 449.

Fig. 2. *Pecten (Plagiectenium) hakei* Hertlein; natural size; plesiotype, left valve; same specimen as Fig. 1; p. 449.



Plate 32

- Fig. 1. *Forreria wrighti* E. K. Jordan & Hertlein, new species; natural size; type, No. 2123 (C.A.S. Type Coll.), from Loc. 945 (C.A.S.), Pliocene beds exposed about a prominent monadnock, from one to two miles to southeast of Turtle Bay. Pliocene; p. 448.
- Fig. 2. *Pecten (Pecten) bellus* Conrad; natural size; paratype, right valve (of *P. hemphillii* Dall), No. 526a (C.A.S. Type Coll.), from Pacific Beach near San Diego, California. San Diego Pliocene; p. 430.
- Fig. 3. *Forreria wrighti* E. K. Jordan & Hertlein, new species; natural size; paratype, No. 2124 (C.A.S. Type Coll.), Loc. same as Fig. 1; p. 448.
- Fig. 4. *Pecten (Lyropecten) cerrosensis* Gabb; natural size; plesiotype, right valve, No. 2134 (C.A.S. Type Coll.), young form, from Loc. 928 (C.A.S.), Pliocene beds at Bernstein's abalone camp on southeast side of Cedros Island. Pliocene; p. 432.



Plate 33

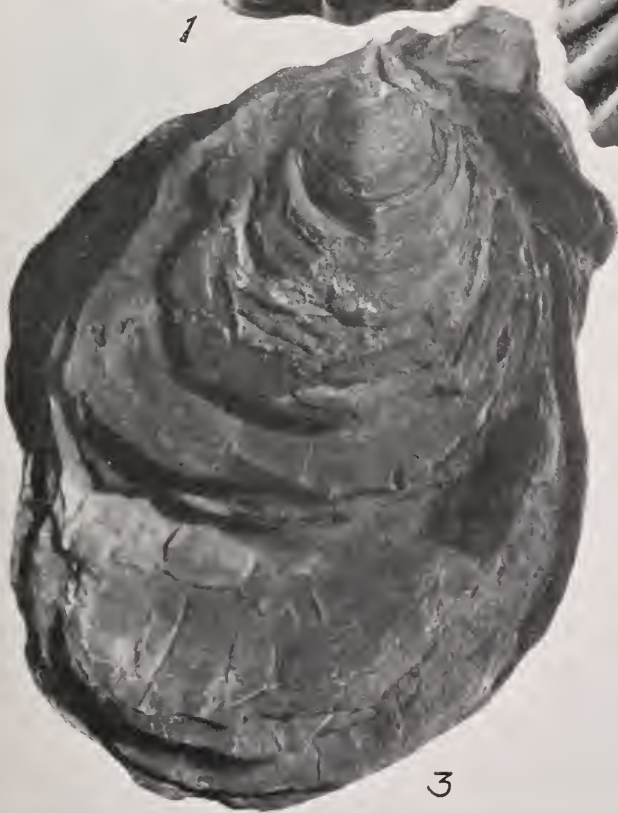
- Fig. 1. *Pecten (Pecten) bellus* Conrad; natural size; plesiotype, right valve, No. 2132 (C.A.S. Type Coll.), from Loc. 928 (C.A.S.), Pliocene beds at Bernstein's abalone camp on southeast side of Cedros Island. Pliocene; p. 430.
- Fig. 2. *Pecten (Pecten) bellus* Conrad; natural size; plesiotype, right valve, No. 2133 (C.A.S. Type Coll.), from same Loc. as Fig. 1; p. 430.
- Fig. 3. *Ostrea tayloriana* Gabb; natural size; plesiotype, right valve, No. 2094 (C.A.S. Type Coll.), from Loc. 48 (L.S.J.U.), mouth of big arroyo northwest of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California. Pliocene; p. 428.



1



2



3

Plate 34

- Fig. 1. *Chama frondosa* Broderip; natural size; plesiotype, right valve, No. 2092 (C.A.S. Type Coll.), from Loc. 946 (C.A.S.), Pliocene beds exposed near the shore on east side of Cedros Island about nine miles north of Bernstein's abalone camp. Pliocene; p. 427.
- Fig. 2. *Pecten (Pecten) bellus* Conrad; natural size; paratype, left valve (of *P. hemphillii* Dall) No. 526a (C.A.S. Type Coll.). Same specimen as Plate 32, Fig. 2; p. 430.
- Fig. 3. *Pecten (Pecten) bellus* Conrad; natural size; plesiotype, left valve, No. 2132 (C.A.S. Type Coll.). Same specimen as Plate 33, Fig. 1. Pliocene; p. 430.
- Fig. 4. *Pecten (Pecten) bellus* Conrad; natural size; plesiotype, left valve, No. 2133 (C.A.S. Type Coll.). Same specimen as Plate 33, Fig. 2. Pliocene; p. 430.



PROCEEDINGS
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XV
EXPEDITION TO THE REVILLAGIGEDO ISLANDS,
MEXICO, IN 1925

LAND SHELLS OF THE REVILLAGIGEDO AND
TRES MARIAS ISLANDS, MEXICO¹

BY
WILLIAM HEALEY DALL

The Tres Marias Islands have long been of interest to naturalists, especially ornithologists, as several forms of bird life are peculiar to them. They have been visited by Grayson, Forrer, Richardson, Nelson and Goldman, and Fisher, collectors, who appear to have paid most attention to vertebrate life, as prior to the Academy's expedition only nine species of land mollusks were reported from the group, and these with few exceptions were referred, not to the particular island from which they came, but simply to the "Tres Marias." Of these, five have not been identified from the Academy's collection, and to make the list complete, references to them have been included here. It may be suspected, however, that some of them are misidentifications for species actually collected by the Academy's expedition.

The few species collected by the expedition at the isolated Clarion Island are of especial interest, as only one of them had

¹ All of the previous papers dealing with the scientific results of the expedition appear in the current volume of Proceedings (XV) No. 1, pp. 1-113 containing the general report with itinerary.

July 22, 1926



previously been obtained and that in a condition precluding description. It may be mentioned that the marine shells of Clarion Island, judging by the few which have come to hand, are more closely related to the tropical Pacific fauna than to that of continental America.

It is notable that the land-shell fauna of the Tres Marias is distinctly related to that of Mexico proper,—the Epiphragmophoras and peculiar Bulimuli of Lower California are conspicuously absent. The only large species are the Oxystylas; the *Drymæus* and *Polygyra* belong to the smaller forms of their genus. All the Socorro species are small, and only the Clarion Island *Succinea* is comparable in size to the average continental species. In short, in all these islands there is nothing but the *Oxystyla* which might not have easily been introduced by the natural means of distribution from the nearest land. The fact that recorded continental distribution of most of the species is from the eastern part of Mexico and middle America, is probably due to the lack of exploration for these minute forms in the western portion of these countries.

The following lists show the distribution of the species among the several islands. The species designated from Maria Madre of the Tres Marias have an M prefixed; those from Maria Magdalena a G; and those recorded only from the group without designation of the particular island have a T.

Species from the Tres Marias

- M. G. *Euglandina mariana*
- M. *Euglandina mazatlanica*
- T. *Euglandina albersi*
- M. G. *Opeas rarum*
- M. *Cæcilioides consobrina prima*
- M. G. *Leptinaria martensi*
- M. G. *Pseudosubulina evermanni*
- M. *Oxystyla delphinus nebulosa*
- M. *Oxystyla delphinus nesiotica*
- T. *Oxystyla princeps*
- T. *Drymæus trimarianus*
- M. *Drymæus uhdeanus tepicensis*
- M. G. *Polygyra richardsoni paucicostata*
- T. *Polygyra ventrosula*
- T. *Polygyra bicruris*
- M. G. *Thysanophora materna*

- M. G. *Guppya perforata*
 M. G. *Guppya montanicola*
 M. G. *Punctum pygmæum*
 M. G. *Punctum pygmæum rotundum*
 M. G. *Punctum pygmæum albeola*
 M. *Punctum planatum*
 M. *Gastrocopta pellucida*
 M. G. *Vitrea indentata*
 M. *Proserpinella hannaë*

Species from Socorro Island

- Cæcilioides consobrina prima*
Pseudosubulina evermanni
Guppya capsula
Guppya montanicola
Guppya socorroana
Strobilops labyrinthica
Strobilops strebeli
Punctum pygmæum
Punctum pygmæum albeola
Gastrocopta pellucida
Gastrocopta pellucida hordeacella
Zonitoides socorroënsis
Tornatellides mexicana
Succinea socorroënsis

Species from Clarion Island

- Thysanophora clarionensis*
Gastrocopta pellucida
Gastrocopta pellucida hordeacella
Tornatellides clarionensis
Succinea clarionensis

The absence of *Succinea* from the Tres Marias is peculiar, as it is one of the forms usually most easy to detect. It may be noted that a very large proportion of the collection consists of dead shells, and the few fresh ones have indications of being in æstivation, probably owing to the season of the year.

I am under obligations to Dr. H. A. Pilsbry, of the Philadelphia Academy of Natural Sciences, for assistance in identifying some of the minute forms of which he is the acknowledged master.

Genus *Euglandina* Crosse and Fischer, 18721. *Euglandina mazatlanica* Martens

Glandina mazatlanica MARTENS, Biol. Centr. Am., p. 65, pl. 4, figs. 2, 2a, 1891.

Glandina mazatlanica MARTENS, var. *abbreviata* MARTENS, l. c., p. 65, pl. 4, fig. 3, 1891.

The variety is reported as collected at the Tres Marias by Forrer, with the typical form.

2. *Euglandina albersi* Pfeiffer

Achatina (*Glandina*) *albersi* PFEIFFER, Proc. Zool. Soc. 1854, p. 295.

Glandina albersi MARTENS, Biol. Centr. Am., p. 75, pl. 4, figs. 10, 10a, 1891.

Collected by Forrer at Mazatlan and the Tres Marias.

3. *Euglandina mariana* Dall, new species

Plate 35, figure 4

Shell pinkish fawn-color, having the general form of *E. rhoadsi* Pilsbry, from eastern Mexico, as figured in the Proceedings of the Academy of Natural Sciences for 1903 (p. 771, pl. 47, figs. 3, 3 a-b), but much smaller; whorls, six and a half, the nucleus smooth, of two and one-half whorls; subsequent whorls finely axially striated, polished, the folds not coronate at the suture and becoming obsolete near or slightly beyond the periphery of the last whorl; whorls moderately convex; suture distinct but not deep; aperture narrowly ovate, the outer lip not sharp; pillar concavely arcuate, sharply truncate, shorter than the aperture; length of shell, 29; of last whorl, 20; of aperture, 14; maximum diameter 10 mm.

Type: No. 2190, Mus. Calif. Acad. Sci.; collected by the Academy expedition on Maria Madre and **Maria Magdalena**, **Tres Marias** islands.

In the literature the lines between nominal species are very closely drawn, but I can not make this shell agree with any of those figured.

Dr. H. A. Pilsbry has described in the Proceedings of the Academy of Natural Sciences, Philadelphia, for 1925, p. 308,

a possible variety of *E. turris* Pfeiffer, which he calls *E. turris longuris*, the type coming from Mazatlan, but other specimens recorded from the Tres Marias. According to the excellent figures given in his article the species is larger, more inflated in proportion, and more coarsely axially striated than *E. mariana*.

Genus *Opeas* Albers, 1850

4. *Opeas rarum* Miller

Opeas rarum MILLER, Malak. Blatt., n. ser., 1. p. 125, pl. 14, fig. 2, 1879—
STREBEL, Beitr. V, p. 103, pl. 17, figs. 8, 17; pl. 7, fig. 5, 1882—
PILSBRY, Manual, XVIII, p. 208, pl. 29, figs. 82, 83; 1906.

A single fresh specimen was collected on Maria Magdalena Island, Tres Marias, 6.5 mm. in length. This form is also reported by Strebel from San Miguel, Jucuma, Guatemala, and a slight variation from Mirador, Vera Cruz.

Genus *Cæcilioides* Herrmannsen, 1846

5. *Cæcilioides consobrina prima* De Folin

Achatina consobrina ORBIGNY, Moll. Cuba V, p. 89, pl. XI bis, figs. 10, 11, 12; 1845.

Achatina pygmæa PFEIFFER, Zeitschr. f. Malak. 1847. p. 148.

Karolus primus DE FOLIN, Fonds de la Mer, 1. p. 189, pl. XXXVI, figs. 7, 8; 1870.

Achatina iota STREBEL, Beitr. Mex. Land u. Süsw. Conch. II, 1875, p. 53, pl. 13, fig. 50.

Cæcilianella veracruzensis CROSSE & FISCHER, Moll. terr. et fluv. Mexico, p. 591, pl. 26, fig. 4, 1878.

Cæcilioides (Cæcilianopsis) jod PILSBRY, Nautilus, XXI, p. 28, 1907.

Cæcilioides consobrina PILSBRY (ex parte) Man. Conch. XX, p. 39, pl. 5, figs. 81, 82, 1909.

Collected by the Academy expedition on Maria Madre of the Tres Marias Islands, near the village on the east side; and on Socorro Island, on the north slope of Mount Evermann at from 2,000 to 2,800 feet elevation, and on the lowlands at Braithwaite Bay and Grayson's Cove.

This species is very widely distributed, being originally described from Cuba and later recorded with slight variations

from Panama and various localities in Mexico. Its minute size renders it peculiarly fitted for accidental transportation by birds and violent winds.

Genus *Leptinaria* Beck, 1839

6. *Leptinaria martensi* Pfeiffer

Plate 35, figure 5

Bulinus martensi PFEIFFER, Proc. Zool. Soc. 1856, p. 318.

Spiraxis martensi CROSSE & FISCHER, Miss. Sci. Mex., Moll. 1, p. 619, pl. 25, fig. 9, 1878.

Lamellaxis modestus STREBEL, Beitr. V, p. III, pl. 7, fig. 15, pl. 17, figs. 5a-b, 6a, 7b, 31.

Leptinaria martensi MARTENS, Biol. Am. Centr., p. 316, with variety *inflata*, 1898.

Leptinaria martensi PILSBRY, Man. XVIII, p. 308, pl. 41, figs. 6, 7, 8, 1907.

Collected by the Academy expedition on Maria Madre and Maria Magdalena, Tres Marias Islands.

There was only one fresh specimen in the lot. The others varied from 6 to 7.5 mm. in length. The pillar has no lamella but a smooth swelling, and a section shows the tubular axis somewhat angularly twisted and rapidly diminishing in diameter toward the apex.

This form has such feeble striation axially that the shell appears smooth except for incremental lines. I follow Doctor Pilsbry in referring it to *Leptinaria* though it offers quite a contrast to the average species of that genus and as far as I know has not been anatomically examined.

Genus *Pseudosubulina* Strebel, 1882

7. *Pseudosubulina evermanni* Dall, new species

Plate 35, figures 7, 8

Shell slender, subcylindrical, with nearly seven whorls, the first small and smooth, forming a blunt apex to the shell; the second finely, closely, axially striated; the remainder with straight thread-like low axial riblets with wider interspaces; suture distinct, not coronated by the riblets; whorls moder-

ately rounded; base evenly rounded, imperforate. pillar straight, pillar lip hardly truncate; height, 4.52; diameter, 1.5 mm.

Type: No. 2192, Mus. Calif. Acad. Sci.; collected by the Academy expedition on the slope of Mount Evermann, Socorro Island, at from 2,000 to 2,800 feet elevation; *paratype*: No. 2193, from Maria Magdalena Island; others were taken on the east side of Maria Madre Island, near the village.

Doctor Pilsbry notes in regard to this species that it appears to be related to east Mexican species such as *P. orisabensis* Pilsbry. The regular spacing of the ribs, their early appearance, only the first whorl being smooth, and the small size of the shell, are the chief differential characteristics.

Genus *Oxystyla* Schlüter, 1838

(*Zebra* SHUTTLEWORTH, 1852. *Ortalichus* MARTENS, 1893.)

8. *Oxystyla delphinus*, forma *nebulosa* Strebel

Zebra delphinus forma *nebulosus* STREBEL, Revision subfamily Orthalicinæ, p. 31, pl. 3, fig. 47, 1909.—Pilsbry, in Tryon's Manual, XII, pl. 16, fig. 5, 1899.

Maria Madre Island, Tres Marias, Academy Expedition. Strebel cites it from Mazatlan and Misantla, Vera Cruz, Colima, and Costa Rica. It was collected on one of the Tres Marias islands (probably Maria Madre) by Grayson, Forrer, and Richardson. Specimens from Maria Magdalena in the National Museum were collected by Nelson and Goldman. Specimens almost identical in form and color pattern were collected by Lieutenant Herndon, U. S. N., on the Amazon River, Brazil.

This form is distinguished by its relatively slender and produced shape; a dark-brown smooth nucleus; the obsolescence or entire absence of the spiral brown bands on the last whorl, which are barely indicated by slight angularities in the dark axial streaks. The surface is closely sculptured by minute spiral striation. The outer lip, body, and a single varical marking, are of rich dark brown; the edge of the nearly straight pillar is white.

It is somewhat remarkable that so large a species as this should be found on these islands abundantly, while *Epiphragmophora*, so common on the peninsula, is absent, and leads to a suspicion that the former might have been artificially introduced. A specimen of *Oxystyla* was collected on Socorro Island by Grayson, according to Pilsbry, but the species is uncertain.

It would seem from the literature and figures that several of the species of *Oxystyla* have an albinoid mutation in which the body of the shell is white while the dark-colored varical stripes and sometimes the spiral bands retain their color. These pale forms have been tentatively associated together and grouped under various names, chiefly *O. melanocheilus* Valenciennes, while others apparently of the same nature have been called *O. fulvescens* Pfeiffer, *O. leucochilus* Crosse & Fischer, etc. The mutation of *O. delphinus* belonging to this type does not agree exactly with any of those figured but is most like Strebel's figure 45². It seems desirable therefore to distinguish it.

9. *Oxystyla delphinus* forma *nesiotica* nov.

