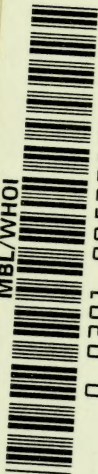


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ALLAN HANCOCK FOUNDATION
PUBLICATIONS
OF
THE UNIVERSITY OF SOUTHERN CALIFORNIA

FIRST SERIES
ALLAN HANCOCK PACIFIC EXPEDITIONS

VOLUME 13
1946-1950



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AND GALAPAGOS ISLANDS IN 1932, IN 1933, IN 1934, IN 1935,
IN 1936, IN 1937, IN 1938, IN 1939, IN 1940, AND IN 1941

THE BRYOPHYTA OF THE ALLAN HANCOCK EXPEDITION OF 1939

By WILLIAM CAMPBELL STEERE



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THE BRYOPHYTA OF THE ALLAN HANCOCK EXPEDITION OF 1939

By WILLIAM CAMPBELL STEERE

The collection of bryophytes brought back by the Allan Hancock Expedition of 1939 is much smaller than that resulting from the 1934 Expedition,¹ and contains no species new to science. However, since Dr. Wm. Randolph Taylor and Mr. Francis H. Elmore collected the specimens in areas little known by botanists, such as the west coast of Costa Rica and Panama, and Socorro Island of the Revillagigedo group (Mexico), it seems worth while to report on them.

The five species of Hepaticae listed below were identified by Dr. Margaret Fulford of the University of Cincinnati, and I wish to acknowledge here my obligation to her. All specimens are deposited in the herbaria of the Allan Hancock Foundation, The University of Southern California, and the University of Michigan, and a set of the Hepaticae are in the possession of Dr. Fulford.

HEPATICAЕ

LEJEUNEACEAE

BRACHIOLEJEUNEA CORTICALIS (Lehm. & Lindenb.) Schiffn.,
Hedwigia 33:180. 1894.

Costa Rica (West Coast): On a large smooth-barked tree in forest, Golfo Dulce; 26 March 1939; *W. R. Taylor No. 39-754*.

Distribution: Florida; West Indies; Central America; northern South America.

CAUDALEJEUNEA LEHMANNIANA (Gottsche) Evans, Bull. Torrey Bot. Club 34:554. 1907.

Costa Rica (West Coast): On twigs in the forest, Golfo Dulce; 26 March 1939; *W. R. Taylor No. 39-753*.

Distribution: Florida; West Indies; Central America; northern South America.

RECTOLEJEUNEA BERTEROANA (Gottsche) Evans, Bull. Torrey Bot. Club 33:12. 1906.

¹ Steere, Mosses of the G. Allan Hancock Expedition of 1934, collected by Wm. R. Taylor. Hancock Pacific Expeditions 3(1):1-12. 1 pl. 1936.

Costa Rica (West Coast): On bark of trees in the forest, Golfo Dulce; 26 March 1939; *W. R. Taylor No. 39-765*.

Distribution: Florida; West Indies; British Honduras. This seems to be the first report of the species from Costa Rica.

STICTOLEJEUNEA KUNZEANA (Gottsche) Schiffn., in Engler & Prantl, Nat. Pflanzenfam. 1(3): 131. 1895.

Costa Rica (West Coast): On bark of trees in forest, Golfo Dulce; 26 March 1939; *W. R. Taylor No. 39-764*.

Distribution: Andes of South America. This seems to be one of the first collections to be reported from Central America.

STICTOLEJEUNEA SQUAMATA (Willd.) Schiffn., in Engler & Prantl, Nat. Pflanzenfam. 1(3): 131. 1895.

Costa Rica (West Coast): On the bark of trees in forest, Golfo Dulce; 26 March 1939; *F. H. Elmore No. 39-759, W. R. Taylor No. 39-760*.

Distribution: West Indies; Central America; northern South America.

MUSCI

FISSIDENTACEAE

FISSIDENS GARBERI Lesq. & James, Proc. Amer. Acad. 14: 137. 1879.

Mexico (West Coast): On soil with a small fern, three-quarters of a mile up the canyon from the landing place, Braithwaite Bay, Socorro Island, Revillagigedo Islands; 18 March 1939; *F. H. Elmore No. 39-751*.

Distribution: Southern United States; West Indies; Mexico; Central America.

CALYMPERACEAE

CALYMPERES DONNELLII Austin, Bot. Gaz. 4: 151. 1879.

Costa Rica (West Coast): On twigs in the forest, Golfo Dulce; 26 March 1939; *F. H. Elmore No. 39-757, W. R. Taylor No. 39-762*.

Trinidad: On branches of *Cacao* plants by the side of the Manzanilla Beach Road; 18-20 April 1939; *W. R. Taylor No. 39-768*.

Distribution: Southern United States; West Indies; Central America; northern South America. In spite of its wide distribution in tropical America, this species has not been previously reported from Costa Rica.

CALYMPERES RICHARDI C. Müll., Syn. Musc. 1: 524. 1849.

Costa Rica (West Coast): Growing high in a tree, among orchids, Port Baker, near Salinas Bay; 24-25 March 1939; *F. H. Elmore No. 39-752*.

Distribution: Southern United States; West Indies; Central America; northern South America. Although this species is widely distributed in the American tropics, it has not been reported before from Costa Rica.

ERPODIACEAE

ERPODIUM DOMINGENSE (Brid.) C. Müll., Bot. Zeit. 1: 774. 1843.

Mexico (West Coast): On soil with a small fern, mixed with *Fissidens Garberi* Lesq. & James, three-quarters of a mile up the canyon from the landing place, Braithwaite Bay, Socorro Island, Revillagigedo Islands; 18 March 1939; *F. H. Elmore No. 39-751a*. Only one small stem of this unmistakable moss was found, but it was enough to establish the identification beyond any doubt.

Distribution: Cameron County, Texas; Santo Domingo; Haiti; Puerto Rico; Yucatán; Guatemala. This is the first collection and report of what has always been considered to be a typically Caribbean species from the Pacific side of Central America.

ORTHOTRICHACEAE

MICROMITRIUM FRAGILE (Mitt.) Jaeg., Adumb. 1: 435. 1872-73.

Trinidad: On branches of *Cacao* plants by the side of the Manzanilla Beach Road; 18-20 April 1939; *W. R. Taylor No. 39-767*.

Distribution: West Indies; Mexico; Central America; tropical South America; Galapagos Islands. Although this species is known from the West Indies, I do not believe that it has been reported previously from Trinidad.

LEUCODONTACEAE

LEUCODONTOPSIS FLORIDANA (Aust.) E. G. Britton, Bryologist 15: 28. 1912.

Trinidad: On branches of *Cacao* plants by the side of the Manzanilla Beach Road; 18-20 April 1939; *W. R. Taylor No. 39-769*.

Distribution: Florida; West Indies; Mexico; Central America; northern South America.



PTEROBRYACEAE

ORTHOSTICHOPSIS TETRAGONA (Hedw.) Broth., in Engler & Prantl, Nat. Pflanzenfam. 1(3):805. 1906.

Panama (West Coast): In forest, Bahia Honda; 26 March 1939; *F. H. Elmore No. 39-755*.

Distribution: West Indies; Mexico; Central America; tropical South America.

METEORIACEAE

PAPILLARIA NIGRESCENS (Hedw.) Jaeg., Adumb. 1:169. 1875-76.

Trinidad: On branches of *Cacao* plants by the side of the Manzanilla Beach Road; 18-20 April 1939; *W. R. Taylor No. 39-766*.

Distribution: Florida; West Indies; Mexico; Central America; tropical South America. This is a common and very widely distributed species.

METEORIOPSIS PATULA (Hedw.) Broth., in Engler & Prantl, Nat. Pflanzenfam. 1(3):825. 1906.

Trinidad: On branches of *Cacao* plants by the side of the Manzanilla Beach Road; 18-20 April 1939; *W. R. Taylor No. 39-768*.

Distribution: Florida; West Indies; Mexico; Central America; tropical South America; Galapagos Islands.

PILOTRICHACEAE

PILOTRICHUM AMAZONUM Mitt., Journ. Linn. Soc., Bot., 12:387. 1869.

Costa Rica (West Coast): On delicate twigs in the forest, Golfo Dulce; 26 March 1939; *W. R. Taylor No. 39-756*; on the bark of trees, *W. R. Taylor No. 39-763*.

Distribution: Amazon region of South America, extending northward through Panama to Guatemala. This is apparently the first report of the species from Costa Rica.

REPORTS OF THE COLLECTIONS OBTAINED BY ALLAN HANCOCK PACIFIC EXPEDITIONS OF
VELERO III OFF THE COAST OF MEXICO, CENTRAL AMERICA, SOUTH AMERICA, AND
GALAPAGOS ISLANDS IN 1932, IN 1933, IN 1934, IN 1935, IN 1936, IN 1937, IN 1938,
IN 1939, IN 1940, AND IN 1941

LAND PLANTS COLLECTED BY THE
VELERO III, ALLAN HANCOCK PACIFIC
EXPEDITIONS 1937-1941

(PLATES 1-15, MAPS 1-3)

By HOWARD SCOTT GENTRY



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Fig. 1. section of branchlet with leaf $\times\frac{1}{2}$.

Fig. 2. pod $\times\frac{1}{2}$.

2. *Moringa oleifera* Lam.

Fig. 3. flower at anthesis $\times 3.3$.

Fig. 4. stamen $\times 11$.

Fig. 5. bud $\times 5$.

Fig. 6. sepal $\times 6.7$.

3. *Echinopepon peninsularis* Gentry

Fig. 7. habit $\times\frac{1}{2}$.

Fig. 8. node $\times 4$.

Fig. 9. fruit prickles $\times 6.5$ to compare with.

Fig. 10. fruit prickles $\times 6.5$ of *Echinopepon minimus*.

4. Fig. 11. View on the north end of Santa Rosa Island. Grassland covers the more level slopes, while bushy perennials are spotted on the bluff. (Photo from the Los Angeles Museum Channel Island Survey)

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5. Fig. 13. Punta Frailes, Cape District, Baja California. The arborescent growth is widely dispersed on the steep rocky slopes, dense on the outwash fans.

6. Fig. 14. Vegetation above Frailes Bay, Cape District. On the basic rock slope the vegetation is sparse and stunted.

Fig. 15. Dense Thorn Forest vegetation in a broad wash near Frailes Bay, Cape District, Baja California.

7. Fig. 16. View southward near Puerto Escondido, Baja California, overlooking a narrow coastal plain with the scarp of the Sierra Giganta in the background. The foreground shows a xerophytic grass ground cover with scattered tree of *Bursera microphylla* and *Lemnaireocereus Thurberi*.

Fig. 17. Canyon above Escondido, Baja California. The steep slopes are brecciated lavas; the palm, *Erythea Brandegeei*.

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Fig. 19. Angel de la Guardia Island. The effect of wind on the sarcophytic tree *Pachycormus discolor pubescens* along a rocky crest.

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15. Fig. 33. Forest of the tierra caliente in the Golfo de Dulce, Costa Rica. The varied tree forms indicate the richness of the flora.

LAND PLANTS COLLECTED BY THE *VELERO III*, ALLAN HANCOCK PACIFIC EXPEDITIONS 1937-1941

(PLATES 1-15, MAPS 1-3)

By HOWARD SCOTT GENTRY

GENERAL INTRODUCTION

The complete itinerary of the voyages of the *Velero III* on the Allan Hancock Pacific Expeditions is given by Fraser (1943). An outline of the land plants secured are given in Table 1. Since the expeditions were primarily concerned with marine biology and especially the collection of marine faunas, the land plant collections were only incidental and are not large. They are samplings of several distinct floral elements of western North America.

(1) Those from the Channel Islands belong to the unique California flora, in one of the five regions of the world having a Mediterranean type of climate. This climate is characterized by winter rainfall, dry summers, and maritime influence conducive to equable temperatures, on-shore winds, and regular seasonal fogs. Cedros Island, off the west coast of middle Baja California, contains in its high elevations a southern outpost of the California flora.

(2) The Sonoran Desert flora is generally peripheral to the Gulf of California. It extends farther south on the peninsula (to the Cape District) than it does on the mainland (to about Guaymas, Sonora). In its area an arid continental type of climate competes with an arid maritime one, the former most evident in the northern part of the region around the lower Colorado River basins, while the latter is particularly steadfast in the middle and southern outer coastal part of the peninsula. While both types have low and irregular rainfalls, the maritime desert differs in having more equable annual and daily temperatures, higher relative humidity, and summer rainfall is more common in the southern latitudes. This latter feature is a tropical factor in the situation.

(3) The Sinaloan subtropical flora is the great transitional element between deserts and tropics. Rainfall is about 90% summer. The high temperatures are ameliorated, particularly through the spring, by on-shore westerlies. The dominating life form is the tree of short to medium

stature, densely spaced, with epiphytes common in the more humid localities. On the mainland of Mexico, the Sinaloan flora occupies the low and middle elevations from southern Sonora south at least to Nayarit. Farther south it is local or transitional with the Central American floral element. The *Velero III* collections from the Tres Marias Islands, the Revilla Gigedo Islands, and the Cape District of Baja California are referable to the Sinaloan flora.

(4) The Central American flora is distinctly tropical under medium to high rainfalls. It contains a very great number of species and is dominated by both evergreen and deciduous trees of medium to tall stature. It is further characterized by broad leaf blades and an abundance of epiphytes. The Pacific part of the area is distinctly arid as compared to the Atlantic, and its coastal forests are mostly deciduous, of medium stature, and are interspersed with areas of savanna. There is a long dry season from November to May. From the standpoint of vegetation there is little to separate the Pacific coast of Costa Rica from the Pacific coast of southern Mexico, since the dominating plant forms and associations apparently extend throughout with but little modification as far north as Nayarit. The *Velero III* collections from coastal Jalisco, Oaxaca, and Costa Rica reflect this general relationship.

The report has been organized according to geographic regions under the following headings: The Channel Islands of California, Cedros and San Benitos Islands, Revilla Gigedo Islands, Tres Marias Islands, The California Gulf Region, Jalisco and Oaxaca, Mexico, and Costa Rica. The desirability of so enumerating these scattered collections, representative of several regions and several floras, is so obvious it is unnecessary to recount them here. Each section is introduced by a general discussion of the physiography, the climate, and the plant geography with special emphasis on the historical or developmental aspects of the flora involved. I have also attempted to evaluate the botanizing that has been done to date on the respective areas, the islands in particular. The discussions are opinionated summaries, according to my experiences and observations in the fields or to reports read, rather than documented conclusions. It is hoped that they will stimulate interest and activity in the richly rewarding botanical field of northwestern Mexico.

As is usual in works of this kind, the author is indebted to many people for their willing assistance in making the report possible. To all of them he extends his sincere thanks. Ira L. Wiggins of Stanford Uni-

versity, E. Yale Dawson and Kenneth O. Emery of the Allan Hancock Foundation and The University of Southern California, and P. A. Munz of the Santa Ana Botanical Garden all read various sections of the manuscript and made valuable criticisms and suggestions. The following taxonomists made determinations in certain genera or families:

S. F. Blake	National Arboretum	Compositae
Elzada Clover	University of Michigan	Cactaceae
L. Constance	University of California	Hydrophyllaceae
E. Y. Dawson	Allan Hancock Foundation	Cactaceae
L. H. Harvey	Montana State University	Gramineae
C. V. Morton	National Herbarium	Pteridophytes
Hugh O'Neill	Catholica University of America	Cyperaceae
R. C. Rollins	Stanford University	Cruciferae
L. C. Wheeler	University of Southern California	Euphorbiaceae
I. L. Wiggins	Stanford University	Malvaceae

NEW NAMES PROPOSED IN THIS PUBLICATION

Agave costaricana Gentry sp. nov.

Agave Shawii sebastiana (Greene) Gentry new comb.

Lyrocarpa linearifolia Rollins sp. nov.

Calliandra Brandegeei (Brit. & Rose) Gentry new comb.

Tephrosia hamata (Rydb.) Gentry new comb.

Dalea variegata (Rydb.) Gentry new comb.

Pachycormus discolor Veatchiana (Kell.) Gentry new comb.

Pachycormus discolor pubescens (Wats.) Gentry new comb.

Echinopepon peninsularis Gentry sp. nov.

Vaseyanthus Palmeri (Wats.) Gentry new comb.

INTRODUCTION TO THE CATALOGUES

In the plan of the catalogues of species collected by members of the Allan Hancock Expeditions, families are listed according to the sequence of the Engler and Prantl system. The genera and species are listed alphabetically under each family. The first entry under the species heading is the citation of collection together with any note that the collector may have left upon his field label. It will be noted also that I have included the date of collection, which I estimate of some importance because it gives a record of the time of flowering or fruiting. In cases where the specimen is sterile, it is either so indicated in parentheses along with specimen citation or is noted in the following paragraph.

TABLE 1
LAND PLANTS COLLECTED BY THE *VELERO III*

Locality and Date	Collector and his numbers	*No. Sp. Col.
1937		
<i>Baja California</i> (outer coast)		
Manuela Lagoon near Lagoon Head Anchorage, March 1.....	Rempel 1-22	25
San Juanico Bay, March 2.....	Rempel 24-52	50
Cabeza Ballena, March 3.....	Rempel 54-74	26
Islands in Pond Lagoon, July 11.....	Rempel 350-355	6
<i>Gulf of California</i>		
Ensenado de los Muertos, Cape District, Baja California, March 5.....	Rempel 76-78	4
San Gabriel Bay, Espiritu Santo Island, March 7.....	Rempel 80-100	30
San Francisco Island, March 9.....	Rempel 101-112	16
Agua Verde Bay, Baja California, March 10.....	Rempel 114-140	34
Puerto Escondido, Baja California, March 13.....	Rempel 141-170	40
Idefonso Island, March 15.....	Rempel 170a-170b	2
West Cove in Concepción Bay, Baja California, March 15.....	Rempel 171-186	17
Island in Concepción Bay, Baja California, March 16.....	Rempel 188-209	25
Tortuga Island, March 17.....	Rempel 210-230	23
Los Angeles Bay, Baja California, March 19, 20.....	Rempel 231-250	21
North end of Los Angeles Bay, Baja California, March 20.....	Rempel 251a-262	12
Puerto Refugio, Angel de la Guardia Island, March 20.....	Rempel 262-280	24
Willard Point, Gonzaga Bay, Baja California, March 23.....	Rempel 283-285	3
North of Point Lobos, Sonora, March 26.....	Rempel 287-288	2
Patos Island, March 26.....	Rempel 290	1
San Esteban Island, March 27.....	Rempel 291-294	6
South end of Tiburon Island, March 27.....	Rempel 295-298	6
San Pedro Nolasco Island, March 29.....	Rempel 300-307	10
Ensenado de San Francisco, Sonora, March 30.....	Rempel 311-315	8
Fraile Bay, Cape District, Baja California, April 4.....	Rempel 317-328	12
<i>Cedros and San Benito Islands</i>		
East side of Cedros Island, July 10.....	Rempel 330-348	19
San Benito Islands, July 14.....	Rempel 356-362	15
West San Benito Islands, July 15.....	Rempel 364-371	8
1938		
<i>Channel Islands</i>		
Middle Island of Anacapa Group, August 1.....	Elmore 220-252	40
Becher Bay, Santa Rosa Island, August 2.....	Elmore 170-215	50
Santa Barbara Island, August 12.....	Elmore 295-310	20
San Miguel Island, Tylers Bight, August 3 and Point Bennett, September 12.....	Elmore 312-341	47
San Clemente Island, February 18, 19.....	Elmore 381-428	53
Santa Catalina Island, February 28.....	Elmore	3

TABLE 1—*Continued*
LAND PLANTS COLLECTED BY THE *VELERO III*

Locality and Date	Collector and his numbers	*No Sp. Col.
1939		
San Clemente Island, February 18, 19.....	Elmore 312-341	47
Santa Catalina Island, February 28.....	Elmore 430-439	15
1941		
Santa Cruz Island:		
Between Pelican Bay and Prisoners Harbor, April 17.....	Elmore 254-293	45
Hill west of Prisoners Harbor, April 17.....	Elmore 440-468	30
1939		
<i>Mexico</i>		
Cedros Island, "Cannery Bay," March 14.....	Elmore A1-A37	80
Revilla Gigedo Islands		
Sulphur Bay, Clarion Island, March 16.....	Elmore B1-B15	50
Braithwaite Bay, Socorro Island, March 18.....	Elmore C1-C11	40
Chacagua Bay, Oaxaca, March 21.....	Elmore D1-D25	130
Tenacatita Bay, Jalisco, May 8.....	Elmore 1A1-1A24	90
Magdalena Island, Tres Marias Group, May 9.....	Elmore 1B1-1B3	10
1939		
<i>Costa Rica</i>		
Port Parker, Salinas Bay, March 24, 25.....	Elmore E1-E-25	115
Golfo de Dulce, March 26.....	Elmore F1-F28	150
Southwest island of Secas Group, March 27.....	Elmore G1-G2	10
1940		
<i>Gulf of California, Mexico</i>		
Guaymas, Sonora, January 23.....	Dawson 1000-1009	45
Tiburon Island, January 25.....	Dawson 1010-1020	28
Puerto Refugio, Angel de la Guardia Island, January 26.....	Dawson 1021-1032	50
San Pedro Nolasco Island, February 6.....	Dawson 1033-1036	20
Pond Island, February.....	Dawson	4
San Esteban Island, February.....	Dawson	6
San Carlos Bay, Sonora, February 8.....	Dawson 1050-1073	90
Near Guaymas, Sonora, February 9.....	Dawson 1074-1084	60
Puerto Escondido, Baja California, February 11.....	Dawson 1085-1109	50
Punta Frailes, Baja California, February 16.....	Dawson 1111-1149	100
San Jose del Cabo, Baja California, February 17.....	Dawson 1150-1225	180

Table 1. The land plant collections made by members of the Allan Hancock Foundation Expeditions in the Eastern Pacific on the *Velero III*, 1937 to 1941.

*No. Sp. Col.=number of specimens obtained, approximate.

In the following paragraph I have noted the distribution of each species generally, drawing upon my notes and travels, upon notes and records furnished me by Dr. Forrest Shreve of the recent Carnegie Desert Laboratory, upon manuscript copy of the "Flora of the Sonoran Desert" under preparation by Dr. Ira Wiggins of Stanford University and which he was generous enough to loan, upon information furnished by Dr. Dawson of the Allan Hancock Foundation regarding cactus distributions, and upon information in publications. The type locality is given if it is known or specific enough to mean anything. Some taxonomic notes on the species or specimen at hand are also offered and in this I have often tried to clarify some of the important characters for specific recognition. The list, however, makes no attempt to be a descriptive flora. I have tried to add to, rather than merely duplicate, information already carried in earlier publications.

The abbreviations used are those that are well established in taxonomic literature with but two exceptions. The first is C.N.H. for Contributions from the United States National Herbarium, rather than Contr. U. S. Nat. Herb., as has been frequently used. In employing this abbreviation I have followed Riley of the Royal Botanic Gardens at Kew (cf. *Flora of Sinaloa*, Kew Bull. 1923-1924).

Proposed here is the abbreviation Brge. for Townsend Seth Brandegee, who did so much pioneer work on the Flora of Baja California, and K. Brge. for Katherine Brandegee, his coworker and wife. T. S. Brandegee has been abbreviated in various ways, viz., T. S. Brandeg., Brandg., and Brand. The first is too long to function as an efficient abbreviation, two digits only having been stricken out, one of which is replaced by the period, leaving a net gain of only one digit. The third is easily confused with Brand. According to the recommendations in article 49 of the International Rules of Nomenclature, Brandegee should be contracted to Brande. However, as an abbreviation this is ineffective since it has eliminated only two digits of a long name. Since none of the above abbreviations are short enough to carry the functional advantage of brevity, Brge. stands for T. S. Brandegee in the following pages.

Trinomials have been briefed to the citation of the varietal author, or authors, only, and are not designated as to subspecies, variety, or form. With very few exceptions the authors have regarded them as varieties. The criteria used to differentiate subspecific entities is quite variably subjective, and particularly meaningless in dealing generally with a wild and incompletely known flora. Subspecific entities can be used effectively

when genetic values are obtained. Hence, pending the genetic stages of taxonomic inquiry into the plants of the regions considered, the nomenclature has been kept simple.

Synonymy is given when required in proposing new names and also in a few cases of special significance.

CHANNEL ISLANDS

INTRODUCTION

The southern California coast from Point Arguello southeastward describes a long shallow irregular curve. The outer margin of the continental shelf, trending more nearly southward, accordingly broadens. Its submarine surface is irregular with submarine valleys and ridges; the topography suggesting land surface rather than sea bottom. The greatest heights of the shelf rise above the sea and form the Channel Islands, bearing the appellations cast upon them by the early Spaniards, San Miguel, Santa Rosa, Santa Cruz, Anacapa, Santa Catalina, Santa Barbara, San Nicolas, and San Clemente. They comprise a residual area of considerable antiquity, which, according to Reed (1933) and other geologists, dates from the Cretaceous. The ratio of sea to land area over the shelf has varied greatly, but during much of the Tertiary this shelf segment actually formed a large land body, known as Catalinia. In the early Miocene and again in the Pleistocene, if not also at other times, Catalinia appears to have been bridged to the continent.

Structurally the islands are separated into two groups. The northern consists of San Miguel, Santa Rosa, Santa Cruz, and Anacapa, representing disjunct segments of the Santa Monica Mountains, which appear to have been more variably emerged and submerged in the sea than has the southern group. The southern group, consisting of Santa Barbara, Santa Catalina, San Nicolas, and San Clemente, have been part of a more consistent land area and are structurally tied to the San Pedro peninsula. The present islandic configuration is the result of geologically recent submergence of all but the higher elevations. The biota of such a land area can be expected to differ considerably from that of the near mainland and actually the evolution of the plants and animals is to be correlated with that of the land. Behind the present configuration of flora and fauna the elusive steps of evolution can be discerned.

The climate of the Channel Islands is Mediterranean in type, semi-arid, and, of course, maritime. The average annual rainfall is around 12 inches, about 90% of which is precipitated in winter (November

through March). The dominating factor is the northwest winds, which pour around the islands for the majority of the days of the year. This increases aridity over what might be expected on the basis of rainfall and temperature (60°F. mean annual) only. However, transpiration and general aridity are tempered by high humidity and frequent fogs. The climate borders on a fog or maritime desert over the southern portion of San Clemente Island, the southern-most of the group.

There is considerable variation in climate locally, both on individual islands and between different islands. This is explainable primarily in terms of the predominating direction of air flow. Physical conditions vary greatly whether a given area is on a windward or leeward side. This is expressed by the vegetation. Windward slopes commonly are covered with grass and forbs (Pl. 4, fig. 11), or stunted wind-tolerant shrubs, while protected slopes support shrub and tree communities. Some of the smaller islands that have been greatly disturbed by man have been nearly denuded of cover and top soil by the erosive action of wind. This is true of San Miguel, which catches the full force of the north-westers, and its sterile mobile sands are being discharged into the lee sea.

The vegetation of the islands has been greatly altered by man. Both the aborigine, who burned and cut the native plants, and the modern European segregates, who burned, cut, cleared, and pastured, have left only remnants of the virgin cover. Many of the native plants are intolerant to grazing, and as they were destroyed, the aggressive weeds were introduced and have persistently spread. While considerable has been published about the flora of the islands, very little is on record regarding the vegetation. The only study of the plant ecology, that I have been able to find, which gives an adequate account of the vegetation is a doctoral thesis by M. B. Dunkle (1944). Between 1939 and 1943 he made repeated visits to the islands and his introductory statement (1944:128-129) is a concise general picture of the island vegetation:

"Varied as are the different islands in topography and climate, they possess certain basic similarities. The western slope of all the islands, except San Nicolas which consists of barren sand dunes in this area, are covered with grasses, low forbs, suffrutescent perennials, and a few low wind-tolerant shrubs. The eastern slopes, except on the smaller islands, are quite generally covered with chaparral, or shrub and tree savannas. The canyons, which afford protection from the wind, usually have more or less shrubby growth on their slopes. This varies from an *Opuntia littoralis* association, through various facies of the coastal sage brush association, to chaparral on the larger islands. On these larger islands, and on

Anacapa, there may be occasional trees in the canyons, and where there is a continuous supply of running water there may be a riparian community with trees or arborescent shrubs. The seaward bluffs have a varied growth of succulents, forbs, suffrutescent perennials, and occasional shrubs. Sand dune vegetation, very similar to that of mainland areas, is present on low dunes back of the few sandy beach areas. On the larger islands the protected north and northeast slopes support scattered groves of trees, while Santa Cruz has an extensive area of woodland."

It is to be expected that such a residual area, representing a considerable area of long though interrupted isolation, would have many endemics in its flora. Of the approximately 950 species and varieties that have been catalogued from the islands, 80 of them are endemic. The original endemic element was undoubtedly reduced during times of the land bridges and migratory exchanges appear to have been made in both directions. Hence, if the apparent migrants from the islands to the mainland were included, the total island endemics would be about 100 species and varieties. Many of the endemics make up the unique plant communities known only on the islands, as the *Pinus* and the *Lyonothamnus* associations among the trees, the shrubby or suffrutescent communities, as the *Coreopsis-Artemisia* association, the *Atriplex-Hemizonia-Lotus-Astragalus* community, the *Echevaria-Eriogonum-Opuntia* community, and the *Eriogonum-Eriophyllum* association forming a low tangle of suffrutescents. As on the mainland, the grasslands are dominantly composed of aggressive introductions and indicate little of the natural virgin climax.

The most exhaustive flora published on the islands is that of Millspaugh and Nuttall (1923) on Santa Catalina Island. Subsequent papers have stressed other islands, as Hoffman (1932) and one has recently catalogued the plants from all of the islands (Eastwood 1941). The following annotated catalogue is based upon the collections secured by Mr. Francis H. Elmore on voyages of the *Velero III* of the Allan Hancock Foundation in 1938, 1939, and 1941, as outlined in Table 1. The complete itinerary of the *Velero III* voyages is given by Fraser (1943). On these and several other works as well, the author has drawn in formulating the collections. Philip A. Munz, an authority on southern California botany (1935), of the Rancho Santa Ana Botanical Garden, has read considerably and criticized the manuscript. No new plants are reported but the collections confirm and add to the distributional knowledge of plants in and about the Channel Islands.

CATALOGUE OF COLLECTIONS

POLYPODIACEAE

PELLAEA ANDROMEDAEFOLIA (Kaulf.) Fee, Gen. Fil. 129. 1850-52.
San Clemente Island, February 18, 19, *Elmore* 383, 413.

In maritime climate up to 4000 feet elevation from Oregon to northern Baja California, and known from the adjacent islands of Santa Catalina, Santa Rosa, and Santa Cruz.

SELAGINELLACEAE

SELAGINELLA BIGELOVII Underw., Bull. Torr. Bot. Club 25:130. 1898.

San Clemente Island, February 18, 19, *Elmore* 398.

Southern half of California west of the deserts and adjacent islands of Santa Rosa, Santa Cruz, and Catalina. Probably also in northern Baja California.

PINACEAE

PINUS RADIATA Don, Trans. Linn. Soc. 17:441. 1836.

Santa Cruz Island, Prisoners Harbor, August 2, *Elmore* 284.

Maritime of central coastal California from Pescadero to Santa Cruz; type from Monterey.

The Santa Cruz Island pines have recently been reviewed by Howell (Leaf. West. Bot. 3:1-7. 1941), who recognized only *P. remorata* Mason in varying forms. Of the authors of California floras, Jepson and McMinn & Maino attribute *P. radiata* to Santa Cruz Island, while Abrams and Munz do not, excepting the doubtful status of *P. radiata binnata* (Engelm.) Lemmon. Hence the Elmore collection was considered critically. The 3-needed leaf fascicles and the light brown, slightly assymmetric, open cone specimens appear to belong definitely to *P. radiata*. Regarding his Santa Cruz Island pine collection, Mr. Elmore has recently written, "I remember well collecting the pine specimens, but as the trees were in a regular grove and near a fence line, I remember thinking at the time that they were probably exotics, having been planted there." (Letter dated February 2, 1948).

PINUS REMORATA Mason, Madrono 2:8-10. 1930.

Santa Cruz Island, Prisoners Harbor, August 2, *Elmore* 290.

Known only from Santa Cruz and Santa Rosa Islands.

GRAMINEAE

DISTICHLIS SPICATA (L.) Greene, Bull. Calif. Acad. Sci. 2:415. 1887.

Santa Cruz Island, Prisoners Harbor, September 14, *Elmore* 289.

On both coasts of North America through the temperate and sub-tropical regions in saline soils and marshes; type from the north Atlantic coast. Also known on Catalina, San Nicolas, San Miguel, and Santa Rosa Islands.

ELYMUS TRITICOIDES Buckl., Proc. Acad. Phil. 1862:99.

San Miguel Island, Tyler Bight, August 3, *Elmore* 317.

Widely distributed in the western United States; type from the Rocky Mountains. Known from San Miguel, Santa Cruz, Santa Rosa, and Santa Catalina Islands.

FESTUCA MEGALURA Nutt., Jour. Acad. Phil. II, 1:188. 1848.

Santa Cruz, hill west of Prisoners Harbor, April 17, *Elmore* 444.

Mostly maritime from British Columbia and Idaho south to Baja California; type locality, Santa Barbara, California. On the islands it is known from Santa Cruz, Santa Rosa, San Miguel, and Catalina.

FESTUCA PACIFICA Piper, C.N.H. 10:12. 1906.

Santa Cruz Island, hill west of Prisoners Harbor, April 17, *Elmore* 454.

Maritime from British Columbia to Baja California and the Channel Islands of San Miguel (Hoffman ??) and San Nicolas.

MONANTHOCLOE LITTORALIS Engelm., Trans. Acad. St. Louis 1:437. 1859.

San Miguel, Tyler Bight, August 3, *Elmore* 318.

Littoral in salt marshes, tidal flats, and strands throughout tropical America and north on the Pacific coast to Santa Barbara; type from Texas. The only other records from the Channel Islands are from Catalina.

POLYPOGON MONSPELIENSIS (L.) Desf., Fl. Atlant. 1:67. 1798.

Santa Rosa, Becher Bay, August 3, *Elmore* 193. Santa Cruz, Prisoners Harbor Canyon, September 14, *Elmore* 267.

Introduced from Europe, common now from Alaska to Mexico along the coast. Also on Santa Catalina, San Miguel, San Nicolas, and Santa Cruz Islands.

CYPERACEAE

SCIRPUS CALIFORNICUS (Meyer) Brit., Trans. N. Y. Acad. 2:80. 1892.

Santa Cruz Island, Prisoners Harbor, September 14, *Elmore* 293.

From California to Florida across southern United States and south through tropical America to South America; type from California. It is not known from any other of the Channel Islands.

LILIACEAE

BRODIAEA CAPITATA Benth., Pl. Hartw. 339. 1857.

San Clemente Island, February 18, 19, *Elmore* 391.

Common through the coast ranges from southern Oregon to northern Baja California. On all the Channel Islands.

FAGACEAE

QUERCUS AGRIFOLIA Nee, Anal. Cien. Nat. 3:271. 1801.

Santa Cruz, Prisoners Harbor, September 14, *Elmore* 273.

Maritime climate of the coast ranges from Mendocino County, California south to San Pedro Martir Mountains of northern Baja California. Also known from Santa Rosa Island.

QUERCUS DUMOSA Nutt., Silva 1:7. 1842.

Santa Cruz, Prisoners Harbor Canyon, September 14, *Elmore* 283.

Mostly in the chaparral of the Lower Sonoran Life Zone from northern California south into Baja California; type from Santa Barbara. Also on Santa Rosa and Catalina Islands.

URTICACEAE

URTICA HOLOSERICEA Nutt., Jour. Acad. Phil. II, 1:183. 1847.

Santa Cruz, Prisoners Harbor Canyon, August 2, *Elmore* 258, dry river bed.

From Washington and Idaho south to Baja California; type locality, Monterey, California. Also on Santa Catalina Island.

POLYGONACEAE

ERIOGONUM ARBORESCENS Greene, Bull. Calif. Acad. Sci. 1:11. 1884.

Middle island of Anacapa group, August 1, *Elmore* 234, steep rocky slope.

Canyon walls and steep slopes on the California Islands of Santa Rosa, Santa Cruz, and Anacapa; type from Santa Cruz Island.

ERIOGONUM GIGANTEUM Wats., Proc. Am. Acad. Sci. 20:371. 1885.

Santa Barbara Island, August 12, *Elmore* 306, dry hillside.

In canyons and on bluffs on the islands of Santa Cruz, San Clemente, and Santa Catalina; type from the latter. Elmore's collection from Santa Barbara is apparently the first citation for that island.

ERIOGONUM GRANDE Greene, Pittonia 1:38. 1887.

Middle island of Anacapa group, August 1, *Elmore* 232, steep rocky slope.

Southern California and the Channel Islands; the type from Santa Cruz. It appears to be lacking only on San Nicolas Island.

ERIOGONUM RUBESCENS Greene, Pittonia 1:39. 1887.

San Miguel Island, Tyler Bight, August 3, *Elmore* 321. Point Bennett, September 12, *Elmore* 334. San Miguel Island, August 10, *Elmore* 325.

Known only from the Channel Islands of Santa Cruz, Santa Rosa, Santa Catalina, San Clemente, and San Miguel.

This plant is closely related to *E. grande* Greene, to which it has been referred as a variety by some authors. Numbers 325 and 334 are atypical in the densely flocculose tomentum of the involucre and the compact cymose head-like inflorescences. They may represent a hybrid form, a condition also indicated by the tendency of the mature involucre to double their number of teeth.

The interesting genus *Eriogonum* shows considerable specific and subspecific variation and in this it appears to be expressive of environmental differences. Hence, since environments have varied in the geologic past, the present segregates of *Eriogonum* would be reactive products. A cytogenetic study of the genus might find physiographic correlatives in insular evolution. Who will make it?

POLYOGONUM AVICULARE L., Sp. Pl. 362. 1753.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 213.

A cosmopolitan weed native of Eurasia; on Santa Rosa and Santa Catalina Islands also.

CHENOPODIACEAE

ATRIPLEX LEUCOPHYLLA (Moq.) Dietr. in DC., Prodr. 132:109. 1849.

Middle island of Anacapa group, August 1, *Elmore* 237, steep rocky slope.

A littoral halophyte from Humboldt Bay, California to Vizcaino Bay, Baja California; type from California.

SALICORNIA SUBTERMINALIS Parish, *Erythea* 6:87. 1898.

San Clemente, February 18, 19, *Elmore* 402.

Salt marshes along the coast from San Francisco Bay, California to Sinaloa, Mexico; occasional in saline soils of the interior valleys; type from the San Jacinto River, California. On the Channel Islands of San Miguel, Santa Rosa, Santa Cruz, Santa Catalina, and San Clemente. Also collected at Avila, Port San Luis, near San Luis Obispo, August 4, *Elmore* 402.

SUAEDA CALIFORNICA Wats., *Proc. Am. Acad. Sci.* 9:89. 1874.

San Clemente Island, February 18, 19, *Elmore* 403.

Salt marshes from San Francisco, California to northern Baja California; type from San Francisco Bay. On Santa Cruz, Santa Catalina, Anacapa, and San Nicolas Islands.

SUAEDA TAXIFOLIA Standl., *N. Am. Fl.* 21:91. 1916.

Santa Barbara Island, August 12, *Elmore* 302, dry hillsides.

Salt marshes along the coast from Santa Barbara County to Los Angeles County; type from Playa del Rey.

Some of the collections reported from the islands as *S. californica* may rightly belong to this species. It has not previously been listed from the islands. Elmore's collection compares favorably with mainland material reviewed by the author.

CHENOPODIUM MURALE L., *Sp. Pl.* 219. 1753.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 178.

A cosmopolitan weed naturalized from Europe. On all of the Channel Islands.

NYCTAGINACEAE

ABRONIA ALBA Eastw., *Proc. Calif. Acad. Sci.* III, 1:97. 1898.

San Miguel Island, Tyler Bight, August 2, *Elmore* 232. Point Bennett, September 12, *Elmore* 339. San Miguel Island, August 10, *Elmore* 330a.

Insular. In addition to San Miguel Island it is also known from San Nicolas, Santa Rosa, and San Clemente Islands.

ABRONIA MARITIMA Nutt. ex Wats., *Bot. Calif.* 2:4. 1880.

Middle island of Anacapa group, August 1, *Elmore* 243. San Clemente Island, February 18, 19, *Elmore* 381. San Miguel Island, Point Bennett, September 12, *Elmore* 340.

Sandy sea strands from San Luis Obispo County south to Baja California and Sinaloa, Mexico; type from San Pedro, California.

HESPERONIA LAEVIS (Benth.) Standl., C.N.H. 12:363. 1909.

San Clemente Island, February 18, 19, *Elmore* 415, 328.

Coast ranges and adjacent islands from Monterey County south to central Baja California; type from Magdalena Bay, Baja California.

AIZOACEAE

MESEMBRYANTHEMUM CHILENSE Molina, Sagg. Chile ed. 2:133. 1810.

San Miguel, Tyler Bight, August 3, *Elmore* 316.

Coastal, common on bluffs and sandy soils from Oregon to northern Baja California; type from Chile. Also reported from Australia and Tasmania.

MESEMBRYANTHEMUM NODIFLORUM L., Sp. Pl. 480. 1753.

San Clemente Island, February 18, 19, *Elmore* 406. Santa Barbara Island, August 12, *Elmore* 310.

Native of South Africa and the Mediterranean region; introduced and now common along the shores of southern California and northern Baja California. It has been collected on all the Channel Islands except Santa Cruz. This small mat plant is the least conspicuous and showy of the adventive *Mesembryanthemum*.

PORTULACACEAE

MONTIA PERFOLIATA (Donn.) Howell, Erythea 1:38. 1893.

San Clemente Island, February 18, 19, *Elmore* 418.

A hydrophytic shade-tolerant herb widely distributed through western North America north of Mexico.

CARYOPHYLLACEAE

SILENE GALLICA L., Sp. Pl. 417. 1753.

Santa Cruz Island, hill west of Prisoners Harbor, April 17, *Elmore* 456.

A common weed naturalized from Europe; known on all the Channel Islands.

SILENE LACINIATA Cav., Ic. Pl. 6:44. 1801.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 206. Middle island of Anacapa group, August 1, *Elmore* 239.

Widely distributed in the mountains of western North America from central California and western Texas south to southern Mexico; type from Mexico. In addition to the above cited islands, it is also known on Santa Cruz and San Miguel Islands.

SPERGULARIA MACROTHECA (Hornem.) Heynh., Nomen. 2:689. 1840.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 189.

Saline soils near the coast from Washington to Baja California; type from California.

PAPAVERACEAE

ESCHSCHOLTZIA CALIFORNICA Cham. var., in Nees Hor. Phys. Ber. 73. 1920.

Santa Rosa, Becher Bay, August 2, *Elmore* 187, on dry hillsides.

The material is not sufficient for certain identification. It may be the same as the collection annotated by Hoffman (Bull. So. Calif. Acad. Sci. 31:102. 1932) as *Eschscholtzia* sp. He stated that it is an annual with clear yellow flowers on Santa Cruz Island. On the basis of fruit and receptacle, however, I have no hesitancy in assigning it to the *E. californica* complex, which is so well known for its variability. It differs from *E. californica maritima*, the common variety of the islands, in the non-glaucous and longer-lobed leaves, and the reduced stature.

ESCHSCHOLTZIA CALIFORNICA MARITIMA Jep., Man. Fl. Pl. Calif. 402. 1925.

San Miguel Island, August 10, *Elmore* 329. Tyler Bight, August 3, *Elmore* 320. Point Bennett, September 12, *Elmore* 337.

Endemic to the Channel Islands where it is known from Santa Cruz, Santa Rosa, and San Miguel, the latter island, according to Hoffman, having the most widely dispersed population.

PLATYSTEMON CALIFORNICUS Benth., Trans. Hort. Soc. Lond. II, 1:405. 1835.

Santa Cruz Island, hill west of Prisoners Harbor, April 17, *Elmore* 458.

Widely distributed in western United States; also in northern Baja California.

CRUCIFERAE

LEPIDIUM LASIOCARPUM Nutt. in Torr. & Gray, N. Am. Fl. 1:115. 1838.

San Clemente Island, February 18, 19, *Elmore* 401.

Widely distributed in the southwestern United States and northern Mexico; type from near Santa Barbara, California. It has been collected on nearly all of the other Channel Islands. The above cited collection consists of several depauperate specimens, 6-8 cm high, fruiting, and are the first taken from San Clemente.

CAULANTHUS INFLATUS Wats., Proc. Am. Acad. Sci. 17:364. 1882.

Santa Cruz Island, hill west of Prisoners Harbor, April 17, *Elmore* 453.

The known range of this plant is from the Mojave Desert in California and Nevada and thence westward to the more arid localities in the San Joaquin Valley and Monterey County; type from the Mojave Desert, California. It has never before been reported from the Channel Islands, and in so far as it is a desert plant, Elmore's collection from the maritime habitat is open to question. There was no accompanying note of locality in the field sheet, as there was in the majority of them, but it was in with the sheets in the packet of plants marked from Santa Cruz Island.

CRASSULACEAE

DUDLEYA GREENEI Rose, Bull. N. Y. Bot. Gard. 3:17. 1903.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 180.

Rocks and cliffs near the sea in southern California and on Santa Cruz, Santa Rosa, and San Miguel Islands.

DUDLEYA FARINOSA (Lindl.) Brit. & Rose, Bull. N. Y. Bot. Gard. 3:27. 1903.

San Miguel Island, Tyler Bight, August 3, *Elmore* 314, dry hillside.

Along the coast of northern and central California. The above cited collection is the first known record of the species in the Channel Islands. It agrees well with mainland material.

CROSSOSOMATACEAE

CROSSOSOMA CALIFORNICUM Nutt., Jour. Acad. Phil. II, 1:150. 1847.

Santa Catalina Island, February 29, *Elmore* 437.

Southern California, Baja California and adjacent islands; type from Santa Catalina Island. Also on San Clemente.

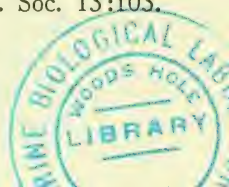
ROSACEAE

LYONOTHAMNUS FLORIBUNDUS ASPLENIFOLIUS (Greene) Brge., Zoe 1:136. 1890.

Santa Cruz Island, ranch yard in Central Valley, August 2, *Elmore* 255.

Endemic to the islands, Santa Cruz, Santa Rosa, and San Clemente.

PHOTINIA ARBUTIFOLIA (Ait.) Lindl., Trans. Linn. Soc. 13:103. 1821.



Santa Cruz, Prisoners Harbor Canyon, September 14, *Elmore* 269.
Santa Rosa Island, Becher Bay, August 2, *Elmore* 210.

Widely distributed in the Upper Sonoran Zone of California; type from Monterey, California. Known also from the islands San Miguel, Santa Catalina, San Nicolas, and San Clemente. *Elmore* 269 from Santa Cruz Island has small, subentire, proximate leaves on short diffuse twigs making a compact crown of foliage indicative of an arid situation.

PHOTINIA ARBUTIFOLIA MACROCARPA Munz, Bull. So. Calif. Acad. Sci. 31:64. 1932.

San Clemente Island, February 18, 19, *Elmore* 421.

Known previously only from Santa Catalina Island.

PRUNUS LYONI (Eastw.) Sarg., Pl. Wilson. 74. 1911.

Santa Cruz Island, Prisoners Harbor Canyon, September 14, *Elmore* 271, rocky hillside.

Endemic to the islands, Santa Cruz, Santa Rosa, Santa Catalina, and San Clemente; the type from Santa Catalina.

ROSA GRATISSIMA Greene, Fl. Fran. 73. 1891.

Santa Cruz Island, hill west of Prisoners Harbor, April 17, *Elmore* 447.

Central Sierra Nevada to southern California; type from the mountains of Kern County. Not previously credited to the Channel Islands, but the few weak straight spines, the spatulate-tipped sepals, and the nature of the stipules appear to relate the above-cited collection with the *R. gratissima* complex rather than with *R. californica*.

LEGUMINOSAE

ASTRAGALUS LEUCOPSIS Torr. & Gray, N. Am. Fl. 1:344. 1838.

Middle island of Anacapa group, August 1, *Elmore* 252, steep rocky slopes. San Miguel Island, Tyler Bight, August 3, *Elmore* 319.

Upper and Lower Sonoran Life Zones from Santa Barbara County south into northern Baja California; type from Santa Barbara, California. Also reported from Santa Barbara and Santa Catalina Islands.

ASTRAGALUS NEVINII Wats., Proc. Am. Acad. Sci. 21:412. 1886.

San Clemente Island, February 18, 19, *Elmore* 395.

Known only from the Channel Islands of Santa Catalina, Santa Barbara, Anacapa, and the type locality, San Clemente.

LOTUS DENDROIDEUS (Greene) Greene, Pittonia 2:148. 1890.

Santa Rosa Island, August 2, *Elmore* 196, dry canyon wall.

Endemic to the Channel Islands of Santa Catalina, Santa Cruz, Santa Rosa, and Anacapa; type from Santa Cruz.

LOTUS NIVEUS (Greene) Greene, Pittonia 2:148. 1890.

San Clemente Island, February 18, 19, *Elmore* 409.

Known only from Santa Cruz and San Clemente Islands.

Referred here is *Elmore* 410, a sterile shrubby perennial 2-4 dm high with silvery sericeous twigs, spikoid foliage, also densely silvery tomentose, with 3 ovate-lanceolate leaflets 10-15 mm long.

LOTUS ORNITHOPUS Greene, Bull. Calif. Acad. Sci. 1:185. 1885.

San Clemente Island, February 18, 19, *Elmore* 392.

Southern California, northern Baja California and adjacent islands; type from Guadalupe Island off Baja California.

LUPINUS SPARSIFLORUS Benth., Pl. Hartw. 303. 1848.

Santa Cruz Island, hill west of Prisoners Harbor, April 17, *Elmore* 446.

Widely scattered in southern California and in adjacent Baja California.

TRIFOLIUM MICROCEPHALUM Pursh, Fl. Am. Sept. 2:478. 1814.

Santa Cruz Island, hill west of Prisoners Harbor, April 17, *Elmore* 441.

Open grassy slopes from British Columbia to Baja California and east to Nevada; type from Bitter Root River, Montana. On San Miguel, Santa Rosa, Santa Catalina, and San Clemente Islands.

TRIFOLIUM TRIDENTATUM ACICULARE (Nutt.) McDermott, N. Am. Trifol. 26. 1910.

Santa Cruz Island, rock slide between Pelican Bay and Prisoners Harbor, April 17, *Elmore* 465.

Central valley of California, cismontane southern California, and adjacent islands; type from Santa Barbara. Also on Santa Rosa and San Clemente Islands.

OXALIDACEAE

OXALIS CERNUA Thunb., Diss. Oxal. 14. 1781.

San Clemente Island, February 18, 19, *Elmore* 423.

Naturalized from southern Africa and now common in cismontane southern California; on the Channel Islands it has previously been listed from Santa Catalina only.

EUPHORBIACEAE

EREMOCARPUS SETIGERUS (Hook.) Benth., Bot. Voy. Sulph. 53. 1844.

Santa Cruz Island, Prisoners Harbor Canyon, August 2, *Elmore* 259, dry river bed.

Common in wasteland and fallow fields from Washington to southern cismontane California. Known also on Santa Rosa, Santa Catalina, and San Clemente Islands.

ANACARDIACEAE

RHUS INTEGRIFOLIA (Nutt.) Benth. & Hook. ex Wats. in Wheeler, Rep. U.S. 100th Merid. 6:84. 1878.

Santa Catalina Island, February 29, *Elmore* 439. San Clemente, February 18, 19, *Elmore* 394. Santa Cruz Island, Prisoners Harbor Canyon, September 14, *Elmore* 275. Anacapa Island, August 1, *Elmore* 224.

Maritime southern California and northern Baja California and adjacent islands from Santa Barbara to Cedros Island; type from San Diego, California. Known from all the Channel Islands except San Nicolas.

TOXICODENDRON DIVERSILOBIUM (Torr. & Gray) Greene, Leaflet 1:119. 1905.

Santa Cruz Island, Prisoners Harbor Canyon, September 14, *Elmore* 265, dry rocky hillside.

Common along the Pacific coast below 4000 feet from Washington through California and south in the mountains of northern Mexico to Sinaloa. Known also from San Miguel, Santa Rosa, and Santa Catalina Islands.

MALVACEAE

LAVATERA ASSURGENTIFLORA Kell., Proc. Calif. Acad. Sci. 1:14. 1854.

Santa Catalina Island, Indian Rock in Emerald Cove, February 29, *Elmore* 435. Santa Rosa, Becher Bay, August 2, *Elmore* 191, dry hillside.

Native of the Channel Islands, apparently originally lacking only on San Nicolas, escaped and cultivated on the adjacent mainland.

SIDALCEA MALVAEFLORA (DC.) Gray ex Benth., Pl. Hartw. 300. 1848.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 181, wall of wet ravine.

Cismontane southern California to northern California and on the islands of Santa Rosa, San Miguel, Santa Cruz, and Catalina.

FRANKENIACEAE

FRANKENIA GRANDIFOLIA C. & S., *Linnaea* 1:35. 1826.

Middle island of Anacapa group, August 1, *Elmore* 250.

Along the coast from central California south to northern Baja California and on the adjacent islands of Anacapa, San Miguel, Santa Rosa, Santa Cruz, and Santa Catalina.

CACTACEAE

OPUNTIA LITTORALIS (Engelm.) Cockr., *Bull. So. Calif. Acad. Sci.* 4:15. 1905.

San Clemente Island, February 18, 19, *Elmore* 382. Santa Cruz, Prisoners Harbor Canyon, September 14, *Elmore* 279, rocky hillside. Middle island of Anacapa group, August 1, *Elmore* 245, steep rocky slope.

Along the coast from Santa Barbara to northern Baja California and on the adjacent islands; the exact type locality is not known. Eastwood (1941:67) also reports it from Santa Barbara, San Nicolas, and Santa Rosa Islands.

The above series of specimens, particularly *Elmore* 382 from San Clemente, are atypical of the mainland plants in the more orbicular pads (rather than ovate) and in the straightness of their spines.

ONAGRACEAE

OENOTHERA CHIERANTHIFOLIA Hornem. ex Spreng. *Syst.* 2.228

San Miguel Island, August 10, *Elmore* 331. Tyler Bight, August 3, *Elmore* 313. Point Bennett, September 12, *Elmore* 335. Santa Rosa Island, Becher Bay, August 2, *Elmore* 209, sandy hill slope.

Sea beaches from Oregon to southern California and adjacent islands. Not listed from San Clemente and Anacapa, but apparently common on all the others.

ZAUSCHNERIA CALIFORNICA VILLOSA Jeps., *Man. Fl. Pl. Calif.* 667. 1925.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 183, dry hillside.

Stated by Jepson to be in southern California. It is known from the islands of Santa Cruz, San Clemente, and Santa Catalina, and may originally have been an island endemic.

UMBELLIFERAE

FOENICULUM VULGARE (L.) Gaertn., *Fr. Sem.* 1:105. 1788.

Santa Cruz Island, Prisoners Harbor Canyon, August 2, *Elmore* 254, dry river bed.

A naturalized weed from Europe and now widely dispersed in western North America and in South America. It is also listed from Santa Rosa and Santa Catalina Islands.

SANICULA ARGUTA Greene ex Coult. & Rose, C.N.H. 7:36. 1900.
Santa Cruz Island, hill west of Prisoners Harbor, April 17, *Elmore* 462.

Southern California and the adjacent islands of San Nicolas, Santa Catalina, San Clemente, and Santa Cruz.

PRIMULACEAE

ANAGALLIS ARVENSIS L., Sp. Pl. 148. 1753.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 208, grassy hillside.

Weed naturalized from Europe and widely scattered in western North America. Known on the Channel Islands of San Miguel, Santa Cruz, Santa Catalina, and Santa Rosa.

GENTIANACEAE

CENTAURIUM VENUSTUM (Gray) Robs., Proc. Am. Acad. Sci. 45: 397. 1910.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 204, grassy hillside.

From northern Baja California to Butte County, California where it is common along the coast and rarely in the desert. Known also from Santa Cruz and Santa Catalina Islands. Elmore's collection appears to be the first from Santa Rosa Island.

CONVOLVULACEAE

CONVOLVULUS OCCIDENTALIS CYCLOSTEGIUS (House) Jeps., Man. Fl. Pl. Calif. 776. 1925.

Santa Barbara Island, August 12, *Elmore* 313, climbing on shrubs in dry canyon. San Clemente Island, February 18, 19, *Elmore* 396. Santa Cruz Island, Prisoners Harbor, August 2, *Elmore* 282.

Coastal from San Francisco Bay to southern California. Its insular distribution has previously been reported only on Santa Catalina Island.

POLEMONIACEAE

GILIA AFF. *MULTICAULIS* Benth., Bot. Reg. 19: t. 1622. 1833.

Santa Cruz Island, hill west of Prisoners Harbor, April 17, *Elmore* 440.

Common in cismontane southern California and reported also from Catalina.

BORAGINACEAE

AM SINCKIA INTERMEDIA Fisch. & Mey., Ind. Sem. Hort. Petrop. 2:26. 1836.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 212, dry hillside.

Widely scattered in California, northern Baja California, Arizona, and on the Channel Islands.

CRYPTANTHA CLEVELANDII Greene, Pittonia 1:117. 1887.

San Miguel Island, Tyler Bight, August 3, *Elmore* 312.

Maritime, from northern Baja California to Santa Barbara, California and the Channel Islands of Santa Catalina, Santa Cruz, and San Miguel; type from the hills above San Diego, California.

HELIOTROPIUM CURASSAVICUM L., Sp. Pl. 130. 1753.

Middle island of Anacapa group, August 1, *Elmore* 222, steep rocky slope. Santa Cruz Island, Prisoners Harbor Canyon, September 14, *Elmore* 277, rocky edge of salty pool. San Miguel Island, August 10, *Elmore* 328.

Widely dispersed in saline lowland soils of tropical and subtropical America.

PECTOCARYA LINEARIS FEROCULA Jtn., Contr. Arn. Arb. 3:95. 1932.

Santa Cruz Island, hills west of Prisoners Harbor, April 17, *Elmore* 463.

Cismontane southern California from Ventura south into Baja California and the adjacent islands.

VERBENACEAE

VERBENA ROBUSTA Greene, Pittonia 3:309. 1898.

Santa Cruz Island, Prisoners Harbor, September 14, *Elmore* 291, along edge of swamp.

San Diego County and the Channel Islands of San Miguel, Santa Rosa, Santa Cruz, Santa Catalina, and San Clemente. Apparently originated on Catalina and migrated to the mainland.

LABIATAE

MARRUBIUM VULGARE L., Sp. Pl. 583. 1753.

San Clemente Island, February 18, 19, *Elmore* 417.

Weed naturalized from Europe, widely scattered across North America and on all the Channel Islands except San Nicolas and Anacapa.

SALVIA BRANDEGEI Munz, Bull. So. Calif. Acad. Sci. 31:69. 1932.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 194, dry canyon wall.

Endemic to Santa Rosa Island.

SOLANACEAE

LYCIUM CALIFORNICUM Nutt. in Gray, Bot. Calif. 1:542. 1876.

Santa Barbara Island, February 12, *Elmore* 295, forming thickets in dry fields. San Clemente Island, February 18, 19, *Elmore* 397.

Cismontane southern California and south along the coast to central Baja California, type from San Diego. In addition to the above listed Channel Islands it is also reported from Santa Catalina. Dunkle (1944) reports it as characteristic of the grassland on Santa Barbara Island, where it forms a biome with *Suaeda* and the gull *Larus*.

PETUNIA PARVIFLORA Juss., Ann. Mus. Paris 2:216, t. 47. 1803.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 170, sandy hills.

Widely distributed in the moist sandy soils of southern United States and tropical America. On the Channel Islands it is known only from Santa Rosa.

SOLANUM CLOKEYI Munz, Bull. So. Calif. Acad. Sci. 31:69. 1932.

Santa Cruz Island, rock slide between Pelican Bay and Prisoners Harbor, April 17, *Elmore* 467.

Endemic to Santa Cruz Island.

SOLANUM DOUGLASII Dunal, in DC., Prodr. 13, 1:48. 1852.

Santa Catalina Island, February 28, *Elmore* 438.

Cismontane southern California and the Channel Islands of San Miguel, Santa Rosa, Santa Cruz, Santa Catalina, and San Clemente.

SOLANUM VILLOSUM (L.) Mill., Gard. Dict. ed. 8, n. 2.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 200, dry canyon walls. San Clemente Island, February 18, 19, *Elmore* 420.

A European weed adventive in southern California. Not previously reported from the Channel Islands.

SCROPHULARIACEAE

CASTILLEJA ANACAPENSIS M. B. Dunkle, Bull. So. Calif. Acad. Sci. 41:135. 1942.

Middle island of Anacapa group, August 1, *Elmore* 230, steep rocky slope.

Endemic to Anacapa Island.

CASTILLEJA HOLOLEUCA Greene, Pittonia 1:38. 1887.

Middle island of Anacapa group, August 1, *Elmore* 226, steep rocky slope.

Endemic to the islands of San Miguel, Santa Rosa, Santa Cruz, and Anacapa.

CASTILLEJA LATIFOLIA Hook. & Arn., Bot. Beech. Voy. 154. 1839-40.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 172, 174, sandy hills.

From Monterey County to northern California and on the islands of Santa Rosa and Santa Cruz. The flowers are reported as being normally red, but *No. 174* was noted by the collector as having yellow flowers.

CASTILLEJA MOLLIS Penn., Proc. Acad. Nat. Sci. Phil. 99:185. 1947.

San Miguel Island, August 10, *Elmore* 333. Point Bennett, September 12, *Elmore* 341.

CASTILLEJA SP.

San Clemente Island, February 18, 19, *Elmore* 384, 411.

The material is too young for certain determination. It is a low shrubby or suffrutescent plant with sordid pubescence, linear attenuate bracts and leaves, both of which are irregularly lobed.

DIPLACUS LONGIFLORUS Nutt. in Taylor's Ann. Nat. Hist. 1, 1:139. 1838.

Santa Cruz Island, Prisoners Harbor, August 2, *Elmore* 261, rocky hillside.

Common on the cismontane and chaparral slopes of southern California and on Santa Rosa, Santa Cruz, and Catalina Islands. Also in northern Baja California.

DIPLACUS PARVIFLORUS Greene, Pittonia, 1:36. 1887.

Santa Rosa Island, Becher Bay, August 2, *Elmore* 185, dry hillside. Santa Cruz Island, rock slide between Pelican Bay and Prisoners Harbor, April 17, *Elmore* 464.

Apparently limited to Santa Cruz and Santa Rosa Islands.

MIMULUS GUTTATUS DEPAUPERATUS (Gray) Grant, Ann. Mo. Bot. Gard. 11:170. 1924.

Santa Cruz Island, Prisoners Harbor Canyon, August 2, *Elmore* 257, dry stream bed.

Widely dispersed in the western United States. This variety has not previously been reported from the islands and the fragmentary material is doubtfully referred here.

LINARIA CANADENSIS TEXANA (Scheele) Penn., Proc. Acad. Phil. 73:502. 1922.

Santa Cruz Island, hill west of Prisoners Harbor, April 17, *Elmore* 461.

Widely distributed in both North and South America. On the Channel Islands it is known from San Miguel, Santa Rosa, Santa Catalina, and Santa Cruz.

ORTHOCARPUS PURPURASCENS Benth., Scroph. Ind. Introd. 13. 1835.

Santa Cruz Island, hill west of Prisoners Harbor, April 17, *Elmore* 459, 460.

Common along the coast from central California to northern Baja California and the adjacent islands of San Nicolas, San Miguel, Santa Rosa, Santa Cruz, and Santa Catalina.

CUCURBITACEAE

MARAH FABACEA (Naud.) Greene, Pittonia 2:129. 1890.

San Clemente Island, February 18, 19, *Elmore* 422, 386.

The Channel Islands and mainland from Monterey north to Sonoma County, California.

COMPOSITAE

ACHILLEA MILLEFOLIUM LANULOSA (Nutt.) Piper, Mazama 2:97. 1901.

Santa Barbara Island, August 12, *Elmore* 308, dry hillside.

From the mountains to the coast in southern California and northern Baja California and on all the Channel Islands.

ARTEMESIA CALIFORNICA Less., Linnaea 6:523. 1831.

Middle island of Anacapa group, August 1, *Elmore* 228, steep rocky slope.

Common and widespread on slopes and mesas of the Upper Sonoran from central California to northern Baja California and the adjacent islands. It is one of the strongly successful elements in and about chaparral. With a stable population it is quickly adventive on new habitats, and was doubtless migratory on the Tertiary land bridges.

BACCHARIS DOUGLASH DC., Prodr. 5:400. 1836.

Santa Cruz Island, Prisoners Harbor Canyon, September 14, *Elmore* 281, dry stream bed.

Mostly coastal from San Francisco south to northern Baja California and the adjacent islands of Santa Rosa, Santa Cruz, and Santa Catalina. It is tolerant of new immature soils and apparently has a strong potential as a migrant in new areas of Mediterranean climate type.

BACCHARIS PILULARIS CONSANGUINEA (DC.) O. Kuntze, Rev. Gen. Pl. 1:319. 1891.

Prisoners Harbor Canyon, Santa Cruz Island, September 14, *Elmore* 285, dry rocky hillside.

Coastal from Oregon to southern California and the adjacent islands of Santa Rosa, Santa Cruz, and Catalina.

BACCHARIS PLUMMERAE Gray, Proc. Am. Acad. Sci. 15:48. 1880.

Prisoners Harbor Canyon, September 14, *Elmore* 287, dry rocky hillside.

Santa Cruz Island and the adjacent mainland.

BAERIA CHRYSOSTOMA GRACILIS Hall, U. C. Publ. Bot. 3:170. 1907.

Hill west of Prisoners Harbor, Santa Cruz Island, April 17, *Elmore* 468. San Clemente Island, February 18, 19, *Elmore* 400.

Common on Pacific slopes from Oregon south to northern Baja California and listed (by Eastwood 1941:75 under *Baeria Palmeri clementina*) from San Nicolas, San Miguel, Santa Rosa, Santa Cruz, and San Clemente Islands. A quick annual in a genus developmentally responsive to the semi-arid climates of both maritime and continental types.

COREOPSIS GIGANTEA (Kell.) Hall, U. C. Publ. Bot. 3:142. 1907.

Santa Barbara Island, August 21, *Elmore* 297, dry canyon walls and rocky hillside. Catalina Island, February 28, *Elmore* 436.

Coastal bluffs from San Luis Obispo County south to the Santa Monica Mountains and on all the Channel Islands. Apparently evolved on Catalina and recently migratory to the mainland.

CORETHROGYNE FILAGINIFOLIA ROBUSTA Greene, Pittonia 1:89. 1887.

Middle island of Anacapa group, August 1, *Elmore* 220, steep rocky slope.

The variety is endemic to the islands San Miguel, Santa Rosa, Santa Cruz; not previously known from Anacapa.

ENCELIA CALIFORNICA Nutt., Trans. Am. Phil. Soc. II, 7:357. 1841.
San Clemente Island, February 18, 19, *Elmore* 393.

Common on the semi-arid coastal slopes from Santa Barbara, California south into northern Baja California and on the adjacent islands of Santa Cruz, Santa Catalina, and San Clemente. An adaptive species of maritime climate which has responsively evolved into varietal populations.

ERIGERON FOLIOSUS Nutt., Trans. Am. Phil. Soc. II, 7:309. 1841.
Becher Bay, Santa Rosa Island, August 2, *Elmore* 177, dry hillside.

Mainly coastal from Humboldt County, California south into southern California. The typical form of the species has not been reported from the islands. However, the variety, *stenophyllus* (Nutt.) Gray, is reported by Eastwood (Leaflet W. Bot. 3:74. 1941) for San Miguel, Santa Rosa, and Santa Cruz Islands. Elmore's collections lack the filiform leaves of the variety, being up to 5 mm wide.

ERIGERON GLAUCUS Ker., Bot. Reg. 1: pl. 10. 1815.

Point Bennett, San Miguel Island, September 12, *Elmore* 336. Tyler Bight, San Miguel Island, August 3, *Elmore* 315, dry sandy hill slope. San Miguel Island, August 10, *Elmore* 332.

Common along the shores from Oregon south to Monterey County and on the Channel Islands of San Miguel, Santa Rosa, and Santa Cruz.

ERIOPHYLLUM NEVINII Gray, Syn. Fl. I, 2:452. 1886.

Santa Barbara Island, August 12, *Elmore* 300, dry hillside.

Apparently endemic to the islands Santa Catalina, San Clemente, and Santa Barbara; not previously reported from the latter.

GNAPHALIUM BENEOLENS Davidson, Bull. So. Calif. Acad. Sci. 17:17. 1918.

Becher Bay, Santa Rosa Island, August 2, *Elmore* 215, dry hillside. Southern California east to Texas and northern Mexico.

GNAPHALIUM BICOLOR Bioletti, Erythea 1:16. 1893.

San Clemente Island, February 18, 19, *Elmore* 407.

Coastal and inland valleys from Monterey and Tulare Counties south to Baja California and on the adjacent islands of Santa Rosa, Santa Catalina, and Santa Cruz; not previously reported from San Clemente.

GNAPHALIUM PALUSTRE Nutt., Trans. Am. Phil. Soc. II, 7:403. 1841.

Hill west of Prisoners Harbor, Santa Cruz Island, April 17, *Elmore* 443.

Widely distributed in western North America from British Columbia to Mexico; on the islands Santa Cruz, Santa Catalina, and San Clemente.

HAPLOPAPPUS VENETUS VERNONIOIDES (Nutt.) Munz, Man. So. Calif. Bot. 522, 601. 1935.

Middle island of Anacapa group, August 1, *Elmore* 246, steep rocky slope.

Common on dry slopes at low elevations from San Francisco south into Baja California and on all the adjacent islands.

HEMIZONIA CLEMENTINA Brge., Erythea 7:70. 1899.

Santa Barbara Island, August 12, *Elmore* 299, dry hillside. San Clemente Island, February 18, 19, *Elmore* 408.

Endemic to the islands Santa Catalina, San Clemente, Santa Barbara, and Anacapa.

A perennial herb with dimorphic inflorescence; the early flowers in larger heads on simple leafy peduncles, the later in diffuse corymbose panicles. *Elmore's* collection from San Clemente is in the early flowering stage and differs from typical material also in the long villous pubescence of branches and foliage. It may be in need of varietal or possibly even specific segregation.

HEMIZONIA FASCICULATA (DC.) Torr. & Gray, N. Am. Fl. 2:397. 1841-43.

Becher Bay, Santa Rosa Island, August 2, *Elmore* 175, dry hillside.

Common from southern California south through Baja California to Cedros Island; also on San Miguel, Santa Rosa, Santa Catalina, and San Clemente Islands. It is tolerant of immature soils and apparently is aggressive on local wastelands.

LAYIA PLATYGLOSSA (F. & M.) Gray, Pl. Fendl. 103. 1849.

Becher Bay, Santa Rosa Island, August 2, *Elmore* 202, dry hillside. Hill west of Prisoners Harbor, April 17, *Elmore* 442.

Widely scattered in southern California and on San Miguel, Santa Rosa, Santa Cruz, and Santa Catalina Islands.

MALACOTHRIX CLEVELANDII Gray, Bot. Calif. 1:433. 1876.

Santa Barbara Island, August 12, *Elmore* 370.

Aggressive on disturbed areas in cismontane southern California and on the islands Anacapa, Santa Cruz, and on the above new extension of range, Santa Barbara Island. Apparently migratory on the mainland.

MALACOTHRIX FOLIOSA Gray, N. Am. Fl. ed. 2, 1, pt. 2, suppl. :455. 1886.

Point Bennett, San Miguel Island, September 12, *Elmore* 338.

On the islands Santa Cruz, San Clemente, Santa Barbara, and the above extension of range, San Miguel.

MALACOTHRIX INCANA (Nutt.) Torr. & Gray, N. Am. Fl. 2:486. 1841-43.

Tyler Bight, San Miguel Island, August 3, *Elmore* 322. San Miguel Island, August 10, *Elmore* 327.

Channel Islands of Santa Rosa, Santa Cruz, San Miguel, and the adjacent coast.

MALACOTHRIX SAXATILIS IMPLICATA (Eastw.) Hall, U. C. Publ. Bot. 3:269. 1907.

Middle island of Anacapa group, August 1, *Elmore* 248, steep rocky slope.

Channel Islands of San Miguel, Santa Rosa, Santa Cruz, San Nicolas, and Anacapa.

The evolution of the genus *Malacothrix*, judging from the numerous segregates of varying rank that are known from the islands, has apparently been highly responsive to the stimulation of successive disjunctions and conjunctions of populations as induced by physiographic evolution.

PEREZIA MICROCEPHALA (DC.) Gray, Pl. Wright. 1:127. 1852.

Prisoners Harbor Canyon, Santa Cruz Island, August 2, *Elmore* 263, dry rocky hillside.

Open arid slopes of the chaparral belt from San Luis Obispo County south to Baja California and the adjacent islands of Catalina, Santa Rosa, and Santa Cruz. The limited island distribution of this strongly successful perennial of the mainland, indicates at least recent appearance on the islands.

PERITYLE EMORYI Torr. in Emory, Rep. N. Mex. Bound. Sur. 142. 1848.

San Clemente Island, February 18, 19, *Elmore* 414, 385.

Widespread from southern California to Arizona south in Mexico to southern Sonora and throughout Baja California; also on Santa Catalina, Santa Rosa, Santa Cruz, San Clemente, and Cedros Islands. It is an aggressive winter annual with white rays in the arid maritime climates.

SENECIO LYONII Gray, Syn. Fl. I, 2:456. 1886.

San Clemente Island, February 18, 19, *Elmore* 404, 399.

On the Channel Islands of San Clemente, Santa Barbara, Santa Cruz, and in Baja California.

SILYBUM MARIANUM (L.) Gaertn., Fruct. 2:378. 1791.

Santa Cruz Island, August 2, *Elmore* 264.

Common weed in California naturalized from Europe; also on Santa Catalina Island.

SONCHUS OLERACEUS L., Sp. Pl. 794. 1753.

Santa Barbara Island, August 12, *Elmore* 304, dry hillside.

Common weed in wasteland, naturalized from Europe; widespread on the islands and probably on all of them.



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CEDROS AND SAN BENITO ISLANDS

Cedros Island is a partially submerged mountain that stands about midway along the coast of Baja California across the broad Vizcaino Bay. North to south it is about 38 kilometers long, averages about 8 kilometers wide, and contains about 300 square kilometers of rugged land. It has several peaks, the highest of which is about 1200 meters above the level of the Pacific Ocean. Dissected by numerous canyons, some of which dip steeply to the sea, it contains several physiographic habitats; peak, ridge, hill slope, mesa, canyon, cliff, and brief narrow beaches. Alluvial slopes and valleys are notably minor. Salty and otherwise highly mineralized and unpalatable water is reported to stand in the lower reaches of the canyons. Near the south end of the island, about 3 miles from what was formerly known as Bernstein's abalone camp and at about 600 to 900 meters elevation, is a good fresh water spring. Fishing has recently been developed by the construction of a large cannery in the locality and a village has grown up around it.

The island is composed mostly of sedimentary rocks. The south end shows fossiliferous marine sediments of Cretaceous shales, Miocene shales and sandstones, and Pliocene sands and conglomerate. Near the middle of the east side of the island, "Grand Canyon" cuts back deeply. G. Dallas Hanna, paleontologist on the California Academy of Science's expedition to the Eastern Pacific islands in 1922 and 1923, wrote in reference to the middle section, as follows (1926:88): "It was found that a fault line crosses the island following approximately the course of the canyon. To the south only, Jurassic cherts, supposedly Franciscan in age, were found. To the north there is a block of Cretaceous shales, 200 or more feet thick, with a generally westward dip of about 30°. —Our studies convinced us that Cedros Island is 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 much higher land mass." He found igneous rocks only at the two extremities of the island. "At the southwestern corner of the island there has been some volcanism and at the north end the land is greatly disturbed with intrusions of serpentine" (1925:268).

Since the axis of Cedros Island is aligned with that of Sierra Vizcaino to the south on the western edge of the peninsula, and because soundings show the intervening channel to be only 9 to 12 meters in

depth, it appears that the two land masses were continuous at times in the geologic past. If this is true, the floras of the two mountains should show much in common and a comparison would contribute evidence for the historical problem. Unfortunately, the flora of Sierra Vizcaino is quite unknown, except by what may be inferred from neighboring localities of collections, the nearest being northwest of the mountains on San Bartolome Bay, or, as it is now commonly known, Tortuga Bay. Three collecting parties have visited this locality: Hinds on H.M.S. *Sulphur* in 1839, Pond on the U.S. ship *Ranger* in 1889, and Brandegee on the *Wahlberg* in 1897. The latter on his spring visit found, "the region was perfectly dry and seemed not to have been rained upon for years. A few plants were recognized that were before known only from Cedros Island, and made it evident that an accurate knowledge of the distribution of neighboring island forms cannot be obtained without a more thorough examination of the adjacent mainland." The isolated position of Sierra Vizcaino, sitting out by itself across a broad low desert plain about 60 miles wide, indicates that it too was for indeterminant periods in the past an insular body and that like Cedros it may possess its own relic biotic elements.

