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CONTENTS

ERRATA

p. 6. Bottom line, delete [=B].

p. 239. Abstract, line one. For "(Foraminferida)" read "(Foraminiferida)".

p. 242. *Lada (Adrana) exoptata* Pilsbry and Lowe. Read "*Leda* . . .".
Lada (Adrana) penascoensis Lowe. Read "*Leda* . . .".

p. 246. *Anachis reedi* Bartsch. Add "Bartsch, 1928, p. 71.".

p. 247. *Beringuis everdami* Smith. Read "*Beringius* . . .".

p. 265. *Acanthochitoma tabogensis* Smith. For "(Fig. 1)" read "(upper fig.)".

p. 271. Dall, W. H., and W. H. Ochsner. For "17: 114-185." read "17: 141-185.".
Fritchman, H. K. *1931*. Read "Frizzell, D. L. 1931. A molluscan species . . .".

p. 276. eyerdami, Beringuis. Read "eyerdami, Beringius".

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME 14, No. 1, pp. 1-8

HOLOTYPE SPECIMENS OF REPTILES IN THE COLLECTION OF THE SAN DIEGO SOCIETY OF NATURAL HISTORY

BY

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SAN DIEGO, CALIFORNIA
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HOLOTYPE SPECIMENS OF REPTILES IN THE COLLECTION OF THE SAN DIEGO SOCIETY OF NATURAL HISTORY

BY

ALLAN J. SLOAN

The herpetological collection of this institution was established in 1920, with Laurence M. Klauber serving as the first curator. Dr. Klauber has supervised this collection as well as accumulating an impressive personal collection. This personal collection of about 34,000 specimens recently has been donated to the Society and is now deposited at the San Diego Natural History Museum. The combined collection now consists of some 48,000 specimens of reptiles and amphibians including the 46 reptile holotypes listed below. There are no holotypes of amphibians.

Material from western North America is best represented with particular emphasis on southern California, Arizona, Baja California, and islands in the Gulf of California. Snakes form the bulk of the collection (nearly ½ of the total number) including about 7,800 rattlesnakes of all but a few of the currently recognized forms.

Type specimens other than holotypes have never been segregated from the regular collection, and in most cases have not been so designated in the catalog. No attempt has been made to determine the status or the whereabouts of such specimens; the reader may refer to the publications cited below for this information.

The families in the following list are arranged according to Schmidt (1953, A check list of North American amphibians and reptiles, 6th ed., Univ. Chicago Press, viii + 208 pp.); the genera are in alphabetical order under their respective families. The information contained in the citations of the original descriptions is arranged in the following manner: name, author, year of publication, where published, and the actual date of publication. The departmental catalog number (SDSNH is the preferred abbreviation) of the holotype is followed by the type locality, the collector(s), and the date of collection or preservation. Corrections and additional comments such as coordinates of the type locality, are contained in brackets[ ]. The currently used name, if different from that originally given, follows the literature citation.

All holotypes have been kept in a dark, air-conditioned room with the alcohol level carefully maintained, and are in good condition.

Family EUBLEPHARIDAE

Coleonyx variegatus abbotti Klauber, 1945, Trans. San Diego Soc. Nat. Hist. 10(11):154. March 9.

HOLOTYPE: 34790, Proctor Valley, San Diego County, California, William Moore, February 28, 1942.

Coleonyx variegatus bogerti Klauber, 1945, Trans. San Diego Soc. Nat. Hist. 10(11):176. March 9.

HOLOTYPE: 32486, Xavier, about 10 miles south of Tucson, Pima County, Arizona, Lee W. Arnold, July 17, 1939.

Coleonyx variegatus utahensis Klauber, 1945, Trans. San Diego Soc. Nat. Hist. 10(11):171. March 9.

HOLOTYPE: 35792, Watercress Spring, about 1 mile northwest of Saint George, Washington County, Utah, Dr. Ross Hardy, April 16, 1941.

Family GEKKONIDAE

Phyllodactylus xanti nocticolus Dixon, 1964, New Mexico State Univ. Research Center Sci. Bull. 64-1:55, fig. 13. March.

HOLOTYPE: 34824, Aqua Caliente Hot Springs, San Diego County, California, Laurence M. Klauber [Charles Shaw and Paul Breeze in catalog], [preserved March 8, 1942.].

Family IGUANIDAE

Sauromalus australis Shaw, 1945, Trans. San Diego Soc. Nat. Hist. 10(15):286. August 31.

HOLOTYPE: 30170, San Francisquito Bay, [on the east coast of] Baja California, Mexico [near 28°26′N, 112°54′W], Robert S. Hoard, July 30, 1938.

Sauromalus klauberi Shaw, 1941, Trans. San Diego Soc. Nat. Hist. 9(28):285. April 30.

HOLOTYPE: 6859, Santa Catalina Island, Gulf of California, [Baja California] Mexico [near 25°38′N, 110°47′W], J. R. Pemberton, December 14, 1931.

Sauromalus obesus tumidus Shaw, 1945, Trans. San Diego Soc. Nat. Hist. 10(15):292. August 31.

HOLOTYPE: 27323, Telegraph Pass, Gila Mountains, Yuma County, Arizona, L. M. Klauber, June 15, 1937.

Uta stansburiana klauberi Lowe and Norris, 1955, Herpetologica 11(2):91. July 15.

HOLOTYPE: 6642, San Esteban Island, Gulf of California, Sonora, Mexico [near 28°42′N, 112°35′W], J. R. Pemberton, January 11, 1932.

Family ANNIELLIDAE

Anniella geronimensis Shaw, 1940, Trans. San Diego Soc. Nat. Hist. 9(24):225, fig. 1. July 31.

HOLOTYPE: 7543, San Gerónimo Island, [off the west coast of] Lower [Baja] California, Mexico [near 29°47′N, 115°48′W], Margaret Bancroft, March 28, 1932.

Family XANTUSIIDAE

Xantusia arizonae Klauber, 1931, Trans. San Diego Soc. Nat. Hist. 7(1):3, pl. 1, figs. 1-2. October 6.

HOLOTYPE: 5433, one mile south of Yarnell, Yavapai County, Arizona, elevation 4940 feet, P. M. and L. M. Klauber, Aug. 21, 1931.

Family LEPTOTYPHLOPIDAE

Leptotyphlops humilis cahuilae Klauber, 1931, Trans. San Diego Soc. Nat. Hist. 6(23):339. July 8.

HOLOTYPE: 2637, Yaqui Well, San Diego County, California, County Road Camp, [preserved] May 15, 1930.

Family BOIDAE

Charina bottae umbratica Klauber, 1943, Trans. San Diego Soc. Nat. Hist. 10(7):83. December 30.

HOLOTYPE: 12101, Fern Valley, elevation 5800 ft., near Idyllwild, Riverside County, California, Clyde Searl, July 1, 1929.

Lichanura roseofusca gracia Klauber, 1931, Trans. San Diego Soc. Nat. Hist. 6(20):307, pl. 21, fig. 1. April 30.

= *Lichanura trivirgata gracia* Klauber

HOLOTYPE: 2995, Randsburg, Kern County, California, Miss Lucile Rector, June, 1930.

Family COLUBRIDAE

Arizona elegans candida Klauber, 1946, Trans. San Diego Soc. Nat. Hist. 10(17):364, pl. 8, fig. 2. March 29.

HOLOTYPE: 34191, Kramer Hills (6 miles south of Kramer Junction on U S 395), San Bernardino County, California, James Deuel, [preserved] June 16, 1941.

Arizona elegans eburnata Klauber, 1946, Trans. San Diego Soc. Nat. Hist. 10(17):350, pl. 8, fig. 1. March 29.

HOLOTYPE: 33094, Bensons Dry Lake, San Diego County, California, James Deuel, preserved June 5, 1940.

Arizona elegans noctivaga Klauber, 1946, Trans. San Diego Soc. Nat. Hist. 10(17):343. March 29.

HOLOTYPE: 34188, 8 miles southwest of Owlshead (Owlshead is on U. S. 80, 45 miles southeast of Florence), Pinal County, Arizona, Charles E. Shaw and L. M. Klauber, May 31, 1941.

Arizona elegans pacata Klauber, 1946, Trans. San Diego Soc. Nat. Hist. 10(17):379. March 29.

HOLOTYPE: 17652, Santo Domingo, Baja California, Mexico (lat. 25°30′N.), Frank F. Gander, Nov. 16, 1941.

Arizona elegans philipi Klauber, 1946, Trans. San Diego Soc. Nat. Hist. 10(17):333. March 29.

HOLOTYPE: 34456, 10 mi. east of Winslow, Navajo County, Arizona, Charles E. Shaw and Carl Engler, July 29, 1941.

Chilomeniscus stramineus esterensis Hoard, 1939, Pomona College Jour. Ent. Zool. 31(4):45, fig. December.

HOLOTYPE: 30368, Estero Salina[s], [west coast of] Lower [Baja] California [Mexico, near 24°36′N, 111°49′W], R. S. Hoard, July 10, 1938.

Chionactis occipitalis klauberi (Stickel), see *Sonora occipitalis klauberi* Stickel.

Chionactis palarostris organica Klauber, 1951, Trans. San Diego Soc. Nat. Hist. 11(9):178, pl. 10, fig. 2. April 30.

HOLOTYPE: 40673, on the Sonoyta-Ajo road, 9 miles north of the U. S.-Mexican Border, in the Organ Pipe Cactus National Monument, Pima County, Arizona, William R. Supernaugh and Grover E. Steele, May 22, 1950.

Chionactis palarostris palarostris (Klauber), see *Sonora palarostris* Klauber.

Hypsiglena o.[chrorhynchus] klauberi W. Tanner, "1944" [1946], Great Basin Nat. 5(3 & 4):71. "December 29" [September].

= *Hypsiglena torquata klauberi* W. Tanner.

HOLOTYPE: 20228, South Cornoado [= Coronado] Island, [off the west coast of] Lower [Baja] California, [Mexico, near 32°24′N, 117°15′W] Philip M. Klauber, June 11, 1933.

Masticophis bilineatus slevini Lowe and Norris, 1955, Herpetologica, 11(2):93. July 15.

HOLOTYPE: 3826, San Esteban Island, Gulf of California, Sonora, Mexico [near 28°42′N, 112°35′W], Mrs. Griffing Bancroft, April 18, 1930.

Phyllorhynchus browni lucidus Klauber, 1940, Trans. San Diego Soc. Nat. Hist. 9(20):202, pl. 8, fig. 2. April 30.

HOLOTYPE: 28819, Enchanto [= Encanto?] Valley, 7 mi. w. of Cave Creek [= Cavecreek], Maricopa County, Arizona, received from V. Housholder May 21, 1938.

Phyllorhynchus decurtatus nubilus Klauber, 1940, Trans. San Diego Soc. Nat. Hist. 9(20):197, pl. 8, fig. 1. April 30.

HOLOTYPE: 32493, Xavier (Weisner's Ranch), Pima County, Arizona, Lee Arnold, July 16, 1939.

Phyllorhynchus decurtatus perkinsi Klauber, 1935, Bull. Zool. Soc. San Diego No. 12:11, figs. 2, 4. September 4.

HOLOTYPE: 23757, [Bensons] Dry Lake, San Diego County, California, L.M.K. [= Laurence M. Klauber], May 4, 1935.

Pituophis catenifer bimaris Klauber, 1946, Trans. San Diego Soc. Nat. Hist. 11(1):7. August 26.
= *Pituophis melanoleucus bimaris* Klauber.
HOLOTYPE: 32621, Santa Gertrudis, near El Arco (Lat. 28° N.), Baja California, Mexico [near 28°03'N, 113°07'W], Robert S. Hoard, August 1939.

Pituophis catenifer coronalis Klauber, 1946, Trans. San Diego Soc. Nat. Hist. 11(1):19. August 26.
= *Pituophis melanoleucus coronalis* Klauber
HOLOTYPE: 20229, South Coronado Island, [off the west coast of Baja California] Mexico [near 32°24'N, 117°15'W], Philip M. Klauber, June 11, 1933.

Pituophis catenifer fuliginatus Klauber, 1946, Trans. San Diego Soc. Nat. Hist. 11(1):14. August 26.
= *Pituophis melanoleucus fuliginatus* Klauber
HOLOTYPE: 17449, San Martín Island, off the west coast of Baja California, Mexico [near 30°29'N, 116°06'W], Lewis W. Walker, July 11, 1939.

Pituophis catenifer pumilus Klauber, 1946, Trans. San Diego Soc. Nat. Hist. 11(2):41, pl. 3, fig. 1. August 26.
= *Pituophis melanoleucus pumilus* Klauber
HOLOTYPE: 17238, Santa Cruz Island, Santa Barbara County, California, Norman Bilderback, May 5, 1938.

Rhinocheilus lecontei clarus Klauber, 1941, Trans. San Diego Soc. Nat. Hist. 9(29):308, pl. 13, figs. 1-2. September 26.
= *Rhinocheilus lecontei lecontei* Baird and Girard
HOLOTYPE: 31440, 2 miles north of The Narrows, Borrego Valley, San Diego County, California, Richard Neill, May 7, 1939.

Salvadora grahamiae virgultea Bogert, 1935, Bull. So. Calif. Acad. Sci. 34(1):89, pl. 13. May 15.
= *Salvadora hexalepis virgultea* Bogert
HOLOTYPE: 12025, Deerhorn Flat, San Diego County, California, F. E. Walker, [preserved] June 29, 1929.

Salvadora hexalepis klauberi Bogert, 1945, Amer. Mus. Novit. 1285:2, figs. 1-4. May 14.
HOLOTYPE: 20912, Cape San Lucas, Baja California, Mexico [near 22°53'N, 109°55'W], Fred Lewis, preserved August 6, 1933.

Sonora bancroftae Klauber, 1943, Trans. San Diego Soc. Nat. Hist. 10(4):69. December 30.
HOLOTYPE: 35077, 2 miles east of San Jorge (San Telmo River Valley, near lat. 31), Lower [Baja] California, Mexico [near 30°56'N, 115°57'W], Mrs. Griffing Bancroft, April 10, 1942.

Sonora occipitalis klauberi Stickel, 1941, Bull. Chicago Acad. Sci. 6(7):138, figs. 1-2. November 28.
= *Chionactis occipitalis klauberi* (Stickel)
HOLOTYPE: 29647, Tucson, Pima County, Arizona, C. T. Vorhies, June 3, 1938.

Sonora palarostris Klauber, 1937, Trans. San Diego Soc. Nat. Hist. 8(27):363. December 15.
= *Chionactis palarostris palarostris* (Klauber)
HOLOTYPE: 26771, 5 miles south of Magdalena, Sonora, Mexico, George Lindsay, April, 1937.