Plate 35, figure 3

The shell is white with a minute brown nucleus and occasionally with faint obsolescent obliquely axial flammules simulating those of normal *delphinus*, but usually white except for the blackish varical streaks of which there are two to four on the body whorl and one or two on the penultimate whorl. The margins of the aperture and the parietal region are blackish brown as in the normal form. The height of the shell varies from 50 to 60 mm. and the specimens examined average a little less slender than the specimens of *delphinus*. In well-preserved specimens the surface is more or less covered with a pale yellowish extremely thin periostracum, which is generally missing over the greater part or the whole of the shell.

Type: No. 2194, Mus. Calif. Acad. Sci., taken with the normal form on **Maria Madre Island**. This is probably what has

² Revision d. unterfam. d. Orthalicinen, pl. 3, fig. 45.

been reported as collected at the Tres Marias by Forrer and Richardson under the name of *melanochilus*.

10. *Oxystyla princeps* Broderip

Bulinus princeps (Broderip) SOWERBY, Conch. Ill. *Bulinus*, fig. 18, 1833.
Orthalicus princeps MÖRCH, Malak. Blatt. VI, p. 112, 1859.
Ortalichus princeps MARTENS, Biol. Centr. Am., p. 182, pl. 10, figs. 3, 3 a-b, 4-7, 1893.

Collected at the Tres Marias by Forrer and Richardson. This species has a very wide distribution, being reported from northern Mexico to Panama.

Genus *Drymæus* Albers, 1850

11. *Drymæus uhdeanus*, var. *tepicensis* Martens

Ostostomus uhdeanus var. *C. tepicensis* MARTENS, Biol. Centr. Am., p. 234, pl. 15, fig. 5, 1893.

Tepic, State of Jalisco, West Mexico: Höge. Two (one poorly preserved) specimens were collected on Maria Madre Island, Tres Marias, by the Academy expedition.

The fresher one of the two had been aestivating on some twig, and part of the bark remains closing the aperture.

12. ?*Drymæus* sp. juv.

Some nepionic specimens were obtained by the Academy expedition on Maria Madre, which appear to belong to a species of this genus but not to the species referred to above. However, they are too immature for definite determination.

13. *Drymæus trimarianus* Martens

Ostostomus trimarianus MARTENS, Biol. Centr. Am., p. 216, pl. 13, fig. 17, 1893.

Martens described this species from specimens collected at the Tres Marias by Forrer and Richardson. He states that it almost forms a connecting link between *D. attenuatus*, *D. serperastrum*, and *D. pallidior* Sowerby. Some specimens are

entirely white, others have more or less distinct traces of pale brown spots on the penultimate whorl, arranged in four rows. The shells measure from 27 to 32 mm. in length and from 12 to 14 mm. in diameter.

Genus *Polygyra* Say, 1817

14. *Polygyra ventrosula* Pfeiffer

Helix ventrosula PFEIFFER, Proc. Zool. Soc. 1845, p. 131—BINNEY, Terr. Airbr. Moll. N. Am. IV, p. 72, pl. 77, fig. 14, 1859.

Polygyra ventrosula MARTENS, Biol. Centr. Am., p. 169, pl. 7, figs. 10 a-c, 11, 1892; var. *hindsii* PFEIFFER, l. c. p. 132, 1845—BINNEY, l. c. III, p. 17; IV, p. 92, pl. 78, figs. 5, 6, 8, 1859.

Tres Marias, Forrer (the variety). Maria Madre, Nelson and Goldman.

15. *Polygyra richardsoni* Martens

Plate 36, figures 3, 4, 5

Polygyra richardsoni MARTENS, Biol. Centr. Am., p. 168, pl. 7, figs. 9, 9 a-c, 1892; Presidio de Mazatlan, Sinaloa, Mexico, Richardson.

A form designated by Doctor Pilsbry as a variety of this species under the name of *paucicostata* was obtained by the Academy's expedition on Maria Madre and Maria Magdalena of the Tres Marias, and by Nelson and Goldman on both islands. It differs from the typical *richardsoni* in somewhat larger size, larger umbilicus and in a somewhat differently shaped basal lamella.

The group to which these species belong is represented by a large number of closely allied forms in northwestern Mexico. It is difficult to decide what is specific and what merely varietal value to assign to the differences. The size of the shell varies a good deal in specimens from the same locality and as far as the writer can judge the most persistent characters are the size of the umbilicus and the form of the basal lamella in the aperture.

16. *Polygyra bicruris* Pfeiffer

Helix bicruris PFEIFFER, Proc. Zool. Soc. 1857, p. 109.

Polygyra bicruris MARTENS, Biol. Centr. Am., p. 168, pl. 7, figs. 8, 8 a-c, 1892.

Tres Marias Islands, Forrer and Richardson.

Genus *Thysanophora* Strebel, 188017. *Thysanophora materna* Dall, new species

Plate 35, figures 16, 17

Shell minute, slightly rufous brown, four whorled, the spire slightly elevated with a rather deep suture; whorls well-rounded above and below, the last descending slightly near the aperture; umbilicus deep, subcylindrical; aperture sub-circular, a little oblique, the lips thin, sharp, not reflected but slightly expanded; surface with low sharp incremental lines, with microscopic wrinkles crossing them irregularly and microscopic smaller wrinkles and very minute granulations in the interspaces, the whole covered with a furfureaceous periostracum to which particles of dirt adhere very abundantly; major diameter, 4; minor diameter, 3; height, 2 mm.

Type: No. 2196, Mus. Calif. Acad. Sci., and others collected by the Academy expedition on **Maria Madre Island** near the village on the east side and at another locality on the island not specified; also more abundantly on Maria Magdalena at two localities.

The sticky periostracum and peculiar sculpture are conspicuous characters. The microscopic granulation sometimes here and there is arranged in rows, but there is no real spiral sculpture and the nucleus is smooth.

18. *Thysanophora clarionensis* Dall, new species

Plate 36, figures 1, 2

Shell closely resembling *T. materna* in general appearance and with the same number of whorls, but smaller, with a flatter spire, the umbilicus more funnel-shaped, showing the edges of the whorls and the peculiar sculpture relatively less con-

densed; major diameter, 2.5, minor diameter, 2.0; height, 1.0 mm.

Type: No. 2197, Mus. Calif. Acad. Sci., and other specimens collected by the Academy expedition on **Clarion Island at Sulphur Bay** near sea-level, and at other localities from 500 to 1,040 feet above sea-level, about equally common at each place.

Genus **Guppya** Mörch, 1867

(*Habroconus* CROSSE & FISCHER, 1878.)

19. **Guppya perforata** Dall, new species

Plate 35, figures 12, 13

Shell minute, smooth but not polished, with about four well-rounded whorls separated by a deep suture; the spire is rather dome-like than pointed, incremental lines very oblique, faint, base well rounded; aperture oblique, semilunate, the lips sharp, slightly expanded, separated widely by the body, the inner lip slightly overshadowing a deeply perforate umbilicus; major diameter, 3; height, 3 mm.

Type: No. 2198, Mus. Calif. Acad. Sci.; collected by the Academy expedition on **Maria Madre Island**; others came from Maria Magdalena of the Tres Marias Islands. Apparently not abundant.

In the only fresh specimen, under high magnification, the thin periostracum rises slightly from the incremental lines with edges minutely serrate, but this is lost in the dead individuals.

20. **Guppya socorroana** Dall, new species

Plate 35, figures 14, 15

Shell small, pale horn-color, smooth, turbinate, with about five moderately convex whorls separated by a rather deep suture; incremental lines feeble, oblique; periphery rounded, base moderately convex; aperture semilunate, the lips sharp, very slightly expanded, widely separated by the body, the

inner lip springing from the imperforate umbilical depression; major diameter, 3.1; height, 2.8 mm.

Type: No. 2199, Mus. Calif. Acad. Sci.; collected by the Academy expedition on **Socorro Island** at 2,000 feet elevation, a single adult but bleached specimen, and another (No. 2200) on Maria Magdalena in fresh condition. It differs from all the figured allied species in having a rounded rather than a pointed apex.

21. *Guppya montanicola* Dall, new species

Plate 35, figures 10, 11

Shell small, pale straw-color, smooth, with about four and one-third whorls; upper surface finely radiated by delicate striae starting from the suture and becoming obsolete near the periphery, the base marked only by feeble incremental lines; spire low, whorls rounded but not inflated; base moderately convex, the umbilical depression shallow, imperforate; aperture narrowly semilunate, the lips sharp, hardly expanded, the inner lip starting from the umbilical pit and widely separated from the outer one by the body of the whorl; major diameter, 2.5; height, 2.2 mm.

Type: No. 2201, Mus. Calif. Acad. Sci.; collected by the Academy expedition on **Socorro Island**, on the north slope of Mount Evermann, between 2,000 and 2,800 feet above the sea level.

This is well distinguished, even in the young, from the preceding species by its depressed form. The juvenile specimens sometimes show a minute umbilical perforation.

22. *Guppya capsula* Dall, new species

Shell minute, translucent brown above, lighter olivaceous below, not polished, of three and a half turbinate well-rounded whorls; apex dome-like, suture well marked, base evenly rounded, perforate; aperture rounded; lips sharp, not reflected, interrupted by the body; surface only marked by faint incremental lines; height, 1.2; maximum diameter, 1.1 mm.

Type: No. 2202, Mus. Calif. Acad. Sci.; collected on **Socorro Island**, on the north slope of Mount Evermann at from 2,000 to 2,800 feet elevation, by the Academy expedition.

Two of the specimens contained a spherical shining white egg, seemingly rather large for so minute a shell. The species appears to be rare, as only a few specimens were obtained. The figures of *Helix punctum* Morelet, given by Martens, resemble it.

Genus **Strobilops** Pilsbry, 1892

(*Strobila* MORSE, 1864)

23. **Strobilops labyrinthica** Say

Helix labyrinthica SAY, Journ. Acad. Nat. Sci. Phila., 1, p. 124, 1817.

Strobila labyrinthica MORSE, Portland Soc. Journ., vol. 1, p. 26, figs. 64-67, 1864.

Strobilops labyrinthica PILSBRY, Nautilus, VII, p. 57, 1893.

A few specimens were collected on Socorro Island at an elevation of 2,000 feet above the sea, by the Academy expedition.

The variations notable in individual specimens from the northern United States seem quite sufficient to cover the differences between the northern and Mexican shells.

24. **Strobilops strebeli** Pfeiffer

Helix strebeli PFEIFFER, Mal. Blatt., VIII, p. 71, pl. 1, figs. 5-8, 1861.

Strobilops labyrinthica strebeli PILSBRY, Nautilus, VII, p. 57, 1893.

A single specimen from Socorro Island at an elevation of 2,000 feet was obtained by the Academy expedition. It agrees exactly with specimens sent by Berendt from Mirador, Mexico, where Strebel collected it. It appears not to be the shell figured by Crosse & Fischer under this name and seems to be a sufficiently good species.

Genus *Punctum* Morse, 186425. *Punctum pygmæum* Draparnaud

Plate 35, figures 18, 19

Plate 36, figures 15, 16, 17

Helix pygmæa DRAPARNAUD, Hist. Moll. Terr., p. 114, 1805.*Helix minutissima* LEA, Trans. Am. Phil. Soc. IX, p. 17, 1841.*Punctum minutissimum* MORSE, Journ. Portland Soc. Nat. Hist., 1, p. 27, figs. 69-70, pl. II, fig. 1, pl. VIII, fig. 71, 1864.

Collected by the Academy expedition on Socorro Island at an altitude of 2,000 feet, where the species appears to be abundant.

A careful comparison of British specimens of *P. pygmæum* with specimens of *P. minutissimum* from Lea's collection leads to the conclusion that Binney was justified in uniting the two, as the differences seem within the limits of specific variation. With those which seem comparable with *P. pygmæum*, from the Academy collection, are several forms which under high magnification appear distinct, if not extreme variations, which value it seems prudent to allow them at present.

Form *A.* (var. *rotundum.*)—Similar to the type in sculpture and with a small subcylindric umbilicus, but with three rounder whorls, more elevated spire, and larger than typical *pygmæum* with the same number of whorls.

Type: No. 2203, Mus. Calif. Acad. Sci.; collected on **Maria Magdalena Island**, Tres Marias.

Form *B.* (var. *albeolum.*)—Larger than typical *pygmæum*, shiny white, the sculpture subobsolete, the spire less elevated, the end of the last whorl nearly on a level with the antecedent whorl (while in *pygmæum* it is depressed), the umbilicus wider and more funnel-shaped. Whorls three and a half, the shell larger than typical *pygmæum* of the same number of whorls.

Type: No. 2204, Mus. Calif. Acad. Sci.; collected on **Maria Magdalena Island**; the species was also taken on Maria Madre Island, near the village on the east side, and on Socorro Island between 2,000 and 2,800 feet elevation on the slopes

of Mount Evermann; *paratype*: No. 2204a has been selected from the latter locality.

26. *Punctum planatum* Dall, new species

Plate 36, figures 12, 13, 14

Shell smaller than *P. pygmæum*, with a flat spire and three and a half whorls; the nucleus is transparent, the rest snow white; sculpture of more prominent and less close-set axial ribs; suture moderately deep; whorls and aperture rounded, the peritreme thin, not expanded; the umbilicus wide, shallow, showing a large part of the three whorls. Diameter of shell, 1 mm.

Type: No. 2205, Mus. Calif. Acad. Sci.; collected on **Maria Madre Island**, near the village on the east side, by the Academy expedition.

The differences between this and the typical *P. pygmæum* seem too great for mere varietal rank.

Genus *Gastrocopta* Wollaston, 1878

27. *Gastrocopta pellucida* Pfeiffer

Pupa pellucida PFEIFFER, *Symbolæ*, 1, p. 46, 1841—KUSTER, in CHEMNITZ *Conch. Cab.* ed. 2, *Pupa*, p. 89, pl. 12, figs. 24, 25, 1852—STREBEL, *Beitr. Mex. Land and Süsw. Conch.* IV, p. 91, pl. 4, fig. 19.

Pupa servilis (GOULD) PFEIFFER, *Mon. Hel. Viv.* II, p. 360.

Leucochila pellucida TRYON, *Am. Journ. Conch.* III, p. 308, pl. 15, fig. 24, 1868.

Pupa (Leucochilus) pellucida (PFR.) BOETTGER, in MARTENS, *Conch. Mitth.* 1, p. 69, 1881.

Gastrocopta pellucida (PFR.) PILSBRY.

Collected by the Academy expedition near the village on the east side of Maria Madre, Tres Marias Islands, and on Socorro Island at from 2,000 to 2,800 feet elevation, on the north slope of Mount Evermann.

28. *Gastrocopta pellucida hordeacella* Pilsbry

Pupa hordeacella PILSBRY, Proc. Acad. Nat. Sci. Phila. for 1890, p. 44, pl. 1, figs. G, H, I, J, K, Arizona and Florida.

Collected by the Academy expedition on the island of Socorro, from the low lands at Braithwaite Bay, Grayson's Cove, and at elevations of 2,000 and 2,800 feet on the slope of Mount Evermann. Also on Clarion Island from Sulphur Bay, near the sea level and at elevations of 500 and 1,040 feet above the sea.

The distribution of this species and the variety is extremely widespread, as indicated by Martens. It has been reported from the Gulf States, Mexico, Guatemala, Panama, Ecuador, and most of the Antilles.

Genus *Vitrea* Fitzinger, 183329. *Vitrea indentata* Say

Helix indentata SAY, Journ. Acad. Nat. Sci. Phila., vol. 2, p. 372, 1822—
GoULD, Invert. Mass., p. 181, fig. 109.

Hyalinia (Glyphyalinia) indentata (SAY) MARTENS, Biol. Centr. Am., p. 117, 1892.

Collected by the Academy expedition near the village on the east side of Maria Madre and at another unspecified locality on that island; also on Maria Magdalena, rather abundantly.

I have not been able to examine *V. paucilirata* Morelet, but from the figures and descriptions it would seem doubtfully distinct from the present species.

At first sight the fresh individuals from the Tres Marias impressed one as having the indented radial lines less numerous and more deeply cut than in the northern *indentata*, but on careful study of specimens of the same size no valuable differences could be observed. The island specimens on the whole seem larger on the average than those from the United States, but not extremely so. The very wide range of this species is well known. It is recorded from Canada to Texas and from the boundary to southward from the Federal District of Mexico.

Genus *Zonitoides* Lehman, 186230. ? *Zonitoides socorroënsis* Dall, new species

Plate 36, figures 9, 10, 11

Shell minute, polished, brownish, subtranslucent, with four whorls, having much the aspect above of a small *Z. arboreus* Say, but with a relatively more widely coiled umbilicus; the spire is low and in profile appears flattish; the sculpture is much the same as in *Z. arboreus*, both showing under high magnification microscopic pittings or obscure punctations over the entire surface; the other characters reproduce *Z. arboreus* in miniature; major diameter, 3.5; minor diameter, 3.0; height, 1.2 mm.

Type: No. 2206, Mus. Calif. Acad. Sci.; collected on **Socorro Island** on the slopes of Mount Evermann at the elevation of 2,000 to 2,800 feet above sea level, by the Academy expedition.

This may not be a *Zonitoides* but seems nearest to that genus in shell characters. There is some slight variation in the convexity of different individuals.

Genus *Tornatellides* Pilsbry, 191031. *Tornatellides mexicana* Dall, new species

Plate 35, figure 6

Shell light brown with about six well-rounded whorls; suture conspicuous, surface smooth and shining with faint incremental lines; base rounded, perforate; pillar with two strong but not high plaits, the parietal lamina thin and sharp; a section shows the axis continuously tubular with the plaits continuing obliquely up the spire; height, 3.5; diameter, 2.0 mm.

Type: No. 2207, Mus. Calif. Acad. Sci.; collected by the Academy expedition on **Socorro Island** on the north slope of Mount Evermann, Socorro Island, at an elevation of 2,000 to 2,800 feet.

This is smaller, more obtusely conical, and less common than the following species, from which it can be promptly distinguished by its two columellar plaits.

32. *Tornatellides clarionensis* Dall, new species

Plate 35, figure 9

Shell reddish brown with six moderately rounded whorls; suture distinct, not deep; base evenly rounded, perforate; a very slender thread-like rather than sharp parietal lamina and a feeble plait on the pillar, often invisible from in front, but stronger in the young; axis slender and twisted; height, 4.0; diameter, 2.25 mm.