There are no meteorological data for Cedros Island nor for the adjacent peninsula. Rainfall is probably under 8 inches annually on the average for the lower slopes and most of the island area, something over that for the highlands. The rainfall incidence is irregular, judging from oral accounts of peninsular natives, and years may pass without effective precipitation. There is apparently only one source of rainfall and that is in the cyclonic winter storms of the northern latitudes which occasionally extend to Cedros. According to the natives, the convectional summer storms rarely reach Cedros Island. The moist westerlies are reported by the inhabitants of the adjacent peninsula to be the dominant and persistent winds. A fog desert similar to that found along the western border of the peninsula may exist over some of the island. Visitors report that fog drips from the trees in the higher elevations to such an extent that it causes little rivulets of water and that these have been mistaken for springs.

Few botanists appear to have visited the western margin of Cedros and very little has been published regarding its plant life. According to accounts left us by visitors, most of the island is covered with a dispersed formation of Desert Shrub. Suffrutescents in *Eriogonum*, *Fran-*

seria, *Atriplex*, *Viguiera*, and *Encelia* are common. Succulents are represented in *Agave* and cacti and semi-succulents by such shrub and tree forms as *Euphorbia misera* and *Pachycormus discolor*. The sclerophyllous shrubs of *Rhus* and *Simmondsia* appear to be prevalent and Greene mentions (1888:197) two evergreen shrubs, *Gilia Veatchii* and *Harfordia fruticosa*, "which grow on these lower hills in sufficient quantities to impart an appearance of verdure." To Greene the most conspicuous tree was the corpulent xerophyte, *Pachycormus discolor*, endemic to Baja California and adjacent islands. A scrubby juniper, *Juniperus cerrosianus*, he reported as growing throughout all elevations. Towards the summits of the mountains, *Pinus muricata cedrosensis* is accompanied by *Arctostaphylos bicolor*.

George O. Hale and Lee Haines, as two students of botany at the University of California at Los Angeles, spent six weeks in the early spring of 1939 on the island and made an ecologic study of the vegetation. Hale (1941) reported about 97% of the island is covered through all elevations with Desert Shrub. It has a uniform growth as a regularly dispersed open formation of low bushy shrubs spotted with large shrubs or dwarf tree forms; among the latter, that of *Pachycormus discolor* being the most ubiquitous. He found differences in composition between the higher elevations and the lower elevations, and divided the Desert Shrub accordingly into "High Altitude Desert" (650 to 1300 meters elevation) and "Low Altitude Desert" (below 650 meters elevation). As dominants of the former he listed *Eriogonum fasciculatum*, *Pachycormus discolor*, *Haplopappus propinquus*, and *Franseria camphorata leptophylla* and for the latter he listed as most abundant *Harfordia fruticosa*, *Euphorbia misera*, *Pachycormus discolor*, *Franseria chenopodiifolia*, and *Encelia californica asperifolia*.

The only other low altitude association he reported is "Maritime Dune Scrub," occupying a small dune area on the southwest coast. Dominated by *Atriplex julacea* and *Frankenia Palmeri*, it is also characterized by *Brodiaea*, *Abronia*, *Achyronchia Cooperi*, *Oenothera*, and *Lycium Andersoni*.

The highland vegetation, other than High Altitude Desert Shrub, occupies limited areas at middle and high elevations.

A Closed Cone Pine Forest (250 to 900 meters elev.) occurs in two widely separated areas on western and northern slopes, in the central and northern parts of the island. The pines usually occur in pure stands and have an average mature stature of about 50 feet. Hale

concluded that they are coincident with the elevations and tracks of regular fog ingressions.

A local Chaparral, dominated by *Arctostaphylos*, *Adenostema*, *Quercus*, *Eriogonum*, and *Juniperus*, occurs on the northern slopes of the highest peaks, above the pine forest. This is a most interesting ecologic find with considerable historical significance. Small patches of Coastal Sagebrush and Juniper Woodland border the pine stands irregularly.

These formations show little or no natural transitional grading, but are sharply one or the other. Where the pine forest begins, the desert shrub leaves off. Chaparral occupies higher elevations than the pines and both formations appear largely dependent upon the upsurging fogs from the westward, especially the latter. These are aspects peculiar to the island, and while the vegetations show climatic qualities, they are interesting instances of what climate and soil types have generated out of the limited plant materials available.

The flora of the island is now known to consist of about 182 species of vascular plants and has recently been annotated by Eastwood (1929) and Howell (1942). Around 600 numbers have been taken by 14 collectors, but little collecting has been done in summer, only one small one made in winter (Pond, 15 numbers), and none at all during the fall (Table 2). Considering this, the fact that little or no collecting has yet been done on the western side, the areal nature of the island, and the irregular rainfall, I would estimate that some, perhaps 10%, of the island flora is still unreported. In addition to the unknowns, more material of many of the known plants, and more field work are needed for a thorough evaluation of the Cedros flora.

The plant collections of the Allan Hancock Expeditions to Cedros Island were made in 1937 by P. J. Rempel and in 1939 by Francis H. Elmore. They are enumerated below together with Rempel's collection from the neighboring San Benito Islands. Their collections add three genera and four species to the Cedros Island flora: *Aristida adscensionis*, *Eschscholtzia minutiflora*, *Fagonia laevis*, and *Euphorbia bartolomaei*.

TABLE 2

Year	Collector	Cedros Island		San Benito Islands	
		Spring	Summer	Spring	Summer
1859	Veatch	28			
1876	Streets	11		10?	
1882	Belding	10			
1885	Greene	82			
1889	Pond	15		24	
1889	E. Palmer	87		18	
1897	T. S. Brandege	100?		50?	
1905	Stewart		7		
1911	J.N. Rose	97		44	
1922	Hanna		7		
1925	Mason	63			
1932	Howell		41		
1937	Rempel		19		15
1939	Elmore	38			
1939	Hale and Haines	150			

Table 2. Plant collectors and collections on Cedros and San Benito Islands. Estimated numbers are followed by a question mark.

The San Benito Islands consist of three small islands, East, Middle and West, lying about 24 kilometers from the north end of Cedros Island. Although they rest upon the continental shelf, they are separated from Cedros Island by a channel 180 to 190 fathoms deep. This is more than enough to prevent junction during low eustatic sea levels of the Glacial Periods. Whether they were ever land-bridged to Cedros or the peninsula is not presently known. The highest elevation of 200 meters (661 feet) is attained on West Island, the largest of the three. Fraser (1943:65) speaks of them as "all rocky and barren," but Greene (1889: 261), the first chronicler of the islands, described them in glowing terms. "Lieutenant Pond judges the San Benito Islands to be of much older formation than the large island of Cedros near by. The surface is not sharply rocky; the slopes are not abrupt; there is good depth of soil almost everywhere, and vegetation is abundant, the whole group presenting, on near approach, a picture of freshness and verdure at the showery season of the year, the months from December to February, during which several visits were made (by Pond). At this time sweet flowing water was found in most of the canyons and ravines; a condition not likely to obtain during the dry summer season." Such opposing impressions in addition to the personal factor of prejudice appear to be conditioned by the lack or presence of seasonal rains.

Before Pond's collection of 1889, Streets had collected, among other plants the endemics *Lavatera venosa*, and *Hemizonia Streetsii*. Following Pond the next important collection is that of the remarkable peregrinating botanist, Edward Palmer, who visited the San Benitos in March of the same year that Pond did. His collections were reported by J. N. Rose (1890:20-21). No additions to Greene's first published list of 25 species were made, however, until Brandegee visited the San Benito Islands on the voyage of the *Wahlberg* in 1897 and published (1900: 22-23) a small supplementary list, bringing the known flora of the San Benitos to 40 species. Rose and Rempel appear to complete the roster of collectors on San Benito Islands (Table 2).

Except for the five plants which still appear to be endemic to the San Benito Islands, the flora is almost completely repeated on Cedros Island, the exceptions being common wide-spread species, as *Lepidium lasiocarpum*, which may have been passed by collectors on Cedros. Because of the striking lack of the genera *Astragalus* and *Eriogonum* in the San Benito flora, Greene saw a straight relationship between the San Benito flora and that of Guadalupe Island 150 miles westward, and not at all between San Benito and Cedros. The absence of these genera, so conspicuous on the peninsula and on Cedros Island, is, of course, interesting, and the explanation of it could easily lead one into many conjectures. However, because so many Cedros genera and species are represented on the San Benito Islands and so few of the Guadalupe Island species are, Greene's statement now appears rather meaningless. The position and character of the San Benito flora, however, does remain in part anomalous.

The collection of 15 numbers by P. J. Rempel from the San Benito Islands during July on the 1937 voyage of the *Velero III*, is apparently the first to be made in summer. Although no novelties are added, the collection provides fruiting and flowering records and one addition, *Mesembryanthemum nodiflorum*, as annotated below in the catalogue of species.

CATALOGUE OF COLLECTIONS

GNETACEAE

EPHEDRA ASPERA Engelm. ex Wats., Proc. Am. Acad. Sci. 18:157. 1883.

Ephedra peninsularis Jtn., U. C. Publ. Bot. 7:437. 1922.

East side of Cedros Island, July 10, 1937, *Rempel 340*, alluvial fan.

Widely distributed in the southwestern United States and northern Mexico; type apparently from Frontera, Texas. Rempel's collection is sterile and not certainly determinable, but *aspera* is the only species known from Cedros Island. Hale, (1941:56) reports that the plants are broad and bushy, scarcely exceeding a foot in stature.

GRAMINEAE

ARISTIDA ADSCENSIONIS L., Sp. Pl. 82. 1753.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A6*, in dry wash.

A xerophytic grass commonly scattered throughout southwestern United States and southward into Mexico; also in warmer parts of the Old World. The collection is a single depauperate plant, but it adds another species to the published flora of the island.

AMARYLLIDACEAE

AGAVE SHAWII Engelm., Trans. Acad. St. Louis 3:314. 1875.

West San Benito Island, July 14, 15, 1937, *Rempel 364* (sterile), on southerly exposures with wind appearing to prevail from north.

Typical *A. Shawii* is abundant from San Diego, California south to Rosario in northwestern Baja California, where it commonly forms dense stands along the slopes facing the moist sea air. The type was described from Point Loma near San Diego. The short ovate-lanceolate blades with strong crooked, closely set, marginal prickles of the San Benito plant pretty certainly align it with the peninsular plant.

Agave Shawii Engelm., var. *sebastianiana* (Greene) Gentry new comb.

Agave sebastianiana Greene, Bull. Calif. Acad. Sci. 1:214. 1885.

East side of Cedros Island, July 10, *Rempel 330*, general.

The variety is known certainly only from Cedros Island. Greene first collected and described it as a distinct species. Trelease (C.N.H. 23:110, 124. 1920) maintains *A. Shawii* and *A. sebastianiana* as distinct species, separating them in his key on the basis of sinuous (*Shawii*) or straight (*sebastianiana*) terminal spine. The *sebastianiana* population appears

also to differ from typical *Shawii* by its less robust form and by fewer, more remote, and smaller marginal spines, characters which appear to have subspecific rather than specific value.

Agave Shawii sebastiana may also occur on the San Benito Islands. Brandegee reported an Agave from the San Benito Islands (1900) which he considered the same as on Cedros. Palmer (Rose 1890:20) spoke of two species of Agaves on San Benito Islands.

POLYGONACEAE

ERIOGONUM FASCICULATUM Benth., Trans. Linn. Soc. 17:417. 1837.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A24*, sandy rocky slope in dry wash, flowers white.

Generally distributed on the maritime and desert slopes and valleys from Santa Barbara, California south to central Baja California and on adjacent islands. This collection appears to be related to the variety *flavoviride* Munz and Johnston, but differs in the pubescent peduncles and larger stature.

ERIOGONUM INTRICATUM Benth., Bot. Voy. Sulph. 46, t. 22. 1844. East side of Cedros Island, July 10, *Rempel 337*.

Known only from Cedros Island and the adjacent peninsula; the type from San Bartolome Bay, Baja California. The above material is very young, but a few young flowers at the base of the plants with wine-red strigulose sepals in sessile involucre and the pubescent leaves limited to the basal node are diagnostic.

ERIOGONUM PONDII Greene, Pittonia 1:267. 1889.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A16, A25*, dry rocky wash.

In and along arroyos in sandy and coarse detrital soils on Cedros Island and the adjacent peninsula near Tortuga Bay (San Bartolome Bay); type from Cedros Island. Elmore reports in his notes that the flowers on *No. A16* were pink, and white on *No. A25*. A very low wide-spreading suffrutescent bush.

CHENOPODIACEAE

ATRIplex DILATATA Greene, Pittonia 1:264. 1889.

West San Benito Island, July 14, 15, *Rempel 366*, west side of island; small-leaved plant all over island. San Benito Islands, July 14, 15, *Rempel 361*, general distribution.

Known only from the San Benito Islands to which it is apparently confined. The species is related to *A. Barclayana*, but differs in the woody branches, the thicker fruits with less tuberculation on the sides. The shrubby nature of the plant is apparent in the above cited collections. On the sheet of *Rempel 361* even the terminal branches are woody, the leaves reduced, while *Rempel 366* shows new herbaceous shoots from a thick woody branch, the leaves uncommonly wide and herbaceous, the broad ovate blades 3-4 cm long, mostly 2-2.5 cm wide; petioles 5-10 mm long.

ATRIPLEX PACIFICA A. Nels., Proc. Biol. Soc. Wash. 17:99. 1904.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A37*, sandy, rocky soils of alluvial fan.

Southern California and adjacent islands to Cedros Island; type from San Diego, California. Elmore reports only a few plants observed and the collection consists of a single small plant. I have seen no collections of this species from northern Baja California, but it probably occurs there, since it is a weedy type that is often passed by collectors.

SUAEDA SP.

San Benito Islands, July 14, 15, *Rempel 358* (sterile).

NYCTAGINACEAE

HESPERONIA CEDROSENSIS Standl., C.N.H. 12:362. 1909.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A15*, alluvial fan with sand and pebbles.

On coarse arid soils from Cedros and San Benito Islands, along the northern coast of Baja California, and on San Clemente Island in the Channel group; type from Cedros Island. Elmore noted but a few plants; flowers purple.

AIZOACEAE

MESEMBRYANTHEMUM CRYSTALLINUM L., Sp. Pl. 480. 1753.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A26*, gentle slope of pebbly alluvial fan.

Naturalized along the coasts of the Californias and adjacent islands from Santa Barbara, California south into northern Baja California; type from Cape of Good Hope.

MESEMBRYANTHEMUM NODIFLORUM L., Sp. Pl. 480. 1753

West San Benito Island, July 14, 15, *Rempel 369, 371*, north side of island.

This Mediterranean adventive is abundant on the coast through the northern part of Baja California and is also common farther north as far as Oregon. Rempel's collections are the first records from San Benito Islands.

PORTULACACEAE

CALANDRINIA MARITIMA Nutt. in Torr. & Gray, N. Am. Fl. 1:197. 1838.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A28*, gentle slope of a rocky alluvial fan; flowers purple.

From Santa Barbara County, California south along the coast to central Baja California. Locally on Cedros the plant is known as "ver-dolaga" and was regarded by Elmore's informant as edible.

ESCHSCHOLTZIA MINUTIFLORA Wats., Proc. Am. Acad. Sci. 11:122. 1876.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A17*, gentle slope of rocky alluvial fan.

From southern Utah south through the Sonoran Desert to middle Baja California. The above collection is a considerable extension of range for the species and an addition to the known flora of the island.

CRUCIFERAE

SIBARA PECTINATA Greene, Pittonia 3:11. 1896.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A32*, on gentle rocky slope of alluvial fan; flowers light purple.

Central Baja California and Cedros Island; type from San Bartolome Bay (Tortuga Bay). A delicate and rarely collected winter annual, slender, erect, with dissected leaves 4-6 cm long, the lobes remote and narrowly linear, spreading.

CAPPARIDACEAE

ISOMERIS ARBOREA Nutt. in Torr. & Gray, N. Am. Fl. 1:124. 1838.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A14*, dry wash and fans on exposed, sandy, pebbly, gentle slopes; flowers yellow.

Widely but irregularly distributed in the deserts of California, Sonora, and Baja California; type from San Diego, California. Forms a low bushy shrub on the island and flowers through February and March after rainy winters.

LEGUMINOSAE

ERRAZURIZIA BENTHAMII (Brge.) Jtn., Proc. Calif. Acad. Sci. IV, 12:1043. 1924.

Dalea Benthamii Brge., Proc. Calif. Acad. Sci. II, 2:148. 1890.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A20*, on rocky, sandy, exposed, gentle slope of alluvial fan. East side of Cedros Island, July 10, *Rempel 341*, alluvial fan and hill side.

Known only from the Sierra Vizcaino area and the neighboring islands; type from Santa Margarita Island.

This is a low stiff shrub with short intricate branches, gray twigs, and conspicuously gland-dotted light gray leaves, the whole often matted into a low rounded crown. Both Johnston and Rydberg have indicated the advisability of separating this species (together with the related *E. megacarpa* from the California Gulf Region), with its regular non-papilionaceous corolla, from the genus *Dalea*, having a typical papilionaceous corolla; a view with which the writer thoroughly agrees. Unfortunately, Phillip's awkward name, *Errazurizia*, (Ann. Univ. Chile 1872:688) has priority over Rydberg's *Psorobatus* (N. Am. Fl. 24:41. 1919). It was reported to Elmore by local informant as edible to human beings, but caused insanity among animals. The informant may have been confusing the plant with members of the genus *Astragalus*.

LOTUS HUMILIS Greene, Pittonia 2:140. 1890.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A27*.

A low prostrate winter annual common to the sands of central Baja California and Cedros Island; type from San Bartolome Bay.

LUPINUS PONDII Greene, Pittonia 1:288. 1889.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A1*, a few plants in a dry wash.

Central and northern Baja California and Cedros Island; type from San Bartolome Bay, Baja California. It is a low annual herb with spreading stems, sparse, coarse, long pubescence, and the flowers glomerate along the rachis of the inflorescence, according to the specimen at hand.

ZYGOPHYLLACEAE

FAGONIA LAEVIS Standl., Proc. Biol. Soc. Wash. 24:249. 1911.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A18*, gentle slope with rocky sandy soil on alluvial fan; flowers light purple.

Widely distributed around the upper half of the Gulf of California in California, Arizona, Sonora, Baja California, and on intervening and adjacent islands. This is a rather dense form of the usually more open habit of the species, which is characterized by the 3 small very narrow leaflets and the short spreading stipules.

EUPHORBIACEAE

EUPHORBIA BARTOLOMAEI Greene, Pittonia 1:290. 1889.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A29*, rocky sandy soil in dry wash; flowers white.

One of the small finely cut prostrate spurge inhabiting the arid soils on Cedros Island and adjacent Baja California; type from San Bartolome Bay.

EUPHORBIA MISERA Benth., Bot. Voy. Sulph. 51. 1844.

Euphorbia Benedicta Greene, Pittonia 1:263. 1889.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A19*, gentle slope on sandy rocky alluvial fan. San Benito Islands, July 14, 15, *Rempel 370*, north side of West Island (flowering).

Irregularly distributed through the deserts of southern California, Baja California, and perhaps in the Thorn Forest of central Sinaloa (*Gentry 7001*, near Culiacan); type from San Diego, California.

Eastwood (1929:432) reported it tentatively as collected by Mason, his material being too poor for certain identification. Elmore's number agrees well with typical material from the peninsula. The San Benito Island plants are apparently more succulent and dwarfed in stature, and are perhaps worthy of varietal distinction.

BUXACEAE

SIMMONDSIA CHINENSIS (Link) Schneider, Ill. Handb. Laubholz 2:141. 1907.

Simmondsia californica Nutt., Lond. Jour. Bot. 3:400, t. 16. 1844.

Simmondsia pabulosa Kell., Proc. Calif. Acad. Sci. 2:21. 1860.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A3*, dry wash. East side of Cedros Island, July 10, *Rempel 331* (sterile).

Widely scattered upon the arid slopes on the mountains and in the canyons of the Sonoran Desert from southern California and southern Arizona south into Sonora and through Baja California to the Cape District; the type is probably from San Diego, California, although the describer attributed it to China, due to error in labeling or sorting by the collector who visited both California and China on the same voyage.

It is a leathery-leaved evergreen shrub with acorn-like fruits, which, although it may assume a dominant role in the vegetation, is more often widely scattered as individual plants.

Although somewhat bitter the seeds are eaten by the desert peoples as they ripen, either raw or roasted, and a kind of coffee has been made of them by the Mexicans in times of coffee shortages. Elmore reports that it is employed locally as a pomade by women for their eyelashes and by men for their moustaches. The family affinities of the plant are uncertain.

ANACARDIACEAE

***Pachycormus discolor Veatchiana* (Kell.) Gentry new comb.**

Rhus Veatchiana Kell., Proc. Calif. Acad. Sci. 2:24. 1860.

Veatchia discolor Veatchiana (Kell.) Jtn., Proc. Calif. Acad. Sci. IV, 12:1081. 1924.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A13*, on wash walls and fans. East side of Cedros Island, July 10, *Rempel 344* (with young leaves and budding inflorescence).

This variety, which according to Johnston is distinguished by its larger, more colored, coarser, and more conspicuously pubescent flowers, is known definitely only from Cedros Island. However, it likely will be found to occur also on the adjacent island of Natividad and the Sierra Vizcaino part of the mainland. Elmore collected it at 75 feet elevation where he noted a few trees or shrubs up to 10 feet high, trunks as much as two feet in diameter and with peeling papery bark, known locally as "Copalquin." Hale (1941:68) reports it as "Abundant throughout the desert formation, and reaches its best development as to size in Grand Canyon, where on the lateral alluvial fans it reaches tree size.—On the west coast near the ocean it is often of low stature, not two feet tall."

This remarkable plant with its massive, smooth, round, paper-barked trunk and branches together with the pinnate leaves make it appear much like the *Bursera*s, which abound in Mexico. The massive stems accommodate the enlarged water-storing tissues, which serve to carry the plant over the extended and regular drought periods of the peninsular desert, and which in extreme times are known to last for several years. Bentham first described it under *Schinus* (Bot. Voy. Sulph. 11, pl. 9. 1844), while later authors have assigned it to *Veatchia* and *Rhus*. Were not the name *Veatchia* preoccupied, it would have priority over *Pachycormus* of Coville.

RHUS LENTII Kell., Proc. Calif. Acad. Sci. 2:16. 1863.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A4*, on sandy gentle slope with pebbles on alluvial fan.

On outer coast of middle Baja California and adjacent islands; type from Cedros Island. It forms a dense green shrub or even a small tree, flowering in the early spring. Elmore noted that it was used locally for wood and that the fruits are three to four times larger than our "lemonade berry."

MALVACEAE

LAVATERA VENOSA Wats., Proc. Am. Acad. Sci. 12:249. 1877.

Middle island of the San Benito Islands, July 14, 15, *Rempel 362*, near shore on south side.

It is known only from the San Benito Islands. The collection is in full leaf, flower, and fruiting.

SPHAERALCEA FULVA Greene, Pittonia 1:201. 1888.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A11*, gentle slope of alluvial fan.

Commonly in washes along the outer coast of middle Baja California and on Cedros Island, the type locality. Elmore noted that the flowers are orange-colored, that it is known locally as "malva silvestre," and a decoction of the herbage is made and applied to the back for fevers.

LOASACEAE

MENTZELIA HIRSUTISSIMA Wats., Proc. Am. Acad. Sci. 12:252. 1877.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A5*, sandy pebbly soil of alluvial fan; flowers light yellow.

Infrequently scattered in the mountains of the mid Baja California Desert and on some of the adjacent islands; type from Angel de la Guardia Island. The single collection contains two depauperate plants 6-7 cm high with the dry corollas 12-15 mm long.

FRANKENIACEAE

FRANKENIA PALMERI Wats., Proc. Am. Acad. Sci. 11:124. 1876.

West San Benito Island, July 14, 15, *Rempel 368*. San Benito Islands, July 14, 15, *Rempel 359* (sterile).

A halophyte on either salty or "sweet" soils of the arid coastal slopes and flats throughout northern Baja California and adjacent southern California. It forms low brittle woody bushes 2-6 dm high, rather dense,

and often forming dispersed pure stands over considerable area in some localities.

CACTACEAE

COCHEMIEA PONDII (Greene) Walton, Cact. Jour. 2:51. 1894.

East side of Cedros Island, July 10, *Rempel* 332 (sterile).

Known only from Natividad and Cedros Islands, the type locality being the latter.

ECHINOCEREUS MARITIMUS (Jones) Schuman, Gesamtb. Kakteen 27. 1898.

East side of Cedros Island, July 10, *Rempel* 333 (sterile).

West coast of Baja California and adjacent islands; type from Ensenada.

FEROCACTUS CHRYSANTHUS (Orcutt) Brit. & Rose, Cactaceae 3: 127. 1922.

East side of Cedros Island, July 10, *Rempel* 331 (sterile).

Northwestern Baja California and the adjacent islands; the type from Cedros Island. The numerous, curved, light brown to gray, annular spines in the closely set areoles identify this insular plant.

MAMMILLARIA GOODRIDGEI Scheer in Salm-Dyck, Cact. Hort. Dyck. 1849:91. 1850.

West San Benito Island, July 14, 15, *Rempel* 364.

West coast of middle Baja California and the adjacent islands of Cedros, San Benito, and Guadalupe; type from Cedros Island. Some of the *Rempel* specimens are fruiting. The series show all low plants tending to be obovate in outline, 5-10 cm high, woody at base, and one plant is branched.

OPUNTIA SP.

San Benito Islands, July 14, 15, *Rempel* 357, infrequent—mostly top and north sides.

This is a sterile *Cylindropuntia*, showing affinities to the section *Imbricatae*. The inflated straw-like sheaths of the spines suggest *O. calmalliana*, but the joints are too thick, the spines too few, too long, and the areoles too remote for that species. It is neither *O. tessellata* nor *O. prolifera*, the only two *Opuntia* which have been reported (Brandege 1900:20) for the San Benito Islands. The collection probably represents an undescribed species, but is insufficient for diagnosis.

HYDROPHYLLACEAE

PHACELIA IXODES Kell., Bull. Calif. Acad. Sci. 1:6. 1884.

East side of Cedros Island, July 10, *Rempel* 335, damp place in canyon.

Known only from Cedros Island, the species is readily recognized by its coarse stems, long scorpioid cymes, and heavy glandular pubescence.

BORAGINACEAE

CRYPTANTHA MARITIMA Greene, Pittonia 1:117. 1887.

Cannery Bay on east side of Cedros Island, March 14, *Elmore* A9, sandy soils of wash and alluvial fans.

In coarse sandy soils apparently throughout the Sonoran Desert in California, Arizona, Baja California, and on adjacent islands.

LABIATAE

SALVIA CEDROSENSIS Greene, Bull. Calif. Acad. Sci. 1:212. 1885.

Cannery Bay on east side of Cedros Island, March 14, *Elmore* A33, dry wash.

Known certainly only from Cedros Island, but possibly also at Magdalena Bay, Baja California. It is a low suffrutescent plant with blue flowers. The collector reported but few plants observed and the one collected is depauperate.

TEUCRIUM GLANDULOSUM Kell., Proc. Calif. Acad. Sci. 2:23. 1863.

Cannery Bay on east side of Cedros Island, March 14, *Elmore* A10, a few plants in a wash in the bottom of a small canyon in pebbly sand, corolla white tinged with lavender.

Ranges sparingly through middle Baja California and the adjacent islands, the type from Cedros Island.

SCROPHULARIACEAE

GALVEZIA JUNCEA (Benth.) Gray, Proc. Am. Acad. Sci. 22:311. 1887.

Cannery Bay on east side of Cedros Island, March 14, *Elmore* A30, on alluvial fan with gentle, rocky, sandy slope.

Widely scattered through central Baja California and adjacent islands; type locality, west coast of Baja California, probably at San Quentin. It is a perennial herb with round, smooth, strictly ascending, green branches and few small linear-lanceolate, glabrous, ephemeral leaves about 1 cm long; flowers red, the sepals and peduncles strongly glandular pubescent.

CUCURBITACEAE

ECHINOPEPON MINIMUS (Kell.) Wats., Proc. Am. Acad. Sci. 24: 52. 1889.

Marah minima Kell., Proc. Calif. Acad. Sci. 2:18. 1863.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A12*, climbing on shrubs on the sides of dry washes. "Guisapol."

Central and southern Baja California and the outer adjacent islands; type from Cedros Island.

It is a small scabrous vine, the leaves mostly broadly 3-lobed, small white flowers, and solitary fruits rather strongly but flatly prickled.

COMPOSITAE

BACCHARIS SARATHROIDES Gray, Proc. Am. Acad. Sci. 17:211. 1882.

East side of Cedros Island, July 10, *Rempel 338* (sterile).

Desert washes of the southwestern United States and northwestern Mexico; type from near Old Mission Station, San Diego County, California.

BEBBIA JUNCEA (Benth.) Greene, Bull. Calif. Acad. Sci. 1:180. 1885.

East side of Cedros Island, July 10, *Rempel 345*, fan. Cannery Bay on east side of Cedros Island, March 14, *Elmore A35*, steep rocky slope with sandy soil.

This is a bushy broom-like shrub 1-2 m tall, long-flowering through spring and summer, but with ephemeral reduced leaves, and found throughout the Sonoran Desert in California, Arizona, Sonora, Baja California, and accompanying islands. It is common to the banks and bottoms of the desert arroyos. Type locality: Magdalena Bay, Baja California.

ENCELIA CALIFORNICA ASPERIFOLIA Blake, Proc. Am. Acad. Sci. 49:368. 1914.

Cannery Bay on east side of Cedros Island, March 14, *Elmore A22*, dry wash.

Northern Baja California and adjacent islands; type from Cedros Island. This forms a low spreading bush with many radiating stems from the base. It is a more xerophytic edition of the species, characterized by the light brittle branches and the smaller paler leaves.

ENCELIA STENOPHYLLA Greene, Bull. Torr. Bot. Club 10:41. 1883.

Cannery Bay on east side of Cedros Island, March 14, *Elmore* 47, dry wash and fans in coarse rocky soil, flowers yellow, leaves resinous and odorous. East side of Cedros Island, July 10, *Rempel* 342, fan.

Known only from Cedros Island. It is a low shrubby plant with very narrow glutinous leaves (1-3 mm wide) and Senecio-like flowering heads. Local name reported by Elmore is "yerba de venado."

ERICAMERIA DIFFUSA Benth., Bot. Voy. Sulph. 23. 1844.

Haplopappus sonoriensis (Gray) Blake, C.N.H. 23:1490. 1926.

East side of Cedros Island, July 10, *Rempel* 346, fan.

On both coasts of middle Baja California and the adjacent islands; type from Magdalena Bay, Baja California. The material is sterile and doubtfully referred here. It differs from typical peninsular material in having larger linear-lanceolate leaves as well as the typical narrow linear ones. This may be due to the late vegetative stage in which it was collected. Not previously listed from Cedros Island.

FRANSERIA CHENOPODIFOLIA Benth., Bot. Voy. Sulph. 20. 1844.

Cannery Bay on east side of Cedros Island, March 14, *Elmore* 431, alluvial fan.

From southern California south through Baja California to the Cape District, Cedros Island. Type from Magdalena Bay, Baja California. A low shrubby bush with crowded whitish to yellowish leaves and rich brown stems with glutinous golden pubescence.

HAPLOPAPPUS TRIDENTATUS (Greene) Blake, C.N.H. 23:1493. 1926.

East side of Cedros Island, July 10, *Rempel* 348 (its flowering period is done, only a few achenes remain in the persistent involucre).

Known from Cedros Island and adjacent peninsula; type from Cedros Island. It is a low suffrutescent plant with linear leaves terminally tridentate.

HEMIZONIA FASCICULATA (DC.) Torr. & Gray, N. Am. Fl. 2:397. 1841-43.

Cannery Bay on east side of Cedros Island, March 14, *Elmore* 48, on gentle slope of alluvial fan.

Southern California and northern Baja California.

HEMIZONIA STREETSH Gray, Proc. Am. Acad. Sci. 12:162.

West San Benito Island, July 14, 15, *Rempel* 367, north side of island.

Known only from the San Benito Islands. It is a low suffrutescent plant with yellow flowers, the base definitely woody and as much as a half inch in diameter.

PERITYLE GRAYI Rose, in Coulter, Bot. Gaz. 15:117. 1890.

Cannery Bay on east side of Cedros Island, March 14, *Elmore* A21, dry wash. East side of Cedros Island, July 10, *Rempel* 336, wash.

Southern California, Baja California and adjacent islands; type from Guadalupe Island.

POROPHYLLUM GRACILE Benth., Bot. Voy. Sulph. 29. 1844.

Cannery Bay on east side of Cedros Island, March 14, *Elmore* A34, gentle slope with rocky soil on alluvial fan.

Found nearly throughout and limited to the Sonoran Desert in California, Arizona, Sonora, and Baja California; type from Magdalena Bay, Baja California. It is a small highly ramified suffruticose plant with small linear leaves and long pedunculate reddish involucre with white flowers. The herbage is glandular and emits a pungent aromatic odor when plucked or crushed. Never really abundant, it is common in arid situations and may often be found growing up through the branches of low shrubbery.

VIGUIERA LANATA (Kell.) Gray, Proc. Am. Acad. Sci. 17:218. 1881-82.

East side of Cedros Island, July 10, *Rempel* 339, wash (fruiting). Cannery Bay on east side of Cedros Island, March 14, *Elmore* A22a, dry wash.

Known only from Cedros Island. A scapose herb frutescent at the base, white-woolly pubescent on stems, leaves, and involucre. The older scapes shed their woolliness and show the brown-colored stems. It is a handsome plant and worthy of cultivation.

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REVILLA GIGEDO ISLANDS

The Revilla Gigedo Islands are small and widely scattered far off the Mexican west coast. Southward about 380 kilometers from the tip of Baja California is San Benedicto Island. Just south of it is the largest, Isla Socorro, which is about 520 kilometers west by south of Jalisco. Three hundred miles westward of Socorro is Clarion. Rocca Partida is a barren double rock westward of San Benedicto and Socorro.

All these islands are volcanic, their geologic history obscure, and their relationship vague. They may be oceanic islands, but Johnston (1931:45) considers them as continental. On the basis of bathymetrics and flora he regards them as peaks of a submerged land mass that was part of the Mexican mainland. The islands are in general alignment with the Tarascanahuan Cordillera, a volcanic massif forming the southern border of the Mexican central plateau, which breaks off in Jalisco at the sea. Because the flora of the Revilla Gigedos is related to both that of the Cape District of Baja California and southern Mexico, his theory presupposes that the whole area of the California peninsula and its periphery was once a part of the continental land mass, more or less outlined by the bathymetric contour of 4000 meters. This could only have been true previous to the Upper Tertiary, because Miocene and Pliocene formations on Baja California, the Mexican west coast, and adjacent islands show that their respective areas were covered by salt water. Johnston's argument is brilliantly developed, but the entire structure of the area is in need of detailed field study before credence of his theory can be assured.

The climate of the islands is semi-arid and maritime tropical with a dry spring season. There are no meteorological records, but in these latitudes rainfall should be about 80% summer and fall. The geographic position places it in Köppen's classification of Savanna Climate, which is characterized by a dry winter and wet summer. The long dry spring and the foggy montane forest of Socorro, however, make it atypical. That the spring is dry and the winters in part wet is attested by the five expeditions which have visited the islands between 1889 and 1939. This is strongly indicated both by their reports and the dry quality of the specimens collected during the spring months. Though the northern anticyclonic storms may cause some mild precipitation during the winter and local temperatures be productive of winter and spring fogs, the rainfall regime belongs definitely with the tropical and appears quite comparable to that which prevails on the west coast mainland in these

latitudes. The members of the California Academy of Sciences Expedition to the islands in 1922 found the vegetation dripping with early morning fog around the summit of Mount Evermann. These fogs ameliorate the spring aridity and help support the epiphytes of the montane forest, and even the tree growth by reducing transpiration.

The total known flora of this archipelago consists of only 120 vascular plants (Johnston 1931); Socorro 102 species, Clarion 43 species, San Benedicto 11 species, and is based upon about 325 numbers collected by five men, Table 3. All of these collections but one were made in the spring dry season. Barkelew only collected during the summer months (May 15 to July 8) and he apparently failed to exploit fully the opportunity to obtain representatives of the rich upper canyon flora. It is not known if the summer rains preceded him. I have not seen his specimens, which would indicate the condition of the vegetation at the time of his visit. As on the Mexican mainland, collecting on the islands should be best from August through November and the first botanist to engage the flora at this season will undoubtedly be richly rewarded with plants and information. Johnston (1931) has given good geographic descriptions of the islands, and with his and Hanna's reports (1926), I have drawn up the following brief summaries of the islands.

TABLE 3

Year	Collector	Socorro		Clarion		San Benedicto	
		spring	summer	spring	summer	spring	summer
1887	Stockton (Anthony)	41		25		6	
1889	Townsend	19		12			
1903	Barkelew		70		10?		6
1925	Mason	83		44		9	
1939	Elmore	11		15			
Total known species		102		43		11	

Table 3. Plant collectors and their collections from the Revilla Gigedo Islands.

San Benedicto Island. 48 kilometers north of Socorro, is about 5 kilometers long, averages about 1 kilometer wide, and contains in the neighborhood of 5 square kilometers. The southern half is an ash cone about 296 meters high, the northern half a lava plateau. Physiographically it is young and little developed with a poor diversification of habitats. The known flora consists of but 11 species of land plants.

Clarion Island. the extreme western outpost, is roughly rectangular, about 8 kilometers long, 3 kilometers wide, and 24 square kilometers in area. It is surrounded by an immature coral reef (Hanna,

l.c. p. 36). It has three distinct hills, the eastern being the highest and reaching about 321 meters above sea level. "The hills are rounded by erosion and show few canyons of any size. Over most of the island there is a deep reddish brown soil that suggests antiquity. Undoubtedly erosion now takes place very slowly; the rainfall is slight but the island is well covered with vegetation" (Johnston 1931:25). The few habitats of two sand beaches on the south side, rocky sea cliffs, mesa, slopes, and hill tops are not indicative of a rich flora. There is no permanent source of fresh water. Hanna (1926:39) mentions a pool of brackish water at the east end behind a sand beach, which he thought might be potable during the rainy season.

The island appeared to Hanna to have been very little altered by human interference. Such spots are so rare on the extra-polar portions of our little earth that his remarks on this point are quoted in full (1926:33).

"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 the 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 the 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."

The natural vegetation is dominated by thorny shrub under 15 feet in stature. Hanna noted "One species of plant—, a shrub about 15 feet high and the nearest approach to a tree found" (1926:38). One of the most abundant shrubs was *Opuntia occidentalis*, which "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" (1926:32). For ingress to the interior it was necessary to cut trails through the dense spiny thickets. Other dominant thorn shrubs include *Zantroxylon fagara*, and *Euphorbia anthonyi* is probably the shrub, the fruits of which stained the parties' clothing. On the tops of the island they found large areas covered with grass.

The 43 species of vascular plants known from Clarion Island have been discussed in some detail by Johnston. The collection and notes obtained by Elmore on the Allan Hancock Pacific voyage to that island are listed below together with his collections from Socorro Island. As with other spring collections from the island, their condition reflects the dryness of that season.

Socorro Island at about latitude $18^{\circ}50'$ N and longitude $111^{\circ}00'$ W, stands as a rough quadrangular hulk (Plate 4, fig. 12). Fourteen kilometers in length by about 11 kilometers in width, and with about 154 square kilometers of area, it is the largest of the Revilla Gigedo group. Near the center is Mount Evermann, a little over 1138 meters in elevation, a volcanic structure which Hanna (1926:56) and party found mildly active in 1922. "The whitish mud flows out in 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 crystalized 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."

The land form of the island is mountain broken up into ridges, slopes, and radiating canyons. A small dry lake exists in an eastern canyon. Recent and ancient lavas have contrasting soils and vegetations. Permanent water is available at sea level at Grayson Cove on the south side of the island, where a spring of fresh water comes out of a crack in the lava rocks.

Sheep were introduced on the island in 1896 and were still running freely about the island in considerable numbers in 1922. Grayson introduced hogs at about this same time, but they have not been observed since and it is most likely that they have expired. One species of lizzard is known from Socorro and it is the home of numerous sea and land birds.

The vegetation apparently consists of two types determined by the topography, soil, and the upland fogs; a maritime subtropical Thorn Forest on the lower slopes and ridges and a maritime tropical montane drought deciduous forest in the upper reaches of the canyons. Of the brushy Thorn Forest, the ornithologist Anthony wrote (Auk II, 15:312. 1898) "The greater part of the island is covered with a very dense growth of underbrush, the weather side [north and west exposure] being especially thickly covered, making travel, except in favored spots,

well nigh impossible. Trees are abundant on the weather side of the island but on the south and east sides they are mostly confined to canyons, and were smaller than on the north slopes. They were nowhere seen over forty or fifty feet in height, though usually covering considerable area with their broad spreading branches."

Hanna and party found an upland section of red hills with flattened and denuded vegetation, which they attributed to a cataclysmic wash-out by a tropical cloud burst. On the south slopes of the mountain above Grayson Cove, they found grass, cactus, and some shrub adventive over the area that Grayson (1871:295) had fired 53 years earlier. The montane forest is found only in the upper reaches of the canyons—"In the canyon 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. "The forests in the canyons were so dense that the sunlight rarely penetrated to the ground; hence mosses, lichens, ferns, and orchids, were abundant on the trees and branches.

"From the top we were able to study the best means of approaching the mountain and found it unquestionably to be from Grayson Cove. But that route does not pass through any such interesting country as we had traversed on the ascent. Wooded canyons are absent on the south side but are abundant on the north, east and west. Between them brush covered ridges radiate outward like spokes of a wheel" (Hanna, 1926:48, 54, 57).

The flora of Socorro is the richest of the Revilla Gigedo Islands. The larger and higher area of more diversified terrain is accompanied by a more highly evolved indigenous flora. The five collectors who have visited the island have given us records of 102 species of vascular plants, Table 3. Barkelew's collection of 70 numbers is the only one made in the summer and he apparently failed to reach much of the higher richer flora of the interior. To Mason goes credit for first having brought the rich potentialities of the montane forest to our attention by his collections. Late summer and fall collections would add more species and genera to the island flora. And, as Johnston wrote (1931:15) "the most important botanical work now awaiting attention on the islands concerns not species so much as the vegetation and the living plant. The past collectors on the islands have been quite satisfied in making a single collection of each species found on each of the islands. No attempt has been made to make repeated collections either to show variation of the plants or their distribution on particular islands. There is almost nothing on record regarding the abundance, habits, stature,

habitats, associates, flower-color, etc., of the various plants of the islands. Few, if any, notes have been made which would permit the botanists who have not visited the islands to visualize the living plant and see it in relation to its environment. The plant ecology of the islands is an untouched subject." That is as true today as it was when Johnston wrote it.

Elmore's collection of 11 numbers is annotated below along with those of Clarion.

CATALOGUE OF COLLECTIONS

POLYPODIACEAE

CHEILANTHES PENINSULARIS INSULARIS Weatherby, Am. Fern Jour. 21:25. 1931.

Braithwaite Bay, Socorro Island, March 18, *Elmore C8*, elev. 100 feet.

This variety is endemic to the Revilla Gigedo Islands, where it has been collected from Socorro and Clarion. Elmore reports it growing in shaded crevices of lava rocks in the side of a canyon.

GRAMINEAE

CENCHRUS MYSUROIDES H.B.K., Nov. Gen. & Sp. 1:115, t. 35. 1816.

Braithwaite Bay, Socorro Island, March 18, *Elmore C1*, among boulders on upper beach.

Widely distributed in the warmer parts of North America.

JOUEVA PILOSA (Presl) Scribn., Bull. Torr. Bot. Club 23:143. 1913.

Braithwaite Bay, Socorro Island, March 18, *Elmore C4*, among lava rocks on steep slopes, elev. 10 feet.

Widely scattered along the coast from southern Baja California to Nicaragua.

SPOROBOLUS ARGUTUS (Nees) Kunth., Enum. Pl. 1.215. 1833.

Sulphur Bay, Clarion Island, March 16, *Elmore B12*, on edge of fresh water lagoon.

From Kansas to Arizona and south through tropical America.

MORACEAE

FICUS COTINIFOLIA H.B.K., Nov. Gen. & Sp. 2:49. 1817.

Braithwaite Bay, Socorro Island, March 18, *Elmore C6*, elev. 20 feet.

In low and middle elevations from southern Baja California and central Sonora south into Central America, especially along canyon water courses. It is the most common and widespread fig tree in western Mexico. Elmore notes it as growing on the island "in good red dry volcanic soil with aerial roots from overhead branches." Johnston (1931) reports that these broad large trees are a favorite haunt of the untended sheep so numerous on Socorro Island. He attributes this to their desire for shade. They may also be attracted by the edible fruits dropping upon the ground and which are a favorite source of food for both wild and domestic animals in Mexico. People eat them in times of hunger, but generally as a source of food they are not desirable.

This island collection shows some minor differences in leaf venation from that of typical mainland material, but due to lack of florescence it cannot be more critically compared. Its affinities are obviously close to that of *F. cotinifolia*, and in spite of the apparently long isolation of the Socorro Island population, it is unlikely that it would show more than varietal distinction. *Ficus* is an old genus, known from the Cretaceous.

NYCTAGINACEAE

BOERHAAVIA CARIBEA Jacq., Obs. Bot. 4:5, t. 84. 1771.

Braithwaite Bay, Socorro Island, March 18, *Elmore* C7, C11, elev. 100 feet, in crevices of basaltic rocks where there was sufficient disintegrated rock to form soil.

A low viscid perennial herb with small dark purple flowers widely distributed in the American tropics. The specimens are fragmentary remains of plants indicating an earlier period of florescence. It normally flowers in the summer and fall.

AIZOACEAE

SESUVIUM PORTULACASTRUM L., Syst. Nat. ed. 10, 2: 1058. 1753.

Sulphur Bay, Clarion Island, March 16, *Elmore* B10, clay soil around old lagoon, flowers pink.

Widely distributed in brackish soils in the American tropics, but not abundant on the adjacent Mexican coast and not known from other Revilla Gigedo Islands.

LEGUMINOSAE

PHASEOLUS ATROPURPUREUS SERICEUS Gray, Proc. Am. Acad. Sci. 5:156. 1861.

Sulphur Bay, Clarion Island, March 16, *Elmore* B2, many plants on upper beach, flowers dark red.

On coarse arid soils in southern Arizona and western Mexico. The densely sericeus variety is here recognized for the race inhabiting northwestern Mexico. The species ranges from southwestern United States to Costa Rica.

SOPHORA TOMENTOSA L., Sp. Pl. 373. 1753.

Sulphur Bay, Clarion Island, March 16, *Elmore B4*, upper beach.

Although widely distributed in the tropical littoral of both hemispheres, it is not known from the Mexican mainland, so that its presence on Clarion Island is a special problem in distribution. Native peoples make use of the plant for supposed or actual medicinal properties, and it is possible that early seafaring people introduced the plant on Clarion Island.

ZYGOPHYLLACEAE

TRIBULLUS CISTOIDES L., Sp. Pl. 387. 1753.

Sulphur Bay, Clarion Island, March 16, *Elmore B1*, beach sand.

Widely distributed through the warmer parts of America.

EUPHORBIACEAE

EUPHORBIA ANTHONYI Brge., Erythea 7:7. 1898.

Braithwaite Bay, Socorro Island, March 18, *Elmore C9*, a few plants growing in crevices of lava rocks in side of canyon wall.

A low shrubby plant endemic to the Revilla Gigedo Islands; the type described from San Benedicto. In Standley's "Trees and Shrubs of Mexico" (C.N.H. 23:602) the type locality is given erroneously as San Benito Island. Dr. Wheeler, who determined the above collections, states that it is atypical, perhaps juvenile.

EUPHORBIA CF. CALIFORNICA Benth., Bot. Voy. Sulph. 49, pl. 23B. 1844.

Sulphur Bay, Clarion Island, March 16, *Elmore B8*, rocky loam on gradual slope, flowers about one-quarter inch across, yellow green.

The material is insufficient for certain identification. Typical *E. californica* has not been reported from these islands and is known only in the California Gulf Region.

EUPHORBIA CLARIONENSIS Brge., Erythea 7:7. 1898 and Zoe 5:27. 1900.

Sulphur Bay, Clarion Island, March 16, *Elmore B6*, upper beach in exposed dry sandy soil, flowers white, the white tips with red brown centers.

Endemic to the Revilla Gigedo Islands.

STERCULIACEAE

WALTHERIA AMERICANA L., Sp. Pl. 673. 1753.

Sulphur Bay, Clarion Island, March 16, *Elmore B9*, among lava boulders on dry slope. Braithwaite Bay, Socorro Island, March 18, *Elmore C2*, elev. 5 feet.

Widely distributed in the warmer parts of the world, common through Mexico. A low perennial herb, often polypodial, 5-8 dm high, very aggressive on disturbed areas, and one of the most collected weeds of tropical America. Its presence on even the remote Revilla Gigedo Islands is not surprising. Elmore reports that only a few plants were observed.

CACTACEAE

OPUNTIA OCCIDENTALIS Engelm. & Big., Proc. Am. Acad. Sci. 3:291. 1856.

Braithwaite Bay, Socorro Island, March 18, *Elmore C10*, in basaltic canyon in between boulders where there is a little soil formed by disintegrating lava.

Southwestern California, northern Baja California, and the adjacent islands along the maritime slopes; type from "western slopes of the California Mountains."

Elmore's collection is the first identifiable material of the *Platyopuntia* which has long been noted upon the slopes of Socorro. Although sterile, his specimens exhibit only minor differences from California plants, as reviewed by Dr. Clover, who made the determination. The presence of this species appears to be another bit of evidence supporting the theory of the dissemination of migrules by oceanic currents. The relationship of the Revilla Gigedo plants to the flora of California and means of dispersal has been discussed by Johnston (1931).

CONVOLVULACEAE

IPOMOEA CATHARTICA Poir., Encycl. Suppl. 4:633. 1816.

Sulphur Bay, Clarion Island, March 16, *Elmore B5*, upper beach in exposed sandy soil, flowers blue or purple.

Common to the American tropical lowlands; among the Revilla Gigedo it is known only from Clarion Island.

BORAGINACEAE

HELIOTROPIMUM CURASSAVICUM L., Sp. Pl. 130. 1753.

Sulphur Bay, Clarion Island, March 16, *Elmore B11*, on edge of fresh water lagoon.

Common on saline or alkaline soils throughout most of tropical and subtropical America.

LABIATAE

TEUCRIUM TOWNSENDII Vasey & Rose, Proc. U.S. Nat. Mus. 13: 146. 1890.

Sulphur Bay, Clarion Island, March 16, *Elmore B14*, on 40° slope in lava rocks with a little soil between, flowers white.

A low succulent appearing herb with crowded ovate leaves, remotely and irregularly crenate, thickish, inflorescence crowded at the ends of the branches. Known only from Clarion Island.

SOLANACEAE

NICOTIANA NESOPHILA Jtn., Proc. Calif. Acad. Sci. IV, 20:93. 1931.

Braithwaite Bay, Socorro Island, March 18, *Elmore C3*, in crevices of basaltic rocks where sufficient soil has formed.

Known only from Socorro Island. The lower leaves of the *Elmore* specimens are undulate, tending to be lobed toward the base, not crenate as described for the species by Johnston, but otherwise agreeing. The flowers are reported as cream colored.

COMPOSITAE

BRICKELLIA PENINSULARIS AMPHITHALASSA Rob., Proc. Calif. Acad. Sci. IV, 20:93. 1931.

Sulphur Bay, Clarion Island, March 16, *Elmore B7*.

Known only from Clarion and Socorro Islands, this variety is a low brittle shrub with pale yellowish branches and prominent nodes. Mason (in Johnston 1931:100) reported it the most dominant cover on Clarion Island.

PERITYLE SOCORROSENSIS Rose, Bot. Gaz. 15:118, t. 13, f. 9. 1890.

Sulphur Bay, Clarion Island, March 16, *Elmore B13, B3*, growing in crevices of lava boulders, partially shaded on upper beach.

Herbaceous, said to be perennial. Known only from Socorro, San Benedicto, and Clarion Islands. *Elmore B3* is a more vigorous form with larger leaves and without ray flowers.

VIGUIERA DELTOIDEA TOWNSENDII Vasey & Rose, Proc. U.S. Nat. Mus. 13:148. 1890.

Braithwaite Bay, Socorro Island, March 18, *Elmore C5*, growing among lava boulders in decomposed lava soil at 15 feet elev.

Known only from Socorro Island.

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TRES MARIAS ISLANDS

The **Tres Marias Islands** are out on the steep edge of the continental shelf about sixty to seventy miles off the mainland shore of Nayarit, opposite the port of San Blas. They appear to have been in existence since sometime in the Pliocene and in part much earlier. They are composed of several kinds of both igneous and sedimentary rocks. The Miocene and Pliocene marine formations on Maria Madre and the Mesozoic rocks on Maria Magdalena indicate local differential faulting. To Nelson (1899:9-11) the position of the islands upon the continental shelf and the similarity of the vertebrate animals to those of the mainland indicated a Quaternary land bridge. However, the seven species of endemic mammals, the 24 species and subspecies of endemic birds and an endemic reptile, as well as the 21 species of endemic plants known from the islands, strongly indicate a considerable period of insular development. A local insular biota was apparently well developed before the Quaternary land bridge, so that aggressive mainland adventives would have had to compete to establish themselves.

Soundings show a rather narrow submarine ridge extending out from Punta Mita, Nayarit, toward the Tres Marias and in line with their axis. The deepest sounding along this line shows 70 fathoms (ca. 30 m), with greater depths to port and starboard. Glaciation is thought to have lowered sea levels from 80-100 m (Zeuner, 1945:248), which is sufficient to cause peninsulation in this case. Probability of the land bridge hypothesis is also dependent upon local epirogenic movements and a study of geology still in waiting.

The climate of the Tres Marias is subhumid, tropical, maritime, and equable with a binary pattern of seasons; rainy summer, and arid spring. The maritime influence appears to ameliorate the long spring dry season. (Grayson 1871:267) "In the dry season heavy dews are frequent, the drops of which I have often seen the birds sipping, for want of other means of quenching their thirst, there being but few *ojas de agua* (springs)." Summer rains are convectional in type, the "chubasco" storms of wind-driven rain being common and making navigation for small boats hazardous. Hurricanes in the fall rarely swing in across the islands from the southwest (Schiaffino, 1939). No rainfall data are available for the islands but precipitation should be approximately that of San Blas on the mainland, which has an annual average of 58.5 inches. The annual average temperature at San Blas is 24° C., with no record of frost (1939).

The natural vegetation of the islands is a subhumid tropical drought

deciduous forest with a multiple dominance of tree species. One of the most conspicuous dominants originally was Spanish cedar, *Cedrela*, which oddly enough, although still living upon the islands, has never been collected. The first naturalist to see these forests was Grayson in 1865, 1866, 1867, who wrote of them (1871:264). "The immense cedar (*Cedrela odorata*) grows in great abundance on this island (Maria Magdalena), not having been disturbed by the wood cutters. This tree makes the finest lumber in the world. It is also common on the coast of tierra caliente. Cleofa, the smallest of the three islands, is also well wooded and has a good little port. All these islands, except Juanito, are covered with a dense forest from the water's edge to the top of the highest hills. The shape of the trees (of which there is a great variety), is generally straight or straighter and taller than upon the main. There is but little thorny underbrush, so characteristic of the tierra caliente."

Cutting of *Cedrela* was in progress on Maria Madre at the time of Grayson's visits. Later a penal colony was established on Maria Madre by the Mexican government and disturbance of the native vegetation has continued. Ferris in 1925 (1927:64) found the area about the penal colony cut over and a weedy aggressive cover advancing, many species of which appeared to be newcomers from the mainland and characteristic of disturbed areas about Mazatlan and San Blas. Little agriculture has been practiced on this island.

The islands are reputed to have been uninhabited by man until the coming of Europeans, the first of whom to inhabit the islands were buccaneers (cf. Dampier, 1703). If it is true that the Amerindian never inhabited the islands, it is very remarkable indeed, for traces of man indicate that he has over-run almost every square mile of North America at some time during his long residence on this continent. Sixty miles of sea water is a small barrier and although the Spaniards may have found the islands uninhabited, it is still likely that some of the prehistoric peoples who inhabited the adjacent mainland, and some of whom had advanced cultures, must have known of, visited, and even inhabited the Tres Marias for some periods. Maria Magdalena has apparently been only partially disturbed by man, and should this fragment of primeval vegetation (never affected by early man) still exist, it would be a singular boon to all students of natural vegetation.

The known flora of the islands consists of 11 species of ferns and 313 spermatophytes. These have been catalogued in 3 separate papers, Rose (1899), Ferris (1925), Eastwood (1929). Over 90% of these

are known only from Maria Madre. In addition to a species of *Cedrela*, a giant Agave, and a native cotton mentioned by authors and still unidentified, are many other plants still awaiting collection and study. Altogether these islands offer a most interesting subject for field research. The job calls for a botanist of ethnographic and geologic background in insular residence throughout the summer and fall, at least.

San Juanito Island. The Tres Marias Islands are actually four. The odd one is San Juanito, the northwesternmost of the group, lying across a narrow channel from Maria Madre. It is the smallest, being about 5 kilometers long, 3 kilometers wide, 15 square kilometers in area, and about 300 meters in elevation. Nelson and Goldman are apparently the only biologists who have visited it and the former gives the following short description (1899:10, 12), "San Juanito which is nearly flat with a narrow border of low bluffs along the northern shore—. On San Juanito the vegetation is largely made up of bushes and scrubby trees 8 to 15 feet high, with many Agaves on the sandy southern end. Agaves are very numerous also on the northern end of Maria Madre." There are no known plant collections and it apparently has never been visited by botanists, the accounts of other expeditions do not mention any landings there.

Maria Madre Island is the largest of the Tres Marias group, 21°35' N. by 106°40' W. It is approximately 20 kilometers long, 10 kilometers wide, and 200 square kilometers in area. The peak of the island is 616 meters above sea level.

The land forms consist of narrow beaches, cliffs, canyons, mesas, hill slope and ridge. Arroyo Hondo is a notable intermittent water course originating near the central peak and descending northwestward through a deep canyon to discharge water into the sea during the rainy season. In the past it has been difficult of access by land. Hanna (1926:67-71) found the island to consist of a central pediment of granite with Pliocene marine sediments of chert, limestone, and sandstone lapped upon it to near the top of the peak. "During a portion of Pliocene time large coral reefs existed around this old land mass and large blocks of the fossiliferous material, firmly cemented, having fallen from the exposures and have rolled indiscriminately far out into the forest." The island appears to have had its inception in Miocene times, if not before, and grew in area during the Pliocene. Maximum size was probably attained during one of the glacial periods when sea levels were universally lower.

What is known of the vegetation has been described above. As with nearly all of the Eastern Pacific islands, very little attention has been

paid to the life histories and the ecology of the plants that live upon them. We are still ignorant of the community make-ups and the inter-relationships of the biota. Certainly the terrain is sufficiently diversified to support various associations, although the elevation is not spectacular and the present island area is not an ancient one. The area of the island, its tropical nature, the observations of visitors, and the lack of summer and winter collecting all indicate that the known flora of about 300 plants is probably little over half of what actually exists. Many of the plants listed, due to inadequate material, have been determined to genus only, others are tentative. The Euphorbiaceous genus, *Calacnodendron*, appears to be endemic. Should more be found, we would have to revise our opinion regarding the age of the island, which seems to have been little more than a large rock until some time in the Pliocene. Until the amount and nature of endemism and the identity of most of the species are known, all inferences regarding the development and relations of the flora must be very tentative. There is no group of islands in the Eastern Pacific more worthy of thorough investigation.

Maria Magdalena Island lies about 11 kilometers across channel from Maria Madre. It is approximately 150 square kilometers in area, 16 kilometers long, 10 kilometers wide, and with a central peak of about 450 meters elevation. Physiographic habitats include beaches, sea cliffs, canyons, rocky slopes and ridges. Hanna (1926:73) mentions various canyons and a water hole in the next canyon west of the one in which they were camped, near the center of the north side of the island. They were there in May, when the dry season is well advanced, so that the water must be nearly or actually permanent. Concerning the geology he wrote (1926:72) "Maria Magdalena 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 compose the central core of Maria Madre Island was found."

In 1865-67 Grayson found Maria Madre "unoccupied and covered with a grand forest of fine timber" (1871:264). Nelson in 1897 found the vegetation similar to that on Maria Madre. He stated that most of the Spanish cedar was gone, but that a large percentage of the original forest remained intact. Hanna and party "all agreed that the fauna and flora of Maria Madre and Maria Magdalena were almost identical." This is what one would expect of the vegetation, but not of the flora, if Hanna's supposition regarding the geology of the two islands is correct. If Miocene and Pliocene rocks are absent on Magdalena and present on Madre, one would infer that the former is the older, larger area and its flora with a consequent difference in speciation of related groups, which might in part be represented on the younger Maria Madre.

The known flora of Maria Magdalena consists of only 31 species of vascular plants collected principally by Nelson in 1897 and Mason (35 numbers) in 1925. Francis H. Elmore made a small collection in May of 1939 during the Allan Hancock Pacific voyage. They are enumerated below, *Jacquinea aurantiaca* being a new addition to the island flora.

CATALOGUE OF COLLECTIONS

POLYGONACEAE

COCCOLOBA SCHIEDEANA Lindau, Bot. Jahrb. Engler 13:187. 1890.

Magdalena Island, May 9, *Elmore 1B3*, a few plants in boulders and sand along a dry stream at 15 feet elev.

Apparently along both coasts of Mexico from Sinaloa and Vera Cruz south to Guatemala; type from Papantla, Vera Cruz.

THEOPHRASTACEAE

JACQUINEA AURANTIACA Ait., Hort. Kew. ed. 2, 2:6. 1811.

Magdalena Island, May 9, *Elmore 1B1*, dry rocky partially shaded stream bank, elev. 15 feet.

From Sinaloa to southern Mexico, Central America, and the West Indies; also on Maria Madre Island.

VERBENACEAE

AVICENNIA NITIDA Jacq., Enum. Pl. Carib. 25. 1760.

Magdalena Island, May 9, *Elmore 1B2*, dry sandy soil of the upper beach. Widespread along the coasts of tropical America.

Maria Cleofa Island. The last and southern-most of the group is Maria Cleofa. In dimensions this island is approximately 6 kilometers long, 5 kilometers wide with an area of about 25 square kilometers. The one central peak is given as 402 meters in elevation.

Except for the brief remarks of Grayson and Nelson, the only naturalists who have visited the island, there is little known of the island. Nelson noted that canyons descend from the central peak in all directions. At least one of them carries an intermittent stream, which sinks in its bed before reaching the sea during the dry season. In comparison to the other islands Nelson states (1899:12), "Maria Cleofa is more rocky and sterile, and the trees are bushy and stunted."

The total known flora of land plants consists of Nelson's collection of these four species: *Zamia loddigesii* (?), *Arundo donax*, *Cyperus ligularis*, and *Trixis Wrightii*.

TABLE 4

Year		Spring	Summer	Fall	Winter
	<i>Maria Madre Island</i>				
1897	E. W. Nelson	95			
1925	H. L. Mason	128			
1925	R. S. Ferris			221	
	<i>Maria Magdalena Island</i>				
1897	E. W. Nelson	14			
1925	H. L. Mason	35			
1939	F. H. Elmore	3			
	<i>Maria Cleofa Island</i>				
1897	E. W. Nelson	4			
Totals		279		221	

Table 4. Plant collectors and their respective numbers collected on the Tres Marias Islands.

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CALIFORNIA GULF REGION

GENERAL PHYSIOGRAPHY

The California Gulf Region possesses considerable physiographic unity, although its boundaries are not fast. For the purpose of this study it includes, besides the great gulf nucleus itself and its chromosomic islands, the surrounding coastal plains, mostly narrow and in part lacking, the coastal mountains, and the Cape District of the peninsula. It forms a long narrow area nearly 1000 miles long containing about 150,000-175,000 square miles. It is nearly co-extensive with the Sonoran Desert, the latter comprising additional area in northern Sonora, south-eastern California, southwestern Arizona, and on the peninsula except in the Cape District. The western middle portion of the peninsula is being considered in another study.

Nearly half the area is occupied by the sea. Its western shores are generally precipitous and without rivers, while its eastern are mostly low coastal shores with several intermittent rivers. From the mouth of the Colorado River in the apex, the gulf gradually deepens to 2600 meters under its 225 kilometer-wide mouth. The upper part of the gulf is generally less than 300 meters in depth with low gradients on the eastern and northern margins. South of Angel de la Guardia and Tiburon Islands it rapidly deepens to over 1000 meters and the 1500 meter contour comes well up into the gulf. In this water are 25 to 30 larger islands and many smaller ones, some of which are no more than jagged rocks set upon by the tides and wind-driven waves. The topography of the northern half is terrestrial in type rather than marine.

It is the water relations, both of the sea and of the air, that give the country its distinctive quality. The gulf water is changeful. It can be as quiet as a forest pool at dawn or as choppy as Lake Erie. High seas often run under the strong and recurrent winds. In the late summer of the convectional storm cycle, hard squalls suddenly appear and have upset many a light ship, and in the early colonial days made the passage of the gulf and the colonization of the peninsula a hazardous undertaking. The waters teem with life; fish, shrimp, whale, and many other animals run in and out in their seasons, as also do a vast assemblage of birds over the surface; others, from plankton and crabs to sharks and turtles, are permanent residents. The sublittoral zone is covered with an abundance of varied algae. Under the brilliant sunlight, the ever mobile waters, blue or green or vermilion or gray, are set sharp against the rocky, uneven, and disconsolate shores.

The water of the air is rare, because it seldom falls as rain, although

actually the hot air contains more moisture than usually exists over temperate regions. Hence, in contrast to the dense biota in the sea, the land is relatively barren. The land biota, though seemingly dead, is nevertheless there, and with many special adaptations for survival of drought. When rains fall, the plant life suddenly becomes intensely active and the land becomes green and flower-colored. To the man who may be there the desolate then becomes a garden of well-spaced forms. And it, too, in brilliant sunshine is set sharp against the inanimate rocks beside the waters of the gulf. Such is the impression of the gulf region on the senses today. Geologically, the perception has quite a different quality, because the eye and mind are removed from the object by many milleniums.

In spite of changeful orogeny, the California Gulf Region has had a persistent character since the early Mesozoic. The gulf itself is a depressed block, which Schuchert (1935), has discussed as a part of the southern Pacific geosyncline. This sea-invaded trough has had a striking physiographic evolution, the remarkable events and character of which are geologically revealed at every great turn. The biota of the lands has had a restless place and has endured displacements, inundations, extinctions, and has been forced into migrations with the coming and going of the sea, with the submergence or emergence of mountains, and with the concomitant changes of local climate. Close study of the plant and animal life, when directed by a correlating intelligence, should reveal a course of evolution, expressed jointly by plant and rock, hardly equaled in plant geography. There is some lack of agreement among geologists regarding the history of the gulf region, primarily because investigations are still in preliminary stages. From the reconnaissance work that has been done, however, the general history can be outlined. Schuchert has been foremost in synthesizing available knowledge and I have drawn heavily upon his great work in the following paragraphs.

Judging from the world-wide deposits of fossil plants, the modern angiosperms had their inception in the Upper Mesozoic, following the biota dominated by such groups as the seed ferns, the cycads, and the saurians. When the Tertiary opened, the majority of the modern plant families and genera were pretty well established. Hence, in seeking the origin of the desert flora of the gulf region we are concerned with events in the Cretaceous and onward. Of all the major floral elements, the desert floras are the most obscure in origin. They are almost unrepresented in the fossil record. We must seek other sources of evidence for determining their origin, their migrations, and their growth. A

knowledge of the evolution of land forms is primary.

The withdrawal of the Mesozoic seas from the Mexican continent was accompanied by widespread uplift. Large areas became land. They included not only what is now the Gulf of California, but also a marginal area. During the Cretaceous and early Tertiary the shore lines of Baja California and northwestern Mexico reached 50 or more miles westward of present limits, including some of the islands. This land mass might even have included the Channel Islands on the northwest, Guadalupe on the west, and the Revilla Gigedos to the southwest, although there is no real geologic evidence to support such a presumption (cf. Jtn. 1931). However, irrespective of the exact boundaries, it is evident that during the Cretaceous and early Tertiary, Baja California and its gulf were a part of a land mass areally different than exists today. The progenitors of our modern flora had a broad base for development in arid latitudes; arid because the land lay in a rain shadow of the Mexican continent, barred from the trade winds, and because the weak westerlies blowing onshore are warmed and dried by the radiation of these latitudes.

The climate of the Eocene appears to have been somewhat wetter than the late Mesozoic, which, because of the extensive sandstone and gypsiferous deposits, is judged to have been relatively arid. However, the granite batholithic and pyroclastic intrusions of the late Cretaceous and Eocene must have raised some mountains, which in turn localized climate abetting drought on the one side and decreasing it on the other, according to the mountain orientation to air flow. However, the interiors of the western land areas have apparently been relatively arid since the middle Mesozoic. Since then, if not before, there have been deserts, though the boundaries of them have been modified or shifted according to climatic cycles and to the raising and lowering of land masses. So, at the beginning of the Tertiary in the California Gulf Region, the environment was already diversified and the evolution of modern seed plants well begun.

In the Oligocene the sea began to invade the old downwarped block of the Southern Pacific Geosyncline for the first time since the Triassic. As the bend deepened the sea invaded the gulf and by the middle Miocene reached half way up the present gulf to about Angel de la Guardia Island and Tiburon Island. By middle or late Miocene it was maximal and covered all of the present gulf, the Colorado Desert, and a section of adjacent Arizona and northwestern Sonora besides. Some of the gulf islands apparently date from that time and still persist as the tops of

submerged mountains, i.e., Angel de la Guardia, San Lorenzo and Ceralbo. Others, as Tortuga may not have appeared until the marked diastrophism of the Upper Pliocene and Pleistocene, when the peninsula gained its present elevation and general outline. San Jose, Carmen, San Marcos, and other islands close along the peninsular shore, may be fault splinters, and their developments intimately related to the dynamics of this compensatory zone. Too little is known geologically to time events in detail.

It was not until the Pleistocene that the modern peninsula arrived. During the late Miocene and the early Pliocene most of the modern southern half of the peninsula was covered by sea, judging from the sedimentary beds. The marine formation described by Darton as "the yellow beds" (Jour. Geol. 24:720-748. 1921), is particularly significant. The beds appear to have covered all but the several old central igneous masses along the Sierra Giganta axis south of San Ignacio and a couple of western outposts. Hence it would appear that for a portion of the Upper Tertiary, the peninsula south of Sierra Calmalli was represented only by a series of islands, where Tertiary pediments crested the invading sea, and which are still represented by locally exposed schists and granites about the bases of modern mountains (Darton l.c. fig. 3).

The more important of such postinsular and prepeninsular masses appear to be represented by the Sierra Vizcaino, the Magdalena Island area, Sierra Zacatecas, a segment of the Sierra Giganta about Cerro Giganta east of Comondu, and the Cape District. A shallow portal across the mid-peninsula about the latitude of San Ignacio appears to be clearly defined and to have been contemporaneous with the yellow beds. As the Giganta fault subsequently became active, the modern peninsula grew southward by anticlinal uplift and accompanying pyroclastics, which now form the greater part of the higher land. Today we see that the whole eastern side of the peninsula from San Ignacio south was tilted upward, the great Giganta scarp reared, the Pliocene waters retreated from the southern and western borders and from the transpeninsular portals. The mountains of the Cape District and the Sierra Vizcaino complex were tied onto the peninsula. This was not accomplished as one gradual sea recession, but according to local orogeny and to the eustatic periods of the Pleistocene. Hence such lowlands as the Vizcaino Depression were alternately opened and closed. The expanse of sand in remotely serried dunes appears to have been formed by successive beaches. In summary, there is little or nothing in the stratigraphy to indicate that the southern half of the peninsula was anything more

than an archipelago during a considerable portion of the Upper Tertiary. The evolution of the biota, the distributions and speciations, are linked with the physiography.

It was inevitable that the evolution of the fauna and flora developed synchronously with the radical physiographic stages, but even though we have both spacial and temporal yardsticks, we have yet to measure these events in terms of plant development and to make specific correlations between organic and inorganic evolution. Plant populations were repeatedly restricted or provided with new areas and divergent habitats. This effected lines of descent with swamping, with infrequent crossing opportunities, with new placements for variants and chance natural selections, and also with entire eliminations. However, it appears that plant evolution can be evaluated in accordance with rates of divergence in many groups, in so far as isolation has fostered it, or as migration has interrupted it, and as speciation has expressed it.

The California Gulf Region was split by the sea invasion, creating disjunct populations on the peninsula, the mainland, and the islands. Specific divergence due to isolation should be greatest about the mouth of the gulf because the sea invaded that end first and the distances separating mainland and peninsula populations are greatest. The Cape District appears to have been isolated, except for its Quaternary union with the peninsula, since early Tertiary times and its high ratio of endemism is to be expected and correlates nicely with a tempo-spacial yardstick. Endemism in the disjunct segments of the upper part of the gulf dates generally from the Upper Miocene or Lower Pliocene. Correspondingly speciation is not so clearly developed and we encounter difficulties in separating the entities to our taxonomic satisfaction. The Pleistocene disjuncts are even less mature and here we often engage the aggravating problem of choosing between species, subspecies, or varieties.

Nevertheless we have to deal with them, since they represent stages in a natural rate of evolution. Were it not for the irrepressible tendency of life to vary, the units of life would be fixed and we would be denied many fascinating problems. By a study of the events that demark the periods of California Gulf history in relation to the evolving organisms, the origins of our desert flora should be less obscure.

THE POSTINSULAR LOCALITIES

The Cape District, consisting primarily of a granitic batholithic block and volcanic intrusives, was not until recently a continuous part of the peninsula, as has been stated above. Westward and southward of La Paz are a series of fossiliferous beach deposits underlaid by marine

deposited arkose. In this locality also, trending north and south, may be seen a southern segment of the Sierra Giganta fault, which itself appears to be a continuation of the San Leandro fault zone, so well known in "Alta California." The sediments of this locality show that this low section of the peninsula did not arrive above the sea until the Pleistocene. The adjacent part of the peninsula, the Sierra Giganta anticline, is composed largely of Pliocene marine sediments. This all indicates that the block of igneous rock in the Cape District had a long existence in the Tertiary as an island. This is significant in the consideration of the biota and especially the flora. Many plants are known only from the Cape District and the adjacent peninsula, to which latter area they have migrated in Quaternary times. I propose to call such land bodies as the Cape District, *postinsular*.

Besides the Cape District there are many coastal "cerros" (a word which the Mexicans apply to their craggy hills), whose positions and the adjacent landward strata indicate are also postinsular mountains. It is not within the scope of this paper to present detailed evidence for this interpretation of the physiography, but the facts: that post-Pliocene detrital and alluvial materials from the Sierra Madre Occidental have built up the coastal plains from 100 to 500 feet; that the Pacific coast is rising; that higher sea levels existed universally in the interglacial periods; and that several Quaternary estuarine deposits and sea caves exist several miles inland, all provide excellent grounds for this theory. More detailed evidence accumulated during my several years of paleontological reconnaissance in the area, will, I hope, appear in a later study. The larger coastal mountains which may be considered postinsular are; in Sonora, Sierra Coloral, Sierra Seri, the monadnock north and west of Guaymas, probably Sierra Bacatete, Sierra Bojihuáqueme, and in Sinaloa, Sierra Navachiste, Sierra Tecomate, and possibly Sierra Tacuichamona.

The floras of these postinsular localities have not been individually studied. On most of them few if any collections have been made. More collections have been made on the Guaymas monadnock than on any of the others, but they are widely scattered in herbaria and not available for detailed study. Nor do they represent all of the postinsular land body lying northwest of Guaymas. Beginning with the collections of Thomas Coulter in 1829-30, the plants taken at Guaymas and vicinity have disclosed a surprising number of novelties, some of which presumably had their specific origin on the Guaymas monadnock. The post-insular Sierra Coloral has not been studied by botanists. McDougal,

Shreve, Gentry, and perhaps a few others have made some fleeting collections on the north end. No collections are known from Sierra Seri; except a few *Mammillaria*, there are none from Sierra Bacatete and Sierra Bojihuáqueme; none from Sierra de Navachiste except Edward Palmer's collections at the harbor of Topolobampo; from Cerro Tecamate, Gentry 100 numbers; from Sierra Tacuichamona, Gentry 192 numbers.