Tantilla eiseni transmontana Klauber, 1943, Trans. San Diego Soc. Nat. Hist. 10(5):71. December 30.
HOLOTYPE: 29273, on the road one mile east of Yaqui Well, San Diego County, California, Charles E. Shaw and Cyrus S. [= B.] Perkins, June 6, 1938.

Family CROTALIDAE

Crotalus cerastes laterorepens Klauber, 1944, Trans. San Diego Soc. Nat. Hist. 10(8):94, pl. 5, fig. 2. August 18.

HOLOTYPE: 34074, The Narrows, San Diego County, California, C. B. Perkins and C. E. Shaw, June 6, 1941.

Crotalus confluentus abyssus Klauber, 1930, Trans. San Diego Soc. Nat. Hist. 6(3):114, pl. 11, fig. 1. February 28.
= *Crotalus viridis abyssus* Klauber

HOLOTYPE: 2216, on the Tanner Trail 300 ft. below the south rim of the Grand Canyon, Coconino County, Arizona, E. D. McKee, September 15, 1929.

Crotalus confluentus kellyi Amaral, 1929, Bull. Antivenin Inst. Amer. 2(4):91. February.
= *Crotalus scutulatus scutulatus* (Kennicott)

HOLOTYPE: 194, Needles, [San Bernardino County] California, Santa Fe [Railroad], July 11, 1926.

Crotalus confluentus lutosus Klauber, 1930, Trans. San Diego Soc. Nat. Hist. 6(3):100, pl. 10, fig. 1. February 28.
= *Crotalus viridis lutosus* Klauber

HOLOTYPE: 1814, 10 miles northwest of Abraham on the road to Joy, Millard County, Utah, C. B. Perkins, May 12, 1929.

Crotalus confluentus nuntius Klauber, 1935, Trans. San Diego Soc. Nat. Hist. 8(13):78, pl. 8, fig. 1. August 24.
= *Crotalus viridis nuntius* Klauber

HOLOTYPE: 3105, Canyon Diablo, Coconino County, Arizona, R. L. Bordon, [preserved] August 9, 1930.

Crotalus mitchelli angelensis Klauber, 1963, Trans. San Diego Soc. Nat. Hist. 13(5):75, figs. 1-2. September 27.

HOLOTYPE: 51994, about 4 miles southeast of Refugio Bay, at 1500 feet elevation, Isla Angel de la Guarda, Gulf of California, [Baja California] Mexico (near 29°29½′N, 113°33′W), Dr. Reid Moran, March 22, 1963.

Crotalus mitchelli muertensis Klauber, 1949, Trans. San Diego Soc. Nat. Hist. 11(6):97, pl. 6, fig. 1. January 31.

HOLOTYPE: 37447, El Muerto Island [= Miramar], Gulf of California, [Baja California] Mexico [near 30°05′N, 114°33′W], Charles H. Lowe, Jr., June 6 or 7, 1946.

Crotalus molossus estebanensis Klauber, 1949, Trans. San Diego Soc. Nat. Hist. 11(6):104, pl. 6, fig. 2. January 31.

HOLOTYPE: 26792, San Esteban Island, Gulf of California, [Sonora] Mexico [near 28°42′N, 112°35′W], expedition under Capt. G. Allan Hancock, preserved April 17, 1937.

Crotalus viridis caliginis Klauber, 1949, Trans. San Diego Soc. Nat. Hist. 11(6):90, pl. 5, fig. 2. January 31.

HOLOTYPE: 2800, South Coronado Island, [off the west coast of] Baja California, Mexico [near 32°24′N, 117°15′W], E. H. Quayle, June 2, 1930.

Crotalus willardi meridionalis Klauber, 1949, Trans. San Diego Soc. Nat. Hist. 11(8):131. September 30.

HOLOTYPE: 6569, Coyotes (on the railroad to El Santo), Durango, Mexico, elevation 8000 ft., Edmund Heller and Charles M. Barber, August, 1904.

TRANSACTIONS

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VOLUME 14, No. 2, pp. 9-40

ECOLOGY OF THE MICROBIOTA OF SAN DIEGO BAY, CALIFORNIA

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SAN DIEGO, CALIFORNIA
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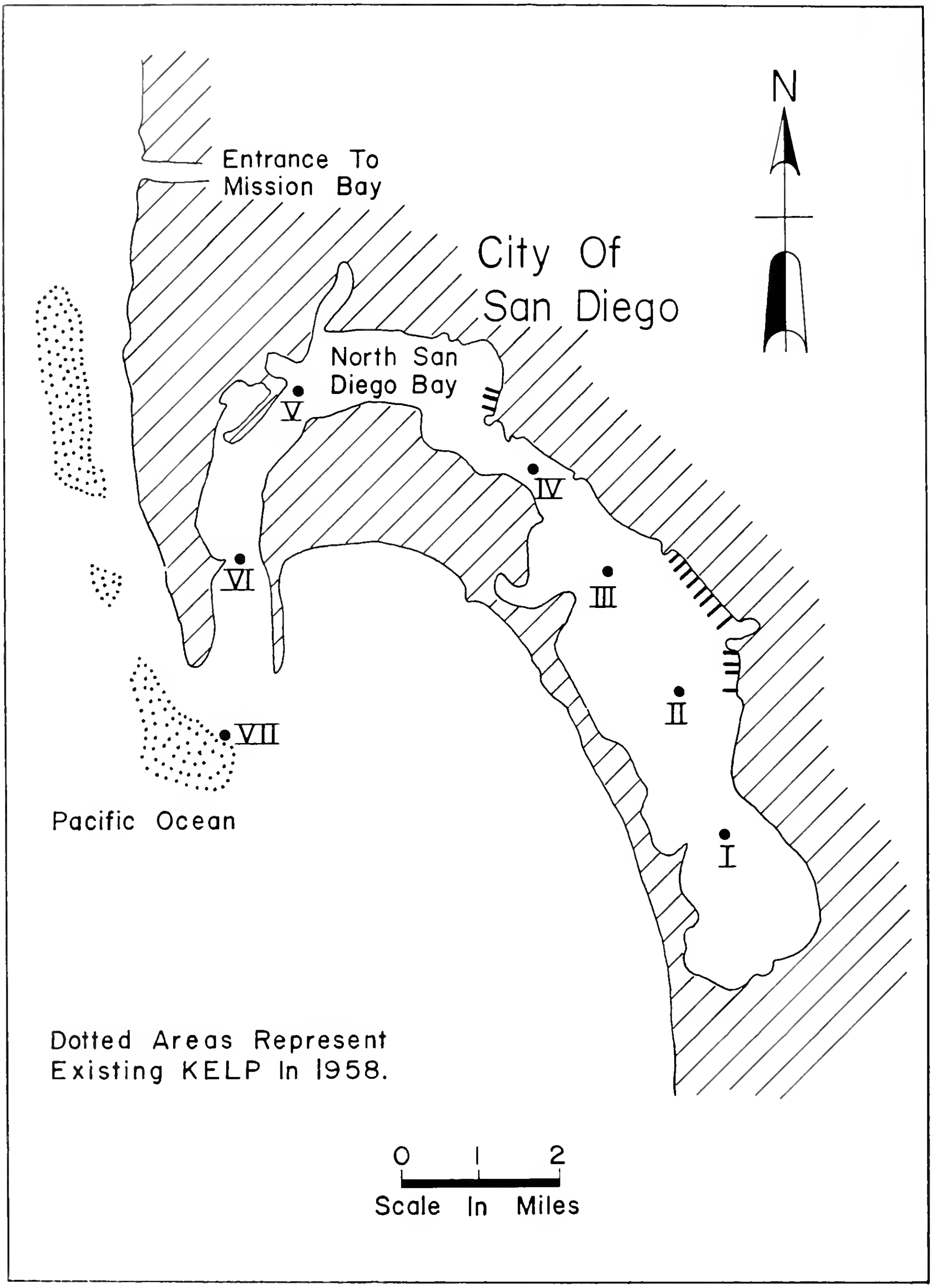

Fig. 1. Location of Sampling Stations I-VII in San Diego Bay. Station VIII was off the 1000-foot pier of the Scripps Institution of Oceanography, 16 miles north of Station VII. Stations VII and VIII were in the open Pacific Ocean.

ECOLOGY OF THE MICROBIOTA OF SAN DIEGO BAY, CALIFORNIA[1]

BY

JAMES B. LACKEY AND KENNETH A. CLENDENNING[2]

CONTENTS

INTRODUCTION

San Diego Bay is a very large and deep natural harbor, as shown in figure 1. During the summer months at least, it receives no dilution from fresh water streams. The harbor is surrounded by metropolitan San Diego, with a population in excess of 500,000. Prior to August, 1963, municipal and industrial wastes entered the inner harbor, and these both fertilized and polluted the water there to a considerable extent. Nannoplankton blooms occurred almost continuously in the harbor each summer (Nusbaum and Miller, 1952; Sweeney and Clendenning, 1958). Since the diversion through a long ocean outfall of all but a minimal quantity of sewage, evidence of pollution and fertilization has largely disappeared (Dennis O'Leary, personal communication). Daily tidal exchange averages one-third of the bay volume (Anon., 1950, 1952) and exceeds the waste discharge about five hundred fold at the present time. The bay is a neutral-type estuary, since annual evaporation approximately balances the fresh water input from all sources.

Dense beds of the giant kelp, *Macrocystis pyrifera*, formerly extended for eight miles along the Point Loma peninsula, between the entrances to San Diego Bay and Mission Bay (fig. 1). From charts provided by the U. S. Coast and Geodetic Survey, it is known that these kelp beds retained a similar size and density between 1851 and 1917. The 45 kelp beds of southern California were assigned numbers by the California Department of Fish and Game before commercial harvesting commenced; records have been maintained of the harvests from each bed since 1916. During 1917 and 1918, two of these kelp beds (No. 2 and No. 3) yielded annual harvests as large as are now obtained from all the kelp beds of southern California. The Point Loma kelp beds have since decreased greatly in area and density (Wohnus, 1942; North, 1960), and the decrease in their standing crop now amounts to about 100,000 tons in seven square miles. Kelp bed No. 1, opposite the Tia Juana River estuary just north of the international boundary, has disappeared, as have kelp beds 11 to 15 along twenty miles of the Palos Verdes peninsula near Los Angeles.

Because of their ecological and economic importance, the recession of kelp beds 2 and 3 prompted a comprehensive study by the Institute of Marine Resources, University of California, in which a wide range of factors were explored, e.g., direct and indirect effects of domestic

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[1] Contribution from the Scripps Institution of Oceanography, University of California, San Diego.

[2] Dr. Clendenning died October 11, 1962, just as he was completing this paper.

and industrial wastes, dredging, ship traffic, kelp predation, substrate alteration, harvesting, and unfavorable natural factors such as storm and temperature damage. One facet of this large problem may well be alterations of the planktonic and benthic microbiota induced by man. It was deemed cogent, therefore, to survey the microbiota throughout San Diego Bay, in the kelp by the harbor entrance, and at a coastal control station (fig. 1).

The 1959 investigation as here reported was followed in 1961 by a corresponding microbiological investigation of Mission Bay and the neighboring coastline formerly occupied by kelp beds, with re-examination of the entrance to San Diego Bay (Stations VI, VII) and the coastal control station (VIII) at La Jolla. The three latter stations were re-examined by the senior author from June to August, 1961, along with additional samples from Stations I and V, San Diego Bay. The microbiota of San Diego Bay was largely unknown when this survey was undertaken, but observations in previous years provided the background information which prompted this comprehensive study.

The first observations on phytoplankton in San Diego Bay were made in 1920 to 1924 by G. F. Sleggs (1927) and W. E. Allen (1928). Thirty years later, the harbor phytoplankton was investigated as a source of oxygen by Nusbaum and Miller (1952). These authors observed that the harbor water undergoes sluggish horizontal mixing, but is well mixed vertically except in the deepest parts of the bay. Photosynthesis and respiration measurements were made by them at different depths, and dissolved oxygen and BOD were monitored throughout the bay. Supersaturated oxygen contents were observed below the compensation depth in summer, a result of intensive photosynthesis coupled with vertical mixing (Nusbaum and Miller, 1952). They also observed that photosynthesis in the inner harbor is reduced in the autumn and winter. Water samples were collected between Stations II, III, and IV (fig. 1) by Nusbaum and were examined for phytoplankton by B. M. Sweeney, July to December, 1952. She observed a preponderance of microflagellates, which included *Eutreptia viridis*. The standing crop of harbor phytoplankton was much smaller in December than in midsummer. These observations of 1952 were confirmed in 1957 and 1958.

During an investigation of ship hull corrosion near Station II by Kittredge and Corcoran (1955), the brown harbor water by Pier No. 11 was examined in July, 1954, by R. W. Holmes. He recorded a complex association of small algae (20,000/ml.) in which unidentified microflagellates again predominated. Water from Pier No. 11 was re-examined in July, 1958, by Anne M. Dodson with confirmatory results. Between December, 1958, and May, 1959, San Diego Bay and the Point Loma kelp area were repeatedly sampled for phytoplankton, with weekly monitoring of the control Station, VIII, by E. Balech, B. M. Sweeney and Anne Dodson. Reference is made to their observations in the results section.

During the autumn, winter and spring months preceding this study (September 15, 1958, to April 15, 1959), the entrance to San Diego Harbor (Stations VI, VII), the entire area formerly occupied by dense kelp beds off the Point Loma peninsula, and the control station, were sampled extensively in a study of total suspended matter including plankton (Clendenning, 1959a). The suspended solids recovered from carboy lots by continuous flow centrifugation at 32,000 g. from Stations VI and VII in this period amounted to 1 ± 0.4 mg. solids/liter, with mineral contents of 60-65%. These leptopel constituents were in the usual range for coastal water (Fox, Isaacs and Corcoran, 1952). Water transparency measurements were made monthly throughout a complete year, 1958-1959, by San Diego Marine Advisors (1959). The average transparencies remained the same from our Station VII northward for ten miles, and the water in outer San Diego harbor was less turbid than the water of Mission Bay which receives no wastes.

We wish to express appreciation to Wheeler J. North, whose reports were of material assistance. He made some of the arrangements for this study and also offered suggestions concerning the manuscript. Messrs. James R. Stewart, Charles T. Mitchell and Harold L. Scotten obtained the benthic samples by Scuba diving, as well as most of the plankton samples. Unpublished hydrographic information on San Diego Bay was provided by Marston C. Sargent,

Office of Naval Research, and Mr. Leonard Burtman, San Diego Regional Water Pollution Control Board. We appreciate extensive assistance of Mrs. Elsie W. Lackey in the tabulations, and thank Professors Francis T. Haxo, Carl L. Hubbs, Charles D. Wheelock, and Claude E. Zobell, faculty members of the Kelp Study Panel.