Type: No. 2208, Mus. Calif. Acad. Sci.; collected by the Academy expedition on **Clarion Island** rather abundantly, at the east end, at an elevation of 500 feet, also at 1,040 feet, and near sea level at Sulphur Bay.

Doctor Pilsbry states that this is a species of the *T. simplex* group of Polynesia. It differs from all Hawaiian and Polynesian species but not more than they differ among themselves. This, *T. mexicana*, and *T. chathamensis* Dall, of the Galapagos Islands, are the only species recorded from off the American shores, but it would not be surprising if future collectors should discover the genus on the continent.

Genus *Succinea* Draparnaud, 1805

33. *Succinea clarionensis* Dall, new species

Plate 35, figure 2

Shell of moderate size, obliquely twisted, with three whorls of a dark honey-yellow color, the nuclear whorl with a faint tinge of pink; suture deep, surface more or less axially rugose from the irregularly prominent incremental lines; not polished; last whorl forming most of the shell; aperture oblique, ample, outer lip thin, sharp, inner lip with a layer of enamel uniting the outer and basal margins; periostracum more or less fibrous; height of shell, 15.5; of last whorl, 15.0; of aperture, 11.0; maximum diameter, 10.0 mm.

Type: No. 2209, Mus. Calif. Acad. Sci.; collected by the Academy expedition on **Clarion Island**, at 1,040 feet elevation.

This appears to be very abundant. Some years ago the Fish Commission steamer *Albatross* touched at Clarion Island and collected a large number of this species, but, as they were put in formalin, they arrived totally disintegrated.

34. **Succinea socorroënsis** Dall, new species

Plate 35, figure 1

Shell small, polished, very pale greenish-yellow, of nearly three whorls usually covered thickly with the animal's excretory pellets; surface more or less axially undulated by irregularities of growth; whorls well rounded, suture deep; aperture oblique, margins thin and sharp; not united over the body by a layer of enamel; height of shell, 9.0; of last whorl, 8.5; of aperture, 7.0; maximum diameter, 5.0 mm.

Type: No. 2210, Mus. Calif. Acad. Sci.; collected on **Socorro Island**, on the north slope of Mount Evermann at 2,800 feet elevation, by the Academy expedition.

This appears to be rare, as only seven specimens, old and young, were obtained.

Genus **Proserpinella** Bland

35. **Proserpinella hannæ** Dall, new species

Plate 36, figures 6, 7, 8

Shell small, depressed, white, of three and a half smooth whorls; periphery evenly rounded, suture distinct, not deep; spire very slightly convex, base in the young with an umbilical depression, in the adult covered with a flattish layer of enamel, which extends about one-third of the way from the axis to the periphery of the whorl; the last whorl is slightly depressed as it approaches the aperture, which is recessively oblique; outer lip entire, not sharp nor notably thickened, with a small excavated curve where it approaches but does not quite reach the umbilical pit; body with a very thin wash of enamel and nearly midway of the whorl a low lamella entering the whorl some

distance on the parietal wall, but absent in the young; there is no columellar fold; major diameter, 4; minor diameter, 3; altitude, 1.5 mm.

Type: No. 2211, Mus. Calif. Acad. Sci.; collected on **Maria Madre, Tres Marias Islands**, by the Academy expedition.

One adult and several immature specimens were obtained. This is the first species of the genus to be found on the western shores of Mexico. It somewhat resembles *P. berendti* Bland, from Mirador, on the Atlantic slope some 3,000 feet above sea level, but is larger, with the basal callus smaller. It is named in honor of Dr. G. Dallas Hanna, who was responsible for most of the shell-collecting done by the expedition.

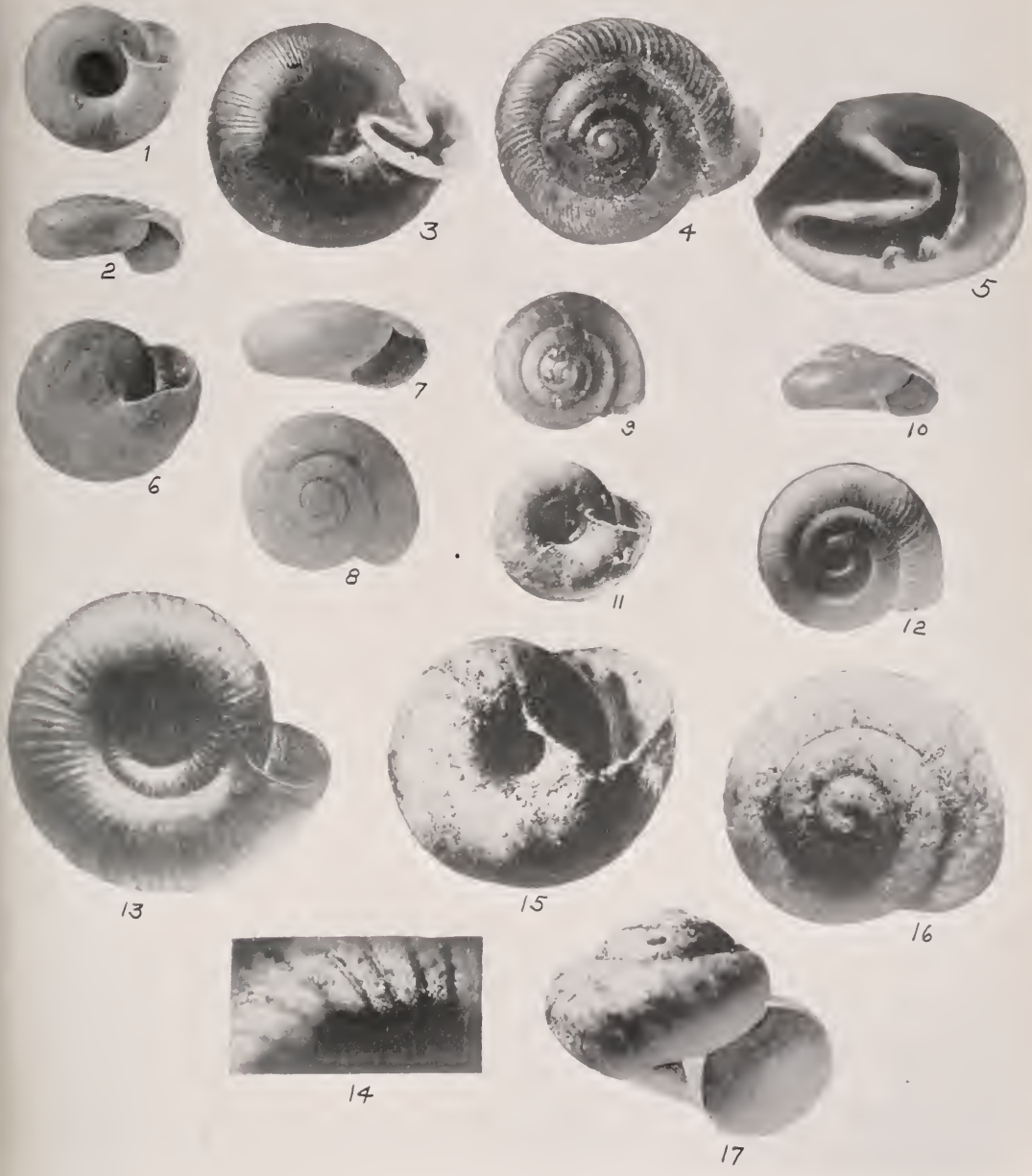
Plate 35

- Fig. 1. *Succinea socorroënsis* Dall, n. sp. Type, No. 2210 (C.A.S. Coll.), from Socorro Island; height, 9 mm.; p. 486.
- Fig. 2. *Succinea clarionensis* Dall, n. sp. Type, No. 2209 (C.A.S. Coll.), from Clarion Island; height, 15.5 mm.; p. 485.
- Fig. 3. *Oxystyla delphinus* forma *nesiotica* Dall, nov. Type, No. 2194 (C.A.S. Coll.), from Maria Madre Island, Tres Marias Group; height, 59.4 mm.; p. 474.
- Fig. 4. *Euglandina mariana* Dall, n. sp. Type, No. 2190 (C.A.S. Coll.), from Maria Magdalena Island, Tres Marias Group; length, 29 mm.; p. 470.
- Fig. 5. *Leptinaria martensi* Pfeiffer. Plesiotype, No. 2191 (C.A.S. Coll.), from Maria Magdalena Island, Tres Marias Group; length, 6 mm.; p. 472.
- Fig. 6. *Tornatellides mexicana* Dall, n. sp. Type No. 2207 (C.A.S. Coll.), from Socorro Island; height, 3.5 mm.; p. 484.
- Figs. 7, 8. *Pseudosubulina evermanni* Dall, n. sp. Type, fig. 7, No. 2192 (C.A.S. Coll.), from Socorro Island; height, 4.52 mm.; paratype, fig. 8, No. 2193 (C.A.S. Coll.), from Maria Magdalena Island, Tres Marias Group; p. 472.
- Fig. 9. *Tornatellides clarionensis* Dall, n. sp. Type, No. 2208 (C.A.S. Coll.), from Clarion Island; height, 4 mm.; p. 482.
- Figs. 10, 11. *Guppya montanicola* Dall, n. sp. Type, No. 2201 (C.A.S. Coll.), from Socorro Island; major diameter, 2.5 mm.; p. 482.
- Figs. 12, 13. *Guppya perforata* Dall, n. sp. Type, No. 2198 (C.A.S. Coll.), from Maria Madre Island, Tres Marias Group; major diameter, 3 mm.; p. 478.
- Figs. 14, 15. *Guppya socorroana* Dall, n. sp. Type, No. 2199 (C.A.S. Coll.), from Socorro Island; major diameter, 3.1 mm.; p. 478.
- Figs. 16, 17. *Thysanophora materna* Dall, n. sp. Type, No. 2196 (C.A.S. Coll.), from Maria Madre Island, Tres Marias Group; major diameter, 4 mm.; p. 477.
- Figs. 18, 19. *Punctum pygmæum* var. *albeolum* Dall, nov. Type, No. 2204 (C.A.S. Coll.), from Maria Magdalena Island, Tres Marias Group; major diameter, 2.4 mm.; p. 481.



Plate 36

- Figs. 1, 2. *Thysanophora clarionensis* Dall, n. sp. Type, No. 2197 (C.A.S. Coll.), from Clarion Island; major diameter, 2.5 mm.; p. 477.
- Figs. 3, 4, 5. *Polygyra richardsoni paucicostata* Pilsbry. Plesiotype, No. 2195 (C.A.S. Coll.), from Maria Madre Island, Tres Marias Group; major diameter, 9.2 mm.; p. 476.
- Figs. 6, 7, 8. *Proserpinella hannæ* Dall, n. sp. Type, No. 2211 (C.A.S. Coll.), from Maria Madre Island, Tres Marias Group; major diameter, 4 mm.; p. 486.
- Figs. 9, 10, 11. *?Zonitoides socorroënsis* Dall, n. sp. Type, No. 2206 (C.A.S. Coll.), from Socorro Island; major diameter, 3.5 mm.; p. 484.
- Figs. 12, 13, 14. *Punctum planatum* Dall, n. sp. Type, No. 2205 (C.A.S. Coll.), from Maria Madre Island, Tres Marias Group; diameter, 1 mm.; p. 482.
- Figs. 15, 16, 17. *Punctum pygmaeum* var. *rotundum* Dall, nov. Type, No. 2203 (C.A.S. Coll.), from Maria Magdalena Island, Tres Marias Group; major diameter, 1.8 mm.; p. 481.



PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES
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SEPTEMBER 15, 1926

XVI
A CRITICAL INSPECTION OF THE GNATCATCHERS
OF THE CALIFORNIAS

BY
JOSEPH GRINNELL
Museum of Vertebrate Zoology, University of California

In further process of critically determining the collections of birds accumulating from the San Pedro Martir region of Lower California, I have come to the gnatcatchers (genus *Polioptila*). Two groups are involved, the Black-tailed series and the Blue-gray series. In making this inquiry, there have been available to me not only the extensive materials in the Museum of Vertebrate Zoology but also certain important specimens in the private collection of Dr. Louis B. Bishop, and, through the courtesy of Dr. Barton Warren Evermann, Director, the pertinent specimens in the Museum of the California Academy of Sciences. From the United States National Museum, through the kindness of Doctors Wetmore and Richmond of its staff, there have been sent on for my examination the examples in that Museum from the Cape district of Lower California including the two Ridgway types.

With respect to the Blue-gray Gnatcatchers first: A western subspecies, *Polioptila cacrulea obscura*, has been recognized almost universally since first pointed out by Ridgway (1883, p. 535). The form was named in an "editorial" footnote, by

September 15, 1926

Ridgway, in one of Belding's articles based on the latter's Lower California collections. The type was from San José del Cabo, in the Cape district. It was stated that this specimen agreed in certain respects with other western examples. There was no intimation in that connection, however, that the birds of the Cape district might differ in some degree from those of the Pacific Coast district to the northward.

The materials now accessible in sufficient amount show that there is a separately recognizable race of Blue-gray Gnatcatcher resident in the restricted faunal area known as the Cape San Lucas district of Lower California. The facts above stated indicate that the name *obscura* of Ridgway applies definitely to this Lower Californian race. As has been fully set forth by numerous systematic students, most clearly by Ridgway himself (1904, p. 720), the Blue-gray Gnatcatchers of the "southwestern United States and contiguous parts of northern Mexico" differ from the race of the eastern United States. By the present interpretation, the birds of the west, outside of the southern tip of Lower California, must be provided with a new name; and since in Ridgway's synonymy (loc. cit., pp. 721-722) there is no previous name available, one may now be provided, as follows:

Polioptila caerulea amoenissima, new subspecies

Western Blue-gray Gnatcatcher

Type locality.—Pleasant Valley, 600 feet altitude, Mariposa County, California.

Type.—Male adult, in full breeding plumage; No. 25813, Mus. Vert. Zool.; May 23, 1915; collected by J. Grinnell, orig. No. 3173.

Diagnosis.—Similar to *Polioptila caerulea caerulea* (Linnaeus), of eastern North America, "but gray of upper parts slightly duller, and black at base of inner web of outermost rectrix more extended, usually showing beyond tip of under tail-coverts" (as according to Ridgway, 1904, p. 720); similar to *P. c. obscura* Ridgway, of the Cape San Lucas region, but wing and tail (especially the tail) longer, bill slightly slen-

derer, and median lower surface less clearly white, more imbued with very pale gray.

Range.—Precisely as set forth by Ridgway (*loc. cit.*) for his *obscura*, save for the elimination of the Cape San Lucas district.

Measurements.—Average, minimum and maximum, in millimeters: *Polioptila caerulea amoenissima*, 20 examples, 10 of each sex, from Upper California (Mariposa County south to Riverside County): Wing, 49.6 (46.5-53.0); tail, 52.0 (49.3-55.2); exposed culmen, 10.0 (9.3-10.4). *P. c. obscura*, 10 examples, four of them "males", from the Cape San Lucas district (La Paz and San José del Cabo): Wing, 47.1 (45.5-49.5); tail, 48.1 (44.9-51.0); exposed culmen, 9.9 (9.2-10.4). My reason for combining the sexes here is primarily that I believe some of the specimens were wrongly marked as to sex. And, anyway, the dimensional difference between the sexes in these gnatcatchers is very slight.

Remarks.—Since in essence the present naming is merely the result of the setting off of a local race of very restricted habitat, it is the latter that should be accorded special comment. Ridgway's table of measurements (1904, p. 720) will be found to indicate, but not strongly, the fact of the Cape district birds having the relative proportions indicated in the present diagnosis. Curiously, the type of *obscura* (No. 87530, U. S. Nat. Mus., ♂, San José del Cabo, April 17, 1882, L. Belding) shows the greatest dimensions of any of the Cape specimens before me. This led me to suspect that it might have been a winter visiting individual of the more northern race, in which case an opposite course of naming procedure would have been necessary. But this type, it seems to me, in the average of its characters falls with the Cape birds rather than with the northern birds. Paucity of material (only three males and one female were measured by Ridgway) and a very proper feeling of conservatism, were probably the factors that have held back the formal separation of these two races until now.

Now with respect to the "black-tailed" series of gnatcatchers, a somewhat similar situation is found to occur as in

the blue-grays, even though involving a greater number of forms. The specific name to be used for this group is, as shown by Penard (1923, p. 335), *Polioptila melanura* Lawrence, and not *P. plumbea* of Baird as heretofore within recent years usually employed. Up until now the "Plumbeous" Gnatcatchers of the Cape district of Lower California have been referred to *melanura* (or *plumbea*); but several authors, notably Brewster (1902, p. 210), comment upon differences apparent in specimens from the Cape region as compared with specimens from Arizona and Texas.

Until the present time, *Polioptila californica* Brewster, of southern California and northwestern Lower California, has been considered a full species. But certain authors (Thayer and Bangs, 1907, p. 138, and McLellan, 1926, p. 318) have reported specimens from subterminal parts of the Lower Californian peninsula as being intermediate in characters between "*plumbea*" of the Cape district, and *californica*. The implication of intergradation was not, however, put upon record in suitable nomenclatural manner. Furthermore, Ridgway (1904, p. 733, footnote), it turns out, definitely gave a name, *Polioptila margaritae*, to this intermediate form, though apparently thinking he had named an insular species. Material at hand shows that nearby mainland birds are identical with those of Santa Margarita Island, the type locality of *margaritae*.

My own present study shows that the "Plumbeous" Gnatcatchers of the immediate Cape San Lucas district are distinguishable from those of southeastern California and Arizona, fully meriting naming, though so close that the trinomial must be employed. It thus appears that, even though *californica* is to *melanura* of southeastern California and Arizona as a full species, variation geographically to the southward, through the race *margaritae*, to the Cape form, and intergradation thence with *melanura* through individual variation, warrants considering it just the extreme in a continuous series of subspecies. The case is quite parallel to that of the Brown Towhees, *Pipilo fuscus* and subspecies, occupying about the same areas (see Oberholser, 1919, p. 211, and Grinnell and Swarth, 1926). Diagnoses of the exclusively Lower Californian races of Black-tailed Gnatcatcher may now be given.