These postinsular floras should show differences from that of the mainland, more or less correlated with the ages of the respective cerros or with the duration of their islandic isolations. Some of them may show considerable endemism, if not of species rank, then of lesser degree. The rare plants that are known from only one or two restricted areas along the Mexican west coast may be postinsular endemics that have persisted or migrated locally since their original habitats joined the mainland. Some of the cases that attract the attention at this point are the following:

Adelia obovata Wiggins & Rollins

Jatropha purpurea Rose

Desmodium Wigginsii Schubert

Lippia Palmeri Wats.

Phrygilanthus sonorae (Wats.) Standl.

Caesalpinia gracilis Benth.

Karwinskia latifolia Rose

Indigofera laevis Rydb.

Ruellia leucantha postinsularis Gentry

Physalis purpurea Wiggins

Sesbania sonorae Rydb.

Physalis sonorensis Standl.

Prosopis reticulata Wats.

Aloysia nahuire Gentry & Mold.

Holographis pallida Leonard & Gentry

Porophyllum pausodinum Rob. & Greenm.

Each of these postinsular localities possesses its own floristic problems in relation to the land flora. A detailed knowledge of their floras would provide considerable evidence regarding their geologic histories and the rate of evolution, in so far as species divergence can be chronologized with physiographic developments. While it may be possible to determine which plants have insular origin, it will be harder in many cases to ascertain what species are of mainland origin and whose distributions now represent migrations upon postinsular mountains. All such problems



offer a fascinating invitation to the student of plant evolution and geography and their solution would contribute to the great latent story of the California Gulf Region.

CLIMATE

The California Gulf Region in spite of its large water surface, is extremely arid around its upper portion. In so far as the continental air circulation dominates, its climate is continental in type. Theoretically, the prevailing air currents are those of (1) the western Pacific anticyclone, the maritime character of which is eliminated by its passage over the west coast land surface northwest of the gulf region; (2) the continental anticyclone, dry, and with marked annual and daily temperature extremes; (3) the mild Pacific westerlies prevailing through the spring as on-shore breezes are consistently dry because of the warmer land surface. The conspicuous fog desert along the outer coast of the peninsula is lacking in the gulf region proper. Near the mouth of the gulf epiphytes occur locally on the mainland, as at Cerro Tecamate. (4) A maritime air current appears to swing in from the near south Pacific as a western limb of the Caribbean anticyclone. In the fall, storms develop along this track (Schiaffino, 1939) and may reach into the gulf.

However, unstable humid air masses are of two sources and two seasons; the winter rains from the northwest Pacific storms which are uncertain and do not fall every year; the summer rains of the tropical convections, which occur regularly in the southern portion of the region, but lighten materially in the interior of the gulf. Averages of yearly rainfalls, as far as regional records are available and vegetative growth indicate, range from 20 to 30 inches for the mountains on either side of the mouth of the gulf to about 3 inches for the lowlands in the upper portion of the gulf. Data are carried in the accompanying table (Table 5). Average winter rainfall is similar for all stations except the high of Alamos in southern Sonora, which is explained by the proximity of that station to Sierra de Alamos (height 1800 m) and its obvious precipitative effect on humid air masses. The same phenomenon is operative throughout the region on other mountains having comparable mass and height.

Average summer rainfall generally decreases from south to north. The average for the five southern stations (Muleje, La Paz, Guaymas, Alamos, Topolobampo) is 9.5 inches, while for the northern stations of Brawley, Lechuguilla, Tule Tank, Cirio Point, and Libertad, it is only 1.6 inches. This greater summer rainfall in the southern part of the

California Gulf Region is most responsible among the climatic factors for the tropical elements in the southern flora. It fosters the existence of many plants requiring or responding only to summer rains, when higher temperatures, longer daylight periods, periods of shortening daylight (fall), higher humidities, etc., prevail. The lack of synchrony of these factors in the northern area excludes many subtropical plants.

TABLE 5

Station	Elev. ft.	Length of record (years)	Average summer rainfall	Average winter rainfall	Average annual rainfall
Brawley, California.....	-100	29	0.63	2.01	2.64
Mexicali, Baja California.....	3	15	1.0	2.0	3.0
Muleje, Baja California.....	110	15	2.7	1.3	4.0
La Paz, Baja California.....	60	15	4.4	2.7	7.0
Lechuguilla, Arizona.....	700	5	1.7	2.6	4.3
Tule Tank, Arizona.....	1100	9	2.2	1.9	4.1
Cirio Point (Sierra Coloral), Sonora.....	180	10	2.1	1.5	3.6
Libertad, Sonora.....	100	10	2.1	1.8	3.7
Hermosillo, Sonora.....	700	15	10.1	2.1	12.2
Guaymas, Sonora.....	13	15	7.6	2.5	10.1
Alamos, Sonora.....	1200	15	22.1	6.2	28.3
Topolobampo, Sinaloa.....	10	15	11.0	3.2	14.2

Table 5: Average rainfall in inches for some representative stations in the California Gulf Region. Data extracted from Turnage and Mallery (1941) and Atlas Climatológico de Mexico (1939).

COLLECTION LOCALITIES

The Cape District since its beginnings in the Cretaceous (cf. Schuchert 1935:132-133), apparently has had a relatively long and stable geologic history as an island. Due to its age, its high elevations, and its tropical and wetter climate, it has the best developed vegetation and the richest flora of any other part of the gulf region of comparable size. The complex physiography and variety of rock also contribute to its floral richness by providing a wide range of habitats. Present are valleys, hillsides, cliffs, mountain tops, sandy beaches, detrital slopes, springs, short intermittent streams, and on top of Sierra Laguna a small meadow-like basin holds shallow water during the summer rains. The arroyo beds, although with steep gradients, carry deep lenses of granitic sands and support a rich assemblage of mesophytic trees and shrubs.

The principal vegetation formations are: Desert Shrub, Thorn Forest, Short-tree Forest (a subtropical, mixed, drought-deciduous for-

est), and Pine-oak Forest. Grasslands are lacking except for a few small mountain meadow-lands, as "La Laguna" on Sierra Laguna and an obvious increase in grasses in the Pine-oak Forest generally. Thorn Forest is not as well developed as it is on the adjacent mainland, being but a brief transitional element between Desert Shrub and the more prevalent Short-tree Forest of the slopes and canyons which comprise the greater part of the area. Except for the minor role of Thorn Forest and the lack of a well defined Oak Grassland, the vegetations show a comparable alignment to that of southern Sonora. The variance may be attributable to the islandic origin. Views of Cape District vegetation are shown in Plate 6.

The flora of the Cape District is more tropical than temperate. Brandegee's floristic survey of the eighteen nineties (1891, 1892, 1894, 1901), listed 104 species of Leguminosae, 103 species of Compositae, and 52 species of Gramineae. While this is incomplete, he did collect generally through all elevations and his collections appear fairly representative of these three major groups of angiosperms. The respective ratios of these groups per given area are often instructive about floristic relations. The light showing of grasses is comparable to that found in Thorn Forest and Short-tree Forest on the adjacent mainland. Generally, the Compositae are more numerous through temperate regions, while Leguminosae dominate the floras of tropical regions. The fact that legumes equal or exceed the composites in numbers of species in the Cape District attests its tropical affinities. The number of genera common to the cape and the adjacent mainland is far greater than those common to the cape and the northern part of the gulf region, as may be expected. In North America the following genera of the Leguminosae in the Cape District have their centers of area in southern Mexico and Central America. *Acacia*, *Mimosa*, *Pithecolobium*, *Lysiloma*, *Desmanthus*, *Albizia*, *Caesalpinia*, *Cassia*, *Bauhinia*, *Indigofera*, *Tephrosia*, *Coursetia*, *Benthamantha*, *Sesbania*, *Nissolia*, *Aeschynomene*, *Erythrina*, *Galactia*, *Phaseolus*, *Haematoxylon*, and *Leucaena*. This list is incomplete, but much longer than we would cite for those having northern centers of areas, as *Astragalus*, *Lupinus*, *Lotus*, and *Trifolium*, and which are not strongly represented in species in the Cape District. Three endemic genera (*Coulterella*, *Clevelandia*, and *Faxonia*) are known from the Cape District, and over 100 endemic species and varieties have been described (interpreting their occurrences along the Sierra Giganta as postinsular migrations).

Actually, except for the flora of the Desert Shrub formation, the

flora of the Cape District is still in isolation. The climatic and edaphic conditions of the peninsula, particularly north of the Sierra Giganta, are not tolerable to the majority of the cape plants. Comparable habitats on the mainland are still over 100 miles of water and coast away. Equally significant to differences in the make-up of the cape flora and the adjacent mainland are the numbers of species the two areas have in common. Considering the long tenure of isolation for the cape flora and the vicissitudes besetting diaspores across salt water, a higher endemism could reasonably be predicted. It may be that the Cape District was bridged to the peninsula during the middle Tertiary, allowing ingress of the aggressive Sinaloa element, which displaced some of the insular population. However, whether cape isolation dates from early or late Tertiary, it is clear that genera have generally been conservative in species generation. The genesis of species does not appear to have progressed nearly as rapidly in land plants as it has in land mammals (cf. Zeuner, 1945:253-269, and 1946).

In April of 1937 and in February of 1938 the *Velero III* made stops in the Cape District. P. J. Rempel and E. Yale Dawson made collections of land plants at San Jose del Cabo, and at Punta Frailes and vicinity (Tables 1, 6). Their collections are enumerated below in the catalogue of species for the California Gulf Region.

Punta Frailes is among the least known of the localities visited by the *Velero III*, the collections from there being the first. Punta Frailes is a granite cerro that juts out into the mouth of the gulf on the southeastern tip of the peninsula (Plate 5, fig. 13; pl. 6, figs. 14, 15). Southwestward of the cerro is a sandy beach, where members of the expedition landed and made collections. For causes which are still obscure, this southeastern tip of the peninsula is the driest portion of the Cape District. North of Punta Frailes is a mountain, known by the natives as Sierra Victoria. This has been confounded by cartographers (who have followed an early error) with Sierra Laguna which is the main central mountain mass of the Cape District. There are no known collections from Sierra Victoria. This mountain and the adjacent area around Punta Frailes form a locality in need of detailed field work.

Puerto Escondido is a small harbor with a neighboring rancho lying at the foot of the precipitous Sierra Giganta scarp. Here the massive sedimentary formation is exposed and variously over-lapped by volcanic lavas and breccias. A narrow plain bounds part of the shore, in part the scarp rises high and spectacular out of the water (Plate 7, figs. 16, 17). The climate is hot and arid, being on the lee side of the

Sierra Giganta, which blocks the westerlies that cool the opposite side of the peninsula. The vegetation is dominated by a dispersed, succulent, microphyllous Desert Shrub with scattered small trees which increase in stature and in number of species up in the steep canyon. Among these latter are *Bursera* sp., *Lemaireocereus Thurberi*, *Cercidium molle*, and the palm *Erythea Brandegeei*.

Four collections have been made from Puerto Escondido and vicinity, mainly in the canyons cutting steeply back into the mountains of Sierra Giganta.

I. M. Johnston	May, June 1921	50 numbers
P. J. Rempel	March 1937	30 numbers
H. S. Gentry	April 1938	50 numbers
E. Y. Dawson	February 1940	25 numbers

It should be noted that all collections were made in the spring and that the late summer flora fostered by the summer rains has not been collected. Due to the precipitous slopes, the arid climate, and the torrential type of rains, the soils are rankly immature. The humic soils are confined to pockets in rocks, or to riparian embayments, and in them are commonly found the small succulents (e.g. *Mammillaria*) and mesophytes of erratic dispersion. In the high, narrow, and rocky canyons, where shade and run-off conserve and augment soil moisture, there are found many subtropical species of the wetter Cape District. *Pachycormus discolor* here forms one of the largest trees with erect straight trunks 30 feet high or more, presenting quite a different habit from the dwarf contorted members of the species found in more arid habitats on the peninsula. *Quercus idonea* occurs in the mesic saddles and slopes near the tops of the Sierra Giganta.

In the sierran area about Puerto Escondido, including the collecting localities of Agua Verde Bay 25 miles to the south and Comondu on the other side of the mountains, there are several plants having local distributions. These include *Verbesina oligocephala*, *Polygala apopetala*, *Ruellia cordata*, *Cercidium molle*, *Dalea vetula*, *Mimulus* sp., *Perityle aurea*, *Agave sobria*, and *Vallesia laciniata*. Their limited distributions corroborate the little geologic evidence gathered to date that indicates insular periods during the Tertiary for the Sierra Giganta area.

Angel de la Guardia Island, lying close along the peninsula, is the second largest of the gulf islands. It has an approximate area of 975 square kilometers and the highest peak is 1315 meters above sea level. As indicated in Plate 8, figs. 18-20, the island is rugged, "barren," with precipitous slopes, and canyons shortly discharging into the sea.

No permanent source of fresh water is known. Physiographically it is young and the arid climate tends to perpetuate the youthful appearance. Sedimentary rocks appear to overlie basic igneous and are in part overlapped by extensive lavas. Very little appears to be on record describing the island. W. H. Burt of the University of Michigan in his notes generously loaned to me described the island as follows: "A range of mountains, attaining a height of 4315 feet in the northern part, traverses the entire length of the island. This mountain range is highest at the two ends and there is a low pass near the center of the island. The west shore is for the most part precipitous but there are several landing places on the east shore and at the north and south ends. The mammalian fauna which is represented by three species, a pocket mouse (*Perognathus*), rock mouse (*Peromyscus*), and a wood rat (*Neotoma*), seems very small for an island of this size which is only eight miles from the mainland shore at its nearest point."

Vegetation is sparse, particularly at the northern end of the island. Both Slevin (1923:69) and Johnston (1924) state that they found more vegetation at the southern end. It is densest on the low gentle slopes in the valleys, and along washes. Judging from the flora (Table 7 and Plate 8), it appears to be a microphyllous, succulent tree and suffrutescent shrub desert, not essentially different from that common to the low and middle elevations of the adjacent mid-peninsula. The succulent or sarcophytic tree forms consist of *Pachycereus Pringlei*, *Le Maireocereus Thurberi*, *Pachycormus discolor pubescens*, *Bursera microphylla*, and are accompanied, at least in the washes and valleys, by such nonsucculent microphyllous trees and shrubs as *Prosopis juliflora*, *Acacia Greggii*, *Cercidium microphyllum*, and *Olneya tesota*. A similar mixture of succulent and microphyllous species occurs in the shrub populations also. Low shrubby suffrutescents are well represented in *Dalea*, *Errazurizia*, *Frankenia*, *Atriplex*, *Petalonyx*, *Franseria*, and *Encelia*.

The flora also shows a strong relationship to the central peninsula, although some of the more striking peninsular species are apparently lacking, e.g., *Idria*, palms and yuccas. Many of the plants of the upper gulf region are here near their southern limits. The 96 species known to the island are enumerated in Table 7. The known endemics are only 6, surprisingly few for the extent and nature of the area. But here again only the spring flora is known. Additional field work is necessary before we can be satisfied of an adequate showing of the flora and before problems of distribution and speciation can be evaluated. The Rempel and Dawson collections are enumerated below in the general catalogue of

species. They collected on the north end of the island, chiefly at Puerto Refugio. Dawson has 4 numbers from Pond Island, a small rocky body connected with the east side of the Angel de la Guardia at low tide. Their collections add 6 species to the known flora of Angel de la Guardia Island, one of which is new to science, *Lyrocarpa linearifolia*.

Tiburón Island is the largest in the gulf. It is separated from the Sonoran mainland by a shallow narrow channel, "el infernillo," two to five kilometers wide and only three to four meters deep. Roughly quadrangular in shape, the island contains about 1170 square kilometers. Although mountainous, there are extensive valleys and several "aguajes," where fresh water is available for indeterminate periods following rains. On the north end, where Bahía Agua Dulce roundly indents the shore line, there is a permanent fresh water spring. In former times it was regularly used as a base settlement for the seminomadic Seri Indians, who still occasionally roam over the island hunting, fishing, and foraging upon the native wild plants and animals. There are two igneous ranges of mountains trending north and south and paralleling the adjacent ranges of Sonora. The western is Sierra Menor, the eastern and higher is Sierra Kunkaak (the Seri name for it) with a middle peak elevation of 1218 meters.

A porphyritic granite occupies the southeast part of the island, according to Jones (1910), who explored the island. He traversed the island north to south along the east side, east to west across the south end, and went into the interior around the highest peak. The greater area of parent rock is volcanic. "The types are profuse and belong to the effusive class." Also present are andesite, rhyolite, "the latter passing into the extreme phases of obsidian and pumice." No limestone or other sedimentaries were observed by him and his party. The volcanics may be a part of the Upper Miocene pyroclastics (Comondu formation), which predominate much of the California gulf area, although Jones took them to be much younger.

The vegetation and the flora, so far as known, appear closely related to that of the adjacent mainland (Plate 9, fig. 21). This is to be expected, since the shallow infernillo channel was emerged repeatedly during the low sea levels of the glacial periods. The land bridge would then have allowed plant migration to or from the island, excepting those plants restricted to the rocky slopes and which find the sandy lowlands intolerable. The dry rocky slopes support a dispersed Desert Shrub formation, while the bottomlands and aggrading surfaces are thinly forested

with the wide spread mesquite, *Olneya tesota*, *Cercidium*, and several of the cactus trees.

The known flora consists of only 77 species, which is considerably less than one would expect on the basis of area and elevation of the island. Obviously, Tiburon Island has been little collected and like other islands in the California gulf, the summer-fall flora is unknown. When the floras of Tiburon and adjacent Sierra Seri are better known, a common origin will probably become apparent that may show some degree of independence from the surrounding region. Both Dawson and Rempel visited Tiburon Island on the voyages of the *Velero III*. Their collections, consisting of 36 numbers were obtained on the southeast corner of the island and add 11 plants to the recorded flora of Tiburon Island.

Tiburon Island has the richest insular vertebrate fauna known in the gulf. The following mammals are represented: coyote (*Canis*), rock squirrel (*Citellus*), two species of pocket mice (*Perognathus*), kangaroo rat (*Dipodomys*), rock mouse (*Peromyscus*), wood rat (*Neotoma*), jack rabbit (*Lepus*), and the burro deer (*Odocoileus*). Bird life is well represented and the following varieties appear to be endemic to the island: Tiburon quail (*Lophortyx gambeli pembertoni*), Tiburon woodpecker (*Centurus uropygialis tiburonensis*), Tiburon gnatcatcher (*Polioptila melanura curtata*), Tiburon cardinal (*Richmondia cardinalis townsendi*), Tiburon towhee (*Pipilo fuscus jamesi*).

San Esteban Island lies in mid-channel in the middle of the gulf region off Tiburon Island. Quadrangular in shape, it embraces about 35 square kilometers of rugged land with a top elevation of 540 meters at the south end. Volcanic in origin, it has "scoriae-covered slopes and much breccia" (Johnston 1924:954). It is shored mostly with high vertical cliffs, but on the southeast is a pebble beach and a broad valley above the beach provides ready ingress. No source of fresh water has been reported.

The ubiquitous Desert Shrub forms a fairly close cover over the gentle valley gradients, where growth is fostered by run-off, and a widely dispersed cover upon the open rocky slopes. The flora is very similar to that of adjacent islands and there are no known endemics other than the small number of plants it shares with neighboring islands, as *Echinocereus grandis* which is common to San Pedro Nolasco, San Lorenzo, and San Esteban Islands. The mammal fauna consists of one endemic species of *Peromyscus* and a colony of introduced rats, *Rattus*.

The *Velero III* land plant collections from San Esteban Island, Rempel 6 numbers, Dawson 6 numbers, consist mainly of cactus. The

early springs 1937 and 1940, when their collections were made, apparently were too dry for general floral response. The summer-fall flora of San Esteban Island is not known, all collections having been made in the spring, Table 6. The known flora consists of 48 species. The Rempel and Dawson collections are annotated in the following catalogue of species.

San Pedro Nolasco is a rocky island 8 to 10 miles off the Sonoran coast along the latitude of Guaymas (N 28°). About 3.5 kilometers long and 1 kilometer wide, it is approximately 3.5 square kilometers in area, and reaches a height of 315 meters. Like most of the gulf islands, it rises sharply with steep rocky slopes out of the restless sea. Landings have been made on the southeast side, where a narrow rocky defile leads up into the interior. No source of fresh water has been reported. It is reported as both volcanic and granitic (Fraser 1943:137, 149). Judging from its stage of weathering (Plate 9, fig. 22), it is a youthful island, but its age is unknown.

In accordance with the rocky slopes there is a heavy succulent element in the vegetation represented by *Pachycereus Pringlei*, *Lemaireocereus Thurberi*, *Fouquieria peninsularis*, *Agave chrysoglossa*, *Pedilanthus macrocarpus*, and several smaller inconspicuous cacti (Plates 10, 11, figs. 23-26). In addition to the tree cactus listed above there are *Bursera microphylla*, the peninsular *Ficus Palmeri*, and the Sonoran *Acacia Willardiana*. Unique also is the extensive growth of a bunch grass, *Setaria macrostachya*, which Johnston reports (1924:987), "extremely abundant on north-facing slopes on San Pedro Nolasco Island (4397) where it makes some hillsides appear like hay fields." This odd assortment of flora is dominantly composed of rock-inhabiting species and suggests fortuitous occupancy characteristic of an infant island. The island appears too young for soils and maturely balanced plant communities to have developed. Comparable pioneer societies have been noted on the recent volcanics of the adjacent mainland, as on the southwestern out-lyers of the Bacatete range along the Sonoran coast.

The known flora (Table 7) consists of 27 species, of which 8 have been added by the *Velero III* collections, represented by 15 numbers collected by Rempel and Dawson as annotated below. The iguana (*Ctenosaura hemilopha*) is a conspicuous resident.

The Guaymas monadnock consists of a discontinuous range of cerros with intervening and bordering valleys and plains. The area has a certain physiographic unity and comprises about 3000 square kilometers with a peak elevation of 1316 meters. Cliff and rocky slopes form an

extensive habitat, which show considerable variance according to the degree of sun and wind exposure. Such rare plants as *Perityle Palmeri*, *Asclepias leptopus*, and *Desmodium Wigginsii* have been found along the cliffs, as well as many cacti, *Agave*, and *Ficus Palmeri*. Conglomerates are apparent and the Recent alluvial deposition of clay and silt has tended to lap upon the mountain sides. The present cycle of degradation at work in the area, however, exposes and sorts the coarse and fine gravels along the shallow arroyo channels, or hurries the coarse fractured rocks down the mountain slopes and canyons.

Plants that attain true tree stature are limited to the run-off channels or the margins thereof. Saline littoral flats are extensive and an unusually rich assortment of halophytes make up a complex association, and among which are commonly found the following genera: *Atriplex*, *Lycium*, *Atamisquea*, *Zizyphus*, *Wislizenia*, *Salicornia*, *Prosopis*, *Stegnospermum*, *Rhizophora*, and many others. The sandy beach lines are widely and intricately interrupted by the steep rocky slopes and cliffs that are hammered by the palpitating sea. On the landward side of the area, alluvial materials have been banked high upon the mountain pediments forming broad plains of Pleistocene aggradation.

The strata are dominated by volcanics which have intruded and overlaid sedimentaries and are in turn partly overlaid by Quaternary beach and littoral deposits. The process of deposition on the bajadas and a structural uplift have raised the area above the confines of the sea. "The hills about Guaymas and for about 80 kilometers to the north are volcanic, consisting of basalt, tufa, and agglomerate. In the hills behind Guaymas a number of old sea caves were noted which, though now over 50 meters above the ocean, contained unconsolidated sands and modern shells. This indicates recent movement at least in one section of the coast" (Johnston 1924:953). The implications of the area being postinsular have been noted above, and while we are not yet certain of this, it is obvious that it has grown in area during the recent period.

The predominating plant formation of the Guaymas locality is Desert Shrub. However, because it is near the southern limits of the Sonoran Desert (see map in Shreve, Mallery, and Turnage 1936:215) and perhaps because of conditions imposed by insulation, there are atypical elements in the floral composition. The Sonoran Desert Region is bounded on the south by the Sinaloan Thorn Forest and species from this latter formation find their northern limits in or near Guaymas. This component includes such prominent Thorn Forest species as *Acacia cymbi-*

spina, *Lysiloma divaricatum*, *Melochia tomentosa*, *Bursera laxiflora*, *Pithecolobium sonorae*, *Zizyphus sonoriensis*, and *Hintonia pterosperma*, which here are either reduced in stature and incidence, or confined to the more favorable situations of soil moisture, as along valley drainways. Certain shrubs achieve local dominance in the Guaymas area that are quite secondary in vegetational weight elsewhere. Among these are *Cordia parvifolia* and *Lippia Palmeri*. With low to medium shrub stature they act a strong part locally in the dispersed shrub formation.

There is present also an arborescent element typical of the Sonoran Desert, including species of *Prosopis* and *Cercidium*, which have normal growth in the valleys but are stunted on the dry rocky slopes. *Pachycereus Pringlei* is abundant upon the rocky slopes and like *Ficus Palmeri* presents a special problem in distribution. These two plants are found widely over the peninsula and on the adjacent islands. Why is their incidence on the Sonoran coast so restricted?

The Guaymas flora was referred by Axelrod (1939) to the Sierra Madre element of the American flora. Chaney's (1944) inclusion of it in the "Southwest American Element" is more appropriate, since the relation of the Guaymas flora to that of the Sierra Madre is remote and at best but general. It is, however, an integral part of the great floral complex that has a long but obscure Tertiary history and a large spacial occupancy in the arid and semiarid southwest of North America. As suggested above, the Guaymas flora has as yet an indeterminate uniqueness in so far as insular isolation may have effected local evolution. Another striking feature of the flora is the number of apparent natural erratics. Some of the species whose occurrences at Guaymas and vicinity appear extralimital are *Ficus Palmeri*, *Pachycereus Pringlei*, *Hermannia pauciflora*, *Lysiloma candida*, *Indigofera mucronata*, *Acacia cymbispina*, *Vincetoxicum petiolare*, *Colubrina glabra*, *Boerhaavia Xantii*, *Lobelia splendens*, *Bouchea dissecta*, and *Vitex mollis*. There is, of course, always the possibility that early man made such local displacements, but in any case they now belong to the native flora.

Guaymas and San Carlos Bays are well known collection localities. Edward Palmer in 1877 was the first to do detailed botanizing in their vicinities. According to Watson's report (1888:36-87), the only paper that has itemized the Guaymas flora, Palmer collected 299 species of flowering plants during the summer months from mid-June to mid-November. Dawson's collections (43 numbers) from there and Rempel's 8 numbers from neighboring Ensenada de San Francisco represent the land plant samplings of the *Velero III*, catalogued below.

SUMMARY OF THE INSULAR FLORAS

Table 6 is a summary of plant collections that have been made on the islands in the California Gulf Region. They represent species or varieties collected, rather than numbers of each collector. In most cases, species collected equals numbers collected, the only notable exception

TABLE 6

Islands	Palmer 1890	Nelson & Goldman 1905-06	Rose 1911	Johnston 1921	Ferris 1934	Rempel 1937	Dawson 1940	Total Coll.	
								summer fall	winter spring
<i>Northern Gulf</i>									
San Luis.....				9					9
Mejia.....				9					9
Angel de la Guardia.....				78		20	16		114
Pond.....				1			4		5
Raza.....	11			7					18
Sal si puedes.....				6					6
Las Animas.....				3					3
San Lorenzo.....				19					19
Patos.....				5		1			6
Tiburón.....			40	60		4	21		125
Turner's.....							3		3
San Esteban.....				37		4	6		47
San Pedro Martir.....	23	1		14				21	17
San Pedro Nolasco.....				13		10	6		29
Tortuga.....				19		21			40
<i>Southern Gulf</i>									
San Marcos.....				31	31				62
Santa Inez.....				4					4
Ildefonso.....				11		2			13
Coronados.....				10					10
Carmen.....	70		32	49				70	81
Danzante.....				2					2
Monserate.....				4					4
Catalina.....			10	5					15
Santa Cruz.....				7					7
San Diego.....				9					9
San Jose.....				9					9
San Francisco.....				12		12			24
Partida Sur.....				9					9
Espiritu Santo.....		22	19	48		20			109
Ceralbo.....		2		42					44

Table 6: Collections of plants from the California Gulf Islands, according to collector and to island.

being I. M. Johnston, who frequently made more than one collection of a species at one locality or on one island. The list of collectors is not complete, but as far as I have been able to determine from literature, it includes all of the important ones. Others that may have collected on the islands, as Diguet and George Lindsay who had special interests in the Cactaceae, have provided few, if any, cited records.

From the table it is clear that botanical exploration has been fleeting. On all except San Pedro Martir and Carmen Islands the summer flora has not been collected and is therefore imperfectly known. While many of the xerophytes produce leaf and bloom following both winter and summer rains, there are also many which respond only in the summer-fall period. These latter are abundant in the southern portion of the region, where summer rains are heavier. Except for Johnston's published notes of a general nature, the ecology of the islands has been given only the most cursory attention. The development of the vegetation, the nature of plant communities, the amount of endemism, and the many diverse problems facing the phytogeographer cannot be determined until further careful and less nomadic field work has been systematically done.

In Table 7 are listed all the plants that have been recorded from the larger California gulf islands. A few of the smaller islands have been omitted from the table for reasons of space, smallness of flora, or because their floras are unknown.

Among the numerous small islands, the floras of which have not been collected, are Consag Rock, Smith, Tassne, and Montague Islands. The known plants on Mejia and Granite Islands are included in the list of Angel de la Guardia Island. Omitted are some small islands found in the bays of Guaymas, Concepcion, and La Paz (Pichilinke). Islands having small lists of spring flora are the following:

Georges Island

Chenopodium murale L.

Patos Island*

Bouteloua barbata Lag.

Amaranthus fimbriatus (Torr.)
Benth.

Carnegiea gigantea (Engelm.)
Britt. & Rose

Opuntia sp.

Atriplex Barclayana typica H. &
C.

Atriplex Barclayana Palmeri
(Wats.) H. & C.

Machaerocereus gummosus (Engelm.) Brit. & Rose

Encelia farinosa phenicodonta
(Blake) Jtn.

* In 1945 all the sporophytes were stripped off Patos Island by a Mexican guano company and the guano producing Peruvian cormorant was introduced.

San Luis Island

<i>Eriogonum galioides</i> Jtn. (type loc.)	<i>Atriplex Barclayana typica</i> H. & C.
<i>Hoffmanseggia microphylla</i> Torr.	<i>Atriplex Barclayana Palmeri</i> (Wats.) H. & C.
<i>Lotus tomentellus</i> Greene	<i>Dalea mollis</i> Benth. (o)
<i>Larrea divaricata</i> Cav.	<i>Bursera Hindsiana</i> (Benth.) Engl.
<i>Euphorbia polycarpa hirtella</i> Boiss.	<i>Eucnide cordata</i> Kell.
<i>Cryptantha maritima pilosa</i> Jtn.	

Pond Island

<i>Mammillaria angelensis</i> Craig	<i>Vaseyanthus insularis</i> Rose
<i>Aster frutescens</i> Wats.	

Raza Island

<i>Monanothocloe littoralis</i> Engelm.	<i>Atriplex Barclayana typica</i> H. & C.
<i>Batis maritima</i> L.	<i>Atriplex Barclayana Palmeri</i> (Wats.) H. & C.
<i>Sesuvium sessile</i> Pers.	<i>Fouquieria peninsularis</i> Nash
<i>Lemaireocereus Thurberi</i> (Engelm.) Brit. & Rose	<i>Pachycereus Pringlei</i> (Wats.) Brit. & Rose
<i>Opuntia tunicata</i> Lehm.	<i>Cressa truxillensis</i> HBK.
<i>Lycium brevipes</i> Benth.	

Turner's Island

<i>Mentzelia adhaerens</i> Benth.	<i>Opuntia Bigelovii</i> Engelm.
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Santa Inez Island

<i>Atriplex Barclayana Palmeri</i> (Wats.)	<i>Amaranthus Watsoni</i> Standl.
<i>Atriplex Barclayana sonorae</i> (Standl.)	<i>Lemaireocereus Thurberi</i> (Engelm.) Brit. & Rose
<i>Lophocereus Schottii</i> (Engelm.) Brit. & Rose	<i>Cressa truxillensis</i> HBK.

Isla Partida**

<i>Antigonon leptopus</i> H. & A.	<i>Atriplex Barclayana typica</i> H. & C.
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** There are two Isla Partidas in the Gulf of California; one in the northern area between Isla Raza and Isla Angel de la Guardia, the other in southern waters on the northern tip of Espiritu Santo Island. It is here suggested that these should be designated respectively as Isla Partida del Norte and Isla Partida del Sur. From the accounts of the California Academy of Sciences Expedition to the Gulf of California (Slevin 1923, Johnston 1924), it is not possible to determine whether the plants listed from "Isla Partida" belong to the north or to the south island.

<i>Amaranthus Watsoni</i> Standl.	<i>Atriplex Barclayana</i> Palmeri (Wats.) H. & C.
<i>Lemaireocereus Thurberi</i> (Engelm.) Brit. & Rose	<i>Cuscuta corymbosa stylosa</i> (Choisey) Engelm.
<i>Datura discolor</i> Bernh.	<i>Lycium brevipes</i> Benth.
<i>Nicotiana trigonophylla</i> Dunal	<i>Hofmeisteria fasciculata</i> (Benth.) Walp.

Bebbia juncea (Benth.) Greene

Las Animas Island

<i>Ficus Palmeri</i> Wats.	<i>Atriplex Barclayana sonora</i> (Standl.) H. & C.
<i>Amaranthus Watsoni</i> Standl.	<i>Echinocereus grandis</i> Brit & Rose
<i>Solanum Hindsianum</i> Benth.	<i>Vaseyanthus insularis</i> Rose

Some synonymy in names of the California gulf islands are:

Las Animas=North San Lorenzo (Proc. Calif. Acad. Sci. IV, 12. 1923-24)

Pichilique=San Juan Nepomucens (according to Leon Diguët)

San Jose=San Josef (Proc. Calif. Acad. Sci. IV, 12. 1923-24)

San Pedro Martir=San Pedro Martin (Rose, C.N.H. 1:78-79. 1890)

San Pedro Martir=San Pedro Martin (Rose, C.N.H. 1:78-79. 1890)

Tassne=Pelican

Turner's=El Datil (local idiom)

TABLE 7

[illegible]

FABACEAE

[illegible]

CELASTRACEAE									
Maytenus phyllanthoides Benth.....	X		X						X
Schaefferia cuneifolia Gray.....									X
SAPINDACEAE									
Cardiospermum halicacabum L.....	X								X
Paullinia tortuosa (Benth.) Brge.....									X
RHAMNACEAE									
Colubrina glabra Wats.....	X	X	X						X
Condalia globosa Jtn.....									X
Condalia globosa pubescens Jtn.....		X							X
Condalia lycioides canescens (Gray) Trel.	X	X							
Karwinskia Humboldtiana (R. & S.) Zucc.....									X
MALVACEAE									
Abutilon aurantiacum Wats.....				X					
Abutilon Dugesii Wats.....									
Abutilon Lemmoni Wats.....	X								
Abutilon Nuttallii Torr. & Gray.....			X						
Abutilon Palmeri Gray.....									
Gossypium Davidsonii Kell. ?									
Gossypium Harknessii Brge.....									
Hibiscus denudatus Benth.....	X		X		X				
Horsfordia alata (Wats.) Gray.....	X	X			O				
Horsfordia Newberryi (Wats.) Gray.....	X	X							
Sphaeralcea ambigua versicolor Kearney.....	X	X							
Sphaeralcea axillaris Wats.....									
Sphaeralcea Hainesii Brge.....			X		X	X			
STERCULIACEAE									
Ayenia filiformis Wats.....		X							
Melochia tomentosa L.....			O	O					X
FRANKENIACEAE									
Frankenia Palmeri Wats.....	X								X
FOQUIERIACEAE									
Fouquieria burragei Rose.....									X
Fouquieria peninsularis Nash.....	O	O							O
Fouquieria splendens Engelm.....		X							O

[illegible]

Table 8 compares the number of known species with the approximate areas and peak elevations for each island. According to other studies made of island floras (Cain, 1944:215-220), we could expect the islands with more numerous species to be correlated with (1) greater island area, (2) islands with higher elevations, (3) complex physiogra-

TABLE 8

Islands	Area in sq. km	Elevation meters	Number of plants known
San Luis	5.0		11
Mejia	3.0		8
Angel de la Guardia	975.0	1315	97
Pond	1.0		4
Smith	10.0		
Raza	1.5		11
Sal si puedes	3.0		7
Las Animas	7.0		6
San Lorenzo	60.0		22
Patos	2.0		8
Tiburón	1170.0	1218	80
Turner's	2.0	172	3
Tassne	5.0		
San Esteban	35.0	540	48
San Pedro Martir	2.0		21
San Pedro Nolasco	3.5	330	29
Tortuga	7.0	312	48
San Marcos	43.0	274	36
Santa Inez			6
Ildefonso	1.5		14
Coronados	6.0	224	23
Carmen	135.0	483	100
Danzante	4.0	138	23
Montserrat	20.0	226	25
Catalina	44.0	475	14
Santa Cruz	14.0	461	28
San Diego	1.0	222	24
San Jose	210.0	583	31
San Francisco	4.5	212	30
Partida	30.0		11
Espiritu Santo	90.0	600	78
Pichilínque			16
Cerralbo	162	775	55

Table 8: The number of known species and varieties of plants compared with area and elevation of the respective gulf islands. Areas have been computed on the basis of approximate measurements and can only be considered relatively.

phy, (4) wetter latitudes, and degree of endemism to be heightened with these same factors plus greater duration of isolation. However, the available figures show us scarcely no such correlations. For example, although Tiburon Island is the largest and one of the highest, it has fewer species (80) than the much smaller island of Carmen (100). Catalina with an area of 44 square km has only 14 species, while San Francisco with an area of 4.5 square km has 30 species of plants. Such figures are meaningless for phytogeographic analysis, because the islands have been so incompletely collected. There is no published meteorological data for any of the islands.

The most striking aspect of the island floras is the apparent lack of divergent evolution. Endemism is at an all space low. This may be explainable on the basis of island youthfulness, or the types of migrules and the agencies that bear them. Or it may be that lack of endemism is in large part apparent rather than actual, since the summer-fall flora is unknown. Can we expect more endemism to have evolved out of the sub-tropical element than has appeared already in the temperate one? The most certain deduction that can be made at present is that all analysis will be tenuous until the island floras are individually and completely known and the physiography of the gulf well dated. The tables are presented at this time not for a complete reference, but rather as a summing up of our present knowledge and to accentuate the need for additional field work. Our ignorance regarding the island floras is nearly enormous.

CATALOGUE OF COLLECTIONS

POLYPODIACEAE

ADIANTUM CAPILLUS-VENERIS L., Sp. Pl. 1096. 1753.

Puerto Escondido, February 11, *Dawson 1090*.

Cosmopolitan in warm temperate regions. In western North America it is known from southern California south to the Sierra Giganta in southern Baja California and central Sinaloa, Mexico.

GRAMINEAE

ANTHEPHORA HERMAPHRODITA (L.) Kuntze, Rev. Gen. Pl. 2:759. 1891.

Punta Frailes, Cape District, February 16, *Dawson 1122*.

Widely distributed in tropical and subtropical America; type from Jamaica.

ARISTIDA PURPUSIANA Hitchc., C.N.H. 17:276. 1913.

San Jose del Cabo, February 17, *Dawson 1211*.

Known only from southern Baja California; the type from San Jose del Cabo.

BOUTELOUA BARBATA Lag., Cienc. 24:141. 1805.

San Jose del Cabo, February 17, *Dawson 1182*. Punta Frailes, Cape Frailes, February 16, *Dawson 1119*.

Southwestern United States and northern Mexico; type from Mexico. It is most abundant through the middle and low elevations of the Grama Grasslands, where it often takes its place as one of the codominants. The cape specimens show no significant differences from mainland material and the population from which they come may be a recent or post-Pleistocene development.

BOUTELOUA CURTIPENDULA (Michx.) Torr. in Emory, Notes Mil. Recon. 154. 1848.

San Jose del Cabo, February 17, *Dawson, 1207*. Agua Verde Bay, March 10, *Rempel 136*.

Widely distributed in North America from Canada to Central America. It is most abundant in the Grama Grasslands of the semiarid southwestern United States and northern Mexico, where it is one of the codominating gramas. It is also in South America, occupying similar habitats. The type locality is the Limpio Mountains, Texas. The February collection is in anthesis, that of March already seeded. The species is apparently capable of flowering twice a year.

CENCHRUS PALMERI Vasey in Brge., Proc. Calif. Acad. Sci. II, 2:211. 1889.

San Jose del Cabo, February 17, *Dawson 1181*.

This strongly spined burr grass is endemic to the California Gulf Region where it is known from the southern half of the peninsula, on the adjacent islands, and around Guaymas, Sonora, the latter being the type locality. It forms extensive stands along the stationary dunes of the outer peninsular coast and is obnoxious because of the strong sharp spines on the large fruits.

ERAGROSTIS VISCOSA (Retz.) Trin., Mem. Acad. Petersb. Ser. VI, Math. Phys. Nat. 1:397. 1830.

San Jose del Cabo, February 17, *Dawson 1160*.

The Cape District of Baja California and India; the type from Malabar Beach. Obviously an introduction, perhaps in ballast.

HETEROPOGON CONTORTUS (L.) Beauv. Roem. & Schult., Syst. Veg. 2:836. 1817.

San Jose del Cabo, February 17, *Dawson 1151*.

Widely distributed in the warmer parts of both the Old and New Worlds; type from India. An aggressive persistent, harsh, scarcely palatable grass and a nuisance in many areas of Mexico. It may be successive on burnt areas.

JOUEA PILOSA (Presl.) Scribn., Bull. Torr. Bot. Club 23:143. 1913.

Punta Frailes, February 16, *Dawson 1122*.

Coastal from Baja California to Nicaragua. In the California Gulf Region it is known from the Cape District and on the adjacent islands as far north as Carmen Island (*Johnston 3835*).

MUHLENBERGIA PORTERI Scribn. in Beal, Grasses N. Am. 2:259. 1896.

San Jose del Cabo, February 17, *Dawson 1203*.

Southwestern United States and northern Mexico.

SETARIA MACROSTACHYA H.B.K., Nov. Gen. & Sp. 1:110. 1851.

San Pedro Nolasco Island, February 6, *Dawson 1035*.

Texas to Colorado, Arizona, and Mexico; type from Guanajuato, Mexico. On San Pedro Nolasco Island it forms extensive stands, being the dominant vegetation over some of the open hill slopes.

CYPERACEAE

CYPERUS ELEGANS L., Sp. Pl. 45. 1753.

San Pedro Nolasco Island, February 6, *Dawson 1036*.

Apparently native to northern Mexico. This is the first record of the species on San Pedro Nolasco Island.

CYPERUS PERENNIS (Jones) O'Neill, in Morton C.N.H. 29:93. 1945.

San Jose del Cabo, February 18, *Dawson 1164*.

Known only from the Cape Region. Apparently rare and seldom collected.

PALMAE

ERYTHEA BRANDEGEI Purpus, Gartenflora 52:11, f. 1-2. 1903.

Canyon above Puerto Escondido, March 13, *Rempel 146, 146a*.

Described originally from the mountains back of San Jose del Cabo, Baja California, the species is common to the canyons where intermit-

tent streams have regular perennial flows through their steep rocky channels in the canyons of the Sierra Laguna and to the north along the east face of the Sierra Giganta. It has not been collected north of Puerto Escondido, but may occur as far north as the sierras west of Muleje. The leaves are small and more lucid than glaucous. Typical specimens appear in Plate 10, fig. 23.

COMMELINACEAE

COMMELINA ELEGANS H.B.K., Nov. Gen. & Sp. 1:259. 1851.

San Jose del Cabo, February 17, *Dawson* 1225.

Widespread in the region of summer rainfall from northern Mexico to Central America; type from "ad ripas fluvii Juanambu, alt. 760 hexap.," central Mexico. A low polypodial perennial herb with bright blue frosty flowers and thick fibrous roots.

AMARYLLIDACEAE

AGAVE CHRYSOGLOSSA Jtn., Proc. Calif. Acad. Sci. IV, 12:998. 1924.

San Pedro Nolasco Island, March 29, *Rempel* 300.

This distinctive Agave of the subgenus *Littaea* is characterized by the unarmed leaf margins, geminate flowers, and small capsules (2 cm long) and is known certainly only from San Pedro Nolasco Island. The above collection, with missing fruit and flowers, is apparently the second collection. The species apparently flowers through March and April.

AGAVE DENTIENS Trel., Rep. Mo. Bot. Gard. 22:51, pl. 38-40. 1911

South end of San Esteban Island, March 27, *Rempel* 295.

Described from San Esteban Island, the extent of its range is uncertain, but it most likely occurs on adjacent islands. I cannot agree with Johnston (Proc. Calif. Acad. Sci. IV, 12:996-997) in assigning the San Esteban plants to *Agave deserti*. In comparing them with the populations on Angel de la Guardia Island, he apparently was misled by intergrading or hybrid plants. The above specimen with its linear-lanceolate leaves and its distinctive deciduous or "friable" mammilloid marginal prickles shows no close relation to plants of *A. deserti* at the type locality, San Felipe, California and which I have observed. Until more material and evidence is obtained, it appears appropriate to maintain the San Esteban plants as specifically distinct.

AGAVE OWENI Jtn., Proc. Calif. Acad. Sci. IV, 12:999. 1924.

Ensenada de San Francisco, Sonora, March 30, *Rempel* 311.

Apparently endemic to the mountains about Guaymas; the type from an islet in Guaymas Harbor. Except for the smaller marginal prickles

and the dark brown color of the terminal spine, probable ecologic variations, the above collection agrees well with Johnston's description. The present collection as well as his description, however, hardly bear out his surmise that the plant is related to *A. yaquiana* Trel. The short conical terminal spine, the grooved or striate perianth, and the ovoid capsule, rather, express a relationship to *A. datylio* Simon of the Cape District of the peninsula.

AGAVE SOBRIA Brge., Proc. Calif. Acad. Sci. II, 2:207. 1889.

Agave carminis Trel., Rep. Mo. Bot. Gard. 22:55. 1912.

Agave affinis Trel., 1. c. p. 56.

Canyons above Puerto Escondido, Baja California, March 13, *Rempel* 143.

Ranges through the mountains south of San Ignacio to and along the Sierra Giganta, its southern limits are not exactly known. Brandegee collected the type on the mesas above Comondu. Dispersed colonies or stands of this *Agave* were commonly observed by the author on the rocky slopes and rocky summits of the long mesas running out westward from the Sierra Giganta towards the Magdalena Plains. The rather small panicles of greenish-yellow flowers are conspicuous through the spring months.

MORACEAE

FICUS PALMERI Wats., Proc. Am. Acad. Sci. 24:77. 1889.

Canyon above Puerto Escondido, Baja California, March 13, *Rempel* 168.

Endemic to the California Gulf Region, where it occurs on many of the gulf islands and the southern two-thirds of the peninsula from Yubay southward. Except for Guaymas and vicinity it is lacking on the mainland. Type locality is San Pedro Martir Island, where Palmer first collected it. It is found principally along rocky canyons, cliffs, and rocky slopes on the mountains where run-off augments the precipitation in increasing soil moisture. The leaves are rather variable, but the most typical form appears to be regularly cordate and during the rainy season they form a dense shade.

LORANTHACEAE

PHORADENDRON CALIFORNICUM Nutt., Jour. Acad. Phil. II, 1:185. 1848.

Tiburon Island, January 25, *Dawson* 1016. Agua Verde Bay, Baja California, March 10, *Rempel* 131.

Known from southern Utah, Arizona, southern California, and

northern Mexico; type from California. It appears partial to leguminous trees. Rempel collected it on *Prosopis*. Both specimens are in flower indicating a considerable latitude for seasonal flower.

PHORADENDRON DIGUETIANUM Van Tieghem, Bull. Mus. Hist. Nat. Paris 1:31. 1895.

Escondido Bay, February 10, *Dawson 1106*. San Gabriel Bay, Espritu Santo Island, March 7, *Rempel 90, 91*, on *Bursera*.

Known from the southern half of Baja California and the islands in the California gulf; *sensu lato* of the species as defined by Johnston (1924:1008).

OLACACEAE

SCHOEPFIA CALIFORNICA Brge., Proc. Calif. Acad. Sci. II, 2:139. 1889.

San Jose del Cabo, February 17, *Dawson 1179*. Puerto Escondido, February 11, *Dawson 1090*.

It forms a shrub or small tree. The leaves are sclerophyllous, ovate, sessile, thickish, mostly 1.5 to 2.0 cm long, and fall away on the herbarium sheets. It is known from near Miller's Landing and Santo Domingo at the north end of the Vizcaino Desert (Goldman, C.N.H. 16:324. 1916) to the cape.

POLYGONACEAE

ANTIGONON LEPTOPUS Hook. & Arn., Bot. Beech. 308, t. 69. 1840.

San Jose del Cabo, February 17, *Dawson 1174*. Punta Frailes, February 16, *Dawson 1127*. Cabeza Ballena, Cape District, March 3, *Rempel 68*.

Mostly in the Thorn Forest along the west coast of Mexico from southern Baja California and southern Sonora to Oaxaca; type from Tepic, Nayarit. It is a showy summer vine with bright pink sprays of inflorescence; cultivated in Mexico and southwestern United States as an ornamental.

ERIOGONUM DEFLEXUM Torr., Bot. Ives Rep. 24. 1860.

Angel de la Guardia Island, Puerto Refugio, January 26, *Dawson 1027*.

Known from around the upper gulf in California, Arizona, and Baja California; type from Three Point Bend, Colorado River.

ERIOGONUM INFLATUM DEFLATUM Jtn., Proc. Calif. Acad. Sci. IV, 12:1013. 1924.

Puerto Refugio, Angel de la Guardia Island, January 26, *Dawson*

1030; March 20, *Rempel* 274. Tortuga Island, March 17, *Rempel* 228.

Known only from the Colorado Desert, northern Baja California, and the adjacent islands of San Marcos, Angel de la Guardia, and Tortuga; type from the Colorado Desert, California. This variety differs from the species in the tendency to produce more numerous and noninflated stems. The March specimen from Tortuga is less advanced than the January one of a later year, indicating a broad seasonal tolerance in harmony with the irregularity of winter rain in the region.

CHENOPODIACEAE

ALLENROLFIA OCCIDENTALIS (Wats.) Kuntze, Rev. Gen. Pl. 1:546. 1891.

Agua Verde Bay, Baja California, March 10, *Rempel* 116, forms mounds on the crescentic dunes. San Francisco Island, March 9, *Rempel* 111, (both sterile).

In moist saline soils of arid southwestern United States and northwestern Mexico from Oregon and Utah south to the Cape District; type from about Great Salt Lake, Utah. A low succulent shrub with brittle short branches and caducous leaves common to the halophytic associations around the lagoons and estuaries of the gulf and western peninsular shores.

ATRIplex BARCLAYANA (Benth.) Dietr., Synop. 5:537. 1852.

Puerto Refugio, Angel de la Guardia Island, January 26, *Dawson* 1031. Guaymas, Sonora, January 23, *Dawson* 1007. Tortuga Island, March 17, *Rempel* 219, 220.

A common and widespread bush on salty or nonsalty soils throughout the gulf area in Baja California and western Sonora; type from Magdalena Bay, Baja California. Goldman (C.N.H. 16:326. 1916) reports it as an abundant low shrub 90 to 120 cm high between Calmalli and San Ignacio. In its several varieties it is an abundant and widespread plant, either as low decumbent perennial herbs or more erect bushes which may become woody.

ATRIplex POLYCARPA (Torr.) Wats., Proc. Am. Acad. Sci. 9:117. 1874.

Puerto Refugio, Angel del la Guardia Island, March 20, *Rempel* 271. Los Angeles Bay, Baja California, March 19, 20, *Rempel* 246.

Widely distributed in the arid southwest from southern Utah and central California south to Sonora and southern Baja California; type from the Gila River Valley, Arizona. While abundant around the

shores of the gulf, there are relatively few collections of the plant from the outer coast of the peninsula. The narrower leaves, shrubby branches, and multituberculate fruits are a combination of characters conveniently separating this species from *A. Barclayana*.

AMARANTACEAE

AMARANTHUS CAUDATUS L., Sp. Pl. 990. 1753.

Tortuga Island, March 17, *Rempel* 213.

Pansubtropical; type locality unknown, described from cultivated plants. It is apparently one of the weeds that was early and widely disseminated in ballast and baggage. It has not previously been reported for the California gulf area.

AMARANTHUS WATSONI Standl., Bull. Torr. Bot. Club 41:505. 1914.

Tiburon Island, January 25, *Dawson* 1014. Agua Verde Bay, Baja California, March 10, *Rempel* 135, reef.

Rather frequent in bottomland and saline soils in the southern part of the gulf region from about Calmalli south on the peninsula; type from vicinity of Guaymas, Sonora. It is also known from several of the gulf islands. (See Table 7.)

CELOSIA FLORIBUNDA Gray, Proc. Am. Acad. Sci. 5:167. 1861.

Cabeza Ballena, Cape District, March 3, *Rempel* 64.

Southern part of Baja California along the rocky slopes and canyons of the mountains; type from Cape San Lucas. A shrub or small tree with rather variable leaves, varying from ovate to ovate-acuminate and from crenate to serrate. Those of *Rempel* 64 are unusual in being broadly lobed near the base. The specimen is fruiting.

FROELICHIA INTERRUPTA (L.) Moq. in DC., Prodr. 132:421. 1849.

San Jose del Cabo, February 17, *Dawson* 1206.

Widely distributed in warmer America. It is a slender erect perennial herb about 1 m high with tomentose pallid leaves all basal and several terminal or nodal, brownish yellow, dense spikes 1.5 to 5 cm long, the lower flowers caducous leaving a whitish naked rachis.

IRELINE ANGUSTIFOLIA Euphrasen, Beskr. St. Barthel. 165. 1795.

Puerto Escondido, February 11, *Dawson* 1940. Punta Frailes, February 16, *Dawson* 1116.

From Baja California to Vera Cruz south through Central America to Brazil and the West Indies; type from St. Barthelomew Island, West Indies.

NYCTAGINACEAE

ABRONIA MARITIMA Nutt. in Wats., Bot. Calif. 2:4. 1880.

San Francisco Island, March 9, *Rempel 103*, on beach dunes. San Juanico Bay, March 2, *Rempel 46*.

Widely distributed in the California Gulf Region where it has been collected or reported along the shores and on many of the islands. Type locality is San Pedro, California.

COMMICARPUS BRANDEGEI Standl., C.N.H. 12:374. 1909.

Puerto Escondido, February 11, *Dawson 1099*. Punta Frailes, February 16, *Dawson 1123*. San Jose del Cabo, February 17, *Dawson 1204*.

Endemic to southern Baja California; type from San Pablo. Insular in origin, it appears to have migrated in Quarternary times northward along the Sierra Giganta. It is a scandent shrub similar in habit to *C. scandens*, but distinguished by larger leaves and the annular arrangement of glands on the fruits.

BATIDACEAE

BATIS MARITIMA L., Syst. Nat. ed. 10:1289. 1759.

San Francisco Island, March 9, *Rempel 102*, around playa.

Littoral in the warmer parts of the New World from Hawaiian Islands to Florida and Brazil; type locality unknown.

PHYTOLACCACEAE

STEGNOSPERMA HALIMIFOLIUM Benth., Bot. Voy. Sulph. 17. 1844.

San Jose del Cabo, February 17, *Dawson 1202*. Sonora, near Guaymas, February 9, *Dawson 1083*. San Carlos Bay, February 8, *Dawson 1058*. Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel 278*. Tortuga Island, *Rempel 230*. Island in Concepción Bay, *Rempel 192*.

Widely distributed through the littoral of middle America; type from Cape San Lucas, Baja California. It forms a dense symmetrical bush 1-2 x 1-3 m and has a long inflorescence period through the spring.

AIZOACEAE

MOLLUGO VERTICILLATA L., Sp. Pl. 89. 1753.

San Jose del Cabo, February 17, *Dawson 1205*.

Widely distributed in North America and the Old World. A low prostrate or ascendant-stemmed annual herb with radiating stems, verticellately branched, lanceolate to linear leaves, and cymose inflorescence. The minute apetalous flowers having tripartite stigmas distinguished it from the Drymarias, which it greatly resembles in appearance. The seeds are reniform, shiny brown, and distinctly ribbed.

SESUVIUM PORTULACASTRUM L., Syst. Nat. ed. 10:1058. 1759.

Cabeza Ballena, Cape District, March 3, *Rempel* 54. West cove in Concepción Bay, March 15, *Rempel* 171. Agua Verde Bay, March 10, *Rempel* 114. Lagoon Head Anchorage, Vizcaino Desert, March 1, *Rempel* 21.

Common along the shores of the tropics and subtropics of the Old and New Worlds; type from Curaçao, Dutch West Indies. The above collections established the plant as general in distribution along the saline littoral of the southern half of the California peninsula.

CARYOPHYLLACEAE

DRYMARIA HOLOSTEOIDES Benth., Bot. Voy. Sulph. 16. 1844.

San Francisco Island, March 9, *Rempel* 108, edge of playa. San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel* 100, transition between beach dunes and alluvial flats. Los Angeles Bay, March 19, 20, *Rempel* 260, north end.

Sandy soils from central Baja California to the Cape District and the surrounding islands. It is one of the most common low winter annuals in the middle peninsula where it affects the arid gravelly soils as well as the sands of alluvial fills and dunes. The type locality was erroneously given as Cape San Lucas, but it is most likely Magdalena Bay, where Barclay and Hinds collected it (Wiggins, Proc. Calif. Acad. Sci. IV, 25:194. 1944).

DRYMARIA PENINSULARIS Blake, Jour. Wash. Acad. Sci. 14:285. 1924.

San Jose del Cabo, February 17, *Dawson* 1189.

Endemic to the postinsular Cape District. A diffuse stipitate-glandular annual 15 to 18 cm tall with thickish linear leaves. A close examination of the petals shows the appendages in the sinuses to be variable. They may consist of one forked ligulate appendage, or 2 to 3 lobes of varying width, some of which are nearly subulate, and which, according to Wiggins (1. c. p. 203, pl. 22), separates the peninsular species from the mainland *D. arenarioides*. Hence, in the Dawson specimens, this floral character separating the two species is not consistent, and suggests that typical *D. arenarioides* may exist on the peninsula, although it has never been collected there, and the Dawson specimen is an intergrading or hybrid form. If this should prove to be the case, then *D. peninsularis* had better be regarded as a variety of *D. arenarioides*.

DRYMARIA POLYSTACHYA DIFFUSA (Rose) Wiggins, Proc. Calif. Acad. Sci. IV, 25:198. 1944.

Puerto Escondido, February 9, *Dawson 1095*.

Known only from Carmen Island and the adjacent peninsula; type from Carmen Island. Annual diffuse herb with sparsely puberulent stems and small broadly cordate leaves 6 to 8 mm long, 6 to 9 mm wide. The Dawson collection disagrees with Wiggins' description in having the sepals acute rather than retuse to rounded and the claw is unusually long. Otherwise it agrees and the clawed long-lobed petals are particularly diagnostic of the species.

PAPAVERACEAE

ARGEMONE MEXICANA L., Sp. Pl. 508. 1753.

San Jose del Cabo, February 17, *Dawson 1223*.

Widely adventive in the tropics of both hemispheres, especially in waste lands; type from Mexico. This specimen is typical of the pale yellow-flowered annual commonly aggressive in the fallowing fields of western Mexico; flowers, spring.

ESCHSCHOLTZIA MINUTIFLORA Wats., Proc. Am. Acad. Sci. 11:122. 1876.

Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel 269*.

The species is widely distributed in the southwestern deserts, reaching its southern limits in central Sonora and middle Baja California. The above collection is the first reported from the California Gulf Islands. It is a small slender annual 20 cm tall with reddish root, scape, the dried petals only 4 mm long.

CRUCIFERAE

DRYOPETALON PALMERI (Wats.) O. E. Schultz in Notizbl. Bot. Gart. Berlin 10:561. 1929.

Puerto Escondido, February 11, *Dawson 1089*. Agua Verde Bay, Baja California, March 10, *Rempel 140a* (fruiting).

Winter annual of southern Baja California.

Lyrocarpa linearifolia Rollins sp. nov.

Herba perennis suffruticosa; caulis ramosis stramineis pubescentibus; foliis linearis sparse lobatis vel integris pubescentibus 1-4 cm longis, 1-3 mm latis; siliquis obcordatis pubescentibus 4-10 mm longis, 5-12 mm latis; stigmatibus sessilibus.

Suffrutescent perennial; older stems ash gray, glabrate, striate, bark exfoliating in longitudinal strips, young stems densely pubescent, terete, reddish-purple beneath the white trichomes; leaves persistent, subfasciculate, densely pubescent with white substellate trichomes, sparingly lobed with 1 to 3 pairs of small lobes or sometimes entire, linear, scarcely dif-

ferentiated into petiole and blade, 1-4 cm long, 1-3 mm wide, lobes 1-3 mm long, ca. 1 mm wide; flowers unknown; siliques clustered at the apex of a nearly leafless peduncle, the infrutescence approaching a subumbellate condition, siliques broadly obcordate with a very shallow sinus above, densely pubescent throughout, strongly flattened contrary to the replum, 4-10 mm long, 5-12 mm wide; stigma sessile and not lobed.

Known only from the type no. 6913 in the herbarium at the Allan Hancock Foundation, University of Southern California, collected at Puerto Refugio, Angel de la Guardia Island, Gulf of California, March 20, 1937, *Rempel* 280.

Lyrocarpa linearifolia is unmistakably related to *L. Coulteri*, var. *Palmeri*. It differs strikingly from var. *Palmeri* in having narrowly linear, relatively undifferentiated leaves, smaller siliques and sessile undivided stigmas. In some plants of var. *Palmeri*, the leaves show a strong trend toward reduction of the blade, but in no case do they approach the narrowness and small lobes of *L. linearifolia*. The leaves of the latter species are subfasciculate but never so in var. *Palmeri*. The stigmas of var. *Palmeri* terminate in a definite short style and are conspicuously lobed, whereas those of *L. linearifolia* are sessile and undivided. Another difference is notable in the infructescence which is subumbellate in *L. linearifolia* and racemose in var. *Palmeri*. The material of *L. linearifolia* is insufficient to permit speculation as to the natural variation found in the species. The type specimen lacks roots, and the stems appear to have been broken off somewhat above the root-crowns. For this reason it is not possible to form any notion as to the height of the plants from which the specimens were taken.

LYROCARPA XANTH Brge., Proc. Calif. Acad. Sci. II, 2:127. 1890.
San Jose del Cabo, February 17, *Dawson* 1199.

Stony canyon slopes and coarse alluvium along the mountains from the Vizcaino Desert to the Cape District.

RESEDACEAE

OLIGOMERIS LINIFOLIA (Vahl) McBr., Cont. Gray Herb. II, 53:13. 1918.

North end of Los Angeles Bay, March 19, 20, *Rempel* 258.

Widely scattered in the deserts of the southwest from Texas and California south throughout Baja California; also in Asia and Africa.

MORINGACEAE

MORINGA OLEIFERA (L.) Lam., Encycl. 1:39. 1783.

Guilandina Moringa L., Sp. Pl. 381. 1753.

Punta Frailes, Cape District, February 16, *Dawson 1139*.

Native of eastern Africa and perhaps of the East Indies. It is cultivated in the tropical latitudes for the "ben" oil of commerce obtained from the seeds. In India the young leaves, pods, and flowers are cooked and eaten. It is cultivated in parts of the American tropics and has become naturalized locally. The collector reports that the above cited number was found growing spontaneously with native vegetation, far from any appreciable settlement.

The plant forms a small tree or shrub and the pinnate leaves, 5-merous and slightly irregular corolla on jointed pedicles, and long legume-like capsules strongly suggests some of the Caesalpiniaceae. The author narrowly averted erecting a new genus to receive it. It is distinguished from members of the Caesalpiniaceae by its tripinnate leaves and the 3 parietal placentae (or 2 plus 1 double placentae) of the ovary. The pod in Dawson's collection is quite terete, somewhat longitudinally ribbed, not perceptibly 3-angled as described by authors, and the anthers are basally affixed rather than dorsifixed as described. The seeds appear to be imbedded in a pulpy aril, rather than winged. The specimen is illustrated in Plates 1 and 2.

KRAMERIACEAE

KRAMERIA PARVIFOLIA Benth., Bot. Voy. Sulph. 6, pl. 2. 1844.

San Jose del Cabo, February 19, *Dawson 1201*.

Arid rocky situations of the gulf region and throughout the Sonoran Desert. This species shows considerable variation in leaf form and in the presence or absence of glandular hairs. Through the northern part of its range in northern Baja California and southwestern United States a wider-leaved glandular variety occurs, *K. parvifolia glandulosa* (Rose & Painter) McBr. Gentry (Carn. Inst. Wash. Publ. 527:120. 1942) reports the species also from southern Sonora and western Chihuahua. A close study of collections should reveal geographic segregates of historical significance.

KRAMERIA PAUCIFOLIA ROSE, C.N.H. 10:108. 1906.

Island in Concepción Bay, Baja California, March 16, *Rempel 198*, on alluvial fan. North end of Los Angeles Bay, March 19, 20, *Rempel 254*.

A low stiff spreading shrub with canescent twigs and foliage common

on the rocky arid slopes of central and southern Baja California; type from La Paz, Cape District.

MIMOSACEAE

ACACIA FARNESIANA (L.) Willd., Sp. Pl. 4:1083. 1806.

Near Guaymas, February 9, *Dawson 1079*. Agua Verde Bay, Baja California, March 10, *Rempel 126*, floor of valley.

Widely distributed in the tropics and subtropics of both hemispheres. A low thorny tree. In the Old World the flowers are employed in making perfume.

ACACIA GOLDMANII (Brit. & Rose) Wiggins, Cont. Dud. Herb. 3:68. 1940.

Acaciella Goldmanii, Brit & Rose, N. Am. Fl. 23:99. 1928.

San Jose del Cabo, February 17, *Dawson 1173*. Cabeza Ballena, March 3, *Rempel 67*.

A slender tree, rare in herbaria, known only from southern Baja California; the type from between San Pedro and Tres Pachilas, Lower California Desert, *Nelson and Goldman 7336*.

Calliandra Brandegeei (Brit. & Rose) Gentry new comb.

Anneslia Brandegeei Brit. & Rose, N. Am. Fl. 23:62. 1928.

San Jose del Cabo, February 17, *Dawson 1165*.

Known only from the Cape District; type from Sierra San Francisco, Baja California. This is a low, stiff, tortuously twigged shrub, the old branches gray, the new reddish brown. The reddish-yellow flowers are described as glabrous, but the above specimen shows a few whitish hairs on both the calyx and corolla.

CALLIANDRA CALIFORNICA Benth., Bot. Voy. Sulph. 14. 1844.

San Juanico Bay, Baja California, March 2, *Rempel 31*.

Scattered through middle Baja California from the latitudes of Rosario south along the outer coast to Magdalena Bay, the type locality. Goldman (C.N.H. 16:332) cites it also from the Cape District, but the cape population is referable rather to *C. peninsularis* Rose. It forms a low stiff bush broadly spreading, its specific ecologic niche being the rocky arroyos. When in bloom through the spring the bright red flowers make it one of the most attractive of the *Calliandra*.

LYSILOMA CANDIDA Brge., Proc. Calif. Acad. Sci. II, 2:153. 1889.

San Jose del Cabo, February 17, *Dawson 1171*. Agua Verde Bay,

March 10, *Rempel* 132 (sterile).

Southern half of Baja California; type from La Purissima. The northern limits appear to be in the mountains just north of San Ignacio about Lat. 27°30'. It is a small tree with conspicuously white bark, white flowers, and rather sparse open foliage.

PITHECOLOBIUM CONFINE Standl., C.N.H. 20:191.1919.

Cabeza Ballena, Cape District, March 3, *Rempel* 61.

A low branching, broad, spreading shrub with thick spiny branches and very heavy, wide, dark brown pods, usually constricted in the middle, common to the river valleys and arroyos of the southern half of the peninsula; the type from Cabo San Lucas.

PROSOPIS JULIFLORA (Swartz) DC., Prodr. 2:447. 1825.

San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel* 84 (sterile). Agua Verde Bay, March 10, *Rempel* 124 (flowering).

Widely scattered in the deserts of North America, the mesquite shows many local variants which are hard to define, but which are in need of close taxonomic study.

CAESALPINIACEAE

CAESALPINIA ARENOSA Wiggins, Cont. Dud. Herb. 3:68, figs. 1-3. 1940.

San Juanico Bay, March 2, *Rempel* 41.

Sandy coastal plains in the southern part of the peninsula from Loreto and San Juanico south nearly to La Paz; type from Guadalupe, Baja California. A rather openly branched shrub up to 2 m tall related to *C. pannosa* and *C. placida*, both of which are apparently cape endemics. *C. arenosa* differs from the others in having tortulose branchlets, puberulent, glandular leaflets, eglandular calyces, and the outer surfaces of the petals glandular almost to the tip.

CAESALPINIA CALIFORNICA (Gray) Standl., C.N.H. 23:426. 1922.

Punta Frailes, February 16, *Dawson* 1125.

Known only from the Cape District. An open shrub with very long peduncles 18 to 24 cm long, pods puberulent, eglandular, straw-colored; pedicels, calyces, petals, and filaments long puberulent. First collected by Xantus, this shrub has rarely been taken since.

CAESALPINIA PALMERI Wats., Proc. Am. Acad. Sci. 24:47. 1889.

San Carlos Bay, Sonora, February 8, *Dawson* 1053, 1061.

Northern Sonora along the coast and foothills to central Sinaloa; type from Guaymas, Sonora. A small tree with irregular divaricate branching, the bark brown and spotted with lenticels. The foliage is sparse, especially in the arid spring when the small leaflets are reduced in size and number. It is distinguished from other members of the genus by its glabrous leaves, eglandular calyces, and small flowers usually not more than 1 cm long.

CASSIA CONFINIS Greene, Pittonia 3:225. 1897.

West cove in Concepción Bay, March 15, *Rempel* 184. North end of Los Angeles Bay, March 19, 20, *Rempel* 251.

It has been collected only along the east side of the peninsula and adjacent islands from the vicinity of Los Angeles Bay to Santa Rosalia; the type from Los Angeles Bay. It is distinguished from its near Sonoran relative, *C. Covesii*, by its larger leaves, thicker fruits, and generally shorter pubescence.

CERCIDIUM MICROPHYLLUM (Torr.) Rose & Jtn., Cont. Gray Herb. II, 70:66. 1924.

West cove in Concepción Bay, March 15, *Rempel* 186, rocky hillside (sterile).

This is one of the most common of the palo verde trees so characteristic of the Sonoran Desert. On the mainland it reaches into southern Sonora and well into middle Baja California. It forms a low spreading tree with a round crown of foliage and while scatteringly common on the open slopes, it attains its best development along arroyos and alluvial fans.

CERCIDIUM PENINSULARE Rose, C.N.H. 8:301. 1905.

Agua Verde Bay, Baja California, March 10, *Rempel* 125 (sterile).

Southern part of the peninsula and on Carmen and Cerralbo Islands; type from La Paz, Cape District. A small symmetrical tree with relatively dense foliage. Goldman (C.N.H. 16:336) provided a photograph of the tree and states, "The type of this species was taken by the present writer on the open plain near La Paz April 16, 1899, then in flower. It is abundant throughout the Cape District south of La Paz except on the upper slopes of the mountains and reaches northward to an undetermined limit, its range overlapping or so continuous with that of *torreyanum* that we did not distinguish between them."

HOFFMANSEGGERIA INTRICATA Brge.?, Proc. Calif. Acad. Sci. II, 2: 151. 1889.

Tiburon Island, January 25, *Dawson 1017*.

Northern Baja California; type from El Campo Aleman. This almost sterile leafless specimen is not certainly identifiable. It contains two or three sordid flowers 4 to 5 mm long, regularly stipitate glandular on bracts, pedicels, sepals, and petals. The filaments are barbate below and with a few stipitate glands above the hairs midway along the filaments. The ovary is 4 to 5 ovulate and bears 2 or 3 irregular rows of sessile or subsessile glands. It is apparently a low shrub with slender numerous purple to glaucous branches forming a broom-like crown.

FABACEAE

AESCHYNOMENE NIVEA Brge., Proc. Calif. Acad. Sci. II, 2:150. 1889.

San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel 94*.

A virgate subshrub, striking because of its silvery pubescence. The above collection is sterile indicating no spring flowering. Known from the southern half of the peninsula and the adjacent islands; type from La Purissima.

COURSETIA GLANDULOSA Gray, Proc. Am. Acad. Sci. 5:156. 1862.

Sonora: San Carlos Bay, February 8, *Dawson 1067*. Baja California: San Jose del Cabo, February 17, *Dawson 1180*. Cabeza Ballena, Cape District, March 3, *Rempel 60*.

Cape District of Baja California, southern Sonora to central Sinaloa; type locality, vicinity of Cape San Lucas. A slender polypodial shrub characteristic of the arid rocky soils along washes in the Sonoran Desert and in washes and on slopes in the Thorn Forest. It is host to a lac insect. It flowers in the spring with depauperate foliage. Its real period of vegetative growth is during summer and fall concomitant with the summer rains.

DALEA EMORYI Gray, Mem. Am. Acad. Sci. II, 5:315. 1854.

Los Angeles Bay, March 19, 20, *Rempel 245*.

Found nearly throughout the Sonoran Desert, lacking apparently only in southern Sonora and tending to be replaced on the outer peninsular coast by *D. tinctoria*, its close relative. Type locality: Tablelands of the Gila, Arizona.

DALEA MARITIMA Brge., Proc. Calif. Acad. Sci. II, 3:125. 1891.

San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel 98*, in

more or less alkaline soil at west end of pass.

A decumbent suffrutescent with canescent, purplish, and glandular-pustulate stems. Known hitherto only from the Cape District; the type from Todos Santos.

DALEA MOLLIS Benth., Pl. Hartw. 306. 1848.

San Juanico Bay, Baja California, March 2, *Rempel* 45.

A prostrate or decumbent or somewhat ascending herb in sandy and coarse gravelly soils nearly throughout the Sonoran Desert.

DALEA PARRYI (Gray) Torr. & Gray, in Gray, Proc. Am. Acad. Sci. 7:397. 1868.

Tortuga Island, March 17, *Rempel* 227. Los Angeles Bay, March 19, 20, *Rempel* 240. Island in Concepción Bay, March 16, *Rempel* 200, on alluvial fan.

Low, erect, slender, suffrutescent herb with divergent branches widely scattered in sandy and gravelly soils, slopes and washes throughout the California Gulf Region; type from Fort Mojave, California.

Dalea variegata (Rydb.) Gentry new comb.

Parosela variegata Rydb., N. Am. Fl. 24:55. 1919.

Cabeza Ballena, Cape District, March 3, *Rempel* 71.

A low slender subshrub described originally from San Jose del Cabo. It appears to be a postinsular endemic and to have migrated little north of its original confines. It is closely related to *D. divaricata*, which ranges northward along the gulf side of the peninsula.

OLNEYA TESOTA Gray, Mem. Am. Acad. Sci. II, 5:328. 1855.

Los Angeles Bay, March 19, 20, *Rempel* 247. West cove in Concepción Bay, March 15, *Rempel* 182, rocky hillside of east exposure.

Widely but intermittently distributed throughout the Sonoran Desert in washes and on alluvial fans up to 2500 feet elevation; type from the tablelands along the lower part of the Gila River, Arizona. A densely branched tree, armed or thornless, with rather persistent leaves, and characteristic of the open washes of the deserts. The *Rempel* collections are sterile. The tree normally flowers from latter April to June.

PHASEOLUS ATROPURPUREUS DC., Prodr. 2:395. 1825.

San Jose del Cabo, February 17, *Dawson* 1214.

Widely distributed in North America from Arizona and Texas to Central America. This lacks the sericeous pubescence of typical material from the Cape District, which Gray described as variety *sericeus*.

PHASEOLUS FILIFORMIS Benth., Bot. Voy. Sulph. 13. 1844.

Punta Frailes, February 16, *Dawson 1145*. San Jose del Cabo, February 17, *Dawson 1213*. Puerto Escondido, February 10, *Dawson 1085*. March 13, *Rempel 156*. Tortuga Island, March 17, *Rempel 223*.

A common small vine throughout Baja California below the chaparral and on adjacent islands; type from Magdalena Bay, Baja California. The leaves are dimorphic; flowers pink.

STYLOSANTHES VISCOSA Sw., Prod. Veg. Ind. Occ. 108. 1788 vel aff. San Jose del Cabo, February 17, *Dawson 1154*.

Swartz' species is widely distributed through tropical America. The genus is in need of revision and Dawson's collection is tentatively assigned.

Tephrosia hamata (Rydb.) Gentry new comb.

Tephrosia Palmeri Brge., Proc. Calif. Acad. Sci. II, 3:126. 1891. Not *T. Palmeri* Wats. 1889.