This study was sponsored in the Institute of Marine Resources, University of California, by the California State Water Pollution Control Board, and by the California Department of Fish and Game.

SAMPLING AND METHODS

The study was made during July and August, 1959. Stations I-VI formed an axial transect throughout the navigable length of San Diego Bay (fig. 1). Station I was located in the center of South San Diego Bay. Station II, opposite Pier No. 1, National City, and Station III, opposite the 28th Street Mole, were equi-distant from the San Diego municipal outfall, the main source of organic wastes. Stations II to IV bracketed the main receiving area for municipal and industrial wastes from San Diego. From previous work, it was known that the water of North San Diego Bay is of much better quality than the inner harbor water. Station V, off Shelter Island, was in a recreational area that meets health requirements for water contact sports. Station VI, at Ballast Point, was in the narrow bay entrance. Station VII was located in the center of the area formerly occupied by kelp bed No. 2, alongside the harbor entrance. Stations II to VII are in an area of heavy ship traffic. Station VIII, off the end of the Scripps Institution of Oceanography (SIO) pier, La Jolla, sixteen miles north of Point Loma, served as the coastal control station; this station is not shown in figure 1.

Insofar as possible, surface water and bottom sediments were sampled weekly at these eight stations. Surface water from Stations I through VII was always collected during ebb tides, in sequence from Station I. Water had been flowing out of the bay for several hours at the time of each sampling at Stations VI and VII. The one liter samples of water were brought to the laboratory immersed in sea water. They were maintained in a cool sea water laboratory at low light intensity (0 to 30 f.c.) until examined. Later in the same week, bottom sediment with associated water was collected from each of these eight stations by Messrs. James R. Stewart and Charles T. Mitchell, using Scuba equipment. In addition to the regular samplings, some further collections were examined from these and other locations as time permitted. Open jars were suspended five feet off the bottom at Station VIII, and recovered after several days. Water from intermediate depths was obtained at Stations IV to VI with Van Dorn samplers for testing vertical mixing, which appeared to be thorough. Two surface water collections were made from the northern end of the La Jolla kelp bed (Station IX — not shown in fig. 1). In all, 118 samples were examined qualitatively or quantitatively (table 1).

All samples were examined without preservation. Surface samples were concentrated by centrifuging for five minutes at about 2200 r.p.m. Bottom sediment was examined with a minimum of dilution in its own overlying water. Counting was done by a drop method, described in Standard Methods for the Examination of Water, Sewage and Industrial Wastes (American Public Health Association, 1955). The microscope used was a Zeiss 1957 Optovar, which provided phase contrast and darkfield illumination at magnifications of 100× to 2500×. Additional information on procedures has been provided by Lackey (1960).

Microorganisms having dimensions of a few microns upward belonged almost entirely to the following groups which were studied quantitatively:

1. Beggiatoales (Schizophyta)
2. Chroococcales and Nostocales (Cyanophyta)
3. Chlorococcales (Chlorophyta)
4. Volvocales (Chlorophyta)
5. Euglenales — green (Euglenophyta)
6. Euglenales — colorless (Euglenophyta)
7. Desmophyceae and Dinophyceae (Pyrrophyta)
8. Cryptophyceae (Cryptophyta)
9. Chrysophyta
10. Xanthophyta
11. Chloromonadida
12. Bacillariophyta
13. Zooflagellata
14. Ciliata
15. Rhizopoda
16. Rotifera, Foraminifera, Copepoda, etc.

TABLE I

Types and numbers of samples examined during survey.[1]

Station	Qualitative	Quantitative	Benthic	Planktonic
I	0	9	4	5
II	1	10	4	7
III	0	10	4	6
IV	0	12	4	8
V	0	12	4	8
VI	1	12	4	9
VII	1	12	4	9
VIII	5	14	8	11
IX	1	2		3
Torrey Pines salina	3			3
Open jar, SIO pier	3	1		
Kelp fronds	4			
Totals	19	94	36	69

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[1] Five incompletely examined samples not included.

All except Group 1 were identified to genus and species where possible. Occurrences of all organisms were recorded for each station, as were population densities of the more abundant ones.

Organisms were found in some groups which manifestly have never been described. Several Chrysophyceae could not be found in the literature. As noted in the tables, a few organisms were given provisional names. Also, there was some lumping of genera and species for cryptomonads, dinoflagellates and diatoms. Despite the California work of Cupp (1943) on diatoms, of Kofoid and Swezy (1921) on dinoflagellates, and various other monographs, it was impossible to identify some of the organisms in these groups. The monographs of Kahl (1930-1935) and papers of Faure-Fremiet (1950, 1951) were used for the ciliates, as were those of Bergey (1957) for the sulfur bacteria. Other groups necessitated using a large and scattered literature. If there is anywhere in the literature a comprehensive microbiological study of a salt water bay or estuary, comparable to the one attempted here, the writers were unware of it.

ORGANISMS STUDIED

The list of organisms observed is shown in the various tables. This is a more comprehensive list than was found by the senior author in more than a year of study of the Gulf coast of Florida over a shore range of some 300 miles, in Chesapeake Bay at Solomons, Maryland, or in water adjacent to Woods Hole, Massachusetts. Bottom sediments received less attention in the latter three areas, however, than in the present study. Over three hundred genera and species of algae and protozoa were observed in San Diego Bay and nearby coastal water during this study, and over two hundred blooms (>500/ml.) were observed in the samples. The microbiota of this area is therefore characterized by a wealth of species and by frequent blooms, at least in the summer months.

Schizophyta

The only bacteria taken into account were the Beggiatoales, which are indicators of H_2S and often are abundant in polluted areas. Various species of *Beggiatoa* were present in marine muds from Los Angeles harbor which were sent to us by Reish (1957), who has demonstrated substantial pollution in that area. Actually the densest populations of *Beggiatoa* previously encountered were found in Warm Mineral Springs in Florida, which are unpolluted but contain H_2S (Lackey, 1957), Hays process sewage treatment plants in Texas being the next most productive situation (Lackey and Dixon, 1943).

All six of the species of *Beggiatoa* listed in Bergey's Manual (1957) occurred in the present samples, and four or more species were observed at each station (table 2). Although

TABLE 2

Occurrence of *Beggiatoa* at all stations.

Species	Stations I	II	III	IV	V	VI	VII	VIII
Beggiatoa minima	×	×	×	×	×	×	×	×
Beggiatoa leptomitiformis			×	×	×			×
Beggiatoa alba	×	×	×	×	×	×	×	×
Beggiatoa mirabilis	×	×	×	×	×	×	×	×
Beggiatoa arachnoidea	×	×	×	×	×	×	×	×
Beggiatoa gigantea			×	×				

the pier (Station VIII) is considered a clean-water station, five species of *Beggiatoa* were collected there, and in 22 collections from that station there were 14 occurrences and three blooms of one or another species of *Beggiatoa*. None was collected in open jars submerged off the SIO pier.

Any hope of using members of this genus as more than casual indicators was not realized. To obtain an idea of population density of species of this genus, the silt was diluted with filtered sea water, until counting of filaments was possible. *Beggiatoa gigantea*, a marine or brackish water species, was found only at Stations III and IV in San Diego harbor, in small numbers (table 2). Otherwise, the species of *Beggiatoa* found in San Diego harbor were the same as at the control station. The densest *Beggiatoa* bloom encountered in this study was found under the kelp at Station VII (*B. arachnoidea* at 20,000 filaments per ml.); *B. alba* was also observed there at 800 filaments per ml. A bloom of *B. minima* was observed at Station I (2000 filaments per ml.), and *B. arachnoidea* was found in sediment from Station VI at 800 filaments per ml. On the whole, the rather sparse occurrences of *Beggiatoa* at the harbor stations resembled those observed previously by the senior author in marine muds near Woods Hole, Massachusetts, which were associated with decaying vegetation.

Vast tonnages of seaweed debris are deposited each year in a deep submarine canyon near the SIO pier at La Jolla. Harold L. Scotten had observed bottom sediment in this canyon covered with white growths presumed to be sulfur bacteria. This was borne out by the dense blooms of sulfur bacteria which were observed in sediment which Scotten collected there August 12, 1959, at a depth of 120 feet — there were 3000 filaments per ml. of *B. leptomitiformis*, 750 filaments per ml. of *B. minima*, and 3000 per ml. of *Thiospira* sp. The densest populations of *Beggiatoa* encountered in this study seemed to be associated with natural supplies of sulfur-containing organic matter such as seaweed debris.

CYANOPHYTA

Blue-green algae were found only once at Station III and once at Station VIII. Inasmuch as some species of *Oscillatoria* and a few other genera often flourish in polluted water, their absence in the samples from San Diego harbor is taken as a denial of a high degree of pollution.

CHLOROPHYTA

Chlorococcales are not regarded as common in marine waters. There are known exceptions, however — Great South Bay, Long Island, for example. A serious organic pollution in that area was accompanied by exceedingly dense, persistent blooms of small Chlorococcales. The predominating organism there was identified as *Nannochloris* by R. W. Butcher. Equally dense Chlorococcales blooms (10^6 to 10^7 per ml.) develop in sewage oxidation ponds (Allen, 1955), where *Chlorella* often outnumbers all other algae, especially in the earliest stages of organic decomposition.

Chlorococcales of the genera *Chlorella* and *Nannochloris* occurred at each station (table 3), but seldom in large numbers. In comparison with Great South Bay, Long Island, numbers of these small green cells remained low during this survey; hence they were not identified

TABLE 3

The numbers per ml. of small Chlorococcales in blooms during this survey.

Date in 1959	Stations								
	I	II	III	IV	V	VI	VII	VIII	IX
July 6		4896	2448	1200	4896	2448	840	1296	480
July 8		800	2400	25600	4800	1192			
July 13								900	
July 16	1200	1800	8400	7200	5400	2700			
July 20								690	
July 28			720						
Aug. 5	1200			1200	3600				
Aug. 9		900	600	600	708	540	564		
Total Blooms	2	4	5	5	5	4	2	3	1

further. The densest Chlorococcales populations observed in San Diego Bay were about one thousand times smaller than the densest observed in oxidation ponds (Allen, 1955). Chlorococcales were present in similarly small numbers in the samples from the Point Loma kelp and from the control station.

Using the arbitrary definition of 500 cells per ml. as the minimum constituting a bloom, thirty Chlorococcales blooms were encountered in the samples, with at least two mild blooms at each of the regularly sampled stations (table 3). The Chlorococcales bloomed most frequently at Stations III-V, and were densest at Station IV. When Chlorococcales blooms occurred, they tended to be widespread. Thus on four sampling dates, blooms were observed simultaneously at Stations II to VI inclusive, spanning most of San Diego Bay; on three other dates, none of these stations had Chlorococcales blooms (table 3). This group responded to fertilization in San Diego Bay, but the response was mild and sporadic. Three mild blooms were observed in the plankton collections off the SIO pier. One of the densest encountered (18,000/ml.) was found in an open jar submerged off the SIO pier.

Taking their small size (3 to 6 microns) into consideration, Chlorococcales probably played only a minor role during this study. These small green cells can multiply very rapidly, however, and may attain importance. *Chlorella vulgaris* has been observed to increase 20,000 fold in three days under field conditions (Lackey, 1957), which is equivalent to a doubling of the population every five hours. This was in a shallow settling basin at Oak Ridge, Tennessee, presumably under optimal conditions.

VOLVOCALES

These flagellated Chlorophyta bloom frequently in polluted fresh waters — *Chlorogonium* and *Chlamydomonas* in citrus wastes (Lackey, Calaway and Morgan, 1956), *Spondylomorum* in distillery wastes (Lackey, 1942), various *Chlamydomonas* in sewage oxidation ponds (Silva and Papenfuss, 1953; M. B. Allen, 1955). *Dunaliella* often occurs in large numbers in tidal pools contaminated by gull droppings. *Dunaliella* and *Platymonas* are produced in dense cultures in the U. S. Fish and Wildlife Laboratory, Beaufort, North Carolina (Rice, 1954), and in the Phelps Laboratory, University of Florida, where they are used to feed shellfish. The culture media used are rich in soluble organic matter. These green flagellates apparently favor organic substrates, and offer some evidence of favoring specific ones. *Pyramimonas*, however, is apparently ubiquitous, being found in almost any salt water. The *Pyramimonas* encountered here was *P. obovata* (Butcher, 1959). There was an unidentified group of very small biflagellated green cells which may have been small species of *Chlamydomonas*.

The Volvocales were fairly well represented, and are believed to have some significance in this area (table 4). Eight species were found at Station II. They occurred in every plankton sample collected there. There were three blooms of *Pyramimonas obovata* at Station II (cf. Butcher, 1959), the only station having three Volvocales blooms during the survey. This

TABLE 4

Occurrence of Volvocales during the survey.

Species	Stations I	II	III	IV	V	VI	VII	VIII
Carteria sp.		×	×	×	×			×
Chlamydomonas sp.	×	×			×			×
Dunaliella salina		×			×	×		×
Heteromastix angulata		×						
Pedinomonas minor	×	×	×				×	×
Platymonas elliptica		×						×
Polyblepharides sp.								×
Polyblepharis sp.						×		
Pyramimonas obovata		×						
Green flagellates, unidentified		×	×		×			

constitutes some indication of recent organic fertilization at this station. Even at Station II, the supply of dissolved organic matter was not consistently high enough to maintain steady blooms of Volvocales, or its effect was periodically limited by other factors. Volvocales were only minor constituents of the plankton in the Point Loma kelp; fewer species of Volvocales were observed in the kelp (Station VII) than at any other station (table 4).

The densest Volvocales blooms encountered in this study were observed not at a regularly sampled station, but in a stagnant natural salina near the Torrey Pines bathing beach, a few miles north of La Jolla. These high tidepools were obviously well fertilized by shore birds and gulls, and by decaying vegetation. They bore dense populations of *Chlamydomonas* and *Platymonas*, *Chromatium*, *Rhodomonas*, *Amphidium operculatum*, and other microorganisms including ciliate protozoa. Organic enrichment certainly favors the Volvocales and Chlorococcales, both of which flourish in fresh water oxidation ponds. Neither of these groups was more abundant in the Point Loma kelp than at the coastal control station in 1959 and 1961.

EUGLENOPHYTA

Green Euglenophyta. — There is one widespread and well recognized marine green euglenid genus, *Eutreptia*, containing 5 species. *Eutreptia lanowi* seems to occur mainly in off-shore waters, but past experience with *E. viridis* indicates that it blooms abundantly in waters receiving sewage. The heaviest bloom of it ever seen by the senior author was off Riverhead, Long Island, off a sewage treatment plant.