Polioptila melanura abbreviata, new subspecies

Cape San Lucas Black-tailed Gnatcatcher

Type locality.—Cape San Lucas, Lower California.

Type.—Male adult, in full breeding plumage; No. 27835, coll. Calif. Acad. Sci.; May 28, 1925; collected by Frank Tose, orig. No. 864.

Diagnosis.—In general character similar to *Polioptila melanura melanura* (see Ridgway, 1904, p. 731, under *Polioptila plumbea*) of southeastern California and southern Arizona, but (in both sexes) tail decidedly shorter, bill somewhat larger, leaden hue of dorsum slightly deeper, and lower surface slightly more imbued with gray, not so clearly white.

Measurements.—Average, minimum and maximum, in millimeters: *Polioptila melanura abbreviata*, 9 adult examples, 5 marked male, 4 female, from Cape San Lucas, San José del Cabo, Todos Santos (latitude, 23° 25'), and La Paz: Wing, 45.4 (44.0-46.7); tail, 46.7 (45.0-48.8); exposed culmen, 9.4 (8.9-10.0). *P. m. melanura*, 20 examples, 10 of each sex, from the lower Colorado River valley in Arizona and California: Wing, 46.0 (44.5-47.8); tail, 50.7 (46.8-53.2); exposed culmen, 8.6 (7.8-9.2).

Range.—So far as now definitely known, only the southern end of the Lower Californian peninsula, from San José del Cabo and Cape San Lucas north to La Paz.

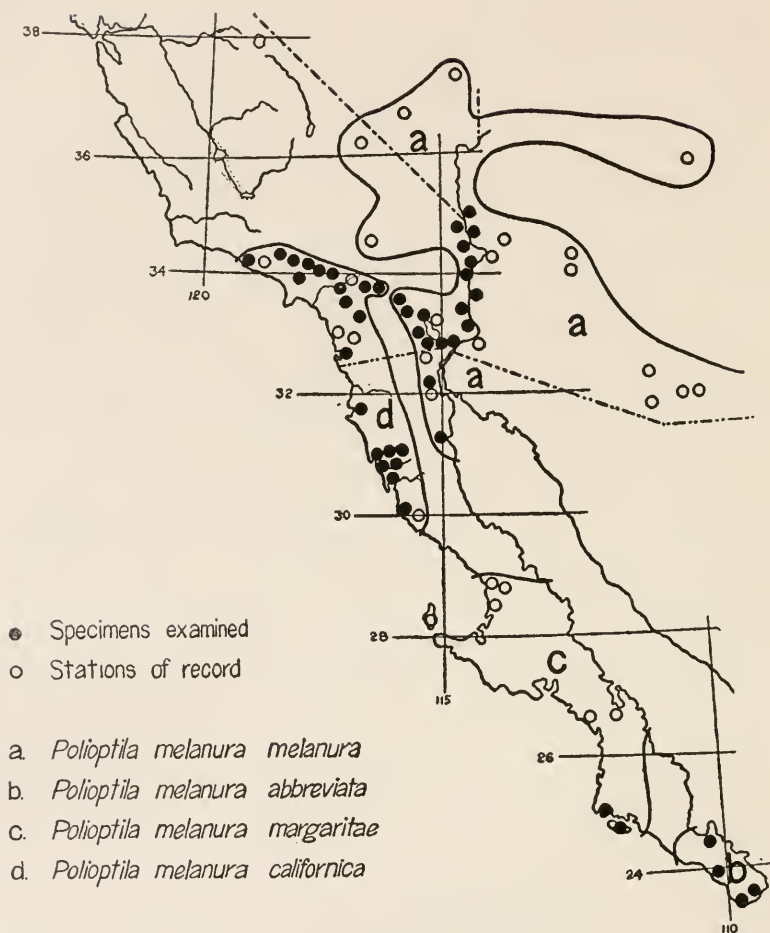
Polioptila melanura margaritae Ridgway

Santa Margarita Black-tailed Gnatcatcher

Type locality.—Santa Margarita Island, latitude near 24° 30', west coast of Lower California.

Type.—Juvenal, ♀ (?); No. 149938, U. S. Nat. Mus.; May 2, 1888; taken on one of the U. S. S. "Albatross" expeditions; skinned from alcoholic and somewhat discolored.

Diagnosis.—Named originally (Ridgway, 1904, p. 733, footnote) from two young birds skinned from alcoholics; so that adequate characterization was impossible. Full-plumaged, adult specimens now at hand from Santa Margarita Island



Approximate Ranges of the Subspecies of the Black-tailed Gnatcatcher in the Californias.

and Magdalena Bay show the following characters: Similar to *P. m. abbreviata*, but bill a little smaller, tones of color above and below in both sexes a trifle deeper, and tail with white edges and tips of outermost rectrices greatly reduced—to practically as in *P. m. californica* (see Brewster, 1881, p. 103); as compared with *californica*, tail somewhat shorter, and upper and lower surfaces decidedly paler (less darkly slaty).

Measurements.—Average, minimum and maximum, in millimeters: *Polioptila melanura margaritae*, 7 adult examples, 4 males and 3 marked female, from Santa Margarita Island and Magdalena Bay: Wing, 46.7 (44.1-48.7); tail, 46.4 (45.5-48.0); exposed culmen, 9.1 (8.4-9.7). *P. m. californica*, 20 examples, 10 of each sex, from Los Angeles County, California: Wing, 46.2 (44.0-49.9); tail, 49.8 (46.0-53.4); exposed culmen, 9.3 (8.8-10.1).

Range.—A section of the Lower Californian peninsula extending at least from Santa Margarita Island and closely adjacent mainland, north to Rosarito and Santana, latitude about 29° (see Thayer and Bangs, 1907, p. 138). Santa Margarita Island is very close to the mainland, indeed only 4 miles, with islets serving as stepping stones between; so that there is no reason to expect any effect of insularity upon its bird-life.

Remarks.—The range of the California Black-tailed Gnatcatcher, *Polioptila melanura californica* Brewster, in northwestern Lower California extends south from the United States boundary over the lower Pacific slopes as far as the vicinity of El Rosario, latitude 30°, as shown by specimens actually in hand. There are other record stations for Black-tailed Gnatcatchers in Lower California, for instance Cedros Island; but in absence of specimens their subspecific status remains in doubt. The Plumbeous Black-tailed Gnatcatcher, *Polioptila melanura melanura* Lawrence, extends its range into the northeastern (Colorado Desert) section of Lower California, south at least as far as San Felipe Bay, whence newly collected specimens are at hand. (See accompanying map.)

The species and subspecies of the genus *Polioptila* as occurring in Upper and Lower California may now, in accordance with the analysis given above, be listed as follows:

1. *Polioptila caerulea amoenissima* Grinnell.
Western Blue-gray Gnatcatcher.
2. *Polioptila caerulea obscura* Ridgway.
Cape San Lucas Blue-gray Gnatcatcher.
3. *Polioptila melanura melanura* Lawrence.
Plumbeous Black-tailed Gnatcatcher.

4. *Polioptila melanura abbreviata* Grinnell.
Cape San Lucas Black-tailed Gnatcatcher.
5. *Polioptila melanura margaritae* Ridgway.
Santa Margarita Black-tailed Gnatcatcher.
6. *Polioptila melanura californica* Brewster.
California Black-tailed Gnatcatcher.

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Berkeley, July 1, 1926.



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VOL. XV, Nos. 17 AND 18, pp. 501-546

MARCH 31, 1927

XVII
REPORT OF THE PRESIDENT OF THE ACADEMY
FOR THE YEAR 1926

BY
C. E. GRUNSKY
President of the Academy

The hope entertained by the officers of the Academy that from some source or other funds would be contributed during the year for needed extensive additions to our building in Golden Gate Park, has not been realized. The Academy is still waiting for some one of means to duplicate what was done in its earlier history by James Lick and establish an endowment not only to provide housing for research work and for exhibits but also to permit of a broadening of the scope of the research work which, within the means provided, is being so well done in the several departments of the Academy under the direction of able and hardworking curators and their assistants.

It is with pride that the Academy may point to its record and there is every reason to believe that it will never lose the high rank to which the achievements of its scientific staff have raised it.

The Academy does not depend upon income from membership dues for revenue with which to carry on its activities and no attempt is therefore made to extend materially the list of

March 31, 1927

members. This list has for some years past been maintained at 1000 to 1100.

On January first, 1926, the number stood at.....	1099
New members added during the year.....	82
Members lost by death.....	24
Members resigned.....	24
Members dropped for non-payment of dues... ..	57
	—
	105
Loss during the year.....	23
	—
Leaving the membership January first, 1927, at.....	1076

Lost by Death during 1926:

Mr. Philip E. Bowles.....	Member.....	January 20, 1926
Mr. Luther Burbank.....	Life.....	April 11, 1926
Mr. Ezra T. Cresson.....	Honorary.....	April 19, 1926
Dr. E. C. Fleischner.....	Member.....	October 11, 1926
Mr. George H. Gould.....	Member.....	January 25, 1926
Mr. B. Hendon.....	Member.....	August 18, 1926
Mr. William Hood.....	Member.....	August 27, 1926
Mr. Edward W. Hopkins.....	Member.....	January 19, 1926
Mr. Le Roy Jeffers.....	Member.....	July 25, 1926
Mr. William Pierce Johnson.....	Life.....	August 24, 1926
Mr. Thomas P. Keating.....	Member.....	October 9, 1926
Mr. Augustus S. Kibbe.....	Member.....	August 21, 1926
Mrs. John G. Kittle.....	Member.....	March 25, 1926
Prof. Hermann Kower.....	Life.....	February 9, 1926
Dr. E. P. Lewis.....	Fellow.....	November 17, 1926
Mr. Geo. W. Luce.....	Member.....	July 4, 1926
Mr. Horace H. Miller.....	Member.....	May 28, 1926
Colonel Seeley W. Mudd.....	Member.....	May 24, 1926
Dr. Saxton Pope.....	Member.....	August 8, 1926
Dr. Geo. B. Somers.....	Member.....	February 20, 1926
Prof. Addison E. Verrill.....	Honorary.....	December 10, 1926
Mr. Rolla V. Watt.....	Member.....	May 15, 1926
Mr. Charles G. Yale.....	Life.....	March 25, 1926

The following whose deaths occurred on the dates named were inadvertently omitted from the reports for 1923 and 1925:

Prof. Louis Falkenau.....	Life.....	August 12, 1923
Mrs. M. J. Hubbert.....	Member.....	1925
Mr. I. H. Morse.....	Member.....	September 11, 1925

The membership consists of:

Patrons.....	16
Honorary members.....	22
Life Members.....	85
Fellows.....	32
Members.....	921
<hr/>	
Total.....	1076

The Academy carries on its list of patrons the following names:

Living

Mr. George C. Beckley	Mr. A Kingsley Macomber
Dr. Frank E. Blaisdell, Sr.	Mr. John W. Mailliard
Mr. William B. Bourn	Mr. Joseph Mailliard
Mr. William H. Crocker	Mr. M. Hall McAllister
Mr. Peter F. Dunne	Mr. Ogden Mills
Dr. Barton Warren Evermann	Mr. William C. Van Antwerp
Mr. Herbert Fleishhacker	Mr. Edward P. Van Duzee
Mr. Joseph D. Grant	Dr. E. C. Van Dyke



Deceased

Mr. William Alvord	Mr. James Lick
Mr. Charles Crocker	Mr. Alexander F. Morrison
Mr. John W. Hendrie	Mr. Amariah Pierce
Mr. Henry M. Holbrook	Mr. Ignatz Steinhart
Mrs. Charlotte Hosmer	Dr. John Van Denburgh

In the year 1926 eleven free lectures were delivered at the stated meetings of the Academy, as follows:

- JANUARY 6. The importance of Geographical Distribution in determining the Phylogenetic Relationship of Species, illustrated, by Prof. H. E. McMinn, Professor of Botany, Mills College.
- MARCH 3. Mountain Lion Hunting in California, illustrated, by Mr. Jay C. Bruce, Mountain Lion Hunter, California Fish and Game Commission.
- APRIL 7. Tunis, Algeria and Morocco, illustrated, by Mr. Ansel F. Hall, Chief Naturalist, National Park Service.
- MAY 12. The Rat, illustrated with motion pictures, by Mr. J. V. Cloos, San Francisco.

- JUNE 2. China and the Chinese, illustrated, by Mr. Isaac C. Upham, well known traveller, San Francisco.
- JULY 7. San Francisco: The World's Dream, by Mr. Charles B. Turrill, Vice President of the California Genealogical Society, San Francisco.
- AUGUST 4. The Apache Trail, illustrated with stereopticon slides and motion pictures, by Mr. Harry S. Swarth, Curator of Birds, Museum of Vertebrate Zoology, University of California.
- SEPTEMBER 1. Applied Chemistry, by Dr. Frank T. Green, Professor of Chemistry, College of Pharmacy, University of California, and Toxicologist for the Coroner, San Francisco.
- OCTOBER 6. The Useful Fishes of Japan, illustrated, by Dr. Shigelo Tanaka, Professor of Zoology, Imperial University, Tokyo, Japan.
- NOVEMBER 3. A Trip to Guatemala, illustrated, by Mr. Joseph R. Slevin, Assistant Curator of Herpetology, California Academy of Sciences.
- DECEMBER 1. Chrysanthemums, illustrated with specimens, by Miss Alice Eastwood, Curator of Botany, California Academy of Sciences, San Francisco.

The Sunday afternoon lectures at the Museum building were continued throughout the year except during the vacation months of summer. Despite the inadequacy of the temporary lecture room, the attendance at these lectures has been satisfactory. These lectures have included the following:

- JANUARY 10. The Woody Flora of the Colorado and Mohave Deserts, illustrated, by Prof. H. E. McMinn, Professor of Botany, Mills College.
- JANUARY 17. The Stars and Atoms, illustrated, by Dr. Robert G. Aitken, Associate Director Lick Observatory, Mount Hamilton.
- JANUARY 24. Some Notable Achievements in Western Irrigation Development, illustrated, by Prof. Frank Adams, Professor of Irrigation Investigations and Practice, University of California.

- JANUARY 31. Mountain Lion Hunting in California, illustrated, by Mr. Jay C. Bruce, Mountain Lion Hunter, California Fish and Game Commission.
- FEBRUARY 7. Our Friends the Bacteria, illustrated, by Dr. T. D. Beckwith, Associate Professor of Bacteriology, University of California.
- FEBRUARY 14. Pyorrhœa, what does it mean to us? illustrated, by Dr. T. D. Beckwith, Associate Professor of Bacteriology, University of California.
- FEBRUARY 21. Science as Conservation Insurance, illustrated with motion pictures and stereopticon slides, by Dr. H. C. Bryant, in charge Education, Publicity and Research, California Fish and Game Commission.
- FEBRUARY 28. Geographic Features of the Bay Region, illustrated, by Prof. Earle G. Linsley, Director Chabot Observatory.
- MARCH 7. Birds of Eagle Lake, illustrated, by Mr. Joseph Dixon, Economic Mammalogist, Museum of Vertebrate Zoology.
- MARCH 14. The Philippine Islands, illustrated, by Colonel John R. White, Superintendent, Sequoia and General Grant National Parks.
- MARCH 21. The Rat, illustrated with motion pictures, by J. V. Cloos.
- MARCH 28. African Archery, illustrated, by Dr. Saxton Pope, Associate Clinical Professor of Surgery, University of California.
- APRIL 4. Life and Mind in Relation to Structure and Mechanism illustrated, by Dr. S. S. Maxwell, Professor of Physiology, University of California.
- APRIL 11. The Teaching of Science in the Public School, by Mr. C. A. Colmore, Science Teacher, High School of Commerce, San Francisco.
- APRIL 18. The Geologic Relations of the Faunal and Floral Provinces and Subprovinces of the Philippines, illustrated, by Dr. Roy E. Dickerson, Geologist, San Francisco.

- APRIL 25. The Painted Desert, illustrated, by Dr. Charles L. Camp, Assistant Professor of Zoology, University of California.
- OCTOBER 3. Prehistoric Wall Writings in the Hava Supai Cañon in Arizona, illustrated with motion pictures, by Mr. Samuel Hubbard, Curator of Archæology, Oakland Museum.
- OCTOBER 10. Birds and Mammals of Mount McKinley National Park, illustrated, by Mr. Joseph Dixon, Economic Mammalogist, Museum of Vertebrate Zoology, Berkeley.
- OCTOBER 17. The Founding of San Francisco, by Mr. Charles B. Turrill, Vice President of the California Genealogical Society, San Francisco.
- OCTOBER 24. Food Habits of Common Birds, illustrated with stereopticon slides and motion pictures, by Dr. H. C. Bryant, Economic Ornithologist, Museum of Vertebrate Zoology, Berkeley.
- OCTOBER 31. Forest Fires and Wild Life in California, illustrated, by Mr. J. W. Nelson, Assistant District Forester, United States Forest Service, San Francisco.
- NOVEMBER 7. A Riddle of Animal Behavior: Migration and Homing of Birds and Other Animals, by Dr. S. S. Maxwell, Professor of Physiology, University of California.
- NOVEMBER 14. Termites or White Ants; one of the Most Interesting as well as Destructive Groups of Insects, illustrated, by Dr. E. C. Van Dyke, Associate Professor of Entomology, University of California.
- NOVEMBER 21. Relation of the North Pacific Trade Winds to the Climate of California, illustrated, by Mr. E. A. Beals, Consulting Meteorologist, Alameda, Calif.
- NOVEMBER 28. Through the Province of Sonora in old Mexico, illustrated, by Dr. Charles L. Camp, Assistant Professor of Zoology, University of California.
- DECEMBER 5. Glimpses of India, illustrated, by Dr. Walter K. Fisher, Director, Hopkins Marine Station.
- DECEMBER 12. Recent Developments in China, by Dr. Ng Poon Chew, Managing Editor of the local Chinese paper, Chung Sai Yat Po, San Francisco.
- DECEMBER 19. Air and Well Being, by Dr. T. D. Beckwith, Associate Professor of Bacteriology, University of California.