Cracca hamata Rydb., N. Am. Fl. 24:177. 1923.

Tephrosia hamata Brge. ex. Rydb., N. Am. Fl. 24:177. 1924, a MS name in synonymy only.

San Jose del Cabo, February 17, *Dawson 1153*.

Endemic to the postinsular Cape District; type from San Jose del Cabo. It is a low silvery sericeous perennial with sagging stems.

TEPHROSIA TENELLA Gray, Pl. Wright. 2:36. 1853.

Near Guaymas, Sonora, February 9, *Dawson 1076*. Punta Frailes, February 16, *Dawson 1144*. Tortuga Island, March 17, *Rempel 206*, in wash.

Coarse arid soils from Texas to Baja California and Sinaloa; type from San Pedro, Sonora. A low bushy perennial herb with slender branches from near the base, and purple flowers. Apparently long flowering following favorable rains, from October to March. The Cape District specimen has longer stipules, larger and more pubescent flowers.

ZYGOPHYLLACEAE

FAGONIA CALIFORNICA BARCLAYANA Benth., Bot. Voy. Sulph. 10. 1844.

San Juanico Bay, Baja California, March 2, *Rempel 42*, wash.

West side of the peninsula from San Juanico Bay south to the Cape District; type from Magdalena Bay.

FAGONIA CALIFORNICA GLANDULOSA Vail, Bull. Torr. Bot. Club 22:229. 1895.

Puerto Escondido, February 11, *Dawson 1102*. Los Angeles Bay, March 19, 20, *Rempel 237*. Island in Concepción Bay, March 16, *Rempel 203*, on fan.

Arid desert slopes around the Gulf of California on the peninsula and on the mainland.

LARREA TRIDENTATA (DC.) Cov., C.N.H. 4:75. 1893.

Los Angeles Bay, March 19, 20, *Rempel 242*.

Found in nearly all the hot American deserts.

VISCAINOA GENICULATA (Kell.) Greene, *Pittonia* 1:163. 1888.

Los Angeles Bay, March 19, 20, *Rempel 241*. Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel 277*.

An irregular branching shrub along rocky arroyos of the southern two-thirds of the peninsula, along the mid-Sonoran coast, and known also from Tiburon Island. *Rempel 277* appears to represent the first record from Angel de la Guardia Island.

SIMARUBACEAE

CASTELA PENINSULARIS Rose, C.N.H. 12:278. 1909.

San Gabriel Bay, Espiritu Santo Island, March, *Rempel 85* (sterile)

A low stiff spiny shrub with sclerophyllous drought-deciduous and rather ephemeral leaves, the branches varying from yellowish green to reddish purple, the whole pubescent except the spines. It is known from the southern part of the peninsula from Magdalena Bay and near Mujeje southward; the type from San Jose del Cabo. Johnston (*Proc. Calif. Acad. Sci.* IV, 12:1056) collected it on several of the adjacent gulf islands from Catalina south.

BURSERACEAE

BURSERA HINDSIANA (Benth.) Engl. in DC., *Monogr.* 4:58. 1883.

Bursera rhoifolia (Benth.) Jtn., *Proc. Calif. Acad. Sci.* IV, 12:1058. 1924.

West cove in Concepción Bay, March 15, *Rempel 181*, low shrub or tree on rocky slopes. Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel 267a*. Los Angeles Bay, March 19, 20, *Rempel 234a*. Tortuga Island, March 17, *Rempel 229*.

A thick-butted and usually dwarf tree with thick reddish or gray branches and spur branchlets. The leaves are quite variable; simple, or partially trifoliate, or distinctly trifoliate, as on the Tortuga specimen (up to 7 cm long) or small, as on the Concepción Bay sheet (10 to 15 mm long). As Bullock (*Kew Bull.* 1936:366) has pointed out, the

name *B. Hindsiana* takes precedence over *B. rhoifolia*, because Art. 56 of the International Rules makes binding the first selection of a name out of two or more applicable to the same species under the same date. In this case the rule invalidates later combinations made apparently on the basis of page priority. *B. Hindsiana* appears to be common to the rocky slopes and washes from Los Angeles Bay south through the peninsula and has also been collected on the north central Sonoran coast (Pringle, *sine no.* in 1884).

BURSERA MICROPHYLLA Gray, Proc. Am. Acad. Sci. 5:155. 1861.

San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel 93*. Cabeza Ballena, Cape District, March 3, *Rempel 57*.

On rocky slopes and draws it is scattered through the Sonoran Desert. A closely related plant, *B. morelensis* from the state of Morelos, Mexico, has doubtfully been referred to synonymy under this species (Bullock 1.c. p. 371).

MALPIGHIACEAE

THRYALIS ANGUSTIFOLIA (Benth.) Kuntze, Rev. Gen. Pl. 1:89. 1891.

San Jose del Cabo, February 17, *Dawson 1209*.

Widely distributed in northwestern Mexico; the type from Cape San Lucas, Baja California. A suffrutescent plant, in the above specimen 2 to 3 dm tall, the ovary glabrous except for a few minute hairs on the apex and angles.

EUPHORBIACEAE

ADELIA VIRGATA Brge., Zoe 4:406. 1894.

Cabeza Ballena, Cape District, March 3, *Rempel 63*. Agua Verde Bay, Baja California, March 10, *Rempel 137*, in wash.

Arroyos along the mountains of the Cape District and the Sierra Giganta as far north as Comondu, and reported by Johnston on the adjacent gulf islands of San Jose, Espiritu Santo, and Cerralvo; type from the Sierra Laguna, Cape District. It is an erect slender shrub with several branches bearing fascicles of obovate leaves. The Rempel collections are sterile.

DITAXIS BRANDEGEI (Millsp.) Rose & Standl., C.N.H. 16:13. 1912.

Puerto Escondido, February 11, *Dawson 1108*. Agua Verde Bay, Baja California, March 10, *Rempel 123*.

Widely but infrequently scattered in the California Gulf Region; type from San Gregorio, Baja California. A rather succulent polypodial

subshrub with purplish stems 1 to 2 m tall with regularly lanceolate, remote, finely serrate leaves.

DITAXIS LANCEOLATA (Benth.) Pax & Hoffm. in Pflanzenr. IV, 147:64. 1912.

Puerto Refugio, Angel de la Guardia Island, January 26, *Dawson* 1032. San Jose del Cabo, February 17, *Dawson* 1215.

Open situations in the California Gulf Region, Sonora and Baja California; type from Magdalena Bay, Baja California. A low suffrutescent plant with pale, linear-lanceolate, cinereous leaves. Also related to, but not conspecific, is *Dawson* 1150, from San Jose del Cabo.

DITAXIS NEOMEXICANA (Muell. Arg.) Heller, Cat. N. Am. Pl. 5. 1898.

North end of Los Angeles Bay, March 19, 20, *Rempel* 257, washes and sandy benches.

Arid and semi-arid climates from Texas to southern Arizona, Sonora, and middle Baja California.

EUPHORBIA CALIFORNICA Benth., Bot. Voy. Sulph. 49, pl. 23B. 1844.

San Jose del Cabo, February 17, *Dawson* 1170.

Southern part of the gulf region in Baja California, Sonora, and Sinaloa; type from Magdalena Bay, Baja California.

The specimen is unusually robust, reflecting better soil moisture conditions than commonly obtained in other parts of its range. Questionably referred here also is *Rempel* 70 from Cabeza Ballena, Cape District, a shrub having unusually thin, long petiolate, obcordate leaves, and exfoliating bark.

EUPHORBIA ERIANTHA Benth., Bot. Voy. Sulph. 51. 1844.

Los Angeles Bay, March 19, 20, *Rempel* 248. San Juanico Bay, outer coast, March 2, *Rempel* 34. San Jose del Cabo, February 17, *Dawson* 1221.

Throughout the deserts of the California Gulf Region in sandy soils, east to Texas; type from Magdalena Bay, Baja California.

An erect winter annual with single stem and ascending branches, long linear leaves, and terminal capitate inflorescences, the erect gray-green fruits usually conspicuous. Commonly scattered in dispersed colonies over sandy areas.

EUPHORBIA LEUCOPHYLLA Benth., Bot. Voy. Sulph. 50. 1844.

Punta Frailes, February 16, *Dawson* 1127.

Known from the southern part of Baja California and the adjacent islands of Tiburon and Cerralbo; type from Cape San Lucas.

EUPHORBIA MAGDALENÆ Benth., Bot. Voy. Sulph. 50. 1844.

San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel* 97, west end of pass on shell and coral. San Francisco Island, March 9, *Rempel* 107, shrub 2 feet high on south-facing hill slope.

On both coasts and adjacent islands of the southern part of the peninsula; type from Magdalena Bay, Baja California. Johnston observed what he took to be this plant at San Pedro Bay on the coast above Guaymas, but apparently failed to collect it. It is a low slender-stemmed, densely and intricately branched shrub 4 to 10 dm tall, forming low globose bushes with minute flowers in the spring.

EUPHORBIA PEDICULIFERA Engelm. in Torr., U.S. & Mex. Bound. Bot. 186. 1859.

Tortuga Island, March 17, *Rempel* 222. North end of Los Angeles Bay, March 19, 20, *Rempel* 259. Island in Concepción Bay, March 16, *Rempel* 199, in wash. San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel* 83, on beach dunes.

Widely scattered on the deserts of southwestern United States and northern Mexico and throughout most of the California Gulf Region.

EUPHORBIA PEDICULIFERA LINEARIFOLIA Wats., Proc. Am. Acad. Sci. 24:76. 1889.

Guaymas, Sonora, January 23, *Dawson* 1005 (topotype).

Southern Sonora; type from Guaymas. It is distinguished from the typical in the species by its erect habit and linear leaves. Both are winter annuals flowering in the early spring or late winter.

EUPHORBIA PETRINA Wats., Proc. Am. Acad. Sci. 24:75. 1889.

Puerto Refugio, Angel de la Guardia Island, January 26, *Dawson* 1022.

Known from southern Sonora, Angel de la Guardia and San Pedro Martir Islands, the type from the latter. Perennial prostrate herb forming dense mats; spring flowering.

EUPHORBIA POLYCARPA Benth.?, Bot. Voy. Sulph. 50. 1844.

Tortuga Island, March 17, *Rempel* 204a.

Widely scattered apparently throughout the California Gulf Region; type from Magdalena Bay, Baja California. A perennial, spring-flower-

ing, prostrate herb. Since the inflorescence of the Rempel collection has been modified by galls, Wheeler has questionably referred the collection to this species.

EUPHORBIA TOMENTULOSA Wats., Proc. Am. Acad. Sci. 22:476. 1887.

Near Guaymas, Sonora, February 9, *Dawson 1080*. San Carlos Bay, February 8, *Dawson 1057*.

Common on coarse rocky dry soils nearly throughout the gulf region as far south as southern Sonora and the Cape District. It is a low suffrutescent, bushy, flat-topped herb.

EUPHORBIA XANTII Engelm. in Boiss., DC., Prodr. 152:62. 1862.

Puerto Escondido, February 11, *Dawson 1092, 1099*. Canyon above Puerto Escondido, March 13, *Rempel 149*.

Southern Baja California and northern coastal Sinaloa; type from Cape San Lucas. It forms a slender, erect, flat-crowned shrub 1 to 2 m tall with dichotomous virgate branching; the leaves are ephemeral following the summer rains. The plant may bloom in a leafless condition in the spring. It has the largest flowers, 6 to 9 m in diameter, of any of the gulf region euphorbs and is attractive in bloom. It was cultivated successfully in the greenhouse of the Carnegie Desert Laboratory in Tucson for many years.

JATROPHA CINEREA (Ort.) Muell. Arg. in DC., Prodr. 152:1078. 1866.

Questionably referred here is *Rempel 119* from Agua Verde Bay collected March 10, 1937. The specimen consists of a sterile and what was once a turgescient shoot, bearing large cordate, ternately lobed, long-petiolate leaves, 9 to 14 cm broad, the emarginate sinuses very narrow and deep. Other collections seen have been referred to either this species or to *J. canescens* of Benthham, but neither name seems satisfactorily applicable. Flower and fruiting material are needed for taxonomic placement of the plant. It occurs in the deep canyons of the Sierra Giganta.

JATROPHA CUNEATA Wiggins & Rollins ?, Cont. Dud. Herb. 3:272. 1943.

San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel 92*, small thick-trunked tree throughout pass except on alkali.

The succulent woody branches with numerous short spur-branchlets of the sterile Rempel collection are doubtfully referred here. The species is widely distributed in the California Gulf Region; type from near Kino Bay, Sonora.

BUXACEAE

SIMMONDSIA CHINENSIS (Link) Schneid., Handb. Laubholz. 2: 141. 1907.

San Carlos Bay, Sonora, February 8, *Dawson 1056*. San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel 95*.

Southern Sonora, southern California, Sonora, and Baja California. It is a characteristic shrub of the arid rocky slopes in the California Gulf Region, occurring usually in widely scattered stands. It is not known south of the Rio Yaqui and the above collection from Sonora is near the southern limits of the species on the mainland.

ANACARDIACEAE

CYRTOCARPA EDULIS (Brge.) Standl., C.N.H. 23:659. 1923.

Tapirira edulis Brge., *Zoe* 5:78. 1900.

Cabeza Ballena, March 3, *Rempel 56*. San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel 89*, up to 12 feet high in Cactus scrub.

Known only from the Cape District and adjacent islands. This is a thick-stemmed Bursera-like tree with smooth yellowish bark that peels off perennially in thin sheets. The above cited specimens are sterile and the leaves are the small drought-pauperized ones of the arid spring. It is widely and naturally spread in the Cape District and also occasionally planted by the inhabitants for its edible plum-like fruits. It appears to be a postinsular endemic, since it is quite distinct from its only near relative, *C. procera* of the Mexican mainland. However, little is known of the ecology of the plant. There is the possibility that it was introduced to the peninsula by early man.

Pachycormus discolor var. **pubescens** (Wats.) Gentry new comb.

Schinus discolor Benth., Bot. Voy. Sulph. 11, pl. 9. 1844.

Pachycormus discolor (Benth.) Cov., Cent. Dict. rev. ed. 6708. 1911.

Bursera pubescens Wats., Proc. Am. Acad. Sci. 24:44. 1889.

Veatchia discolor Brge., Proc. Calif. Acad. Sci. II, 2:140. 1889.

Veatchia discolor pubescens (Wats.) Jtn., Proc. Calif. Acad. Sci. IV, 12:1079. 1924.

Puerto Refugio, Angel de la Guardia Island, January 26, *Dawson 1025* (sterile). March 20, *Rempel 273*.

A low, sprawling, openly crowned, sarcophytic tree with massive trunk and branches, endemic to and characteristic of the arid peninsula about Los Angeles Bay and the adjacent Angel de la Guardia Island, the type locality. The above cited specimens are sterile, but the small

pubescent leaves differ materially from leaves of other varietal populations of the species studied on the peninsula. According to Johnston, this variety is characterized by "its very loose deltoid inflorescence, by its rather small leaves, and perhaps also by its brownish sap."

CELASTRACEAE

MAYTENUS PHYLLANTHOIDES Benth., Bot. Voy. Sulph. 54. 1844.

Puerto Escondido, February 11, *Dawson 1088*. Cabeza Ballena, Cape District, March 3, *Rempel 74* (sterile). San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel 87* (sterile). Island in Concepción Bay, March 16, *Rempel 188* (mature fruit).

Coastal from Baja California to Cuba and Florida; type from Magdalena Bay, Baja California.

SCHAEFFERIA CUNEIFOLIA Gray, Pl. Wright. 1:35. 1852.

San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel 86*, shrub 3-4 feet high scattered in nonalkaline soil.

Semiarid localities of northern Mexico and western Texas; type from "high prairies of the San Felipe and on the San Pedro." In Baja California it has been collected previously only on the slopes of Tres Virgines in middle peninsula, at Muleje, and in the Cape District. It is a short stiff Condalia-like shrub with spinescent branchlets and small, obovate, thickish, drought-deciduous, caducous leaves.

SAPINDACEAE

CARDIOSPERMUM HALICACABUM L., Sp. Pl. 366. 1753.

Guaymas, January 23, *Dawson 1000*. San Carlos Bay, Sonora, February 8, *Dawson 1069*. San Jose del Cabo, February 17, *Dawson 1198*. San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel 96*. Agua Verde Bay, March 10, *Rempel 128*.

A scandent diffuse shrub or self-supporting subshrub forming a low bush with interlocking stems and recurved branches. The common Mexican name is "bolsilla," aptly referring to the inflated papery fruits, hanging showily like unlit jack-o-lanterns through the fruiting season of late fall and again perhaps in the spring. The species in the larger sense is variable and subspecific names have been assigned.

RHAMNACEAE

CONDALIA GLOBOSA Jtn., Proc. Calif. Acad. Sci. IV, 12:1086. 1924.

Los Angeles Bay, March 19, 20, *Rempel 234c* (sterile).

Known in middle and southern Baja California, on adjacent islands in the gulf, and near Guaymas, Sonora; type from La Paz. Though not important in the aggregate of vegetation, this stiff low shrub with spine-tipped branchlets appears to be widely scattered through the desert of the California Gulf Region.

KARWINSKIA HUMBOLTIANA (Zucc.) R. & S., Abh. Akad. Wiss. München 2:351. 1832.

Cabeza Ballena, Cape District, March 3, *Rempel* 69.

The species as now known includes several variants which range over Mexico and southwestern Texas. The peninsular population exists in the Cape District and along the Sierra Giganta scarp, mainly in the wetter canyons and northern slopes, and is not readily separable from some of the populations of northwestern Mexico.

MALVACEAE

ABUTILON CALIFORNICUM Benth., Bot. Voy. Sulph. 8. 1844.

Puerto Escondido, February 11, *Dawson* 1086.

West coast of Mexico from Baja California and Sonora south to Oaxaca; type from Magdalena Bay, Baja California.

ABUTILON CRISPUM (L.) Sweet, Hort. Brit. 53. 1827.

San Jose del Cabo, February 17, *Dawson* 1226.

In open situations from southern Arizona south to Central America. A decumbent perennial herb with inflated fruits; the present specimen with remote, cordate, acuminate, and characteristically gray canescent leaves, the pale petals marked with bright carmine in the base.

ABUTILON INCANUM (Link) Sweet, Hort. Brit. 53. 1827.

San Jose del Cabo, February 17, *Dawson* 1210. San Carlos Bay, Sonora, February 8, *Dawson* 1066.

Widely distributed as a wayside and fallow-land weed in northwestern Mexico; also reported in Hawaii. It is a bushy perennial 1 to 2 m high with rather strictly ascending branches. The yellow petals are carmine spotted within and reflexed at anthesis, closing at night.

GOSSYPIUM DAVIDSONII Kell., Proc. Calif. Acad. Sci. I, 5:82. 1873.

San Jose del Cabo, February 17, *Dawson* 1197.

Southern Baja California; type from San Jose del Cabo. Rarely collected.

HIBISCUS DENUDATUS Benth., Bot. Voy. Sulph. 7, pl. 3. 1844.

West Cove in Concepción Bay, March 15, *Rempel* 176, hill slope of west exposure. Guaymas, Sonora, January 23, *Dawson* 1006.

The more arid situations in northwestern Mexico and western Texas to southern Arizona in the United States. It appears to be quite generally scattered through the California Gulf Region. At best it forms a low open suffrutescent bush, the young branches are densely yellowish tomen-

tose, the old glabrous. The flowers are lavender and with only light winter rains the plant will persist in flowering from late winter months through the spring.

HORSFORDIA ALATA (Wats.) Gray, Proc. Am. Acad. Sci. 22:297. 1887.

Puerto Escondido, February 11, *Dawson 1086*.

California Gulf Region on both the peninsula and the mainland; type from northwestern Sonora, Mexico. The genus is distinguished by its winged carpels; this species is distinguished from *H. Newberryi*, the only other Sonoran Desert species, by its relatively large, thickish, ovate leaves and pink petals drying purplish or blue.

HORSFORDIA NEWBERRYI (Wats.) Gray, Proc. Am. Acad. Sci. 22:297. 1887.

West Cove in Concepción Bay, March 15, *Rempel 179*, foot of rocky slope. Island in Concepción Bay, March 16, *Rempel 191*, in wash.

Rather infrequently scattered in the lower elevations of the California Gulf Region. It is uncommon or lacking along the outer coast of the peninsula and has a smaller range than *H. alata*.

SIDA XANTH Gray, Proc. Am. Acad. Sci. 22:296. 1887.

San Jose del Cabo, February 17, *Dawson 1190*.

Known in Baja California and listed also by Standley (C.N.H. 23:765. 1920-26) as occurring in Sinaloa. The type locality is from Cape San Lucas, Baja California. The pale flowers are unusually large for the genus, the petals may be as much as 1.5 to 2 cm long.

SPHAERALCEA COULTERI (Wats.) Gray, Proc. Am. Acad. Sci. 22:291. 1887.

San Carlos Bay, Sonora, February 8, *Dawson 1050*.

In sandy and coarse detrital soils of the Sonoran Desert from the Colorado Desert, California south and in the Sinaloa Thorn Forest south to Mazatlan; type apparently from southwestern Arizona or adjacent Sonora. It is a leafy annual, single-stemmed or polypodial, rather showy with salmon-colored flowers through the arid spring.

SPHAERALCEA COULTERI CALIFORNICA (Rose) Kearney, U. C. Publ. Bot. 19:32. 1935.

Puerto Escondido, February 11, *Dawson 1091*.

Southern half of Baja California; type from La Paz.

SPHAERALCEA HAINESII Brge., Proc. Calif. Acad. Sci. II, 2:136. 1889.

Tortuga Island, March 17, *Rempel* 224. Los Angeles Bay, Baja California, March 19, 20, *Rempel* 244.

Middle part of the California Gulf Region along the eastern coast of the peninsula and the islands of San Pedro Martir, San Marcos, Tortuga; type from Jesus Maria, Baja California. On the peninsula it frequents waste lands like a weed, but Johnston reported "it is the most abundant herbaceous perennial on the island" of San Pedro Martir.

STERCULIACEAE

HERMANNIA PALMERI Rose, C.N.H. 1:67. 1890.

San Jose del Cabo, February 17, *Dawson* 1220.

Apparently endemic to southern Baja California; type from La Paz. This plant is rare in collections. The above cited specimen is in flower only, the characteristic Solanum-like stamens conspicuous. The cordate-triangular crenate leaves are unusually ample, the blades up to 4 cm wide and 4 cm long, indicating good moisture conditions or shade during the weeks preceding collection.

MELOCHIA TOMENTOSA L., Syst. Nat. ed. 10:1140. 1759.

San Carlos Bay, Sonora, February 8, *Dawson* 1062. San Jose del Cabo, February 17, *Dawson* 1191.

Lower elevations nearly throughout Mexico and south into Central America. It is a common shrub in the environs of Guaymas, where, in the fall after the summer rains, it forms a rather showy slender shrub with light purplish flowers.

WALTHERIA AMERICANA L., Sp. Pl. 673. 1753.

San Jose del Cabo, February 17, *Dawson* 1158.

Widely distributed through the American tropics and subtropics; type from the Bahama Islands.

FRANKENIACEAE

FRANKENIA PALMERI Wats., Proc. Am. Acad. Sci. 11:124. 1876.

Los Angeles Bay, March 19, 20, *Rempel* 262, 238.

Littoral flats of the upper gulf region, where it forms low rounded brittle-stemmed bushes. It is one of the common halophytes of the region. but Johnston (Proc. Calif. Acad. Sci. IV, 12:1097) attributes its apparent halotropism to the salt air rather than to saline soils. It is also found on nonalkaline soils and locally occurs in extended stands making a low suffrutescent vegetation with or without associates.

FOUQUIERIACEAE

FOUQUIERIA PENINSULARIS Nash, Bull. Torr. Bot. Club 30:454. 1903.

Near Guaymas, Sonora, February 9, *Dawson 1079*. Baja California: Punto Frailes, February 16, *Dawson 1136*; San Jose del Cabo, February 17, *Dawson 1219*; Puerto Escondido, March 13, *Rempel 167*, on alluvial fan; Frailes Bay, April 4, *Rempel 328*.

Mainly coastal in the southern part of the California Gulf Region in southern Baja California, Sonora, and northern Sinaloa; type from La Paz, Baja California. These collections all show the thickish pedicels and narrow panicles typical of the species.

FOUQUIERIA SPLENDENS Engelm. in Wisliz., Mem. Tour. Mex., 30th Cong. 1st Sess. misc. rep. No. 26:98. 1848.

Los Angeles Bay, March 19, 20, *Rempel 249*.

Northern part of the California Gulf Region in Sonora, on the peninsula, on Tiburon Island, north into the deserts of California, Arizona, and Nevada, and eastward in northern Mexico.

TURNERACEAE

TURNERA DIFFUSA Willd., Schult. Syst. Veg. 6:679. 1820.

San Jose del Cabo, February 17, *Dawson 1152*.

Widely distributed in Mexico, Central America, and South America, mainly in arid soils on hill slopes.

PASSIFLORACEAE

PASSIFLORA ARIDA (Mast. & Rose) Killip, Jour. Wash. Acad. Sci. 12:256. 1922.

Island in Concepción Bay, March 16, *Rempel 190*, on fan.

Widely scattered along the coasts in the California Gulf Region as far south as Mazatlan, Sinaloa; type from Guaymas, Sonora. It is particularly abundant along the inner shore of the mid-peninsula, infrequent on the outer peninsular coast and the Sinaloa coast. It is a densely pubescent vine flowering and fruiting in the spring and related to *P. Palmeri* and *P. fruticosa*, but distinguished from those two species by the lack of oily stipitate glands.

PASSIFLORA PALMERI Rose, C.N.H. 1:131, pl. 14. 1892.

West Cove in Concepción Bay, March 15, *Rempel 175*, on hillside. Island in Concepción Bay, March 16, *Rempel 195*, generally distributed on fans and lower hillsides.

On the gulf side of the peninsula and adjacent islands in the gulf

from Angel de la Guardia south to San Jose del Cabo; type from Carmen Island. A low spreading flat-topped viscous shrub with showy flowers in the spring.

LOASACEAE

EUCNIDE CORDATA Kell. in Curran, Bull. Calif. Acad. Sci. 1:137. 1885.

San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel* 99, in alkaline flats not far from beach dunes. Agua Verde Bay, Baja California, March 10, *Rempel* 121, wash. Tortuga Island, March 17, *Rempel* 215.

Common to the cliffs, rocky slopes, and occasional in washes through the mid-section of the peninsula and the adjacent islands; type from Cedros Island. It is a coarse rather succulent or turgescient perennial herb with bright green, cordate, crenate, lobate leaves, and creamy white tubular flowers.

MENTZELIA ADHAERENS Benth., Bot. Voy. Sulph. 15. 1844.

Turner's Island, January 25, *Dawson* 1012. Near Guaymas, February 9, *Dawson* 1096. Tortuga Island, March 17, *Rempel* 226.

Sonora and Baja California; type from Magdalena Bay, Baja California. Johnston also reports it from Tortuga and Tiburon Islands. The Dawson numbers show the pauperate foliage of a dry winter season, the blades being mostly less than 2 cm long. It is a brittle herb sometimes found clambering among the low branches of shrubs. The Mexicans have been heard to call it "pega pega."

PETALONYX LINEARIS Greene, Bull. Calif. Acad. Sci. 1:188. 1885.

Tortuga Island, March 17, *Rempel* 214.

A low bushy subshrub with rough scabrous leaves, large floral bracts, and small white flowers. Widely scattered over the northern half of the peninsula and the adjacent islands; into southern California and Arizona. Type from Cedros Island.

SYMPETALEIA RUPESTRIS (Baill.) Gray in Wats., Proc. Am. Acad. Sci. 24:50. 1889.

Tiburon Island, January 25, *Dawson* 1013. Puerto Escondido, March 13, *Rempel* 162. Island in Concepción Bay, March 16, *Rempel* 202.

On cliffs and dry rocky situations in the mid-gulf region in Sonora, Baja California, and the gulf islands of Sal si puedes, Tiburon, and Tortuga. A low sticky herb forming rounded clumps; spring flowering.

CACTACEAE

COCHEMIEA POSELGERI (Hildm.) Brit. & Rose, *Cactaceae* 4:22. 1923.

Punta Frailes, Cape District, February 16, *Dawson* 1111. Agua Verde Bay, Baja California, March 10, *Rempel* 115, in wash. Frailes Bay, Cape District, April 4, *Rempel* 327.

Cape District of Baja California and northward along the Sierra Giganta scarp; exact locality of type collection unknown.

ECHINOCEREUS GRANDIS Brit. & Rose, *Cactaceae* 3:18. 1922.

San Pedro Nolasco Island, February 6, *Dawson* 1037; San Esteban Island, February, *Dawson* 1042. South end of San Esteban Island, March 27, *Rempel* 294.

Known only from San Pedro Nolasco, Las Animas, San Lorenzo, and San Esteban Islands in the Gulf of Baja California; the type from San Esteban. Flowers March and April.

ECHINOCEREUS MAMILLATUS (Engelm.) Brit. & Rose, *Cactaceae* 3:41. 1922.

West Cove in Concepción Bay, March 15, *Rempel* 172 (sterile), hillside of east exposure. Frailes Bay, April 4, *Rempel* 323a (sterile).

A short-bodied, long-spined species, the stems tapered at the base. Ranges along the Sierra Giganta scarp and through the mountains of the Cape District; type from "mountain sides south of Muleje, Lower California."

ECHINOCEREUS SCIURUS (K. Brge.) Purpus, *Monatsschr. Kakteenk.* 14:130. 1904.

San Jose del Cabo, February 17, *Dawson* 1222.

Known only from the Cape District of the peninsula. The type locality is the hills near San Jose del Cabo, *Dawson* 1222 being a topotype.

ECHINOCEREUS SCOPULORUM Brit. & Rose, *Cactaceae* 3:31. 1922.

Ensenada de San Francisco, Sonora, March 30, *Rempel* 315. Guaymas, January 23, *Dawson* 1008.

Native of the coastal mountains of southern Sonora and northern Sinaloa; type from near Guaymas, Sonora.

ECHINOCEREUS WEBSTERIANUS G. Lindsay, *Cact. Succ. Jour.* 19:153. 1947.

San Pedro Nolasco Island, March 29, *Rempel* 301, 303; February 6, *Dawson* 1040.

Known only from San Pedro Nolasco Island where it commonly grows in close association with *Mammillaria multidigitata*. Lindsay (l.c.) has written that "its large golden clumps [contrast] pleasantly with the white masses of the latter."

FEROCACTUS ACANTHODES (Lem.) Brit. & Rose, *Cactaceae* 3:129. 1922.

North of Point Lobos, Sonora, March 26, *Rempel* 287 (sterile).

This is the common *Ferocactus* or bisnaga on the arid slopes and mesas in the northern part of the gulf region; type locality, "California."

FEROCACTUS COVILLEI Brit. & Rose, *Cactaceae* 3:133. 1922.

Guaymas, Sonora, January 23, *Dawson* 1009 (in part).

From southern Arizona to southern Sonora; the type from near Altar, northern Sonora. Guaymas is near the southern limit of the species.

FEROCACTUS TOWNSENDIANUS Brit. & Rose, *Cactaceae* 3:127. 1922.

Frailes Bay, April 4, *Rempel* 318, hillside.

A poorly known species from the southern part of the peninsula and adjacent islands; the type from Isla San Jose. Continuation of this name is questionable, since it appears applicable to the species described earlier by Weber as *Echinocactus peninsulae*, Bull. Mus. Nat. Paris 1:320. 1895. Britton and Rose failed to resolve the question, apparently because they did not have access to Weber's material collected by Leon Diguët in 1894 near Santa Rosalia, and based their concepts of the species on a fragmentary collection of Gabb. This they state to be without radial spines, the main character segregating *F. Townsendianus* from *F. peninsulae* (Weber) Brit. & Rose, *Cactaceae* 3:133. 1922, but Weber describes "Aiguillons rougeâtres, a pointe jaune; extérieurs 11, —." Taxonomically the question can be cleared by field work and ample herbarium material, and more solidly by access to Diguët's original notes and photos. Britton and Rose's name is retained here solely because it is the one in common use for the southern peninsular plexus.

FEROCACTUS SP.

Tetas de Cabra near Guaymas, Sonora, January 23, *Dawson* 1009a.

Referred here is a specimen strongly suggestive of *Ferocactus alamosanus platygonus* G. Lindsay, *Cact. Succ. Jour.* 14:139. 1942, but differing materially in the strongly ascending 7-8 lateral spines and as reported by the collector in the large size; up to 1.5 m. This is the plant

which Johnston referred to *F. alamosanus*, apparently, Proc. Calif. Acad. Sci. 13:1110. 1924. Although the present collection, the species, and its variety appear to be related, further field work and study may reveal that we are dealing with three specific entities.

LEMAIREOCEREUS THURBERI (Engelm.) Brit. & Rose, C.N.H. 12: 426. 1909.

South end of Tiburon Island, March 27, *Rempel* 297. San Pedro Nolasco Island, March 29, *Rempel* 305. Ensenada de San Francisco, Sonora, *Rempel* 312a. Frailes Bay, *Rempel* 322.

The pitaya (traditionally spelled pitahaya, but poorly so from the phonetic standpoint) is widely distributed in the central and southern part of the California Gulf Region; from southern Arizona to central Sinaloa. In central Baja California it favors the rocky slopes where run-off increases soil moisture. In southern Sonora, the area of greatest abundance, it is found both on rocky slopes and alluvial plains, as on the plain south of Navojoa, where it abounds in dense nearly pure stands over many square miles. Flowers in late spring, fruits ripen in late May and June. All the above collections are sterile.

LEMAIREOCEREUS THURBERI LITTORALIS (K. Brge.) G. Lindsay, Desert Pl. Life 12:186. 1940.

Cereus Thurberi Engelm. var. *littoralis* K. Brge., Zoe 5:191. 1904.

Canyon above Puerto Escondido, March 13, *Rempel* 145 (immature). Fraile Bay, April 4, *Rempel* 326.

Cape District and north along the Sierra Giganta scarp to Concepción Bay; type from "on steep seacoast bluffs between San Jose del Cabo and Cabo San Lucas, Baja California." This low slender plant appears to be a good variety. The collections show only 6 to 7 ribs and weaker spines than is typical of the species. *Rempel* 209 from an island in Concepción Bay is probably also referable here. All specimens are sterile.

LOPHOCEREUS SCHOTTII (Engelm.) Brit. & Rose, C.N.H. 12:427. 1919.

Los Angeles Bay, Baja California, March 19, 20, *Rempel* 232, in wash and on fan. Fraile Bay, April 4, *Rempel* 324.

Widely distributed in the gulf area; type from Magdalena, Sonora. A widely spreading plant commonly 2 to 3 m tall with many stems from the decumbently spreading base, recognizable by the sordid "beard" of long bristles of the terminal 1 to 3 feet of the flowering branches.

MACHAEROCEREUS GUMMOSUS (Engelm.) Brit. & Rose, Cactaceae 2:116. 1920.

Puerto Escondido, *Dawson 1109*, abundant over all brush-land. Fraile Bay, *Rempel 323*. Tortuga Island, *Rempel 210*.

Common and widespread through Baja California south of Ensenada and on the adjacent islands; type from northwestern Baja California. In places it is abundant and is a codominant with other desert shrubs.

MAMMILLARIA ALBICANS (Brit. & Rose) Berger, Kakteen, 308. 1929.

San Pedro Nolasco Island, February 6, 1940, *Dawson 1039*.

Recorded only from Santa Cruz, San Jose, and San Pedro Nolasco Islands, the above cited specimen being new to the known flora of the latter island. Referred here doubtfully is *Rempel 302* also from San Pedro Nolasco Island. It is a smaller, slenderer plant with an evident tendency to be cespitose.

MAMMILLARIA ANGELENSIS Craig, Mam. Handb. 165. 1945.

Angel de la Guardia Island (probably Puerto Refugio), January 26, *Dawson sine no.* Pond Island, February 5, *Dawson sine no.* Punta Frailes, February 16, *Dawson 1112*.

Known previously only from Angel de la Guardia Island, the species is now certainly known from Pond Island, but Punta Frailes collection (sterile) is doubtfully referred to this species. The long reflexed petals are singularly characteristic of this species.

MAMMILLARIA DIOICA K. Brge., Erythea 5:115. 1897.

Tiburon Island, January 25, *Dawson 1018*.

Apparently ranges throughout Baja California, but hitherto not reported for any of the California Gulf Islands.

MAMMILLARIA EVERMANNIANA (Brit. & Rose) Orcutt, Cactography 7. 1926.

Canyon above Puerto Escondido, Sierra Giganta scarp, *Rempel 144*, sides of canyon.

Along the Sierra Giganta scarp in southern Baja California and adjacent islands; type from Cerralbo Island. Craig (Mam. Handb. 82. 1945) states, but without citation, that it is also reported from San Pedro Nolasco Island. It is a small globose plant 6 to 10 cm high preferring humic soils in the detrital pockets of rocky terrain. It is rare in both living and herbarium collections.

MAMMILLARIA FRAILIANA (Brit. & Rose) Boedeker, Mammil. Vergl. Schluss. 30. 1933.

South end of San Esteban Island, *Rempel* 293 (sterile).

It is also known from Ceralbo, Catalina, and Pichilique Islands, the latter being the type locality. It will probably be found also on the adjacent part of the peninsula. A closely related species is *M. Verhaertiana* Boedeker, reported from Los Angeles Bay.

MAMMILLARIA INSULARIS Gates, Cact. Succ. Jour. 10:25. 1938.

Ildefonso Island, March 15, *Rempel* 170b, on rocky ridge. Ensenada de San Francisco, Sonora, March 10, *Rempel* 316.

Central part of the Gulf of California; type from easternmost islet of Smith Island, Los Angeles Bay, Baja California. A low cespitose plant with purplish hooked spines. Doubtfully referred here also is *Rempel* 325 (in part). All of his collections, made in March, are sterile.

MAMMILLARIA MULTIDIGITATA G. Lindsay, Cact. Succ. Jour. 19: 152. 1947.

San Pedro Nolasco Island, March 29, *Rempel* 302; February 6, *Dawson* 1038.

Apparently endemic to San Pedro Nolasco Island, this plant is related to *M. albicans*, but differs in its cespitose habit, its slender cylindrical stems (not globose), and the appressed fine white radial spines. Lindsay reports it as being abundant on the steep slopes of the island.

MAMMILLARIA SLEVINII (Brit. & Rose) Boedeker, Mammil. Vergl. Schluss. 44. 1933.

San Francisco Island, March 9, *Rempel* 101 (sterile).

A rare and little known species related to *M. albicans* and may be as Craig (l.c. p. 262) surmised, conspecific with it. Known only from San Francisco and San Jose Islands in the Gulf of California, Rose having collected the type on the latter island.

OPUNTIA BIGELOVII Engelm., Proc. Am. Acad. Sci. 3:307. 1856.

Angel de la Guardia Island, Puerto Refugio, January 26, *Dawson* sine no. Turner's Island, *Dawson* sine no. Tiburon Island, January 25, *Dawson* 1019. Tortuga Island, *Rempel* 210a. South end of San Esteban Island, March 27, *Rempel* 292.

A common cactus shrub of the northern part of the California Gulf Region in Mexico and the United States; type from Bill Williams River, Arizona. The Tortuga Island collection is the southernmost record. All the above collections are sterile.

OPUNTIA BURRAGEANA Brit. & Rose, Cactaceae 1:70. 1919.

San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel* 80, round-jointed Opuntia in cactus-scrub. Fraile Bay, April 4, *Rempel* 319 (flowering). Puerto Escondido, March 13 (flowering), *Rempel* 142, alluvial fan; February 11, *Dawson sine no.* (sterile).

The collections from Puerto Escondido are doubtfully referred here. They are atypical of the species in the elongate slender joints and with more prominent tubercles. The ovaries have numerous, acicular, yellowish spines about 1 cm long that deciduate soon after anthesis on the growing ovary. The specimens also suggest *O. ciribe*, but are scarcely conspecific. Typical *O. Burrageana* is recognized as ranging throughout the Cape District and on the adjacent islands as far north as Carmen. It may be a postinsular endemic of the Cape District. *O. ciribe* distribution is thought to be only in the central part of the peninsula from the vicinity of Santa Rosalia south to the vicinity of Comondu. It is apparent that there is a complex of cylindropuntia species in the central part of the peninsula in marked need of field work and taxonomic study.

OPUNTIA AFF. CLAVELLINA Engelm., in Coulter, C.N.H. 3:444. 1896.

Patos Island, March 26, *Rempel* 290. San Pedro Nolasco Island, March 29, *Rempel* 304. South end of Tiburon Island, March 27, *Rempel* 292. All specimens sterile.

Typical *O. clavellina* is known only along the outer peninsula coast; type from near Purissima (see Map 2). The rather short thickish joints with prominent papery-sheathed spines of the above collections indicate a close but scarcely specific relationship.

OPUNTIA COMONDUENSIS (Coult.) Brit. & Rose, Smith. Misc. Coll. 50:519. 1908.

San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel* 82 (sterile). Fraile Bay, Baja California, April 4, *Rempel* 320 (sterile).

Southern Baja California and the adjacent island of Espiritu Santo and probably others; type from Comondu, Baja California. Little is known of the actual habitat and range of this platyopuntia and the above collections extend the known range southward and to Espiritu Santo Island. Johnston (Proc. Calif. Acad. Sci. IV, 12:1116. 1924) reported observing it on all of the southern gulf islands except Catalina, stating that it was the only platyopuntia observed on these islands. The small oval joints, the remote prominent areoles, and the 1 or 2 long porrect

spines, either whitish or yellow, characterize this species among the platyopuntia of the peninsula.

OPUNTIA AFF. FULGIDA Engelm., Proc. Am. Acad. Sci. 3:306. 1856.

San Pedro Nolasco Island, March 29, *Rempel 304a*.

Doubtfully referred here, the specimen also shows relationship to *O. ciribe* Engelm., a peninsular species (see Maps 1 and 2).

OPUNTIA GOSSELINIANA Weber, Bull. Soc. Acclim. France 49:83. 1902.

Ensenada de San Francisco, Sonora, March 30, *Rempel 313*.

Reported by Britton and Rose from "Sonora and Lower California, Mexico;" type locality, "Coast of Sonora on the Gulf of California." Rempel's collection is flowering and typical except that the joints are suborbicular being broader than long.

OPUNTIA INVICTA Brge., Proc. Calif. Acad. Sci. II, 2:163. 1889.

Los Angeles Bay, March 19, 20, *Rempel 233* (fruiting), in wash on fan.

Central part of the peninsula, the type from San Juanico Bay. A low plant with trailing stems, short thick joints with high tubercles, large, 3-cornered, whitish, sheathless spines, and bristly fruits.

OPUNTIA LEPTOCAULIS DC., Mem. Mus. Hist. Nat. Paris 17:118. 1828.

Tiburon Island, January 25, *Dawson 1020*.

Widely distributed in both the high and low deserts of the southwestern United States and Mexico; type locality in Mexico.

OPUNTIA RAMOSISSIMA Engelm., Am. Jour. Sci. II, 14:339. 1852.

Los Angeles Bay, March 19, 20, *Rempel 231* (flowering), in wash.

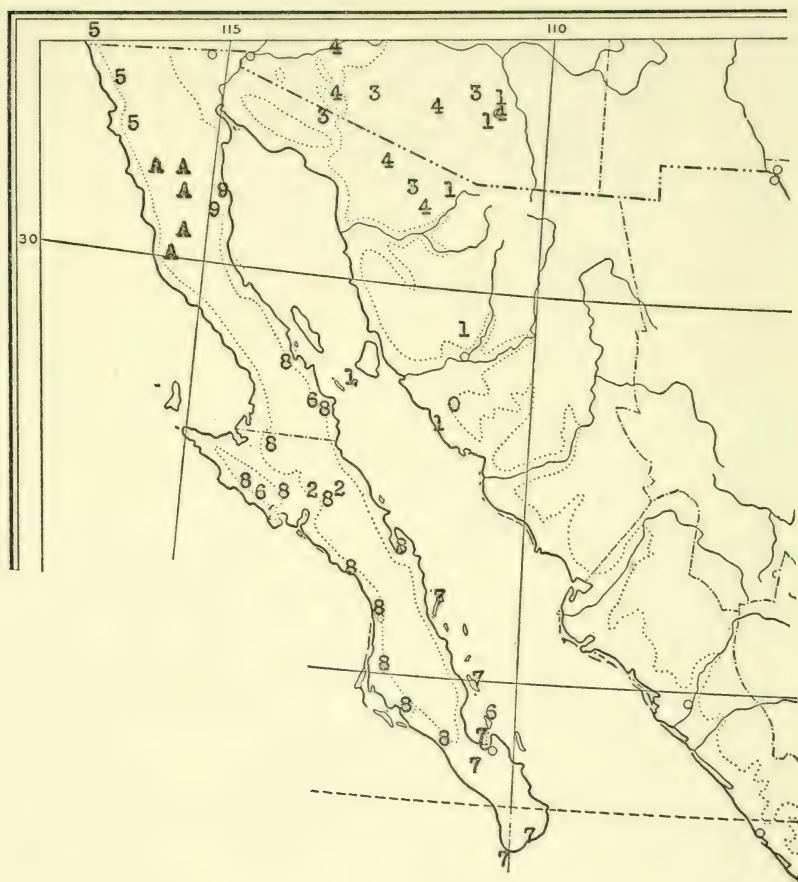
Widely distributed in the southwestern United States and adjacent Mexico west of the continental divide; type from near the Colorado River in California. This appears to be the first cited collection from Baja California, although the species has long been known to occur there.

OPUNTIA VERSICOLOR Engelm. in Coulter, C.N.H. 3:452. 1896.

Ensenada de San Francisco, Sonora, March 30, *Rempel 312*. South end of San Esteban Island, *Rempel 291*.

Widely distributed in the northern part of the gulf region on the mainland from southern Arizona to southern Sonora; type from Tucson, Arizona. I have seen no specimens nor records referable to the peninsula and the above citation from San Esteban Island is the first for the gulf islands; fruiting, it compares favorably with mainland material.

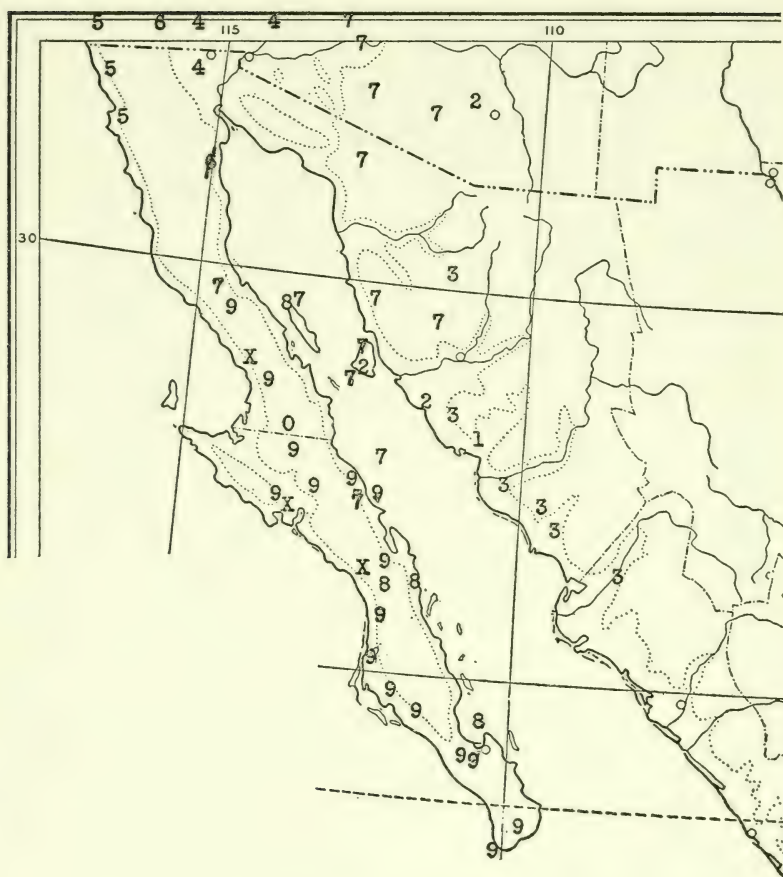
MAP 1



CYLINDROPUNTIA IN CALIFORNIA GULF AREA

1. *O. versicolor* Engelm.
2. *molesta* Brge.
3. *fulgida* Engelm.
4. *spinosior* (Engelm.) Toumey
5. *prolifera* Engelm.
6. *alcahes* Weber
7. *Burrageana* B. & R.
8. *invicta* Brge.
9. *cineracea* Wiggins
0. *reflexispina* Wig. & Rollins
- A. *rosarica* G. Lindsay

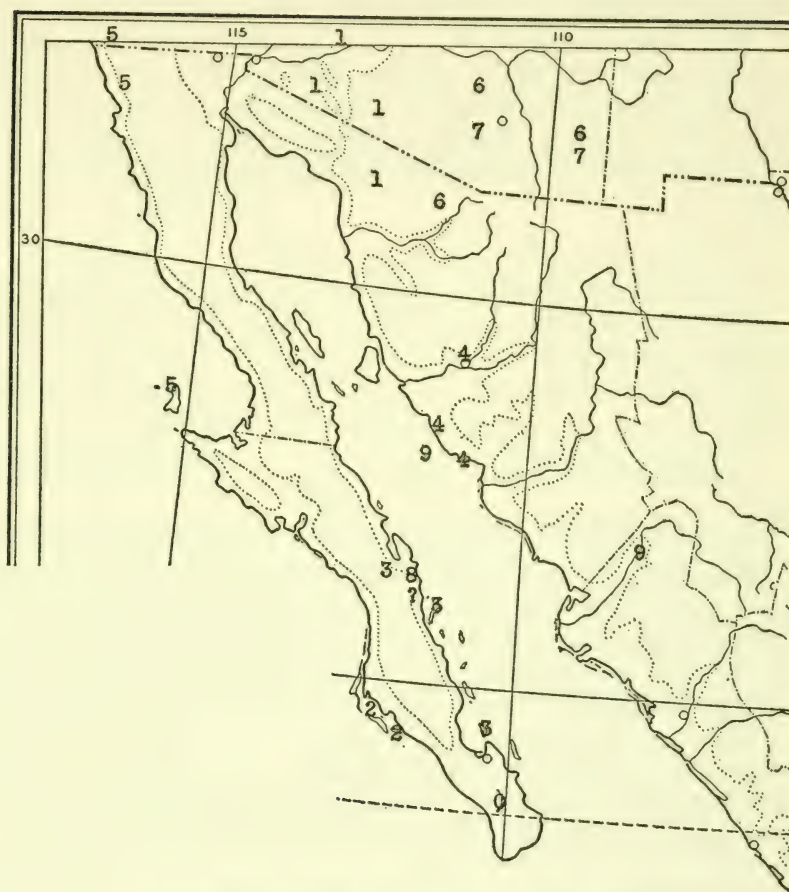
MAP 2



CYLINDROPUNTIA IN CALIFORNIA GULF AREA

1. *O. mortolensis* B. & R.
2. *leptocaulis* DC.
3. *Thurberi* Engelm.
4. *echinocarpa* Engelm.
5. *serpentina* Engelm.
6. *Parryi* Engelm.
7. *Bigelovii* Engelm.
8. *ciribe* Engelm.
9. *cholla* Weber
0. *calmalliana* Coulter
- X. *clavellina* Engelm.

MAP 3



PLATYOPUNTIA IN CALIFORNIA GULF AREA

1. *O. basilaris* Engelm.
2. *pyncnantha* Engelm.
3. *comonduensis* (Coul.) B. & R.
4. *Gosseliniana* Weber
5. *occidentalis* Engelm.
6. *discata* Griffiths
7. *chlorotica* Engelm.
8. *tapona* Engelm.
9. *Wilcoxii* B. & R.
- ? species undescribed
- O. *Bravoana* Baxter

OPUNTIA AFF. WILCOXII Brit. & Rose, Cactaceae 1:172. 1919.

San Pedro Nolasco Island, March 29, *Rempel* 306.

West coast of Mexico in southern Sonora and northern Sinaloa; type from Fuerte in northern Sinaloa. This first insular collection appears to be in good character with the species. It was just coming into flower when collected. Unusual are the areoles around the edge of the joints; they are larger and with longer glochids than those on the flat faces.

OPUNTIA SP.

Dawson 1091 from Puerto Escondido, Baja California, collected in a sterile condition February 11, 1940, is a flat-jointed *Opuntia* resembling *O. tardispina* Griffiths from eastern Texas, as illustrated in Brit. & Rose (1.c. p. 141). Doubtless, this is one of the unknown *Opuntiae* mentioned by Johnston (Proc. Calif. Acad. Sci. IV, 12:1117).

PACHYCEREUS PRINGLEI (Wats.) Brit. & Rose, C.N.H. 12:422. 1909.

South end of Tiburon Island, March 27, *Rempel* 298 (sterile).

Abundant over wide areas through middle and southern Baja California, on the gulf islands, on the cerros southwest of Altar in northwestern Sonora, and in the hills about Guaymas, Sonora; type from the Altar River, Sonora. Its western limit is Cedros Island, where it was recently discovered by Howell (Leaf. West. Bot. 3:183. 1942).

Sterile nubbins represented by *Rempel* 211, 307, 317, from Tortuga Island, San Pedro Nolasco Island, and Fraile Bay respectively, are either referable to this plant or to *Pachycereus pecten-aboriginum*, the other giant cactus abundant through the southern part of the gulf region.

RATHBUNIA ALAMOSENSIS (Coult.) Brit. & Rose, C.N.H. 12:415. 1909.

Ensenada de San Francisco, Sonora, March 30, *Rempel* 314. Near Guaymas, Sonora, January 23, *Dawson* 1074.

Coastal lowlands from southern Sonora to Nayarit; type from Alamos, Sonora. It commonly forms colonies several yards in diameter, spreading by declining or broken stems taking root. It is also employed locally and effectively for making fences, the cuttings taking root readily and eventually forming a dense hedge row.

RHIZOPHORA MANGLE L., Sp. Pl. 443. 1753.

West Cove in Concepción Bay, March 15, *Rempel* 174.

The above cited locality is about the northern limit of this widespread littoral plant on the east side of the peninsula. On the Mexican mainland it reaches Tiburon Island.

ONAGRACEAE

OENOTHERA ANGELORUM Wats., Proc. Am. Acad. Sci. 24:29. 1889.
Los Angeles Bay, March 19, 20, *Rempel 236a*.

Known only from the eastern shore of the peninsula near the type locality, Los Angeles Bay.

OENOTHERA CARDIOPHYLLA Torr., Pacif. R.R. Rep. 5:360. 1856.
North end of Los Angeles Bay, March 19, 20, *Rempel 253a*.

Widely distributed around the north and west sides of the Gulf of California, south to central Baja California, and known from the gulf islands of San Luis, Angel de la Guardia, San Pedro Martir, and San Marcos, Type locality, near Fort Yuma, Arizona. A winter annual or possibly a short-lived perennial, it blooms in the early spring months.

SAPOTACEAE

BUMELIA OCCIDENTALIS Hemsl., Biol. Cent. Am. Bot. 2:298. 1881.
Canyon above Puerto Escondido, March 13, *Rempel 153*. Los Encinos, Sierra Giganta, *Gentry 4264*.

Usually a small rather bushy tree scattered in the canyons of the southern part of the peninsula and northern Sonora on the lower mountain slopes; type locality, "Sonora alta." it flowers and fruits in the spring.

APOCYNACEAE

VALLESIA GLABRA (Cav.) Link, Enum. Pl. 1:207. 1821.
Island in Concepción Bay, March 16, *Rempel 196*.

An evergreen shrub with white flowers and small pyriform translucent fruits adapted to the mesophytic bottomlands, particularly the river margins from southern Baja California and southern Sonora south along the coastal tierra caliente to South America and the West Indies.

ASCLEPIADACEAE

ASCLEPIAS ALBICANS Wats., Proc. Am. Acad. Sci. 24:59. 1889.
Puerto Escondido, February 11, *Dawson 1107*. Island in Concepción Bay, March 16, *Rempel 194*, on fan and low on north exposure. Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel 268*.

Nearly throughout and confined to the Sonoran Desert; type from ravine near Los Angeles Bay, Baja California.

ASCLEPIAS CURASSAVICA L., Sp. Pl. 215. 1753.

Puerto Escondido, February 11, *Dawson 1087*.

Widely distributed in the tropics and subtropics of America. It is a mesophyte found only along stream banks or wastelands of irrigated fields in Baja California. It is an erect perennial herb or strictly branched bush with showy heads of reddish orange flowers.

ASCLEPIAS SUBULATA Decne. in DC., Prodr. 8:571. 1844.

Guaymas, January 23, *Dawson 1101*. San Jose del Cabo, February 17, *Dawson 1156*. Found throughout the desert of the California Gulf Region, mostly along arroyos and canyon bottoms in sandy or gravelly soil; type from "Nova Hispania." This and *A. albicans* are perennial herbs with several to many rush-like stems 1 to 2 m tall, bearing remote filiform leaves for short periods in the rainy seasons, the terminal panicle white and yellowish flowers often outlasting the ephemeral leaves. The flowers are greedily visited by many species of wasps and flies.

CONVOLVULACEAE

EVOLVULUS LINIFOLIA L., Sp. Pl. ed. II:392.

San Jose del Cabo, Baja California, February 17, *Dawson 1188*.

Sonora and Baja California. Distinguished from the more widely spread *E. alsinoides* by the narrower leaves and smaller flowers.

JACQUEMONTIA ABUTILOIDES Benth., Bot. Voy. Sulph. 34. 1844.

Puerto Escondido, February 11, *Dawson 1093*; March 13, *Rempel 148*. Punta Frailes, February 16, *Dawson 1126*. San Jose del Cabo, February 17, *Dawson 1162, 1186*.

Southern Sonora and middle and southern Baja California; type from Magdalena Bay, Baja California.

HYDROPHYLLACEAE

PHACELIA SCARIOSA Brge., Proc. Calif. Acad. Sci. II, 2:185. 1889.

Puerto Escondido, February 11, *Dawson 1103*; March 13, *Rempel 150*. Tortuga Island, March 17, *Rempel 205*.

Southern Baja California and adjacent islands including Tortuga and Carmen in the gulf; type from Magdalena Island on the outer coast.

BORAGINACEAE

BOURRERIA SONORAE S. Wats., Proc. Am. Acad. Sci. 24:62. 1889.

San Jose del Cabo, February 17, *Dawson 1208*.

Baja California and Sonora, type from Guaymas, Sonora. It is a shrub 1 to 2 m tall scattered in the coarse soils of the less arid localities.

COLDENIA PALMERI Gray, Proc. Am. Acad. Sci. 8:292. 1870.

Los Angeles Bay, March 19, 20, *Rempel* 235, 255.

In sandy soils through the northern part of the gulf region, where it forms a low suffrutescent mat or mound with parts of the older stems exfoliating a white cortical layer.

HELIOTROPIUM CURASSAVICUM L., Sp. Pl. 130. 1753.

Punta Frailes, Cape District, February 16, *Dawson* 1138.

Coastal lowlands throughout most of tropical and subtropical America.

HELIOTROPIUM HINTONII Jtn., Jour. Arn. Arb. 21:50. 1940.

Punta Frailes, February 16, *Dawson* 1120, 1176. San Jose del Cabo, February 17, *Dawson* 1185, 1216.

Known from the mountains of west central Mexico and from the Cape District of Baja California. It is a low suffrutescent 3 to 4 dm high with elongating racemes of small white flowers, the stems leafy with strongly pubescent linear-lanceolate leaves 15 to 25 mm long.

LABIATAE

HYPTIS EMORYI Torr. in Ives, Rep. Col. River 20. 1861.

Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel* 276. Near Guaymas, Sonora, February 9, *Dawson* 1081.

Found throughout the California Gulf Region; type from the Colorado River country. It is one of the regular opportunists among the shrubs along rocky arroyos and is able to withstand, or at least to endure as a species, the grinding flash floods that arise with torrential desert rains. Guaymas appears to be about its southern limit on the Mexican mainland. A variant of the species occurs about Guaymas and was described by Watson as a species, *H. Palmeri*, but later was reduced to a variety by Johnston, *H. Emoryi Palmeri*. It may well be a postinsular endemic. Standley (C.N.H. 23:1276. 1924) lists *Hyptis Emoryi* from Tepic, but his statement is in part based on the related *H. albida* Kunth., which is known to range through Nayarit.

HYPTIS LANIFLORA Benth., Bot. Voy. Sulph. 42, pl. 20. 1844.

Punta Frailes, February 16, *Dawson* 1124. San Jose del Cabo, February 17, *Dawson* 1183.

Southern Baja California and adjacent islands; type from Cape San Lucas.

The material from Punta Frailes has calyx lobes shorter than usual, scarcely half as long as the tube, and the lanate pubescence of the calyx is much denser than on the San Jose del Cabo specimen.

STACHYS COCCINEA Jacq., Pl. Hort. Schoenbr. 3:18. 1798.

Canyon above Puerto Escondido in the Sierra Giganta, March 13, *Rempel 170*, canyon bottom.

Widely distributed in the warmer mountains of southwestern United States and northwestern Mexico.

VERBENACEAE

AVICENNIA NITIDA Jacq., Enum. Pl. Carib. 25. 1760.

West cove in Concepción Bay, March 15, *Rempel 173*.

As a regular associate of the mangrove marshes, it is common along the coasts of tropical and subtropical America. Concepción Bay is near its northwestern limit. As residue of sea mist, salt crystals are commonly apparent on its leaves.

SOLANACEAE

DATURA DISCOLOR Bernh., Prommed. N. Jour. Pharm. 26:149. 1838.

North end of Los Angeles Bay, March 19, 20, *Rempel 251a*. Tiburon Island, January 25, *Dawson 1010*. San Jose del Cabo, February 17, *Dawson 1224*.

From southeastern California and southern Arizona south through the California Gulf Region to Central America; type from the West Indies. A relatively small *Datura* with small leaves and narrow flowers with a purple flush in the throat. The Tiburon material has smaller flowers and heavier fruiting spines than the typical peninsular material.

LYCIUM AFF. ANDERSONI Gray, Proc. Am. Acad. Sci. 7:388. 1868.

Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel 276a*.

Common through the deserts from southern Utah and southern Nevada south throughout the California Gulf Region, more common along the coasts than inland in the latter area.

LYCIUM BREVIPES Benth., Bot. Voy. Sulph. 40. 1844.

Lycium Richii Gray, Proc. Am. Acad. Sci. 8:292. 1870.

Island in Concepción Bay, March 16, *Rempel 189*. Agua Verde Bay, March 10, *Rempel 118*.

Sandy slopes, washes, and alluvial and saline soils along the coast throughout the gulf region and south into Sinaloa. It is one of the larger-leaved, bushy *Lyciums*, making dense plants and dense thickets locally.

NICOTIANA GREENEANUM Rose, C.N.H. 1:18. 1890.

Agua Verde Bay, March 10, *Rempel* 127, wash.

Known previously only from Cedros Island and the adjacent western part of the peninsula, this appears to be the first record of the plant from the gulf side of the peninsula. The annual habit, nonclasping and non-auriculate leaves with ovate to lanceolate blades, the small corolla with very narrow limb (3 mm wide in the dried specimen), and the dull light brown muriculate seeds relate it pretty definitely to Rose's plant.

NICOTIANA TRIGONOPHYLLA Dunal in DC., Prodr. 131:562. 1852.

San Carlos Bay, Sonora, February 8, *Dawson* 1023, 1059. Near Guaymas, February 9, *Dawson* 1078. Tortuga Island, March 17, *Rempel* 217.

Mostly in the coarse alluvial soils in arroyos and valleys in Desert Shrub and Thorn Forest from Texas to California and south to Nayarit. This is a common member of the tobacco genus in the arid gulf region. It appears to be perennial in the lower latitudes of its range, as shown by the woody base of *Dawson* 1023. Another sheet, *Dawson* 1078, represents a young plant in its first season of spring flower, indicating it as having germinated during the preceding early fall or late summer rains.

PETUNIA PARVIFLORA Juss., Ann. Mus. Hist. Nat. Paris 2:216. 1803.

San Jose del Cabo, February 17, *Dawson* 1159.

Southern Florida to California and south into tropical America. Through the deserts it is chiefly confined to the moist sands of permanent or intermittent streams. Low herb with minute lavender flowers.

PHYSALIS CRASSIFOLIA Benth., Bot. Voy. Sulph. 40. 1844.

Willard Point, Gonzaga Bay, Baja California, March 23, *Rempel* 283, wash.

Wide-spread in the southwestern United States and adjacent Mexico in arid climates on sandy and rocky soils. Type locality, Magdalena Bay, Baja California.

PHYSALIS CRASSIFOLIA INFUNDIBULARIS Jtn., Proc. Calif. Acad. Sci. IV, 12:1156. 1924.

Puerto Refugio, Angel de la Guardia Island, January 26, *Dawson* 1026.

Known only from San Esteban Island, Angel de la Guardia Island, and the adjacent coast of the peninsula; type from Angel de la Guardia

Island. It differs from typical *P. crassifolia* in having a funnellform corolla as long as or longer than wide, rather than a rotate corolla.

PHYSALIS GLABRA Benth., Bot. Voy. Sulph. 39. 1844.

Punta Frailes, February 16, *Dawson 1128*.

Known only from the Cape District of Baja California.

PHYSALIS PUBESCENS L., Sp. Pl. 183. 1753.

Canyon above Puerto Escondido, March 13, *Rempel 157*; April 22, *Gentry 3764*, riparian in canyon bottom.

A mesophytic to hydrophytic annual with pale yellow flowers, purple stamens, and pubescent viscid herbage, widely distributed across southern United States and southward in Mexico; Galapagos Islands.

PHYSALIS PURPUREA Wiggins, Cont. Dud. Herb. 3:74. 1940.

San Carlos Bay, Sonora, February 8, *Dawson 1063*.

Known only from the vicinity of Guaymas, Sonora. This perennial *Physalis* with its bright purple corolla and rather open habit with remote leaves is not easily confused with any other members of the genus in the gulf area. Its apparent very limited distribution, which kept it from being discovered so long, probably marks it as an endemic of the coastal mountains near Guaymas, and which for a period in the Tertiary may have been insular.

SOLANUM HINDSIANUM Benth., Bot. Voy. Sulph. 39. 1844.

Tiburon Island, January 25, *Dawson 1011*. San Carlos Bay, Sonora, February 8, *Dawson 1052*. Punta Frailes, Baja California, February 16, *Dawson 1142*. San Jose del Cabo, February 17, *Dawson 1192*.

Baja California and Sonora; type from Magdalena Bay. This plant is a low openly branched shrub rather closely related to *S. elaeagnifolium*, but in the field is at once distinguished by its larger size and larger corollas. It becomes abundant locally in the southern part of the gulf region, but is infrequent in the northern part.

SCROPHULARIACEAE

ANTIRRHINUM CYATHIFERUM Benth., Bot. Voy. Sulph. 40. 1844.

Near Guaymas, Sonora, February 9, *Dawson 1084*.

Southwestern Arizona, Sonora, and Baja California; type from Magdalena Bay. Guaymas appears to be about the southern limit for the species on the mainland.

MIMULUS SP.

Canyon above Puerto Escondido, February 11, *Dawson 1104*, seep-

age in palm canyon. Canyon above Puerto Escondido, March 13, *Rempel 161*, on damp rocks.

These collections represent two species, neither of which I can place satisfactorily. *Dawson 1104* is an erect herb about 15 cm high with relatively large orbicular coarsely dentate leaves, strongly 3-veined from the base, the calyces prominently red-spotted, but the spots fading on the fruiting calyces.

The plant represented by the *Rempel 161* is a diminutive, procumbent, finely cut herb with yellow flowers forming mats in wet or moist sand or on rocks by seeps and pools in the canyon bottom. It is to be expected in other localities of the Sierra Giganta. It has also been collected in the same locality; *Gentry 3772* and *Johnston 4113*. The latter collection was referred by Grant (*Ann. Mo. Bot. Gard.* 11:186. 1924) to *Mimulus dentilobus*, described from Nacari, Sonora by Robinson and Fernald. While I have not seen Johnston's collection, those of both Rempel and Gentry fail to show the laciniately-lobed corollas characteristic of *M. dentilobus*. Though the Puerto Escondido plants are clearly related to *M. dentilobus*, they appear worthy of taxonomic recognition. Unfortunately, none of the material at hand is worthy of type designation. Future collectors should make it a point to secure a large series of good material of both of these rare *Mimulus*, not otherwise known.

MOHAVEA CONFERTIFLORA (Benth.) Heller, Muhl. 4:48. 1912.

Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel 270*.

Widely but infrequently scattered through the deserts from southern Nevada south to Angel de la Guardia Island; not known from Sonora. The type locality is uncertain. A diminutive winter annual with large showy flowers.

STEMODIA ARIZONICA Penn., Notul. Nat. Acad. Sci. Phil. 43:1-10. 1940.

Canyon above Puerto Escondido in the Sierra Giganta, March 13, *Rempel 158*, in canyon bottom.

Hydrophytic herb, often with the older branches decumbent. Along the perennial streams from low to middle elevations in the mountains and foothills of northwestern Mexico and adjacent United States.

MARTYNIACEAE

MARTYNIA ALTHEAEFOLIA Benth., Bot. Voy. Sulph. 37. 1844.

Punta Frailes, February 16, *Dawson 1134*.

Widely scattered in the sandy deserts from Texas to California,

Sonora and Baja California; type from Magdalena Bay, Baja California. A procumbent spreading viscid herb 1 m or more in diameter and locally forming extensive dispersed colonies; the sticky stem often with adhering sand particles, the long petiolate leaves cordate to oricular. The Papago Indians still use the tough fibers of the fruits in weaving baskets.

BIGNONIACEAE

TECOMA STANS (L.) HBK., Nov. Gen. & Sp. 3:144. 1789.

Canyon above Puerto Escondido, Sierra Giganta, March 13, *Rempel* 166, hillside.

Widely distributed in tropical and subtropical America. It is often cultivated locally for its showy yellow blossoms and one of its most common names is "lluvia de oro." In the Cape District it is commonly found in the rocky swales where run-off adds to the precipitated soil moisture.

ACANTHACEAE

BELOPERONE CALIFORNICA Benth., Bot. Voy. Sulph. 38. 1844.

Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel* 275 (sterile); January 27, *Dawson* 1029. Puerto Escondido, March 13, *Rempel* 165. Punta Frailes, February 16, *Dawson* 1141. San Jose del Cabo, February 17, *Dawson* 1217. Cabeza Ballena, *Rempel* 65. San Carlos Bay, Sonora, February 8, *Dawson* 1070.

A subshrub with long flowering branches bearing orange-red flowers in the spring through the California Gulf Region and adjacent areas, and south to central Sinaloa along the sandy coast (Isla Tachechilte, January 20, *Gentry* 7127).

BELOPERONE PURPUSII Brge., Zoe 5:172. 1903.

San Jose del Cabo, February 17, *Dawson* 1175.

Known only from the Cape District of Baja California; type from San Felipe. The lower anther only is mucronate, the upper lip is bicuspidate. It is suffrutescent or grows to a small shrub. Rarely collected.

BERGINIA PALMERI Rose, C.N.H. 1:86. 1890.

Island in Concepción Bay, March 16, *Rempel* 197, 208. Puerto Escondido, February 11, *Dawson* 1098.

Known only from the southern part of the peninsula and adjacent Carmen Island; type from Santa Rosalia.

This is a small usually nondescript shrub with brittle shiny branches, sparse foliage, and lavender or pink flowers. It is rare in collections and has often been confused with *B. virgata*. Though very similar in appearance to the latter it is distinguished by the stalked glands of the inflor-

escence, and by the cordate bases of the uppermost leaves. Standley's key (C.N.H. 23:1337. 1926) does not make use of the important gland character and the foliage feature he uses is applicable only to the reduced leaves of the inflorescence; the stems and leaves of both species being narrowly lanceolate and acute at the base. Although he reports *B. virgata* as occurring in Baja California, it is doubtful if it actually occurs there. Others in following his key have also assigned Baja California to *B. virgata*, as Johnston (l.c. p. 1168) who attributed his collections from San Nicolas Bay and Carmen Island to *B. virgata*, but states that they have glandular calyces, which identifies them as *B. Palmeri*.

Though these two species are closely related they appear to be geographically distinct and no intergrading forms have been seen by the author. For the time being they should be kept distinct, or until such time as adequate collections can be brought together for study.

BERGINIA VIRGATA Harv. in Benth. & Hook, Rev. Gen. Pl. 2:1097. 1873.

Guaymas, Sonora, January 23, *Dawson 1004*; February 9, *Dawson 1075*.

Coastal and foothill regions in Desert Shrub and Thorn Forest of Sonora from Puerto Libertad to the Rio Mayo country. A small slender strictly or openly branched shrub about 1 m tall with lavender flowers.

CARLOWRIGHTIA CALIFORNICA Brge., Zoe 5:172. 1903.

Punta Frailes, February 16, *Dawson 1146*. San Jose del Cabo, February 17, *Dawson 1196*.

Baja California, Sonora, and Sinaloa; type locality, southern Baja California. Doubtfully distinct from *C. cordifolia* Gray, described from southwestern Chihuahua and with a similar range on the mainland.

DICLIPTERA RESUPINATA (Vahl) Juss., Ann. Mus. Hist. Nat. Paris 9:268. 1807.

San Carlos Bay, Sonora, February 8, *Dawson 1071*.

Southern part of the California Gulf Region and south to tropical America.

JACOBINIA CANDICANS (Nees) Benth. & Hook. in Hook. & Jacks., Ind. Kew. 1:1246. 1893.

San Carlos Bay, Sonora, February 8, *Dawson 1065*.

Common through the Thorn Forest of southern Sonora and Sinaloa, thence southeast along the Pacific coast to southern Mexico; type from

the mountains of Oaxaca. It forms a low irregularly branched shrub with rather thin ovate to lanceolate acuminate leaves and short racemes of bilabiate red flowers in the spring. Closely related to *J. mexicana*, which occurs in the same region, but distinguished from it by the floral bracts which equal or exceed the calyx, while in *J. mexicana* they are shorter than the calyx. Both plants belong with the Thorn Forest rather than with the desert, and their occurrence in the latter is marginal and restricted to bottomlands of overflow or the more moist canyon slopes.

JUSTICIA HIANS Brge., U. C. Publ. Bot. 6:194. 1915 and Proc. Calif. Acad. Sci. II, 2:194. 1889.

San Jose del Cabo, February 17, *Dawson 1200*.

Low suffrutescent herb rarely collected and apparently a postinsular endemic of the Cape District of Baja California.

RUELLIA CALIFORNICA (Rose) Jtn., Proc. Calif. Acad. Sci. IV, 12:1171. 1924.

Guaymas, January 23, *Dawson 1002*. San Carlos Bay, February 8, *Dawson 1073a*. Agua Verde Bay, Baja California, March 10, *Rempel 133, 138*, rocky hillside. Island in Concepción Bay, March 16, *Rempel 193*.

Southern part of the gulf region, mainly on the rocky slopes of the coastal cerros; type from Santa Rosalia, Baja California. It forms a low shrub with twiggy branches often in dispersed small colonies with showy, lavender, campanulate, caducous flowers about 3 cm long. The foliage is vernicose or glutinous with dull, sparse, blunt or capitate hairs, erect or impacted in the surface excretion.

The species is closely related to *R. peninsularis*, from which it is distinguished by the longer, more attenuate, calyx lobes bearing clavate glandular "hairs." The indument on *R. peninsularis* although glandular is not clavate. Johnston's attempt to separate these two species on foliage characters alone is not altogether satisfactory (Proc. Calif. Acad. Sci. IV, 12:1172), since both species are glandular and glutinous, nor is the foliage of *R. peninsularis* glabrate. The varnish tends to accumulate on the leaf surface with age and in time may submerge the "hairs" in a glutinous film, a condition apparently mistaken by Johnston for glabrate. It is common to both species. *R. peninsularis* appears to be limited to the peninsula, since all the collections I have reviewed from the mainland are referable to *R. californica*.

Johnston assigned some Guaymas collections to *R. peninsularis*, but in view of the criteria used in separating the two species, I believe he

was in error, although I have not seen the specimens he cites. This is not surprising since Rose's original descriptions are inadequate. Leonard of the United States National Herbarium, who has access to the type collections, has kindly determined Dawson's Guaymas collections. With his assistance I believe I am correct in restricting *R. peninsularis* from the Sonora flora until such time as it may be found in typical form.

RUELLIA LEUCANTHA Brge., Zoe 5:109. 1901.

Punta Frailes, February 16, *Dawson 1135*.

Endemic to the postinsular Cape District. It is a suffrutescent perennial with white flowers and densely tomentose leaves. It is rare in collections.

RUELLIA PENINSULARIS (Rose) Jtn., Proc. Calif. Acad. Sci. IV, 12: 1172. 1924.

San Jose del Cabo, February 17, *Dawson 1163*.

Southern part of Baja California; the type from mesas about La Paz.