Eutreptia viridis was observed in surface water from every station, and with a high frequency (table 5). Numbers were usually low, but fluctuated widely. One *Eutreptia* bloom (>500/ml.) was observed at Station II. This is in accord with evidence from the Volvocales of organic fertilization at this station. *Eutreptia* approached bloom proportions in one of the nine plankton samples from the Point Loma kelp. It was regularly present at the control station, but in small numbers.

Visible blooms of *Eutreptia viridis* in San Diego harbor had been observed frequently in previous summers by B. M. Sweeney and Anne M. Dodson, but it has yet to be observed in bloom proportions along the coast in this region. In the summer of 1952, it bloomed extensively in San Diego harbor (>1000/ml.), but at that time it was not observed off the SIO pier (Sweeney and Clendenning, 1958). In the summer of 1958, *E. viridis* was again observed as blooms in San Diego harbor, but it was also encountered in small numbers off the SIO pier and elsewhere along the coast at that time. In view of its almost uniform occurrence at all stations during this study, significance should only be attached to great numbers of *E. viridis* at a given station.

TABLE 5

Eutreptia viridis in San Diego Bay and vicinity.

Station	I	II	III	IV	V	VI	VII	VIII
Occurrences	4	5	3	6	6	7	7	7
Highest no. per ml.	32	>500	32	16	88	224	400	12

Colorless Euglenophyta.—The colorless Euglenophyceae represent a diverse group, and one of the least understood taxonomically, of marine microorganisms. They are generally saprophytes, even in waters having low contents of dissolved organic matter. Many species are large, and all are recognizable as euglenids by their gullet-reservoir system. They are usually more characteristic of the sediment-water interface than either ciliates or rhizopods. They probably share with bacteria the major responsibility for working over organic debris which rains down in such forms as dead organisms and copepod pellets.

Very few colorless euglenids were found in the surface samples. This is a matter of common note elsewhere. Thus, samples of Lake Santa Fe, Florida, water rarely showed members of this group, yet slides suspended in the lake soon acquired heavy populations of *Anisonema* and *Entosiphon*, two genera also common in salt water. Table 6 shows that in 63 examinations of non-bottom water (surface and lower), there were only 11 occurrences of colorless Euglenophyta, and none in bloom proportions. Actually this represents only 1.94 per cent of the potential occurrence of the 9 species found in the plankton. Sediment samples showed 35 species which occurred 119 times, producing 22 blooms. Actual benthic occurrence was 9.44 per cent of potential occurrence. Method of figuring potential occurrence is given elsewhere. Three species of *Anisonema* were observed on kelp blades from Station VII. Their abundance under the kelp may have been connected with supplies of seaweed substance, as seemed to be the case with the Beggiatoales.

Blooms occurred at every station except II, but there were times when few colorless euglenids were observed at a particular station. Station II was all but devoid of these organisms; only *Calkinsia* sp. and *Entosiphon sulcatum* occurred there. Certainly the environment there was unfavorable for this group, as compared to Station I or VIII. Predation seems unlikely, and either toxicity or poor quality of food seems more logical as an explanation for their scarcity at Station II. The control Station VIII, which should have the cleanest water, showed the largest number of colorless euglenid species; the smallest numbers of species, occurrences, and blooms were at Station II. It may be inferred that sewage organic matter is not immediately utilized by colorless euglenids; instead, they are active in the final stages of its breakdown. The point is debatable; *Peranema*, *Anisonema* and *Entosiphon* are cultivated in the laboratory on rich organic media, but along with other organisms including bacteria, so it is not known what substances they actually utilize. *Peranema* is certainly holozoic, or partly so, at times.

Four colorless euglenids were identified only to genus. *Calkinsia aureus*, hitherto found only at Woods Hole, Massachusetts (Lackey, 1960), occurred here, as well as an undescribed species of the genus. There occurred also species of the genera *Anisonema*, *Pleotia* and *Sphenomonas*, which will be described as new. Colorless euglenids merit much more study because they are of large size, abundant in the sediment-water interface, especially noticeable in the kelp areas, and because the marine species and their distribution are insufficiently known.

PYRROPHYTA

Dinoflagellates proved highly important in this survey, by reason of the wealth of species represented and the large differences in their distribution. Unlike the other groups included in this investigation, the coastal dinoflagellates and diatoms of southern California had previously been studied quite extensively.

More species of dinoflagellates were identified than of any other group. There were over one hundred species, and most of them were planktonic (table 7). The coastal stations showed the largest numbers of dinoflagellate species, of occurrences, and of blooms. The smallest num-

TABLE 6

Distribution and number of occurrences of colorless Euglenophyceae in San Diego Harbor.

SPECIES	STATIONS												
	Benthos								Plankton[1]				
	I	II	III	IV	V	VI	VII	VIII	II	III	IV	VII	VIII
Anisonema sp. 1	1		1			1	1	1					
Anisonema sp. 2								1		1			
Anisonema emarginatum			2	1	2	1	1	3					1
Anisonema ovale	1		1		2	2	2	5			1		
Anisonema truncatum	1			1									
Calkinsia sp.		2						3					1
Calkinsia aureus								1		1			
Dinema grisoleum								1				1	
Distigma proteus	1												
Entosiphon obliquum							1						
Entosiphon sulcatum		1			1			1					
Heteronema sp.							1						1
Metanema variable						1		3					
Notosolenus sp.								2					
Notosolenus apocamptus				1	1			5	1	1			1
Notosolenus orbicularis	1												
Petalomonas sp. 1	2			1		1	1						
Petalomonas sp. 2						1							
Petalomonas abscissa	1												
Petalomonas angusta	1												
Petalomonas carinata	1		1		2			3		1			
Petalomonas gigas	1		1		2	2	1						
Petalomonas tricarinata								2					
Peranema inflexum								1					
Peranema tricophorum	1			1	1			1					
Peranemopsis striata				1									
Pleotia tricarinata	1												
Pleotia vitrea				1	1								
Scytomonas pusilla			1		1								
Sphenomonas elongata	1		1	2	2	3	3	6					
Sphenomonas quadrangularis					1			1					
Triangulomonas rigida	1												
Urceolus cyclostomus								1					
Urceolus sabulosus			1		1		1	1					
Unidentified euglenid			1										
Species	14	2	9	8	12	8	9	19	1	4	1	1	4
Occurrences	15	3	10	9	17	12	12	42	1	4	1	1	4
Blooms	4	0	3	2	3	3	7	3	0	0	0	0	0

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[1] Stations I, V, and VI are omitted under plankton because no euglenids were found there.

bers of species and of occurrences were at the inner-harbor stations, both in the sediments and in the plankton (table 7). As noted elsewhere, the populations of several algal groups were larger at the inner-harbor stations than at the coastal stations, the opposite being true of the dinoflagellates.

From the work of W. E. Allen (1941), Balech (1959, 1960) and others at the Scripps Institution of Oceanography, the numerically abundant types of coastal dinoflagellates in southern California are well known. Allen monitored daily collections from the SIO pier (Station VIII) over a twenty-year period, and many of his preserved collections are still available. During the twelve months preceding this investigation, dinoflagellates were monitored weekly off the SIO pier by Anne Dodson, and they were also studied taxonomically by Balech. The leading types of coastal dinoflagellates in these earlier surveys (viz. *Gonyaulax polyedra*, *Prorocentrum micans*, *Ceratium furca*, *Ceratium tripos*, *Fragilidium heterolobum*) were virtually absent at Stations I-IV in San Diego harbor during this study, while they were present

TABLE 7

Dinoflagellata in San Diego Bay and vicinity.

SPECIES	STATIONS													
	Plankton								Benthos[2]					Total occurrences
	I	II	III	IV	V	VI	VII	VIII	I	V	VI	VII	VIII	
1. *Amphidinium* species		1		1		1	1	2					4	10
2. *Amphidinium cucurbita*[1]					1		1							2
3. *Amphidinium extensum*[1]														
4. *Amphidinium fulva*								1					1	2
5. *Amphidinium operculatum*[1]	1	1	1	1	1	1	1	3	1				2	13
6. *Amphidinium rosa*													1	1
7. *Amphidinium scissum*					1									1
8. *Amphidinium stigmata*						1								1
9. *Ceratium* sp.			1		1	1	2							5
10. *Ceratium candelabrum*[1]														
11. *Ceratium curtipes*						1								1
12. *Ceratium depressum*							1	1						2
13. *Ceratium furca*[1]					2	3	3	3						11
14. *Ceratium fusus*[1]							1	4						5
15. *Ceratium gibberum*[1]							1							1
16. *Ceratium lineatum*							1							1
17. *Ceratium longicauda*								1						1
18. *Ceratium massiliensis*[1]														
19. *Ceratium macroceras*[1]														
20. *Ceratium minutus*					1		1	1						3
21. *Ceratium semipulchellum*[1]														
22. *Ceratium tripos*						1	2	1						4
23. *Cochlodinium* sp.								1						1
24. *Cochlodinium catenatum*[1]					4	6	4	2						16
25. *Dinophysis caudata*[1]														
26. *Dinophysis forti*						1								1
27. *Dinophysis punctata*[1]														
28. *Dinophysis tripos*[1]						1	1	3						5
29. *Dinophysis rotunda*				1	1	2	5	2						11
30. *Diplopsalis* sp.								1						1
31. *Diplopsalis lenticula*[1]						4	1	5			1			11
32. *Diplopsalopsis* sp.							1	4						5
33. *Erythropsis* sp.		1						1						2
34. *Exuviaella* sp.													4	4
35. *Exuviaella apora*								1						1
36. *Exuviaella dactylus*[1]		1		1		2	1	3						8
37. *Exuviaella marina*								4					1	5
38. *Fragilidium heterolobum*						2	2	4						8
39. *Gonyaulax* sp.[1]														
40. *Gonyaulax polyedra*[1]					1	1		2						4
41. *Gonyaulax turbynei*[1]								1						1
42. *Gymnodinium alba*	3	2	3	2	5	2	1	3						21
43. *Gymnodinium albulum*[1]		2	1	1	1	2	1	1				1		10
44. *Gymnodinium aureum*					1									1
45. *Gymnodinium helicoides*						1								1
46. *Gymnodinium heterostriatum*					2		1	3						6
47. *Gymnodinium ravenescens*				1	2	2	2					1	1	9
48. *Gymnodinium simplex*		1		1	1	1	1	5						10
49. *Gymnodinium splendens*[1]				1	1	2	1							5
50. *Gymnodinium stigmata*										1				1
51. *Gymnodinium striata*[1]				2	3	2	2	1						10
52. *Gymnodinium uberrima*					1							1		2
53. *Gymnodinium variable*[1]	3	4	3	4	5	6	4	6						35
54. *Gymnodinium* sp., large[1]		1	1	3	3	2	2	4					1	17
55. *Gymnodinium* sp., small[1]	1	2	1	3	2	1	2	6	2	1	2	1		26

TABLE 7
(Continued)

SPECIES	STATIONS													
	Plankton								Benthos					
	I	II	III	IV	V	VI	VII	VIII	I	V	VI	VII	VIII	Total occurrences
56. *Gyrodinium* sp.				1	1	2	1	5						10
57. *Gyrodinium achromatium*					1									1
58. *Gyrodinium contortum*				1	1		1							3
59. *Gyrodinium corallinum*					1									1
60. *Gyrodinium falcatum*	1	1	2	1										5
61. *Gyrodinium lachryma*								1						1
62. *Gyrodinium maculatum*								1						1
63. *Gyrodinium minor*		1												1
64. *Gyrodinium mitra*								1						1
65. *Gyrodinium pingue*			2		2	1	2							7
66. *Heterodinium* sp.					1									1
67. *Massartia* sp.				1			1	1						3
68. *Massartia glandula*[1]														
69. *Minuscula bipes*		1			3	4	2	1						11
70. *Oxyrrhis marina*		2												2
71. *Oxytoxum* sp.[1]			1				1	1						3
72. *Oxytoxum cribosum*					1	1	1							3
73. *Oxytoxum milneri*				1	1	1								3
74. *Oxytoxum truncata*[1]						1	2	1						4
75. *Peridinium* sp.	1	1	2											4
76. *Peridinium cerasus*		1				1								2
77. *Peridinium divergens*[1]						2		3						5
78. *Peridinium granii*								1	1					2
79. *Peridinium minuscula*				1		1	2							4
80. *Peridinium mita*	1	1		1	1	3	3	1						11
81. *Peridinium pellucidum*								1						1
82. *Peridinium quadridens*							1	5						6
83. *Peridinium steinii*[1]							1							1
84. *Peridinium triqueter*								1						1
85. *Peridinium trochoideum*					1		1							2
86. *Phalacroma* sp.							1							1
87. *Phalacroma mitra*					1									1
88. *Phalacroma rotundum*							1							1
89. *Podolampas palmipes*		1				1	1	2				1		6
90. *Polykrikos schwartzi*					1									1
91. *Pronoctiluca pelagica*				1	1	1	1	6						10
92. *Prorocentrum* sp.								1						1
93. *Prorocentrum gracile*[1]		1		2	5	6	6	5						25
94. *Prorocentrum micans*				1	3	2	1	5						12
95. *Prorocentrum triangulatum*[1]	3	4	1	2	1	1	1	3						16
96. *Protodinium* sp.	1	1			1			1						4
97. *Tetradinium minus*[1]														
98. *Thecadinium* sp.[1]												1		1
99. *Thecadinium kofoidi*											2	1	6	9
100. Unidentified dinoflagellates[1]	1	2	1	3	1	3	3	7	1	1	2	1	1	27
Species	10	22	13	25	40	41	49	53	4	3	4	8	10	
Occurrences	16	33	20	38	68	80	81	134	5	3	7	8	22	

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[1] Includes occurrences in occasional samples not necessarily listed as regular samplings, but taken for taxonomic studies alone.

[2] No dinoflagellates were found in the benthos at Stations II, III and IV except one occurrence of a small *Gymnodinium* at II and III, so these stations are omitted.

as usual at the coastal stations. Among the dinoflagellate species absent from the inner harbor and from South San Diego Bay were those which accounted for the bulk of the dinoflagellate standing crops in neighboring coastal water.

Reduced numbers of species at the inner harbor stations were shown by the majority of dinoflagellate genera during this study, and strikingly so by *Ceratium*. Of the fourteen planktonic species of *Ceratium* observed at the coastal stations, there was only a single occurrence of one species at Stations I-IV of San Diego harbor. The reduced list of planktonic dinoflagellates at these harbor stations included four which were not observed at the coastal stations, viz. *Gyrodinium minor*, *Gyrodinium falcatum*, *Oxyrrhis marina*, and an unidentified species of *Peridinium*. Only three planktonic species occurred with some consistency throughout San Diego Bay and at the coastal stations, viz. *Gymnodinium alba*, *Gymnodinium variable* and *Prorocentrum triangulatum* (table 7). There is little in the literature with which to make comparisons, but the three species occurred in vast numbers at the Carman's River Station in Great South Bay, Long Island, when that location was seriously polluted. There was no such occurrence of blooms in the dinoflagellates during the studies here reported. In fact, the only dinoflagellate blooms noted were small ones at the two coastal stations.