LIST OF ACADEMY PUBLICATIONS IN 1926:

OCCASIONAL PAPERS No. XII.—A REVIEW OF THE GIANT MACKEREL-LIKE FISHES, TUNNIES, SPEARFISHES AND SWORDFISHES, by David Starr Jordan and Barton Warren Evermann.

PROCEEDINGS, FOURTH SERIES

- Vol. XIV, No. 18, pp. 427-503—PALEONTOLOGY OF COYOTE MOUNTAIN, IMPERIAL COUNTY, CALIFORNIA, by G. Dallas Hanna.
- Vol. XIV, No. 19, pp. 505-520—REPORT OF THE PRESIDENT OF THE ACADEMY, FOR THE YEAR 1925, by C. E. Grunsky.
- Vol. XIV, No. 20, pp. 521-566—REPORT OF THE DIRECTOR OF THE MUSEUM FOR THE YEAR 1925, by Barton Warren Evermann.
- Vol. II, Part II, No. 18, pp. 347-357—EXPEDITION OF THE CALIFORNIA ACADEMY OF SCIENCES TO THE GALAPAGOS ISLANDS, 1905-1906. THE BEES AND ACULEATE WASPS OF THE GALAPAGOS ISLANDS, by Francis X. Williams.
- Vol. XV, No. 1, pp. 1-113—EXPEDITION TO THE REVILLAGIGEDO ISLANDS, MEXICO, IN 1925. GENERAL REPORT, by G. Dallas Hanna.
- Vol. XV, No. 2, pp. 115-193—EXPEDITION TO THE REVILLAGIGEDO ISLANDS, MEXICO, IN 1925. II. MIOCENE MARINE DIATOMS FROM MARIA MADRE ISLAND, MEXICO, by G. Dallas Hanna and William M. Grant.
- Vol. XV, No. 3, pp. 195-207—EXPEDITION TO THE REVILLAGIGEDO ISLANDS, MEXICO, IN 1925. III. NOTES ON A COLLECTION OF REPTILES AND AMPHIBIANS FROM THE TRES MARIAS AND REVILLAGIGEDO ISLANDS, AND WEST COAST OF MEXICO, WITH DESCRIPTION OF A NEW SPECIES OF TANTILLA, by Joseph R. Slevin.
- Vol. XV, No. 4, pp. 209-217—EXPEDITION TO THE REVILLAGIGEDO ISLANDS, MEXICO, IN 1925. IV. A PLIOCENE FAUNA FROM MARIA MADRE ISLAND, MEXICO, by Eric Knight Jordan and Leo George Hertlein.
- Vol. XV, No. 5, pp. 219-222—EXPEDITION TO THE REVILLAGIGEDO ISLANDS, MEXICO, IN 1925. V. THE BEMBICINI (Digger Wasps), by Charles L. Fox.
- Vol. XV, No. 6, pp. 223-239—EXPEDITION OF THE CALIFORNIA ACADEMY OF SCIENCES TO THE GULF OF CALIFORNIA IN 1921. MOLLUSCA OF THE FAMILY TRIPHORIDÆ, by Fred Baker.
- Vol. XV, No. 7, pp. 241-255—EXPEDITION TO GUADALUPE ISLAND, MEXICO, IN 1922. MOLLUSCAN FAUNA OF THE PLEISTOCENE OF SAN QUINTIN BAY, LOWER CALIFORNIA, by Eric Knight Jordan.

- Vol. XV, No. 8, pp. 257-261—NEW SHARKS FROM THE TEMBLOR GROUP IN KERN COUNTY, CALIFORNIA, COLLECTED BY CHARLES MORRICE, by David Starr Jordan.
- Vol. XV, No. 9, pp. 263-268—THE RELATION OF FORAMINIFERA TO THE ORIGIN OF CALIFORNIA PETROLEUM, by Thomas F. Stipp.
- Vol. XV, No. 10, pp. 269-278—SOURCES OF MATERIAL FROM WHICH PETROLEUM MAY HAVE BEEN DERIVED, by Junius Henderson.
- Vol. XV, No. 11, pp. 279-322—EXPEDITION TO THE REVILLAGIGEDO ISLANDS, MEXICO, IN 1925. VI. THE BIRDS AND MAMMALS, by M. E. McLellan.
- Vol. XV, No. 12, pp. 323-397—THE ANTIRRHINOIDEÆ-AANTIRRHINEÆ OF THE NEW WORLD, by Philip A. Munz.
- Vol. XV, No. 13, pp. 399-408—DESCRIPTION OF SEVEN ANDRENIDS IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES, by Henry L. Viereck.
- Vol. XV, No. 14, pp. 409-464—EXPEDITION TO THE REVILLAGIGEDO ISLANDS, MEXICO, IN 1925. VII. CONTRIBUTION TO THE GEOLOGY AND PALEONTOLOGY OF THE TERTIARY OF CEDROS ISLAND AND ADJACENT PARTS OF LOWER CALIFORNIA, by Eric Knight Jordan and Leo George Hertlein.
- Vol. XV, No. 15, pp. 467-491—EXPEDITION TO THE REVILLAGIGEDO ISLANDS, MEXICO, IN 1925. VIII. LAND SHELLS OF THE REVILLAGIGEDO AND TRES MARIAS ISLANDS, MEXICO, by William Healey Dall.
- Vol. XV, No. 16, pp. 493-500—A CRITICAL INSPECTION OF THE GNAT-CATCHERS OF THE CALIFORNIAS, by Joseph Grinnell.

Title pages and Index were prepared and published as follows:

Fourth Series, Vol. II, Part I; Vol. II, Part II; Vol. XII; Vol. XIV.

ITEMS OF INTEREST

The Academy's income from rent during 1926 was \$92,097.78, this being the largest annual income enjoyed since the lease of the Market Street property in 1909. For 1927 a gross income from rents of about \$89,000 is expected.

Interest charges on a mortgage loan, now \$225,000, will reduce this income by \$12,375 leaving a net anticipated income for 1927 from the Commercial Building of \$76,625. Other sources of income will increase this amount to about \$81,000.

The Academy's mortgage loan has been further reduced during the past year by \$10,000, leaving \$225,000, as above noted, still due.

Mr. Joseph R. Slevin, Assistant Curator of the Department of Herpetology, visited Guatemala last summer where he remained several months and made important collections in the coast and high mountain regions. This collected material is particularly rich in the high mountain forms of salamanders and small snakes, aggregating 2277 specimens.

No important explorations were undertaken by the other departments, the curators and assistants devoting themselves to the study and arrangement of their collections and to the preparation of reports, some of which have already appeared in the Proceedings.

In addition to the Grizzly Bear Group which was rearranged, Mr. Frank Tose, the Academy's taxidermist, has prepared and installed the following small groups during 1926:

Redwood Weasel, Mountain Quail, and Mendocino Flying Squirrel, entirely new.

Tahoe Chipmunk and California Ground Squirrel rearranged by Mr. Tose.

Having been commissioned by the Council to study methods of preparation, installation, lighting, etc., as practised in the best eastern museums, Mr. Tose made a tour of the East in September and October. His observations will be reflected in his future work for the Academy.

On October 9, 1926, Director Evermann left for an extended tour of eastern museums and aquariums. Dr. Evermann's sojourn of about two months in the east will result in great benefit to the Museum and to the Steinhart Aquarium.

Many important additions have been made to the library of rare and much needed scientific works, there having been a larger budget allowance made for the purpose than ordinary.

Early in 1926, Mr. Ogden Mills added \$2,000 to former donations for the rehabilitation of the Grizzly Bear Group, making a total of \$8,000 contributed by Mr. Mills for the installation of this group. The background painted by Captain Charles Bradford Hudson and the taxidermy and general

composition effected by Mr. Frank Tose, have resulted in one of the most artistic and interesting groups in the Museum.

The continued appreciation and approval by the public of the exhibits maintained by the Academy in its museum and in the Steinhart Aquarium is evidenced by the attendance which continues large.

What has been accomplished in the several departments of the Academy will appear more fully in the reports of the Director of the Museum and of the several curators to which reference should be had. For their faithful cooperation and service as for that of all employees of both the Academy and the Aquarium I desire to express the appreciation of the Academy.

It gives me pleasure, too, to note the courtesies extended from time to time in a professional way both by Attorney Edward Hohfeld and by Architect Louis P. Hobart who have when called upon been generous with professional advice.

In closing I can only say that the Academy will continue to serve within its means and holds itself ready to extend its activities along scientific lines to an extent limited only by the funds that may be placed at its disposal.

XVIII

REPORT OF THE DIRECTOR FOR THE YEAR 1926

BY

BARTON WARREN EVERMANN

Director of the Museum and of the Aquarium

The Annual Report of the Director for the year 1925 was presented to the Academy at the Annual Meeting, February 17, 1926.

The present report sets forth briefly the scientific and educational activities of the Academy for the calendar year 1926. On the whole, the year has been a satisfactory one. The members of the clerical force have performed their respective duties with a high degree of fidelity and efficiency. The members of the scientific staff have been very active in building up and caring for the collections in their respective departments and in research work based upon the collections in their care.

PERSONNEL

There have been but few changes in the personnel of the Museum staff in the year. The death on March 10, 1926, of Eric Knight Jordan, Assistant Curator, Department of Paleontology, was a severe blow to the Academy and took from the staff one of its most useful members. Mr. Leo George Hertlein who had been for some months an assistant in the department, was made Assistant Curator April first.

Ignatius McGuire was employed August 19 to December 7, and Miss Lucie Hicks from September 16 to December 31, as temporary assistants in the library, to card catalogue and arrange our duplicate publications. E. L. Rixford was employed in the Department of Paleontology from June 28 to August 6 and September 13 to September 25. Raleigh A. Borrell was employed in the Department of Ornithology and Mammalogy, as an assistant to Curator Mailliard in his field work from May 16 to August 12. Raymond M. Gilmore was em-

ployed in the same capacity from August 25 to October 9. Miss Clara Tose was employed as a temporary assistant in the Department of Botany and elsewhere at intervals in January, February, July and August.

The employes of the Museum January 1, 1927, were as follows: Dr. Barton Warren Evermann, Director and Executive Curator of the Museum, Editor of the Academy publications, and Director of the Steinhart Aquarium; W. W. Sargeant, Secretary to the Board of Trustees; Miss Susie Peers, Secretary to the Director; Joseph W. Hobson, Recording Secretary; Mrs. Constance W. Campbell, office assistant, part time; Raymond L. Smith, office assistant; Miss Mabel E. Phillips, check-room attendant; Miss Alice Eastwood, Curator, and Mrs. Kate E. Phelps, assistant, Department of Botany; Edward P. Van Duzee, Curator, Dr. F. R. Cole, Associate Curator in Dipterology, Hartford H. Keifer, Assistant Curator, and J. O. Martin, temporary assistant, Department of Entomology; Barton Warren Evermann, Curator, and H. Walton Clark, Assistant Curator, Department of Fishes; Joseph R. Slevin, Assistant Curator, Department of Herpetology; Dr. G. Dallas Hanna, Curator, and Leo George Hertlein, Assistant Curator, Department of Paleontology; Joseph Mailliard, Curator, and Miss Mary E. McLellan, Assistant Curator, Department of Ornithology and Mammalogy; Dr. Walter K. Fisher, Curator, Department of Invertebrate Zoology; Joseph Mailliard, Chief of Exhibits; Frank Tose, Chief Taxidermist; Russell Hendricks and Cecil Tose, temporary assistants, Department of Exhibits; Edward P. Van Duzee, Assistant Librarian; C. A. Bellas, Library assistant; Miss Lucie Hicks, Library assistant; Wm. C. Lewis, Janitor; Hugh Jones, assistant janitor; Mrs. Johanna E. Wilkens, charwoman; Patrick O'Brien, day watch; Archie McCarte, night watch.

ACCESSIONS TO THE MUSEUM AND LIBRARY

Many valuable accessions to the Museum, Library and Aquarium have been received within the year. An itemized list will be found in the files of the Academy.

COOPERATION WITH PUBLIC AND PRIVATE SCHOOLS, WITH OTHER INSTITUTIONS, AND WITH INDIVIDUALS

Cooperation of the Academy with public and private schools, other institutions, and with individuals, continued during the year as in the past. Thirteen portable habitat groups have been in circulation during the school year in the Berkeley public schools where the value of proper nature study appears to be most fully appreciated in the Bay region. Additional loan exhibits will be made available whenever there is a demand. Loans of specimens of birds or other natural history objects have been made to a number of schools, institutions and individuals. Lists are in our files.

VISITORS TO THE MUSEUM IN 1926

The total number of visitors to the Museum in the calendar year 1926 was 575,159, an increase of 21,736 over that for 1925, and 18,143 more than visited the U. S. National Museum in the same period. The average daily attendance was 1576.

The number of visitors by months and years since the opening September 22, 1916, is shown in the following table :

VISITORS TO MUSEUM

	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
January.....	23170	25260	17241	27013	25755	19038	15270	32364	34989	26528	
February.....	22058	23698	17586	23450	25679	18534	20529	44439	29295	34183	
March.....	31606	26810	27397	25419	28279	27922	26341	39935	39168	38677	
April.....	32175	23274	25994	32208	24939	36057	21911	41332	40257	36746	
May.....	26154	26391	28369	37107	25517	27237	37597	48152	38137	52913	
June.....	32123	29843	32248	36207	29406	27131	39511	58281	51775	53799	
July.....	37193	31420	48028	52492	43186	36263	64530	91329	69921	83707	
August.....	24619	31137	43730	53470	39422	34787	50849	105130	77847	81362	
September.....	16448	27366	29847	34007	42013	31458	28408	69870	82814	63737	57615
October.....	36933	20629	14743	30463	33500	24861	19459	66894	43074	40418	44654
November.....	27718	21810	8531	25246	19347	18593	19080	48766	37611	35634	30420
December.....	15002	21693	19588	21188	21340	15062	13339	36707	21572	32245	34555
Totals.....	96101	321096	290542	351497	403566	332157	307255	498775	646033	553423	575159

The total number of visitors since the opening, September 22, 1916, has been 4,375,604.

VISITS OF PUBLIC AND PRIVATE SCHOOLS

The public and private schools of the state continue to avail themselves of the educational uses of the Museum exhibits and reference collections.

The number of schools visiting the Museum is so great that the full list cannot be printed here. The following summary must suffice:

Schools of San Francisco:

Number of Visiting Pupils	5103	5103
Number of Visiting Teachers	173	
Number of Visiting Classes	195	
	<hr/>	

Schools Outside of San Francisco:

Number of Visiting Pupils	1881	1881
Number of Visiting Teachers	58	
Number of Visiting Classes	21	
	<hr/>	

Total, Pupils	6984	
Total, Teachers	231	
Total, Classes	266	

USE OF THE LIBRARY AND COLLECTIONS
BY INVESTIGATORS AND STUDENTS

Use of the Academy library and collections by students and investigators continues to be one of the ways in which the Academy is doing real service to the general public as well as to specialists. The library is growing more and more valuable every year. During the past year many important reference works have been added and a number of popular books on travel and the various sciences have been acquired. On the library reading tables are kept many of the current publications of learned societies throughout the world, also many of the scientific journals and outing magazines. Members of the Academy are invited to visit the library and make use of the facilities which it affords for information and aid in other ways.

STEINHART AQUARIUM

The activities of the Aquarium for 1926 are fully covered in the report of the Superintendent.

The total number of visitors for the year was 953,797, a somewhat smaller number than in 1925.

Our chief source of supply of fishes and other live animals continues to be the southern California coast, Monterey Bay, the fishing boats out from San Francisco, the freshwater streams of central California, the upper Mississippi Valley, and Honolulu. Numerous specimens of fishes, turtles, snakes, frogs, etc., have been donated to the Aquarium by interested friends, to all of whom the Academy expresses grateful appreciation.

The Aquarium has, on the other hand, supplied a large number of small aquarium fishes and other objects to schools and individuals, a full list being in our files. Those that have been supplied to schools should prove of much interest. The increasing tendency of teachers toward maintaining aquariums in their schools is to be strongly commended.

AQUARIUM PERSONNEL

Several changes in the personnel of the Aquarium have taken place within the year. These have been due chiefly to our inability to retain the engineers and feeders on the small salaries we are able to pay.

The Aquarium personnel January first, 1927, was as follows:

Dr. Barton Warren Evermann, Director, part time; W. W. Sargeant, Secretary, part time; Susie Peers, Secretary to the Director, part time; Constance W. Campbell, office assistant, part time; Alvin Seale, Superintendent; Wallace Adams, Assistant Superintendent; Clynt S. Martin, Chief Engineer; R. J. Fletcher, assistant engineer; B. T. Culleton, assistant engineer; C. J. MacMeekin, relief engineer and feeder; Robert J. Lanier, electrician and assistant attendant; C. E. Guidry, assistant attendant; Jack Solini, assistant attendant; L. R. Solini, assistant attendant; Herbert Brandt, assistant collector; S. J. Shenefield, carpenter and general utility man; Dora Arnold, doorkeeper; Patrick O'Neill, janitor; Frank J. Maxwell, assistant janitor; James Cavanaugh, police officer.

VISITORS TO THE STEINHART AQUARIUM

The popularity of the Steinhart Aquarium continues. The total number of visitors in the calendar year 1926 was 953,797, as against 1,043,591 in 1925. The daily average was 2601. The attendance by months and years since the opening, September 29, 1923, is shown in the following table:

Visitors to Steinhart Aquarium

MONTH	1923	1924	1925	1926
January.....		82283	72153	38259
February.....		119001	61213	66032
March.....		88172	97986	82153
April.....		83245	79021	64830
May.....		97083	75187	94521
June.....		112785	94717	91451
July.....		145703	128261	127999
August.....		148899	144208	124635
September.....	29800	116032	106492	86645
October.....	209671	71273	72350	79108
November.....	145434	67500	59074	49741
December.....	96757	48376	52929	48423
Totals.....	481662	1180352	1043591	953797

The total number since the opening, September 29, 1923, to the end of the calendar year 1926, has been 3,659,402, a daily average of 3,077.

A list of the schools that visited the Aquarium in 1926 may be found in the Academy's files.