PLANTAGINACEAE

PLANTAGO INSULARIS FASTIGIATA (Morris) Jeps., Man. Fl. Pl. Calif. 956. 1925.

Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel 269*.

A low villous annual common to the deserts of the California Gulf Region.

RUBIACEAE

HOUSTONIA ASPERULOIDES (Benth.) Gray, Proc. Am. Acad. Sci. 5:158. 1860.

Houstonia Brandegeana Rose, C.N.H. 1:70. 1890.

Punta Frailes, February 16, *Dawson 1113, 1132*. San Jose del Cabo, February 17, *Dawson 1187*.

Apparently limited to southern Baja California. A finely cut annual with purple flowers. Although the flowers on the specimens from Punta Frailes are smaller than those described for the species (3 to 4 mm high), the calyx is sparsely strigose and the lobes acute, two characters agreeing with *H. asperuloides*, and there are no other significant differences.

HOUSTONIA MUCRONATA (Benth.) Rob., Proc. Am. Acad. Sci. 45: 401. 1910.

San Francisco Island, March 9, *Rempel 110*, beach dunes.

Southern Baja California and the adjacent islands; type from Magdalena Bay. It forms a low shrubby bush 2 to 9 dm high with white corollas which turn black on drying. Reported by Johnston to be abundant on some of the islands in the southern part of the gulf.

MITRACARPUS PORTORICENSIS Urb., Symb. Antill. 4:609. 1911.

Doubtfully referred to this Caribbean species is *Dawson 1184* from San Jose del Cabo, February 17 (flowering). Standley, who determined the collection, reported that he had not been able to place the specimen satisfactorily.

CUCURBITACEAE

CUCUMIS DIPSACEUS Ehrenb. in Sprach, Hist. Veg. Phan. 6:211. 1838.

San Jose del Cabo, February 17, *Dawson 1194*.

Apparently originally from the north African highlands, it is now widely but discontinuously dispersed in both the Old and New Worlds. In North America it has been collected from such widely separated regions as Oregon, Baja California, and the West Indies.

ECHINOPEPON MINIMUS (Kell.) Wats., Proc. Am. Acad. Sci. 24: 52. 1889.

Marah minima Kell., Proc. Calif. Acad. Sci. 2:18.

Canyon above Puerto Escondido, Sierra Giganta, March 13, *Rempel 152*; April 20-22, 1938, *Gentry 3747* (fruiting).

Rather widely scattered in central and southern Baja California and the adjacent islands on the outer coast; type from Cedros Island. Apparently annual, it has very slender and rather short stems, about the smallest of the cucurbit vines in the region, with densely echinate fruits, dehiscing irregularly, the prickles rather short and somewhat flattened.

Echinopepon peninsularis Gentry sp. nov.

Herba annua; caulis ramique graciles, striati, ad nodos pilis longis albis praediti; petioli 2-3 cm longi; folia membranacea, 4-6 cm longa, 6-8 cm lata, lobis 5, late lanceolatis, serrulatis, aristatis, sparse scabro-pubescentibus; cirrhi graciles 1-2-fidi; ♂ pedunculi glabri, 10-15 mm longi; pedicelli glandulo-hispidi; corolla 12-15 mm lata, segmentis ovatis, ciliolatis; ♀ pedunculi 5-8 cm longi; corolla ca. 10 mm lata; fructus solitarius, 2 cm longus, sparse glandulo-pubescent, echinatus; aculei 8-12 mm longi.

Typus: *Dawson 1193*, "San Jose del Cabo, Cape District, Baja California, Mexico, February 17, 1940," in hb. Allan Hancock Foundation, University of Southern California. Duplum in hb. Univ. Mich.

Annual scandent herb; stems 1-2 m long, slender, sulcate, glabrous except for rings of white hyaline hairs 4-6 mm long at the nodes; petioles 2-3 cm long, slender, glabrous; leaf blades 4-6 cm long, 6-8 cm wide, deeply 5-lobed nearly to the base, rarely 7-lobed, the lobes mostly

ovate-lanceolate, the lower often broadly ovate, obtuse to acuminate, serrulate, ciliolate, aristate, glabrous except for sparse scabrous conic scales or hairs below, thinly membranous, greener above than below; tendrils 1—2-fid; ♂ inflorescence racemose; peduncles 10-15 cm long, glabrous below the pedicles; pedicles filiform, mostly 1-2 cm long at anthesis, glandular hispid; corolla shallowly campanulate, spreading, glabrous without, 12-15 mm broad, the lobes subequal, ovate, obtuse, ciliolate; ♀ flowers solitary from same axials as male; peduncles 5-8 cm long; ovary echinate, glandular-pubescent; corolla like the ♂, but smaller, about 1 cm broad; fruit oblong, 2 cm or more long, glabrate, glandular pubescent, echinate throughout with slender prickles 8-12 mm long, narrowly beaked, 1 cm long.

Taxonomists have assigned earlier collections of this well marked species to either *E. toquata* D.C., an uncertain species from the Mexican mainland (Rose, C.N.H. 5:118) or to *E. minimus*, well known on the peninsula. The proposed new species is distinguished from the latter by the deeply lobed leaves, the hyalinely tufted nodes, the long ♂ peduncles, the larger flowers, and the larger, longer-prickled fruits. The range of the species appears to be restricted to the southern part of the peninsula, and is perhaps a postinsular endemic of the Cape District. Besides the type collection, the following specimens have been reviewed in the University of California Herbarium: San Jose del Cabo, *Brandeggee sine no.* in October 1902; *Brandeggee 231*, September 27, 1890; *Brandeggee sine no.*, September 18, 1893; La Mesa, *Brandeggee sine no.*, October 24, 1893.

VASEYANTHUS BRANDEGEI (Cogn.) Rose, C.N.H. 5:119. 1897.

Echinocystis Brandegei Cogn., Proc. Calif. Acad. Sci. II, 3:59. 1890.

Ensenada de los Muertos, Cape District, March 5, *Rempel 78*, hillside.

This vine is rare in herbaria. It is known only from the Cape District; type from La Paz. It is the basis of Cogniaux's section, *Pseudo-Echinopepon*, (1. c.), characterized by the globose, 1-2 seeded, echinate, long-beaked fruits, features embodied in the genus *Vaseyanthus*.

Vaseyanthus Palmeri (Wats.) Gentry new comb.

Echinopepon Palmeri Wats., Proc. Am. Acad. Sci. 24:52. 1889.

Brandeggea Palmeri (Wats.) Rose, C.N.H. 5:120. 1897.

San Carlos Bay, February 8, *Dawson 1073*.

Known only from Guaymas and vicinity where it has been but rarely collected. It is probably to be grouped with those plants having insular origin in the cerros northwest of Guaymas. It is related to *V. insularis*,

but distinguished by its shorter prickles, more acuminate leaf lobes, and in having but 3-4 stamens, rather than the normal 5.

VASEYANTHUS INSULARIS INERMIS Jtn., Proc. Calif. Acad. Sci. IV, 12:1182. 1924.

Puerto Refugio, Angel de la Guardia Island, January 26, *Dawson* 1024.

Johnston lists it from the following islands in the Gulf of California: San Pedro Nolasco, Tortuga, South San Lorenzo, San Esteban, Angel de la Guardia, Mexia, San Pedro Martir, and Partida, the type from the latter.

A slender twining herb, stems strongly 4-5-angled, sparsely hispid in the deep broad grooves, commonly ovate-pustulate on the angles; petioles 7-12 mm long, appressed hispid, ribbed; leaf blades orbicular, palmately 5-10-lobed, 1.5-3 cm broad, the lobes rounded to biangulate, aristate, strongly scabrous on both sides with scale-like trichomes, 10-nerved; tendrils bifid; inflorescence racemose, hispid; peduncle 1-1.5 cm long; corollas minute, 3 mm broad; fruit globose, acuminate-rostrate, glabrous, unarmed, 6-10 mm long, 4-7 mm in diameter, dehiscing transversely around the middle.

LOBELIACEAE

LOBELIA LAXIFLORA ANGUSTIFOLIA A. DC. in DC., Prodr. 7:383. 1839.

Puerto Escondido, February 16, *Dawson* 1105.

Mainly along canyon bottoms and stream banks in the lower elevations of the mountains from Baja California and Chihuahua south to Oaxaca.

COMPOSITAE

AMAURIA ROTUNDIFOLIA Benth., Bot. Voy. Sulph. 31. 1844.

West cove in Concepción Bay, March 15, *Rempel* 180, foot of rocky slope.

Infrequent along the coasts of Baja California; type from San Quentin. A perennial herb, like *Perityle*, but distinguished by the linear, 4-angled, epappose achenes.

ALVORDIA FRUTICOSA Brge., Erythea 7:5. 1889.

Punta Frailes, February 16, *Dawson* 1114. San Jose del Cabo, February 17, *Dawson* 1172 (topotype).

Known only from the Cape District. The genus, consisting of three species, is limited to the southern half of the peninsula. They are shrubs

with slender peduncles having capitate clusters of few-flowered, small, strongly graduated involucre.

ASTER SPINOSUS Benth., Pl. Hartw. 20. 1839.

Canyon above Puerto Escondido, Sierra Giganta, March 13, *Rempel 154*; April 21, *Gentry 3770*.

Widely distributed in western North America from Texas and California south to Costa Rica; type from Aguascalientes, Mexico. A broom-like, bushy, gray-green perennial with reduced, remote, linear leaves, the branchlets often spine-tipped. It commonly forms bushy clumps along the canyon bottoms of the Sierra Giganta escarpment.

BACCHARIS SARATHROIDES Gray, Proc. Am. Acad. Sci. 17:211. 1882.

San Gabriel Bay, Espiritu Santo Island, March 7, *Rempel 88*, west end of pass.

Widely scattered along the washes of the California Gulf Region and into adjacent deserts of the southwestern United States; type from near Old Mission Station, San Diego County, California. It is a rather dense broom-like shrub ordinarily 1-2 m tall. The Rempel collection is a low suffrutescent 1-2 dm tall, quite sterile, and doubtfully referred to this species.

COREOCARPUS DISSECTUS LONGILOBUS Blake, Proc. Am. Acad. Sci. 49:345. 1913.

Leptosyne dissecta Gray, N. Am. Fl. 1:301. 1884.

Canyon above Puerto Escondido, Sierra Giganta, March 13, *Rempel 163*, canyon bottom. Isla San Pedro Nolasco, February 6, *Dawson 1034*.

Middle Baja California and adjacent islands in the gulf; type from Carmen Island. Distinguished from the typical form of the species by the long filiform leaf lobes and the crenate margins of the achenes.

COREOCARPUS SHREVEI Sherff, Bot. Gaz. 97:185. 1935.

Tiburon Island, January 25, *Dawson 1015*.

Middle and southern Baja California, islands in the gulf, and middle coast of Sonora. The above citation is the first record for Tiburon Island. It is a widely distributed species for one that remained so long undescribed. A winter annual flowering in the early spring; the rays rosaceous or yellow, the achenes biaristate, pectinately winged.

COULTERELLA CAPITATA Vasey & Rose, C.N.H. 1:71. 1890.

San Francisco Island, March 9, *Rempel 112*, hillside facing south.

On San Francisco and Espiritu Santo Islands and probably on the adjacent peninsula. Originally described from near La Paz, but the type colony is reported to have been washed out by a storm. Johnston (l.c. p. 1199) makes some interesting observations concerning this rare, monotypic, and endemic plant.

DYSODIA SPECIOSA Gray, Proc. Am. Acad. Sci. 5:163. 1861.

Punta Frailes, Baja California, February 16, *Dawson* 1131.

Apparently endemic to the postinsular Cape District and the adjacent islands; type from Cape San Lucas. It is a slender-stemmed subshrub with showy orange-colored rays and a pungent aromatic odor.

ENCELIA FARINOSA Gray in Emory, Mil. Recon. 143. 1848.

Near Guaymas, February 9, *Dawson* 1082.

Mostly on the arid rocky foothill slopes in southern Nevada, California, Arizona, Sonora, and south to central Sinaloa; type from California.

ENCELIA FARINOSA PHENICODONTA Blake, Proc. Am. Acad. Sci. 49:362. 1913.

Ensenada de los Muertos, Cape District, March 5, *Rempel* 76. Tortuga Island, March 17, *Rempel* 218.

Irregularly through the gulf region from southern Arizona south to Guaymas, Sonora on the mainland, on the islands Patos, Tiburon, Tortuga, and probably others, on the deserts of the peninsula, and in the Cape District; type from near San Quentin, Baja California. This form is distinguished from the typical species by the purple disk flowers in generally smaller heads. Johnston (Proc. Calif. Acad. Sci. IV, 12:1198. 1924) raised Blake's form to a variety. It appears to be more widely distributed than the species.

ERICAMERIA DIFFUSA Benth., Bot. Voy. Sulph. 23. 1844.

San Francisco Island, March 9, *Rempel* 106, shrub 2 feet tall on hillside facing south. Agua Verde Bay, Baja California, March 10, *Rempel* 117, in draw on mesa about 2 miles inland; *Rempel* 122, wash. Los Angeles Bay, March 19, 20, *Rempel* 243.

Along the coasts of southern Sonora and southern Baja California as far as La Paz and on adjacent islands; type from Magdalena Bay. It forms a bushy shrub 1-2 m tall, common and even abundant in some localities. Besides San Francisco Island it has also been collected on San Marcos and Ildefonso Islands. The Rempel collections are either sterile or in the last stages of seeding.

EUPATORIUM PURPUSII Brge., *Erythea* 7:3. 1899.

Canyon above Puerto Escondido, Sierra Giganta, March 13, *Rempel* 160, canyon bottom.

Southern Baja California in the mountains of the Cape District and along the Sierra Giganta; type from San Pablo. A low polypodial herbaceous perennial with stems 3-6 dm long, often forming colonial bushes in the damp shady recesses of the mountains. The triangular serrate leaves are large, 5-8 cm long, shallowly emarginate, the lower long petiolate (4-7 cm long), the stems commonly purplish. Rarely collected.

FRANSERIA ARBORESCENS Brge., *Zoe* 5:162. 1903.

Canyon above Puerto Escondido, Sierra Giganta, March 13, *Rempel* 151 (sterile), canyon bottom.

Southern Baja California; type from Ascension. A large-leaved perennial, which may form large woody-stemmed shrubs up to 3 m tall, and which is one of the least xerophytic of the genus, apparently limited to the canyons and arroyos, drawing upon subsurface run-off.

FRANSERIA DUMOSA Gray in Frem. 2nd Rep. 316. 1845.

Los Angeles Bay, March 19, 20, *Rempel* 250 (sterile).

Widely distributed in the drier areas of the Sonoran Desert from central Sonora and middle Baja California north to the Mojave Desert of southeastern California and southern Nevada, also in southern Arizona; type from the sandy uplands of the Mojave River. It is lacking or scarce in the arboreal desert of middle Sonora and the wetter areas of the peninsula. It commonly forms a low, densely intricated, pallid, and rather brittle bush with ephemeral leaves, pinnately dissected. The burr-like fruits mature quickly and are easily detached from the rachis. It normally flowers in March; the Rempel collection is indicative of a dry season.

FRANSERIA ILICIFOLIA Gray, Proc. Am. Acad. Sci. 11:77. 1876.

North end of Los Angeles Bay, March 19, 20, *Rempel* 253. Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel* 279.

Around the shores of the northern part of the gulf region including Sonora; type from the "Great Canyon of the Tantillas Mountains, near the border of Lower California," Baja California. A low, spreading polypodial bush with harsh leaves having spiny marginal aristations. In the gulf it is known from San Lorenzo, Angel de la Guardia, and San southeastern California and adjacent Arizona, but not known from So-Esteban Islands.

HAPLOPAPPUS JUNCEUS Greene, Bull. Calif. Acad. Sci. 1:190. 1885.
Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel* 265.

A low glandular-pubescent suffrutescent with slender ascending branches, the spinulose leaves reduced upward, bearing 1 to a few heads of involucre 6-8 mm high. Known from northern Baja California and adjoining states, Pinacate Mountain in Sonora; the type from San Diego County, California.

HELIOPSIS PARVIFOLIA Gray, Pl. Wright. 2:86. 1853.

Puerto Escondido, Sierra Giganta, February 11, *Dawson* 1100. San Carlos Bay, Sonora, February 8, *Dawson* 1051.

Known from southwestern Texas to Arizona and northern Mexico. The appearance of this plant at low elevations near Guaymas is of interest, since it is more commonly found in the middle elevations of mountains. A related plant, *H. longipes* (Gray) Blake, of central Mexico has recently been found to contain active ingredients in the roots, which give promise of value as an insecticide.

HETEROSPERMA XANTH Gray, Proc. Am. Acad. Sci. 5:162. 1861.
San Jose del Cabo, February 17, *Dawson* 1176, 1168.

Cape District. Annual, yellow-flowered in spring.

HOFMEISTERIA FASCICULATA PUBESCENS (Wats.) Rob., Proc. Am. Acad. Sci. 47:192. 1911.

Puerto Escondido, February 11, *Dawson* 1105. West cove in Concepción Bay, March 15, *Rempel* 178, foot of rocky slopes. Agua Verde Bay, Baja California, March 10, *Rempel* 120. Punta Frailes, February 16, *Dawson* 1143.

Gulf side of the southern part of the peninsula; type from Muleje, Baja California. Flowers February to April or May.

LAGASCEA DECIPIENS Hemsl., Diag. Pl. Mex. 33. 1879.

San Carlos Bay, Sonora, February 8, *Dawson* 1064.

Sonora and Chihuahua to Jalisco; type from Sierra Madre Occidental of northern Mexico. It is common along the coast and in the foothills, rarely or not at all penetrating the Sierra Madre itself, and may be frequently seen along the washes where it occasionally rambles over other shrubs.

MALACOTHRIX XANTH Gray, Proc. Am. Acad. Sci. 9:213. 1874.

Puerto Escondido, February 11, *Dawson* 1101. Agua Verde Bay, March 10, *Rempel* 139, foot of rocky arroyo wall.

Southern Baja California; type from Cape San Lucas. Annual with the leaves all basal, the scape 2-2.5 dm tall, bearing several, narrow, irregularly fimbriate bracts and terminating in an open panicle, minutely bracteate. The involucre bracts are pale, with irregular rather large glands, the ray flowers pale pink, erose. The above collections are near the northern limit for the species.

MALPERIA TENUIS Wats., Proc. Am. Acad. Sci. 24:54. 1889.

Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel* 270a.

Coarse arid soils of the rocky slopes through the deserts of northern and middle Baja California; type from stony ridges near Los Angeles Bay. It is a diminutive winter annual, corymbosely branching, the seeds maturing in March and early April.

NICOLLETIA TRIFIDA Rydb., N. Am. Fl. 34:180. 1915.

Los Angeles Bay, March 19, 20, *Rempel* 236, on fan and in washes.

Sandy soils of middle Baja California; the type from Los Angeles Bay. A distinctive perennial herb with linear dissected leaves, a *Dysodia*-like odor and appearance. The flowers are made striking by the conspicuous white rays striped medially with reddish purple.

PALAFIXIA LINEARIS (Cav.) Lag., Gen. & Sp. Pl. 26. 1816.

Los Angeles Bay, March 19, 20, *Rempel* 239.

From southern Utah and southern Nevada south through the deserts into northern and northwestern Mexico, chiefly in sandy soils. It is aggressive in colonizing disturbed soils, as along roads and trails. The woody section of old stem and the strigose leaves of the *Rempel* collection indicate it should be more closely assigned to the variety *leucophylla* (Gray) Jtn.

PECTIS MULTISETA Benth., Bot. Voy. Sulph. 20. 1844.

Punta Frailes, February 16, *Dawson* 1121. San Jose del Cabo, February 17, *Dawson* 1155.

Southern Baja California; type from Cape San Lucas. The ray flowers are about 8 mm long or 3 mm longer than described for the species by Rydberg (N. Am. Fl. 34:214. 1916).

PERITYLE AUREA Rose, C.N.H. 1:84. 1890.

Tortuga Island, March 17, *Rempel* 225. Agua Verde Bay, Baja California, March 10, *Rempel* 140, foot of rocky side of arroyo. Canyon above Puerto Escondido, March 13, *Rempel* 141.

Middle Baja California and the adjacent islands of San Marcos and Tortuga; type from Santa Rosalia, Baja California. The plant has a limited distribution, has been little collected, and may be a postinsular relic from the mountains south of Santa Rosalia, now migratory upon Quaternary lands. The Tortuga Island collection shows a plant significantly different in its more robust and diffusive growth, the leaves larger, coarser, and more deeply lobed, and in bearing 20 to 50 rather than only 2 to 10 heads as typical of the mainland forms.

PERITYLE CUNEATA Brge., *Zoe* 1:54. 1890.

Punta Frailes, February 16, *Dawson* 1118.

Southern Baja California; type from Sierra Laguna, Cape District. Apparently a postinsular endemic.

PERITYLE EMORYI Torr. in Emory, *Mil. Recon.* 142. 1848.

San Carlos Bay, February 8, *Dawson* 1068, 1073b. Canyon above Puerto Escondido, Sierra Giganta, March 13, *Rempel* 147, canyon bottom.

Southern California, Baja California, Arizona, and Sonora; type from "Cordilleras of California." A common winter-spring annual, abundant in many localities of the Sonoran Deserts.

PERITYLE INCOMPTA Brge., *U. C. Publ. Bot.* 6:503. 1919.

Agua Verde Bay, Baja California, March 10, *Rempel* 134, beach dunes; *Rempel* 130, wash. Ensenada de los Muertos, Cape District, March 5, *Rempel* 77, among rocks close to shore.

Southern part of the peninsula from San Ignacio south mostly along outer coast; on Santa Magdalena and Santa Margarita Island; type from Los Dolores, Baja California, probably in the Cape District.

Resembles *P. crassifolia* somewhat, but lacks the dense glandular pubescence of that species and the leaves of *P. incompta* are more intricately dissected.

PERITYLE PALMERI Wats., *Proc. Am. Acad. Sci.* 24:57. 1889.

Guaymas, January 23, *Dawson* 1003.

Coastal cerros in southern Sonora; type from Guaymas. Low caespitose pilose perennial herb with relatively large radiate heads with yellow rays.

POROPHYLLUM CRASSIFOLIUM Wats., *Proc. Am. Acad. Sci.* 24:57. 1889.

West cove in Concepción Bay, March 15, *Rempel* 183.

Southern Baja California mainly along the gulf coast and adjacent islands; type from Carmen Island. Suffrutescent with linear succulent leaves having a large gland at the apex below the claw-like tip; the involucre bracts are 5 or 6, rounded, with a single large gland above the middle. Related to *P. tridentatum* and, as Johnston suggests (l.c. p. 1211), may be only a variety of it.

POROPHYLLUM GRACILE Benth., Bot. Voy. Sulph. 29. 1844.

Punta Frailes, Cape District, February 16, *Dawson 1115*. San Jose del Cabo, February 17, *Dawson 1218*. Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel 266*.

Widely distributed in the California Gulf Region and adjacent area in southeastern California and Arizona as far north as the Grand Canyon, south into Sinaloa; type from Magdalena Bay, Baja California.

A shrubby herb with purplish, slender stems, small linear leaves, rather colorless or purplish flowering heads, and a pleasant pungent odor when crushed. It is not infrequent through southern Sonora, where it often grows up under shrubbery.

POROPHYLLUM PORFYREUM Rose & Standl., N. Am. Fl. 34:191. 1916.

San Jose del Cabo, February 17, *Dawson 1166, 1153a*.

Known only from the Cape District; type from San Jose del Cabo. Another linear-leaved species, but characterized by its short, thick, purplish flowering heads.

SENECIO MOHAVENSIS Gray, Syn. Fl. 12:446. 1884.

North end of Los Angeles Bay, March 19, 20, *Rempel 261*.

General through the Sonoran Desert. A diminutive winter annual 2-3 dm tall, the leaves auriculately clasping, coarsely dentate, both leaves and stems purplish. Sometimes found on shady talus slopes.

TRIXIS CALIFORNICA Kell., Proc. Calif. Acad. Sci. I, 2:182, f. 53. 1863.

San Carlos Bay, Sonora, February 8, *Dawson 1072*. Guaymas, February 9, *Dawson 1077*. San Jose del Cabo, Cape District, February 17, *Dawson 1161*. Tortuga Island, March 17, *Rempel 216*. Puerto Refugio, Angel de la Guardia Island, March 20, *Rempel 264*.

A low spreading shrubby bush, long flowering through the spring with numerous heads on short erect branchlets. It is common in arroyos and also on slopes throughout the gulf region and adjacent territory, southern California, southern Sonora; type from Cedros Island.

VERBESINA OLIGOCEPHALA Jtn., Proc. Calif. Acad. Sci. IV, 12: 1200. 1924.

Canyon above Puerto Escondido, Sierra Giganta, March 13, *Rempel 164*, canyon bottom.

Known only from the canyons of the Sierra Giganta, southern Baja California; type from mountains back of Agua Verde Bay. Rempel's collection is the second. The plant may well be a relic endemic of a Sierra Giganta postinsular locality. Johnston reports it as an erect growing little-branched shrub about 1 m tall. It is distinguished by its rather large triangular, coarsely irregularly serrate to undulate leaves, the tomentose stem, and the long-pedunculate (2-4 cm) heads with a double series of unlike involucre bracts, the outer of which are broader than the inner and markedly reflexed.

VIGUIERA DELTOIDEA CHENOPODINA (Greene) Blake, C.N.H. 54: 91. 1918.

San Pedro Nolasco Island, February 6, *Dawson 1033*. Island in Concepción Bay, March 16, *Rempel 201*.

Middle Baja California and adjacent islands; type from between Santo Domingo and Matancita.

Although Johnston (l.c. p. 1201) referred his Nolascan collection (3127) to typical *Viguiera deltoidea* Gray, the present collection with its small, deltoid, entire, strigillose leaves appears to relate the plant to the variety, *chenopodina*. The flowers and achenes, however, are considerably smaller and the leaves larger than Rempel's Concepción Bay number, which appears typical of the variety.

VIGUIERA TOMENTOSA Gray, Proc. Am. Acad. Sci. 5:161. 1861.

Punta Frailes, February 16, *Dawson 1117, 1129*. San Jose del Cabo, February 17, *Dawson 1169*. Cabeza Ballena, Cape District, March 3, *Rempel 58*.

Known only from the Cape District of Baja California; the type from Cape San Lucas. A large-leaved and large-flowered shrub.

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JALISCO AND OAXACA

Tenacatita Bay is a rather broad bay in the southernmost part of the Mexican state of Jalisco not far from the Colima border, plate 13. So far as I am aware, the collection of plants, made there by the Allan Hancock Expedition in the *Velero III* in 1939, is the first. Jalisco, like other Mexican states has been incompletely and intermittently collected. One of the first botanists to collect in the state was Jose Mariano Moctiño, who traveled through the state in the latter part of the eighteenth century. About 100 years later in the 1890's, Cyrus Guernsey Pringle made what are probably the largest Jaliscan collections. Two of his more important localities were a barranca near Guadalajara and the hills about Etzatlan. Rose, Standley, and others have since collected along the railroad through the interior highland. The most important collection in this century to date is that of Inez Mexia, made during the last decade in the western mountains, where she discovered many new plants. Except for Edward Palmer's important collections about the port of Manzanillo, the coast flora has not been sampled, and the slopes of the mountains facing the sea are quite untouched.

The plants collected at Tenacatita Bay are therefore of interest for the records they provide in the distribution of subtropical and tropical American plants. A few of the species collected have not previously been known in Jalisco. Taken in the tierra caliente zone, they are typical representatives of the tropical drought-deciduous heterogeneous forest that extends along the Pacific Coast from Sinaloa to Costa Rica. It is unfortunate that the expedition happened to visit this little known locality in the month of May, because the dry season is then at its height and very few of the plants are in a collectable or even recognizable condition. Except for the riparian communities, the innumerable members of the natural flora covering the hills and mountains are leafless and either resting or dormant. A few only fruit and flower during this period. The whole great biota is in a kind of waiting for the summer rains, which normally start in June.

Chacagua Bay, Oaxaca, plate 13, is in southernmost Mexico and although it is not a wet climate except for the summer months, it is within the American tropics. Unlike Jalisco, the state of Oaxaca has had the attentions of a resident botanist. Professor C. Conzatti of Ciudad Oaxaca has long given the state special study. He classifies the region around the littoral of Chacagua Bay as the "Subregion de la Costa y Cañada de Cuicatlan."* Although less accessible than Jalisco, Oaxaca

*Las Regiones Botanico-Geograficas del Estado de Oaxaca. Presented at the IV International Botanical Congress, Ithaca, New York. Printed by the author, C. Conzatti, 1926, Oaxaca, Oaxaca.

seems to have had more attention from botanists and several have made extended collections through portions of the state. The *Velero III* visited Chacagua Bay on March 21, 1939. Francis H. Elmore went ashore and made a small collection of plants, consisting of 27 numbers representing 26 species. These together with the 25 numbers, representing 22 species, from Tenacatita Bay, Jalisco are catalogued below.

CATALOGUE OF COLLECTIONS

POLYPODIACEAE

LYGODIUM VENUSTUM Sw. in Schrad., Jour. 1801 2:303. 1803.

Tenacatita Bay, May 8, *Elmore 1A12*, along dry stream bank.

Southern Mexico through Central America to Brazil and the West Indies.

BROMELIACEAE

TILLANDSIA FASCICULATA Sw., Prodr. 56. 1788.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A17*, epiphytic on *Conocarpus erectus*.

Widely distributed in tropical America from Florida and the West Indies to Mexico and Central America to Colombia and Guiana. It is a highly polymorphic species and has been divided into many varieties.

PIPERACEAE

PIPER AFF. MISANTLENSE C.DC. in DC., Prodr. 161:286. 1869.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A20*.

Vera Cruz and perhaps elsewhere.

The above collection with pubescent branchlets is doubtfully referred to this species, which is described as having glabrous branchlets. It agrees fairly well with herbarium material labeled *P. misantlense*.

PIPER TUBERCULATUM Jacq., Icon. Pl. Rar. 2:2. 1786.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A22*.

From Vera Cruz and Nayarit south through tropical America. It is one of the few species of *Piper* having a wide distribution.

MORACEAE

FICUS MEXICANA Miquel, Ann. Mus. Bot. Lugd. Bat. 3:300. 1867.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A10*, rocky sandy soil of hot dry forest along a dry stream bank of 15 feet elevation.

In Mexico from southern Sonora south to Oaxaca; reported also to be in Yucatan.

The trees along the west coast of Mexico which taxonomists have assigned to Miquel's name are among the largest in the genus. They affect the open streamways, as the intermittent arroyos, which though

dry on the surface for much of the year, carry a charge of water in their sandy beds. The trees spread with ponderous limbs into a great mound of relatively open foliage. The leaves are uniformly elliptic, acute at both ends, with strong scalleriform lateral veins, the blade commonly 14 to 18 cm long. The fruit is 1 to 1.5 cm in diameter, quite round, dryish, and little suited to human taste and consumption.

AMARANTACEAE

PHILOXERUS VERMICULARIS (L.) R. Br., Prodr. 416. 1910.

Gomphrena vermicularis L., Sp. Pl. 224. 1753.

Chacagua Bay, Oaxaca, March 21, *Elmore D26*.

Florida through the West Indies and Central America to northern South America.

NYCTAGINACEAE

PISONIA ACULEATA L., Sp. Pl. 1026. 1753.

Chacagua Bay, Oaxaca, March 21, *Elmore D18*, shaded in dry sandy soil, a vine with yellow flowers.

Widely distributed along beaches in tropical and subtropical America. Also in southern Asia.

A large, spiny, intricately branched shrub with sweet-scented flowers. It occasionally takes a scandent form and runs over large trees.

SALIPIANTHUS ARENARIUS H. & B., Pl. Aequin. 1:139. 1807.

Chacagua Bay, Oaxaca, March 21, *Elmore D4*, dry shaded sandy soil.

Jalisco to Oaxaca; type from near Acapulco, Guerrero.

An herbaceous shrub common to sandy and alluvial soils. Elmore reports it as having "a very strong pleasant odor." A closely related species, *S. macrodontus*, is known to have a large tuberous edible root (Gentry, Carn. Inst. Publ. 527:111. 1942), and it would be of interest to know if the present species has a similar organ.

PAPAVERACEAE

ARGEMONE MEXICANA L., Sp. Pl. 508. 1753.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A11*, dry alluvial soil of a stream bank.

Common in wastelands and fallow fields of low and middle elevations throughout Mexico and into Central America.

CAPPARIDACEAE

CAPPARIS BADUCA L., Sp. Pl. 504. 1753.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A21*.

On both coasts of Mexico south through tropical America. The collection represents a new plant for the flora of Jalisco and extends the known range northward.

This *Capparis* is distinguished from other members of the genus by the combination of long petioles below and short petioles (some leaves subsessile) above towards the apex of the branchlets.

AMYGDALACEAE

CHRYSOBALANUS ICACO L., Sp. Pl. 513. 1753.

Chacagua Bay, Oaxaca, March 21, *Elmore D15*, few plants in dry sandy soil at 10 feet elevation, flowers white.

Widely distributed along the coasts of tropical America and in west Africa; type from Jamaica. The cocoa-plum tree is widely known for its edible fruits, eaten raw or cooked.

COUEPIA POLYANDRA (HBK.) Rose, C.N.H. 5:196. 1899.

Chacagua Bay, Oaxaca, March 21, *Elmore D14*, many plants in dry sandy soil at 10 feet elevation, flowers white.

Sinaloa to Oaxaca in the tierra caliente; type from Acapulco Guerrero.

LEGUMINOSAE

ACACIA HINDSIANA Benth., Lond. Jour. Bot. 1:504. 1842.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A13*, in dry open forest at 10 feet elevation. Chacagua Bay, Oaxaca, March 21, *Elmore D11*.

Along the Pacific coast from Sinaloa to San Salvador.

It is a shrub or small tree belonging to that group of trees known as the Bull Horn Acacias, so-called from the large hollow spines with flaring bases along the branches, and in which ants live. These animals are pugnacious with a strong sense of proprietorship and rush forth from their spine retreats to attack anything that disturbs their arboreal world, botanists included. This species is found in the more open forests and along stream banks and is tolerant to a wide range of soils.

CANAVALIA MARITIMA (Aubl.) Thouars, Jour. de Bot. Desv. 1:80. 1813.

Chacagua Bay, Oaxaca, March 21, *Elmore D1*, growing on small sand dunes.

Littoral of tropical America; commonly associated with *Ipomoea pes-caprae*.

This collection may be referable to *C. apiculata* Piper (C.N.H. 20: 566. 1925), but the leaves are broadly ovate and retuse, not acute, which latter character Piper used to separate his northwest Mexican maritime species. He does not cite *C. maritima* from the Mexican west coast, hence Elmore's Oaxaca collection with the characters of *C. maritima* makes Piper's *C. apiculata* a dubious species, since the small differences apparently are not correlated with geographic segregation.

DESMODIUM SCORPIURUS (Sw.) Desv., Jour. de Bot. 1:122. 1813.

Chacagua Bay, Oaxaca, March 21, *Elmore D9*, on dry, shaded, sandy soil under cocoanut trees.

Littoral from central Sinaloa south through Central America. A procumbent herb characteristic of the sandy littoral.

PHASEOLUS ADENANTHUS Meyer, Prim. Fl. Esseq. 239. 1818.

Chacagua Bay, Oaxaca, March 21, *Elmore D2*, growing on and among sand dunes on the upper beach.

Widely distributed through lowlands of tropical America.

A glabrous or puberulent vine with lanceolate leaflets, very unequal calyx lobes (upper broad and rounded, lower lanceolate, acute), bracts strongly 9-10-nerved, pale flowers, and rather straight pods 7-8 x 100 mm.

PROSOPIS AFF. JULIFLORA (Sw.) DC., Prodr. 2:447. 1825.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A24*.

This form of the species is common along the west coast of Mexico from Sinaloa south, chiefly below 2000 feet elevation.

EUPHORBIACEAE

EUPHORBIA HIRTA TYPICA Wh., Cont. Gray Herb. 127:68. 1939.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A13*, dry clay soil in forest clearing.

Widely dispersed through tropical and subtropical America.

HIPPOMANE MANCINELLA L., Sp. Pl. 1191. 1753.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A18*, in dry open forest.

From southern Mexico south through Central America to South America and the West Indies.

SAPINDACEAE

PAULLINIA FUSCESCENS HBK., Nov. Gen. & Sp. 5:93. 1821.

Chacagua Bay, Oaxaca, March 21, *Elmore D5*, growing as a vine over a tree in sandy soil in dry forest at 10 feet elevation.

Widely distributed in the tierra caliente from central Sinaloa, Mexico to Brazil; type from the Rio Amazon.

During the arid spring when many plants are leafless through the Pacific lowlands, this vine is conspicuous by its clusters of reddish fruits and dissected, strongly crenate, lobed leaves.

STERCULIACEAE

GUASUMA ULMIFOLIA Lam., Encycl. 3:52. 1789.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A8*, in dry open forest.

Widely distributed in tropical and subtropical America from central Sonora and Tamaulipas, Mexico to South America.

The guazima tree is primarily a riparian dweller along the Pacific tierra caliente from sea level up to 2500 to 3000 feet. It appears to require ground water either at high or low levels, at least in the more arid climates as in Sonora, and grows readily in a wide variety of soils, coarse or fine. In contrast to the trees of the slope forests, it carries its leaves through most of the year, dropping them only at the height of the spring dry season. Its apparent absence from the Cape District of Baja California is rather puzzling, when so many of its mainland associates are found there.

WALTHERIA AMERICANA L., Sp. Pl. 673. 1753.

Chacagua Bay, Oaxaca, March 21, *Elmore D7*, in dry, shaded, sandy soil.

Widely distributed in the warmer parts of both hemispheres.

WALTHERIA PRESLI Walp., Report. Bot. 1:340. 1842.

Chacagua Bay, Oaxaca, March 21, *Elmore D10*, in dry sandy soil at 10 feet elevation, flowers yellow.

Oaxaca to Guerrero along the southwest coast of Mexico; type from Acapulco, Guerrero.

This plant has been collected rarely and the above collection is the first cited from Oaxaca.

TURNERACEAE

TURNERA ULMIFOLIA L., Sp. Pl. 271. 1753.

Chacagua Bay, Oaxaca, March 21, *Elmore D8*, a few plants in dry sandy soil at 10 feet elevation, flowers yellow.

Widely distributed in tropical America; naturalized in the Old World.

PASSIFLORACEAE

PASSIFLORA HOLOSERICEA L., Sp. Pl. 958. 1753.

Chacagua Bay, Oaxaca, March 21, *Elmore D20*, vine with white and purple flowers climbing on *Chrysobalanus icaco* in dry, hot, shaded jungle with sandy soil.

Tierra caliente from southern Mexico to Honduras, Cuba, Venezuela, and northern Colombia; type locality, Vera Cruz, Mexico.

Vine with flexuous stems and coriaceous, pubescent, 3-lobed leaves, the lobes aristate, bidentate on the broadly rounded base. It is common in the southern low country of Mexico and is known from collections at Mazatlan, Sinaloa, the most northern records, and the Tres Marias Islands.

RHIZOPHORACEAE

RHIZOPHORA MANGLE L., Sp. Pl. 443. 1753.

Chacagua Bay, Oaxaca, March 21, *Elmore D24*, edge of lagoon.

From Tiburon Island south throughout the tropics of the Americas; type from the Caribbean Sea.

COMBRETACEAE

COMBRETUM MEXICANUM H. & B., Pl. Aequin. 2:159, pl. 132. 1809.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A1*, vine growing on trees from dry clay soil in the forest, elevation 10 feet.

Tierra caliente, Jalisco to Oaxaca, Mexico; type from Acapulco, Guerrero. This collection apparently is the first from Jalisco and constitutes a northern record for the species.

CONOCARPUS ERECTUS L., Sp. Pl. 176. 1753.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A16*, in sand on upper beach. Chacagua Bay, Oaxaca, March 21, *Elmore D25*, on edge of lagoon.

On the shores throughout tropical America and in western Africa.

CONOCARPUS ERECTUS SERICEUS DC., Prodr. 3:16. 1828.

Chacagua Bay, Oaxaca, March 21, *Elmore D21*, in moist sandy soil by a lagoon.

Widely distributed in the American tropics from southern Mexico through Central America to South America and the West Indies along the shores.

LAGUNCULARIA RACEMOSA (L.) Gaertn., f. Fruct. & Sem. 3:209. 1807.

Chacagua Bay, Oaxaca, March 21, *Elmore D27*.

Littoral of the tropics and subtropics in North and South America and in western Africa.

The inflorescence is very young, indicating the start of the flowering period for the Oaxaca population.

PLUMBAGINACEAE

PLUMBAGO SCANDENS L., Sp. Pl. ed. 2, 215. 1762.

Chacagua Bay, Oaxaca, March 21, *Elmore D6*, sandy soil in the shade of dry hot forest, 10 feet elevation.

Widely distributed in the tierra caliente of tropical America from Tamaulipas and Sonora south along both coasts.

ASCLEPIADACEAE

ASCLEPIAS CURASSAVICA L., Sp. Pl. 215. 1753.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A19*.

Widely distributed in tropical and subtropical America from southern Sonora and central Baja California southward.

FUNASTRUM CLAUSUM (Jacq.) Schlechter, Rep. Sp. Nov. Fedde 13:283. 1914.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A23*, climbing on shrubs on stream bank around pools of a dry stream, flowers white.

Widely known through tropical and subtropical America and nearly throughout Mexico.

CONVOLVULACEAE

IPOMOEA PES-CAPRAE (L.) Roth., Nov. Sp. Pl. 109. 1821.

Chacagua Bay, Oaxaca, March 21, *Elmore D23*, among and on the small sand dunes of the beach.

Along the beaches of the tropics and subtropics of both hemispheres; type from India.

HYDROPHYLLACEAE

WIGANDIA CARACASANA HBK., Nov. Gen. & Sp. 3:127. 1819.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A15*, sandy rocky alluvium on dry stream bank at 10 feet elevation, flowers blue.

From northern Sinaloa, Mexico south through Central America to northern South America.

BORAGINACEAE

CORDIA SELERIANA Fern., Proc. Am. Acad. Sci. 36:498. 1901.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A4*, in dry open forest at 15 feet elevation, flowers white.

Southwestern Mexico from Jalisco to Oaxaca; type from Huilotepec,

Oaxaca.

Not previously known from Jalisco, the collection of this shrub marks a northern extension of range. Like many other spring blooming shrubs of the semiarid tropical Pacific tierra caliente, it is nearly leafless at flowering time, as faithfully reflected by Elmore's specimens.

TOURNEFORTIA HIRSUTISSIMA L., Sp. Pl. 140. 1753.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A5*, in dry open forest at 15 feet elevation, flowers white.

Widely distributed in tropical and subtropical America, from Sinaloa to South America and the West Indies.

VERBENACEAE

AVICENNIA NITIDA Jacq., Enum. Pl. Carib. 25. 1760.

Chacagua Bay, Oaxaca, March 21, *Elmore D21a*.

Littoral from Baja California and Tamaulipas south through tropical America.

LANTANA HORRIDA HBK., Nov. Gen. & Sp. 2:261. 1817.

Chacagua Bay, Oaxaca, March 21, *Elmore D13*, a few plants in dry sandy soil climbing on *Couepia polyandra*, flowers red and yellow.

Widely distributed in the warmer parts of America; from southern Sonora south along the Mexican west coast.

PHYLLA NODIFLORA (L.) Greene, Pittonia 4:48. 1899.

Chacagua Bay, Oaxaca, March 21, *Elmore D3*, dry sandy soil near sea level.

Widely distributed in the tropical lowlands of both hemispheres.

This is a common strand plant along the beaches and bottomlands of western Mexico. On the sand dunes it forms only sparse covering of loosely branched, prostrate, dispersed plants, while on the moister clay soils back of the beach dunes and inland it may form a compact turf-like covering.

SOLANACEAE

SOLANUM DIVERSIFOLIUM Schlecht., Linnaea 19:297. 1846.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A9*, a few shrubs with white flowers growing in dry open exposed clay soil.

Apparently along both Mexican coasts from Baja California, Sinaloa, and Tamaulipas south to Central America.

SOLANUM NUDUM HBK., Nov. Gen. & Sp. 3:33. 1818.

Chacagua Bay, Oaxaca, March 21, *Elmore D17*, many plants,

shaded in dry sandy soil under the forest, flowers white.

Tierra caliente of Mexico and Central America; type from Jalapa, Vera Cruz.

BIGNONIACEAE

ASTIANTHUS VIMINALIS (HBK.) Bail, Hist. Pl. 10:44. 1888.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A14*, sandy rocky alluvium along dry stream bank, elevation 10 feet.

From Jalisco southeast across southern Mexico to Guatemala; type from between Mexcala and Estola, Guerrero. Apparently not previously known from Jalisco. It is a tree with long linear leaves and showy yellow flowers. The genus consists of a single species.

TABEBUIA PENTAPHYLLA (L.) Hemsl., Biol. Cent. Am. Bot. 2: 495. 1882.

Chacagua Bay, Oaxaca, March 21, *Elmore D19*, a large tree of the forest about 100 feet high with lavender flowers, the ground below covered with its leaves.

Southern Mexico through Central America to Venezuela and the West Indies.

As Elmore's notes indicate the leaves are normally dropped in the dry spring season, before or about the time of flowering, the time being determined largely by the time and amount of precipitation in the last rainfalls of the fall or winter. The tree is very showy when in bloom and the wood has a high quality for furniture. It has often been employed for ceiling beams and other structural uses. See Standley's account (C.N.H. 23:1320).

RUBIACEAE

DIODIA SARMENTOSA Sw., Prod. Veg. Ind. Occ. 30. 1788.

Chacagua Bay, Oaxaca, March 21, *Elmore D12*, a few plants in dry sandy soil at 10 feet elevation, flowers lavender.

Mexico, Central America, and the West Indies.

COMPOSITAE

EUPATORIUM CF. *BREVIPES* DC., Prodr. 5:168. 1836.

Tenacatita Bay, Jalisco, May 8, *Elmore 1A6*, in dry, open, level, clay ground of grassland, flowers white.

Northwestern and southern Mexico; chiefly Sierra Madrean from southern Sonora and Chihuahua to Oaxaca.

The above specimen apparently represents a shrub, the branchlets smooth, white, glabrous, the prominent nodes remote, the corymbose inflorescence deeply oval in outline; phyllaries mostly in one series, sub-



tended by a few short ones, the former longer than the corollas, linear lanceolate, acute, hispid; heads about 40-flowered. The leaves are deciduated except for a few young ones subtending the inflorescence, which are 2 to 3 cm long, lanceolate, mostly acuminate, remotely serrulate, cuneate, hispid above and below, 3-nerved from near the base.

COSTA RICA

The best work on the fabulously rich flora of Costa Rica is that of Standley (*Flora of Costa Rica*, Field. Mus. Bot. 18:1-1571. 1937-38). Because of the author's inimitable style, his introductory discussion of the region and its plants is one of the most interesting to be read in any flora. His work has been my guide in preparing the following report on the collections of the Allan Hancock Pacific Expedition of 1939. The expedition visited two peninsular localities which apparently had not been botanized previously. On March 24, the collecting botanist, F. H. Elmore, went ashore at Port Parker, Salinas Bay in northwestern Costa Rica, where he secured 25 numbers with 1-8 duplicates. On March 26 he collected 28 numbers with duplicates on the Peninsula de Osa, Golfo de Dulce in southwestern Costa Rica. This gulf is named Golfo de Osa on some maps. Plates 14 and 15 are general views in these collecting localities.

Both localities are tropical and only 8 to 11 degrees north of the equator. They are, however, rather arid, since the prevailing winds are from the south Caribbean equatorial current and are deprived of most of their precipitable moisture in rising over the central mountains. Throughout the long spring there is little or no rainfall. Both localities are in what is universally known in Central America as the "tierra caliente," the warm to hot lowlands under 3000 feet elevation.

"For half the year, at least, there is less of green than of brown and yellow. In the wet season the general hue of the landscape is not the deep, dreary green of the rain forest, but a livelier green, brightened by abundant sun, more like the vivid green of temperate lands.—The Atlantic forests are evergreen, those of the Pacific, such as they are, mostly deciduous, many of the trees and shrubs being leafless during much of the dry season, and many of the herbs dying if annual, or remaining dormant if perennial." (Standley, l. c. p. 17)

In addition to the forests and thickets there are extensive savannas, where arborescent vegetation is scattered and the grassy herbs dominate. In such areas agriculture takes the form of cattle ranching.

The strand vegetation is not notably different from that found widely along the shores of the Caribbean or from the Mexican Pacific coast.

As a whole the Pacific tierra caliente may be considered as one major floristic unit, so uniform are its climatic and vegetative characters. But while the strand flora is homogeneous, that of the coastal interior is not, for several floristic elements have met and blended through the more northern latitudes. Among these floral elements are Caribbean, the Mexican Continental, and the Sinaloan. The latter two appear to have been derived largely from a Tertiary element part of which during geologic times may have migrated southward and blended with the more tropical one. The following genera of trees and shrubs are common through the Pacific tierra caliente from Sinaloa to Panama and are either abundant in number of species or in individuals, exercise a dominating influence in the vegetation, and are characteristic of the Pacific slope flora. The legumes are the most dominating family of plants.

Prosopis	Anacardium	Cedrela
Pithecolobium	Solanum	Ficus
Acacia	Coccoloba	Ceiba
Mimosa	Cereus	Euphorbia
Lonchocarpus	Eupatorium	Croton
Enterlobium	Hamelia	Jatropha
Cassia	Ruellia	Acalypha
Diphysa	Ipomoea	Hura
Gliricidia	Diospyros	Chlorophora
Inga	Palms	Guasuma
Caesalpinia	Piper	Psidium
Bauhinia	Bursera	Byrsonima
Platymiscium	Cordia	Cochlospermum
Spondias		Tabebuia

The Costa Rican Pacific tierra caliente has apparently had little botanical exploration. Men have preferred to visit the more varied and interesting, as well as the healthier, highland. "Certainly it is the least agreeable in which to work, for the climate is hot, the forests and thickets particularly so, and full of tangled vines and spiny branches, not to mention the ticks that thrive better than elsewhere. On this account, and for lack of good means of transportation, partly also because of the sparsely settled country, the Pacific tierra caliente has been relatively little investigated by botanists. Its exploration involves long rides on horseback on obscure trails, where there are few and often uncomfortable lodging places. It must not be forgotten that some localities on the Pacific coast are noted for a virulent type of malaria" (Standley l. c. p. 21). The following enumerations of the Allan Hancock Pacific collections,

therefore, are of interest for the additional records they provide in plant distribution.

CATALOGUE OF COLLECTIONS

POLYPODIACEAE

BOLBITIS (LEPTOCHILUS) CLADORRHIZANS (Spreng.) Ching, in C. Chr. Ind. Suppl. 3:47. 1934.

Golfo de Dulce, March 26, *Elmore F23*, rocky walls of a moist shaded stream at 20 feet elevation.

West Indies to Mexico and Colombia.

DRYOPTERIS SUBTETRAGONA (Link) Maxon, Pter. Porto Rica 473. 1926.

Golfo de Dulce, March 26, *Elmore F10*, in humus of moist shaded jungle at 10 feet elevation.

West Indies and Central America.

NEPHROLEPIS PENDULA (Raddi) J. Smith, Job. 4:197. 1841.

Golfo de Dulce, March 26, *Elmore F4*, growing on old coconut palm stump.

Central America.

GRAMINEAE

GYNERIUM SAGITTATUM (Aubl.) Beauv., Ess. Agrost. 138. 1812.

Golfo de Dulce, March 26, *Elmore F3*, shaded in moist humus of the forest at 10 feet elevation.

From southern Mexico to Paraguay and the West Indies; type apparently from Peru. This giant grass is abundant along the tropical coasts and widely used by the native peoples in their buildings and for many miscellaneous uses.

CYPERACEAE

CYPERUS HAYESII (Clarke) Standl., Jour. Wash. Acad. Sci. 15: 457. 1925.

Golfo de Dulce, March 26, *Elmore F11*, in sandy soil of clearing in jungle at 15 feet elevation.

Panama and Costa Rica. It has previously been known only from the canal zone, so Elmore's collection supplies an extension of range for the species and an addition to the flora of Costa Rica.

RHYNCHOSPORA CEPHALOTES (L.) Vahl, Enum. 2:237. 1806.

Southwest island of the Secas group, March 27, *Elmore G1*, shaded in moist peat humus of the jungle at 50 feet elevation.

Found generally in forests and thickets of the tierra caliente in tropical America. Elmore reports seeing only a few plants on a 30° slope; the inflorescences green.

BROMELIACEAE

BROMELIA PINGVIN L., Sp. Pl. 285. 1753.

Port Parker, Salinas Bay, March 24, *Elmore E3*, sandy soil of the upper beach, fruits orange-colored.

Common along the Pacific slope where it forms spiny colonies.

AMARYLLIDACEAE

Agave costaricana Gentry sp. nov.

Folia glauca, lineari-lanceolata, tenuia, 6-10 cm lata, 70-80 cm longa; spina terminali conica, ferruginea, 4-5 cm longa, 3-4 mm diam. ad basim, decurrenti 8-12 cm; spinis lateralibus minutis papillatis 0.5-2 mm altis, 8-10 mm distantibus; marginibus foliorum directis; inflorescentia paniculata; perianthio pallide flavo, brevi-campanulato, 2.5 cm longo, segminibus 2 cm longis, 4-5 mm latis, linearibus, obtusis, involutis; staminibus longi-exsertis; ovario juvenali, 20-25 mm longo, lineari-oblongo; semina non vidi.

Typus: *Elmore E18*, "a few plants growing along the rocky bank of a dry stream bed, at or near Port Parker, Salinas Bay, Costa Rica, March 18, 1939," in hb. Allan Hancock Foundation, University of Southern California. Duplum in hb. Univ. Mich.

Leaves glaucous, linear-lanceolate, rather thin, at least 6-10 cm wide, 70-80 cm long, gradually tapering below; terminal spine straight, reddish brown, conical, 4-5 cm long, 3-4 mm in diam. at base, with or without a narrow basal groove, decurrent as a narrow horny margin along the blade for 2 to 3 times the length of the spine; marginal spines minute, papilloid, brownish, 0.5-2 mm high, more prominent towards the terminus of the blade, mostly 8-10 mm apart; margin of the blade straight, lightly and narrowly calloused; inflorescence a terminal compound panicle; perianth yellowish, rotate or shallowly campanulate, constricted below, 2.5 cm long, the segments 2 cm long, 4-5 mm wide, linear obtuse, involute; filaments inserted a little above the middle of the short corolla tube, long exserted; stamens large, attached below the middle; style about 4 cm long, long exserted; stigma triquetrous, truncate; ovary 20-25 cm long, linear-oblong, constricted above; seeds not seen.

This is only the second species of *Agave* reported for the flora of Costa Rica, the other being *Agave Werklei* Weber (C.N.H. 23:132. 1920). The proposed new species is distinguished by its narrow linear-lanceolate leaves with minute marginal prickles along a straight margin,

and by the small flowers with relatively wide linear perianth segments. These characters together with the open paniculate inflorescence place it in the section *Sisalanae* of Trelease or *Rigidae* of Berger. It is apparently related to *Agave nivea* Trel., from which it differs by its flat and shorter leaves, the unraised bases of the prickles, and the straight decurrent terminal spines. *Agave Seemanniana* Jacobi, known from Guatemala and Nicaragua, is to be expected in Costa Rica also.

ORCHIDACEAE

BRASSAVOLA NODOSA Lindl., Gen. & Sp. Orch. 114.

Golfo de Dulce, March 26, *Elmore F26*, on trees in jungle.

Widely distributed in the American tropics from southern Mexico to South America and the West Indies. It blooms in the spring dry season, having relatively inconspicuous greenish flowers tinged with purple.

LAELIA TIBICINIS (Batem) L. O. Wms.

Port Parker, Salinas Bay, March 24, *Elmore E19*, a shaded epiphyte high on a tree, elev. 175 feet. Petals pale lavender to a dark lavender red with yellow markings on the upper petal.

This is a first record of the species from Costa Rica.

LORANTHACEAE

PHORADENDRON QUADRANGULARE (HBK.) Krug. & Urb., Bot. Jahrb. 24:35. 1818.

Port Parker, Salinas Bay, March 24, *Elmore E17*, growing on *Byrsonima crassifolia*.

Widely distributed from southern Mexico to South America and the West Indies, growing mostly on broad-leaved trees in middle and lower elevations. Trelease recognized six or eight closely related species that Standley and Steyermark (Fl. Guata., Fieldiana Botany 24:73. 1946) relegated to synonymy under the above name.

AMARANTHACEAE

ALTERNANTHERA LAGUROIDES Standl. in Standl. & Cald., Lista Pl. Salvador 74. 1925.

Golfo de Dulce, March 26, *Elmore F13*, sandy soil of clearing in jungle near sea level. Vine with white flowers.

Clearings and thickets of the Pacific slope from Guatemala to Panama.

CYATHULA ACHYRANTHOIDES (HBK.) Moq. in DC., Prodr. 13 pt. 2:326. 1849.

Golfo de Dulce, March 26, *Elmore F14*.

From southern Mexico to northern South America and the West Indies; type from Magdalena River, near Mompos, Colombia.

MENISPERMACEAE

HYPERBAENA LEPTOBOTRYOSA (D. Sm.) Standl., Field Mus. Bot. 18:618. 1937.

Golfo de Dulce, March 26, *Elmore F2*, shaded in moist humus at 10 feet elev.

Type from Santo Domingo de Golfo Dulce, Prov. Puntarenas, Costa Rica. Known only from the vicinity of the type locality.

LAURACEAE

OCOTEA VERAGUENSIS (Meisn.) Jahrb. Bot. Gart. Berlin 5:240. 1889.

Port Parker, Salinas Bay, March 24, *Elmore E13*, shaded in moist soil on rocky stream bank. Flowers white.

Common in the forests of the Pacific tierra caliente from southern Mexico (Chiapas) to Panama. A common tree along stream banks.

CAPPARIDACEAE

CRATAEVA TAPIA L., Sp. Pl. 444. 1753.

Golfo de Dulce, March 26, *Elmore F22*, shaded in moist humus soil in jungle at 15 feet elev.

A tree widely distributed in the thickets and forests of tropical America from southern Mexico to South America and the West Indies.

LEGUMINOSAE

ACACIA HINDSII Benth., Lond. Jour. Bot. 1:504. 1842.

Port Parker, Salinas Bay, March 24, *Elmore E8*, dry sandy soil of a dry stream bank. Infested with ants.

Rather common in the tierra caliente of the Pacific coast from southern Sinaloa, Mexico to San Salvador.

DIPHYSA HUMILIS Oerst. ? in Benth. & Oerst. Vid. Meddel. 1853: 12.

Port Parker, Salinas Bay, March 24, 25, *Elmore E20*, upper beach in moist hot exposed rocky soil. "Small tree with yellow flowers."

The collection is doubtfully referred to the only known Costa Rican species, apparently represented by only one collection from the Volcan Rincon in Guanacaste province. The collection is fragmentary; in flower, but leafless.

GLIRICIDIA SEPIUM (Jacq.) Steud., nom. Bot. ed. 2, 1:688. 1841.

Port Parker, Salinas Bay, March 24, *Elmore E7*, moist rocky sand

of the upper beach, elev. 5 feet. Flowers pink with a yellow spot on banner.

Common in the tierra caliente from Mexico to South America and the West Indies. This tree is often planted for shade in the cacao plantations.

OXALIDACEAE

OXALIS NEAEI DC., Prodr. 1:690. 1824.

Port Parker, Salinas Bay, March 26, *Elmore E12*.

In moist soils from southern Mexico to tropical South America. It is frequent as a weed in cultivated ground.

MELIACEAE

CEDRELA MEXICANA Roem., Fam. Nat. Syn. 1:137. 1846.

Golfo de Dulce, March 26, *Elmore F6*, in moist shaded humus of the jungle, elev. 10 feet.

In the tierra caliente from central Sinaloa south through southern and eastern Mexico and south through Central America to Brazil. In groves this tree forms long straight boles of commercial timber of soft wood; one of the species that supplies the Spanish Cedar of commerce.

MALPIGHIACEAE

BYRSONIMA CRASSIFOLIA (L.) DC., Prodr. 1:579. 1824.

Port Parker, Salinas Bay, March 24, *Elmore E16*, dry sandy soil on a dry stream bank, elev. 50 feet. Flowers yellow and orange.

Widely distributed and common in many areas on coastal hill slopes and with higher grasslands from central Sinaloa through southern Mexico, Central America, the West Indies, and northern South America.

STIGMAPHYLLON LINDENIANUM Juss., Arch. Mus. Paris 3:362. 1843.

Golfo de Dulce, March 28, *Elmore F19*, shaded in dry forest humus.

Common in the tierra caliente from southern Mexico to Panama. The leaves of this woody vine vary from deeply 3-lobate to nearly ovate entire. In the field it can be distinguished from most other species by the dentate leaf margins. In the above collection the dentations are remote.

POLYGALACEAE

SECURIDACA DIVERSIFOLIA (L.) Blake, C.N.H. 23:594. 1923.

Polygala diversifolia L., Sp. Pl. 703. 1753.

Port Parker, Salinas Bay, March 24, *Elmore E9*, moist sandy soil on a dry stream bank, flowers dark lavender.

From Jalisco and Tamaulipas, Mexico south through Central Ameri-

ca to Ecuador and the West Indies. A scandent shrub with shiny thickish leaves. The genus is distinctive in the Polygalaceae because of the samaroid fruits.

EUPHORBIACEAE

ACALYPHA VILLOSA Jacq., Enum. Pl. Carib. 32.

Golfo de Dulce, March 26, *Elmore F9*.

Widely dispersed in tropical America. The determination by Croizat is based on vegetative characters, female flowers being absent, and it is therefore tentative.

HIPPOMANE MANCINELLA L., Sp. Pl. 1191. 1753.

Port Parker, Salinas Bay, March 24, *Elmore E4*, shaded in moist sand of the upper beach.

This small tree, with poisonous apple-like fruits, is common along the Pacific beaches and is found nearly throughout the tropical Americas.

ANACARDIACEAE

ANACARDIUM OCCIDENTALE L., Sp. Pl. 383. 1753.

Golfo de Dulce, March 26, *Elmore F20*.

Widely distributed in the New World tropics, naturalized in the Old World tropics. This is the Cashew Tree. Both the fruit, borne on the fleshy receptacle, and the receptacle itself are edible.

HIPPOCRATEACEAE

HIPPOCRATEA OBOVATA Pittier, C.N.H. 12:176. 1909.

Port Parker, Salinas Bay, March 24, *Elmore E14*, shaded on moist sandy rocky stream bank at 20 feet elev.

Endemic to Costa Rica where it occupies the forests and thickets of the Pacific tierra caliente. The flowers are reported by Elmore to be greenish white.

MALVACEAE

HIBISCUS TILIACEUS L., Sp. Pl. 694. 1753.

Golfo de Dulce, March 26, *Elmore F18*, shaded in moist sandy soil of the upper beach; flowers yellow turning dark orange or reddish on withering. Port Parker, Salinas Bay, *Elmore E5*.

Widely distributed as a littoral plant in tropical regions. On the west coast it is known as far north as central Sinaloa (Altata, *Gentry 5427*), Mexico. The pressed flowers on the herbarium sheet are a dark purple or brown.

BOMBACACEAE

BOMBACOPSIS SESSILIS (Benth.) Pittier, C.N.H. 18:162. 1916.

Southwest Island of the Secas group, off Costa Rica, March 27,

Elmore G2, steep rocky slopes of the upper beach.

From Costa Rica and Panama. Also reported at Buenos Aires, South America.

CLUSIACEAE

CLUSIA ROSEA Jacq., Enum. Pl. Carib. 34. 1760.

Golfo de Dulce, March 26, *Elmore F27*, in humus and shade of hot moist level jungle at 100 feet elev.

Widely distributed in the American tropics from Yucatan south through Central America to northern South America and the West Indies. It forms a small tree, beginning as an epiphyte on other trees; characterized by the thick obovate leaves, almost as wide as long, with a heavy midvein and numerous ascending parallel secondaries, and pulpy gummy fruits up to 2 inches in diameter.

PASSIFLORACEAE

PASSIFLORA FOETIDA SALVADORENSIS Killip, Carn. Inst. Wash. Publ. 461:327. 1936.

Port Parker, Salinas Bay, March 25, *Elmore E10*, in moist rocky bank of dry stream bed. Flowers lavender, fruit red.

Known only from San Salvador and Costa Rica, type from Nahu-lingo, Sonsonate, Salvador. Elmore's collection is an extension of range, adding another plant to the flora of Costa Rica.

RHIZOPHORACEAE

RHIZOPHORA MANGLE L., Sp. Pl. 443. 1753.

Port Parker, Salinas Bay, March 24, *Elmore E6*, sandy upper beach. Widely distributed in tropical America.

COMBRETACEAE

COMBRETUM ERIANTHUM Benth., Pl. Hartw. 73. 1840.

Port Parker, Salinas Bay, March 24, *Elmore E15*, dry sandy soil on a dry stream bank, flowers red. Elev. 50 feet.

From Costa Rica to southern Mexico in the tierra caliente, type from Retalhuleu, Guatemala.

CONOCARPUS ERECTUS L., Sp. Pl. 176. 1753.

Port Parker, Salinas Bay, March 24, *Elmore E2*, sandy lower beach on tidal land.

Littoral of tropical and subtropical America, also in western Africa. It often forms borders around lagoons above the mangroves.

MELASTOMACEAE

MICONEA ARGENTEA (Sw.) DC., Prodr. 3:182. 1828.

Golfo de Dulce, March 26, *Elmore F17*, a few plants in peaty or

humus soil in the jungle, flowers white.

Known in Central America from southern Mexico to Panama; type from the Mosquito Coast.

UMBELLIFERAE

ERYNGIUM FOETIDUM L., Sp. Pl. 232. 1753.

Golfo de Dulce, March 26, *Elmore F12*, dry sandy soil in forest clearing.

Widely distributed as a weed in tropical America. The plant has a strong offensive odor, but in spite of it, is used with good results as a seasoning for foods, the offensive quality being dispelled by heating.

BORAGINACEAE

TOURNEFORTIA HIRSUTISSIMA L., Sp. Pl. 140. 1753.

Golfo de Dulce, March 26, *Elmore F16*, dry sandy soil of a forest clearing, flowers white.

From Sinaloa and Tamaulipas south through Central America to South America and the West Indies. In Costa Rica it has been reported from Region of Dota and San Ramon. It is a scandent shrub with irritant hairs along the stem.

VERBENACEAE

AVICENNIA NITIDA Jacq., Enum. Pl. Carib. 25. 1760.

Port Parker, Salinas Bay, March 24, *Elmore E1*, on sandy beach in tidal land.

Widely distributed along the shores of tropical and subtropical America where it is associated with mangrove.

SCROPHULARIACEAE

RUSSELLIA VERTICILLATA HBK., Nov. Gen. & Sp. 2:360. 1817.

Port Parker, Salinas Bay, March 24, *Elmore E11*, dry sandy soil of a dry stream bank, elev. 10 feet.

From northern Mexico to Panama along the Pacific coast mainly below 3000 feet elev.; type from Puente de la Madre de Dios.

ACANTHACEAE

APHELANDRA DEPPEANA Schlecht. & Cham. Linnaea 5:96. 1830.

Golfo de Dulce, March 26, *Elmore F21*, shaded in moist humus soil at the edge of a jungle clearing, elev. 15 feet.

From southern Mexico to northern South America and the West Indies; type from Hacienda de la Laguna, Vera Cruz.

RUELLIA AFF. *BIOLLEYI* Lind. in Pittier, Prim. 2:301. 1900.

Golfo de Dulce, March 26, *Elmore F7*, in moist soil of the forest at 10 feet elev.

Wet forests of Costa Rica and Panama.

RUBIACEAE

HAMELIA MAGNIFOLIA Wernham, Jour. Bot. 49:210. 1911.

Golfo de Dulce, March 26, *Elmore F8*, shaded in dry humus at the edge of a clearing, flowers yellow and red.

Costa Rica and Panama.



PLATE 1

Moringa oleifera Lam.Fig. 1. Section of branchlet with leaf $\times\frac{1}{2}$.Fig. 2. Pod $\times\frac{1}{2}$.



PLATE 2

Moringa oleifera Lam.

Fig. 3. Flower at anthesis x3.3.

Fig. 4. Stamen x11.

Fig. 5. Bud x5.

Fig. 6. Sepal x6.7.

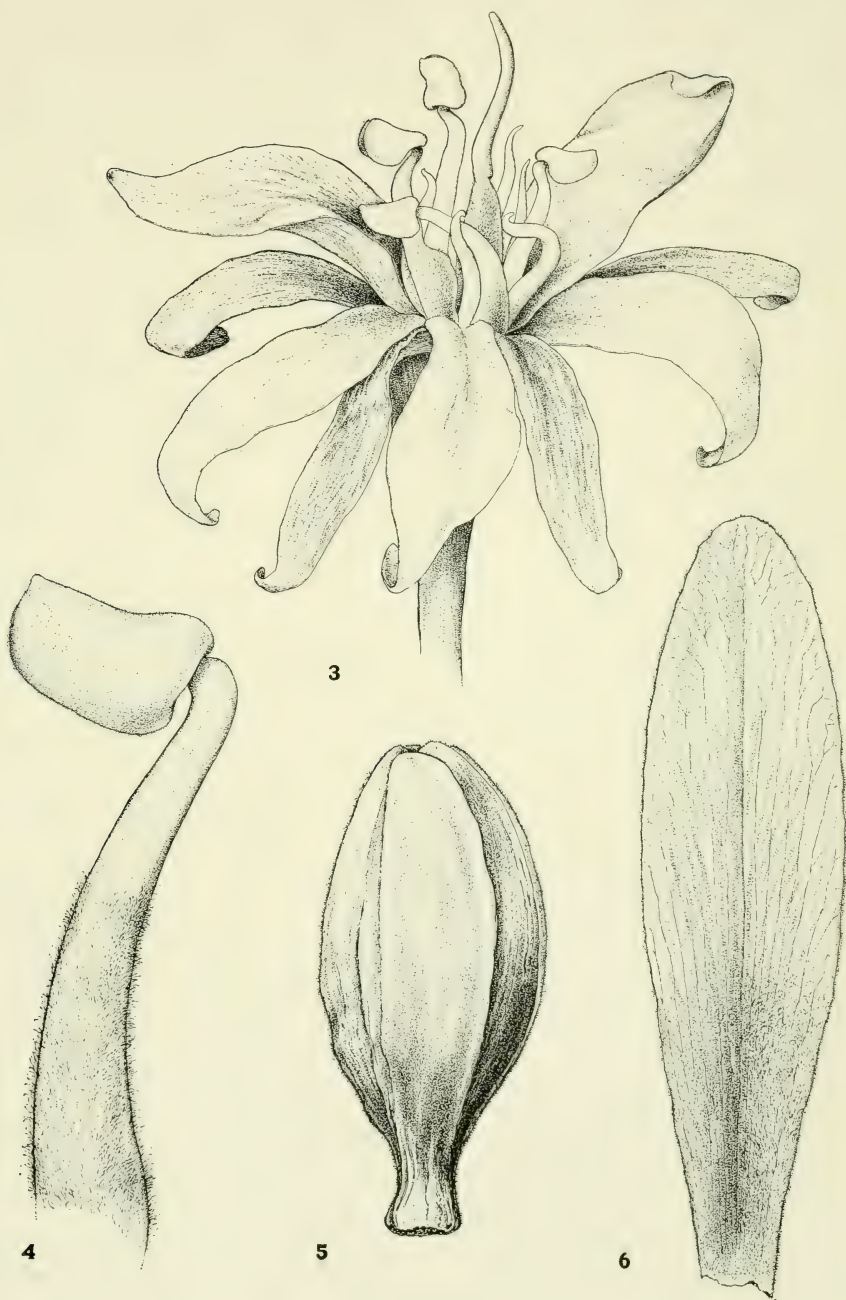


PLATE 3

Echinopepon peninsularis GentryFig. 7. Habit $\times \frac{1}{2}$.Fig. 8. Node $\times 4$.Fig. 9. Fruit prickle $\times 6.5$ to compare with.Fig. 10. Fruit prickle $\times 6.5$ of *Echinopepon minimus*.



9

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PLATE 4

- Fig. 11. View on the north end of Santa Rosa Island. Grassland covers the more level slopes, while bushy perennials are spotted on the bluff. (Photo from the Los Angeles Museum Channel Island Survey).
- Fig. 12. Braithwaite Bay, Socorro Island on a calm cloudy day in March.



PLATE 5

Fig. 13. Punta Frailes, Cape District, Baja California. The arborescent growth is widely dispersed on the steep rocky slopes, dense on the outwash fans.

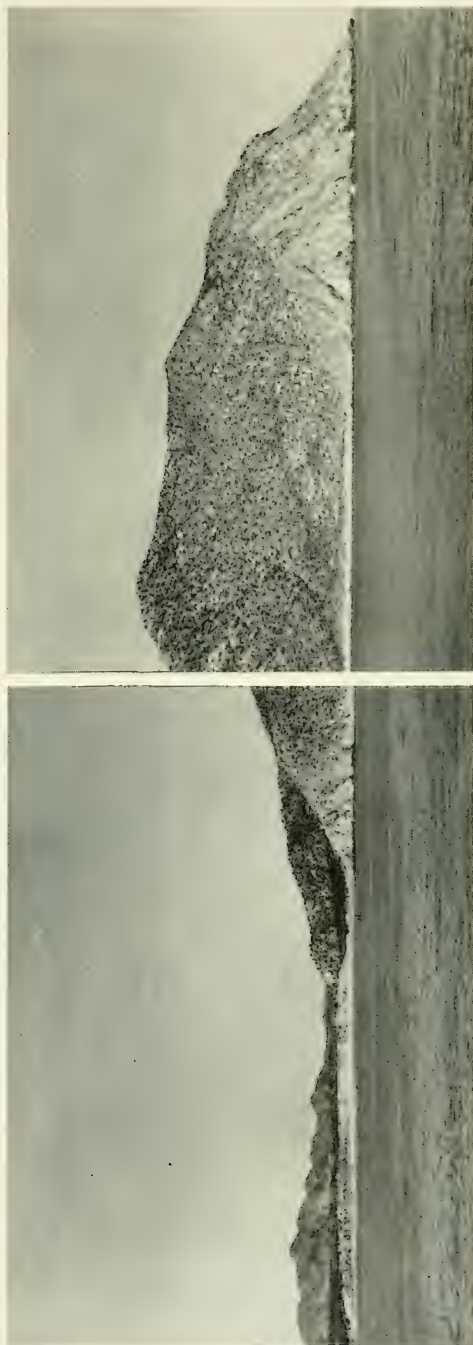


PLATE 6

Fig. 14. Vegetation above Frailes Bay, Cape District. On the basic rock slope the vegetation is sparse and stunted.

Fig. 15. Dense Thorn Forest vegetation in a broad wash near Frailes Bay, Cape District, Baja California.



PLATE 7

Fig. 16. View southward near Puerto Escondido, Baja California, overlooking a narrow coastal plain with the scarp of the Sierra Giganta in the background. The foreground shows a xerophytic grass ground cover with scattered trees of *Bursera microphylla* and *Lemaireocereus Thurberi*.

Fig. 17. Canyon above Escondido, Baja California. The steep slopes are brecciated lavas; the palm, *Erythea Brandegei*.



PLATE 8

- Fig. 18. Angel de la Guardia Island. Typically sparse desert vegetation on washes and fans with a scattered grove of *Pachycereus Pringlei*.
- Fig. 19. Angel de la Guardia Island. The effect of wind on the sarcophytic tree, *Pachycormus discolor pubescens*, along a rocky crest.
- Fig. 20. Angel de la Guardia Island. Sparse Desert Shrub on an east exposure with *Pachycereus Pringlei* on the lower gentler slopes.



PLATE 9

- Fig. 21. Tiburon Island. Low Desert Shrub on the granitic terrain of the southeast coast.
- Fig. 22. San Pedro Nolasco Island, showing the "raw" rock surfaces, almost no soil, and adventive or pioneering perennials.



PLATE 10

Fig. 23. San Pedro Nolasco Island. A clump of *Echinocereus grandis*.

Fig. 24. San Pedro Nolasco Island. A succulent vegetation of *Agave*,
Opuntia, and *Pachycereus* on very rocky terrain.