The sediments from Stations II-IV of the inner harbor were devoid of all dinoflagellates except for one small species of *Gymnodinium*. The dinoflagellate which was most characteristic of the interface or first few millimeters of sand under clean water was *Thecadinium kofoidi*, which was found in nine sediment samples from Stations VI-VIII. This species was found in other benthic samples not completely analyzed, hence not tabulated, such as three from about the 90-foot depth in Papalote Bay, Baja California, and several from shallower depths at other coastal locations. *Thecadinium kofoidi* was not found in wet sand between the tide levels at the SIO pier or in any of the surface water collections. It is common in the sand between tide marks in Rhode Island (Lackey, 1961) and at Cedar Keys, Florida. It is inferred, on this evidence, that *Thecadinium kofoidi* is a cleanwater, interfacial dinoflagellate.

There were five species of interfacial dinoflagellates, including two of *Thecadinium*, which were not observed in surface water. These were all virtually colorless and seemed to be saprophytes. *T. kofoidi* had very pale chromatophores, sometimes barely discernible, and the single larger species of *Thecadinium* was colorless. Of the more than one hundred dinoflagellate species observed, a maximum of 17 species was collected from the sediments. Some of these may have been incidental contaminants from the associated water. There were only 33 occurrences of one or another of these 17 benthic species in the sediments, whereas the plankton collections showed 470 occurrences of the 85 or more plankton species. There was a striking difference in the habitat preference of the dinoflagellates and of the colorless euglenids, the latter being concentrated in the sediments. Dinoflagellates and colorless euglenids were both more abundant at the coastal stations than at the inner harbor stations.

Dinoflagellates are notorious bloom-formers along the coast of California, the Gulf coast of Florida, and elsewhere. Usually such aggregates occur in shallow inshore waters where nutrients could be contributed from the land, but this is not always true. *Gymnodinium breve*, the Florida red tide organism, occurs over vast stretches of the Gulf of Mexico, and no unusual nutrient concentration has been implicated (Lackey and Hynes, 1955). Dinoflagellate red tides in southern California usually occur near shore, but the neighboring land is dry and supports sparse vegetation. Rainfall or runoff is not associated with red tides in southern California. Marine outfalls provide extra supplies of algal nutrients, but there is no evidence of a causal connection between them and California red tides (Clendenning, 1959b). Many instances could be cited of dinoflagellates blooming in organically enriched waters, but not for the species that are responsible for red tides off the coast of southern California or the Gulf coast of Florida.

The ecology of dinoflagellates of San Diego Bay merits more intensive study. Despite the wealth of available literature, numerous dinoflagellate species were encountered which have yet to be described.

TABLE 8

Occurrences of Cryptomonads in San Diego harbor and vicinity.

Organisms	Stations							
	I	II	III	IV	V	VI	VII	VIII
Chilomonas marina	4	5	4	6	6	4	1	4
Chroomonas sp.	3	6	5	6	7	5	3	5
Cryptomonas acuta	1	1	2	3	4		2	
Cryptomonas erosa	1	3	1	2	2	1	1	2
Cryptomonas, red, unidentified								6
Cyathomonas truncata					1	1	1	4
Rhodomonas sp.	4	8	5	7	7	9	6	15
Unidentified	1	1						1
Total occurrences	14	24	17	24	27	20	14	37

CRYPTOPHYTA

There are only a few genera and species in this small group of planktonic flagellates. There are perhaps five genera which appear to be important in the ecology of estuarine waters. Table 8 shows the genera found and their occurrences during this survey.

Twelve cryptomonad blooms were observed in San Diego Bay, and there were seven planktonic blooms of cryptomonads at Stations I-III. Even when not present as blooms at these harbor stations, the plankton cryptomonads were regularly abundant there, and they can be termed highly characteristic of that area. From their behavior and occurrence in fresh water situations, it is inferred that cryptomonad blooms indicate recent organic enrichment. Those parts of San Diego Bay which bore the smallest numbers of dinoflagellate species were characterized by large cryptomonad populations. The present data refer to stations near the midline of the bay; denser populations of microflagellates occur between the mainland piers opposite Stations II and III.

Chroomonas was observed in bloom three times at Station I, on July 6 and 14 and on August 9 at 600, 1080 and 886 per ml., respectively. On August 9, *Chroomonas* was also observed in bloom at Stations II-V inclusive, with 1560, 1704, 1404, and 504 per ml., respectively. Thus, on one sampling date, August 9, *Chroomonas* was simultaneously in bloom at Stations I-V, spanning about nine miles of San Diego Bay. *Rhodomonas* was observed in bloom three times, once each at Stations II, III and IV. These blooms were respectively 864 per ml. on July 6, 1728 per ml. on July 14 and 720 per ml. on August 9.

The numbers of planktonic cryptomonads decreased toward the harbor entrance, and they were less abundant in the Point Loma kelp than at the control station. This was true on dates when the cryptomonads were in bloom throughout the inner harbor.

Chilomonas marina and *Cyathomonas truncata* are colorless saprophytes, the latter most often a bottom dweller. *Chilomonas* was found in small numbers at every station. *Cyathomonas* was not observed at Stations I-IV (table 8), and its two blooms in the outer harbor were benthic — 1600 per ml. at Station V on July 8 and 800 per ml. at Station VI on July 30. The red *Cryptomonas* found only off the SIO pier also came from bottom samples. This genus is usually red when collected at considerable depths and in the colder months.

The largest number of cryptomonad species was observed at the control station (SIO pier), but the cryptomonad populations at the coastal stations were small. The cryptomonads which bloomed in San Diego harbor were also found at the coastal stations, but only in small numbers. No attempt was made to identify species of *Chroomonas* and *Rhodomonas* because they are not well separated taxonomically.

Cryptomonads in general are autotrophic in bacteria-free laboratory culture, but other types of phytoplankton have similar organic requirements. The cryptomonad blooms in San Diego harbor may have been stimulated by extra supplies of vitamins or other organic nutrients,

TABLE 9

Blooms of Chrysophyceae and Xanthophyceae observed during this survey.

	Station								
	I	II	III	IV	V	VI	VII	VIII	IX
Chromulina ovalis								1200	
Chrysochromulina kappa		1440	540	600	630			648 (13,800 jar)	600
Chrysochromulina chiton		1200							
Kephyrium ovum					624				
Olisthodiscus luteus		1642					1560		
Unidentified Chrysophyceae					32,000			(3,000 jar)	

but this is a topic for future study. The planktonic cryptomonad blooms imparted a brownish color to the water, their chlorophyll being masked by bilichromoproteins and carotenoids. Information has recently been provided on the photosynthetic pigments and action spectra of several marine and fresh water cryptomonads (Allen, Dougherty and McLaughlin, 1959; Oh Eocha and Raftery, 1959; Haxo and Fork, 1959).

CHRYSOPHYTA and XANTHOPHYTA

Chrysomonads tend to be pale yellow, their chlorophyll being obscured by carotenoids. Holophytic, holozoic and saprophytic modes of nutrition are represented in this group, and laboratory cultures indicate that even the deeply pigmented ones may be partly saprophytic. This group includes naked photosynthetic flagellates, and the chrysomonad blooms encountered (table 9) were mainly of this type. These organisms are apt to be undercounted because they are one of the first to disintegrate on centrifuging or standing, and most of them cytolize after formalin preservation.

The present list (table 10) does not include some colorless forms which we prefer to treat as zooflagellates. It does include *Olisthodiscus* and *Chloramoeba* of the Xanthophyceae, a group that was not otherwise represented. Only three of the listed species were common in the portion of the bay which might be suspected of pollution. Assuming there were only 24 species of chrysomonads in the 99 marine samples, the percentage of occurrence was rather high. There could have been 2376 (24 × 99) occurrences instead of 311 (table 10). Actually the percentage of possible occurrence was 13.09, which we interpret to mean that under the conditions of the survey, Chrysophyceae were common and widespread, and therefore important in the ecology of the area.

That chrysomonads generally favor water of good quality was borne out in this study. Stations I-III had fewer species and occurrences of chrysomonads than Stations V-VIII. However, there were blooms of a few species at the inner harbor stations at times (table 9). *Chrysochromulina* was the only member of this group which showed widespread large numbers. The most dense chrysomonad bloom encountered was caused by an unidentified species near Shelter Island (32,000 per ml. at Station V).

Olisthodiscus luteus was widespread, occurring frequently at Stations I-VII (41 occurrences), often in some abundance. Typically it is found in dim light near the sediment-water interface, which was the location of the blooms we recorded (table 9). It is believed that this is the second time that this genus has been reported since Carter (1938) published the original description. An extensive bloom developed in surface water during cloudy weather in 1957, near Shelter Island and our Station V. Anne Dodson isolated the predominant organism and maintained it on Miquel's medium as a dark brown culture, and Lackey identified it as *Olisthodiscus luteus* in 1959.

The organism termed *Chrysochromulina* might be identified as *Prymnesium* by some workers, but the stiff bristle emerging anteriorly between the two posterior-pointing undulant

TABLE 10

Occurrence of Chrysophyceae during this survey.

Organism	Stations								
	I	II	III	IV	V	VI	VII	VIII	Total occurrences
Calyptrosphaera sp.					1	3	3	4	11
Chloramoeba marina								1	1
Chromulina ovalis	1	1	1	2	4	5	2	6	22
Chromulina elongata								1	1
Chromulina globosa							1	1	2
Chrysamoeba sp.					1	1		1	3
Chrysochromulina kappa	2	7	8	12	11	10	9	14	73
Chrysochromulina chiton	1	1	1	1	1	1	1	1	8
Coccolithophora, unid.								2	2
Chrysococcus cingulum		2	1	1	2	1			7
Dictyocha fibula							2		2
Dinobryon sp.					1	2	3	4	10
Ebria tripartita					1	2	1	3	7
Kephyrion ovum	4	5	5	6	6	7	4		37
Ochromonas sp.		1		1	2	1		2	7
Olisthodiscus sp.		1		3	2	2	1	9	18
Olisthodiscus luteus	3	5	4	5	9	9	5	1	41
Pontosphaera sp.					1	2	4		7
Pontosphaera huxleyi				2	4	4	4	2	16
Pontosphaera inermis					1	2			3
Pseudopedinella pyriformis				2	1	1	1		5
Syracosphaera sp.					2	2	2	1	7
Syracosphaera carteri					1	1	1	5	8
Chrysophyceae, unid.	1	1	1	2	3	3	1	1	13
Totals	12	24	21	37	54	59	45	59	311

flagella is not a flagellum but a hapteron. This view is abundantly borne out by the work of Parke, Manton and Clarke (1955), so the organism is properly called *Chrysochromulina.*

CHLOROMONADIDA

This group was represented by *Thaumatomatix setifera*, which was observed a single time, and by a new organism which is tentatively assigned to this group. None of the green Chloromonadida occurred in the samples. *Trentonia flagellata*, a constant inhabitant of Warm Mineral Springs in Florida and of estuarine situations, was not encountered.

BACILLARIOPHYTA

Diatom taxonomy is the weakest part of this report. There was simply not enough time to identify all of the species encountered, many of which occurred in very small numbers. Most of the common planktonic types were represented, but blooms were restricted to those listed in table 11. During the previous summer, extensive blooms of *Leptocylindrus* were observed at the SIO pier and in La Jolla kelp.

Asterionella japonica and a minute *Cyclotella* occurred as extensive blooms in San Diego Bay. The *Cyclotella* is exceedingly small, and there is a good possibility that it is not correctly identified, but may be a *Detonula* such as occurred in Great South Bay, Long Island, in 1958 (Ryther *et al.*, 1958). In the latter instance, its identity was established with an electron microscope. For practical purposes it will be referred to as *Cyclotella.* Some *Coscinodiscus nitidus* less than 16μ in diameter may have been included in the *Cyclotella* blooms.

TABLE 11

Diatom blooms during the survey (cells per ml.).

	Stations							
	I	II	III	IV	V	VI	VII	VIII
Asterionella japonica	3084	6000	6960	8440	624	1260		
		410	4290	630	4080	1218	1800	
				6600	6480	1260		
				630		2676		
Chaetoceras sp.	2544							
Chaetoceras solitaria							600	
Cyclotella sp.	996	24480	840	720	660	558	720	
		1200	6600	2040	5700	3300	1920	
		24480	26400	56000		9792		
		7392	2880	1080	552	80000		
			16320	8400	1224			
		1200	6120	3672	14688			
					105600			
Coscinodiscus sp., 10					720			
Melosira sulcata						1536		
Navicula spp.	12600		800		5600	800	2112	3200
						4000	4800	4800
							3600	
Nitzschia closterium								1200
								1200
								540
Pleurosigma elongatum							528	
Skeletonema costatum				840	720			
					600			
Unidentified diatoms			2400		1800	4800	2688	

Seventy-two diatom blooms were observed in this study, and sixty-three of these were at Stations II-VII (table 11). In consideration of the many papers written on the nutrition and blooming of fresh-water diatoms, the principal reason for the frequent blooms of diatoms in San Diego harbor would seem to be that the water is fairly rich in inorganic nutrients. Diatoms were more abundant at the harbor entrance and in the Point Loma kelp than at the control station, and this difference was mainly due to *Asterionella japonica* and *Cyclotella.* More dense populations of the latter were observed than of any other organism included in this study, and the most dense of these were collected near the 10th Avenue pier (Station IV) and Shelter Island (Station V). The 30 blooms of *Cyclotella* were limited to San Diego Bay and its immediate vicinity. There were also 17 blooms of *Asterionella* in this area, and the distribution patterns of the *Cyclotella* and *Asterionella* blooms in San Diego Bay were similar. These diatom blooms may have exerted influences in several ways. They may have depleted nutrients that would otherwise be available for other photosynthetic plankters, and the possibility of antibiotic influences cannot be excluded. They may have provided grazing for animals, particularly copepods, which were quite abundant at the same time. The blooms were sufficiently abundant to decrease the submarine light intensity in the deep water of Stations III-VI. The three mild blooms of *Cyclotella* and *Asterionella* observed in the nearest kelp (Station VII) may have originated in San Diego Bay, where they were much more numerous; they were not observed at the control station. The increased numbers of diatoms observed in the Point Loma kelp were offset to a considerable extent by decreased numbers of other algae; the overall abundance of phytoplankton was quite similar at the kelp and control stations.

TABLE 12

Number of times zooflagellates occurred during the survey at each station.