DEPARTMENT ACTIVITIES

The several departments of the Academy have been very active during the year in field work, in building up the research collections, preparing and installing exhibits, caring for the collections and exhibits, and in other scientific and educational activities. The details for each department are fully set forth in the departmental reports.

Department of Botany.—Miss Eastwood, Curator of Botany, made a number of short field trips, chiefly to type localities for the purpose of securing for the herbarium topo-

types of as many as possible of the species originally described from those localities. In this she was fairly successful. The growth of the herbarium has been very satisfactory. The total number of mounted sheets is now 143,566.

Exhibits.—Perhaps the most important event in the year in the Department of Exhibits was the rearrangement of the Grizzly Bear group, including the painting by Captain Charles Bradford Hudson of a new background.

The group now shows a scene on Jackson Lake, Wyoming, with the Grand Teton in the background. The foreground, including the animals and the accessories, has been rearranged. This and the new background have greatly improved this really wonderful group.

Another important event in connection with this department was the visit of Mr. Tose to many of the museums in the East in September and October for the purpose of studying the latest developments in the preparation, installation and lighting of habitat groups and other exhibits. It is believed the information and knowledge acquired by Mr. Tose on this trip will prove very useful in his work for the Academy.

Three new panel groups were installed by Mr. Tose in the year; they are the Redwood Weasel, the Mountain Quail, and the Mendocino Flying Squirrel, all very interesting groups.

The total number of habitat groups now completed is 52, of which there are in the Mammal Hall 11 large, four intermediate, and 18 small panel groups; in the Bird Hall, six large and 12 small panel groups; and in the Aquarium, one large group, as shown in the following list in which the names of the large groups are printed in CAPITALS, the intermediate groups in *italics*, and the small panel groups in roman:

*California Mammal Hall*¹—

1-Desert Wood Rat	6-Redwood Brush Rabbit
2-ROOSEVELT ELK	7-Mountain Beaver
3-Western Bushy-tail Wood Rat	8-NORTHERN BLACK-TAIL DEER
4-Yellow-bellied Marmot	9-Desert Antelope Ground Squirrel
5-SAN JOAQUIN VALLEY ELK	

¹ The groups are listed in order beginning with the first at the right as one enters the hall.

- | | |
|--|------------------------------|
| 10-California Ground Squirrel | 21-Mountain Lion |
| 11-IMPERIAL GRIZZLY BEAR | 22-Northwestern Black Bear |
| 12-Tahoe Chipmunk | 23-Mendocino Flying Squirrel |
| 13-Sierra Golden-mantled Ground Squirrel | 24-ALASKA FUR SEAL |
| 14-ROCKY MOUNTAIN MULE DEER | 25-Alaska Fur-Seal Skins |
| 15-California Ring-tail Cat | 26-Red Tree-Mouse |
| 16-Warner Mountain Cony | 27-LEOPARD SEAL |
| 17-ANTELOPE | 28-CALIFORNIA SEA LION |
| 18-Allied Kangaroo Rat | 29-California Woodpecker |
| 19-Redwood Weasel | 30-STELLER SEA LION |
| 20-DESERT MOUNTAIN SHEEP | 31-Lewis's Woodpecker |
| | 32-Raccoon and Skunk |
| | 33-Coyote |

California Bird Hall—

- | | |
|------------------------------------|-------------------------------------|
| 34-Western Robin | 43-Burrowing Owl |
| 35-FARALLON ISLANDS BIRDS | 44-WHITE PELICAN |
| 36-Coast Bush-tit | 45-Lazuli Bunting |
| 37-California Linnet | 46-Water Ouzel |
| 38-SAN JOAQUIN VALLEY SPRING BIRDS | 47-CALIFORNIA CONDOR |
| 39-California Clapper Rail | 48-Sharp-shin Hawk |
| 40-Mountain Quail | 49-Nuttall Sparrow |
| 41-DESERT BIRDS | 50-SAN JOAQUIN DUCK AND GOOSE GROUP |
| 42-California Valley Quail | 51-Western Meadowlark |

Aquarium—

- 52-ELEPHANT SEAL

Entomology.—Edward P. Van Duzee, Curator of Entomology, reports commendable progress in his department.

The most notable event of the year in connection with this department was the acquisition of the Koebele Collection of insects, estimated to contain about 100,000 specimens, resulting from the many years of very active field collecting by the late Albert Koebele in California, Hawaii and elsewhere.

The Academy is deeply indebted to Mr. Walter M. Giffard of Honolulu for his successful efforts in securing this valuable collection. Mr. Giffard is a Life Member of the Academy and is constantly alert to opportunities to enrich the Academy's collections.

Herpetology.—The most important event in 1926 in connection with the Department of Herpetology, was the expedition to Guatemala by Joseph R. Slevin, the Assistant Curator. Mr. Slevin sailed from San Francisco April 17 and landed April 28 at Port of San José de Guatemala, whence he proceeded to Samayac and other points in the interior, where he devoted about five months to field collecting and observations, returning to San Francisco September 8.

The collection obtained contains 2277 specimens of reptiles and amphibians and is one of the most valuable that has ever been secured in that country. It is particularly rich in high mountain species of salamanders, and in many species of snakes not previously collected by the department. Through the courtesy of Captain H. W. Rhodes, Superintendent of Lighthouses, 18th Lighthouse District, Mr. Slevin visited the Farallon Islands October 15, and obtained a large series of the interesting salamander (*Ancides lugubris farallonensis*) which is known only from those islands.

Library.—The growth of the Library during the year has been satisfactory. The total number of accessions was 2541. A somewhat larger appropriation for library purposes made it possible for the various departments to purchase a number of technical publications, some of them quite expensive, much needed in the research work of the Museum.

Ornithology and Mammalogy.—The Department of Ornithology and Mammalogy carried on field work in Trinity, Humboldt, Mendocino, Modoc and Placer counties, California, which added much to our knowledge of the mammal and bird faunas of those parts of the state and many specimens of birds and mammals to the Academy's collections.

The Curator and Assistant Curator of this department were active during the year in research work on the collections. The Curator, Mr. Mailliard, was assisted in field work at intervals by various temporary assistants, including Raleigh A. Borrell, Raymond M. Gilmore and Paul F. Covel.

Paleontology.—The Department of Paleontology was active during the year in arranging and caring for the collections, in carrying on research work, and in field investigations. The

most important expedition was that into Lower California in January, by Assistant Curator Jordan and assistant Hertlein which resulted in valuable collections from several horizons not previously represented in the Academy's museum.

PUBLICATIONS BY THE MUSEUM STAFF IN 1926

The following bibliography lists the papers published in the year 1926 by members of the Museum and Aquarium staffs.

Eastwood, Alice

1. The Aftergrowth of a Mountain Fire. <Out-of-Doors, January, 1926.
2. Annual Report, Department of Botany for 1925. <Proc. Calif. Acad. Sci., 4th Ser., Vol. XIV, No. 20, pp. 536-537, April 28, 1921.

Evermann, Barton Warren

1. A Bird that Flies Under Water. <Pacific Sportsman, Vol. II, No. 2, 13, 1 plate, February, 1926.
2. (Report of Chairman), Section on Scientific Research of the Commonwealth Club of California for the year 1925. <The Commonwealth, Vol. II, No. 9, 502-503, March 2, 1926.
3. Wonders from the Deep; Honolulu's Fish Markets. <Aloha, Vol. 7, No. 1, 2 pages, 2 illustrations, March, 1926.
4. Annual Report, Director of the Museum. <Proc. Calif. Acad. Sci., 4th Ser., Vol. XIV, No. 20, pp. 521-559, April 28, 1926.
5. Frank Davis—An Appreciation. <Kokomo Dispatch, Kokomo, Ind., July 4, 1926; also in <Delphi Journal, Delphi, Ind., July 15, 1926.
6. The Fur-Seal in the Pacific. <The Mid-Pacific Magazine, Vol. XXXII, No. 3, 207-212, September, 1926.
7. A Review of the Giant Mackerel-Like Fishes, Tunnies, Spearfishes, and Swordfishes. (Junior author with David Starr Jordan.) Occasional Papers of the California Academy of Sciences, No. XII, 113 pages, 20 plates, 1 text-figure, September 30, 1926.

Hanna, G. Dallas

1. Microscopical Research in California Petroleum Fields. <The Oil and Gas Journal (Tulsa, Oklahoma), Vol. 24, No. 45, p. 96, April 1, 1926.
2. Paleontology of Coyote Mountain, Imperial County, California. <Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 18, pp. 427-503, pls. 20-29, 1 text figure, March 23, 1926.

3. Annual Report, Department of Paleontology for 1925. <Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 20, pp. 546-547, April 28, 1926.
4. Expedition to the Revillagigedo Islands, Mexico, in 1925. General Report. <Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 1, pp. 1-113, pls. 1-10, text figures 1-7, March 30, 1926.
5. Expedition to the Revillagigedo Islands, Mexico, in 1925. II. Miocene Marine Diatoms from Maria Madre Island, Mexico. By G. Dallas Hanna and William M. Grant. <Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 2, pp. 115-193, pls. 11-21, 1 text fig., April 6, 1926.
6. Further Notes on *Scalez petrolii*. <The Nautilus, Vol. 40, No. 1, pp. 14-16, July, 1926.
7. Notes on the age and correlation of the Moreno Shale. By J. A. Taff and G. D. Hanna. <Bull. Am. Assoc. Petrol. Geol., Vol. 10, No. 8, pp. 812-814, August, 1926.
8. Concerning Shark-Tooth Hill. <Standard Oil Bulletin, Vol. 14, No. 4, pp. 12, 16, 2 figures (teeth of shark and sea cow), August, 1926.
9. Disintegrating shales by mechanical attrition. <Micropaleontology Bulletin, No. 3, pp. 1-2 (issued by mimeograph), Dec. 15, 1926.
10. Grizzly Bear specimen at S. F. Academy. <San Francisco Examiner, Second main news section, p. N. 5, Sunday, Nov. 21, 1926.

Hertlein, Leo George

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ACKNOWLEDGMENTS

An unusual number of courtesies of one kind or another have been shown the Academy by many individuals and by various institutions. Space does not permit specific mention of all, but the Academy is grateful to all who have shown interest in its work or who have helped it in any way.

First of all must be mentioned those who have contributed to the educational activities of the Academy by giving one or more lectures in our Sunday afternoon and Wednesday evening lecture courses. The Academy's thanks are due also to each of those who have donated specimens to the Museum or the Aquarium or books to the library.

Special acknowledgment must be made of the Academy's appreciation of the deep interest which the Southern Pacific Company, the Atchison Topeka, and Santa Fe Railway System, the Matson Navigation Company, and the Los Angeles Steamship Company have shown in the scientific and educational activities of the Academy. Each of these companies has extended many courtesies to members of the staff and has rendered valuable assistance in connection with the field work of the Museum and the Aquarium. Through their cooperation the Museum and Aquarium collections have been materially increased in number and value.

The Academy is also deeply grateful to Señor Juan Zenon Posadas of Guatemala for many courtesies extended to Mr. Slevin while collecting reptiles and amphibians in that country in 1926. Mr. L. M. Klauber of the San Diego Zoological Park and Mr. Richard P. Erwin of Boise, Idaho, have shown the Academy many courtesies, including the donation of valuable specimens.

Thanks are due also to Captain H. W. Rhodes, Superintendent of the 18th Lighthouse district, who kindly arranged for a visit to the Farallon Islands of a number of the Museum staff for the purpose of securing specimens of the plants and of the rare salamander found there. Mention must be made also of the valuable services of Mr. Walter M. Giffard of Honolulu in securing, through Attorney E. K. Taylor of Alameda the large Koebele collection of insects containing about 100,000 specimens. This collection was donated to the Academy by the widow of Dr. Koebele, Mrs. Fanny Koebele, now of Waldkirch, Germany, to whom grateful acknowledgment is made.

The Academy's grateful thanks are due to Mr. B. Preston Clark of Boston for the donation of a splendid series of hawk-moths numbering 567 specimens purchased by Mr. Clark in England. Many other valuable donations have been made to the Museum and Aquarium which are acknowledged in the various departmental reports.

Special mention must be made of the splendid cooperation and assistance rendered by Mr. W. H. Shebley, in charge of fish culture of the California State Fish and Game Commission, and other officials of the Commission, in connection with the Aquarium. They are always ready and willing to assist us in securing live fishes for our exhibits.

NEEDS OF THE MUSEUM

I feel that it is my duty again to call attention to a few of the more urgent needs of the Museum. The greatest and most pressing need is that of additional room for new exhibits, for our educational activities, for our rapidly growing research collections, and for library purposes. Each of the three public halls of the Museum is already congested. Several exhibits in each do not properly belong there but are there because there is no other place to put them. Each of the departments of botany, entomology, herpetology and paleontology has material that would make excellent public exhibits if there only were suitable halls in which to display them. Among other very instructive exhibits which can be promptly installed when space becomes available may be mentioned the following: 1. An exhibit showing the different fur-bearing

animals of the state. This would include a pair of mounted animals of each species, together with a prime and an unprime skin of each. 2. Several groups of gigantic tortoises, a very large leatherback turtle, lizards, snakes, etc. 3. Seasonal groups of the birds of Golden Gate Park. 4. A series of groups of intermediate size, such as Golden Eagle, Bald Eagle, Osprey, Red-tail Hawk and other Hawks, various Owls, Sage Hen, Mink, Wolverine, Badger, Fox, Marten, Fisher, Jack Rabbit, etc. 5. A synoptical series of the birds of the San Francisco Bay region.

The present auditorium is wholly inadequate and unsatisfactory in every way. In the first place, it is too small to accommodate the audiences that attend the Sunday afternoon lectures which are given throughout the year, except during the summer vacation. The seating is really disgraceful; for the most part the seats are old benches very unsubstantial, uncomfortable and unsightly. The acoustics are very poor and the ventilation is abominable. When the East wing is built it is the intention that it shall contain an auditorium, up to date in every respect, and ample for all lecture audiences and other public functions of the Academy. When this is provided the present lecture hall will become available for six or eight additional habitat bird groups.

Should the construction of the East wing at an early date be found impossible then I strongly recommend that the whale court be inclosed and made into an exhibition hall. This can be done at relatively slight expense and would provide space for a considerable number of habitat groups of various sizes, also for additional library, laboratory and office space.

Library Endowment.—Another pressing need is an endowment for the Library which, through exchanges, donations and purchases, has been growing rapidly during the past few years, in spite of the small allotments that it has been possible to include in the budget each year. Many publications, transactions of learned societies, reports of early exploring expeditions, and special technical papers we have been unable to get because the cost is prohibitive. It seems to me one of the best ways to meet the constant and increasing needs of the Library is by means of an endowment of about \$250,000, which would yield an annual income of \$12,000 to \$13,000

to meet all expenses connected with the Library, including salaries of librarian and assistants, purchase of books, subscriptions to proceedings and transactions of such learned societies as will not supply their publications by exchange, subscriptions to technical and popular magazines and periodicals, binding, and all other expenses properly connected with the building up and care of a library.

Publication Endowment.—Of equal importance are the publications of the Academy. These are *Proceedings*, *Occasional Papers*, *Memoirs*, and *Bulletins*. A volume of *Proceedings* has usually been published annually since 1854, when volume 1 of the First Series was published. The First Series consists of seven volumes (I to VII, 1854 to 1876), totaling 1932 pages. The Second Series began in 1888, and ended in 1896 (Vols. I to VI), with a total of 3417 pages. The Third Series began in 1897 and closed in 1906; 9 volumes with a total of 2918 pages. The Fourth Series began after the fire in 1906 and is the current series which to the close of 1926 totaled 15 volumes (I to XV), 7420 pages of text, and 547 plates, mostly halftones, but some colored.

The series known as *Occasional Papers* began in 1890 and has appeared from time to time as the designation indicates. Up to the present time 12 numbers (I to XII) have been published, with a total of 4040 pages, and 262 plates.

Of *Memoirs* only four volumes and part of a fifth have been published. These appeared from 1868 to 1905 and contain a total of 1070 pages, and 135 plates.

A *Bulletin* was published from 1884 to 1887, two volumes only, totaling 930 pages and 20 plates.

It is chiefly through its publications that the scientific activities of the Museum staff of the Academy are reflected; and it is through our publications that the Academy and the scientific men and women connected with it become known and attain standing in the world of science.

A staff of trained experts is kept busy preparing portable habitat groups and other exhibits of educational value which are loaned to the schools for use in their nature study and elementary science program and are kept circulating among

the schools during the school year. Field Museum of Natural History now has more than 1000 such cases or exhibits. New ones are being added at frequent intervals. The endowment was originally \$250,000, but Mr. Harris and his family were so impressed by the splendid results that they recently increased their gift by \$125,000.

I am informed that the Chicago school authorities regard "The N. W. Harris Public School Extension of Field Museum of Natural History" as the greatest and most effective single agency in the education of the youth of Chicago.

The California Academy of Sciences is ready to put into operation a similar agency here in San Francisco whenever an endowment is provided. Is there not some public-spirited man or woman in California who will seize this opportunity to do a really great thing for the children of San Francisco and California?

There are several ways in which friends of the Academy can help it financially, a few of which may be mentioned:

1. *Unconditional gift*, the money to be used by the Academy in any way the Trustees think proper.

2. *Conditional gift*, to be used for a specific purpose specified by the donor.

3. *As an Endowment*, only the income from which may be used and only for the purpose named by the donor. Endowments may be established in any one of several forms, as follows:

- a. The endowment may be established at once, the money invested, and the income used as it becomes available.

- b. The endowment may be provided in the donor's will, and the normal income from the amount paid to the Academy annually, the endowment not to pass to the Academy until the donor's death.

- c. The donor to provide in his will for an endowment the income from which will not be available for the Academy's use until after the estate has been distributed.

It would seem that there should be among the many friends of the Academy or other public-spirited citizens, a number of people to whom one or another of these opportunities would make a strong appeal.

DEPARTMENT REPORTS

DEPARTMENT OF BOTANY

During the year 1926 about 5000 mounted sheets of specimens were added to the herbarium, making a total of 143,566. There are besides these the collections (not yet mounted) from the Academy's expedition to the Revillagigedo and Tres Marias islands in 1925 which are still unlisted and unlabelled by the collector, Mr. Mason, besides a great many duplicates to be used in exchanges.