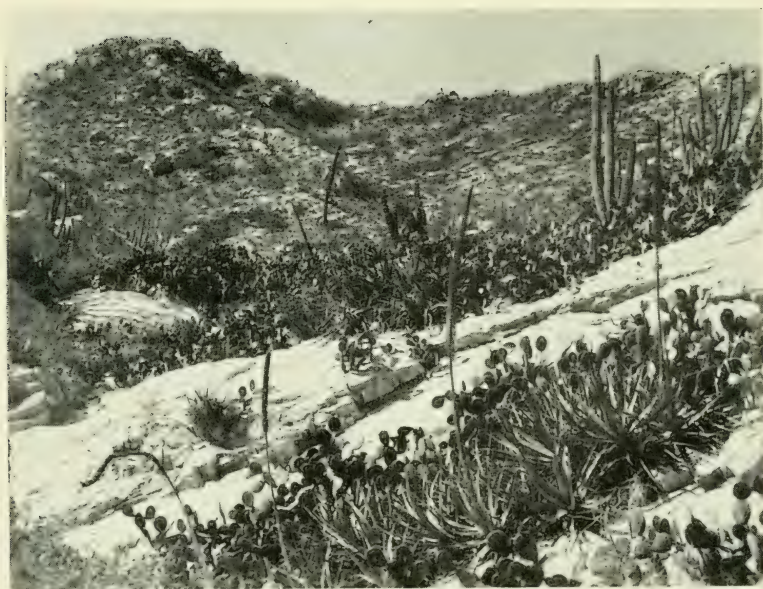


PLATE 11

Fig. 25. San Pedro Nolasco Island. *Agave chrysoglossa* and *Lemaireocereus Thurberi* in foreground.

Fig. 26. San Pedro Nolasco Island. A dense colony of the succulent low shrub, *Pedilanthus macrocarpus*.



PLATE 12

- Fig. 27. Espiritu Santo Island. A dispersed shrub formation with scattered trees of *Pachycereus Pringlei*.
- Fig. 28. Espiritu Santo Island. Detail of branch and fruit of *Opuntia cholla*.



PLATE 13

- Fig. 29. Tenacatita Bay, Jalisco. The subtropical forest is close upon the beach.
- Fig. 30. Chacagua Bay, Oaxaca. The scrubby vegetation on the hill in the background shows evidence of having been cut over.



PLATE 14

Fig. 31. Lowland coastal vegetation of the tierra caliente in Costa Rica near Puerto Culebro.

Fig. 32. Close lowland forest of Costa Rica with a dense tangle of trunks, limbs, and clambering stems, crooked to semi-straight.



PLATE 15

Fig. 33. Forest of the tierra caliente in the Golfo de Dulce, Costa Rica.
The varied tree forms indicate the richness of the flora.



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REPORTS OF THE COLLECTIONS OBTAINED BY ALLAN HANCOCK PACIFIC EXPEDITIONS OF
VELERO III OFF THE COAST OF MEXICO, CENTRAL AMERICA, SOUTH AMERICA, AND
GALAPAGOS ISLANDS IN 1932, IN 1933, IN 1934, IN 1935, IN 1936, IN 1937, IN 1938,
IN 1939, IN 1940, IN 1941, AND VELERO IV IN 1949.

PLANT ECOLOGY OF THE CHANNEL ISLANDS OF CALIFORNIA

(FIGURES 1-12, PLATES 1-6)

By MERYL BYRON DUNKLE



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PLANT ECOLOGY OF THE CHANNEL ISLANDS OF CALIFORNIA

By MERYL BYRON DUNKLE

I INTRODUCTION

Off the coast of populous southern California lie a number of islands, uninhabited for the most part. They are far enough out from shore to have a distinctive climate and a noteworthy endemic plant and animal life. While these islands have been known for over four centuries they have been the object of scientific study for only about one century.

The study of the island plant life was begun in 1847 when Dr. William Gambel of the Philadelphia Academy of Sciences collected a few plants on Santa Catalina Island (Nuttall, 1848). In 1874 Dr. Albert Kellogg and W. G. G. Harford made a small plant collection on Santa Cruz Island (Eastwood, 1941). Yet not until 1884 were any extensive collections made. In that year T. S. and Katherine Brandegee (1890), and W. S. Lyon made collections on Santa Catalina Island, and continued their work for several years, while Dr. E. L. Greene began his extensive work on the island flora in 1886 with an extended visit to Santa Cruz Island.

Lorenzo G. Yates (1889, 1890) in connection with his geological reconnaissances of the Channel Islands devoted considerable study to the island plants. In 1895 Mrs. Blanche Trask went to Santa Catalina Island and during the ensuing twelve years as a resident botanist collected indefatigably there and on the three other southern islands (Trask, 1897, 1898, 1899, and 1904).

C. F. Millspaugh and L. W. Nuttall of the Chicago Field Museum of Natural History started their collections on Santa Catalina Island in 1919 and 1920 respectively, and published their splendid volume on the "Flora of Santa Catalina Island" in 1923. They give a complete account of the botanical work on this island. Ralph Hoffman (1932) made extensive studies of the flora of the four northern islands, but his sudden death in 1932, while collecting on San Miguel Island left his work incomplete.



The Los Angeles County Museum Channel Islands Biological Survey, begun in 1939, was the first attempt to study the complete biota of the individual islands and to integrate the information thus obtained for the island group as a whole. The author, acting as field botanist for the Survey, made extensive collections on all the Channel Islands. The problems arising in this work led to ecological studies under the direction of the late Dr. Howard de Forest of the University of Southern California.

While incidental mention has been made of the general ecological conditions, in the various taxonomic reports of the island flora, there had been previously, no detailed or objective study. No descriptive account of the vegetation as such had been given in either general or specific terms. For instance it was not possible to know, from written accounts, what types of plant associations were to be found on the different parts of each of the several islands.

At intervals geologic, topographic, and oceanographic surveys and reconnaissances had been conducted in the insular area and several reports have been made upon its geologic evolution. Nevertheless, little attempt has been made to trace the effect of these physiographic changes upon the development of the present flora of the islands, and there has been also insufficient study of the affinities of the island flora with the floras of adjacent regions. Accordingly this investigation was undertaken to study the island vegetation, to investigate the distribution and the affinities of the island plants, and to make inquiry into the effects of the ecological agencies upon the island plant life and its communities. The study of the environmental factors of these insular habitats led the writer to select Santa Barbara Island as the most central for quantitative and instrumental analysis. The period of study extended from March 17, 1940 to April 22, 1942.

Meteorological stations have been maintained, by different agencies, for various periods during the past forty five years. However, there had been previously, little or no attempt to correlate the results of climatological studies with the characteristics of the present vegetation.

Ten instrument stations were set up on Santa Barbara. The instruments used were: standardized, spherical, Livingston porous black-cup and white-cup atmometers for measuring evaporation and insolation, anemometers, rain gauges, and maximum and minimum registering thermometers. At two stations recording hygrographs and thermographs were used for obtaining a continuous record of humidity and temperature. All of these instruments were modified or rebuilt to serve

for long-period intervals between observations. This was necessitated by the difficulties encountered in arranging for frequent trips to this isolated island. Soil samples were taken at each of the instrument-stations for mechanical analysis and hydrogen ion determination.

While these investigations are necessarily incomplete because of weather hazards, distance, and war-time restrictions, and some of the conclusions hypothetical, it is hoped that the methods used and the problems discussed may be of value to other students of insular conditions and to the administrators of the various islands.

The scope of this ecological study has involved the cooperation of specialists in many fields. Meteorologists, oceanographers, geologists, climatologists, and zoologists have contributed to the solution of the ecological problems. Because of the diversity of the separate fields involved in this study a glossary of technical terms is given. See p. 332. The field of this investigation has covered such a large area, so difficult of access, that it has made other assistance essential. Merely to name all who have contributed in some measure to the success of the undertaking would be impossible. However, this account would be incomplete without mention of those whose assistance has been indispensable.

First among these has been Dr. John A. Comstock, Curator of science in the Los Angeles County Museum, whose leadership in the organization of the expeditions of the Los Angeles County Museum Biological Survey of the Channel Islands has made them possible. Don C. Meadows, the field executive of the island expeditions, assisted in the field work and in the organization of the material.

The scientific interest of Captain Allan Hancock and his generosity with the *Velero III* provided transportation for many of the voyages. The use of the sedimentation laboratory of the Allan Hancock Foundation facilitated the detailed study of the soils and marine sediments of the island area. The patrol boats of the California Fish and Game Commission also assisted in the matter of transportation.

II INSULAR ENVIRONMENT

The continental shelf of the western coast of North America is very narrow when compared with that of the eastern coast. Off central California the edge of the shelf roughly parallels the coast, trending 30 degrees east of south. At Point Conception the coast turns abruptly eastward and then swings southward to regain its original trend only along the coast of San Diego County. As the edge of the shelf does not

change its trend through these latitudes it comes to lie, along southern California, about one hundred and twenty miles farther out than it did at Point Conception.

Thus, within this wide, sweeping arc of the southern California coast lies a great embayment of the sea. The continental shelf is wider here than the entire width of the Coast Ranges of central California and the submerged area is in general alignment with these ranges. This section of the continental shelf thus represents a submerged part of the continent; a mountainous section with peaks rising eight thousand feet above the deeply submerged basins. Only the higher portions of these mountains ranges rise above sea level, and form an archipelago of scattered islands extending over an area of some five thousand square miles. As this archipelago roughly parallels the coast, along which coastwise vessels ply, the island group is called the Channel Islands of California. These islands extend from 23.3 miles south of Point Conception to 62.4 miles west of Point Loma.

THE GEOLOGIC SETTING

The area now occupied by the Channel Islands was in past ages the scene of great epirogenic activity. Reed (1933) states that this area was a large island which he calls "Catalinia." This land mass, which apparently existed from the Cretaceous to the early part of the Tremblor formation of the Middle Micoene, extended west and south from the present islands, probably including the Cortez and Tanner Banks, and possibly also Guadalupe Island, two hundred and fifty miles to the south of San Clemente Island. Intermittent periods of submergence and uplift differentiate areas of this ancient land mass. Only occasionally has it been connected with the mainland. Many plant endemics, many of which are only distantly related to present mainland plants, and some endemic animals are to be found on the islands.

Figure 1 shows the relationship of the Channel Islands to each other and to the southern California coast, as well as to the general contours of the continental shelf.

The northern four islands form the summits of a partly submerged ridge extending westward from the Santa Monica Mountains. San Miguel Island lies the farthest west, nearly due south of Point Conception. The relative positions of the islands can best be visualized by reference to Figure 1. During at least the latter part of the Cenozoic the area about the four northern islands is thought by Reed (1936) to have been a separate geological province, which he calls "Anacapia."

The presence of fossil elephants on Santa Rosa and Santa Cruz (Stock, 1935) indicates that there must have been a land connection with the mainland in the early or middle Pleistocene. This evidence is further substantiated by the presence of many plants with northern affinities on the northern islands. This invasion of northern plants is thought to have occurred during the glacial stages of the Pleistocene (Leconte, 1893).

The four southern islands are much more widely scattered and form the high points of submerged northwest and southeast ridges. Santa Catalina, the largest of the southern islands, lies only twenty-two miles south of Point Vicente. The second in size, San Clemente, the most southern of the islands, is sixty-three miles west of La Jolla, while the third largest of the southern islands, San Nicolas, lies farthest from the coast, sixty miles from the nearest point of the mainland. Santa Barbara is the smallest of the islands and is situated about half way between San Nicolas and Santa Catalina.

A fact of some interest in considering the location of the islands is that the channels separating them from the mainland are shown by Coast and Geodetic Survey charts to be about twice the depth of the channels separating England from France, Asia from Alaska, and Borneo, Java, and Sumatra from the Malay Peninsula, these latter all being less than 100 fathoms in depth. The Catalina Channel is approximately the same depth as the arms of the north Atlantic separating Iceland both from Greenland and from Europe. This not only shows the deep subsidence of this portion of the continental shelf, but indicates that there has been little possibility of any connection of the islands with the mainland during the lower ocean levels of the Wisconsin glacial stage of the ice age, unless diastrophic agencies have considerably altered the levels existing at that time.

Figure 2 shows the islands in such a manner that their sizes may easily be compared, and also shows the fifty-fathom contour which roughly marks the lower limit of the beaches existing during the Wisconsin stage.

PAST CLIMATIC CHANGES

Another element in the geologic evolution of the islands is the long term change which has occurred since the early Pliocene, interrupted by the glacial stages of the Quaternary and by long term cycles since. The overall change has been a gradual drying of the climate. In recent time the general record of geochronological climatology has shown a

gradual amelioration of glacial conditions for several thousand years (Russell, 1941, p. 86). In these latitudes this change has been manifested by the northward spread of desert conditions. It is illustrated by the progressive drying of lakes Bonneville, Lahontan, Searles, and Death Valley. The Mohave River lies directly east of the Channel Islands and far enough south so that the gradual elevation of the Sierra Nevada could scarcely have cast a rain shadow over this region. The drying of the lower streams and lakes of the Mohave system is most eloquent testimony of this increasing desiccation. The study of lake varves and tree rings (Huntington and Visher, 1922), and of ancient Syrian civilization (Butler, 1920) all point to the same progressive desiccation of these latitudes.

Progressive desiccation of the island area itself is indicated, too, by the fact that seedlings of several insular endemics, such as *Lyonothamnus* (Ironwood), *Dendromecon* (Tree Poppy), and *Quercus tomentella* Engelm. (Island Oak), have rarely been found. A few *Dendromecon* seedlings have been found in disturbed soil about mine dumps on Santa Catalina. The lack of young plants of the above mentioned endemics may be due, in part, to grazing animals or to the competition of exotic plants, but the evidence seems to indicate that these plants are incapable of reproducing themselves at present under normal climatic conditions.

The effect of long continued desiccation would be to modify the life forms of the individual species, and to produce changes in the floristic composition of the plant communities. Direct evidence of such change will be produced later in this paper.

CLIMATE

The classification of the climates of the Channel Islands has been an unsettled question in the past owing to the lack of adequate data. However, the United States Navy has recently established two aerological stations, one on San Nicolas in 1932, and another on San Clemente in 1937, and the Coast Guard has been recording meteorological data on Anacapa since 1934. A Weather Bureau station was established at Avalon, Santa Catalina Island, in 1909, and its records have since been continuous. The San Miguel Station of the Weather Bureau was established in 1897, discontinued in 1903, reestablished in 1906, again stopped in 1921, and resumed from 1940 to 1942. These various records, when assembled with other observations to follow, enable reasonably definite conclusions to be drawn.

Precipitation. The summer months are generally dry with the only effective precipitation during the winter. Light rains may start in the latter part of September and gradually increase in intensity until early February, after which they show a rapid decrease until the last of April. The regime of the insular precipitation is shown in table 1.

There is slightly more rain during the summer months on the westernmost and the higher of the islands than on the southern islands and the lower islands to the east. Thus San Miguel, Santa Rosa, San Nicolas, and Santa Catalina each have some light rain during the summer, while practically no summer rain is reported from Anacapa, Santa Barbara, and San Clemente. More rain is reported from San Clemente, Santa Catalina, and San Nicolas for October and the latter part of September than for November. This undoubtedly is owing to the tropical storms that come up along the coast of Mexico in the early fall and tend to turn eastward or die out north of latitude 30° N. The area of precipitation from these storms may occasionally reach the southern islands.

The hydrotherm shown in figure 6 summarizes the monthly precipitation and temperature for the Channel Islands, and is almost identical with those of some of the islands of the Mediterranean Sea, as shown by Raunkiaer (1934). The break in regularity of the precipitation graph for November shows the effect of the tropical storms.

The summer aridity of the islands is reflected in the abundance of many annuals and the marked abundance of suffrutescence of the island vegetation. The general dominance of grasslands and the presence of chaparral in certain areas of Santa Cruz, Santa Rosa, and Santa Catalina, and formerly of San Miguel, is typical of the Mediterranean climates in similar latitudes in corresponding sections of continental masses; i.e., the Mediterranean "maqui," the South African "veldt," the Australian "bush," and the South American "llanos."

In addition to the records obtained from the governmental meteorological stations it was deemed desirable to obtain further information in regard to temperature and humidity ranges, and precise measurement of the evaporation rates in different exposures. This was done by means of specially designed, recording instruments.

Temperature and humidity. In order to obtain records of the temperature and humidity ranges, thermographs and hygrographs were established at two stations on Santa Barbara Island. Because the weather was such as to make visits to this island impracticable for a small boat during the months of January, February, and March of 1942, no records are available for that period. Consequently the records for the first week

TABLE 1
MONTHLY PRECIPITATION FOR THE CHANNEL ISLANDS*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Tot.
San Miguel	3.54	2.82	2.74	0.76	0.35	0.17	0.04	0.04	0.41	0.58	0.82	1.91	14.2
Santa Rosa	2.96	3.50	3.03	0.89	0.12	0.17	0.09	0.07	0.12	0.61	0.82	2.81	15.2
Anacapa	1.81	3.11	2.25	1.05	0.00	0.00	0.00	0.00	0.19	0.61	1.35	3.20	12.58
San Nicolas	2.02	3.00	1.90	0.72	T	0.03	T	0.20	0.22	0.32	0.30	2.37	11.08
Santa Catalina	2.31	2.25	2.01	0.94	0.29	0.07	T	0.02	0.18	0.81	0.70	2.75	12.35
San Clemente	2.17	3.17	1.32	0.71	T	0.01	T	0.00	T	0.05	0.08	3.07	10.56

*Cf. Table 2 for authorities quoted.

of each of several consecutive months have been arbitrarily chosen as a fair example. It is worth noting, however, that the maximum-minimum thermometer readings showed no lower temperatures than are indicated on figs. 5, 6. (pp. 350-2). Consequently these records do well illustrate the remarkably small range of temperature throughout the year. The recordings were taken from instruments at the station situated on the main ridge about the center of the island. The low range of temperature is clearly shown especially for the fall months, as well as the uniformly high humidity. For weeks at a time, during the summer, the relative humidity ran at 100 per cent for from sixteen to eighteen hours of the day. Observation has shown that this is similar to conditions on all of the islands, with the exception of the eastern part of Santa Catalina. Here there is less fog than on the other islands or on the adjacent mainland coast.

The hygro-thermogram for May 4 to 11, 1941, indicates a most remarkable deviation from the normal uniformity. Examination of the Weather Bureau records for southern California for the period in question shows that exceptional temperatures then prevailed on the mainland. Periods of high pressure over the southern part of the Great Basin cause a pressure gradient, bringing dry, hot wind to the coastal area. The inland high pressure area is related to the extensive subtropical anticyclone over the "horse latitudes" of the Pacific, which is characterized by settling air. The adiabatic warming of this air causes extremely low relative humidity.

The extreme fluctuations of relative humidity indicated by this May hygro-thermogram, sometimes as much as 50 per cent within a period of minutes, could only be caused by waves of superior air alternating with the horizontal movement of Pacific maritime air. Only tropical air from the upper troposphere would be capable of producing such exceptionally low relative humidities in an area so far removed from the mainland shore. Dry periods similar to that of this May week have been experienced on several of the other islands and doubtless occur several times a year. Only rarely, however, would conditions probably be such as to produce a relative humidity as low as 2 per cent. The normal offshore breeze usually reaches Santa Barbara Island late at night and persists several hours after sunrise. This normal land breeze, however, does not noticeably affect the relative humidity.

Wind. There are few records of wind velocity but these are fairly consistent. San Miguel is the most windy of all the islands, with San Nicolas a close second. Plate 2, p. 368, in the next sub-section shows clearly the effect of the northwest wind on San Miguel. There it has

been necessary to construct a ten-foot stockade about the ranch house, but even with this protection shutters must be provided for the windows so that the window glass will not be abraded by the sand-blasting. On Santa Barbara the intensity of the wind reaches an unknown maximum. Twice the instrument station of the north peak was wrecked, the rain gauge recording cylinder blown out, the wire screen protecting the instruments torn loose and blown over onto the east terrace. Twice the anemometer on the ridge station was wrecked when the anemometer cups were blown off.

At Wilson Cove on San Clemente Island the average wind velocity for the period from April 1, to June 30, 1940, was 11.8 miles per hour. On the terrace south of the ranch house on Santa Rosa the average wind velocity for a period of 193 days, from October 10, 1921, to May 13, 1922 was 12.0 miles per hour. It is interesting that the average for the night hours was almost identical with that for daylight hours. On the eastern bluff of Santa Barbara near the cabin the wind velocity for the two years from March 26, 1940, to April 1, 1942, averaged 7.8 miles per hour. It should be noted that the anemometer here was only 7.5 feet from the ground, whereas the Weather Bureau anemometers are usually placed thirty feet from the ground. On each of the three islands referred to, the recording station was on the lee side of the island and was operating for different periods of time. The observation that the prevailing winds show less force on the south and east tends to be confirmed.

Observation of the more exposed sections of the islands indicates that the winds there are much stronger, but reliable records are almost wholly lacking. On Santa Barbara the anemometer which was twice wrecked, situated 7.5 feet above the ground, gave a reading from September 11, 1940, to December 6, 1941, of 16.8 miles per hour for the average wind velocity. The wind is the most powerful factor in the environment of the island plant communities. Its variation is so great from one topographical location to another that it appears to be the most effective agent in the distribution and limitation of the communities. This will be treated in more detail later.

The maritime climate of the islands shows also the following characteristics: (1) a mean noon relative humidity of over 60 per cent, (2) a mean July temperature of less than 22°C. (71.6° F.), (3) an aridity coefficient of 12 per cent or less (Gorczyński, 1940, p. 5), and (4) night or morning low stratus or fog for the greater part of the year.

The designation "foggy desert," as defined by Russell (1926, p. 79), might appear to be applicable to some of the southern islands.

However, the low summer temperatures, the high relative humidity, and the great amount of fog or low stratus, give an effectiveness to the annual precipitation well above that of an eleven inch precipitation inland. It is true that on southern slopes, with the high angle of the sun, the shallow soil, and the high wind velocity produce xeric conditions which have misled casual observers as to the true climatic status of the islands. The general physiognomy of the vegetation, its density and its floristic composition, do not fit the definition of a desert. Only on the southern end of San Clemente does the physiognomy of the vegetation approach that of a desert.

Maritime climate. Thus it is seen that the islands have the dry summers, the humid-temperate winters, and the characteristic vegetation of the Mediterranean climate, and the incipient trade winds of summer, supplemented by intermittent westerlies in winter, with some modifications; i.e., uniformly low ranges of annual and diurnal temperatures, high average of relative humidity, considerable low stratus or fog. These latter features are characteristic of an oceanic climate. This type, in contrast to the continental climate, has long been recognized by geographers. That a sub-type of oceanic climate is typical of windward coasts in the low latitude temperate windward coasts of the temperate zones has also been established, and the terms "oceanic," "littoral," and "coastal" have been applied (Blair, 1941), (Salisbury, 1931). Inasmuch as the flora of the Channel Islands is sufficiently distinctive to have led to its classification as one of the primary divisions of the "Nearctic" region (Leconte, 1888), its climatic distinctiveness should be adequately recognized. The controlling factor of the insular climate lies in the narrow range of annual and diurnal temperature. There is a difference of less than 10° C. (18.0° F.) between the January and the July mean temperatures. Indeed, for the islands themselves no annual range of more than 6.3° C. (11.1° F.) has yet been reported.

Additional characteristics of the insular climate shows also the following characteristics: (1) a mean noon relative of over 60 per cent, (2) a mean July temperature of less than 22° C. (71.6° F.), (3) an aridity coefficient of 12 per cent or less (Gorczensky, 1940), and (4) night or morning low fog or stratus for the greater part of the year. Accordingly the term "Mediterranean maritime" is proposed, though for the purposes of this paper the term "maritime" will be used to designate the climatic type of the insular area and of the immediately adjacent mainland coast. The data for computing the annual range of temperature together with the average precipitation, are given in table 2.

TABLE 2

PRECIPITATION AND TEMPERATURE RECORDS
FOR THE MARITIME CLIMATE*

	Length of Record Years	Av. Annual Prec. Inches	Mean Annual Temp. (Degrees Fahrenheit)	Mean July Temp.	Mean Annual Range
<i>Islands</i>					
San Miguel.....	32	14.24	56.7	58.7	5.4
Santa Rosa.....	11	15.19	.....	.....	....
Santa Cruz.....					
Anacapa.....	8	12.58	.....	.....	....
Santa Barbara.....	2	11.84	.....	.....	....
Santa Catalina.....	32	12.35	60.9	66.6	11.3
San Nicolas.....	10	11.08	60.3	63.2	6.2
San Clemente.....	4	10.56	59.4	62.3	5.6
<i>Mainland</i>					
Point Loma.....	25	11.07	60.7	67.0	12.9
San Diego.....	59	9.67	61.2	67.4	12.7
Chula Vista.....	12	10.50	59.5	66.7	14.5
Oceanside.....	10	12.87	68.8	74.1	14.8
Long Beach.....	10	9.93	61.6	70.0	16.9
San Pedro.....	11	10.66	61.3	66.8	10.9
Los Angeles.....	53	14.95	62.7	70.4	15.3
Oxnard.....	8	11.10	58.8	63.4	9.5
Santa Monica.....	33	14.78	59.5	65.9	13.1
Santa Barbara.....	46	18.04	59.9	65.7	12.3
San Luis Obispo.....	36	20.92	58.6	64.3	12.3

*Data obtained from the following sources: San Miguel, San Nicolas, and Santa Catalina, U.S. Weather Bureau, Regional Office, San Francisco; San Clemente, Aerological Office, Naval Air Station, San Diego; Anacapa, Coast Guard Station, Anacapa; Santa Rosa, Dr. Ford Carpenter and H. M. Hall, Los Angeles; Santa Barbara, adjusted instrumental records; Mainland cities, Climatic Summary, U.S. Weather Bureau, Washington.

In addition to these, meteorological data, correlative studies of the life forms, and the distribution of the island plants have been made, and the interpretation of this evidence adds additional information bearing upon the nature of the insular climate and its sub-divisions. This is in accordance with Tihomirov who states (1940) that studies of vegetation may give dependable corroboration of meteorological records and assist in delimiting boundaries in areas where no other data are available.

A seaman, cruising about the islands, is forcibly impressed by the differences of wind and fog, even between different parts of the same

island. This is significant as it has been demonstrated that the wind is the controlling factor, with precipitation a subsidiary factor, in the distribution of insular plant communities. While a study of meteorological records shows clearly that while there is a general climatic similarity for the entire insular area, there are wide extremes between the southern tip of San Clemente and the northern tier of islands. These differences are even more pronounced in the areas of maritime climate on the adjacent mainland.

There is considerable uniformity in both precipitation and temperature in the area between Point Vicente and Cabo San Quintin in Baja California, with a rather sharp break north of the former and south of the latter. Accordingly, these seem logical points for a division of the maritime climate into three types.

The northern or semi-humid maritime would be separated from the central or arid maritime by the isohyet of thirteen inches of annual precipitation. The division between the arid and the desert maritime would be on the isohyet of six inches.

The northern or semi-humid maritime would be separated from the central or arid maritime by the isohyet of thirteen inches of annual precipitation. The division between the arid and the desert maritime would be on the isohyet of six inches. Figure 5 shows the approximate area of the maritime and the proposed division of this climatic type. South of Cabo San Quintin much of the dominant growth is cacti and other low shrubs typical of desert conditions, with the individual plants well spaced. North of Cabo San Quintin, extending to Point Vicente there is much grassland on the rolling slopes with typical chaparral on the steeper slopes, with a general scarcity of trees at lower elevations with the exception of the riparian woodlands. North of Point Vicente trees become increasingly evident and cacti become rare, while more mesic plants such as *Myrica*, *Umbellularia*, and *Holdodiscus* appear.

Among the islands, the counterparts of the sub-divisions of the maritime climate on the mainland are recognized as follows: San Miguel, Santa Rosa, Santa Cruz, and the western island of Anacapa¹ would fall in the semi-humid maritime; Santa Catalina, Santa Barbara, San Nicolas, and the northern two-thirds of San Clemente would be placed

¹An eight-year record on the eastern island of Anacapa shows an average annual precipitation of 12.58 inches, and this period includes two rather exceptional wet years. The middle island of Anacapa possesses much the same aspect as the east island, and *Opuntia prolifera* is to be found on both islands. The vegetation of the western island of Anacapa has a different aspect from the two eastern islands. Due to the greater heights of Santa Cruz and the west island of Anacapa it would appear that the two eastern lie in a rain shadow.

in the arid maritime; while the southern one-third of San Clemente would be provisionally in the desert maritime. Of the three factors which might account for this desert aspect of the vegetation at the southern end of San Clemente Island: climate, soil, and topography; the climate is apparently the limiting factor. The soil of the entire island is of volcanic origin, while the southern exposures of the other islands have no similar vegetation.

Certain plants may well be used as indicators for the sub-divisions of the maritime climate. Thus the following species are suggested for the semi-humid region:

<i>Pinus muricata</i>	<i>Malvastrum Nuttallii</i>
<i>Abronia umbellata</i>	<i>Oenothera cheiranthifolia</i>
<i>Myrica californica</i>	<i>Mimulus longiflorus</i>
<i>Lupinus Chamissonis</i>	<i>Erigeron glaucus</i> ²

Illustrative of plants found in the area designated as arid maritime are:

<i>Abronia umbellata platyphylla</i>	<i>Lycium californicum</i>
<i>Opuntia prolifera</i>	<i>Mimulus puniceus</i>
<i>Oenothera bistorta</i>	<i>Coreopsis maritima</i>

The vegetation of the southern one-third of San Clemente has a true desert aspect and resembles that of the Baja California coast south of Cabo San Quintin. The following plants appear to be limited to this area, or appear only sporadically on southern exposures of the arid maritime:

<i>Euphorbia misera</i>	<i>Senecio Lyonii</i>
<i>Notholaena Newberryi</i>	<i>Phacelia floribunda</i>
<i>Cereus Emoryi</i>	<i>Lupinus argophyllus adsurgens</i>

Cereus Emoryi and *Opuntia prolifera* are dominant here, showing an abundance and luxuriance which can only be equalled south of Cabo San Quintin. Furthermore, the aspect of the vegetation of the northern two-thirds of San Clemente Island is distinctly different from the succulent-suffrutescent shrub type of the southern one-third. The northern uplands bear a typical grassland association with very little cactus.

Thus the marked differences in vegetation and the accompanying variation in the precipitation, appear to justify the division of the maritime climate into the three sub-types.

²The nomenclature followed in this paper is that of Munz (1935) in his Manual of Southern California, with certain changes by Dunkle (1940, a, b, c, 1941, and 1942, a, b.) Author's citations for each species are provided in the tables of sections IV, V, and in section VIII.

THE INFLUENCE OF MAN

The environmental factors of wind, sun, and temperature operate slowly in producing climatic changes and cannot be readily controlled, whereas the activities of man can be. Man has introduced many grazing and browsing animals as well as aggressive plant competitors with the native plants. These agencies have been immensely destructive to the original island vegetation. Few records have been kept of the more direct activities of man. Disastrous fires have occurred on most, if not all, of the islands. Thus Santa Barbara Island was burned over in 1918 to clear the small arable areas for agricultural purposes (Meadows, 1944). Trees have been cut on Santa Rosa, Santa Cruz, San Clemente, and Santa Catalina for fuel, and timber is said to have been used for ship repairs in the early days. Small areas have been under cultivation on Santa Cruz, Santa Barbara, and Santa Catalina. However, the plants and animals introduced by man have been a major factor in changing the aspects of the native vegetation.

DESTRUCTIVE GRAZING AND EROSION

Erosion has assumed dangerous proportions on several of the islands owing to a century or more of destructive overgrazing. The island of San Miguel was used as a sheep ranch prior to 1850 (Ellison, 1937) and has been continuously grazed since, though this has been much restricted in recent years. Santa Rosa was stocked with sheep in 1844 and sixty thousand head of sheep were there in 1874 (Ellison, 1937). There were two hundred sheep on Santa Cruz in 1852; in 1855 the sale of wool from the island brought \$22,000.00; in 1877 twenty five thousand sheep were killed for tallow, glue, and hides. Sheep were being raised on San Clemente as early as 1877 (Meadows, 1944) and on Santa Catalina in considerable numbers for some years prior to the purchase of the island by the Banning brothers in 1892. Sheep were grazed on at least the middle island of Anacapa for several years. Goats have been on some of the islands for even a longer period than sheep, for they were introduced on Santa Catalina in 1827 (Bancroft, 1886), and Farnham (1857) states that San Nicolas, San Clemente, and Santa Barbara islands were densely populated by goats.

Large areas of both San Nicolas and San Miguel have been rendered completely barren by a combination of wind and water erosion. The presence of too many sheep for the available pasturage has resulted in the killing of grasses, forbs, and shrubs. Wind and rain have thus been

able to erode the soil excessively. The roots of trees and shrubs have been exposed and the plants eventually killed. On San Miguel many of the ancient kitchen middens of the aborigines are now perched on ridges fifteen to twenty feet above the surrounding level. The surface covering of shell, bone, and rock fragments has slowed the erosion of the middens themselves. The airplane view of San Miguel Island, plate 2, taken prior to 1933, shows the results of wind erosion. The direction of the prevailing winds is indicated by the deep, parallel trenches eroded in the sandstone. At the time of the writer's visit to the island in 1940 vegetation had already started to reclaim some of the waste land in the east and west parts of the island. This was made possible by the fact that, for several years, the number of sheep had been limited to three thousand.

San Nicolas is nearly as windy as San Miguel. It has been grazed continuously for about seventy-five years. Hence, as a result, the island has undergone great wind and water erosion. When George Nidiver removed an Indian woman from San Nicolas in 1853 he found *Lavatera assurgentiflora* (malva real) bushes and "a species of moss,, growing about the hut of the Indian woman (Ellison, 1937). Today the area about the hut and, indeed, that entire end of the island is a desolate waste of wind-driven sand. The steep slopes leading to the central mesa have been cut into a "bad lands" by water erosion and the gullies are rapidly eroding back into the upland.

While Santa Rosa is somewhat less windy than either San Miguel or San Nicolas, many areas are badly wind-eroded. However, grazing here has been under careful management since 1893. The rule has been to stock the island only to the extent for which the forage of the driest year will be amply sufficient, and to rotate the pasturage so that it is only grazed once in three years. Nevertheless even this plan failed for the cattle had to be removed from the island during the dry seasons of 1946-1948. Water erosion has been the principal erosion problem on Santa Cruz, but check dams and contour cultivation indicate careful conservation of the arable areas by the Caire family during their long ownership of the island.

The effects of wind erosion have greatly increased the sand dune areas on San Nicolas, San Miguel, Santa Rosa, and San Clemente. It is probable that only small coastal dunes were present originally, and the larger dune areas of the present were originally occupied by the forbs and semi-shrubs reported by early travelers. There is no evidence to show that the small salt or fresh-water lagoons on most of the islands have been materially changed since earlier times, except as the result of natural succession.

DESTRUCTIVE GRAZING AND THE
LIFE FORMS OF PLANTS

Other islands have suffered severely from erosion only in limited, exposed areas, but the vegetation has generally suffered from the selective grazing and browsing of various introduced animals. The island vegetation had, previous to the coming of the white man, been free from grazing or browsing animals for an indefinite period in the past, as there is no record or trace of any such animals since the Pleistocene, until their introduction in the past century. It is highly probable that a type of vegetation developed under such circumstances which would have been impossible of development in the presence of herbivorous animals. Certain individual species: *Coreopsis gigantea*, *Lavatera assurgentiflora*, *Malacothrix saxatilis implicata*, *Nemophila racemosa*, *Eriophyllum Nevinii*, *Eriophyllum staechadifolium depressum*, and *Aplopappus canus* are examples of insular plants that are readily damaged by grazing. This is implied by their tender, succulent nature; the lack of ability to reproduce from adventitious buds; and by the fact that they are now limited to inaccessible areas where grazing animals have not been present.

The destructiveness of grazing animals cannot be as well envisioned by the near-extinction of a few species, as by their effect upon the vegetation as a whole. This may best be seen by comparing conditions on the much grazed islands, such as San Miguel, San Nicolas, and San Clemente with the conditions of little grazed areas such as that of the west island of Anacapa, Santa Barbara, Prince, and Sutil islands, and Bird Rock. One or more of the plant species just mentioned are abundant or dominant on these small islands in habitats similar to habitats on the other islands where none or few of these species can be found at present.

Other animals than sheep or goats have been introduced on the islands. Hogs have been on Santa Cruz for many years and on Santa Catalina for at least ten years. A few rabbits are to be found on Santa Barbara; and the eastern island of Anacapa is overrun with rabbits at the present time, with consequent serious destruction of the native vegetation. Rats have also been introduced on most of the islands. Deer and bison have been on Santa Catalina for about fifteen years. Tule elk, deer, and Siberian white deer have been on Santa Rosa since 1893 (Meadows, 1943). The long previous freedom from herbivorous animals permitted the development of extensive and unique plant communities, dominated by tender forbs and semi-succulent, suffrutescent shrubs.

PLANT INVADERS

A further effect of the activities of man has been the introduction of numerous foreign plant species on each of the islands. These have often become more abundant than the native species and grow so vigorously under the existing conditions that the native plants can only rarely, and with difficulty survive the competition. Such species as *Mesembryanthemum crystallinum*, *Hordeum murinum*, *Avena fatua*, *Bromus mollis*, *Atriplex semibaccata*, and *Medicago hispida*, dominate many extensive areas to the almost complete exclusion of the indigenous flora. Only a few of the more vigorous, suffrutescent perennials, shrubs, or bulb plants can withstand the competition.

No adequate attempt can be made to list all of the plant species that have been introduced since the discovery of the islands by Juan Rodriquez Cabrillo in 1542. Four centuries represent a period during which many of the species arriving during the first two or three hundred years may have become thoroughly naturalized. Many species reached the islands from Europe by way of the United States, while others may have come from Siberia or northwestern North America during the days of Russian sea otter hunting, or may have been brought from Mexico or South America by the early Spanish, English, and American voyagers. Holder (1910) considers it highly probable that such explorers as Drake, Woodes, Rogers, Shelvocke, and the adventurers and buccaneers of the latter part of the sixteenth or the early part of the seventeenth may have visited the islands during their journeys along the west coast of North America. Following Vizcaino's visit in 1602, during the next two and one-half centuries many Spanish vessels must have stopped at the islands. Early American merchants made the islands bases for smuggling activities during the Mexican regime, landing their cargoes on the islands to be transferred to smaller boats for surreptitious landing on the mainland. As these cargoes had often been earlier landed in Chile, it is possible that many of the plants now reported as common to both Chile and the islands have reached them through this agency.

Most of the introduced plants have come directly or indirectly from southern Europe or northern Africa where similar climatic conditions prevail. Most of these plants not only come from the semi-arid regions of the world, but come from regions where grazing has been practiced for many centuries, and possess life forms that enable them to successfully withstand the activities of grazing animals.

CLIMAX CHANGES

Climaxes are, in the long run, unstable, since changes are constantly taking place in climate, in soil, and in the biotic environment. Weathering, erosion, and sedimentation are unceasingly active and their rate of activity is being affected by the mutations of the climate and the biota, as well as by diastrophic agencies affecting the topography. Vegetation, through the accumulation of humus, and the disintegration of rock materials, continually modifies the chemical and physical properties of the soil. These changes, operating singly or in various combinations, inevitably affect the floristic composition of an area. That which may be of minor importance in a continental area, may have a powerful influence upon the vegetation within the narrow limits of an island.

The gradual rise of the ocean level and increasing aridity have affected the insular environment since Pleistocene time. The influence of man has been active through only a few centuries, but this effect has been catastrophic. The original vegetation has been affected over wide areas by overgrazing, wind and water erosion, and fires. Yet the most potent instrument of modification brought about by man has been the introduction of plants from other regions of the world as previously described. These exotics have thrived for two reasons: (1) they have come, for the most part, from dry regions and are better equipped to withstand the present arid or semi-humid conditions than the indigenous plants which are relicts of a more humid time; (2) the exotics have survived for centuries because of adaptations which have enabled them to withstand all the destructive agencies of man, whereas the native flora had experienced few previous contacts with either man or herbivorous animals.

Many areas on all of the islands have been so changed that it is now extremely difficult to envision the nature of the original climax or the possible successional stages of the present sub-sere. Thus, broad terraces, wide interior uplands, and long gentle slopes are now dominated by introduced grasses and forbs. These areas of fine-textured, deep soil are those most favorable for grazing. That such parts, or even a major portion of them, were originally grassland is open to doubt. Coarse grasses, such as *Stipa lepida*, *S. pulchra*, and *Melica imperfecta* are present among herbs and suffrutescent perennials. Grazing, erosion, and fire must have destroyed many suffrutescents and most shrubs (cf. ante p. 261). Many sea bluffs and canyon slopes near the sea are now dominated by introduced *Mesembryanthemum* and *Atriplex*. In all these areas the original nature of the vegetation may be estimated

only by the accounts of early explorers, by indirect evidences which remain, or by comparison with the vegetation of similar habitats which may have remained relatively unaffected.

The testimony of early visitors to the islands is rarely trustworthy because their bases of comparison is unknown and their interests varied. Their visits were short and usually localized. In many cases, observations were made largely from boats and amplified by hearsay evidence. The island of San Clemente furnishes an illuminating illustration of such evidence. Farnham (1887) said it was partly covered with trees, but that a greater portion of it was barren sand and rock, while Cronise (1868) said: "it contains neither soil, vegetation, nor water." Trask (1897) wrote of the luxuriant growth of clovers and other forbs on the eastern benches, but said that the main upland was so covered with rock as to make each step a perilous undertaking. Yet the writer, in 1941, forty-five years later, found the main upland well covered by soil and grasses.

The extent of erosion caused by overgrazing on San Miguel and San Nicolas has been mentioned. This combined effect of grazing and erosion has obliterated many of the original plant communities and caused the extinction of several species. Dall has reported of San Miguel as follows³: "Near the shell heaps is a small grove of malva trees whose green leaves and penciled blossoms refresh the eyes. There are no young trees, however, as the omnipresent sheep crop every green thing within their reach close to the ground." In respect to San Nicolas, Schumacher⁴ states: "The vegetation of this island is like that of San Miguel, ruined by overstocking it with sheep . . . On the eastern end, near the house, we found some malva-like bushes, cleared of their foliage to the reach of a sheep, which gave them the appearance of scrub-oak trees when seen from a distance."

George Nidiver was one of the earlier Americans to be occupied about the islands. He hunted sea otter, fished, and engaged in sheep raising on the islands. Fortunately his biography has been preserved (Ellison, 1937). Nidiver and his party had an encounter with north-western Indians, also engaged in otter hunting, on Santa Rosa Island in 1836. Afterwards the Nidiver party hid in the thick brush near the beach. The scene of this encounter has been reestablished and there is now mainly open grassland in that part of the island. Nidiver again speaks of sagebrush and *Lavatera* (malva real) in a section of San Nicolas Island which is now utterly barren, and also speaks of trees,

³The lords of the isles, *Overland Monthly*, June, 1874.

⁴Some remains of a former people, *Overland Monthly*, October, 1875.

brush, and "moss" on San Miguel Island, which now has no trees or shrubs. Parish (1890) states that within the memory of living man *Lavatera* occupied a large part of Santa Catalina, yielding only to the overstocking with sheep and goats, and that it was also on San Miguel, Santa Rosa, and San Clemente. These fragments are almost all of the direct testimony that I have been able to find relative to the original nature of the vegetation.

Natural evidence as to the previous growth on the island is also rare. On San Miguel small tree trunks, as of arborescent chaparral, are still standing near the west end of the island. For many years such fragments have been gathered from all parts of the island and used for fuel. On San Nicolas most of the wind-eroded slopes have root remains, incased in mineral casts, projecting well above the present surface. These may be remains of perennial herbs or of shrubs. The fire-blackened kitchen-middens of the aborigines in all sections of all the islands, except Santa Barbara, indicate the presence of considerable fuel in places where little or no natural fuel is now available. While some of this may have been driftwood, there is not much drift on the beaches today, and it seems probable that there must have been considerably less drift in earlier times.

Lavatera, *Coreopsis*, and other succulent or brittle-stemmed, herbaceous plants have been mentioned (cf. p. 263) as occurring in somewhat inaccessible places on nearly all of the islands. Many of these must have been tid-bits for cattle, sheep, or goats, during the long dry season. Moreover, their brittle stems could easily be broken by animals and the plants destroyed. The largest island of the Anacapa group has been little grazed and on the terraces the introduced grasses are thickly interspersed with forbs, suffrutescent herbs, and woody shrubs (cf. plate 5a). Here also steeper slopes are covered with a dense tangle of herbaceous perennials and low shrubs. The eastern island of Anacapa and Santa Barbara Island have extensive remnants of a *Coreopsis* association that once covered most of the interior mesa. Bird Rock off Santa Catalina, is covered with *Lavatera*. It seems extremely probable that these plants, and others of the same life-forms, once covered extensive areas on other islands which are now grasslands.

The steep walls of canyons and northeastern slopes are now covered by chaparral, by a suffrutescent coastal sagebrush association, or by a mixture of these two associations. This is particularly true of the larger islands, although remnants of the coastal sagebrush association are to be found on even the smaller ones. The western slopes of most of the islands have, at present, a patchy growth of *Lycium*, which, in the

northern islands, is usually combined with, or replaced by *Suaeda*, *Atriplex*, *Lotus*, *Opuntia*, *Aplopappus*, *Astragalus*, and other low herbs and semi-shrubs. Native annuals and geophytes are also abundant in all of the uplands, and in the gently sloping areas where they have not yet been displaced by exotics or destroyed by erosion. It seems probable that this type of vegetation must formerly have extended into many areas which are now occupied by introduced grasses and forbs.

Even if there had been no overgrazing on the islands, it is probable that great change in the plant communities would have been brought about by the introduction of exotic plants. Braun-Blanquet (1932) states that geographic and climatic isolations are essential for the preservation of relict plant communities, saying: "They are ill adapted for combat with the ubiquitous immigrants brought in everywhere by cultivation." While there has been little cultivation on any of the islands, the mere occupation by modern man has inevitably brought about this immigration.

There is little evidence to indicate any considerable changes in these areas now occupied by woodland, by chaparral, or by coastal sagebrush. However, it is probable that woodland may originally have extended into some of the areas now occupied by chaparral. Since San Miguel originally possessed considerable chaparral of the island type, which is more susceptible to browse, it may be considered probable that certain western upland areas of other islands, where the evidences of erosion from destructive overgrazing are present, may once have been occupied by chaparral. It is also possible, in this connection, that, as destructive overgrazing was discontinued on Anacapa, Santa Cruz, and Santa Catalina from thirty to forty years ago, badly eroded land may subsequently have been reclaimed by the dense growth of introduced grasses and forbs.

III SANTA BARBARA ISLAND

Although observations of various environmental factors had already been made on all of the Channel Islands during the course of the Los Angeles Museum Channel Islands Biological Survey it was desirable that detailed measurements of certain ecological factors should be made. Extended instrumental work could not be carried out on each of the islands because of the large area involved and the difficulties of transportation. Therefore it seemed desirable to select one island for this objective study, one so situated that conclusions reached on it might be more or less applicable to the other islands.

Santa Barbara Island was thus chosen for instrumental reasearch, partly because it is centrally located among the Channel Islands, and partly because of its small size. The central location of the island can be most graphically visualized on certain clear, late afternoons, when, from its high central ridge, a magnificent spectacle is presented by the encircling islands. Every island of the entire group can be seen, except San Miguel which is hidden behind Santa Rosa. It is only from this vantage point that the true character of this widespread archipelago can be realized. From Santa Barbara the nearest land, which is the north-western point of Santa Catalina, is 24.0 miles directly east. San Nicolas bears 36° east of south and is 27.5 miles distant. San Clemente lies 39.0 miles bearing 40° east of south, while Anacapa is 41.0 miles in the opposite direction, bearing 40° west of north. Santa Barbara, moreover, is almost equidistant from the coast near the western end of the Santa Monica Mountains and from Point Vicente, both points lying at an approximate distance of 40.0 miles.

The small size of Santa Barbara permitted the instrument stations to be located on all of the principal exposures in such a manner that all the stations could be visited within the twelve-hour period available on a week-end trip. Although the small size of the island does not provide a wide range of habitats, certain advantages are presented by the fact it is uninhabited and has no large grazing animals. Furthermore, as part of the Channel Islands National Monument, it is not liable to disturbance, and the future course of natural succession can be followed.

TOPOGRAPHY

Santa Barbara Island is roughly triangular in outline with a central, saddle-shaped ridge running approximately north and south, and wide terraces to east and west. The area of the island is slightly less than a square mile, 638 acres. The eastern terrace is about one and one-half miles in length, sloping from about 139 meters (450 feet) to 47 meters (150 feet) at the break of the eastern bluffs. The western terrace is shorter, with a slope from about 123 meters (400 feet) to 61.5 meters (200 feet) at the western break. To the west of this terrace there is a small terrace with an average elevation of about 47 meters (150 feet), extending to the northwestern tip of the island.

The central ridge culminates in a peak on the southwestern coast which has an elevation of 200 meters (635 feet), and another peak with an elevation of 172 meters (562 feet) on the northwestern coast.

From both peaks the land falls abruptly to the water's edge in nearly vertical cliffs. The extension of these cliffs forms the northern and southern boundaries of the two main terraces. The eastern face of the island presents an alternating series of abrupt cliffs and moderately sloping bluffs. Detached segments of the main ridge form small islets to the north and south of the island.

There are a few narrow sand beaches in shallow coves on the southern and northwestern coast but as precipitous cliffs encircle these coves the only practicable landing places are on the lee side of projecting rocky ridges. The heavy surge from the south makes landing precarious at best and impossible at times. There is good anchorage in most weather off the eastern coast.

The rocky foundation of the island is volcanic in nature, consisting mostly of alternating beds of indurated breccias and tuffs. One very small sedimentary deposit, apparently of Pleistocene age, is located at an approximate elevation of 148 meters (475 feet) near the southern end of the island. Six shallow canyons cut directly across the lower part of the eastern terrace. Only one of these, Graveyard Canyon, has developed a steep-walled gorge. Except for a small seepage on one of the eastern bluffs there is no permanent water on the island.

The wide marine terraces of the island and the abrupt cliffs rising almost directly from the water play such an important role in the development of plant communities that it may be well to consider the origin of these features. Santa Barbara Island, in common with the other islands, with the possible exception of Santa Catalina, appears to have undergone considerable elevation in no very remote geological time. This is inferred from the presence of marine terraces. San Clemente Island has seventeen terraces, rising to a total height of 400 meters (1320 feet) (Lawson, 1893). These indicate intermittent periods of uplift. Santa Barbara, owing to its lower elevation, has only two levels of terraces. The Pleistocene deposits at a higher level than the terraces might indicate greater uplift than that shown by the terraces, but the sharp angles on the rocks of the highest ridge do not indicate that the island was completely submerged prior to the uplift. The depth of the canyons on San Clemente would place the major period of uplift well back into the Pleistocene, and the small amount of surface erosion on the terraces of San Clemente, San Nicolas, and Santa Barbara would indicate no longer lapse of time.

The formidable cliffs and bluffs surrounding the island are due to the ceaseless attack of the sea upon the shore line. This is undoubtedly the most powerful geological agency operating upon the island during

recent time. The smaller an island the greater is the amount of shore line in proportion to surface area. The evidence of this wave attack is strikingly evident upon all of the islands and typically so on Santa Barbara. The height and slope angle of the bluffs have been largely determined by their relative exposure to wave and surf action. A long, powerful swell with recurring periods of intensification, probably caused by distant, tropical storms, comes from the south. The prevailing west to northwest winds cause shorter waves to pound almost continuously upon exposed flanks of the island. An occasional northeaster sets up violent onslaught upon the northeastern coast.

This wave erosion is particularly active because of the very narrow beaches. Since the island is essentially a mountain ridge rising from a submerged base, narrow beaches might well be expected. This condition has been greatly intensified by the rising level of the ocean since the Wisconsin stage of the Quarternary. It has been estimated that the melting of the last glacial stage has caused, for some 25,000 years, the gradual rise of the ocean level to a total of at least 76 meters (250 feet), (Schuchert and Dunbar, 1937). Disregarding any epeirogenic activity, this must have meant a more or less continuous submergence of detrital beaches, which would facilitate renewed wave attacks upon the main land mass of the island. That such a condition has actually existed has been shown by study of the ocean bottom about Santa Catalina (Shepard and Wrath, 1937).

This condition of rapid shore erosion occasions recurrent slides which set up xeroseres in the plant life of the bluffs. Xeroseres may be found in various stages at different localities, being more noticeable upon the islands with softer or more disintegrated rock layers than on Santa Barbara. All successional stages do not normally occur, since the bare areas are usually first invaded by xeric rock-crevice plants which form on the sea-bluffs a community of many facies. On benches where soil has accumulated, many shrubs, forbs, and grasses of the insular uplands establish themselves. In this rapidly changing environment plants might be expected to undergo considerable modification. That they do so is indicated by the large number of insular endemics to be found in such locations.

SOILS

The soils appear to have been derived almost entirely from the volcanic rocks. They seem to be deepest on the upper part of the main terraces where they have been formed from the material transported

TABLE 3

MECHANICAL ANALYSES AND CERTAIN FACTORS RELATING TO SURFACE SOILS

Particle Size	Stations									
	A 1 East Bluff	C 5 South Bluff	C 4 North Peak	A 2 Main Ridge	C 6 South Peak	C 1 East Terr.	C 2 West Terr.	C 3 West End	B 1 South Canyon Expose.	B 2 North Canyon Expose.
2 mm. up	29.4	46.0	30.2	29.6	17.2	4.2	4.9	14.3	43.1	36.2
1-2 mm.	15.3	7.1	13.6	16.4	6.4	12.6	11.1	10.2	18.0	22.3
1/2-1 mm.	16.1	8.2	10.1	7.9	18.0	8.3	12.6	12.5	12.8	15.3
1/4-1/2 mm.	14.3	17.1	10.3	11.4	26.0	15.3	12.7	18.8	10.4	12.4
1/8-1/4 mm.	8.8	18.6	9.8	8.5	19.4	14.9	9.6	14.9	6.9	6.5
1/16-1/8 mm.	6.4	11.8	6.4	7.3	8.2	10.3	9.2	10.5	4.6	3.7
1/32-1/16 mm.	9.7	7.0	3.8	15.2	4.8	29.2	33.6	16.6	4.2	3.6
Below 1/32 mm.	.....	.....	.....	3.7	.....	5.6	6.3	2.2	.....	.....
pH Content	8.4	8.6	8.6	8.4	8.6	8.6	8.6	8.2	8.6	8.6
*Wind force	3	4	8	6	5	2	2	3	1	1
Slope (degrees)	15	40	30	0	8	4	6	5	40	40

*Estimated according to Beaufort Scale, United States Weather Bureau Standards.

from the higher volcanics and gradually become shallower as the break of the cliffs is approached. The soils of the terraces are relatively deep and underlain by silty clay. At the immediate edge of the cliffs the soil is only a few inches deep and much coarser than on the terraces. On wind-swept headlands the soil is extremely shallow and consists mainly of lag gravels. Soils in all parts of the island are alkaline in character, the pH varying from 8.0 to 8.6.

Table 3 presents data on wind force, angle of slope, and mechanical analyses of different soils.

The percentage of gravel in the soil is highest and the percentages of silt and clay lowest where the slope is greatest or the wind velocity highest. A clear-cut descending sequence in the percentage of particle size is evident under either of the preceding conditions. The fine soils of the terraces have been enriched by the decomposition of the luxuriant vernal growth of grasses and forbs, as well as by the droppings of the thousands of sea birds which have nested there for untold years. The covering of grasses, forbs, and shrubs is so dense that there can be but little run-off from the seasonal rains. This fact is evidenced by the small amount of water erosion.

CLIMATIC AGENCIES

Because of its central location among the other islands the wind, temperature, fog, and precipitation are intermediate in respect to these conditions on adjacent islands. The climate is more oceanic in character than that of the nearby mainland. The thermograph records show an average annual temperature range of less than 3° C. (5.4° F.). This small range is partially accounted for by the more frequent periods of warm, east wind on the island during the late fall, winter and early spring.

Wind must be considered the controlling factor in the climate of the island. The direction of the wind, rather than the height of the sun determines the temperature. The velocity of the wind determines the areal limits of the plant communities. The prevailing direction of the wind is from a little north of west. There is usually, however, a weak land breeze during the early morning hours, and the seasonal pressure gradients from September to May bring a dry, warm, east wind over rather extensive periods. The average wind velocity recorded on the central ridge at an elevation of 133 meters (435 feet) from September 11, 1940, to December 6, 1941, was 16.8 miles per hour, while that recorded on the eastern bluff at an elevation of a little less

than 47 meters (150 feet) from March 22, 1940, to April 2, 1942, was 7.8 miles per hour. Two storm periods were severe enough to break off the atmometer cups at the station on the central ridge, so that the average of 16.8 miles per hour must be well under the actual average for that station, and is probably approximate to an average for the island as a whole.

Variations in the wind velocity between different locations produce a greater variation in evaporation rate than does the sun. The difference between the evaporation rate on the windy north peak and that of the northern exposure of Cave Canyon (cf. map, p. 359) for the same period of seven months was 16.06 cc. per day, as measured by standardized Livingston spherical white-cup atmometers. During the same period the greatest difference in the evaporation rates of white-cup and similar black-cup atmometers⁵ was recorded at the central ridge station, where it averaged 10.81 cc. per day. That is, the effect of wind on evaporation was approximately 50 per cent greater than that of the sun.

Where the full force of the wind sweeps across comparatively level areas on the headlands, the soil, as has been said, is shallow and coarse, while on protected terraces it is deep and fine-grained. Entirely different plant communities occupy the two areas. Exotic plants rarely invade the windiest areas, although *Mesembryanthemum* grows in some windy localities. *Astragalus Traskiae*, *Malacothrix foliosa*, *Hemizonia clementina*, and *Baeria hirsutula* are dominants of the windiest areas.

Under Russell's modification of the Köppen international climatic system the island would probably be described as possessing a "foggy desert" type of climate. This classification, however, does not fit the conditions existing on Santa Barbara Island. In view of the records available for this island and those adjacent, and the general physiognomy of the vegetation, it would seem fitting to apply the climatic designation presented in section III—that of the arid maritime climate.

It was not possible to obtain accurate records of the precipitation with the type of rain gauges available. Even with the use of oil in the rain gauges of the type used, there was considerable evaporation. The latter is indicated by the fact that very much larger readings were obtained from stations sheltered from the sun than from stations exposed to the full sun.⁶ Also, the rain gauge would overflow during

⁵Black-cup atmometers absorb much of the sun's radiation which is reflected from the white-cup atmometers, and thus afford a measure of the influence of insolation upon evaporation.

⁶For November, 1940, the most sheltered station B 2, on the northern exposure of Cave Canyon, recorded 2.13 inches of precipitation while the station B 1, on a sunny southern exposure only about 50 meters from station B 2, recorded only 1.00 inch of precipitation.

periods of heavy rainfall, such as occurred during the winter of 1940-1941. While the actual record of the most sheltered rain gauge was 18.83 inches for 1940-1941 and 6.38 inches for 1941-1942, these figures, on account of evaporation and overflow, are probably considerably less than the actual precipitation. The average annual precipitation should lie between that of the San Nicolas figure of 11.08 and the Santa Catalina figure of 13.35. The recorded average of Santa Barbara for the two wet years of 1940-1942 was 12.60 inches, and an empirical estimate of the ten-year average precipitation might be about 12 inches.

Figure 7 shows the results of over two years of instrumentation at the east bluff station.

In figure 7 it is noticeable that there is a fairly close correlation between wind velocity, maximum temperature, and evaporation rate. During the winter the wind graph shows an increase over the normal, but follows the graph of the evaporation rate very closely during the remainder of the year. The convergence of the graphs for the black-cup and the white-cup evaporation rates is of seasonal rather than insular significance. The rise of the evaporation rate in spring and fall is quite in harmony with previous observations in respect to drying, east winds during those seasons. There is normally much fog during the summer, as hygrograph records show. Both wind and sunshine are more prevalent during spring and fall.

BIOTIC INFLUENCES

Although this little island has not been inhabited continuously for many years and is not easily accessible it has many evidences of man's visits. It has been used as a base for otter hunting, for lobster fishing, and for farming operations. The writer has talked with various individuals who have built cabins there and have tried to fill in unfavorable fishing seasons by desultory farming. It is remarkable how much human activity has been centered about this tiny island and how quickly time and storm have erased most of the visible handiwork. Yet the indirect influences of man will affect the island for years to come.

Twenty species of exotic plants have been introduced and now dominate large sections of the island. Cats and rabbits also have been introduced. The cats have been able to keep the rabbits in check so that they have made no serious inroads upon vegetation, as they have on the eastern island of Anacapa. White-footed mice are the only native land mammals. A recent effort has been made by the National Park Service to reduce the cat population in order to protect nesting birds.

This effort may affect the biotic balance to the detriment of the vegetation, especially as the rabbits and mice have few other enemies.

Man's activities have favored the establishment of the exotic plants. In 1918 nearly the entire island was burned over and both east and west terraces placed under cultivation. As a result the indigenous plants are to be found mainly in the shallow soils and on the steep seaward slopes. Rocky areas on the western terrace and about the headlands, the section of the eastern terrace cut by canyons, and parts of the central ridge, also harbor many native plants together with the aggressive foreign species. Introduced grasses, with *Mesembryanthemum* and *Atriplex semibaccata*, have appropriated most of the area formerly under cultivation, which was the most fertile part of the island. However, at the present time, some of the natives, such as *Coreopsis*, *Lycium*, *Suaeda*, *Brodiaea*, and *Chenopodium californicum* are at least holding their own against the exotic competitors. The smaller annual plants cannot as yet compete successfully with the introduced *Hordeum*, *Avena*, or *Mesembryanthemum*.

As springs, streams, lagoons, or marshes are entirely absent, no hydrophytes, except those of marine habitats, are present. Due to the fact that the few narrow beaches are wave-washed at the periods of spring tides, and are colonized by the California and the Stellar sea lions and an occasional sea elephant, no plant life is to be found on them at the present time. However, *Oenothera cheiranthifolia*, a typical beach plant, has been reported from the island by Hemphill (Jepson, 1925).

PLANT COMMUNITIES

This small island does not present the varied topography of such a larger one as Santa Cruz. No habitat on Santa Barbara is as much as a half mile from the sea, and the highest elevation is but 200 meters (635 feet). The limited number of species on a small island cannot give a great floristic complexity. Thus, there are no chaparral shrubs and trees; neither are there dune or riparian communities. However, the variations in slope, exposure, and soil are as great as on any of the Channel Islands. The habitats which are present on Santa Barbara can be compared later with similar ones on the other islands, even though on Santa Barbara but few species of the normal plant community for that habitat may be present. Because of the essential simplicity of the environmental pattern of Santa Barbara any differences between habitats would be less than the more sharply differentiated environments on the large islands. The general topography of Santa Barbara and the distribution of its plant communities is shown in figure 8.

There are but four closed communities on Santa Barbara Island, two with native dominants; the *Coreopsis* and the *Lycium-Suaeda*; and two exotic dominants: the *Hordeum-Avena* and the *Mesembryanthemum*. It is interesting to note that the two native associations each appear to have a bird in such close association as to form a biome: the *Lycium-Suaeda-Larus* biome on both the eastern and western terraces; and the *Coreopsis-Melospiza* biome on the lower part of the eastern terrace.

Since Santa Barbara is essentially an elevated mesa outlined by precipitous cliffs and steep bluffs it may logically and conveniently be divided into two main areas. These two areas, which differ strikingly in respect to evaporation rates, plant life, and soil, are: (1) mesa and ridges; the central region of terraces, shallow canyons, and most of the central ridge; (2) sea bluffs; the surrounding series of cliffs, benches, and headlands that break off abruptly to the sea, and the upper, wind-exposed parts of the western slope of the central ridge.

Mesa and Ridge. The mesa and ridge are occupied by several communities comparable with somewhat similar ones on the other islands. These communities include a grassland, *Mesembryanthemum* colonies, the suffrutescent *Lycium-Suaeda* association, and the *Coreopsis* association which is related to, but wholly different from, the coastal sagebrush association.

Grassland. A grassland disclimax occupies the upper part of the eastern terrace, much of the central ridge, and a narrow belt extending around most of the main western terrace. Much of the grassland now occupies areas which were burned over and subsequently placed under cultivation. The dominant plant is *Hordeum murinum* except for one rather extensive area about the head of the landing cove where *Avena fatua* is dominant. Even in this last locality the *Hordeum* is a sub-dominant, while *Avena* occurs here and there the entire length of the eastern terrace. These grasses die early in the spring, regardless of the amount of moisture in the soil, and form a deep, tangled mat which persists for the remainder of the dry season.

Scattered plants and small colonies of *Coreopsis gigantea*, *Lycium californicum*, and *Suaeda californica pubescens* occur in various parts of the grassland. Plants such as *Atriplex semibaccata*, *Chenopodium californicum*, and *Brodiaea capitata* occur here and there, while small plants such as *Malva parviflora*, *Trifolium microdon*, and *Amsinckia intermedia* form an understory in many places. *Amblyopappus pusillus*, *Spergularia macrotheca*, *Erodium cicutarium*, and *Mesembryanthemum nodiflorum* may be found in disturbed places, as along trails.

Mesembryanthemum colonies. One of the most successful of the plant invaders of the south-western islands is *Mesembryanthemum crystallinum*. It has colonized large areas on San Clemente, San Nicholas, and Santa Barbara Islands. In these colonies it monopolizes the ground surface so that only a few other plants can become established. Such colonies occur on the east and west flanks of the north peak, the east flank of the south peak, and near the north and south ends of the eastern terrace. Only a few plants of *Hordeum murinum*, *Chenopodium murale*, or *Suaeda californica pubescens* seem able to maintain a foothold in these colonies. If they survive the competition they grow luxuriantly and *Hordeum* will remain green for weeks longer along the margin of a *Mesembryanthemum* colony than elsewhere. One of the most remarkable features of the pure stands is that they appear to occupy exactly the same areas for years. Thus the large colony on the east side of the south peak had been seen from Santa Catalina by the writer, with the aid of field glasses, fifteen years earlier, occupying the same area it does today.

Suffrutescent communities. The greater part of the western terraces appears to have been free from such extensive burning and cultivation as the upper part of the western terrace. Low native suffrutescent shrubs and herbs occupy most of the area. While *Hordeum* is abundant in most of the openings it holds a distinctly subordinate position. *Suaeda californica pubescens* is a dominant in the upper portion of the main terrace at the foot of the main ridge and in a cross-drainage depression that opens toward the northwest. *Mesembryanthemum crystallinum* and *M. nodiflorum* are present in small or medium sized colonies among the *Suaeda*.

Edaphic and climatic conditions are very similar to those on the east terrace. The surface soil is fine, containing 39.19 per cent silt and clay, and there is an exceptionally large amount of colloidal material present, possibly due to the droppings of the gulls which nest here.

Lycium californicum is dominant throughout the middle and western end of the main western terrace, where the elevation is a little higher, the soil somewhat shallower and of coarser texture, and the wind velocity somewhat greater. *Galium aparine* occurs closely associated with the *Lycium*, and *Achillea millefolium lanulosa* occurs in isolated clumps, where the habit of the plant closely resembles that of the variety *maritima* which has been previously reported only from the San Francisco Bay region. *Brodiaea capitata* is also found on the southwestern slopes of the terrace.

Larus occidentalis, the western gull, nests throughout the whole main western terrace, and the area, as a whole, forms a *Suaeda-Lycium-Larus* biome. The two nesting sites of *Larus* on the eastern terrace also supports a vigorous growth of *Suaeda*.

The main western terrace ends in an abrupt rocky slope which drops about sixty feet to the smaller western terrace, which extends to the vertical cliffs at the extreme western end of the island. The west facing section of the rocky slope has an *Echeveria-Opuntia* community with *Echeveria albida*, *Opuntia prolifera*, and *Tillaea erecta* as the most abundant plants. The southern face of this slope drops to low cliffs just back of a narrow beach, and is well covered with *Opuntia littoralis*, which is very similar to the southern slopes of Anacapa Island. The greater part of this lower western terrace is an *Atriplex californica* community, but near the foot of the rocky slope, where the soil is deeper and the wind not so strong, there is a luxuriant growth of therophytes, geophytes, and chanaephytes.

Coreopsis association. *Coreopsis gigantea* is the dominant plant of the island, occurring as individual plants and small colonies in all parts of the island, but the largest and most representative growth occurs on the lower half of the long eastern terrace. This is an area of broad, flat ridges sloping gradually down to the relatively low eastern bluffs. This section of the terrace is traversed by a series of five shallow canyons. A unique shrub community dominated by the grotesque *Coreopsis* covers all this part of the island, except for the northeast headland, extending, where there is enough soil, almost to the splash zone. Typical associated species are *Opuntia littoralis*, *O. prolifera*, *Convolvulus occidentalis macrostegius*, *Lycium californicum*, *Artemisia californicus insularis*, and *Echinocystis macrocarpa*.

The *Coreopsis* grows to an average height of four feet on the ridges and up to eight feet in the canyons. Since the branches grow at right angles to the main trunk the *Coreopsis* shrub forms an intricate tangle which would be almost impossible to penetrate were it not for the extreme brittleness of the plant. A comparatively light touch will break off branches or even the main trunk. This fact might account for its disappearance where extensive grazing has occurred. Only on the eastern island of Anacapa is there a comparable growth of *Coreopsis*, and there it is being rapidly destroyed by the rabbits infesting that island. In the canyons of Santa Barbara, where the *Coreopsis* may have an undergrowth of *O. littoralis* and is bound together by long, vigorous lianas of *Convolvulus*, of the thickness of a fountain pen, or by *Echinocystis*, the growth does become impenetrable. *Coreopsis* puts out its feathery

foliage after the winter rains begin and blooms in March. By the end of April the leaves have withered and most of the new growth has died back to the club-like permanent branches. The plant remains apparently lifeless during the summer and fall.

The *Coreopsis* association is found in all soils, from the coarse, shallow soils of the eastern bluffs, to the fine, deep soils of the terraces, and on the lee slopes of the central ridge. However, as may be expected, sea bluff plants enter the association of the bluffs, and grassland plants enter the upper limits of the *Coreopsis* belt. Wherever openings, such as trails or other clearings, appear in the *Coreopsis* the introduced plants, as well as other plants of the grassland crowd in; but in unbroken stands none of the grassland plants seem able to establish themselves. Since *Coreopsis*, either singly or in small, scattered colonies with many young plants, occurs in much of the grassland and seems to withstand the competition very successfully, it is highly probable that the *Coreopsis* association may ultimately replace most of the introduced grasses and forbs, provided the island remains undisturbed over a sufficient length of time. The *Coreopsis* association, thus, appears to be a climax for the eastern terrace and the lower slopes of the ridge. Isolated *Coreopsis* plants are to be found in every community on the island, except for the wind-swept ridges and headlands. This would tend to support the hypothesis that originally most of the present exotic grassland was occupied by a scrub association, and that *Coreopsis* may have occupied a dominant place in many of the low, suffrutescent plant communities.

The *Coreopsis* association appears to have roughly the same environment as previously stated for the exotic grassland, except that the former may also be found in coarse, shallow soils. Both seem to possess about the same wind tolerance as the windier habitats contain neither *Coreopsis* nor *Hordeum* and *Avena*.

The Santa Barbara Song Sparrow (*Melospiza melodia graminea* C. H. Townsend) seems to have a distribution on the island almost coterminous with that of the *Coreopsis* association. Howell (1917, p. 81) states: "In the type locality the first of May, 1908, I found these birds fairly swarming, flushing from the short scrub at my approach and flitting to the top of nearby bushes."

CANYONS

The short, shallow canyons offer a rather difficult problem as their dominant vegetation shows little deviation from other parts of the *Coreopsis* belt. The canyons appear young geologically, and their micro-

climates are on such a small scale that but few typical canyon communities occur. Species typical of canyon habitats on other islands are either absent or very restricted in number. *Coreopsis* and *Convolvulus* grow luxuriantly in all parts of the canyons.

Opuntia littoralis is a co-dominant with *Coreopsis* and *Convolvulus* on southern slopes. Among other species are *Lotus argophyllus ornithopus*, *Eschscholzia*, *Muhlenbergia microsperma*, *Hemizonia fasciculata ramosissima*, and *Amblyopappus pusillus*. On the canyon bottoms and the lower, northern exposures grow several grasses which are apparently limited to these areas such as *Melica imperfecta*, *Bromus rubens*, and *B. vulgaris*. In such localities will also be found *Phacelia floribunda*. Plants that seem limited to the north exposures of the canyons include *Gilia gilioides*, *Nemophila racemosa*, *Aphanisma blitoides*, and *Polypodium californicum Kaulfusii*. Additional plants found on other northern slopes as well as on those of the canyons include *Trifolium gracilentum*, *Pterostegia drymarioides*, and *Eriogonum giganteum compactum*.

The soils on both slopes of the canyons are very coarse with those of the northern exposure slightly finer and with a larger content of humus. On these steep canyon slopes the run-off of storm water has carried away many of the finer and lighter constituents of the soil, though this surface erosion has been somewhat checked by the heavier plant cover of the northern exposures. Thus the northern exposure had 36.2 per cent of gravel and 3.6 per cent of silt and clay, while the southern exposure had 43.1 per cent and 4.2 per cent respectively.

Since observations on other Channel Islands have shown that similarly oriented, but larger, canyons possess much greater differences between the plant communities of their northern and southern exposures than do the small Santa Barbara canyons, it is apparent that even greater environmental differences must be found on the opposite slopes of these larger canyons. These differences must exist in their evaporation rates, their temperatures, and their soils.

SEA BLUFFS

The sea bluffs, cliffs, and headlands possess much the same soil composition as do the canyon slopes, i.e., a coarse soil containing less than 10 per cent of silt and clay. They present various exposures and slope angles, and differ greatly in their exposure to wind. The sea winds, coming from great ocean distances and cooled by their contact with the water, possess a greater relative humidity than they maintain after

a relatively short passage over the land. With this high humidity it might seem paradoxical that the sea winds could be the master factor in the evaporation rate, yet such is the case. This is partly due to the high average velocity of the winds and partly to the adiabatic warming of the air on the descent of the lee side of the island. This may explain why the evaporation rates on the lee side of the island are about equal to those on the windward side. Repeated direct observation has shown that the velocity is much greater on the sea bluffs, headlands, and the ridges than on the terraces or in the canyons. The average evaporation rates obtained from the former locations were markedly higher than for any station located elsewhere. The profiles of the island, figures 7 and 8, show the relationships of the evaporation rates at different locations, particularly the greater rates of the sea bluffs as compared with those of the terraces.

The sea bluffs present an almost unlimited variety of exposure to wind and sun, and of slope angles. There is also considerable divergence in the depth and character of their soils, and great variety in the floristic composition of their plant communities. Yet they have many characteristics in common. They possess uniformly coarse soils, low extremes of temperature, and high evaporation rates. There is a general uniformity in respect to the life-forms of the plants and in their structural adaptation to the environment. In every particular the sea bluffs form a distinct contrast to the interior of the island. The plants of the sea bluffs are mostly low perennials, usually very compact in habit. A great number of the plants are succulent or have developed a heavy pubescence. This is due partly to the need for the conservation of moisture in their arid environment, and partly to the presence of sea salts in the soil. (Braun-Blanquet, 1932, p. 193).

Many of the differences in the floristic composition of the sea bluff communities in closely adjacent areas are the result of chance inequalities. The vicissitudes of erosion with frequent slides, due mainly to undercutting by wave action, bring about different conditions and different plant life. This combined with the steepness of the slopes makes lateral migration difficult. Unless windborne, or carried by animals, seeds cannot travel laterally across a steep slope. The vertical range of edaphic factors is very narrow in so far as the ecesis of plants from zones in an intensity or degree favorable for the ecesis of plants above or below these slopes may often be very limited. The extent of the sea bluffs and the large variety of plant communities, with the general similarity of edaphic and climatic factors and of the life-forms of the plants, may

well justify the term of sea bluff formation. There are frequently three distinct zones of the sea bluff; (1) the break of the bluff, (2) the talus slope, and (3) the splash zone.

Breaks. The break of the bluff is the place where the normal slope of the hinterland changes angle and where both wind and water erosion become abruptly more effective. The width of this zone may vary from a few feet, at the edge of a perpendicular cliff, to several hundred feet at the upper part of a more gradual slope. The zone has a fairly coarse, residual soil which rapidly becomes more shallow as the slope increases. The angle of the break is frequently accentuated by an outcropping of rock—the rim-rock—which forms a broken row of cliffs. This may, where the wave action is especially powerful, extend to the water's edge.

The communities of the breaks show considerable variation due to the slope exposure and the exposure to wind. On the higher, wind-swept breaks there is little rim-rock. *Astragalus Traskiae* and a low form of *Hemizonia clementina* are the principal suffrutescents. The annuals include *Baeria hirsutula* and *Malacothrix foliosa*.

The still higher breaks of the south peak are not nearly so windy as the breaks of the north peak. In addition to the plants of the north peak may be added *Atriplex californica*, *Mesembryanthemum crystallinum*, *Amblyopappus pusillus*, and *Lotus argophyllus ornithopus*.

The lower southern breaks are still more protected from the prevailing wind and included the following additional plants: *Mirabilis laevis*, *Opuntia prolifera*, *Cryptantha Traskae*, and *Muhlenbergia microsperma*. These, with the others listed from the southern canyon slopes form an open association which varies from place to place with no distinct dominants. The coves of the southern breaks may be designated as an *Opuntia-Lotus* association.