Organisms	Stations								
	I	II	III	IV	V	VI	VII	VIII	Totals
Bodo sp. 1	2	3	2	4	3	2	3	4	23
Bodo sp. 2						1			1
Bodo caudatus	1					1			2
Bodo globosus		1	1	1					3
Bodo minimus	1								1
Bodo parvulus	1		1	1			1	1	5
Bodo spp.	2	1	2	1	1	1	2		10
Bodopsis sp.							1		1
Cercobodo grandis						1			1
Dicraspedella stokesii							2		2
Diplosigopsis socialis						1			1
Histiona zachariasi							1		1
Mastigamoeba reptans					1				1
Monas minima							1		1
Monas sp.		2	1	2	1	1	1		8
Monosiga ovatus	1	4	3	3	2	2	5	4	24
Multicilia lacustris								1	1
Oicomonas spp.	2	5	3	8	5	5	2	2	32
Phanerobia pelophila								1	1
Pleuromonas jaculans							1		1
Rynchobodo sp.	2					2		1	5
Rynchomonas nasuta					1		1		2
Solenicola setigera							2		2
Spiromonas angusta		1	1	1		2	1		6
Stomatochone infundibuliformis								1	1
Tetramitus pyriformis	1								1
Trimastigamoeba sp.		1							1
Large monads	2	2	2	3	2	1		2	14
Small monads	9	9	8	11	12	12	12	11	84
Totals	24	29	24	35	28	32	36	28	236

Some diatoms were always present in the surface and bottom samples. Most of them were in the water, but they were also present at the interface. *Pleurosigma angulatum* was quite characteristic of this last situation. There was a colorless naviculoid species in limited numbers at Stations II, IV and VI, always in the interface. Except for those recorded in table 11, diatom numbers were not large, and few unusual ones (to us) were noted. It appeared that virtually all species could have been identified from existing treatises. Among all the phytoplankton categories included in this study, only the diatoms were found in appreciable greater numbers at the harbor entrance and in the nearest Point Loma kelp than at the control station.

PROTOZOA

Zooflagellata. — The predominately animal-like group of protozoa included a large number of small, colorless flagellates. These flagellates may play important roles in marine plankton ecology. They were numerous in San Diego harbor, and because they and the ciliates are bacteria-consumers, their importance is merited. If present in sufficient numbers they tend to keep the bacterial population in the exponential growth stage. Their rate of reproduction is fast, and many are ubiquitous. They are also difficult to study. Ruinen (1938) has provided figures of some of the smaller ones. Because of their amoeboid characteristics, many must be

TABLE 13

Occurrence of ciliate Protozoa at all stations during the survey.

Stations				Organisms					
	I	II	III	IV	V	VI	VII	VIII	Totals
Aegyria reesi						1	1		2
Amphileptus sp.									1
Amphisia multiseta			1		1				2
Amphorellopsis acuta								1	1
Amphorellopsis tetragona						1	1	2	4
Aspidisca costata	1		1	1		1		7	13
Aspidisca hexeris	1		1	1					8
Aspidisca lynceus	1								1
Aspidisca polystyla									1
Chilodonella uncinatus								1	2
Chlamydodon memosyne									1
Cinetochilum margaritaceum			1						3
Coleps spp.	1		1					3	7
Condylostoma patens			1					1	3
Cristigera minor								1	1
Cryptopharynx setigerus			1					3	4
Cyclidium glaucoma	3	3	5	4		3	3	8	32
Cyclidium sp.									2
Cyclotrichium gigas								1	1
Cyclotrichium meuneri	1								1
Dipleptus marinus								1	1
Drepanomonas revoluta	2			1				1	4
Dysteria monostyla								3	6
Enchelymorpha vermicularis								2	2
Epalxis exigua								2	2
Epiclintes ambiguus							1		1
Euplotes spp.			1	1		1	1	9	17
Favella markusovsky						1			1
Gastronauta membranacea								1	1
Geleia decolor							1	3	5
Halteria grandinella	1								1
Helicostomella edentata						1	1		2
Holosticha violacea									1
Kentrophoros fasciolata					1				1
Lacrymaria olor	1								4
Lembus infusionum		1				1	1		4
Lembus saprophilus								4	5
Lionotus cygnus									2
Lionotus simplex									1
Lionotus sp.								1	2
Loxophyllum sp.	1							1	2
Mesodinium acarus					1				2
Mesodinium pulex	1							1	2
Mesodinium rubrum	2	3	3	2	3	1			14
Oxytricha spp.		1	1			1		1	9
Metopus sigmoidea					1			1	2
Peritromus emmae								4	4
Plagiocampa mutabilis								1	1

TABLE 13
(continued)

Organisms	Stations								
	I	II	III	IV	V	VI	VII	VIII	Totals
Pleuronema marinum			1			1		1	3
Prorodon sp.		1							1
Protocrucia pigerrima									1
Ptychocylis obtusa							1		1
Remanella rugosa				1					1
Remanella brunnea	1								1
Spriostomum intermedium								1	1
Stichotricha secunda								1	1
Strobilidium marinum		2		1		2	1	2	9
Strombidium spp.	3	1	1		2	1		7	17
Strongylidium sp.	1								1
Telostoma ferroi	2						1		3
Tetrahymena sp.						1	1		2
Tiarina fusus							1		1
Tintinnopsis minutus	2	4	3	2	7	7	3	1	29
Trachelocerca coluber	1	1	1			2		8	14
Trachelocerca phoenicopterus	2	1		1	1	2	1	2	11
Trachelostyla caudata	1	2			1	1			5
Trochilia sigmoides									1
Uroleptus sp. no. 1			1	2	1		1	2	7
Uroleptus pisces								1	1
Uroleptus sp.	2	1	1	1	2			2	9
Uronema marinum							1		1
Uronychia setigera								1	2
Urotricha farcta							1		1
Vorticella sp.		3	1	4		1		1	10
Ciliata, unidentified	2	1	3	3	4	5	3	10	34
Totals	33	25	29	25	25	35	25	104	301[1]

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[1] In addition to 301 occurrences of ciliates in regular sampling of Stations I-VIII, there were 57 ciliate occurrences in irregular samples, or samples kept a few days after counting, to make a total of 358.

closely studied, preferably in numbers and in culture, if species determination is to be based on morphological characters. For the purpose of this survey, counting was more necessary, hence work remains to be done on the list of species. However, the information presented here is factual and relatively complete. There were recognized 29 species, genera, or groups, including some to which provisional names have been assigned (table 12). Their occurrences were more uniform between stations than for any other group studied. Blooms were observed most frequently in San Diego Bay and in the Point Loma kelp: only one zooflagellate bloom was observed at the control station, six blooms were observed in the Point Loma kelp, and from five to ten were observed at each of the harbor stations. The bacteria on which they feed apparently were more abundant in San Diego Bay and in the Point Loma kelp than at the control station. The zooflagellates encountered were those characteristic of the later stages of organic decomposition. However, only the aerobic zooflagellates were present here, the anaerobic types being absent. Unlike the blooms of larger organisms which usually have only a single species in great numbers, the zooflagellates often bloomed synchronously. Thus, in a sample collected at Station I on July 30, six different kinds of zooflagellates were present in bloom proportions simultaneously.

Zooflagellates were numerous on old and injured *Macrocystis* blades as well as at the bottom interfaces under the Point Loma kelp. Information is lacking on the benthic populations of these and other microscopic animals in different giant-kelp beds. Any factor that increases the supply of bacteria should increase the zooflagellates, and natural supplies of organic matter are very large in giant-kelp beds.

Ciliata. — Planktonic ciliates, especially tintinnids, were less numerous in this survey than expected. Benthic ciliates were more frequently encountered, but this group is not too well defined taxonomically, and some identifications in table 13 may include more than the single species named. Thus, *Glaucoma scintillans* and *Dysteria monostyla* may include other species. *Eplaxis exigua* is a rarely seen organism; either it varies widely in morphology or there are several other closely related Ctenostomata. The organism listed as *Uroleptus* sp. is not a described species, but is so common in oceanic benthos, and in Warm Mineral Springs, Florida, that it has been given a provisional name in our work, for purposes of recognition. It is always completely invested with tangential brown rods which appear to be bacteria.

Almost all the ciliates listed are holozoic; *Epalxis* and possibly one or two others may not be. The greater number feed on bacteria, although a few eat small algal cells and *Coleps* is predatory on other protozoa. The species *Mesodinium rubrum* (*Cyclotrichium meuneri*) contains small reddish brown bodies which have been called chromatophores, but which likely are algal cryptomonad symbionts. It is this type which is responsible for "ciliate red tides" which are common in certain parts of the world (Bary and Stukey, 1950). *Mesodinium rubrum* was detected throughout the inner harbor, and a mild bloom of it was observed at Station I on August 1, 1959 (522 per ml.). About this same time, an extensive bloom of this organism was observed (without counts) from Baja California. The only other ciliate bloom noted during this study was by *Cyclidium glaucoma*, which attained a density of 1500 per ml. at Station I on July 30.

Except for the two blooms in South San Diego Bay, ciliates were not present in large numbers. A great array of species was encountered, but occurrences of individual species were usually low. There were 32 occurrences of the bacteria-feeder *Cyclidium glaucoma*, which was found at every station and more frequently at the control station than at any other station. Occurrences of ciliate species as a whole were greater at the control station than elsewhere. As to indicator species, there has been too little work on marine ciliates to know whether there are such. Numerous ciliates were observed in benthic samples from the Point Loma kelp and on the kelp blades, but their ecological significance cannot as yet be assessed. Some of these could be predatory on kelp zoospores and later microscopic stages; the ciliates *Holosticha* and *Condylostoma* are known to eat microscopic algae. The red ciliate *Holosticha violacea* was a fairly conspicuous inhabitant of *Membranipora*-encrusted kelp blades, the only habitat in which it was here encountered.

OTHER ORGANISMS

Very few rhizopods were encountered. Radiolarians were present in seven samples from the offshore stations, but in small numbers. A few living Foraminifera were found in sediment from Stations VI, VII and VIII. Amoebae and Heliozoa were present in small numbers in benthic samples, and became more numerous when the samples were cultured. Nematodes were observed at times and a few rotifers were found. Almost all metazoa occurred in scattered fashion and it may be said that during the time of the survey, microscopic forms in the water and sediments were largely restricted to algae and protozoa.

MICROBIOTA OF KELP BLADES

The microbiota of clean healthy blade surfaces was quite sparse. Grazed and sloughed margins had larger populations of bacteria, zooflagellates, colorless euglenids and ciliates. *Membranipora*-encrusted blades were veritable population centers for a wide variety of organisms, both plant and animal. Colonies of a reddish blue-green alga were observed as coatings on the blades under the *Membranipora*, and a green alga was observed in large numbers within

TABLE 14

Number of times organisms in various groups exceeded 500 per ml. during the survey.

Organisms	Stations								
	I	II	III	IV	V	VI	VII	VIII	Group Total
Sulfur bacteria	3	4	3	4	2	4	3	3	26
Chlorococcales	2	3	5	5	5	4	2	3	29
Volvocales		3	2	2	2	1	1	1	12
Diatoms	4	7	10	11	14	12	9		67
Chrysophyceae	1	2	1	1	3		1	3	12
Cryptophyceae	2	2	2	2	2	2			12
Eutreptia lanowii		1							1
Euglenophyceae, colorless	4		3	2	3	7		3	22
Dinoflagellata						3		1	4
Zooflagellata	10	7	9	6	5	10	6	1	54
Ciliata	2								2
Total, all groups	28	29	35	33	36	43	22	15	
Average no. blooms/sample	3.33	2.56	3.4	2.75	3.00	2.77	2.54	1.05	

old *Membranipora* colonies. The chain diatom *Grammatophora* and filamentous red algae grow up between the bryozoans. The ciliate *Holosticha*, copepods and a variety of other motile invertebrates were observed in and around the *Membranipora* encrustations (cf. Wing and Clendenning, 1959). When the kelp blades become colonized with *Membranipora*, a general fouling of the blades follows. Increases in microscopic food supply and other factors favoring the encrusting animals presumably could injure the kelp plants indirectly.

DISCUSSION

The microbiota of San Diego Bay will now be considered in relation to natural hydrographic factors and waste discharges, and in relation to the kelp near the harbor entrance. The gradual development of San Diego Bay as a commercial, military and recreational harbor has involved extensive dredging and filling, an activity which continues. The general effect of these modifications has been to deepen the harbor and to decrease the bay area, with little change in the bay volume. In contrast to Mission Bay, which in its present form is man-created, the general shape of San Diego Bay remains quite similar to that shown in the original American chart, prepared in 1851. Measured from Ballast Point, the axial length of the bay is 13.8 miles, the area is 18.6 square miles, and the average volume is 76 × 10^9 gallons (Anon., 1950, 1952; Nusbaum and Miller, 1952). The tides are of an unequal semi-diurnal type with a small spring maximum. From the data of the U. S. Navy Volunteer Research Unit 11-5, 1950, the near tidal prism is estimated to be 12.8 × 10^9 gallons. Daily tidal exchange by 1.9 cycles therefore averages 24.3 × 10^9 gallons or one-third of the bay volume, which is about five hundred times larger than the daily discharge of municipal wastes during this study. Tidal exchange fluctuates to a known extent from day to day, mainly within a factor of two; on a weekly basis, tidal exchange in San Diego Bay is fairly constant throughout the year. In the summer months, tidal exchange is close to the annual average, as was true during this study. The mean amplitude of particle travel per tidal cycle is assumed to be about two miles in unobstructed parts of the bay. The detention periods are increased by the baffling action of piers, anchored ships, and irregularities in shape and depth; prevailing westerly winds create onshore currents which concentrate plankton and suspensoids between the mainland piers, especially between our Stations II and III (Kittredge and Corcoran, 1955). These factors contribute to the conservative nature of the inner harbor, which was quite evident in this study of the microbiota. Flushing efficiency diminishes along the bay, from the entrance inward. The water depth also decreases from the northern to the southern end. The temperature of the bay undergoes only small changes throughout the year. In the warmer seasons, maximum temperatures and salinities are attained in the shallow southern end. There are large changes in the plankton populations along the bay, and there are also axial gradients in temperature and salinity; these biological and physical attributes of San Diego Bay are enhanced by sluggish horizontal mixing.

A limited fertilizing influence in San Diego harbor was revealed by this study of its microbiota. The photosynthetic microflagellates and other small algae which attain outstanding numbers in the fertilized middle section were mainly retained in the harbor as characteristic resident populations. Exceptions were the diatoms *Cyclotella* and *Asterionella* which were observed in bloom throughout the bay and two miles outside it in the nearest kelp. San Diego Bay was more eutrophic than the coastal stations during this study, but phytoplankton blooms were encountered frequently at all stations (table 14). The nutrient concentrations in the fertilized middle part were sufficient to support a substantial plankton, but were not large enough to support huge populations such as were observed by Lackey in Great South Bay, Long Island, or reported by Braarud (1955) for Oslo Fjord.