The Curator made several short trips chiefly to type localities and succeeded in securing topotypes of a number of species and collected altogether 650 specimens, besides many duplicates. Collections were made in San Luis Obispo County at Cambria, Cholame, Paso Robles, and Avila; in Santa Barbara County at Santa Barbara, Lompoc and Surf; in Kern County at Poso Creek near Bakersfield; in Fresno County at Coalinga, Alcalde and old Fort Miller at Friant; and in Monterey County at the Big Sur. Some specimens were added from San Francisco, Marin County and the Farallons.

Several important collections were received in exchange: 87 sheets from the New York Botanical Garden, Bronx Park, New York, chiefly Atlantic coast species; 186 from the University of Asia Minor, Tashkent, Turkestan, 13 genera and 185 being new to our collection; 293 from Pomona College, Claremont, California, chiefly duplicates from the Marcus E. Jones herbarium; and a set of 125 from the University of California, mainly Californian plants.

Mr. George Haley made important collections in Alaska, adding 436 specimens collected at Nome, Ketchikan and the following islands: St. Lawrence, Panak, Unalaska, Unimak, Kodiak, Sitka and some of the Shumagin Islands. In the collection were several topotypes. Half his expenses were paid by the Academy which received the entire collection.

The following collections were purchased: The A. D. E. Elmer Pacific Coast herbarium, consisting of 436 specimens, some of them probably the types of some of the many species named by him; 363 southern Oregon specimens from L. F. Henderson, University of Oregon, Eugene; 200 Mt. Rainier plants from the University of Washington, Seattle; 106 Texas plants, from Frank C. Seymour, Waltham, Mass., collected along the Gulf of Mexico; 333 Mexican plants collected by and purchased from Inez Mexia, San Francisco, collected chiefly in the mountains near Mazatlan, of which many are still unnamed but among those named are 7 genera and 90 species new to our collection; 250 Chilean plants from Dr. E. Werdermann, an authority on the flora of Chile, adding 13 genera and 183 species; a set of 100 lichens from G. K. Merrill, Rockland, Maine, who

is one of the authorities on this group, and of these 11 genera and 61 species were new to our collection.

The most important donations are as follows, almost all sent for identification: 124 Cecil Hart, Los Angeles; 148 E. Roy Weston, Bakersfield, from Kern County mountains and deserts; 44 Mrs. G. Earle Kelly, Alameda, southern California deserts; 56 Idaho, from Mrs. Rose Donaghe, Pocatello, Idaho; 96 San Luis Obispo and Monterey counties, from Chester Dudley of the U. S. Forest Service; 44 Tahoe Forest Reserve from L. S. Smith of the U. S. Forest Service; 46 from Ynes Mexia collected on Loma Prieta, Santa Cruz Mountains; 295 exotics collected chiefly in southern California by Eric Walther of Golden Gate Park to whom we are indebted for the greater part of our specimens of the exotics cultivated in the gardens throughout California; 107 from Milo S. Baker, collected on Mt. Rainier, southern Oregon and northern California. Smaller collections came in from 45 different correspondents whose names will appear in the general list of donors.

In continuation of exchange, duplicates have been sent to the following: 4 to Dr. Harold St. John, Agricultural College, Pullman, Wash.; 10 to Dr. J. Burt Davy, Imperial Forestry Institute, Oxford, England; 216 to the Arnold Arboretum, Jamaica Plain, Mass.; 23 to the National Herbarium, Washington, D. C.; 45 to the Botanic Garden, Sydney, Australia; 122 to the Royal Botanic Garden, Kew, England; 215 to the University of Asia Minor, Taschkent, Turkestan.

The collection of the exotics cultivated in California is constantly increasing. Specimens come in from all over the state for identification, and as the specimens are frequently incomplete and the native land unknown, it often takes much time for a satisfactory determination. Our herbarium is unexcelled in its collection of exotics and is the most cosmopolitan herbarium west of the Mississippi.

The Curator continues to give popular addresses to schools and clubs on botanical subjects and conservation and on some Sundays accompanies different clubs on excursions to interest the members in the native plants. The California Botanical Club which numbers 80 members holds weekly meetings or excursions except during the absence of the Curator. The class of gardeners meets twice monthly almost throughout the year in the herbarium Thursday evenings to enable the ambitious men to obtain a knowledge of the plants cultivated in the park.

The flower show that continues throughout the year in the vestibule of the Museum is an interesting and instructive feature of the museum. Hundreds of species both native and exotic are on exhibition at different times in the year, labelled with scientific and common name, if there is one, and the native home. My assistant, besides her regular herbarium duties, has taken charge of this during the past year and the exhibit is always most attractive. Friends throughout the state send in flowers occasionally and Mrs. E. C. Sutcliffe brings in flowers every week during the flowering season, while Eric Walther keeps up the supply of plants from the park.

Two collections of wild flower pictures have been properly installed in the Bird Hall of the museum, both donated by the California Botanical

Club. One is the collection of 480 pictures of Californian wild flowers so beautifully photographed and colored by Antone J. Soares and the other a collection of colored lithographs of New York flowers which were published by the State Museum of New York at Albany. They form a most interesting exhibit and are instructive as well as beautiful.

My assistant, Mrs. George H. Phelps, has been most efficient and faithful, attending to the mounting of the accessions, looking after the drying of the fresh specimens that continually come in, putting the mounted specimens into their proper places after distribution into families, looking after the flower show and many other duties that are continually arising in a growing herbarium.

Alice Eastwood, *Curator.*

DEPARTMENT OF ENTOMOLOGY

The acquisition of the Koebele Collection and the sustained growth of the general collection of insects, including some gifts of exceptional value, have marked the year's growth in this department.

For the securing of the Koebele Collection, the Academy is directly indebted to Mr. Walter M. Giffard of Honolulu. During the years Mr. and Mrs. Koebele were detained in Germany by war conditions, Mr. Giffard took charge of this collection and protected it from destruction by insect pests. After the death of Mr. Koebele it was through his suggestion, and the cooperation of Mr. E. K. Taylor of Alameda, that it was finally placed in the care of the Academy. During the past summer it was formally presented to the Academy by Mrs. Koebele as a memorial to her late husband, under practically the same conditions as those under which the Van Dyke, Van Duzee and Blaisdell collections came to the Academy. Mr. Giffard is to retain the parasitic Hymenoptera and Coccinellidæ or "lady beetles," and a few other restricted groups of insects that are of special interest to the Hawaiian entomologists; the great bulk of the material, however, comes to the Academy, making this one of the most valuable single units thus far added to its collection of insects.

The Koebele collection, estimated to contain 100,000 specimens, was accumulated during many years of active field work while Mr. Albert Koebele was carrying on investigations for the State of California, the U. S. Department of Agriculture, and the Hawaiian Sugar Planters Association. The field work undertaken by Mr. Koebele was primarily the discovery and introduction of parasitic and predacious insects to prey upon certain injurious species that from time to time became so destructive as seriously to menace important agricultural interests. Mr. Koebele and those collaborating with him really established the possibility and value of biological control of injurious insects. Their greatest triumphs were the control of the cottony cushion scale that had threatened the destruction of the citrus industry of California, and the sugar cane leaf hopper that had proved equally destructive to the sugar industry of the Hawaiian Islands. In the prosecution of this and similar work Mr. Koebele travelled widely through Japan, China, Australia and other oriental countries, and in Florida, Arizona, and Mexico on this continent, and wherever he went

he was able to add something of value to his collection of insects. Of most value to the Academy is his material in the Coccidæ and the moths, both of which groups are very fully represented in the Koebele collection, and will go far toward giving the Academy a good working series in these groups.

Another gift of unusual value to the Academy is a series of hawkmoths presented by Mr. B. Preston Clark of Boston, Mass. The 567 specimens in this series of large showy moths represent 265 species from all parts of the world, some of them of great rarity. They form one of the most interesting elements of the Academy collection of insects. Special mention should also be made of a collection of about 3000 English insects, made by Mr. C. L. Fox during a three months' visit to his native town of Plymouth, and neighboring parts of England. Of this number, 300 were named species presented by Mr. C. R. L. Perkins and Mr. J. H. Keys. It is a great advantage to our students to have determined European insects for comparison while studying our local forms, so this English collection is most acceptable. During the summer of 1926 Dr. E. C. Van Dyke spent two months collecting in the high mountains of Colorado. The beetles, of which there were 5165 specimens, have been incorporated into the Van Dyke collection of Coleoptera, already a most important unit of the Academy collection. Dr. Van Dyke has also presented to the Academy the miscellaneous insects of other orders, numbering 2837 specimens, taken by him on this Colorado trip. Other interesting additions to the Academy collection are 1338 specimens taken by Mr. J. R. Slevin in Guatamala, a most valuable addition; 1171 specimens taken by Mr. J. O. Martin in the White Mountains of Inyo County, California; 889 taken by Dr. Ernest Nast on a trip to Idaho and Montana, including many species new to the Academy collection; 857 taken by Mr. Clifford Dodds in southern California; 639 taken by Mr. A. Christoffersen in Alaska; 448 taken by Mr. W. M. Giffard in various parts of California; 430 taken by Mr. Louis S. Slevin at Carmel, California, including some very rare moths; 288 taken by Mr. M. C. Van Duzee at Mill Valley and about Buffalo, N. Y., and 240 presented by Mrs. H. E. Ricksecker. Smaller but valuable additions were made by E. R. Leach, J. T. Lamiman, G. D. Hanna, J. A. Kusche, Barton Warren Evermann, Ralph Hopping, Eric Walther, G. R. Wilson, G. P. Rixford, Otto Swezey, W. W. Jones, S. E. Flanders and J. E. Cottle. Prof. P. H. Timberlake gave us some interesting bees of the genus *Perdita*, including a number of paratypes; Mr. R. D. Hartmann a paratype of the very rare *Trachykele hartmanni*, and Mr. H. E. Burke a pair of another rare beetle, *Buprestis fremonti*.

Of the purchases the most interesting was a collection of 2426 insects from Che-Chiang Province, China, gathered by Mrs. Dora E. Wright, and 2400 from Fu-Chow, China, from Mr. C. R. Kellogg. These, together with the large collection made by Dr. E. C. Van Dyke in 1923 and presented to the Academy in 1924, give us a very good representation of the insects of that country.

No extended collecting trips were undertaken by the Department of Entomology in 1926, so the total additions by field work numbered but 4721. A part of these were taken by the curator in a four days' trip to



Lake County, California, as the guest of Dr. Ernest Nast, a part were taken by Mr. H. H. Keifer during a short vacation spent at Oroville, California, the balance being taken on week-ends about the Bay region. The total additions to the department collections during 1926 numbered 25,818 specimens, exclusive of the Koebele collection.

It is a pleasure to acknowledge the continued assistance received from Dr. Wm. Barnes, of Decatur, Illinois, who has most generously allowed his taxonomist, Mr. F. H. Benjamin, to study and determine many boxes of moths for us, a task Mr. Benjamin has most courteously performed, and has already added about 200 species of moths to the Academy collection from his duplicate material. Prof. T. D. A. Cockerell has continued his study of our bees; Prof. H. C. Fall has worked up for us the Chrysomelidæ of the Gulf of California expedition; Mr. M. C. Van Duzee worked part time for a while in the spring, on the determination of certain families of Diptera that had not been studied by Mr. Cole; and Mr. T. H. Frison of the Illinois State Natural History Survey has worked up our entire collection of bumblebees. Reports on these studies will soon be published by the Academy.

During the past year the curator has had the faithful and efficient help of Mr. H. H. Keifer in the preparation and labelling of the material that has come in, and without which it would have been impossible to have kept up with the rapid growth of the department. In addition to this Mr. Keifer has begun the development of a collection of microlepidoptera for the Academy, partly through the incorporation of material already in the museum but mostly by collecting and breeding out our local forms. This work and the study of the material he has done during odd hours, largely in the evenings. Mr. J. O. Martin has helped on part time throughout the year, incorporating the Van Dyke collection into that of the Academy. So far over 50,000 specimens have been transferred from the Van Dyke collection, but as yet the work is hardly more than a third completed. Dr. Van Dyke has given most generously of his time and effort, checking over all families of the beetles as they have been arranged by Mr. Martin and determining much of the unworked Academy material in the groups, as they are arranged into the unit boxes. The curator, during such hours as could be spared from his executive duties has continued the arrangement of the collections of Hemiptera and the macrolepidoptera.

The publication of the *Pan-Pacific Entomologist* has been continued throughout the year. Indirectly this has become a part of the work of the Department of Entomology, especially as an outlet for the shorter entomological papers submitted to the Academy for publication in its Proceedings, or founded upon the collections of the Academy. During 1926 nine such papers were published in this journal, with a total of 87 pages, or two-fifths of the total number of pages for the year.

The need for additional space for the proper development of this department is becoming a serious problem. In accepting these large valuable private collections the Academy assumes the responsibility of properly housing them, a matter that should receive proper attention before the limit of growth in the present laboratory has become exhausted.

EDWARD P. VAN DUZEE, *Curator.*

DEPARTMENT OF EXHIBITS

The first two months of the year 1926 were spent upon a complete re-arrangement of the Grizzly Bear Group in the Mammal Hall, as there yet were some noticeable defects that had not been overcome by the first alterations. A more appropriate background was painted by Mr. Charles Bradford Hudson, who is responsible for several of the most effective backgrounds in the Academy's series of habitat groups. The final arrangement of this group as planned by the department's group artist, Mr. Frank Tose, has met with the hearty approval of the donor, Mr. Ogden Mills.

Another month was devoted by Mr. Tose to the painting of the Leatherback Turtle cast he had made in 1925 for the Department of Herpetology.

For the purpose of keeping the Department of Exhibits in touch with the latest developments in taxidermy, making of accessory materials, arrangement and lighting of groups, and all matters pertaining to group work, Mr. Tose was authorized to visit such museums of the United States as make a feature of educational work of this nature. The months of September and October were devoted to this tour. Mr. Tose was well received by the staff members of the museums visited. Having been given cordial assistance in his studies of the latest methods introduced into group work and of the effects attained by their use, he returned to California with much additional information and knowledge of the sort that can be obtained only by personal observation and interchange of ideas with others intensively engaged in this line of work. Notes were kept of matters of special import; drawings were made of subjects difficult to describe; and there was obtained a series of photographs illustrating effects achieved by the use of the latest methods that have been evolved. The later part of the year was employed in putting into successful practice some of the best methods suggested by this museum tour.

Three more panel groups have been installed by Mr. Tose in the past year, these being the Redwood Weasel, Mountain Quail, and Mendocino Flying Squirrel. In addition to this, the California Ground Squirrel and the Tahoe Chipmunk groups have been so arranged as to show to much better advantage than did the originals.

In the series of habitat groups in the Academy's halls, the possibilities that exist in the scheme for placing before the public examples of animal life in its natural surroundings have barely been touched. The extent to which this educational work might be carried on is limited only by housing room and cost. Unfortunately, after the five remaining spaces still available for small panel groups are filled, which will be in the coming year, this work will have to cease, unless more space can be provided, and for such provision the Academy has no funds.

Student assistants in this department in 1926 have been as follows: Russell Hendricks and Cecil Tose, part time work; Douglas Kelly and Ralph Keating, student assistants.

JOSEPH MAILLIARD, *Curator*.
March 31, 1927

DEPARTMENT OF FISHES

During the year 1926 the Curator and the Assistant Curator have given such time as they could devote to the department chiefly (1) assisting Dr. David Starr Jordan in the preparation of a report on the Giant Mackerel-Like Fishes, Tunnies, Spearfishes and Swordfishes¹ of the World; (2) studying (with Mr. Tsen-Hwang Shaw), a small collection of freshwater fishes from Eastern China²; (3) sorting, tagging and accessioning the Ortolan collection of fishes; (4) caring for the collections; and (5), most important of all, working upon a revised Check-List of the Fishes of North and Middle America upon which Dr. Jordan and the Curator have been engaged at intervals for a number of years. Mr. Clark, the Assistant Curator, has given much of his time to this work. He has also given considerable attention to breeding certain species of small aquarium fishes. From September 18 to November 1 the Assistant Curator was in Iowa, Illinois and northern Indiana making collections of live fishes for the Steinhart Aquarium, and the Curator was in the East from October 9 to December 17 visiting museums and aquariums in New York, Philadelphia, Washington and Chicago.

H. WALTON CLARK, *Assistant Curator.*

DEPARTMENT OF HERPETOLOGY

The collection of reptiles and amphibians has maintained a satisfactory growth during the year 1926. There have been added to the collection 2,464 specimens so that it has now grown to 61,750 specimens.

Gifts of specimens have been received as follows: From L. S. Slevin, 2; E. P. Van Duzee, 6; James A. Campbell, 1; Richard P. Erwin, 53; L. M. Klauber, 17; Dr. G. Dallas Hanna, 4; H. W. Clark, 4; J. August Kusche, 1; E. R. Leach, 1; Paul Ruthling, 6; Mrs. E. C. Van Dyke, 2; Mrs. Blanche Fisher, 1; Provincial Museum, Victoria, B. C., 1; and C. R. Kellogg, 1.

Specimens have been secured from 7 counties of California as follows: Fresno, 3; Marin, 2; Monterey, 2; San Diego, 16; San Francisco, 83; Santa Cruz, 1; and Tulare, 1.

Specimens from other localities are: Arizona, 2; Idaho, 53; Indiana, 1; New Mexico, 3; Oregon, 5; Germany, 6; Africa, 1; China, 1; Vancouver Island, 1; Mexico, 2; Guatemala, 2277; Panama, 1; and Santo Domingo, 3.

Mr. Frank Tose, of the Department of Exhibits, has completed a model of the large leather-back turtle presented by the San Francisco International Fish Co. The turtle from which this model was made measured eight feet in length, its front flippers had a spread of eight feet, and it weighed 1286 pounds.

Field work was carried on for a second time in Guatemala, resulting in a collection of 2277 specimens, rich in some of the high mountain forms of salamanders and many species of snakes not taken on the first expedition

¹ Published September 30, 1926, as Occ. Pap. No. XII, Calif. Acad. Sci.