Precipitous cliffs completely rim the western section of the island so that the cliff breaks there are extremely narrow. This is a bleak region with strong winds, fogs, and hundreds of nesting gulls, pelicans, and cormorants. *Atriplex californica*, *Mesembryanthemum crystallinum*, foliose lichens, and an occasional ruderal, such as *Sonchus* or *Malva*, form a scanty and drab open community. There is a single plant of *Lotus* growing in a shallow niche at the extreme western tip of the island which gives the only spot of color that is to be found along these western breaks. An occasional low, prostrate plant of *Hemizonia clementina* will be found in crevices along the edge of the cliffs. This is the same low form of *Hemizonia* with very short internodes and procumbent habit which marks the *Hemizonia* plants found in windy

locations along the ridges and the breaks of the high bluffs. It is very different from the taller, rounded, and more erect shrub form of the species growing along the eastern bluffs.

The eastern breaks are much less abrupt than those on the other exposures of the island. These breaks extend along the outer face of the wide ridges separating the small canyons and extend down to the splash zone. All the plants of the *Coreopsis* association are to be found here, with other species coming in where the *Coreopsis* thins out on the lower part of the breaks. These additional plants include the tall form of *Hemizonia* mentioned in the last paragraph, *Pterostegia drymarioides*, *Trifolium tridentatum*, *Silene gallica*, *Plantago insularis*, *Calandrinia maritima*, and *Achillea millefolium lanulosa*. Nevertheless this area can only be considered as a facies of the *Coreopsis* association, for *Coreopsis gigantea* is the one example of constancy throughout the area.

Talus. Talus slopes on the Channel Islands frequently display an exceedingly rich variety of plant life, and the southern and southeastern slopes of Santa Barbara are an instance. The varying texture and depth of soil seem to favor this. The southern slopes are perhaps the driest and warmest slopes of the island and are moderately windy, especially during storm periods. Because they are well protected by their lee position in relation to the prevailing winds, only an occasional southwestern storm brings wind of high velocity. The more numerous plants occurring here are: *Echeveria Greenei*, *Eriophyllum Nevinii*, *Eriogonum giganteum compactum*, *Coreopsis gigantea*, *Opuntia prolifera*, *Mirabilis laevis*, *Lycium californicum*, *Muhlenbergia microsperma*, *Perityle Emoryi*, and *Amblyopappus pusillus*.

Splash Zone. Immediately below the talus slopes, the cliffs or the breaks, there is usually an undercut cliff or steep bank. This splash zone rises directly from the water or lies back of a shallow beach. Soil is absent or is to be found only in minute crevices because there is recurrent spraying of the zone by storm waves. Only a few halic annuals and low perennials occur. Among such plants are *Calandrinia maritima*, *Atriplex californica*, *Eriogonum giganteum compactum*, *Perityle Emoryi*, *Echeveria Greenei*, *Eriophyllum Nevinii*, and occasional chance grasses and forbs which have migrated from higher elevations during favorable periods. There is apparently little variation because of slope exposure since the proximity of the sea overshadows all other factors here.

FACTORS IN PLANT DISTRIBUTION

In addition to the edaphic factors which affect the environment of the island communities there are also other relationships which should be noted.

Opuntia littoralis occurs in moderately extensive colonies on the south exposures of the canyons, and on the southwest slope where the main western terrace falls away to a narrow arm of the low western terrace. In such localities it closely resembles *Opuntia* associations of most of the other islands, such as the *Opuntia-Encelia-Atriplex* association on the steep southern slope of Anacapa.

Many of the island plants have a high frequency while others possess marked fidelity. *Hordeum* is to be found in every section of the island though dominant only in fine soil where there is also a moderate exposure to wind. Other exotics which are widely distributed are *Malva parviflora*, which has even been recognized on the inaccessible stack off the western end of the islands, *Sonchus oleraceus*, *Chenopodium murale*, *Erodium cicutarium*, *Mesembryanthemum nodiflorum*, *M. crystallinum*, *Silene gallica*, and *Atriplex semibaccata*. Of the native plants *Atriplex californica* is to be found in every sea bluff community. *Achillea* also occurs in many such communities, particularly on the precipitous northern cliffs, as well as in different parts of the terraces. *Coreopsis* has been mentioned as occurring in every community which is not subject to the more intense winds. On the other hand, *Astragalus*, *Baeria*, and *Malacothrix* show a high fidelity to areas of severe winds. A few plants as *Lotus*, *Echeveria*, *Perityle*, and *Muhlenbergia* appear to be limited to southern southeastern, or southwestern slopes. A few plants, such as *Aphanisma*, *Platystemon*, *Polypodium*, *Gilia*, and *Pterostegia*, are apparently confined to the northern and northeastern areas.

Seasonal aspects consist mainly of green vegetative growth in winter, the spring season of flowering, and the dry brown foliage of summer and fall. However, *Echinocystis* blooms during the winter and *Eriogonum* during the early autumn, while the prostrate form of *Hemizonia* may withhold part of its blossoming until late summer.

IV PLANT COMMUNITIES OF THE ISLANDS

It has been stated earlier in this paper that the original vegetation of the Channel Islands has been greatly affected by the activities of man. The agencies put into play by such activities have destroyed or markedly affected the indigenous communities over large areas. Each of the islands

has been differently affected, owing to the nature of the topography, the variations in climatic conditions, and the various degrees of human interference.

Varied as are the different islands in topography and climate, they possess certain basic similarities in the distribution and the aspects of their plant communities. The western slopes of all the islands, except San Nicolas where barren sand dunes prevail, are covered with grasslands, maritime scrub, or a low atriplex association. The eastern and northern slopes of the larger islands are quite generally covered with chaparral, savannas, or scattered areas of woodland. The canyons, which afford protection from the wind, have much the same vegetation types as are found on the northeastern slopes. Plates 5 and 6 afford characteristic views of these northeastern slopes. In this section the distribution and the floristic composition of these communities, as they now exist, will be considered.

WOODLAND COMMUNITIES

The woodland area on Santa Cruz is located on the main northern ridge which rises to a height of 732 meters (2400 feet), while the major part of the ridge is over 610 meters (2000 feet). This elevation is sufficient to bring a heavier annual precipitation to Santa Cruz than on any of the other islands.⁷ The prevailing winds, which are from the northwest on San Miguel, have veered to follow the Santa Barbara Channel and are nearly due west. As the main ridge runs slightly north of west, the slopes are protected from the winds as well as from the more direct rays of the sun. Thus, to judge from the evaporation data secured on Santa Barbara Island, the evaporation rate should be not more than 80 per cent of that on the southern slopes. The woodland is composed mostly of closed cone pines intergrading between *Pinus muricata* and *Pinus remorata*, with scattered groves of *Lyonothamnus floribundus asplenifolius* and *Quercus tomentella*. In the more open sections of this woodland there is a lower layer of arborescent forms of *Photinia arbutifolia*, *Prunus Lyonii*, *Cercocarpus betuloides*, *Arctostaphylos diversifolia*, and *Ceanothus arboreus*. The closed cone pines are dominant on the higher parts of the ridge while broadleaved sclerophylls are relatively abundant on the lower slopes near the sea. This is particularly true of the dissected remnants of a marine terrace

⁷In conversation with the caretaker on Santa Cruz April 13, 1941, the writer was shown the daily records of precipitation for that year, beginning with January 1, 1941, a total of 52.50 inches. No more records are available.

which occur at an approximate elevation of 61 meters (200 feet). Small groves of *Lyonothamnus* occur also on Santa Rosa, Santa Catalina, and San Clemente. These groves are all on the northern or northeastern slopes. The groves on Santa Cruz are the most extensive and consist of larger trees (plate 4a).

Quercus tomentella occurs as isolated trees about the head of eastern canyons on San Clemente. In Gallagher's Canyon on Santa Catalina there is an extensive grove which has a decided forest aspect. On Santa Rosa, Santa Cruz, and Anacapa islands this endemic oak occurs in small, dense groves about the heads of northern canyons. The one grove on Anacapa is shown in plate 4b. The smaller clumps of trees farther down the canyon are *Photinia arbutifolia* and *Prunus Lyonii*.

Scattered trees of *Quercus MacDonaldii* occur in broad, upland canyons of Santa Catalina. *Q. agrifolia* grows on Santa Rosa and Santa Cruz, both in canyons and on protected slopes. A few trees of *Q. chrysrolepis* and *Photinia arbutifolia macrocarpa* are to be found in protected canyon heads on San Clemente, while *Prunus Lyonii* is in some of the western gorges of this island in the form of trees up to 15 meters (49 feet). *Photinia*, *Prunus*, *Cercocarpus betuloides* and its varieties, and *Sambucus coerulea* occur, usually as scattered trees, in the canyons of Santa Catalina.

On Santa Catalina a rather open riparian association varies from canyon to canyon, according to altitude, soil and available water supply. Among the trees and arborescent shrubs are *Populus trichocarpa*, *P. Fremontii*, *Salix lasiolepis*, *S. Laevigata*, *Quercus tomentella*, *Q. MacDonaldii*, *Photinia*, *Sambucus*, *Prunus*, and *Cercocarpus*. In Cherry Valley there is an extensive, almost pure stand of *Prunus* which forms a most picturesque, miniature woodland. The riparian woodlands of Santa Cruz and Santa Rosa consist mainly of the same species as on Santa Catalina with the addition of *Q. agrifolia*. It is highly significant that several of the mainland riparian and near-riparian genera are entirely lacking on the islands, for examples, *Platanus*, *Alnus*, *Myrica*, and *Umbellularia*.

In forested areas on the islands there is very little undergrowth, due principally to two factors: (1) the utilization of all the available water by the trees because the precipitation is usually below the amount ordinarily required for tree growth, and (2) the intolerance of most of the island plants to shade, especially to the deep shade of the dense foliage of the evergreen sclerophylls. Woodland can be considered as climax only in limited areas where local edaphic conditions favor the retention of soil water, or where underground drainage carries water

near enough to the surface as to make it available to the trees. Such areas are those on the northern slope of Santa Rosa and Santa Cruz, the northeastern slope of Santa Catalina and San Clemente, and the larger canyons. The desiccating effect of wind on exposed slopes has been indicated by the evaporation rates of the exposed stations on the Santa Barbara ridges. As little or no tree growth occurs on slopes exposed to the wind it would appear that this is a most powerful factor in the limitation of woodlands.

MARITIME SHRUBS

It has been previously stated that shrub originally occupied much of the interior upland area on Santa Barbara Island. Since uplands and terraces similar to those of Santa Barbara are to be found on all of the other islands it may be inferred that shrub was originally abundant on all the islands. It has been nearly exterminated on San Miguel and San Nicolas, but shrub of some kind is still locally abundant on all the other islands. Chaparral, coastal sagebrush, *Coreopsis* shrub, *Opuntia littoralis* shrub, and desert shrubs are the common forms. Many varieties of chaparral and coastal sagebrush occur on different islands and in different parts of the same island, but desert shrub is limited to San Clemente and *Coreopsis* shrub to Anacapa and Santa Barbara.

Chaparral. Santa Rosa, Santa Cruz, and Santa Catalina have the greatest areas of chaparral at the present time. On Santa Catalina it is dominated by *Quercus dumosa*, but that of the two northern islands is more varied and resembles, in many respects, the mainland chaparral of the Santa Inez mountains in its short and its tall chaparral aspects. The chaparral of the northern and eastern slopes is much higher than that occurring on southern slopes, whereas it is rarely developed at all on western slopes if these are exposed to the prevailing winds. In favorable locations the larger shrubs of the chaparral tend to become arborescent. This condition has been furthered by the browsing of animals, particularly goats, which has effectively pruned the lower branches.

The broad sclerophyll shrubs are found both in the chaparral and growing as isolated, arborescent specimens. There is no true chaparral on San Clemente or Anacapa although several of the sclerophyll shrubs occur on these islands. The distribution of the species represented in the chaparral is shown in table 4. Chaparral is apparently limited to areas where the annual precipitation is over 12 inches.

Coastal sagebrush. Coastal sagebrush may at one time have been present on all the islands but is now non-existent on San Nicolas and San Miguel, and very limited on San Clemente. It is present only on

seaward slopes on Anacapa but exists in many and varied locations on the three larger islands. The coastal sagebrush, *Artemisia californica* or the variety *insularis* is on all the islands. On southern exposures the species grows stiffly erect and compact, while on northern or eastern exposures it grows with long, flexuous branches and longer leaves. As this association is commonly found on hillsides and canyon slopes the soil is rather coarse in texture and often relatively shallow. There is a great difference in the evaporation rates of southern and northern exposures as was indicated in the preceding section.

TABLE 4
DISTRIBUTION OF CHAPARRAL SHRUBS
ON THE FOUR LARGER ISLANDS

	Islands			
	Santa Rosa	Santa Cruz	Santa Catalina	San Clemente
KEY				
A - Abundant				
X - Occasional				
<i>Quercus dumosa</i> Nutt.	X	X	A	-
<i>Dendromecon Harfordii</i> Kell.	X	A	X	X
<i>Prunus Lyonii</i> Sarg.	X	X	A	X
<i>P. ilicifolia</i> Walp.	X	X	X	X
<i>Cercocarpus betuloides</i> Nutt.	X	X	X	-
var. <i>alnifolius</i> Dunkle	X	X	X	-
var. <i>multiflorus</i> Jepson	-	X	X	-
var. <i>Traskiae</i> Dunkle	-	-	X	-
<i>Photinia arbutifolia</i> Lindl.	X	A	-	-
var. <i>macrocarpa</i> Munz	-	-	A	X
var. <i>cerina</i> Jepson	-	-	X	-
<i>Rhamnus crocea insularis</i> Sarg.	X	X	X	X
<i>Ceanothus arboreus</i> Greene	X	X	A	-
<i>C. crassifolius</i> Torr.	X	X	X	-
<i>C. megacarpus insularis</i> Munz	X	X	A	X
<i>Rhus laurina</i> Nutt.	X	A	A	X
<i>R. diversiloba</i> T. & G.	X	X	A	X
<i>R. ovata</i> Wats.	-	X	A	X
<i>R. integrifolia</i> Benth. & Hook.	X	X	X	X
<i>Arctostaphylos diversifolia</i> Parry	X	A	X	-
<i>A. tomentosa</i> Lindl.	X	A	X	-
<i>A. insularis</i> Greene	X	A	X	-
<i>A. subcordata</i> Eastw.	X	X	-	-
<i>A. bicolor</i> Gray	-	-	X	-

There are many variations in this association. One form occurs on terraces where the soil is much deeper and more finely textured than on the canyon slopes. This terrace type forms the unique and remarkable *Coreopsis* association which occurs on Santa Barbara and the eastern island of Anacapa and was described in the preceding section. Isolated plants of *Coreopsis gigantea* have been reported from each of the Channel Islands, usually growing in inaccessible situations on rocky bluffs. The eastern bluffs of Santa Catalina Island, those which are steep enough to deter grazing animals, support a scattered growth of poorly developed plants. A rocky hill near Empire Landing on Santa Catalina has the largest colony of *Coreopsis* to be found on any of the larger islands at the present time.

The principal communities of this association are given in table 5, with the main constituents of each community and their distribution. Several species which are to be found in nearly every variation of the coastal sagebrush are listed first.

Maritime Desert shrub. The only desert shrub of the islands is located on the southern third of San Clemente Island. On the higher terraces it is composed almost wholly of *Opuntia prolifera*. On middle terraces *Opuntia littoralis* and *Cereus Emoryi* appear, while on the lowest terraces other low shrubs enter into the composition, including *Lycium californicum*, *Artemisia californica insularis*, *Encelia californica*, *Lotus argophyllus adsurgens*, *Euphorbia misera*, and *Castilleja grisea*. No record of the annual precipitation is available for this area but an estimate of six inches is given in the section dealing with climate.

SEA BLUFF COMMUNITIES

Because of the great extent of the coast line in relation to the total area of the Channel Islands the most diversified plant life is that of the sea bluffs. These communities have received detailed treatment in the preceding section. Similar habitat conditions exist on all the islands. Plants of such genera as *Atriplex*, *Echeveria*, *Eriogonum*, *Astragalus*, *Eriophyllum*, *Opuntia*, *Mirabilis*, *Polypodium*, *Lycium*, and *Achillea* are usually present, but the composition varies with different islands. A list of the plants of these communities is given in table 5.

The floristic combinations differ with almost every variation of slope angle and exposure. Yet there is a characteristic pattern of life-forms where the sea is always in the immediate foreground. The soil is usually shallow and rocky, and both the diurnal and the annual

TABLE 5

THE CONSTITUENTS OF THE COASTAL SAGEBRUSH

Dominants starred	Channel Islands							
	Anacapa	Santa Cruz	Santa Rosa	San Miguel	San Nicolas	Santa Barbara	Santa Catalina	San Clemente
Species of general distribution								
* <i>Salvia mellifera</i> Greene	-	X	X	-	-	-	X	X
var. <i>Jonesii</i> Munz	-	-	-	X	-	-	-	-
* <i>Rhus integrifolia</i> Benth. & Hook.	X	X	X	X	-	-	X	X
<i>R. diversiloba</i> T. & G.	X	X	X	X	-	-	X	X
<i>Lycium californicum</i> Nutt.	-	-	-	X	X	X	X	X
* <i>Eriogonum giganteum</i> Wats.	-	-	-	-	-	-	X	X
var. <i>formosum</i> K. Brandg.	-	-	-	-	-	-	-	X
var. <i>compactum</i> Dunkle	-	-	-	-	-	X	X	-
<i>Achillea millefolium lanulosa</i> Piper	X	X	X	X	X	X	X	X
Southern slopes								
<i>Pellaea andromedaefolia</i> Fee.	X	X	X	-	-	-	X	X
<i>Mirabilis laevis</i> Curran	-	X	X	-	-	X	X	-
var. <i>cedrosensis</i> Munz	-	-	-	-	-	-	-	X
var. <i>cordifolia</i> Dunkle	-	-	-	-	-	-	-	X
* <i>Lotus argophyllus niveus</i> Ottley	-	X	-	-	-	-	-	X
var. <i>ornithopus</i> Ottley	-	-	-	-	X	X	X	X
var. <i>adsurgens</i> Dunkle	-	-	-	-	-	-	-	X
<i>Zauschneria californica</i> Presl.	-	-	X	-	-	-	X	X
var. <i>villosa</i> Jepson	-	X	X	-	-	-	-	X
ssp. <i>angustifolia</i> Keck	-	-	-	-	-	-	X	-
<i>Z. cana</i> Greene	-	X	X	-	-	-	X	-
* <i>Salvia apiana</i> Jepson	-	X	-	-	-	-	X	-
* <i>S. Brandegei</i> Munz	X	-	X	-	-	-	-	-
* <i>Optuntia littoralis</i> Cockerell	X	X	X	X	X	X	X	X
<i>O. prolifera</i> Engelm.	X	-	X	-	X	X	X	X
* <i>Brickellia californica</i> Gray	X	X	-	-	-	-	X	X
* <i>Encelia californica</i> Nutt.	-	X	-	-	-	-	X	X
* <i>Artemisia californica</i> Less. f. <i>erecto</i>	-	X	X	X	-	-	X	-

Dominants starred	Channel Islands							
	Anacapa	Santa Cruz	Santa Rosa	San Miguel	San Nicolas	Santa Barbara	Santa Catalina	San Clemente
var. insularis Munz	X	-	-	-	X	X	-	X
<i>Convolvulus occidentalis cyclostegius</i> Jepson	-	-	-	-	-	-	X	-
North and east slopes								
* <i>Polypodium californicum</i> Kaulf.	-	X	X	-	-	-	X	X
var. <i>Kaulfusii</i> D. C. Eaton	X	-	-	-	-	X	X	-
* <i>Mimulus longiflorus</i> Grant	-	X	X	-	-	-	-	-
var. <i>linearis</i> Grant	-	-	X	-	-	-	X	-
* <i>M. Flemingii</i> Munz	X	X	X	-	-	-	-	-
* <i>Mimulus puniceus</i> Steud.	-	-	-	-	-	-	X	-
* <i>Eriophyllum confertiflorum</i> Gray	X	X	X	X	-	-	X	X
var. <i>laxiflorum</i> Gray	-	-	X	-	-	-	-	-
var. <i>trifidum</i> Gray	-	X	X	-	-	-	X	X
* <i>Artemisia californica</i> Less. f. <i>flexilia</i>	-	X	X	X	-	-	X	-
<i>Lotus scoparius dendroideus</i> Ottley	X	X	-	-	-	-	X	-
var. <i>Traskiae</i> Ottley	-	-	-	-	-	-	X	X
var. <i>Veatchii</i> Ottley	-	-	-	X	-	-	-	-
<i>Erysimum insulare</i> Greene	-	-	-	X	-	-	-	-
<i>Convolvulus occidentalis macrostegius</i> Munz	X	X	-	-	X	X	X	X
<i>Echinocystis macrocarpa</i> Greene	-	X	-	-	-	X	X	X
<i>E. guadalupensis</i> Dunkle n.c.	-	X	X	X	-	-	-	-
Terraces								
* <i>Lycium californicum</i> Nutt.	-	-	-	X	X	X	X	X
<i>L. verrucosum</i> Eastw.	-	-	-	-	X	-	-	-
<i>L. Fremontii</i> Gray	-	-	X	-	-	-	-	-
* <i>Grindelia rubricaulis latifolia</i> Steyermark	X	-	X	X	-	-	-	-
var. <i>platyphylla</i> Steyermark	X	-	X	-	-	-	-	-
<i>Baccharis pilularis consanguinea</i> C. B. Wolf	X	X	X	X	X	X	X	X
<i>Aplopappus canus</i> Blake	X	X	X	-	-	-	-	X
* <i>Coreopsis gigantea</i> Hall	X	X	X	X	X	X	X	X
<i>Eriogonum arborescens</i> Greene	X	X	X	-	-	-	-	-
<i>Grindelia arenicola</i> Steyermark	-	X	X	-	-	-	-	-
* <i>Artemisia californica insularis</i> Munz	X	-	-	-	X	X	-	X

TABLE 6
THE CONSTITUENTS OF THE
SEA BLUFF COMMUNITIES

*Dominants	Channel Islands							
	Anacapa	Santa Cruz	Santa Rosa	San Miguel	San Nicolas	Santa Catalina	Santa Barbara	San Clemente
Species of general distribution								
*Atriplex californica Moq.	X	X	X	X	X	X	X	X
A. pacifica Nels.	X	X	X	-	X	-	X	X
A. Coulteri Dietr.	X	X	X	X	-	-	X	-
A. Watsonii Nels.	-	X	X	X	X	-	X	X
*Rhus integrifolia Benth. & Hook.	X	X	X	X	-	-	X	X
*Lycium californicum Nutt.	-	-	-	X	X	X	X	X
Achillea millefolium lanulosa Piper	X	X	X	X	X	X	X	X
Wind exposure								
*Suaeda Torreyana Wats.	-	X	X	X	-	-	X	X
S. californica Wats.	X	X	-	-	-	-	X	-
var. pubescens Jepson	-	-	-	-	X	X	-	-
Spergularia macrotheca Heynh.	X	X	X	X	X	X	X	X
S. Salina Presl.	-	X	-	-	-	-	X	X
Astragalus Traskiae Eastw.	-	-	-	-	X	X	-	X
A. Nevinii Gray	-	-	-	-	-	-	X	X
A. Douglasii T. & G.	X	-	-	X	-	-	-	-
A. miguelensis Greene	X	X	X	X	-	-	-	-
*A. leucopsis Torr.	X	X	X	X	-	-	X	-
Cryptantha Traskae Johnston	-	-	-	-	X	X	-	X
C. maritima Greene	-	-	-	-	X	X	X	X
Aplopappus venetus sedoides Munz	-	X	X	-	-	-	-	-
*var. vernonioides Munz	-	X	X	X	X	-	X	X
var. furfuraceus Munz	-	X	-	-	-	-	X	X
Hemizonia clementina Brandg. f. prostrata	X	-	-	-	X	X	X	X
Baeria chrysostoma gracilis Hall.	X	X	X	X	X	X	X	X
B. hirsutula Greene	-	X	X	-	X	X	X	-
Malacothrix foliosa Gray	-	X	-	-	-	X	-	X
North and east exposure								
*Polypodium californicum Kaulfussii D. C. Eaton ...	X	X	X	-	-	X	X	X
P. Scouleri Hook. & Grev.	-	X	-	-	-	-	X	X
P. vulgare hesperium Nels. & Macbr.	X	-	-	-	-	-	-	-
Pityrogramma triangularis Maxon	X	X	X	-	-	-	X	X
P. viscosa Weatherby	-	X	X	-	-	-	X	X
Adiantum Jordani C. Mull.	X	X	X	-	-	-	X	X
Pellaea mucronata D. C. Eaton	-	X	X	-	-	-	X	-
Cheilanthes californica Mett.	-	X	X	-	-	-	X	-
Aphanisma blitoides Nutt.	-	X	X	-	-	X	-	X
*Eriogonum grande Greene	X	X	X	X	-	-	X	X

Channel Islands

*Dominants

Anacapa

Santa Cruz

Santa Rosa

San Miguel

San Nicolas

Santa Barbara

Santa Catalina

San Clemente

var. rubescens Munz	-	X	X	X	-	-	-	-
E. cinereum Benth.	-	-	X	-	-	-	-	-
Silene laciniata Cav.	X	X	X	X	-	-	-	-
Lupinus albifrons Benth.	X	X	X	X	X	-	X	X
Trifolium tridentatum Lindl.	-	X	X	X	-	X	X	X
var. aciculare McDermott	X	X	X	-	-	-	-	X
T. gracilentum T. & G.	X	-	X	-	X	X	-	X
var. inconspicuum Fern.	-	X	X	-	-	-	-	-
T. stenophyllum Nutt.	-	X	X	X	X	-	X	X
Castilleja hololeuca Greene	X	X	X	X	-	-	-	-
C. foliolosa H. & A.	-	X	-	-	-	-	X	-
C. anacapensis Dunkle	X	-	-	-	-	-	-	-
C. affinis H. & A.	-	X	X	X	-	-	-	-
C. Douglasii Benth.	X	X	X	-	-	-	X	-
Aplopappus canus Blake	X	X	X	-	-	-	-	X
Erigeron glaucus Ker.	X	X	X	X	-	-	-	-
Corethrogyne filaginifolia Nutt.	-	-	X	-	X	-	X	-
* var. virgata Gray	-	X	X	X	-	-	X	-
* var. robusta Greene	X	X	X	X	-	-	-	-
var. latifolia Hall	X	-	-	-	-	-	-	-
Eriophyllum staechadifolium depressum Greene	X	X	X	-	-	-	-	-
*E. confertiflorum Gray	X	X	X	X	-	-	X	X
var. laxiflorum Gray	-	-	X	-	-	-	-	-
var. trifidum Gray	-	X	X	-	-	-	X	X
E. artemisifolia Gray	-	X	-	-	-	-	X	-
Hemizonia clementina Brandg. f. erecta	X	-	-	-	X	X	X	X

Sun exposure

Echeveria albida Berger	-	-	-	X	-	X	X	X
*E. Greenei Berger	X	X	X	-	-	X	-	-
E. virens Berger	-	-	-	-	-	-	X	X
*Mirabilis laevis Curran	X	X	X	-	-	X	X	-
var. cedrosensis Munz	-	-	-	-	-	-	-	X
var. cordifolia Dunkle	-	-	-	-	-	-	-	X
*Lotus argophyllum ornithopus Ottley	-	X	-	-	X	X	X	X
var. adsurgens Dunkle	-	-	-	-	-	-	-	X
*Atriplex Breweri Wats.	X	X	-	X	X	-	X	X
Euphorbia misera Benth.	-	-	-	-	-	X	X	X
Phacelia floribunda Greene	-	-	-	-	-	-	-	X
Eriophyllum Nevinii Gray	-	-	-	-	-	X	X	X
Perityle Emoryi Torr.	X	X	X	-	-	X	X	X
Senecio Lyonii Gray	-	X	-	-	-	-	X	X
Castilleja grisea Dunkle	-	-	-	-	-	-	-	X

ranges of temperature are very small. The pounding of the surf makes the air and the soil decidedly saline. Nevertheless the wide variety of edaphic and orographic conditions usually prevents any one plant, or combination of plants, from being dominant over any extensive area. The communities can be treated conveniently by the relation of their slope exposures to wind and sun.

The sun is the most powerful factor on southern exposures, so that the evaporation rate here is relatively high. Owing to the steepness of the slope, which causes a high run-off of precipitation, and the high evaporation rate, there is more bare soil and rock than there are plants. The aspect of these slopes from the sea has led many casual observers to conclude that the islands are mostly desert.

The western exposures are influenced by the prevailing winds and are of three types: low headlands where there is a decidedly saline influence, high rocky ridges, and high rounded bluffs where the soil is deeper and of somewhat finer texture. The low headlands are marked by *Atriplex* and other low mat-like plants of rather drab appearance. The rocky ridges are covered with foliose lichens where the wind ascending the slope is frequently laden with condensing moisture. Many of the niches between the irregular blocks of rock are occupied by low shrubs, semi-shrubs, and perennials. On the high, rounded bluffs low annuals such as *Baeria* and *Malacothrix* form veritable carpets of green and gold in the spring, interspersed with matted perennials like *Astragalus*, *Hemizonia*, and *Aplopappus*.

The north and east exposures, which are sheltered from the wind and the more direct rays of the sun, are in sharp contrast to other slopes. There is usually a luxuriant growth of grasses, ferns, clovers, and other forbs, suffrutescent perennials, and low shrubs. These remain green and in bloom until mid-summer. One of the best developed examples of this *Eriogonum-Eriophyllum* association is on the long, north-eastern, talus slope of the western island of Anacapa. Here the suffrutescents and forbs form a tangled mat, through which one may proceed only with difficulty. A section of this long slope is illustrated in plate 18.

Shrubby lupines are on all the islands except Santa Barbara, but the variation in species is great and their different characteristics so interwoven that positive identification is yet uncertain. These are apparently varieties of an original parent stock which has been differentiated into geographic races. The variable characteristics resemble those of the closely related mainland species but are combined into different patterns in the insular races. So confused is the nomenclature that five different names have been applied to plants of a single colony. With

this in mind the shrubby lupines of the islands will be considered here as forms of *Lupinus albifrons*. These lupines rarely grow with other plants into any semblance of an association, but rather as isolated plants on rocky bluffs, or as small colonies on slopes near the sea.

GRASSLANDS

Grasslands dominated by vernal soft-leaved annual grasses are present on all of the islands and may be a climax formation on many of the broad ridges, rolling hills, and wide terraces. Much of what is now grassland, however, seems to have been shrub before the period of overgrazing. This is indicated because most of the dominant grasses are introductions, and because wherever grazing has been discontinued for some years, as on Santa Barbara, San Clemente, and the two western islands of Anacapa, shrubs and suffrutescents are beginning to re-establish themselves. At present, however, the major part of the insular area is grassland. The dominating grasses at the present time are *Hordeum murinum*, *Avena fatua*, and *Bromus mollis* except for a typical bunch-grass area on San Clemente, covering much of the middle section of the island. This area is dominated by the indigenous perennial grass *Stipa pulchra*, with *Stipa lepida*, *Melica imperfecta*, and *Muhlenbergia microsperma* as sub-dominants.

Various low species of annuals and perennials are usually intermingled with the grasses, much as in the grassland of the mainland coast. Many of these are exotics, such as *Silene gallica*, *Medicago hispida*, and *Atriplex semibaccata*. There are relatively few endemics among the grasses or the annuals which are associated with them. Such annuals as are endemic seem to be generally associated with coarser, more rocky soils on steep slopes. The grasslands of the islands, except for those on protected north slopes, all occur in fine textured soils. This, agrees with the findings of Lundegardh (1931, p. 115) who states that deep-rooted plants occur in coarse soils, while shallow-rooted plants occur in soil of finer texture. On the coarse soils of protected northern exposures the evaporation rate, as shown for the northern aspect of Cave Canyon on Santa Barbara, is apparently low enough to permit the retention of water in the interstices of the coarser particles, sufficiently to meet the needs of the shallow-rooted grasses. This grassland on sheltered slopes in canyons and on sea bluffs contains such genera as *Agrostis*, *Bromus*, *Melica*, and *Festuca*. These grasses are associated with a different group of annuals and low perennials than are to be found on the more exposed hills and terraces. Here again these plants are usually

the same species which occur in similar situations on the mainland. Typical genera are *Lupinus*, *Gilia*, *Cryptantha*, *Trifolium*, *Amsinckia*, *Lepidium*, *Phacelia*, *Nemophila*, *Platystemon*, *Eschscholtzia*, *Caulanthus*, *Thysanocarpus*, *Lithophragma*, *Layia*, *Orthocarpus*, *Viola*, and *Gnaphalium*.

SAVANNAS

The grasslands very frequently merge by imperceptible degrees into shrub savannas. Various low shrubs and suffrutescents from the coastal sagebrush form a low shrub savanna, the species of which vary with different habitats and different islands. Plate 5a shows such a typical low shrub savanna on the western island of Anacapa. The light colored shrubs at the right are *Aplopappus canus*, with a typical, rounded clump of *Eriogonum arborescens* in the rear center, and with *Baccharis pilularis consanguinea* at right left.

On islands where chaparral shrubs occur, isolated specimens will be spaced through the grassland on the terraces and mesas, particularly on the slopes of ridges. *Ceanothus*, *Rhamnus*, *Crossosoma*, *Adenostoma*, *Rhus*, and *Photinia* are most frequently found in such areas.

Broad upland valleys frequently have scattered trees and arborescent shrubs forming a tree savanna. *Pinus muricata* often forms open savannas on Santa Rosa and Santa Cruz Islands, and with it are often interspersed large, rounded, arborescent sclerophylls such as *Arctostaphylos diversifolia*, *Quercus agrifolia*, *Photinia arbutifolia*, and *Cercocarpus betuloides*. On Santa Catalina a similar association exists but is dominated by *Quercus MacDonalldii*, arborescent forms of *Quercus dumosa*, *Prunus Lyonii*, *Photinia arbutifolia macrocarpa*, *Cercocarpus betuloides*, *C. betuloides multiflorus*, *C. alnifolius*, *Ceanothus megacarpus insularis*, and *Rhamnus megacarpus insularis*. On San Clemente Island *Quercus tomentella*, *Q. chrysolepis*, and *Photinia arbutifolia* form very small areas of savanna. These savannas are usually on terraces or on rolling hills about wide upland watercourses. The trees most frequently occupy slopes or swales where they receive some protection from the wind.

MARSHES

There are salt marshes or salt lagoons on Santa Catalina, San Clemente, San Nicolas, Santa Rosa, and Santa Cruz islands. All of these marshes are rather temporary in their nature and no endemics occur.

The most common of the salt marsh plants are *Salicornia subterminalis*, *Lepturus cylindricus*, *Frankenia grandifolia*, *Heliotropium Curvassicum oculatum*, and *Jaumea carnosa*.

Fresh water marshes and springy hillsides occur on all the islands with the exception of those of volcanic origin. On Santa Barbara, San Clemente, and Anacapa the lava forms no bedding planes and the water is not carried out to the surface, except for small seepages near the water level. *Typha angustifolia* is found on Santa Catalina, Santa Rosa, and Santa Cruz. *Anemopsis californica* grows on Santa Catalina, San Miguel, San Nicolas, Santa Rosa, and Santa Cruz. *Rorippa nasturtium-aquaticum* is on Santa Cruz and Santa Catalina, while *Conium maculatum* has been reported from these two islands and San Nicolas, and *Jussiaea californicum* as well as *Scirpus californicus* on Santa Cruz, while *Scirpus Olneyi* occurs on San Nicolas and Santa Rosa.

There are two very temporary small playa lakes, one on Santa Catalina and one on San Miguel. These hold water for such short periods that they probably contain no specialized vegetation, at least none has yet been reported.

SAND DUNES

There are well developed sand dunes on San Clemente, San Nicolas, and San Miguel, while embryonic dune areas, back of broad sand beaches, occur on Santa Catalina. *Franseria bipinnatifida*, *Abronia maritima*, and *Atriplex leucophylla* are the most common and most widespread of the dune plants. *Abronia alba* and *Franseria chamissonis* occur on San Miguel, San Nicolas, and San Clemente. *Cakile edentula californica*, *Abronia latifolia*, and *Mesembryanthemum chilense* are to be found on San Miguel, the latter also on Anacapa. *Platystemon californicus ornithopus* occurs on the sand dunes of both San Miguel and San Nicolas.

V PHYTOGEOGRAPHY OF THE ISLANDS

The problems of the affinities, origins and distributions of the plants of the Channel Islands have been discussed and in some cases studied by practically every botanist and geologist who has visited the islands. Any attempt to understand these matters involves the interpretation of past geological events and of the climatic changes which may have affected this insular area. Some material for this understanding has already been presented in previous sections of this paper and will be intergrated here. Final solutions must await the accumulation of data of greater extent.

GEOGRAPHIC VARIATION

The plant life of the Channel Islands is remarkably rich and varied for such a limited area. Combining Eastwood's list (1941) and Dunkle's supplementary list (1942a) there are 957 species and varieties for the islands. A critical examination would reveal considerable synonymy and a consequent reduction of this number to about 830. In addition the 150 introduced plants would reduce the number of indigenous plants to about 680. The plant life is particularly remarkable on account of the wide differences between the insular flora and that of the adjacent mainland. This difference consists of approximately 18 per cent of endemism, considerable variation in frequency between species on the islands compared with the same species on the mainland, and many noticeable differences in size and growth-form.

Several plants which are, at least locally, common and vigorous on the islands but relatively rare on the mainland are:

<i>Pityrogramma triangularis</i>	<i>Eriodictyon Traskiae</i>
var. <i>viscosa</i>	<i>Arctostaphylos diversifolia</i>
<i>Pinus Torreyana</i>	<i>Baeria hirsutula</i>
<i>Erysimum insulare</i>	<i>Coreopsis gigantea</i>
<i>Ribes viburnifolium</i>	

There are a number of species which are usually shrubby on the mainland but are much more frequently arborescent on the islands, or have related insular species or varieties which are commonly arborescent. These include:

<i>Quercus dumosa</i>	<i>Ceanothus arboreus</i>
<i>Photinia arbutifolia</i>	<i>C. crassifolius</i>
var. <i>macrocarpa</i>	<i>C. megacarpus</i>
<i>Cercocarpus betuloides</i>	var. <i>insularis</i>
var. <i>alnifolius</i>	<i>Rhamnus crocea</i>
<i>Prunus ilicifolia</i>	var. <i>insularis</i>
<i>Prunus Lyonii</i>	<i>Arctostaphylos diversifolia</i>

There are also several genera, usually herbaceous on the mainland, which have suffrutescent or woody species or varieties on the islands. Among these insular forms are:

<i>Spergularia macrotheca</i>	<i>S. Clokeyi</i>
var. <i>Talinum</i>	<i>Castilleja hololeuca</i>
<i>Erysimum insulare</i>	<i>C. grisea</i>
<i>Lotus argophyllus</i>	<i>C. anacarpensis</i>
var. <i>niveus</i>	<i>Hemizonia clementina</i>
var. <i>adsurgens</i>	<i>Malacothrix Blairii</i>
<i>Solanum Wallacei</i>	

It may also be noted that a small number of suffrutescent or woody shrubs of the mainland frequently have exceptionally long, trailing or procumbent branches on the islands. Among these are *Cereus Emoryi*, *Brickellia californica*, and *Artemisia californica*. Other differences in suffrutescence or pubescence will be treated in the following section. Among many other plants there are minor differences in peduncle length, leaf margin, bract length or form, size of flower, leaf or fruit, or degree of pubescence which may or may not merit varietal rank. Most of these preceding differences between mainland and island plants are due apparently to long isolation on the islands affected by some genetic variation; or to environmental differences of soil, humidity, or temperature; or possibly to longer intervals between devastating fires, floods, or other catastrophic agencies.

ENDEMISM

A study of the insular endemics is necessary for a just conception of the island flora, its composition, its phylogeny, and its phytogeography. The term endemics as used here relates to species, sub species, varieties, or distinctive forms which are found only on the islands or, in some cases, locally on the adjacent mainland. Preceding sections indicate the nature of the insular isolation and some of the factors of the environment which have brought about large amounts of endemism for such a limited area, probably intensified by the effects of genetic variation in isolated environment. A typical example of this variation, with its associated endemism is *Lotus argophyllus*.

DESCRIPTIVE KEY FOR *Lotus argophyllus*

Calyx teeth as long as the tube.

Stems woody, branches stocky with short nodes, silvery-canescant.

L. argophyllus niveus Ottley.

Santa Cruz Island.

Stems herbaceous.

Umbels approximate at the ends of the branches, blade of banner shorter than claw, silvery canescant.

L. argophyllus Fremontii Ottley.

Sierra Nevada Mountains.

Umbels scattered along branches, blade of banner exceeding claw, silky canescant.

L. argophyllus ornithopus Ottley.

Santa Cruz, Santa Catalina,

Santa Barbara, San Nicolas.

The Santa Barbara, San Nicolas

forms have peduncles approximately

one-fourth the length of the peduncles

in the Santa Catalina form.

Calyx teeth shorter than the tube.

Stems woody, branches short virgate, leaves more or less imbricated on the branches.

L. argophyllus adsurgens Dunkle.

San Clemente Island.

Stems herbaceous, decumbent.

Umbels sessile or nearly so.

L. argophyllus Greene.

Pine belt of Southern California Mountains.

Umbels short peduncled.

Umbels approximate at ends of branches, blade of banner sub-equalling claw, silvery canescent.

L. argophyllus argenteus Dunkle.

San Clemente Island.

Umbels scattered along branches, blade exceeding claw. Leaflets 5, broadly elliptical, satiny canescent.

L. argophyllus decorus Ottley.

San Gabriel, San Bernardino, and

San Jacinto mountains.

Leaflets 5-7, narrowly-elliptical, silky canescent.

L. argophyllus Hancockii Dunkle.

San Clemente Island.

This species well illustrates how various genetic tendencies have been interwoven into an intricate pattern. The island varieties of *Eriogonum latifolium* and of *Platystemon californicus* show similar tendencies.

Other endemics which illustrate the effect of the environmental influences are those which have developed a higher degree of pubescence on the foliage than is to be found in related mainland species or varieties. This, according to Lundegardh, is the effect of a relatively high alkaline content of the soil (Lundegardh, 1931), but here the wind is probably at least an equally potent cause of pubescence. Examples of this type of development include:

*Quercus tomentella**Eriogonum gigantum**Cercocarpus betuloides*var. *Traskiae**Astragalus Nevinii**Astragalus Traskiae**Solanum Wallacei**Scrophularia californica*var. *catalina**Castilleja hololeuca**Phacelia floribunda**Aplopappus canus**Eriophyllum Nevinii*

A study of the endemics of the Channel Islands leads to a clear conception of the essential floristic unity of the island group. The large majority of the endemics are to be found on three or more of the islands. Many of those limited to one island are apparently, for the most part, recent initial endemics, many possessing only varietal status. Many of the endemics seem closely related to and apparently derived from California species. Others, however, do not appear to be closely related to any existing California species. These may be considered to be relicts from a Pleistocene Mexican invasion which only locally survived the colder or wetter climates of the glacial stages. Some of these may even be relicts from the hypothetical ancient land of Catalina. There are also a number of plants endemic to the area covered by the maritime climate, many of which are more numerous and more vigorous on the islands than on the mainland coast. Since both prevailing winds and ocean currents are such as to make migration from the islands to the mainland more probable than the reverse migration, such plants may probably have originated on the island and will be listed with the insular endemics. Table 7 presents the distribution of the insular endemics, including plants found otherwise only on Guadalupe Island or the immediately adjacent mainland coast.

Table 7 shows eighty plants endemic to the area of the Channel Islands, with twenty-four more occurring otherwise on Guadalupe Island and seventeen others growing otherwise only in mainland coastal areas which possess a maritime climate. Of the eighty strictly Channel Island endemics fifty are to be found on two or more of the islands, twenty-six are common to islands of both the northern and southern groups, eighteen are common to one or more islands of the northern group and nine are common to one or more islands of the southern group. This would tend to support the hypothesis that all of the islands were at one time part of a common land mass, but that the northern islands have, at another time, formed a separate geological province.

The greater separation of the islands of the southern group is shown not only by the smaller number of endemics common to two or more of these islands, but there are twenty-two endemics limited to single

TABLE 7

PLANTS ENDEMIC TO THE CHANNEL ISLANDS,
OR OCCURRING OTHERWISE ONLY ON GUADALUPE ISLAND
OR RARELY IN MAINLAND AREAS OF MARITIME CLIMATE

	Northern Islands				Southern Islands					
	Anacapa	Santa Cruz	Santa Rosa	San Miguel	San Nicolas	Santa Barbara	Santa Catalina	San Clemente	Guadalupe Island	Mainland Maritime
PINACEAE (Pine Family)										
<i>Pinus remorata</i> Mason		x	x							
<i>Pinus Torreyana</i> Parry			x							x
FAGACEAE (Oak Family)										
<i>Quercus MacDonaldii</i> Greene		x	x				x			
<i>Quercus tomentella</i> Engelm.	x	x	x				x	x	x	
POLYGONACEAE (Buckwheat Family)										
<i>Eriogonum arborescens</i> Greene	x	x	x							
<i>Eriogonum giganteum</i> Wats.							x	x		
var. <i>formosum</i> K. Brandg.								x		
var. <i>compactum</i> Dunkle						x	x			
<i>Eriogonum grande</i> Greene	x	x	x	x			x	x		
var. <i>rubescens</i> Munz		x	x	x						
CHENOPODIACEAE (Pigweed Family)										
<i>Aphanisma blitoides</i> Nutt.				x		x	x	x	x	x
NYCTAGINACEAE (Four O'clock Family)										
<i>Abronia alba</i> Eastw.			x	x	x			x		
<i>Abronia maritima</i> Nutt.	x	x	x	x	x		x	x		x
<i>Mirabilis laevis</i> Curran		x	x			x	x	x		x
var. <i>cedrosensis</i> Munz								x		x
var. <i>cordifolia</i> Dunkle								x		
CARYOPHYLLACEAE (Pink Family)										
<i>Spergularia macrotheca</i> Heynh.	x	x	x	x		x	x	x	x	x
var. <i>Talinum</i> Jepson				x				x		
PAPAVERACEAE (Poppy Family)										
<i>Platystemon californicus</i> Benth.	x	x	x	x			x	x		
var. <i>ornithopus</i> Munz		x	x	x	x					
var. <i>ciliatus</i> Dunkle						x				
<i>Dendromecon Harfordii</i> Kell.		x	x				x	x		
<i>Eschscholtzia elegans</i> Greene	x	x	x	x		x	x	x	x	

TABLE 7 (continued)

	A	S	S	S	S	S	S	S	G	M
	n	C	R	M	N	B	C	CI	I	M
CRUCIFERAE (Mustard Family)										
<i>Thysanocarpus laciniatus</i> Nutt.										
var. <i>ramosus</i> Munz		x	x					x		
var. <i>conchuliferus</i> Jepson		x						x		
<i>Erysimum insulare</i> Gray			x	x						x
<i>Arabis filifolia</i> Greene		x								
<i>Arabis maxima</i> Greene										
var. <i>Hoffmannii</i> Munz		x								
CRASSULACEAE (Stone-crop Family)										
<i>Echeveria Greenei</i> Berger	x	x	x			x				x
<i>Echeveria virens</i> Berger								x		x
<i>Echeveria albida</i> Berger				x		x	x	x	x	
SAXIFRAGACEAE (Saxifrage Family)										
<i>Jepsonia malvaefolia</i> Small		x	x		x		x	x		
<i>Heuchera maxima</i> Greene	x	x	x							
<i>Ribes viburnifolium</i> Gray								x		x
<i>Ribes malvaceum</i> Smith										
var. <i>clementinum</i> Dunkle									x	
CROSSOSOMATACEAE (Crossosoma Family)										
<i>Crossosoma californicum</i> Nutt.								x	x	x
ROSACEAE (Rose Family)										
<i>Lyonothamnus floribundus</i> Gray								x		
var. <i>asplenifolius</i> Brandg.		x	x						x	
<i>Photinia arbutifolia</i> Lindl.										
var. <i>macrocarpa</i> Munz								x	x	
<i>Adenostoma fasciculatum</i> H. & A.										
var. <i>prostratum</i> Dunkle				x						
<i>Prunus Lyonii</i> Sarg.	x	x	x					x	x	
<i>Cercocarpus betuloides</i> Nutt.										
var. <i>multiflorus</i> Jepson		x						x		
var. <i>alnifolius</i> Dunkle		x	x					x		
var. <i>Traskiae</i> Dunkle								x		
LEGUMINOSAE (Pea Family)										
<i>Lupinus clementinus</i> Jepson									x	
<i>Lupinus Moranii</i> Dunkle									x	
<i>Trifolium gracilentum</i> T. & G.										
var. <i>Palmeri</i> McDer.							x	x	x	x
<i>Lotus argophyllus</i> Greene										
var. <i>niveus</i> Otlely		x							x	
var. <i>adsurgens</i> Dunkle									x	
var. <i>ornithopus</i> Otlely						x	x	x	x	x

TABLE 7 (continued)

	A	S	S	S	S	S	S	S	G	M
	n	C	R	M	N	B	C	CI	I	M
<i>var. argenteus</i> Dunkle									x	
<i>var. Hancockii</i> Dunkle									x	
<i>Lotus scoparius</i> Ottley										
<i>var. dendroideus</i> Ottley	x	x	x	x			x			
<i>var. Traskiae</i> Ottley							x	x		
<i>Astragalus leucopsis</i> Torr.										
<i>var. brachypus</i> Greene		x	x	x						
<i>Astragalus trichopodus</i> Gray										
<i>var. capillipes</i> Munz & McBur.							x			
<i>Astragalus Nevinii</i> Gray							x	x		
<i>Astragalus Traskiae</i> Eastw.						x		x		
<i>Astragalus miguelensis</i> Greene	x	x	x	x						
RHAMNACEAE (Buckthorn Family)										
<i>Rhamnus crocea</i> Nutt.										
<i>var. insularis</i> Sarg.		x	x	x			x	x		
<i>Ceanothus arboreus</i> Greene		x	x				x			
<i>var. glabrus</i> Jepson			x							
<i>Ceanothus megacarpus</i> Nutt.										
<i>var. insularis</i> Munz	x	x	x	x			x	x		
MALVACEAE (Mallow Family)										
<i>Lavatera assurgentiflora</i> Kell.	x	x	x	x	x		x	x		
<i>Malvastrum clementinum</i> Munz & Jtn.								x		
<i>Malvastrum nesioticum</i> Robinson		x								
ONAGRACEAE (Evening-primrose Family)										
<i>Zauschneria californica</i> Presl.										
<i>var. villosa</i> Jepson		x	x				x			
<i>Oenothera guadalupensis</i> Wats.								x	x	
<i>Oenothera cheiranthifolia</i> Bornem.										
<i>var. nitida</i> Munz		x	x							x
UMBELLIFERAE (Carrot Family)										
<i>Lomatium insulare</i> Munz					x					
<i>Sanicula bipinnatifida</i> Dougl.										
<i>var. Hoffmannii</i> Munz		x	x							
CORNACEAE (Dogwood Family)										
<i>Cornus glabrata</i> Benth.										
<i>var. catalinensis</i> Dunkle n.c.							x			
ERICACEAE (Heath Family)										
<i>Arctostaphylos insularis</i> Greene		x	x				x			
<i>var. pubescens</i> Eastw.		x								
<i>Arctostaphylos diversifolia</i> Parry		x	x				x			x
CONVOLVULACEAE (Morning-glory Family)										
<i>Convolvulus occidentalis</i> Gray										
<i>var. macrostegius</i> Munz	x	x	x		x	x	x	x	x	

TABLE 7 (continued)

	A	S	S	S	S	S	S	S	G	M
	n	C	R	M	N	B	C	CI	I	M
POLEMONIACEAE (Phlox Family)										
<i>Gilia Traskiae</i> Eastw.								X		
<i>Gilia Nevinii</i> Gray	X	X	X	X	X		X	X	X	
HYDROPHYLLACEAE (Waterleaf Family)										
<i>Nemophila racemosa</i> Nutt.		X			X	X	X	X	X	X
<i>Phacelia phyllomanica</i> Gray								X	X	
<i>Phacelia floribunda</i> Greene						X		X	X	
<i>Phacelia insularis</i> Munz		X	X							
<i>Phacelia Lyonii</i> Gray							X			
<i>Eriodictyon Traskiae</i> Eastw.							X			X
BORAGINACEAE (Borage Family)										
<i>Amsinckia spectabilis</i> F. & M.										
var. <i>nicolai</i> Johnston				X	X			X		
<i>Cryptantha Clevelandii</i> Greene		X	X	X		X	X	X		X
<i>Cryptantha Traskae</i> Johnston					X	X		X		
LABIATAE (Mint Family)										
<i>Salvia Brandegei</i> Munz	X		X							
SOLANACEAE (Nightshade Family)										
<i>Lycium californicum</i> Nutt.				X	X	X	X	X	X	X
<i>Lycium verrucosum</i> Eastw.					X					
<i>Lycium Richii</i> Gray							X	X		
var. <i>Hassei</i> Johnston							X		X	
<i>Solanum Wallacei</i> Parish							X	X	X	
<i>Solanum Clokeyi</i> Munz		X	X							
SCROPHULARIACEAE (Pigwort Family)										
<i>Galvesia speciosa</i> Gray							X	X	X	
<i>Scrophularia californica</i> Cham.										
var. <i>catalina</i> Jepson	X			X			X	X		
<i>Mimulus latifolius</i> Gray		X								X
<i>Mimulus Traskiae</i> Grant							X			
<i>Mimulus Flemingii</i> Munz	X	X	X							
<i>Castilleja anacapensis</i> Dunkle	X									
<i>Castilleja hololeuca</i> Greene	X	X	X	X						
<i>Castilleja grisea</i> Dunkle									X	
PLANTAGINACEAE (Plantain Family)										
<i>Plantago insularis</i> Eastw.					X	X	X	X		
RUBIACEAE (Madder Family)										
<i>Galium catalinense</i> Gray		X		X			X	X		
<i>Galium californicum</i> H. & A.										
var. <i>miguelense</i> Jepson			X	X						
<i>Galium angustifolium</i> Nutt.										
var. <i>foliosum</i> Hilend & Howell	X	X	X							

TABLE 7 (continued)

	A	S	S	S	S	S	S	S	G	M
	n	C	R	M	N	B	C	CI	I	M
CUCURBITACEAE (Gourd Family)										
<i>Echinocystis guadalupensis</i>										
(Wats.) Dunkle n.c.	x	x	x							x
COMPOSITAE (Composite Family)										
<i>Aplopappus canus</i> Blake	x	x	x					x	x	
<i>Aplopappus venetus</i> Blake										
var. <i>sedoides</i> Munz		x	x							
<i>Corethrogyne filaginifolia</i> Nutt.										
var. <i>robusta</i> Greene	x	x	x	x						
<i>Erigeron glaucus</i> Ker.	x	x	x	x						x
<i>Coreopsis gigantea</i> Hall	x	x	x	x	x	x	x	x	x	x
<i>Hemizonia clementina</i> Brandg.	x				x	x	x	x		
<i>Eriophyllum Nevinii</i> Gray						x	x	x		
<i>Eriophyllum staechadifolium</i> Lag.										
var. <i>depressum</i> Greene	x	x	x							
<i>Artemisia californica</i> Less.										
var. <i>insularis</i> Munz					x	x		x		
<i>Senecio Lyonii</i> Gray		x					x	x	x	x
<i>Stephanomeria tomentosa</i> Greene		x	x							
<i>Malacothrix indecora</i> Greene		x		x	x					
<i>Malacothrix Blairii</i> Munz & Jtn.								x		
<i>Malacothrix saxatilis</i> T. & G.										
var. <i>implicata</i> Hall		x	x	x	x					
<i>Hieracium argutum</i> Nutt.		x	x							x

islands in the southern group and only nine limited to single islands in the northern group. San Clemente has eleven local endemics, Santa Catalina seven, and Santa Cruz five.

The distribution of the endemics shared with Guadalupe is most interesting. Eighteen plants are common to Guadalupe and the southern group, while eleven are common to Guadalupe and both the northern and southern groups. In addition five others are common to Guadalupe, both groups of islands, and to the adjacent coastal area of maritime climate. It would seem that if birds, winds, or ocean currents were responsible for the common endemics they would also be found along the mainland coast. The affinity of these two island regions is even more apparent when it is realized that all but three of the common endemics are to be found on San Clemente, the island closest to Guadalupe though it is almost two hundred and fifty miles distant.

AFFINITIES OF ISLAND PLANTS

The origin of the present plant life of the islands is inevitably bound up with the geological vicissitudes of the past. During the warm, moist conditions of the early Miocene, when the ancient land of Catalinia was presumed to have been connected with the mainland (Reed, 1933), a large element of the flora then existing must have reached the insular area. Following the hypothetical almost complete submergence of Catalinia during the upper Miocene and its re-emergence during the Pliocene, the region may have been invaded by a Mexican flora which was adapted to the relatively warm and dry climate of that time. While there is no direct evidence of land connections with the mainland during the Pliocene a large element of Baja California flora on the islands seems to render probable some temporary connection, which may have been established during these millions of years.⁸ The Mexican element of the insular flora contains such genera as *Crossosoma*, *Cereus*, *Galvesia*, and *Lycium*. Many of the endemics listed in table 7 are probably of Mexican derivation. Thirty-two other plants of probable Mexican affinity which are to be found also to the south are included in table 8 under the heading "southern."

NORTHERN ELEMENTS

Another large element of the insular flora is shown in table 8 by the sixty-five "northern" plants which are otherwise mostly found north of the Cuyama River. Munz (1935) lists thirty-five plants of the northern group of islands which otherwise occur mostly from Monterey County northward on the mainland. Leconte (1888) has stated that during the glacial periods of the Pleistocene there must have been a southward migration of northern flora, which reached the islands during periods of uplift sufficient to have created mainland connections. At the same time the warmer climate of the islands and the protected coves along the coast must have harbored many of the Mexican and Great Basin plants which are presumed to have reached the islands from mainland California during the milder climates of the Miocene and Pliocene. Thus this glacial invasion may have included many relicts of previous northward Mexican migrations as well as the many plants of northern affinity which have so enriched the flora of the islands, especially those of the northern group.

⁸This was also held tenable by Le Conte (1888) who stated that the islands were probably connected with the mainland during the late Pliocene and early Quaternary.

TABLE 8
DISTRIBUTION OF CERTAIN NON-ENDEMIC
INDIGENOUS CHANNEL ISLAND PLANTS

Occuring in Areas outside of Cismontane Southern California

	Northern Islands	Southern Islands	Other Areas
	Anacapa Santa Cruz Santa Rosa San Miguel	San Nicolas Santa Barbara Santa Catalina San Clemente	Northern Desert Southern Guadalupe Island
POLYPODIACEAE (Fern Family)			
<i>Polystichum munitum</i> Presl.....	x x		x
<i>Athyrium Filix-foemina</i> Bernh.			
var. <i>sitchense</i> Rupr.	x x		x
<i>Pityrogramma triangularis</i> D.C. Eat.	x x	x x	x x
var. <i>viscosa</i> Weatherby	x x	x x	x x
<i>Pellaea mucronata</i> D. C. Eat.	x x x	x x	x x x
<i>Notholaena Newberryi</i> D. C. Eat.		x	x x
<i>Adiantum pedatum</i> L.			
var. <i>aleuticum</i> Rupr.	x		x
<i>Polypodium californicum</i> Kaulf.		x x	x
<i>Polypodium Scouleri</i> Hook. & Grev.	x	x	x
EQUISETACEAE (Horsetail Family)			
<i>Equisetum hyemale</i> L.			
var. <i>californicum</i> Milde.	x		x
NAIADACEAE (Pondweed Family)			
<i>Zostera marina</i> L.	x x x	x	x
<i>Phyllospadix Torreyi</i> Wats.	x x x x	x x x x	x x
<i>Phyllospadix Scouleri</i> Hook.		x	x
GRAMINEAE (Grass Family)			
<i>Aristida adscensionis</i> L.	x x	x x	x x
<i>Stipa pulchra</i> Hitchc.	x x x x	x x x x	x
<i>Stipa lepida</i> Hitchc.	x x x x	x x	x
<i>Muhlenbergia microsperma</i> Kunth.	x x x	x x x	x x
<i>Dissanthelium californicum</i> Benth.	x x	x x	x
<i>Melica imperfecta</i> Trin.	x x x	x x x	x
<i>Distichlis stricta</i> Rydb.			
var. <i>laxa</i> Fawcett & West	x x x x	x x x	x x
<i>Poa Douglasii</i> Nees.	x x		x
<i>Festuca octoflora</i> Walt.			
var. <i>hirtella</i> Piper	x x x x	x x	x
<i>Bromus maritimus</i> Hitchc.	x	x	x
<i>Bromus carinatus</i> H. & A.			
var. <i>Hookerianus</i> Shear.	x x x x	x x x	x

TABLE 8 (continued)

	A	S	S	S	S	S	S	S	N	D	S	G
	n	C	R	M	N	B	C	Cl	o	e	o	I
CYPERACEAE (Sedge Family)												
<i>Carex pansa</i> Bailey				X							X	
<i>Carex montereyensis</i> Mke.		X									X	
<i>Carex gracilior</i> Mke.		X	X								X	
JUNCACEAE (Rush Family)												
<i>Lazula campestris</i> DC.												
var. <i>congesta</i> Meyer		X	X								X	
LILIACEAE (Lily Family)												
<i>Allium praecox</i> Brandg.		X	X				X	X				X
<i>Brodiaea laxa</i> Jepson								X		X		
<i>Brodiaea capitata</i> Benth.	X	X	X	X	X	X	X	X	X		X	X
<i>Calochortus albus</i> Dougl.												
var. <i>rubellus</i> Greene		X									X	
<i>Calochortus luteus</i> Dougl.		X					X			X		
ORCHIDACEAE (Orchid Family)												
<i>Epipactis gigantea</i> Dougl.		X									X	
<i>Habenaria Michaelii</i> Greene		X	X							X		
<i>Habenaria unalischensis</i> Spreng.							X			X		
URTICACEAE (Nettle Family)												
<i>Hesperocnide tenella</i> Torr.		X					X	X			X	X
POLYGONACEAE (Buckwheat Family)												
<i>Pterostegia drymarioides</i> F. & M.	X	X	X				X	X	X		X	X
CHENOPODIACEAE (Pigweed Family)												
<i>Suaeda californica</i> Wats.		X	X		X		X				X	X
NYCTAGINACEAE (Four O'clock Family)												
<i>Abronia latifolia</i> Esch.				X						X		
PORTULACACEAE (Purslane Family)												
<i>Calandrinia ciliata</i> DC.												
var. <i>Menziesii</i> Macbr.	X	X	X	X			X					X
<i>Calandrinia maritima</i> Nutt.		X	X				X	X			X	X
<i>Montia perfoliata</i> Howell	X	X	X	X	X	X	X	X	X			X
CARYOPHYLLACEAE (Pink Family)												
<i>Stellaria nitens</i> Nutt.		X	X				X	X	X			X
<i>Spergularia macrotheca</i> Heynh.	X	X	X	X			X	X				X
RANUNCULACEAE (Buttercup Family)												
<i>Ranunculus hebecarpus</i> H. & A.							X		X			X
PAPAVERACEAE (Poppy Family).												
<i>Eschscholtzia californica</i> Cham.												
var. <i>maritima</i> Jepson				X						X		

TABLE 8 (continued)

	A n	S C	S R	S M	S N	S B	S C	S C1	N D o	S e	S o	G I
<i>Platystemon californicus</i> Benth.												
var. <i>nutans</i> Brandg.		x	x									x
CAPPARIDACEAE (Caper Family)												
<i>Isomeris arborea</i> Nutt.												
var. <i>globosa</i> Cov.		x	x					x			x	
CRUCIFERAE (Mustard Family)												
<i>Caulanthus lasiophyllus</i> Payson	x	x	x	x	x		x	x	x			x
<i>Lepidium lasiocarpum</i> Nutt.	x	x	x	x	x			x			x	x
<i>Capsella procumbens</i> Fries.											x	x
var. <i>Davidsonii</i> Munz	x	x								x		
RESEDACEAE (Mignonette Family)												
<i>Oligomeris linifolia</i> Macbr.		x	x	x		x	x	x			x	x
CRASSULACEAE (Stone-crop Family)												
<i>Tillaea erecta</i> H. & A. Chile	x	x	x	x		x	x	x	x			x
SAXIFRAGACEAE (Saxifrage Family)												
<i>Lithophragma affinis</i> Gray								x			x	
<i>Lithophragma cymbalaria</i> T. & G.		x	x								x	
<i>Ribes malvaceum</i> Smith	x	x									x	
<i>Ribes Menziesii</i> Pursh.		x									x	
ROSACEAE (Rose Family)												
<i>Holodiscus discolor</i> Maxim		x						x			x	
<i>Rubus vitifolius</i> C. & S.		x	x					x			x	
<i>Potentilla glandulosa</i> Lindl.								x			x	
<i>Potentilla anserina</i> L.		x									x	
<i>Alchemilla cuneifolia</i> Nutt.		x	x					x			x	
LEGUMINOSAE (Pea Family)												
<i>Lupinus nanus</i> Dougl.									x		x	
<i>Lupinus albifrons</i> Benth.	x	x	x	x	x			x	x		x	
<i>Lotus grandiflorus</i> Greene			x						x			x
<i>Lotus scoparius</i> Ottley												
var. <i>Veatchii</i> Ottley	x			x								x
<i>Trifolium amplexens</i> T. & G.		x	x	x	x			x	x	x		x
<i>Trifolium microcephalum</i> Pursh.		x	x	x				x	x	x		x
<i>Astragalus leucopsis</i> Torr.	x	x						x				x
<i>Vicia exigua</i> Nutt.	x	x	x	x	x			x	x	x		x
<i>Lathyrus strictus</i> Nutt.		x	x					x	x			x
POLYGALACEAE (Milkwort Family)												
<i>Polygala californica</i> Nutt.		x									x	
EUPHORBIACEAE (Spurge Family)												
<i>Euphorbia misera</i> Benth.									x			x
ANACARDIACEAE (Sumac Family)												
<i>Rhus laurina</i> Nutt.		x	x					x	x			x

TABLE 8 (continued)

[illegible]

DESERT ELEMENTS

A considerable number of insular plant species have also been reported from the California deserts. Table 8 lists fifteen of these, not including many species of Mexican affinity which also occur in our deserts. Several of these fifteen plants occur only on the islands or the immediate coastal area and then again only in the desert. It may be presumed that the relatively high alkalinity, and the high winds of both maritime and desert habitats produce an environment somewhat alike in these respects. Also precipitation is relatively greater in interior cismontane California than in either maritime or desert areas (U.S. Weather Bureau, 1930) and these plants may not be able to compete successfully with more mesic plants in the intervening area. Whether the incursion of the ocean to the edge of the desert in the Cenozoic (Reed, 1933) and subsequent retreat stranded some of these halic or xeric plants in the desert or whether there was free migration along the margins of this ancient seaway is now impossible to determine. Where so few species are involved no generalization can be established since no satisfactory correlation can be obtained within the range of the probability of error.

Guadalupe relationships. The plants listed in table 8 as occurring also on Guadalupe Island present a similar problem to that of the endemics (p. 303). Guadalupe Island lies nearly two hundred and fifty miles south of San Clemente Island and fifty miles west of Cedros Island and the coast of Baja California. Among the one hundred and sixty-three species of plants reported from Guadalupe (Eastwood, 1929), thirty-five are probably introduced, and ninety-one are to be found on the Channel Islands. It is most remarkable that only two native, non-Californian species are found on both Guadalupe and Cedros. Of the twenty-seven species which occur on both islands ten are probably introduced and fifteen occur on the Channel Islands.

Genera are a better guide in studies of affinity than species alone, especially when the present relationships may have roots in the geologic past. Thus there are nine families and fifty-seven genera of the Guadalupe flora not reported from Cedros by Eastwood (1929), including such outstanding genera as *Polypodium*, *Eschscholtzia*, *Trifolium*, *Ceanothus*, *Epilobium*, *Solanum*, *Castilleja*, *Plantago*, and *Stephanomeria*. On the other hand, eight families and sixty-six genera of the Cedros flora, including such typical Mexican genera as *Ephedra*, *Astragalus*, *Euphorbia*, *Echinocactus*, *Phaseolus*, *Viscainoa*, *Agave*, *Zizyphus*, *Petalonyx*, *Teucrium*, *Acalypha*, and *Echinopepon*, have not yet been

reported from Guadalupe. All of the thirty-five genera common to the two islands are to be found in California. It thus seems logical to conclude that the flora of Guadalupe Island shows a greater affinity with the Channel Islands than with Cedros Island.

The Guadalupe flora appears to be composed of three elements: (1) a large Mexican component, of southern California affinity, part of which is also on Cedros; (2) a large number of ancient *Catalinia* relicts not on Cedros; and (3) a California element, with many plants of northern affinity, common to the Channel Islands and mainland California but not present on Cedros. Insular endemics and *Catalinia* relicts, common particularly to Guadalupe and San Clemente and their common volcanic nature, indicate the possibility of former land connection. Migration of plants by the agency of birds would be possible but it is difficult to understand why they would so exclusively favor the Guadalupe-Channel Islands route to that of the Guadalupe-Cedros. There is a southeastern drift of ocean water along the edge of the continental shelf that might possibly carry drift from the Channel Islands to Guadalupe but with the tendency of the shelf waters to drift shoreward there is at least an equal chance that plants would be carried to Cedros. In this connection it is not probable that seeds or plants of any of the land species would be able to survive ocean transportation for the distance involved.

In view of the trend of the edge of the continental shelf, the extensive banks and submarine ridges lying south and southwest of the Channel Islands, and the great epeirogenic activity which has taken place in this area during past geologic periods, it seems simpler to assume that there may have been land connection sometime between the two regions. Definite geological evidence is, at present, insufficient to lend more than nominal support to this assumption. However, in view of the trend of the submarine ridges, the apparent absence of transverse ranges in Baja California, and the trend of the "Santa Ana Embayment" of the Miocene (Reed, 1933), the suggestion is made that if a land connection ever existed it would most probably have been in the nature of a peninsula reaching south from Catalinia, possibly in the Vaqueros formation of the Miocene. Such a suggestion has been incorporated in the accompanying map of Catalinia, figure 12.

Since the time this study was made there has been considerable oceanographic, taxonomic, and geologic work on the areas including Cedros, Guadalupe and San Clemente. While the author has not been able to review this thoroughly the general impression gained has tended to substantiate these conclusions.

Plant migrations. It seems probable that most of the indigenous island flora is a remnant from the ancient land of Catalinia or reached the islands by land bridges of the early Pleistocene. However, Holder (1910) states that the Indians of the Channel Islands had certain commercial relations with the mainland Indians. It is very possible that there may have been considerable exchange of insular and mainland floras through this intercourse. Millspaugh and Nuttall (1923, p. 220) report possible circumstances by which *Nicotiana glauca* may have been carried to Santa Catalina. In 1902 the chance combination of an east wind with a large grass fire on the adjacent mainland was followed by a greater increase in the number of *Nicotiana* plants the following year. In view of the very small seeds of this species, the updraft from the fire may possibly have carried the seeds high enough for the east wind to have blown them to the island. While no examples have been substantiated, birds have undoubtedly been an agency in carrying seeds from island to island and also from the mainland to the islands, or vice versa.

That plants could be carried to the islands by ocean currents or by prevailing winds seems highly improbable for two reasons: (1) land plants or their seeds rarely survive submergence in salt water; (2) both the prevailing winds and the ocean currents are generally directed shoreward by the configuration of the islands and that of the mainland coast.

Due to the upwelling of bottom waters along the edge of the continental shelf off the coast of California, combined with the general southeastern set of off-shore currents, the water about the islands, probably largely bottom water, is clear and cool. As the prevailing northwest wind passes Point Conception it veers more to the east, following the east-west trend of the Santa Barbara coast. During the late winter and early spring the southeastern drift of the ocean follows the same general course, paralleling the coast. However, Tibby (1939, pp. 13-14) reports that a reverse current seems to develop within the borders of the continental shelf in the vicinity of the Tanner and Cortez Banks, flowing northwesterly about San Clemente and Santa Barbara islands. This current turns east in the Santa Cruz Basin and then south to join the inshore current. Later in the spring the area of this double reverse is increased and the northern drift includes the waters about San Nicolas and the islands of the northern group. During the summer a current, apparently originating far down the Baja California coast, flows northward into the broad gap between Santa Catalina and Anacapa. Here it divides, one branch flowing northwesterly about the northern islands, the other turning toward the coast.

At all times of the year there appears to be a gentle shoreward drift of surface waters toward the southern California coast (Leconte, 1888). Thus driftwood is found on the southern and western beaches of most of the islands, the northwestern on San Miguel, and rarely on the eastern and northern beaches. Such driftwood as is found consists mainly of material from vessels and debris carried to the ocean by the streams of central and northern California. If these conditions have prevailed in past geological periods it is highly improbable that plants could have migrated from the southern California coast to the islands by means of ocean currents.

VI LIFE-FORMS OF ISLAND PLANTS

The life-forms of the island plants seem principally those which best enable the plants to survive the long, unfavorable season of summer and fall. The modifications which have been evolved to meet this unfavorable season are not greatly different, in most respects, from those generally seen in plants of the Mediterranean climate. However, the maritime climate differs definitely from the Mediterranean types present in interior cismontane southern California. Accordingly it may be expected that there will be corresponding differences in the growth forms of the two regions.

Plants adapted to the Mediterranean type of climate are marked by sclerophyllous foliage for trees and shrubs, and by a high percentage of therophytes (annuals), hemicryptophytes (perennial herbs and low suffrutescent semi-shrubs), geophytes (plants with bulbs, tubers, or rhizomes), and chamaephytes (suffrutescent shrubs and low woody shrubs). Maritime plants and those of xeric conditions sometimes develop a succulent form (Raunkiaer, 1934). On the islands a stronger maritime influence, the oceanic type of climate, has accentuated the development of certain of these characteristics. In order to understand better the modifications which have taken place it will be advisable to examine the island forms in some detail.

Very few deciduous shrubs or trees are to be found on any of the islands except Santa Catalina, Santa Rosa, and Santa Cruz. Even here they rarely play a dominant role, and then only in very limited riparian areas. *Populus* and *Salix* are on all three of these islands, and *Acer macrophyllum* is occasionally met on Santa Cruz. Two herbaceous shrubs are exceptions to the hard-wood shrubs and are more typical of moist, subtropical conditions. These shrubs, apparently formerly much more abundant, are *Coreopsis gigantea* and *Lavatera assurgentiflora*.

Coreopsis has very finely divided leaves which wither at the beginning of the dry season, while *Lavatera* has thin, broad, simple, ever-green leaves. *Quercus tomentella*, *Quercus MacDonaldii*, *Ceanothus arboreus*, *Prunus Lyonii*, and *Dendromecon Harfordii* have leaves somewhat larger than those of related mainland species. The larger leaves of these insular endemics are also reminiscent of a warmer and more moist condition in the past.

CHAPARRAL

The chaparral, except for that of the warmer, interior slopes of Santa Cruz, differs from most of the mainland chaparral in its comparative size. Brandegee (1888) has stated that many shrubs of the mainland become arborescent on the islands, apparently owing to effects of the moist sea breezes. The lower evaporation rate, caused by the higher humidity and the lower summer temperature, in places sheltered from the stronger winds would undoubtedly tend to make for a longer growing season. Furthermore, the possibly greater freedom from fires would result in greater longevity. *Quercus dumosa* becomes decidedly arborescent on the islands, growing into small trees which may reach a height of ten meters (33 feet) in favorable localities. *Photinia arbutifolia* and its two varieties, *Cercocarpus betuloides* and its three varieties, *Sambucus coerulea*, *Arctostaphylos diversifolia*, *Ceanothus megacarpus*, and *Rhamnus crocea insularis* are usually arborescent. Many other shrubs, such as *Rhus laurina*, *Rhus integrifolia*, *Malvastrum fasciculatum*, and *Prunus ilicifolia* are very frequently arborescent in form if not in size. Browsing by goats and self-pruning resulting from light deficiency for the lower branches are two of the factors which may contribute to this arborescent form.

On the three larger islands *Quercus tomentella*, *Lyonothamnus floribundus*, and *L. floribundus asplenifolius* develop into trees which may reach fifteen meters (50 feet). On San Clemente *Lyonothamnus* rarely exceeds ten meters (33 feet), and on Anacapa *Quercus* is rarely over six meters (19 feet) in height. On these smaller islands there is less protection from wind as well as a lower annual precipitation.