The main source of organic wastes released in San Diego harbor was the municipal sewage outfall, located between Stations II and III. Organic wastes are also released by a kelp processing plant and by fish canneries between stations II and IV. The municipal waste discharge increased from 5.2 to 44.4 million gallons per day between 1943 and 1958 (North, 1960). The volume of treated sewage released during the summer of 1959 was about fifty million gallons per day. Figure 2 relates the tidal exchange to the municipal waste discharge in different years. Twenty years ago, about 5000 gallons of sea water were exchanged tidally at the harbor entrance per gallon of sewage released 5 to 10 miles within the harbor. A temporary disappearance of kelp along the Point Loma peninsula at that time prompted a study of this problem by Wohnus (1942). This ratio has decreased with time, and now the tidal exchange waste discharge ratio is about 500:1 (fig. 2). This ratio refers not to the present release of 0.2 per cent by volume of sewage at the harbor entrance but to the transformation products which reach there in the form of extra plankton, nutrients and leptopel. Suspended matter in the original sewage ranges from 90 to 100 mgm. per liter. Diluted 500-fold, this amounts to 0.2 mgm. per liter, or 0.02 mgm. per liter after 5000-fold dilution. Leptopel contents of coastal sea water vary widely, but 1 mgm. per liter is a typical value. Detention of the organic matter within the harbor effects a fairly complete mineralization. This was reflected in the high mineral contents (55 to 65 per cent) of the leptopel collected off Ballast Point and Point Loma (Clendenning, 1959a) and in the large changes in the microbiota between Stations II and VI. The abundance of diatoms near Shelter Island is attributed to mineral rather than organic nutrients. The water at this station meets health requirements for water contact sports, and it is four miles closer to the municipal outfall than the nearest kelp.

According to Emery (1960), phosphate and fixed nitrogen are roughly 1000 times more abundant in sewage effluent than in average surface sea water. This estimate was borne out by phosphate analyses conducted throughout a complete year, 1958-59, by San Diego Marine Advisors (1959). Mission Bay receives negligible wastes, so the phosphate concentrations observed one mile within Mission Bay and one mile within San Diego Bay (between our stations V-VI) provide a useful comparison. The average phosphate concentrations (PO_4-P, microgram atoms per liter) were: San Diego Bay, 2.28; Mission Bay, 0.95; coastal stations along the intervening Point Loma kelp area, 0.75. The latter study demonstrated extra phosphate in North San Diego Bay, but the phosphate supply there was not larger than in deep oceanic water along the adjacent continental shelf, 5 to 10 miles seaward. Growth of *Macrocystis* is supposed to be favored by the fertilizing effect of upwelling (Clendenning and North, 1960; Clendenning and Sargent, 1958). In this respect, the effects of San Diego Bay water and of upwelling water on *Macrocystis* should be similar, since they are both enriched with mineral nutrients. During this study, fertilization effects were apparent in the microbiota at the harbor entrance, with a tidal exchange waste discharge ratio of 500:1. Twenty years ago, the dilution there was ten times larger. Fertilization effects are measurable when sewage has been diluted 500-fold, but scarcely so after

5000-fold dilution. This is relevant to the problem of kelp disappearance along eight miles of Point Loma coastline. Vastly greater dilutions are to be expected in the affected kelp area as a whole, along eight miles of coastline, than at the harbor entrance (fig. 2).

The disappearance of kelp off Point Loma was arousing concern twenty years ago. Wohnus (1942) reported a 35 per cent decrease in area of the Point Loma kelp beds between 1911 and 1935, and a 50 per cent decrease between 1911 and 1941. These kelp beds have continued to decrease in area since; the maps for 1955 to (or and) 1956 indicate about 90 per cent reduction in area since 1911 (North, 1958). As Wohnus (1942) pointed out, the Point Loma kelp beds have been receding gradually for a long time. Subtle effects of San Diego harbor water on the nearest kelp could be noted in the study, but were not noted on kelp eight miles northward. The kelp maps provided recently by North (1960) reveal a large recession of the Point Loma kelp from the northern end, opposite Mission Bay, and also from the southern end, with fairly dense kelp remaining about equidistant from Mission Bay and San Diego Bay. Mission Bay and San Diego Bay both seem to be implicated, and organic wastes are not released in Mission Bay. A common denominator for the bays is harbor activity, especially dredging, which has been very extensive over a period of many years. The pattern of kelp disappearance (1911 to 1956) seems to exclude influences of San Diego harbor at the northern or Mission Bay end, where the kelp has receded for several miles. Grazing by sea urchins and other kelp predators is severe in the Point Loma kelp area, especially at the southern end. Another factor to be considered is preferential kelp harvesting because of the convenient location of the Point Loma kelp beds. Superimposed on these are the possible contributing effects of vastly diluted and transformed sewage at the southern end. Natural supplies of animal and vegetable organic matter in giant kelp beds are large. Healthy kelp beds bear teeming populations of fishes and invertebrates. At the vast dilutions now and formerly effected within San Diego harbor (fig. 2), it is difficult to account for the disappearance of 1,000,000 tons of kelp along the Point Loma peninsula in terms of San Diego sewage, especially at the northern end opposite Mission Bay. However, except for Station VII at the southern end, this large kelp area has yet to be investigated microbiologically in a comprehensive sense.

This study was made at a time of long day length and of summer temperatures. By freshwater standards this is a time of generally high plankton populations, and so far as is known this is also true of San Diego Bay and adjacent coastal water. Phytoplankton were sampled daily for twenty years off the Scripps pier (Station VIII) by Dr. W. E. Allen (1941), who found that the algae were most abundant there during the late spring and summer months or summer solstice. Nusbaum and Miller (1952) refer to more frequent phytoplankton blooms and higher concentrations of dissolved oxygen in San Diego harbor during the summer months. This is borne out by the plankton analyses of B. M. Sweeney in 1952, who observed much larger phytoplankton populations in San Diego harbor during the summer than during autumn and winter months. From 1952 to the present, there does not seem to have been any great change in the quantity or character of the mid-summer phytoplankton in San Diego harbor. Phytoplankton blooms were almost continuously present at the harbor stations during this study, and diatom populations up to 100,000 cells per ml. were encountered, the most dense that have been observed to date in San Diego Bay. It is considered unlikely that much denser populations would have been encountered by including other seasons having lower temperatures and shorter day lengths. The phytoplankton blooms observed in San Diego Bay at least were sufficiently frequent and dense to reveal salient features concerning their distribution throughout its length. The year 1959 was not a "red tide" year, in contrast to 1958 and 1960. According to the weekly monitoring data provided by Anne Dodson, phytoplankters were less abundant off the SIO pier during the summer of 1959 than during the preceding and following summers.

Figure 3 summarizes the information concerning relative abundances within different phytoplankton bloom categories through the length of San Diego Bay. Taking the most dense station for each type as 100, there were symmetrical increases in the average populations of Chlorococcales and of *Asterionella japonica* from Station I to IV, then symmetrical decreases

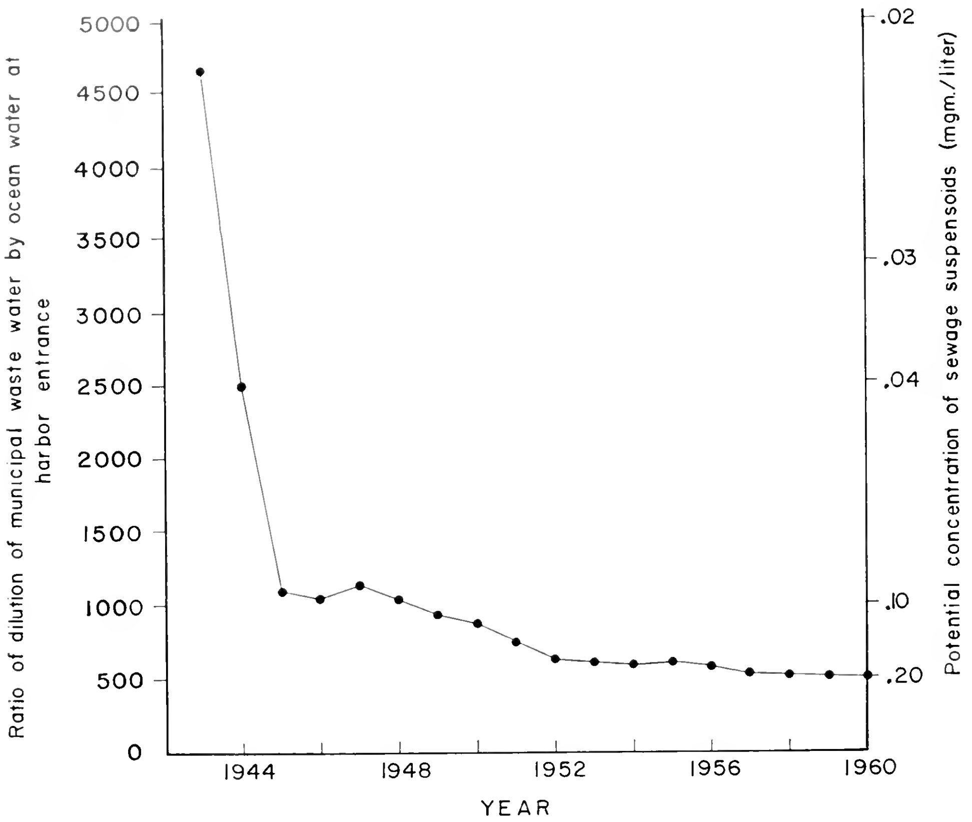

Fig. 2. Twenty year change in tidal exchange ratio, ocean water and waste discharge at the entrance to San Diego Bay.

to oceanic levels toward the harbor entrance. The populations of planktonic cryptomonads were largest at Stations I-III, and they decreased symmetrically through Stations IV and V. A related distribution was observed for the ciliate red tide organism, *Mesodinium rubrum* (*Cyclotrichium meuneri*); on August 17 there were 522 per ml. at Station I, 204 per ml. at Station II, 60 per ml. at Station III, 12 per ml. at Station IV, 9 per ml. at Station V, and none farther out in the bay. Figure 3 provides evidence of an ecological succession along the length of San Diego Bay; moving toward the open sea, the cryptomonad populations decreased first, then the Chlorococcales and *Asterionella*, followed by other diatoms.

An objective of this study was to define microbiological effects of organic wastes released in San Diego harbor on kelp bed No. 2, which formerly occupied 1.85 square miles alongside and athwart the harbor entrance. If we recall the distance of this bed from the waste outfalls, the dissipation of that waste by mixing, the lack of appreciable effects of the Santa Barbara outfall on the adjacent kelp bed, and other factors, we may then look for microbiological effects. These effects could be expressed via phytoplankton or zooplankton, or through sessile inhabitants of the kelp surfaces and rocky bottom. The photosynthetic microflagellates which flourish in the fertilized middle section of San Diego harbor were no more abundant at the Point Loma kelp station than at the control station, sixteen miles up the coast. Diatom blooms were encountered more frequently in the kelp than at the control station, but this was offset, at least partially, by some inhibiting effect on coastal dinoflagellates. Phytoplankton as a whole was not

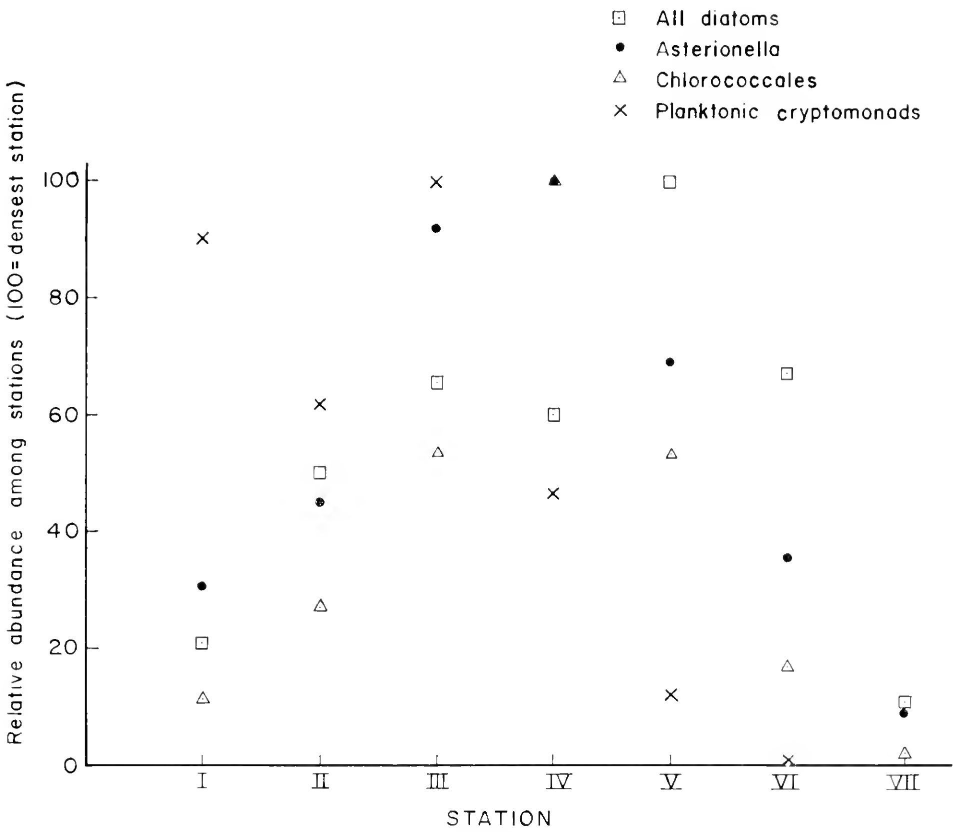

Fig. 3. Relative population densities within several phytoplankton categories throughout the length of San Diego Bay, July - August, 1959.

appreciably more abundant in the Point Loma kelp than at the control station. The more frequent blooms of microbiota in the Point Loma kelp (table 14), apart from diatoms, were due to benthic zooflagellates and colorless euglenids. Extra phytoplankton could possibly shade and impede the growth of young *Macrocystis* plants on the bottom. In assessing this possibility, different lines of evidence need to be considered. The vicinity of Station VII is the best collecting area for young *Macrocystis* plants in the San Diego region. The young plants are often removed by sea urchins, but this bottom area is well supplied with sessile algae. Phytoplankton blooms have a sporadic seasonal distribution, the bulk of the cells being formed in late spring and summer. This is when the water column off Point Loma is thermally stratified to the greatest extent. The warmer water from San Diego Bay enters the mixed layer above the thermocline, but does not mix with the entire water column. Below the thermocline, the water is usually very clear. Water transparency measurements made throughout the year in this area (San Diego Marine Advisors, 1959) revealed greater turbidity within Mission Bay, eight miles northward, and in nearshore water off the Coronado Silver Strand, several miles south of our Station VII, than in the Point Loma kelp or in the outer part of San Diego Bay.