² Published January 31, 1927 in Proc. Calif. Acad. Sci., 4th Ser., Vol. XVI, No. 4, pp. 97-122.

to this region. The thanks of the department are due Señor Juan Zenon Posadas, Jr., of Samayac, Guatemala, whose hospitality and assistance made the expedition a success.

A second field trip was made to the Farallon Islands and a large series of salamanders collected, replacing the original series destroyed in the fire of 1906.

The classification and arrangement of the collection was continued during the year, and, the report on the reptiles taken on the expedition to the Revillagigedo Islands was published.

JOSEPH R. SLEVIN, *Assistant Curator.*

LIBRARY

The total accessions to the library during 1926 number 2541 items, of which about 1300 are pamphlets, 131 are maps and 1118 are complete volumes. Of these complete volumes 112 were received as gifts, 413 on exchange and 593 by purchase. An analysis of these figures shows a most gratifying growth in this department of the Academy. A larger appropriation for books made it possible for each department to purchase a number of very important works. No recent year has shown so large an increase in the technical literature so badly needed by the curators in the several departments. While this increase in the standard technical literature of natural history was an important step in the right direction it was only a step. However, if it can be followed up by similar appropriations for a few more years it will enable the departments to replace many of the valuable books and series destroyed in the fire of 1906. All this especially applies to the three departments of Botany, Paleontology and Entomology, where the output of books essential to systematic work is really enormous and where our present resources are sadly inadequate. The additions made in 1926 helped wonderfully in the technical work of these departments and were most sincerely appreciated. What is true of these three departments is true only in a less degree of all departments. Corresponding additions during a few more years will remove in a great measure the handicap under which our systematic work has been done.

Another cause for satisfaction was the binding of 676 volumes during 1926. While the binding of serials and other books adds nothing to the technical resources of the library, it does add immensely to the readiness with which these resources can be utilized and serves to preserve the books from premature destruction through constant handling. Then the improvement in the looks of the books on the library shelves is certainly a source of satisfaction, if nothing more, to those using them.

Mr. C. A. Bellas remained as library attendant throughout the year. In addition to the care of the library rooms and the accessioning and disposition of all books and other items received, he found time to prepare preliminary lists of the books in the departments of Botany, Paleontology

and Entomology that later can be checked over with the card catalogue of the library.

There has been a satisfactory increase in the use of the library resources by the Academy staff and other students who have had occasion to work on the departmental collections.

EDWARD P. VAN DUZEE, *Assistant Librarian.*

DEPARTMENT OF MAMMALOGY

According to the custom of recent years, this department has been conducted conjointly with the Department of Ornithology, and has participated equally in the field work.

During the field work of the spring and summer, in Trinity, Humboldt, and Mendocino counties, trapping for rodents and other small mammals was constantly carried on, and special efforts were made to secure a series of pocket gophers (*Thomomys*) at every point at which camps were made, from which to work out geographic variation from the interior of the state to the coast region. The Red Tree-Mouse (*Phenacomys longicaudus*) was also kept in mind and was discovered to be resident on the South Fork Mountains, Trinity County, thus extending its known range somewhat farther inland. During the field work in Modoc County special efforts were made to secure certain mammals of species reported or supposed to exist there, but of which no specimens from that region have been recorded and which are now rarely seen. In this work the field party met with only partial success.

An improvement has been made in the Mammal Room in the way of making gas-tight the wall cases in which are stored a large part of the osteological specimens, so that these specimens can be easily and safely fumigated. Among other work connected with this department, Miss McLellan has arranged her time so as to undertake some back work that has long been waiting attention, such as that of bringing up to date the identification and proper labeling of a number of old time specimens in the Academy collection, and making over into study skins some of the alcohols, bats especially. With the exception of some very large ones, the preparation of osteological specimens has been completed to date.

In the past year Mr. Curtis Baird presented the department with a number of skulls of African animals that he had secured on hunting expeditions. Another accession of note was the skeleton of a Prong-horn antelope, found on the summit of Mount Shasta (California), presented by Mr. M. Hall McAllister.

Accessions to the department have been as follows: *By exploration:* 353 specimens. *By gift:* R. Curtis Baird, 42; Mrs. C. S. Capp, 1; T. C. Grant (bequest), 1; E. Hughes, 1; M. Hall McAllister, 1; John McLaren, 1; Mrs. Saxton Pope, 3; Steinhart Aquarium, 5; H. E. Wilder, 1; L. R. Wolfe, 6. *By purchase:* 6 specimens.

JOSEPH MAILLAIRD, *Curator.*

DEPARTMENT OF ORNITHOLOGY

The constant growth of the collections in this department necessitates corresponding expansion of case room, involving rearrangement of specimens from time to time. Such rearrangement, as commenced in the latter part of 1925, has been completed by the assistant curator, Miss. M. E. McLellan, and shows the great need of the department for more extended quarters in which to house the valuable material that is being acquired.

A considerable portion of the year was occupied by the curator in field work. Several weeks in January and February were passed in Placer County, California, principally in banding sparrows of the genus *Zonotrichia*.

Beginning on May 17, field work was carried on in California, with Raleigh Borrell as assistant, on a line extending from the Yolla Bolly Mountains, in Trinity County, west nearly to the coast in Humboldt County, and then south to Laytonville, Mendocino County. Eight camps were made upon this trip, each one being maintained until its possibilities, in the way of supplying new facts or needed specimens, were practically exhausted, when an advance was made to the next locality that seemed to be of promise along the route. This trip was ended at Laytonville, August 11.

On August 27 another field trip was commenced, with Raymond M. Gilmore and Paul F. Covel as assistants, when Eagleville, Modoc County, was again visited. The objects of this expedition were twofold. One object was to endeavor to secure certain birds and mammals to support sight or hearsay records that had never been properly proved, and the other was to band Gambel's Sparrows during the southward fall migration to see what percentage might be secured of those banded in the fall of 1925. Several of the needed species of birds were secured, of which probably the most notable was the Ferruginous Rough-legged Hawk, there being no record of this hawk actually having been secured in northeastern California. Not far from a thousand Gambel's Sparrows were banded, but "returns" of birds banded in the previous fall were very few, the inference being that most of these were migrating along some other route.

At intervals during this work camps were made by one or more members of the party at other promising points, so as to cover as much territory in the county as the length of the visit would permit. This work was brought to a close on October 7, by which time, in this year of drought, but few birds of any species still remained at this elevation.

With the routine work of the department, together with the preparation of a report upon the Academy's recent expedition to the Revillagigedo Islands, and the report upon the field work carried on by herself in Mexico in the fall of 1925, the time of the assistant curator has been very completely filled.

Accessions to the collections have been as follows: Bird skins—*By exploration*: 631 specimens. *By gift*: C. H. Anderson and J. D. Lewis, 1; F. E. Blaisdell (bequest from Mrs. Marie Fuchs), 5; H. Brandt, 1; R. Cabot, 1; H. W. Clark, 1; E. C. Counter, 32; Mrs. Mary C. Fowler, 2; E. W.

Gifford, 1; J. G. Grundell, 1; L. M. Loomis, 1; John McLaren, 1; W. M. Phillips, 2; R. Smith, 1; J. A. Street, 1; H. Trost, 1; E. Walther, 1.

Birds' nests and eggs have been received as follows: *By exploration*: 4 sets of eggs and 1 nest. *By gift*: H. Aldous, 3 sets.

The departmental library has been considerably increased during the year. Notable among the acquisitions are Cassin's *Birds and Mammals of the U. S. Exploring Expedition*, Vieillot's *Oiseaux de l'Amerique septentrionale*, Selater and Salvin's *Exotic Ornithology*, Rothschild's *Avifauna of Laysan*, Elliot's *Birds of North America*, Furbringer's *Morphologie und Systematik der Vogel*, and Brisson's *Ornithologia*.

JOSEPH MAILLIARD, *Curator*.

DEPARTMENT OF PALEONTOLOGY

The activities of the Department of Paleontology during 1926 were largely confined to the arranging of collections made by former expeditions. The explorations conducted by the Academy since 1921 resulted in the accumulation of very large numbers of shells and fossils and to be of use in scientific study these must be sorted, labelled and provided with storage space where they can be readily consulted. This indoor, detailed work is very laborious and time consuming, but is a necessary accompaniment to exploration.

To this end the laboratory was provided during 1926 with some "built in" equipment which greatly facilitates this phase of the work. Certain nondescript pieces of furniture have been eliminated and it can hardly be said that there is a better equipped paleontology laboratory in the country now.

In the early part of January Messrs. Jordan and Hertlein made an automobile trip far into Lower California and they succeeded in bringing back fossils from several horizons which had not been represented in the Academy's collections before. When starting on a similar trip to southern California March 10 an accident occurred which resulted in the death of Mr. Jordan, and the department was severely handicapped the rest of the year through this appalling loss.

On many local trips in the state the Curator managed to collect a considerable quantity of material, chiefly in connection with his studies on the fossil micro-organisms of the state. Being accompanied by accurate geographic and stratigraphic data, this collection, brought together through a series of years, is unquestionably without a rival elsewhere in the world. Late in the year, in cooperation with Mr. Paul Reuderick, a synthetic resin was discovered with refractive index of approximately 1.80. This promises to have wide application in microscopical research.

Many students have continued to use the collections in research and at the end of the year the following loans of specimens were on the records: Dr. Paul Bartsch, U. S. National Museum, Washington, D. C.; Dr. Remington Kellogg, Carnegie Institution; Dr. Mary J. Rathbun, U. S. National Museum; Dr. S. S. Berry, Redlands, Calif.; Dr. Fred Baker, Point Loma, Calif.; Mr. A. M. Strong, Los Angeles, Calif.

G. DALLAS HANNA, *Curator*.

STEINHART AQUARIUM

It is a pleasure to report satisfactory conditions at the Aquarium during the year 1926.

The two outstanding recommendations made by the Superintendent in his report for 1925—that a green-house be built on the roof in which aquatic plants for use in the various balanced aquariums can be cultivated and where small tropical fishes can be bred for experimental purposes, and that additional tanks be supplied with warm salt water,—have been granted. These now form distinct permanent improvements.

That the Aquarium is well regarded by the people of California is attested, not only by the large attendance (953,797), but by the fact that during 1926 gifts which total 4,826 in number have been received. These range from starfish to sea lions, and include a number of alligators. A complete list with the names of the donors will be found in our files.

In the fall of 1926 Dr. Barton Warren Evermann, Director of the California Academy of Sciences and of the Aquarium, visited some of the aquariums of the eastern United States and returned with many helpful suggestions.

In the month of October Mr. Robert J. Lanier of the Aquarium staff returned from New York where he spent his vacation, bringing with him 66 live specimens of eastern fishes, chiefly gifts from the New York Aquarium. Mr. H. Walton Clark secured in the Mississippi Valley and brought to the Aquarium 316 specimens of live fishes.

This is the first time that such fishes as the Red-winged Sea Robin, the Queen Trigger-fish, the Pearl Roach, Darters and many others have ever been seen in the far west. These are now swimming about in our tanks.

The total number of live specimens in the Aquarium tanks December 31, 1926, was 8,096, an increase of 976 during the year. These are divided among the animal kingdom as follows:

Mammals.....	10 specimens of	4 species
Birds.....	1 "	1 "
Reptiles.....	114 "	25 "
Amphibians.....	53 "	9 "
Fishes.....	7570 "	252 "
Invertebrates.....	348 "	10 "
Total.....	8096 specimens	301 species

The above is exclusive of 120,000 Grayling hatched during the year and turned over to the California State Fish and Game Commission, and of 2,000 Salmon and Trout eggs now in the hatchery. A list of all fishes lost during the year will be found in our files.

We suggest the following improvements for the coming year:

That the court in front of the building containing the seal pools be paved with cement and properly drained; that many more fishes from the south be added, especially from the vicinity of the Santa Barbara Islands, and that the Aquarium library be built up.

ALVIN SEALE, *Superintendent.*

FINANCIAL STATEMENTS

REPORT OF THE TREASURER

For the fiscal year ending December 31, 1926

January 1, 1925, Balance due Crocker First National Bank. . . . \$ 3,730.11

Receipts:

Dues	\$ 3,941.75
Charles Crocker Scientific Fund Endowment	
Income	1,780.30
James Lick Endowment Income.....	71,648.26
General Income	18,669.22
John W. Hendric Endowment Income.....	960.00
Publication	366.05
Interest	850.97
Ignatz Steinhart Trust Interest.....	520.81
Ogden Mills Donation	2,000.00
Bills Receivable	16,000.00
Bills Receivable Ignatz Steinhart Trust.....	10,000.00
Wild Life Protection Fund.....	100.00
Post Card Sales.....	1,581.11
Dodge Touring Car Indemnity.....	240.00
W. G. Wright Fund	10.50
	\$128,668.97
	\$124,938.86

REPORT OF THE TREASURER—Continued

Expenditures:

Interest	\$12,590.85
Contingent Fund.....	684.18
Salary Expense General.....	20,132.99
Museum Department Appropriations.....	14,142.70
Museum Department Salaries.....	17,403.27
Insurance	1,899.39
Earthquake Sinking Fund.....	1,200.00
Steinhart Aquarium Equipment.....	228.14
Bills Receivable	20,000.00
Bills Receivable Ignatz Steinhart Trust....	10,000.00
Bills Payable	10,000.00
Sundry Creditors	8,064.26
Wild Life Protection Fund.....	136.76
Publications	2,175.87
Library	7,544.67
Expense	2,835.24
	\$129,038.32

January 1, 1927, Balance due Crocker First National Bank...\$ 4,099.46

M. HALL McALLISTER, *Treasurer.*

Examined and found correct,

McLAREN, GOODE & Co., *Certified Public Accountants.*

San Francisco, Calif., February 9, 1927.

INCOME AND OPERATING EXPENSES

For the fiscal year, January 1, 1926, to December 31, 1926

Income:

Charles Crocker Scientific Fund Endowment	
Income	\$ 1,780.30
James Lick Endowment Income.....	71,648.26
General Income	18,669.22
Dues	3,959.00
Interest from Temporary Investments.....	850.87
Profit on Post Card Sales.....	507.97
	\$97,415.62
Total Income	

Expenditures:

General Expense	\$ 4,256.57
Salaries	36,841.26
Interest	12,590.85
Insurance	2,442.34
	\$56,131.02
Total Expenditures	
Net Income Transferred to Surplus Account...	\$41,284.60

SUMMARY OF SURPLUS ACCOUNT

December 31, 1926

Balance January 1, 1926.....\$469,078.81

Additions:

Net Income for Year ended December 31, 1926.....	\$41,284.60	
Ogden Mills Donation.....	3,000.00	
Income from John W. Hendrie Endowment Account	960.00	
W. G. Wright Fund.....	73.74	
Sale of duplicate books.....	22.00	
To offset depreciation on label press sold at original cost	64.75	
 Total Additions to Surplus.....	 \$ 45,405.09	
	\$514,483.90	

Deductions:

Depreciation	\$15,607.57	
Loss on Dodge Touring Car destroyed in wreck	110.00	
Foreign Exchange Account.....	36.84	
	\$ 15,754.41	
 Surplus, December 31, 1926.....	 \$498,729.49	

BALANCE SHEET

December 31, 1926

*Assets**Property:*

Real Estate 831-833 Market Street.....	\$600,000.00	
Commercial Building, 833 Market Street.....	516,818.66	
Real Estate, Jessie Street.....	8,083.65	
		\$1,124,902.31

Museum, Golden Gate Park:

Construction	\$192,025.92	
General Collections	169,176.28	
Library and Equipment.....	111,703.68	
Tools and Equipment.....	39,924.17	
Office Furniture	4,525.38	
		\$ 517,355.43
Investment Securities		15,400.00

Ignatz Steinhart Trust:

Bills Receivable	\$ 10,000.00	
Steinhart Aquarium Construction	263,390.29	
Steinhart Aquarium Equipment.....	27,129.87	
Steinhart Aquarium Revolving Fund.....	5,000.00	
Uninvested cash on hand.....	1,013.35	
		\$ 306,533.51

Current Assets:

Bills Receivable	\$ 17,000.00	
Post Cards in Stock.....	1,422.85	
Cash on hand.....	143.35	
Sundry Accounts	100.00	
		\$ 18,666.20

Total		\$1,982,857.45
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BALANCE SHEET (Continued)

*Liabilities**Endowments:*

James Lick Endowment.....	\$804,902.31	
Charles Crocker Scientific Fund Endowment	20,000.00	
John W. Hendrie Endowment.....	13,600.00	
		\$ 838,502.31

Funds Held for Special Purposes:

Alvord Bequest Botanical.....	\$ 5,000.00	
W. G. Wright Fund.....	18.04	
Wild Life Protection Fund.....	395.80	
Henry M. Holbrook Bequest.....	25.28	
Park Birds Handbook Fund.....	20.00	
		\$ 5,459.12

Reserve for Depreciation	\$ 102,051.56
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Ignatz Steinhart Trust:

Principal	\$250,000.00	
Interest	56,533.51	
		\$ 306,533.51

Notes and Accounts Payable:

Bills Payable.....	\$225,000.00	
Accounts Payable, Sundry Trade Creditors..	1,468.65	
Due Crocker First National Bk. (Overdraft)	4,099.46	
Due Ignatz Steinhart Trust.....	1,013.35	
		\$ 231,581.46
Surplus		498,729.49
		\$1,982,857.45

W. W. SARGEANT,
Secretary, Board of Trustees.

We have examined the foregoing Balance Sheet, together with the books and accounts of the California Academy of Sciences, and in our opinion, it is properly drawn up so as to exhibit a true and correct view of the Academy's affairs, as shown by the books.

MCLAREN, GOODE & Co.,

Certified Public Accountants.

San Francisco, Calif.,
February 9, 1927.

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I

Expedition to the Revillagigedo Islands,
Mexico, in 1925

GENERAL REPORT

BY

G. DALLAS HANNA

Curator, Department of Paleontology



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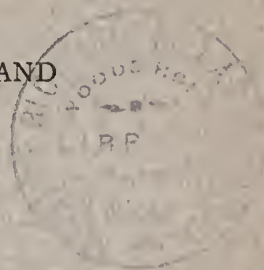
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