The average (fire-type) chaparral on the mainland varies from one and one-half to two meters (5 feet), with *Adenostoma* and *Photinia* up to four meters (13 feet) (Cooper, 1922). This agrees with the average height of the chaparral on the southern ridges of Santa Cruz. There is a tall, "unburned" chaparral in favorable locations in the mountains of southern California and northern Baja California. In all

the examples of this examined by the writer the common species were of a distinctly shrubby habit. The semi-arborescent *Quercus dumosa* association of Santa Catalina varies from four to six meters (13-19 feet), approximately the height of the taller mainland chaparral, while the arborescent *Arctostaphylos-Photinia-Quercus* association of Santa Cruz averages between five and eight meters (16-26 feet). On the four larger islands individual examples of *Photinia*, *Sambucus*, *Cercocarpus*, and *Prunus* may reach a height of twelve meters (40 feet), though *Sambucus* is only occasionally a component of the chaparral.

SUFFRUTESCENT PLANTS

The suffrutescent habit is one of the most characteristic features of the insular vegetation and is much further developed than in mainland communities. The winter season on the islands rarely brings frost. Because of the warmer winters and the more moist summers many perennial herbs do not die back to the surface of the ground during the unfavorable seasons. This condition has perhaps been stabilized by the long period of isolation. To illustrate, *Lotus argophyllus* has two varieties, *niveus* and *adsurgens*, which have developed a suffrutescent habit. The suffrutescent species of *Castilleja* which are endemic to areas of maritime climate are *C. foliolosa*, *C. grisea*, *C. hololeuca*, and *C. anacapsensis*. In the genus *Eriogonum* the following species and varieties are suffrutescent: *E. grande*, *E. grande rubescens*, *E. arborescens*, *E. giganteum*, *E. giganteum formosum*, and *E. giganteum compactum*.

Most of the herbaceous perennials on the western headlands are suffrutescent. Here the heavy fogs of summer are driven against the headlands and precipitate an appreciable amount of moisture. On Guadalupe heavy fogs are condensed upon the trees to such an extent that small streams are formed, which are supposed to give rise to some of the few springs of the island (Eastwood, 1929).

It has been shown that wind is probably the most important factor in evaporation on the islands. Wind, however, rapidly loses its velocity as the surface of the ground is approached (Lundegardh, 1931). The upper branches of erect shrubs will dry out from wind but those upper branches, even though dead, usually persist and aid in reducing the wind velocity about the base of a plant. This is well illustrated in the case of *Coreopsis*, whose withered leaves and flower stalks hang about the trunk of the plant until after new foliage has appeared in the winter, and afford a high degree of protection to the trunk and its main branches.

This protection is enhanced by the highly gregarious nature of the plant, which is indicated by the fact that isolated plants rarely reach the height of those in dense colonies.

The desiccating effect of wind on the Channel Islands is great enough to affect some of the plants which, in the interior of the mainland, would normally be shrubs. There is, on the islands, a distinct tendency for the tips of the upper branches to die back during the dry season. This condition is noted in the insular varieties of *Lotus scoparius*, *L. Dendroideus*, *L. Traskiae*, and *L. Veatchii*. *Rubus vitifolius*, *Holodiscus discolor*, and *Sambucus coerulea* also show this same tendency.

Properly included in the group of suffrutescent plants may be certain low, evergreen herbs (Raunkiaer, 1934), such as *Atriplex californica*, *Atriplex leucophylla*, *Astragalus Nevinii*, *A. Traskiae*, *Frankenia grandifolia*, *Heliotropium Curassavicum oculatum*, and *Heuchera maxina*. In addition to these there are many other suffrutescents, both on the islands and the mainland. Again, several of the introduced plants are suffrutescents. Since these last two groups of plants owe their habits to the Mediterranean climate and not primarily to their insular environment they will not be listed at this time.

Suffrutescent plants are especially prevalent in many parts of the Mediterranean region, according to Raunkiaer (1934), and have an important place in his floristic spectrum for that region. Suffrutescents, in addition to those previously mentioned, occurring in areas of maritime climate include the following:

<i>Suaeda californica</i>	<i>Grindelia rubricaulis</i>
var. <i>pubescens</i>	var. <i>robusta</i>
<i>Mirabilis laevis</i>	var. <i>latifolia</i>
var. <i>cedrosensis</i>	var. <i>platyphlla</i>
var. <i>cordifolia</i>	<i>Corethrogyne filaginifolia</i>
<i>Spergularia macrotheca</i>	var. <i>virgata</i>
var. <i>Talinum</i>	var. <i>robusta</i>
<i>Heuchera maxima</i>	var. <i>incana</i>
<i>Lupinus longiflorus</i>	var. <i>latifolia</i>
<i>L. arboreus</i>	<i>Hemizonia clementina</i>
<i>L. Chamissonis</i>	<i>Encelia californica</i>
<i>L. albifrons</i>	<i>Eriophyllum confertiflorum</i>
var. <i>Douglasii</i>	var. <i>trifidum</i>
<i>Erysimum insulare</i>	<i>Malacothrix saxatilis</i>
<i>Cryptantha maritima</i>	var. <i>tenuifolia</i>
<i>Galium catalinense</i>	var. <i>implicata</i>
<i>G. Nuttallii</i>	<i>M. Blairii</i>

ANNUALS

Large areas of the islands are now dominated by therophytes. There are numerous extensive areas that, because of fire, over-grazing, or cultivation, are now occupied almost exclusively by annual species which are usually associated with suffrutescent plants. These annuals are largely introduced grasses and forbs. However, in places exposed to the full sweep of the winds, native annuals are dominant. The following are examples of these native therophytes:

<i>Muhlenbergia microsperma</i>	<i>Plagiobathrys californicus</i>
<i>Lepidium nitidum</i>	var. <i>gracilis</i>
<i>Tillaea erecta</i>	<i>Cryptantha Traskae</i>
<i>Lupinus bicolor</i>	<i>C. intermedia</i>
var. <i>microphyllus</i>	<i>Baeria chrysostoma</i>
var. <i>umbellatus</i>	var. <i>gracilis</i>
<i>Eromocarpus setigerus</i>	<i>B. hirsutula</i>
<i>Gilia multicaulis</i>	<i>Malacothrix indecora</i>
<i>G. dianthoides</i>	<i>M. foliosa</i>
<i>G. Nevinii</i>	<i>M. californica</i>
<i>Salvia columbariae</i>	<i>Amblyopappus pusillus</i>
<i>Plantago insularis</i>	

In open grassy or rocky places on the north exposures of canyons there are such annuals as:

<i>Pterostegia drymarioides</i>	<i>Papaver heterophyllum</i>
<i>Parietaria floridana</i>	<i>Trifolium gracilentum</i>
<i>Montia perfoliata</i>	var. <i>Palmeri</i>
<i>Platystemon californicus</i>	<i>Amsinckia spectabilis</i>
var. <i>nutans</i>	<i>A. intermedia</i>

In all the associations there are many annuals and the majority of introduced plants are of this category.

GEOPHYTES

Geophytes are not extremely abundant on the islands but one species or another is to be found in nearly every locality. While not so frequent as in the "maqui" of the Mediterranean region (Hardy, 1925) they yet form a larger proportion of the island flora than the normal floristic spectrum would predict. Next to annuals they are best adapted to a long, dry period. Most of the forms are geophytes, hemicryptophytes, or endophytes, and may be considered here whether their vegetative buds are actually below the surface of the ground, at the surface, or under

rocks. Other plants, true geophytes or hemicryptophytes, with their propagating buds at or below the surface of the ground, include the following:

<i>Carex praegracilis</i>	<i>Jepsonia malvaefolia</i>
<i>Eleocharis mamillata</i>	<i>Oxalis californica</i>
<i>Juncus balticus</i>	<i>O. pilosa</i>
<i>Allium praecox</i>	<i>Lomatium insulare</i>
<i>Zygadenus Fremontii</i>	<i>L. caruifolium</i>
<i>Bloomeria Crocea</i>	<i>Bowlesia septentrionalis</i>
<i>Brodiaea capitata</i>	<i>Torillis nodosa</i>
<i>B. laxa</i>	<i>Sanicula arguta</i>
<i>B. synandra</i>	<i>S. bipinnatifida Hoffmanii</i>
<i>Calachortus splendens</i>	<i>Conium maculatum</i>
<i>C. catalinae</i>	<i>Berula erecta</i>
<i>C. luteus</i>	<i>Caucaulis microcarpa</i>
<i>Chenopodium californicum</i>	<i>Echinocystis macrocarpa</i>
(often suffrutescent).	<i>Daucus pusillus</i>

FLORISTIC SPECTRUM

TABLE 9

LIFE-FORMS OF SANTA BARBARA ISLAND NATIVE PLANTS

	No. of species	The percentage distribution of the species among the life-forms.									
		S	E	MM	M	N	Ch	H	G	HH	Th*
Santa Barbara I	57	7	0	0	0	5	21	7	10	2	45
Normal Spectrum	400	1	3	6	17	20	9	27	3	1	13

*The initials for the life-forms of 400 plants of the Mediterranean islands, as used by Raunkiaer (1934) are as follows:

S—Stem succulents.

E—Epiphytes.

MM—Mega Mesophanerophytes. Trees or large shrubs, 3-20 m. high.

M—Microphanerophytes. Woody plants 2-8 m. high.

N—Nanophanerophytes. Woody plants ¼-2 m. high.

Ch—Chamaephytes. Vegetative buds not over 25-30 cm. above surface.

H—Hemicryptophytes. Vegetative buds at surface of soil.

G—Geophytes. Vegetative buds in the soil.

HH—Hydrophytes.

Th—Therophytes. Annuals.

The native plants of Santa Barbara Island have been used for the construction of a floristic spectrum to illustrate the relative frequency of the different types of insular life-forms. Exotic plants have not been

included as all but one of the twenty-one introduced plants of Santa Barbara are therophytes. Here also are none of the larger woody shrubs or trees of chaparral and woodland. The small number of native species, however, is fairly representative of the most extensive of the communities of the other islands: i.e. the sea bluffs, the coastal sage brush, and the suffrutescent-grassland community.

The therophyte percentage for both native and exotic annuals is 60 per cent, which compares well with figures for various islands in the Mediterranean Sea as reported by Raunkiaer (1934). The chamaephyte and the geophyte percentages are also exceptionally large as should be the case for a Mediterranean climate. The number of succulents is also large, as would be expected in a dry maritime habitat. On the larger islands the percentages would be slightly altered by the inclusion of many more phanerophytes, yet the spectrum shown here would be roughly typical of the wind-swept areas of all the islands.

VII CONCLUSION

The Channel Islands possess a flora that is distinctive and responsive to the insular environment. Geologists have postulated, during past epochs, the existence of a former land mass (Catalinia) which included the area through which these eight islands are now scattered, and which probably extended farther to the south and west. The evidence presented by the distribution of the indigenous and endemic species of island plants confirms the conclusion of a former common land mass.

The geographic separation from the mainland, the distinctive climate, and certain edaphic factors have brought about a rich endemic flora. In addition many other island plants show minor variations in form.

The direction of the prevailing wind gives an oceanic type of climate, while the dry summers and mild, moist winters are characteristic of the Mediterranean type. The maritime climate of the islands and of a narrow coastal strip of the mainland may be divided into three types upon the basis of the mean annual precipitation and certain characteristics of the vegetation. The climate, subject to the interruption of intermittent cycles, has gradually become drier since the Pleistocene epoch. Tropical subsidence air causes excessively dry periods during the spring and fall.

The alkalinity of many of the island soils, the wind intensity, and the long period of summer aridity have favored the development of succulence and leaf pubescence. The moist, warm winters have probably favored the development of suffrutescence in both herbaceous perennials and shrubs.

There is a definite causal relationship between wind velocity, the mechanical composition of the soil, and the evaporation rate. That is, where the wind velocity is high the soil is coarse and the evaporation rate high, and where the wind velocity is low the soil is finely textured and the evaporation rate low. The wind appears to be the master factor in the distribution and delimitation of the major plant communities.

The pre-Pleistocene flora of the insular area probably contained many plants which migrated there from the mainland during the lower Miocene, when mainland connections have been postulated for the ancient land of Catalinia. Thus the major affinity of the indigenous island plants is with cismontane southern California. There is also a remarkable relationship between the plants of the Channel Islands and those of Guadalupe Island. The pre-Pleistocene flora was greatly enriched, during Pleistocene time, by migrations from the north, at a time when Catalinia was again connected with the mainland. Presumably the islands have not been connected with the mainland since that epoch. The direction of the prevailing winds and the ocean currents render unlikely the migration of mainland plants to the island by those agencies since the separation.

The nature of the native vegetation has been greatly modified by human activities during the last four centuries, but particularly in the past century when the islands were used for grazing. The overgrazing, which was practiced for nearly a century, has been followed by such great erosion by wind and water that, in many areas, the original climax has disappeared. Much of what is now barren sand dunes, wind-eroded uplands, or exotic grasslands was probably once covered by chaparral, coastal scrub, or a mixed community of coarse, native grasses, forbs, and low suffrutescents. Some areas, free from overgrazing for several years, are now dominated by exotic grasses and are being gradually invaded by plants of the mixed community mentioned.

The presence of grazing animals on the islands since the Pleistocene, prior to the occupation of the island by the white man, is doubtful. Many of the weak-stemmed, herbaceous perennials and semi-shrubs once abundant on the islands have been driven out of the areas which can be reached by grazing animals. Most of the introduced plants are from parts of the world possessing maritime or Mediterranean climates, where grazing has been carried on during historic time.

The sea bluffs occupy a considerable part of the insular area and present a variety of habitats. The edaphic conditions are subject to continuous change owing to the unceasing wave erosion. The gradual rise in the ocean level since glacial time has brought new areas under wave

attack. This has resulted in very narrow beaches or steep cliffs and bluffs bordering the islands. The bluffs possess a large number of endemics and shelter many remnants of the indigenous flora. Owing to high wind velocity, the evaporation rates on the bluffs are higher than in the interior of the islands. The soils of the bluffs are shallow and the soil particles coarse. The variety in slope angle and exposure occasions great variation in the communities of the upper slopes. In communities of the shore and splash zone there is less variation because of the predominating influence of the sea.

Canyon, terrace, and hillside communities are differentiated in accordance with the pattern of similarly situated mainland communities, though on the islands the differences are somewhat more sharply accentuated owing to the higher velocities of the island winds. Woodlands exist only in areas protected from wind and the direct rays of the sun, and where the average annual precipitation is over 13 inches, or where there is underground water available. Grasslands occur on fine-textured soils on terraces, gentle slopes, and uplands exposed to moderate winds. In many parts of the grassland, where it has not been too heavily pastured, there are tree, shrub, and semi-shrub savannas. Northerly and southerly exposures of canyons are sharply differentiated in respect to their evaporation rates, plant life-forms, and floristic composition of the plant communities.

The succulent and thickly pubescent plants of the sea bluffs and the trees and shrubs with sclerophyll foliage maintain a more or less uniform appearance throughout the year. Generally, however, the winter is a season of growth, the early spring of flowering, while summer and fall are rest periods. There is little undergrowth in closed communities.

The limitations of this study have left many interesting problems unsolved. Too little time has elapsed since heavy grazing has been discontinued to present a clear picture of the tendencies of plant succession. Furthermore, it is probable that further field work on San Clemente and San Nicolas islands will disclose additional evidence of plant variation. The scope of the present investigation has not included in detail the nature of the physiological and morphological modifications resulting from insular isolation, nor how genetic or environmental factors have influenced variation. Neither has attention been given to modifications which enable many of the plants of sea bluff and headland to maintain growth and vigor during the long dry season.

VIII ANNOTATED LIST OF THE VASCULAR PLANTS OF SANTA BARBARA ISLAND

POLYPODIACEAE

- Polypodium californicum* Kaulf. var. *Kaulfusii* D.C. Eat. California Polypody.
Perennial geophyte. One colony on north exposure of Cave Canyon. Also
on Anacapa and Santa Catalina islands; mainland coast to Marin County.
Endemic to areas of California maritime climate.

NAIADACEAE

- Phyllospadix Torreyi* Wats. Surf Grass.
Marine perennial. In rock channels below low tide level. On all the islands,
including Guadalupe; Indigenous.

GRAMINEAE

- Stipa pulchra* Hitchc. Beautiful Needle Grass.
Suffrutescent perennial. Occasional in low scrub savanna. On all the islands;
Baja California to Central California. Indigenous.

- Muhlenbergia microsperma* (DC) Kunth. Dropseed Grass.
Annual. Southern exposures generally. Also on Santa Cruz, Anacapa, Santa
Catalina, San Clemente, and Guadalupe islands; adjacent mainland and
Mexico. Indigenous.

- Polypogon monspeliensis* (L.) Desf. Rabbitfoot Grass
Annual. One plant in splash zone of Landing Cove. Also on San Miguel,
Santa Rosa, Santa Cruz, San Nicolas, Santa Catalina, and Guadalupe
islands; mainland. Introduced from Europe.

- Avena fatua* L. Wild Oat.
Annual. Dominant in several small areas on eastern terrace. On all the
islands, including Guadalupe; mainland. Introduced from Europe.

- Melica imperfecta* Trin. Small-flowered Melica.
Perennial. Infrequent in shaded canyon bottoms. On all the islands; Baja
California to central California. Indigenous.

- Lamarckia aurea* (L.) Moench. Golden-top.
Annual. Forming small colonies in openings of *Coreopsis* association. On
all the islands, including Prince Island off San Miguel; mainland. Intro-
duced from the Mediterranean region.

- Bromus marginatus* Nees. Margined Brome Grass.
Perennial. Infrequent in canyons. Also on the four northern islands; San
Diego County to British Columbia. Indigenous.

- Bromus rigidus* Roth. Ripgut Grass.
Annual. Infrequent in canyons. Also on San Miguel, Santa Rosa, and Santa
Catalina islands; mainland. Introduced from Europe.

- Bromus rubens* L. Red Brome Grass.
Annual. Locally common in canyons. Also on Santa Rosa, Santa Cruz,
Anacapa, and Santa Catalina islands; mainland. Introduced from Europe.

- Bromus vulgaris* (Hook.) Shear. Narrow-flowered Brome Grass.
Perennial. Infrequent in canyons. Also on San Miguel, Santa Cruz, and
Santa Catalina; mainland north in mountains to British Columbia and
Montana. Indigenous.

- Bromus sterilia* L. Barren Brome Grass.
Annual. Infrequent in canyons. Also on Guadalupe Island; northern Cali-
fornia. Introduced from the Mediterranean region.

- Hordeum murinum* L. Common Foxtail.
Annual. Dominant on terraces and the central ridge. On all the islands;
mainland. Introduced from Europe.

LILIACEAE

- Brodiaea capitata* Benth. Wild Hyacinth.
Geophyte. Widespread on the terraces. On all the islands; mainland to
Oregon. Indigenous.

POLYGONACEAE

Eriogonum giganteum Wats. var. *compactum* Dunkle.

Round-headed Queen Anne's Lace.

Suffrutescent perennial. Locally common on north, south, and east bluffs. Endemic to Santa Barbara and Santa Catalina islands.

Pterostegia drymarioides F. & M.

Maiden-hair Buckwheat.

Annual. Common on eastern bluffs in *Coreopsis* association. On all the islands, including Guadalupe, except San Nicolas; Baja California to Oregon. Indigenous.

CHENOPODIACEAE

Aphanisma blitoides Nutt.

Seaside Blitum.

Annual. Occasional on eastern bluffs and northern canyon exposures, especially in shallow caves. Also on the four northern islands, Santa Catalina, San Clemente, and Guadalupe islands; adjacent mainland coast. Probable relict, endemic to areas of southern California maritime climate.

Chenopodium californicum Wats.

Soap Plant.

Geophyte, occasionally suffrutescent. Common on eastern terraces and in canyons. On all the islands; cismontane southern to central California. Indigenous.

Chenopodium murale L.

Nettle-leaved Goosefoot.

Annual. Common in *Suaeda-Larus* biome and widespread on the ridge, terraces and canyons. On all the islands; mainland. Introduced from Europe.

Atriplex californica Moq.

California Saltbush.

Suffrutescent perennial. Abundant on headlands and bluffs. On all the islands; Baja California to central California. Endemic to areas of California maritime climate.

Atriplex rosea L.

Red Scale.

Annual. Occasional on eastern bluffs. Unreported from the other islands; mainland. Introduced from Europe.

Atriplex semibaccata R. Brown

Australian Saltbush.

Suffrutescent herb. Common on all the terraces. On all the islands; mainland. Introduced from Australia.

Suaeda californica Wats. var. *pubescens* Jepson.

Sea Blite.

Suffrutescent semi-shrub. Widespread on terraces, abundant in nesting places of *Larus occidentalis* Audubon, the Western Gull. On all the islands; mainland coast from Baja California to central California. Endemic to areas of California maritime climate.

NYCTAGINACEAE

Mirabilis laevis (Benth.) Curran.

Four O'clock.

Suffrutescent perennial. Locally common on southern breaks and talus slopes. Also reported on Santa Rosa, Santa Cruz, and Santa Catalina; dry canyon slopes and washes on mainland. Taxonomic status uncertain. Indigenous.

AIZOCEAE

Mesembryanthemum crystallinum L.

Ice Plant.

Succulent annual, but apparently perennial in the large colonies. On all the islands; mainland coast. Introduced from Africa.

Mesembryanthemum nodiflorum L.

Small-leaved Ice Plant.

Succulent annual. Widespread on the terraces with small, closed colonies. On all the islands; mainland coast. Introduced from the Mediterranean region and Africa.

PAPAVERACEAE

Platystemon californicus Benth. var. *ciliatus* Dunkle.

Pigmy Cream Cup.

Annual. One colony on windswept northern bench, in coarse, shallow soil. Endemic to Santa Barbara Island.

Eschscholtzia elegans Greene.

Island Poppy.

Annual. A single plant on south exposure of Cave Canyon. On all the islands, including Guadalupe. Insular endemic.

Papaver heterophyllum (Benth.) Greene.

Wind Poppy.

Annual. A single report for Santa Barbara, by Bond. On all the islands except San Nicolas; mainland. Indigenous.

PORTULACACEAE

- Calandrinia maritima* Nutt. Sea Kisses.
Annual. Occasional on northern and eastern bluffs. Also on Santa Rosa, Santa Cruz, and Santa Catalina islands; mainland coast to Baja California. Endemic to areas of southern California and Baja California maritime climate.
- Montia perfoliata* (Donn.) Howell. Miner's Lettuce.
Annual. Infrequent on north exposures of canyons. On all the islands; mainland from Mexico to British Columbia and Utah. Indigenous.

CARYOPHYLLACEAE

- Spergularia macrotheca* (Hornem.) Heynh. Sand Spurrey.
Perennial herb. Occasional on terraces and the central ridge. On all the islands; mainland coast. Endemic to areas of California maritime climate.
- Silene gallica* L. Windmill Pink.
Annual. Common and widespread on terraces and bluffs. On all the islands; mainland. Introduced from Europe.

CRUCIFERAE

- Lepidium nitidum* Nutt. Common Peppergrass.
Annual. Common on the ridge and sea bluff breaks. On all the islands; mainland to desert and to Washington. Indigenous.
- Brassica nigra* (L.) Koch. Black Mustard.
Annual. A single plant by trail on eastern terrace. Also on Santa Cruz, Santa Catalina, and San Clemente islands; mainland. Introduced from Europe.

CRASSULACEAE

- Tillaea erecta* Gaertn. Baby Fuzz.
Annual. Common on western breaks. On all the islands, including Guadalupe, except Anacapa; mainland to Oregon; Chile. Origin uncertain, but possibly introduced very early from Chile.
- Echeveria Greenei* (Rose) Berger. Greene's Echeveria.
Succulent perennial. Locally common on southern bluffs. Santa Rosa and Santa Cruz islands also. Taxonomic status uncertain. Insular endemic.
- Echeveria albida* (Rose) Greene. White-flowered Echeveria.
Succulent perennial. Local and rare on western bluff. Also on San Clemente, Santa Catalina, and Prince islands. Taxonomic status uncertain; if *E. Traskae* Berger is valid, this yellow-flowered form is limited strictly to Santa Barbara Island. Insular endemic.

LEGUMINOSAE

- Medicago hispida* Gaertn. Bur Clover.
Annual. Eastern terraces and bluffs. On all the islands; mainland. Introduced from Europe.
- Trifolium tridentatum* Lindl. Three-toothed Clover.
Annual. Occasional on eastern bluffs. On all the islands except San Nicolas and Anacapa; mainland north to British Columbia. Indigenous.
- Trifolium gracilentum* T. & G. var. *Palmeri* (Wats.) McDer. Palmer's Island Clover.
Annual. Occasional on eastern breaks and north canyon exposures. Also on Santa Cruz, San Clemente, Santa Catalina, San Nicolas, and Guadalupe islands. Insular endemic.
- Trifolium microdon* H. & A. Butterfly Clover.
Annual. Occasional on the terraces. Also on Santa Cruz, Santa Catalina, and San Nicolas islands; central California to British Columbia; Chile. Origin uncertain.
- Lotus argophyllus* (Gray) Greene var. *ornithopus* (Greene) Ottley. Silvery Clover.
Suffrutescent perennial. Occasional on southern bluffs and southern canyon exposures, with one plant on western cliff break. The form here is similar to the San Nicolas form (*Hosackia venusta* Eastw.) which has peduncles .5-1.5 mm. long. The variety *ornithopus* has many variants on the islands and the taxonomic status of the different forms is, as yet, involved and uncertain. Insular endemic.

Astragalus Traskiae Eastw.

Trask's Astragalus.

Suffrutescent perennial. Common on western and northern, wind-swept breaks of the ridge and western bluffs. Also on San Nicolas and San Clemente islands. *A. Nevinii* Gray and *A. leucopsis* (T. & G.) Torr. have also been reported from Santa Barbara but not verified. Insular endemic.

GERANIACEAE

Erodium Botrys Bertol.

Broad-leaf Filaree.

Annual. Reported only by Bond. Also on Santa Rosa Island; mainland. Introduced from Europe.

Erodium cicutarium (L.) L'Her.

Red-stemmed Filaree.

Annual. Abundant on terraces, the ridge, and bluffs. On all the islands; mainland. Introduced from Europe.

Erodium moschatum (L.) L'Her.

White-stemmed Filaree.

Annual. Occasional on northern canyon exposures. On all the islands, except Anacapa; mainland. Introduced from Europe.

MALVACEAE

Malva parviflora L.

Cheese-weed.

Annual. Widespread and locally abundant on terraces, the ridge, and headlands. On all the islands except Anacapa; mainland. Introduced from Europe.

CACTACEAE

Opuntia prolifera Engelm.

Coast Cholla.

Succulent shrub. Common on southern, eastern, and western bluffs. On all the islands, including Guadalupe, except San Miguel and Santa Cruz islands; mainland coast south to Baja California. Probable element of early Mexican invasion; endemic to areas of southern California and Baja California maritime climate.

Opuntia littoralis (Engelm.) Cockerell.

Coast Prickly Pear.

Succulent shrub. Common on eastern terrace and southwestern bluffs. On all the islands; mainland south to Baja California. Probably of Mexican affinity; endemic to areas of southern California and Baja California maritime climate.

ONAGRACEAE

Oenothera cheiranthifolia Hornem.

Beach Primrose.

Perennial herb. Reported only by Hemphill. Also on San Nicolas, San Miguel, Santa Rosa, and Santa Cruz islands; mainland coast from Surf north to Oregon. Indigenous.

CONVOLVULACEAE

Convolvulus occidentalis Gray var. *macrostegius* (House) Munz.

Giant Morning Glory.

Suffrutescent climber. Common on eastern terrace and canyons, in *Coreopsis* association, and on southern bluffs. Reported from all the islands, but only common and well developed on the southern islands, including Guadalupe. Insular endemic.

POLEMONIACEAE

Gilia gilioides (Benth.) Greene.

Blue Star Gilia.

Annual. Occasional on northern canyon exposures and northern breaks. Also on Santa Cruz, Santa Catalina, San Clemente, and Guadalupe islands; mainland north to Oregon and east to Nevada. Indigenous.

HYDROPHYLLACEAE

Nemophila racemosa Nutt.

Pale Nemophila.

Annual. Occasional on northern exposures of canyons. Also on Santa Cruz, Santa Catalina, San Clemente, and Guadalupe islands; mainland coast to Baja California. Endemic to areas of southern California and Baja California maritime climate.

Phacelia floribunda Greene.

Flowery Phacelia.

Annual. Common in shaded parts of canyons. Also on San Clemente and Guadalupe Islands. Intergrading with *P. hispida* Gray on Santa Barbara. Insular endemic.

Phacelia hispida Gray

Hairy Phacelia.

Annual. Occasional in canyon bottoms, and northern exposures, intergrading with the preceding. Also on Santa Rosa, Santa Cruz, and Anacapa islands; mainland to Baja California. Indigenous.

BORAGINACEAE

Amsinskia intermedia F. & M. (*A. sanctae barbara* Brand.)

Coast Fiddleneck.

Annual. Common on eastern terrace in grassland. Also on the four larger islands; mainland from Baja California and Arizona northward through California. A variable species that undoubtedly includes many insular segregates. Indigenous.

Cryptantha Clevelandii Greene var. *hispidissima* (Greene) Johnston.

Hairy Cryptantha.

Annual. Infrequent on northern exposures of canyons. Also on Santa Rosa, Santa Cruz, San Miguel, San Clemente and Guadalupe islands; mainland. Indigenous.

Cryptantha maritima Greene.

Pin-cushion Cryptantha.

Suffrutescent perennial. Occasional on southern bluff breaks. Also on Santa Catalina, San Clemente, San Nicolas, and Guadalupe islands; mainland to Arizona and Baja California. Indigenous.

Cryptantha intermedia (Gray) Greene.

Common Cryptantha.

Annual. On eastern terrace in cactus clumps. Also on the four larger islands; mainland from Baja California to northern California. Indigenous.

Cryptantha Traskae Johnston.

Trask's Cryptantha.

Annual. Occasional on ridges. Also on San Nicolas Island. Insular endemic.

SOLANACEAE

Lycium californicum Nutt.

Coastal Box Thorn.

Suffrutescent shrub. Widespread and frequently dominant on all terraces, southern bluffs, and western headlands; frequently a component of the *Suaeda-Larus* biome. Also on other southern islands; mainland coast to Baja California. Endemic to areas of southern California and Baja California maritime climate.

PLANTAGINACEAE

Plantago insularis Eastw.

Island Plantago.

Annual. Occasional on southern bluffs. Also on the other southern islands; adjacent mainland coast. Endemic to areas of southern California maritime climate.

CUCURBITACEAE

Echinocystis macrocarpa Naud.

Common Man-root.

Climbing geophytic herb. Abundant in canyons and on eastern bluffs. On all the islands; mainland to edge of desert. Indigenous.

COMPOSITAE

Heliantheae

Coreopsis gigantea (Kell.) Hall.

Giant Coreopsis.

Suffrutescent shrub with fleshy trunk. Common in all but the most extremely wind-swept areas; dominant on the lower eastern terrace, bluffs, and canyons. Undoubtedly dominant over more extensive areas before cultivation of the terraces. On all the islands, including Guadalupe; adjacent mainland coast. Endemic to areas of southern California maritime climate.

Madieae

Hemizonia clementina Brandg.

Island Bush Tarweed.

Suffrutescent shrub. Forma *prostrata*, a low prostrate form with short internodes, abundant on main ridge and southern breaks. Forma *erecta*, a small, rounded shrub with erect branches and long internodes, common on the breaks of the eastern bluffs. *H. clementina* also on Anacapa, and the other southern islands, with related species on Guadalupe Island. Insular endemic.

Hemizonia fasciculata (DC) T. & G. var. *ramosissima* (Benth.) Gray.

Slender Tarweed.

Annual. Common on eastern terrace. Also on Santa Catalina and San Clemente islands; adjacent mainland coastal areas. Taxonomic status uncertain. Probably indigenous.

*Helenieae**Perityle Emoryi* Torr.

Cliff Daisy.

Annual. Common on talus slope of southern bluffs and at upper edge of splash zone. On all the islands, Except San Nicolas; mainland to Mexico. Closely related forms on Guadalupe Island. Indigenous.

Baeria chrysostoma F. & M. var. *gracilis* (DC) Hall.

Gold Fields.

Annual. Occasional in shallow soil of exposed ridges. On all the islands, including Guadalupe; mainland throughout California to edge of desert. Indigenous.

Baeria hirsutula Greene.

Succulent Gold Fields.

Annual. Abundant on rounded, windy breaks and headlands. Also on Santa Catalina, Santa Rosa, Santa Cruz, and San Miguel islands; coastal central California. Endemic to areas of California maritime climate.

Eriophyllum Nevinii Gray.

Island Dusty Miller.

Low suffrutescent shrub. Occasional on upper part of splash zone; also on the two adjacent islets. Also on Santa Catalina and San Clemente islands, with a related form on Guadalupe Island. Insular endemic.

Amblyopappus pusillus H. & A.

Coquimbo.

Annual. Abundant on southern bluff breaks, the central ridge, and eastern terrace. On all the islands, including Guadalupe; adjacent mainland coast; South America. Origin uncertain, possibly a very early introduction.

*Anthemideae**Achillea millefolium* L. var. *lanulosa* (Nutt.) Piper.

Yarrow.

Suffrutescent perennial. Common and widespread on terraces and northern exposures. On all the islands; mainland from Mexico to British Columbia. Closely approaches var. *maritima* Jepson, and taxonomic status in view of later revisions of species. Maritime variant of a cosmopolitan complex.

Artemisia californica Less var. *insularis* (Rybd.) Munz.

Island Sage Brush.

Suffrutescent woody shrub. Common and widespread on eastern terraces, southern exposures of canyons, and southern bluffs. Also on San Nicolas and San Clemente islands.

*Cichorieae**Malacothrix foliosa* Gray.

Lava Daisy.

Annual. Abundant on windy breaks and headlands. Also on Santa Cruz and San Clemente islands. Insular endemic.

Sonchus oleraceus L.

Sow Thistle.

Annual. Common and widespread in all parts of the island. On all the islands; mainland. Introduced from Europe.

GLOSSARY

- Abundant*—A frequency term which indicates that the individuals of a species constitute a large fraction of all the plants within a specified area.
- Adaptation*—The structural responses which plants develop on becoming adjusted to changed environmental conditions.
- Adiabatic*—A change of atmospheric temperature in consequence of compression or expansion accompanied by an increase or decrease of atmospheric pressure.
- Anemometer*—An instrument measuring the rate of flow of air past a given point.
- Arborescent*—Tree-like in form or size, or both form and size.
- Association*—A plant community with definite physiognomy, ecological structure, and general uniformity of floristic composition; showing climax adjustment to a particular complex of environmental conditions.
- Atmometer*—An instrument for measuring the rate of evaporation from a saturated surface.
- Biome*—A community composed of both plants and animals.
- Biotic*—Referring to such environmental factors as result from the interrelations of living organisms.
- Bluff*—A cliff or a headland, consisting of a broad, steep face, usually with a rounded break at the summit.
- Break*—A change of direction in the slope angle at the summit of a cliff or bluff.
- Breccia*—A rock composed of angular fragments united by a matrix.
- Chamaephytes*—Low shrubs or semi-shrubs with perennial stems that are woody at the base and whose propagating buds for the next season are not over 30 cm. above the surface.
- Cismontane*—In southern California it refers to the area between the main interior mountain masses and the coast, that is, the area draining directly to the ocean.
- Cliff*—A high, steep rock or bank, used here to refer to nearly perpendicular slopes which have an angular break at the summit.
- Colony*—A group of one or more species of plants which has developed as an immediate consequence of invasion.
- Common*—A frequency term indicating that the species may be found without difficulty in a specified area.
- Constancy*—The consistent presence of a species in different parts of a given area, or in different examples of a plant association.
- Corrasion*—Refers to the action of surface wear by physical processes, as by the impact of solid particles driven by wind or water; distinguished from corrosion, which is a process of chemical wear.
- Desiccation*—The drying out of a region by increased aridity; the drying out of a plant at the end of the growing season.
- Dominant*—The plant species, one or more, exerting control over the habitat, usually the largest and most frequent species.
- Ecesis*—The establishment of a plant species in a new area, involving migration, germination, development, and repeated reproduction.
- Edaphic*—All characteristics of the substratum in which plants grow.
- Endemic*—A plant whose natural distribution is limited to a certain area, or a few nearby areas, used here in a relative sense.
- Epeirogeny*—The process of the surface adjustment of large areas by vertical uplift or depression, operating over a long period of time.
- Exotic*—A plant which has been introduced into an area where it is not native.
- Facies*—A portion of a community in which one or more dominants have been replaced by other species, the general aspect of the community remaining unchanged.
- Feral*—Untamed or uncultivated; referring here to an animal which has reverted from the domesticated state.
- Floristic*—Relating to the species and other taxonomic categories of plants in a given community.
- Forb*—A general term for all herbaceous plants which are not grasses.

- Formation*—Vegetation occupying a natural area characterized by rather uniform climatic or edaphic conditions, having a more or less physiognomy, but with communities of different floristic composition, these last being sometimes termed the plant associations of the formation.
- Geophyte*—A perennial plant whose propagating organs for the growing season lie below the surface of the earth, as in bulbs, corms, tubers, and many rhizomes.
- Halophyte*—A plant which grows on saline or alkaline soil.
- Hemicryptophyte*—A perennial plant with its propagating organs at the surface of the soil, as in the case of many rhizomes, herbs with a tap root, and certain low suffrutescents.
- Hydrotherm*—A combination of two graphs showing precipitation and temperature at stated intervals in a given locality.
- Hygrograph*—An instrument producing a continuous record of relative humidity for a certain period.
- Hydrophyte*—A plant which lives in the water or in wet or saturated soils.
- Hygro-thermogram*—A combination of two graphs showing both temperature and relative humidity for a specified time in a given locality.
- Indigenous*—Native to a given area; not introduced.
- Initial endemic*—A plant species of recent origin and not spread beyond a very limited area, because of lack of time or difficulty in migration, or both.
- Isohyet*—A line indicating areas of equal precipitation.
- Local*—A frequency term indicating that a given plant species may be found in one or only a very few parts of a given area.
- Limiting factor*—A condition that limits the development of a plant species or of a plant community.
- Master factor*—One, of the paramount environmental conditions exerting more or less of a controlling influence over a type of vegetation.
- Megaphanerophyte*—A tree over 30 meters (100 feet) high; most forest trees.
- Mesophanerophyte*—A tree or large shrub 8 to 30 meters (25 to 100 feet) high; most trees or large shrubs of woodlands or savannas.
- Microphanerophyte*—A shrub or small tree 2 to 8 meters ($6\frac{1}{2}$ to 25 feet) high; most shrubs of the chaparral.
- Nanophanerophyte*—A woody plant $\frac{1}{4}$ to 2 meters (10 inches to $6\frac{1}{2}$ feet) high; most shrubs of the coastal sage brush, fire-type chaparral, and desert shrub.
- Nearctic region*—An obsolescent term referring to North America as far south as Mexico.
- Normal spectrum*—A list of percentages of the life-forms of Raunkiaer which is supposed to represent their proportions under the average conditions for the entire world. This is used as a norm with which to compare the biological spectrum of any region, the important feature being the amount of deviation of that region from the normal.
- Orogeny*—The process of mountain building, characterized by tangential stresses operating for periods of relatively short duration geologically.
- Occasional*—A frequency term used to indicate that a given plant species is relatively uncommon and that it might not be found without considerable search.
- Rain shadow*—An area to leeward of an elevation, with less precipitation than occurs on the windward side.
- Relict endemic*—A plant species of more general distribution in the geologic mass, whose range has been restricted by changing environmental conditions, to one locality, or a few nearby communities.
- Riparian vegetation*—Vegetation growing along streams or rivers.
- Savanna*—Grassland with trees or shrubs growing well separated or in small groups.
- Sclerophyll*—A term referring to the foliage of vegetation found in climatic regions with arid summers; leaves evergreen, reduced in size, and more or less thickened and coriaceous.
- Scrub*—Any community in which shrubs, suffrutescents, or dwarf trees dominate.
- Sere*—A plant succession.
- Society*—A plant assemblage within an association, consisting of subordinate species which have assumed temporary dominance.

Suffrutescent—Perennial plants in which the upper parts of the branches die back during an unfavorable season, but at least the lower part of the stem or stems is more or less woody and perennial.

Therophyte—An annual plant, dying at the close of a single growing season.

Thermograph—An instrument for producing a continuous record of temperature during a certain time in a given locality.

Tolerant—A term referring to the ability of a plant to withstand unfavorable elements of its environment; as shade tolerant, lime tolerant, etc.

Troposphere—That part of the earth's atmosphere in which there is a regular decrease of temperature with increasing altitude; below about 11 kilometers (37,000 feet).

Tufa—A rock composed of indurated volcanic ash.

Widespread—A term applying to plants which occur in many parts of a given area, but not abundant in any part.

Woodland—Vegetation composed predominately of tree life-forms, growing in an open condition without a closed or interlacing canopy.

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FIGURE 1

The Channel Islands of southern California

(Taken from U.S. Coast and Geodetic Survey Chart 5020) depths
indicated in fms.

FIGURE 2

The Channel Islands of southern California

showing relative areas. The southern islands have been shifted west 30° north as indicated, adapted from U.S. Coast and Geodetic Survey Charts 5202 and 5101A.

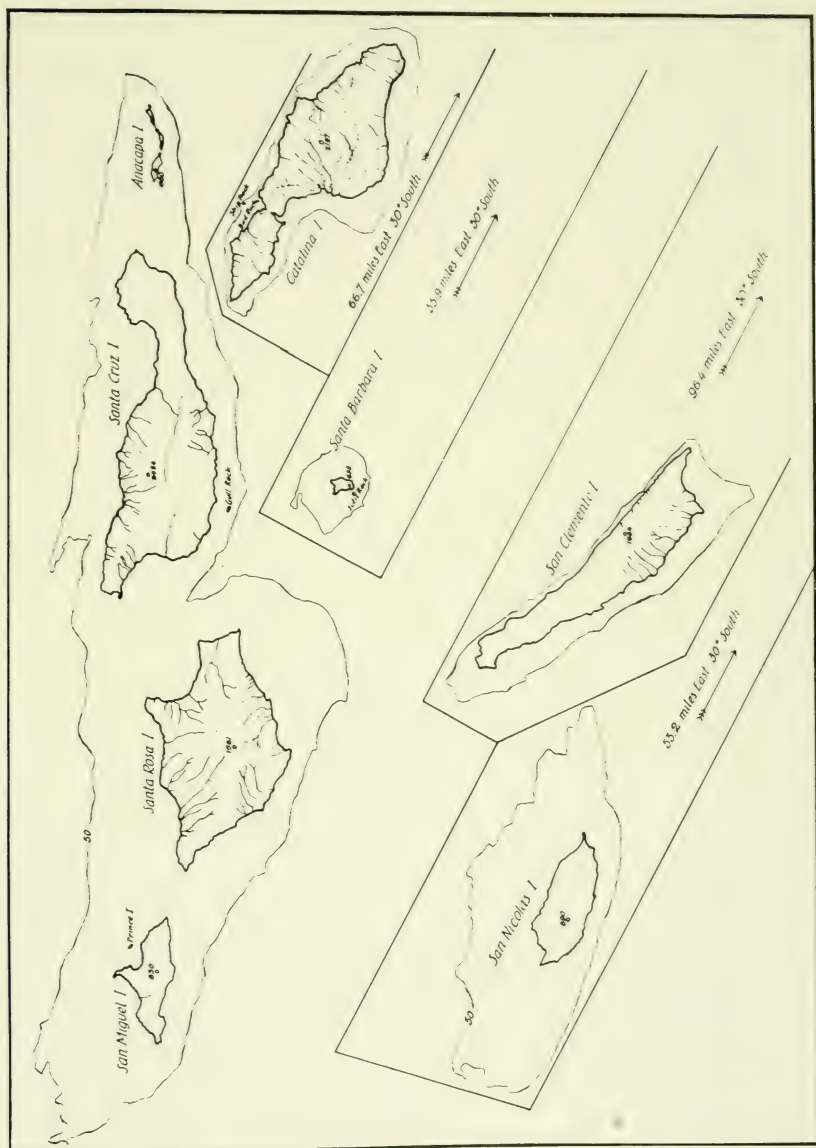


FIGURE 3

Approximate limits of maritime Mediterranean climates in California north of upper dash line represents semi-humid maritime. Between dash lines represents arid maritime. South of lower dash line represents desert maritime.

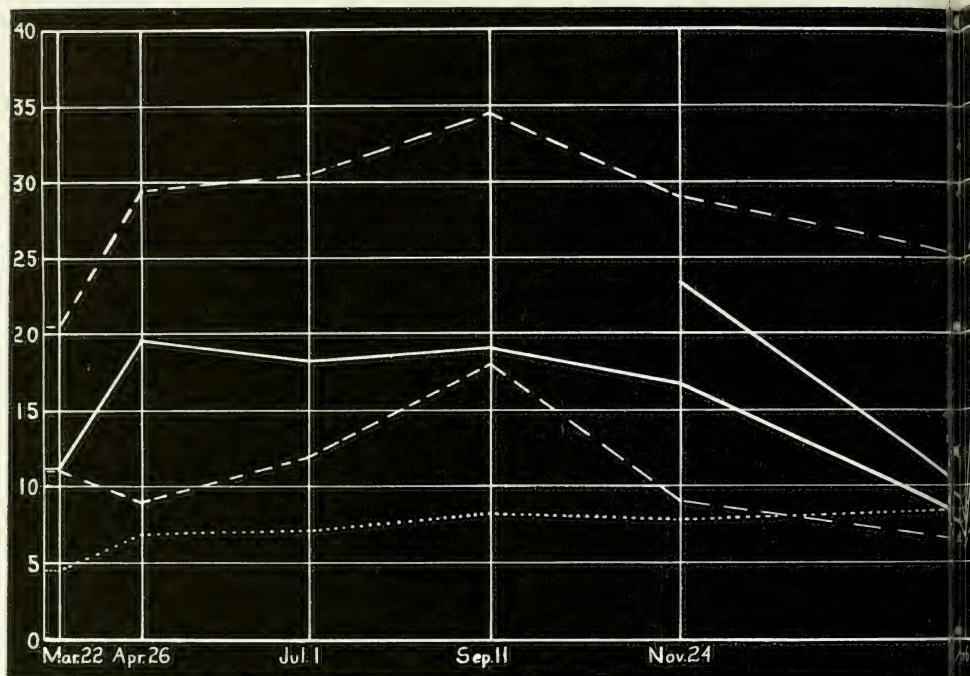
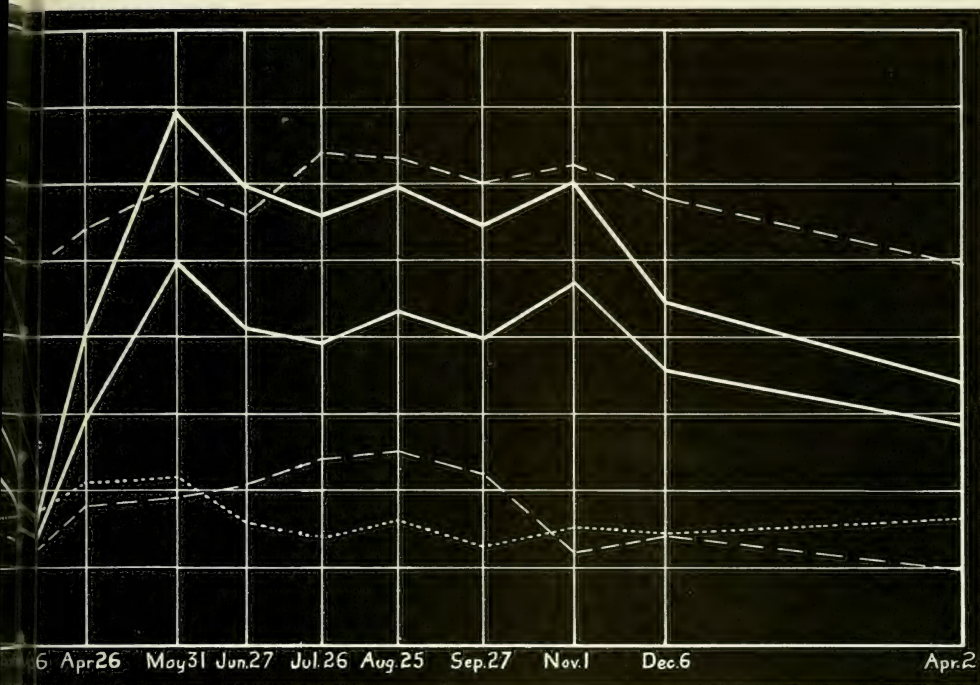


FIGURE 7

Instrumental records for Station A1, on the east bluff of Santa Barbara Island. Solid lines represent average daily evaporation, the upper line of black-cup atomometers, the lower of white-cup atomometers. Dash lines represent temperature, the upper line maximum temperatures, the lower, the minimum temperatures.



Dotted line represents average hourly wind velocity.

Numbers represent (1) cubic centimeters, (2) degrees centigrade, (3) miles per hour.

FIGURE 4

Hydrotherm for the Channel Islands

Numbers on the chart represent degrees Centigrade and centimeters of precipitation. The initials are of the months beginning with April.

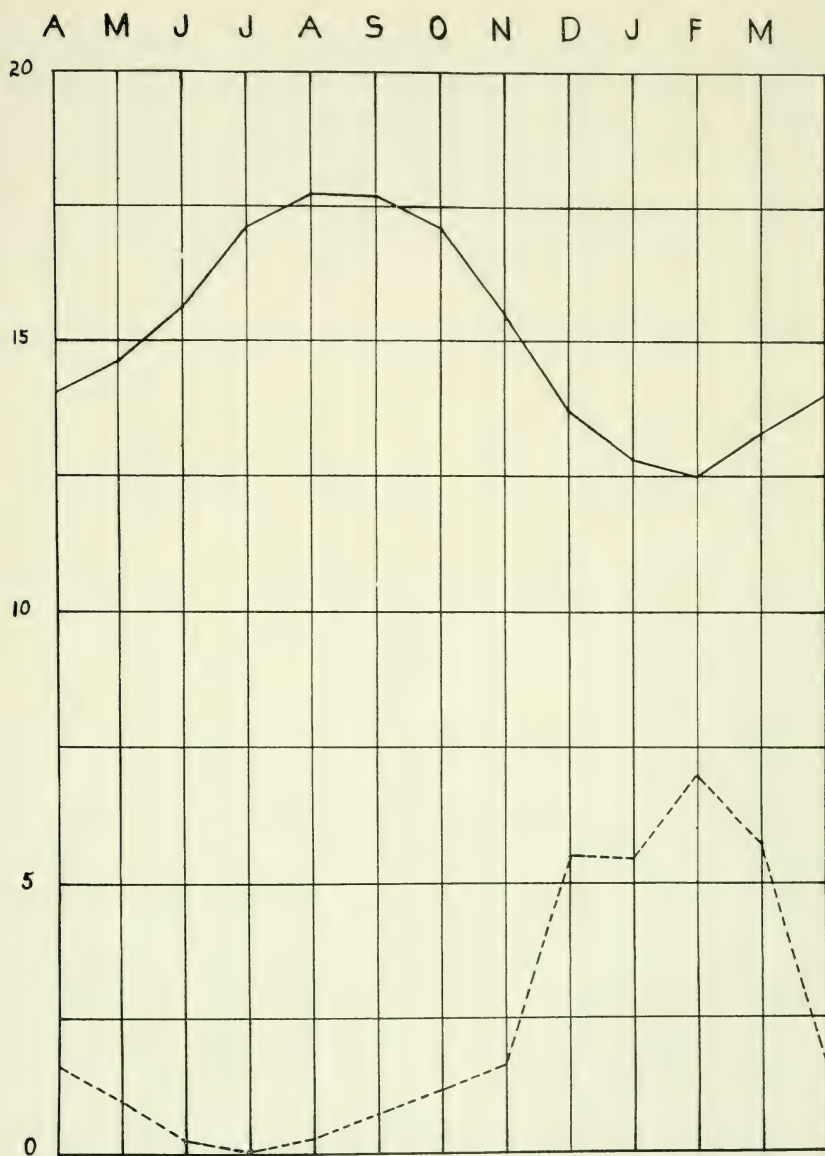
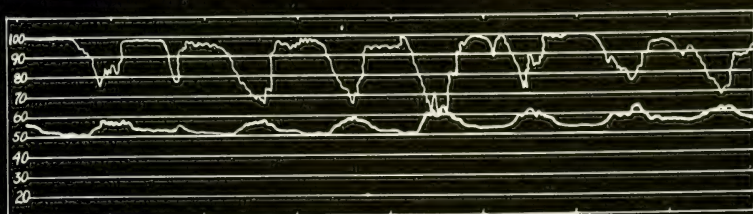


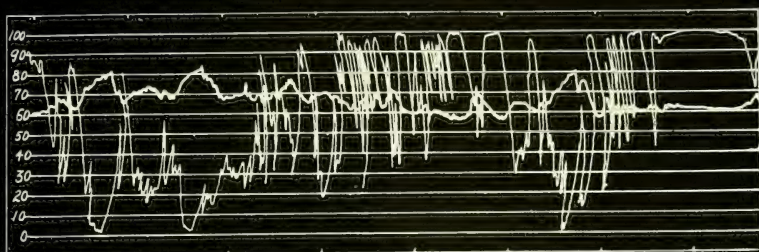
FIGURE 5

Selected hydro-thermograph records for Santa Barbara Island, 1941.

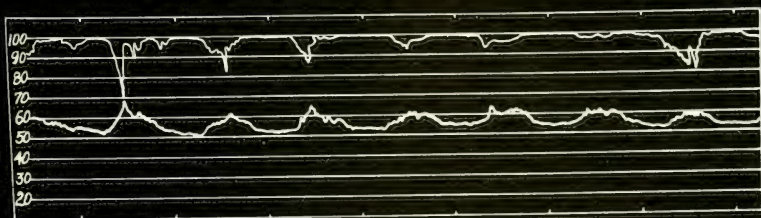
Numbers represent per cent of relative humidity and degrees Fahrenheit. Thin line represent relative humidity, heavy lines represent temperature.



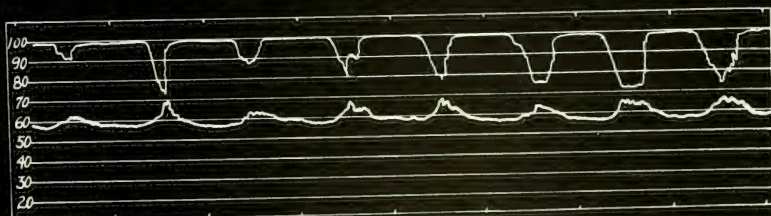
Week of April 6 to 13



Week of May 4 to 11



Week of May 31 to June 7



Week of July 2 to 9

FIGURE 6

Selected hydro-thermograph records for Santa Barbara Island, 1941.

Numbers represent per cent of relative humidity and degrees Fahrenheit. Thin lines represent relative humidity, heavy lines represent temperature.

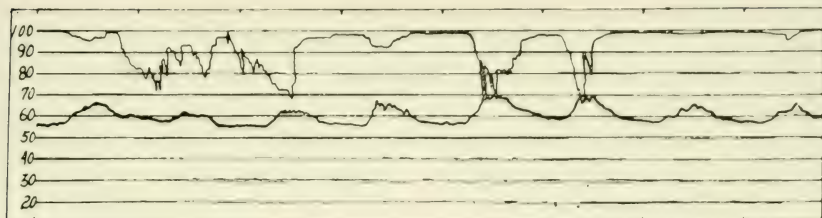
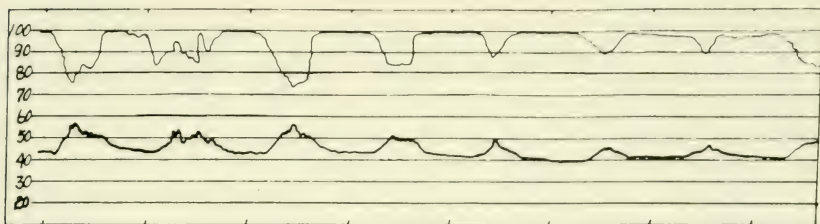
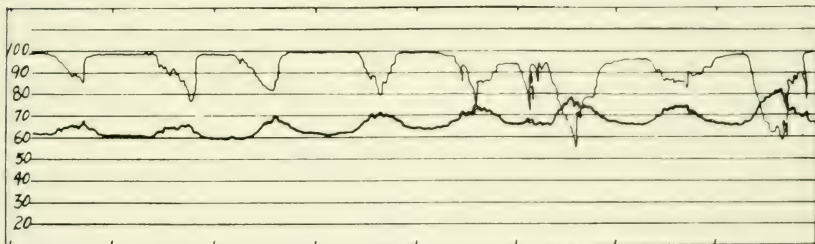
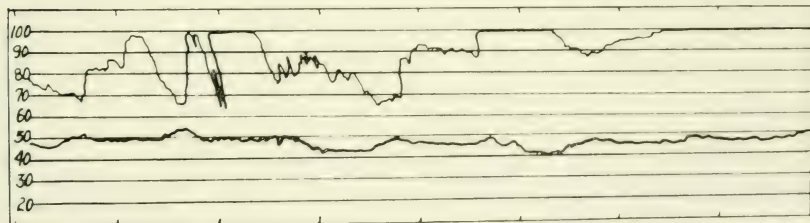
*Week of August 3 to 10**Week of September 1 to 8**Week of November 2 to 9**Week of December 21 to 28*

FIGURE 8

Comparison of evaporation rates with black-cup and white-cup atmometers on the southern and northern exposures of a canyon.

Station B1, southern exposure—solid lines

Station B2, northern exposure—dash lines

Upper solid and upper dash lines show average daily evaporation of black-cup atmometers.

Lower solid and dash lines show average daily evaporation of white-cup atmometers. Numbers represent cubic centimeters.

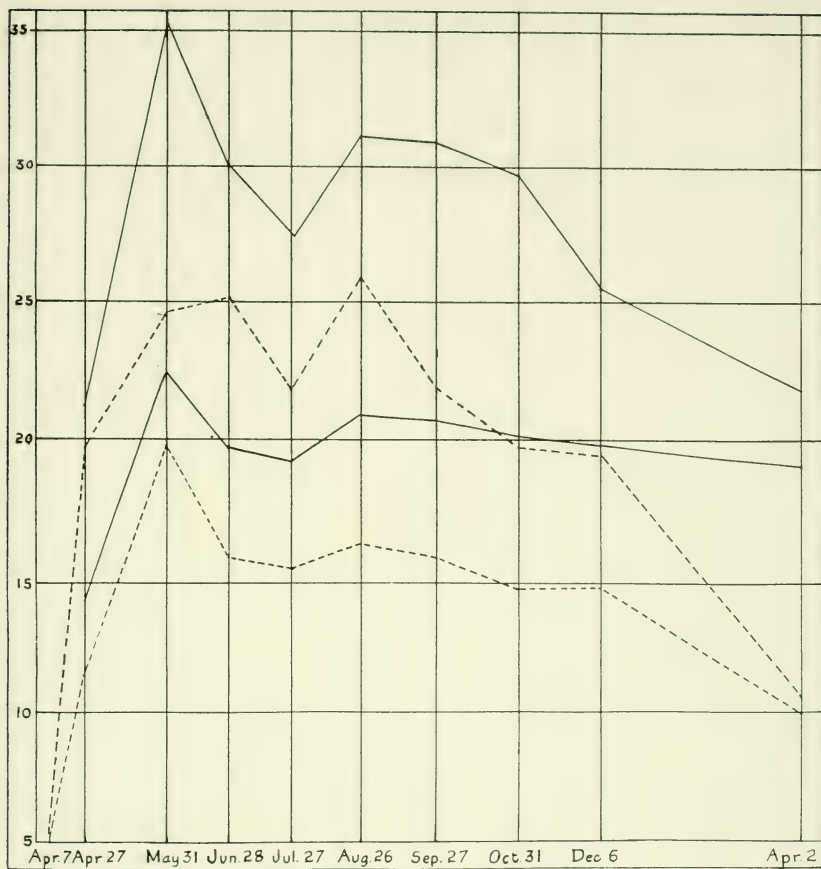


FIGURE 9

Santa Barbara Island, showing distribution of vegetation communities.

- o o *Coreopsis* association.
- .. *Mesembryanthemum crystallinum* colonies.
- vv *Lycium californicum* societies.
- *Astragalus-Baeria-Malacothrix* community.
- — Sea bluff break community.
- xx *Suaeda-Larus* Biome.
- ● *Opuntia littoralis*.
- nn *Echeveria-Eriogonum-Eriophyllum* community.
- blank Grassland.

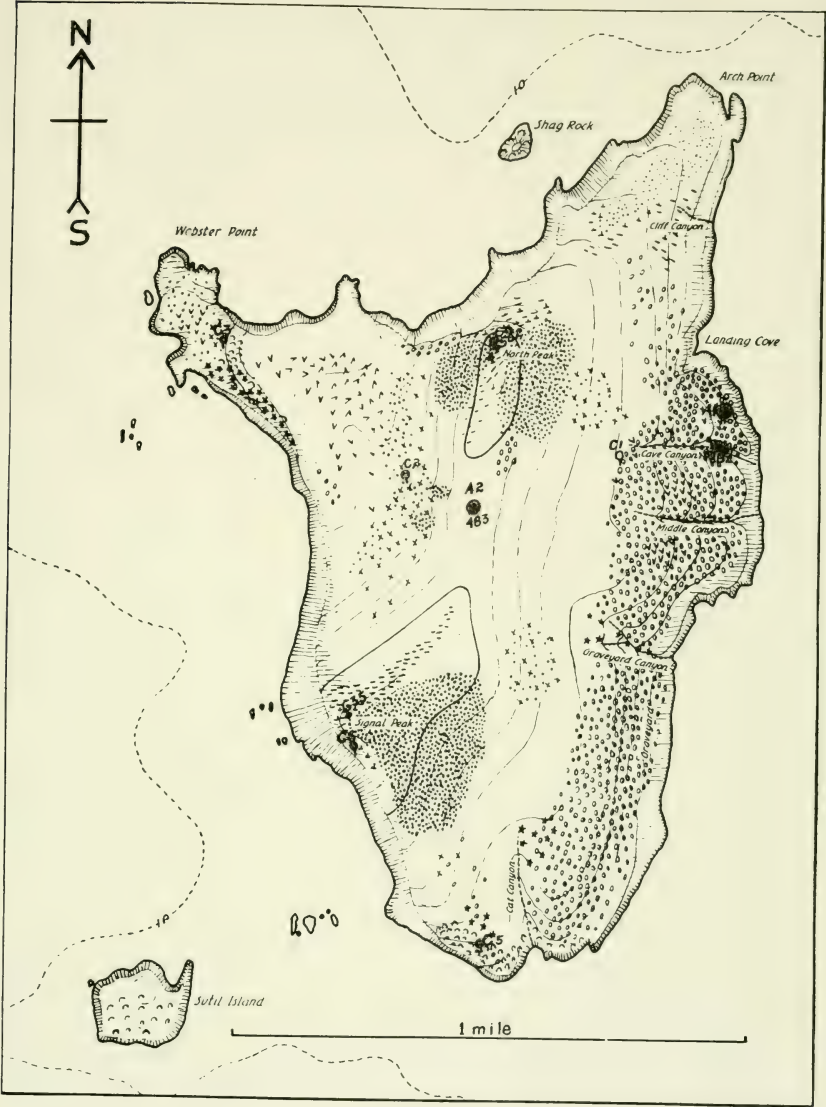


FIGURE 10

North-south profile of Santa Barbara Island with evaporation rates.

Profiles through south peak, north peak, and east terrace.

Evaporation given in even hundreds.

Evaporation given in average cubic centimeters per day.

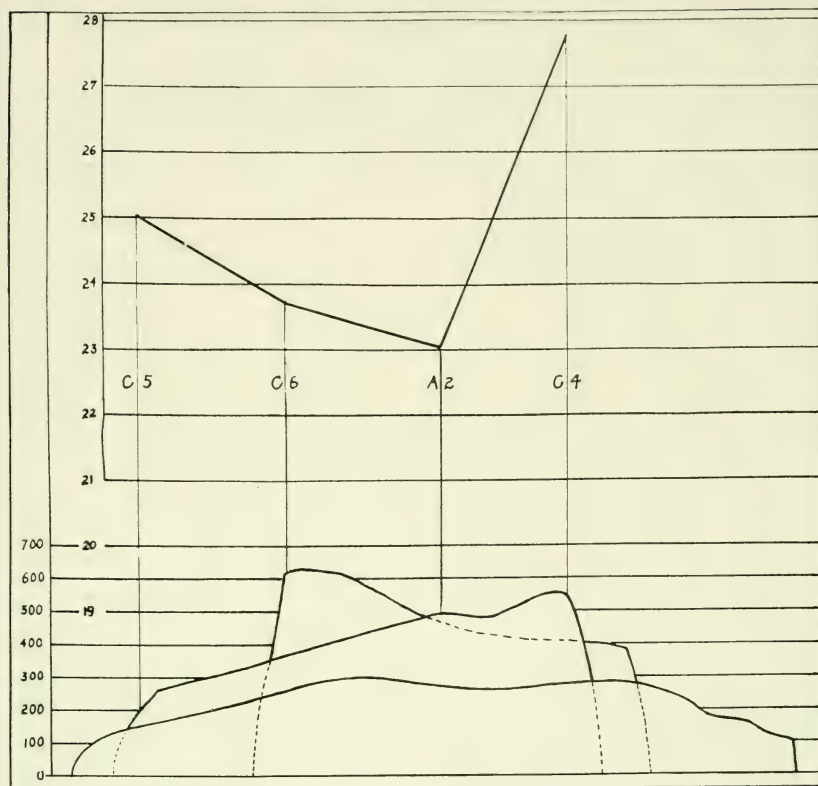


FIGURE 11

East-west profile of Santa Barbara Island with evaporation rates.

Elevation given in even hundreds.

Evaporation given in average cubic centimeters per day.

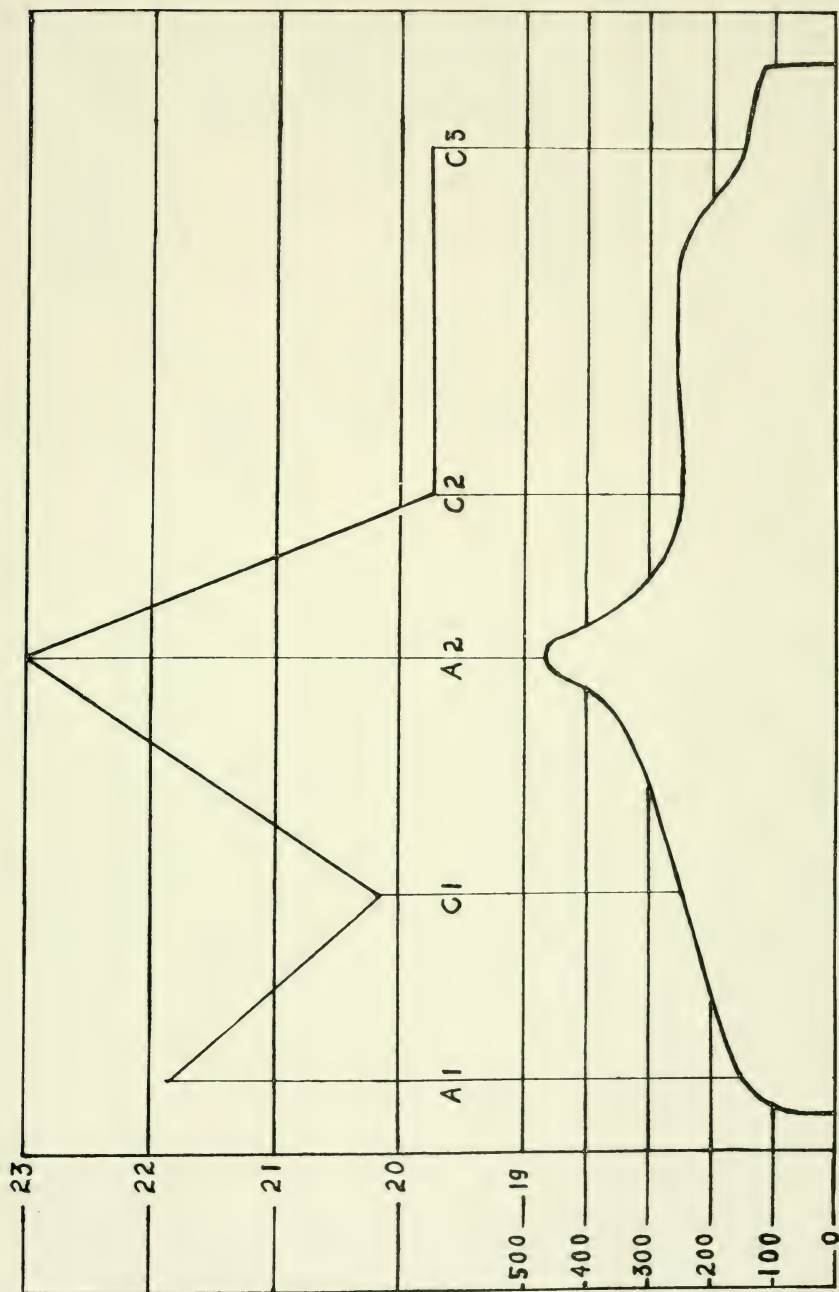


FIGURE 12

Catalinia in the Pliocene, with the Peninsula of Guadalupia.

(Adapted from Reed, 1933, p. 252)

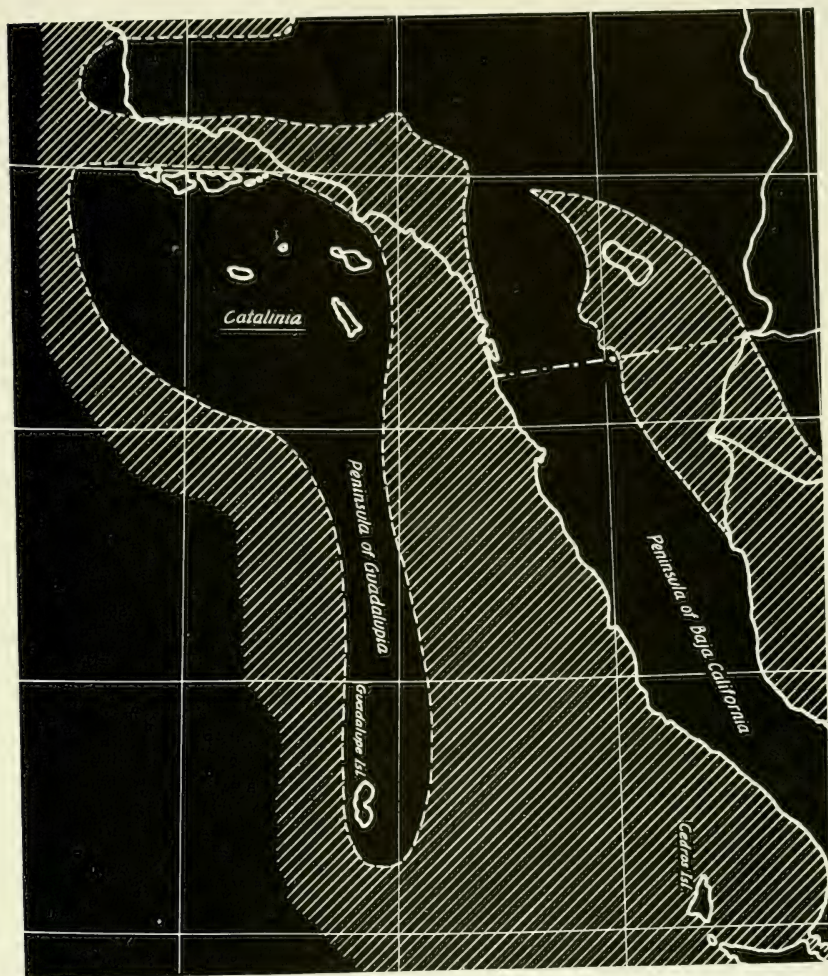


PLATE 1

- a. Anacapa Island from the west summit.
- b. *Lyonothamnus* grove, Santa Cruz Island.



Plate 1a



Plate 1b

PLATE 2

Santa Barbara Island from the south.



PLATE 3

San Miguel Island from 22,000 feet elevation.

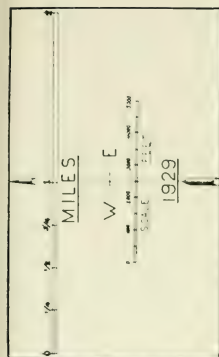


PLATE 4

- a. Emerald Bay at Johnson's Landing, Santa Catalina Island.
- b. Prisoner's Harbor, Santa Cruz Island.



Plate 4a



Plate 4b

PLATE 5

Quercus tomentella in canyon, Anacapa Island.



PLATE 6

- a. *Eriogonum-Eriophyllum* association, Anacapa Island.
- b. Scrub savanna, Anacapa Island.



Plate 6a



Plate 6b

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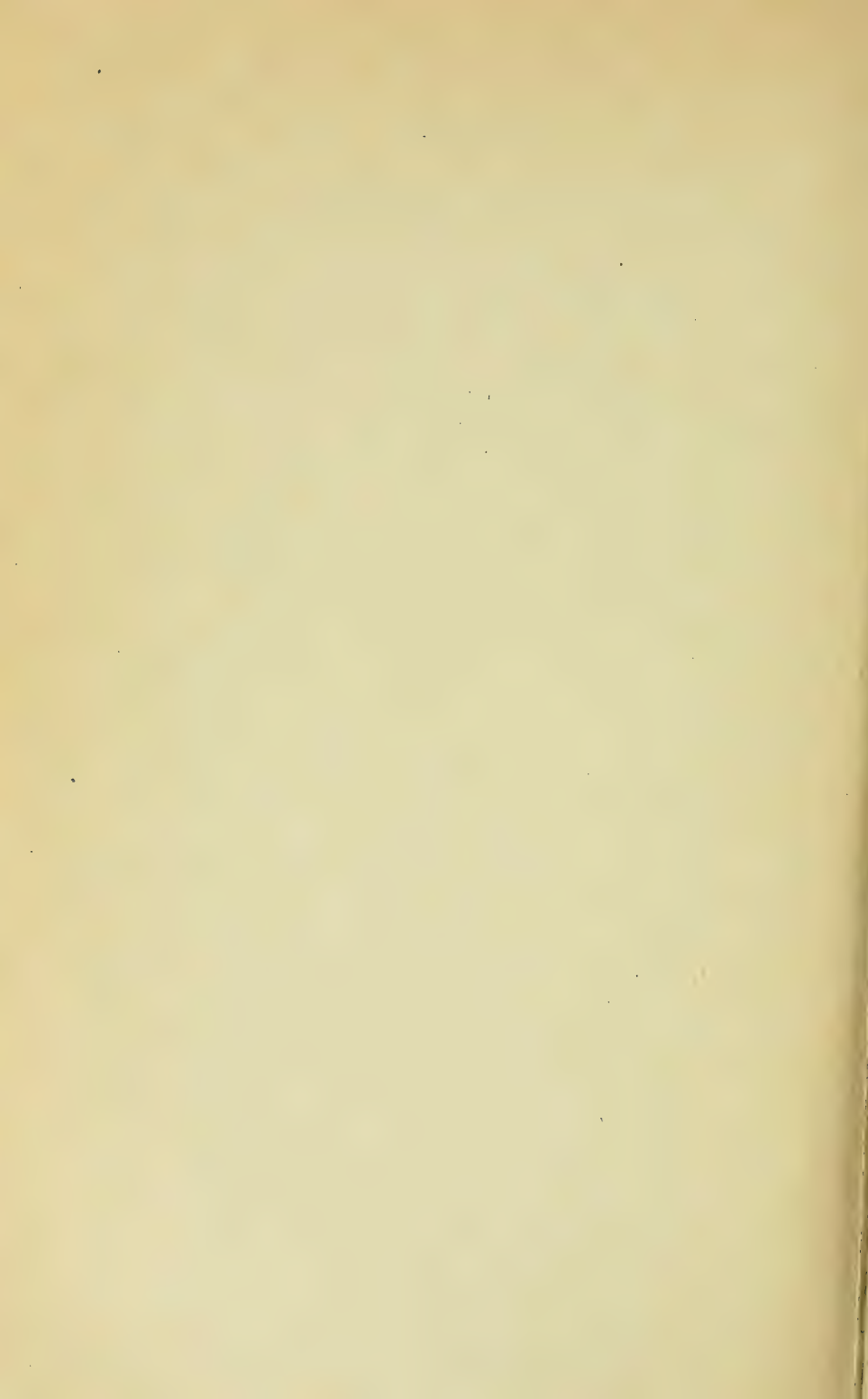
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LAND PLANTS COLLECTED BY THE
VELERO III, ALLAN HANCOCK PACIFIC
EXPEDITIONS 1937-1941

(PLATES 1-15, MAPS 1-3)

BY

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THE UNIVERSITY OF SOUTHERN CALIFORNIA



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PLANT ECOLOGY OF THE CHANNEL ISLANDS OF CALIFORNIA

(FIGURES 1-12, PLATES 1-6)

BY

MERYL BYRON DUNKLE



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