As a further test of the fertilizing action of wastes on the harbor phytoplankton, occurrences of *Pyramimonas* (probably two or three species) were averaged in all samples at each station (table 15). Average occurrences for all other Volvocales, for two species of the Chrysophyceae and for all other Chrysophyceae are also shown in table 15. Average occurrences

TABLE 15

Averaged occurrences of certain phytoplankters, or groups of phytoplankters.

Organism or Group	Stations							
	I	II	III	IV	V	VI	VII	VIII
Pyramimonas spp.	17	458	155	67	96	64	14	18
Other Volvocales	42	148	162	107	173	71	28	84
Olisthodiscus luteus	42	252	25	19	11	28	0.8	0
Prymnesium sp.	92	342	209	205	188	60	183	306
Other Chrysophyta	50	104	109	25	69	27	61	112

were low at Station I, highest at Stations II and III, and then decreased toward the open ocean. *Prymnesium* departed from this pattern to an extent; it is a widespread and ubiquitous organism. *Olisthodiscus*, first reported from a brackish water pool (Carter, 1938), tends to be an inshore organism. The variable pattern for Chrysophyta depended on increases in the Coccolithophoraceae as the open sea is approached.

Inhibiting as well as stimulating influences of the fertilized harbor water were apparent on the plankton and benthos. The more frequent (table 14) and denser blooms (fig. 3) in the harbor were associated with a reduced list of species. Coastal dinoflagellates were absent from the fertilized middle section of the harbor. The cause of this phenomenon remains unknown, but it may be connected with the inhibiting action of reduced nitrogen compounds on marine dinoflagellates, as demonstrated by Barker (1935). Diatoms and dinoflagellates comprise the bulk of the coastal phytoplankton off southern California; the general effect of the fertilized harbor water on these seemed to be to increase the diatoms and to limit the coastal dinoflagellates.

Blooms of small dinoflagellates had been observed in San Diego harbor in previous summers by B. M. Sweeney and Anne Dodson, but the dinoflagellates there have always been small unarmored species, quite unlike the dominant coastal forms. During the summer of 1958, the coastal waters of Southern California bore heavy blooms or "red tides" of *Gonyaulax polyedra.* While these blooms were flourishing in neighboring coastal water, *G. polyedra* could not be found in the fertilized middle section of San Diego harbor (Clendenning, 1959b). An inverse relation between the population densities of *Gonyaulax polyedra* and proximity to the Tijuana outfall was simultaneously recorded over a ten mile distance by San Diego Marine Advisors (1959).

The populations of several phytoplankton categories were lower in South San Diego Bay than elsewhere in the harbor. Nusbaum and Miller (1952) also observed low phytoplankton production in South San Diego Bay, which they attributed to its shallow turbid water. This section has a soft mud bottom which they believed was mainly responsible for the turbidity. It should be well fertilized by organic wastes from San Diego as well as from Chula Vista. Chemical wastes from an aircraft industry and bittern from the salt plants at the head of the bay are factors which also would tend to keep the plankton low. South San Diego Bay is warmer and more saline than the harbor in midsummer, and it should be subject to larger seasonal changes in temperature and salinity than the deeper sections. The ecology of South San Diego Bay is a large subject in itself, which has yet to be investigated in detail.

FUTURE STUDIES

Studies of the microbiota of San Diego Bay and nearby coastal waters are of timely interest because large changes are to be expected in this region in the near future. The domestic and industrial wastes from a city of over half a million people released in San Diego harbor have certainly altered it from its past primitive conditions. These wastes are now largely diverted from San Diego Bay by a deep ocean outfall extending 13,500 feet seaward from Point Loma, beyond the kelp beds. Additional studies of the planktonic and benthic microbiota are needed throughout the eight-mile length of the Point Loma kelp area, in Mission Bay and San Diego bay, and in one or more highly productive kelp beds. This study was intended to evaluate the microscopic algae and protozoa, and if possible to relate kinds and numbers to the condition of the kelp. But future studies should include experimental approaches to the life cycle of kelp as affected by the microbiota. They should include what microorganisms are predatory on kelp gametes, gametophytes, and zoospores. Turbidity effects tolerated by young kelp and turbidity produced by microorganisms need more study, as do all forms of competition between juvenile kelp and associated microbiota. The ecological roles of ciliates, zooflagellates, colorless euglenids, fungi and bacteria in giant-kelp beds largely await definition. The ecology and taxonomy of diatoms and dinoflagellates in San Diego Bay, macroscopic kelp predators and encrusting animals also merit further attention.

SUMMARY

During July and August, 1959, the plankton in 69 samples and the benthos in 36 samples from eight stations in and near San Diego Bay were listed qualitatively and quantitatively. The samples were taken at about weekly intervals. The examinations revealed a high plankton production in San Diego Bay for the period of observation. Over 340 species or genera of algae, protozoa and sulfur bacteria were represented in the samples.

The more frequent and denser blooms observed in San Diego harbor indicated considerable fertilization from the surrounding urban population. Inhibiting as well as stimulating influences of organic wastes were apparent in the planktonic and benthic microbiota. Coastal dinoflagellates were almost absent from the fertilized sections of San Diego harbor which bore large populations of photosynthetic microflagellates and other small algae. Fertilizing materials were evidently transformed and greatly diluted within the bay, since at the outermost stations there was a large diminution of the plankton and changes in its species composition.

No particular indicator organisms were found. The species found in San Diego harbor were practically all present at the coastal control station, which showed the greatest array of species. Sulfur-depositing bacteria, when abundant, indicated deposits of organic matter and partial to complete anaerobism in the mud. Chlorococcales were assumed to indicate soluble organic substances in the parts of the bay where they were most abundant. On the basis of planktonic Volvocales, Station II opposite National City was the only sampling point in San Diego Bay that showed evidence of recent organic enrichment.

The large numbers of colorless euglenids in the mud-water interface indicates an important role for them in the mineralization of organic matter. They were probably second in importance to the bacteria in this function. Since most of the solid materials eventually reach the bottom, their role in the transformation of organic sediment needs critical evaluation. Ciliates are probably the third most important group at the sediment-water interface. Dinoflagellates occurred infrequently in the sediment-water interface, but their effects include some reaeration due to photosynthesis and they were not aggregated except in a thin film at the interface. They were mainly planktonic, and the fertilized harbor water apparently decreased the number of dinoflagellate species and the frequency of their occurrence. Several phytoplankton categories (e.g. Cryptomonadaceae, Chlorococcales, Volvocales) which attained outstanding numbers in fertilized sections of San Diego harbor seemed to be retained there as a characteristic resident population. A related distribution was observed for the red ciliate *Mesodinium rubrum* (*Cyclotrichium meuneri*), which attained bloom proportions in South San Diego Bay with a progressive diminution in numbers toward the harbor entrance.

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NOTES ON BIRDS OF NORTHWESTERN BAJA CALIFORNIA

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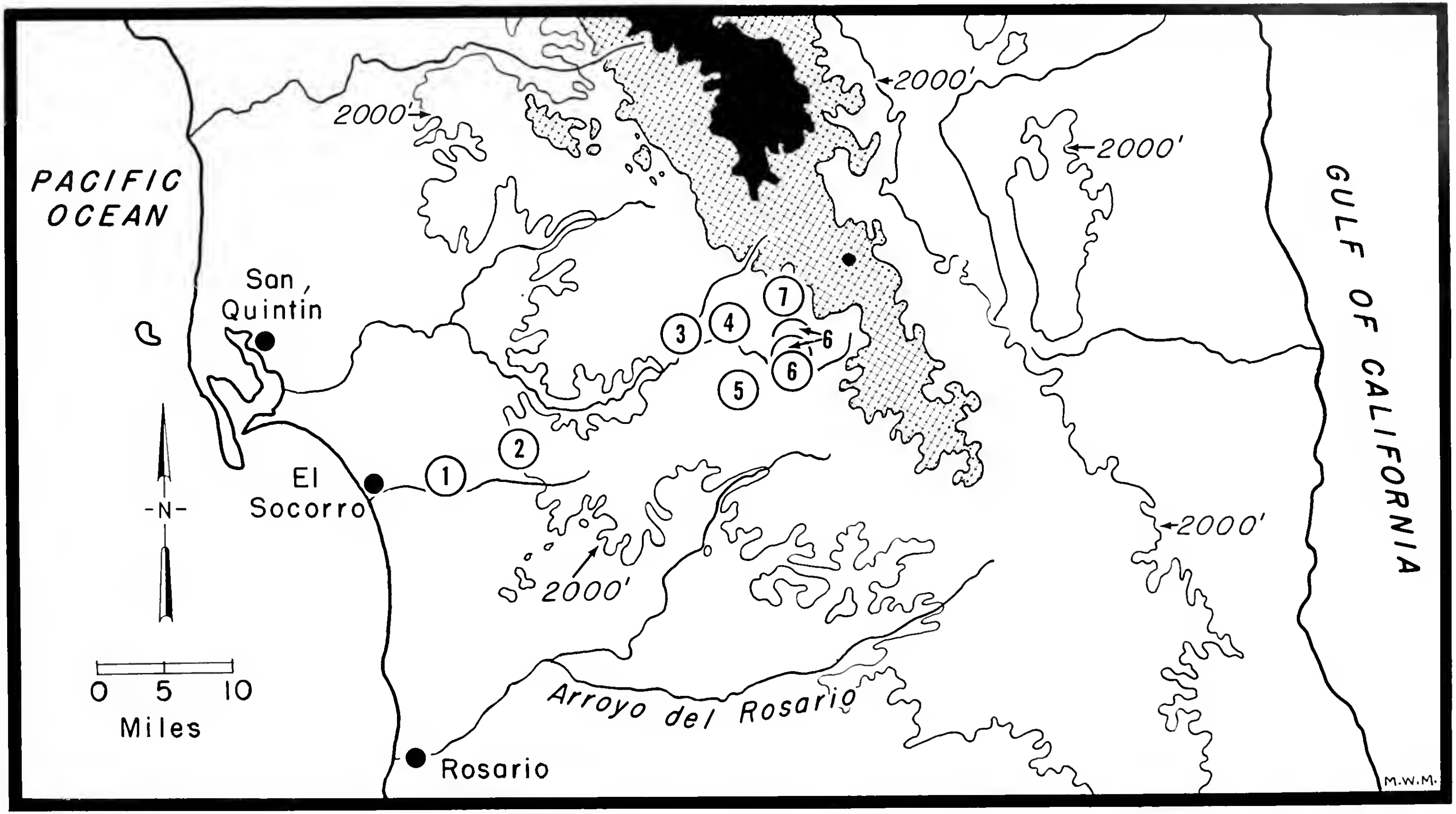

Fig. 1. Transection of northern Baja California at the south end of the Sierra San Pedro Mártir.

The numbered localities, described in the text, are: 1) 4 miles E El Socorro; 2) El Ciprés; 3) El Salto; 4) Rancho Rosarito; 5) Rancho San Miguel; 6) from south to north, Rancho Nuevo, El Palmarito, and 1 mile N El Palmarito; and 7) La Suerte. The map is based on the United States Air Force Operational Navigational Chart H-22, 1964. Mountain areas over 6000 feet in elevation are shown in solid black; the cross-hatching indicates areas between 4000 and 6000 feet in elevation.

NOTES ON BIRDS OF NORTHWESTERN BAJA CALIFORNIA

BY

LESTER L. SHORT, JR., AND RICHARD C. BANKS

We visited the upland desert east of San Quintín and southwest of the Sierra San Pedro Mártir of northwestern Baja California from April 20 to 29, 1964. The trip was primarily planned to permit Short to search for possible areas of contact and hybridization between Red-shafted and Gilded Flickers (*Colaptes auratus;* Short, in press). We collected 74 bird specimens during our trip; these are deposited in the United States National Museum, the San Diego Natural History Museum and the Direccíon General de Caza, Mexico City. We are indebted to Dr. Rodolpho Hernandez Corzo for permission to collect in Baja California, and to Dr. Reid Moran for advice concerning the vegetation of the area.

Little has been published concerning the avifauna of the chaparral-Sonoran desert ecotone of northwestern Baja California (see Huey, 1926). We found that the avifauna of the vast foothill area southwest of the Sierra San Pedro Mártir is dominated by desert birds, such as "Gilded" Flickers, Gila Woodpeckers, Ladder-backed Woodpeckers, Verdins, Cactus Wrens, and Black-throated Sparrows. Except for limited areas of chaparral, the vegetation and the avifauna of the foothill region we visited is typical of upland desert.

Shreve (1936) discussed the chaparral-desert transition near the coast, and excluded (1951) almost the entire ecotone from the Sonoran Desert. Although Shreve realized the ecotonal nature of the area, workers mapping the biomes, biotic areas and vegetation of this region have consistently included almost the entire ecotone as chaparral (chaparral biome or California biotic province; see, e.g., Dice, 1943; Jaeger, 1957; Leopold, 1959). The extent of the desert foothill region and the widespread distribution of desert plants and birds east of San Quintín make it appear likely that desert plants and birds occur inland north to about the Arroyo San Telmo, considerably north of the line usually drawn separating desert and chaparral. If the ecotone itself is not designated on future maps, we suggest that the Sonoran Desert limit be extended north of the limits set by Shreve (1951), to express the predominantly desert nature of the biota of the foothill region east of San Quintín.

DESCRIPTION OF LOCALITIES

Figure 1

EL PALMARITO, 3,000 feet ±, 40 miles E San Quintín. April 21-26. An abandoned three-room building stands near the road at the upper end of a palm-lined arroyo. Rocky slopes surround the dry stream bed, which extends south and west to meet another one-half mile downstream, and beyond to join the main stream at Rancho Nuevo. For about one-half mile south of the building, palms are frequent and the arroyo's slopes are steep and brush-covered. The slopes become less steep and mesquites begin to occur in a solid stand a little over one-half mile toward Rancho Nuevo. East of the arroyo at El Palmarito is a wide "amphitheater" containing a mesquite grove. The upper slopes of the steep hills around the arroyo tend to be grassy, while the lower slopes are agave-opuntia desert, with increasing plant density toward the arroyo (fig. 2). Some of the plants observed are the following:

platyopuntias
cylindropuntias
Agave deserti
Yucca schidigera

mesquite	(*Prosopis juliflora*)
palm	(*Erythea armata*)
senita	(*Lophocereus schottii* — scattered)
juniper	(*Juniperus californica* — few)

ONE MILE N EL PALMARITO, 3,200 feet ±. April 25. A rocky plateau bears an ecotonal community, namely an extensive, variously dense to open, juniper-mesquite woodland (fig. 3). Washes are surrounded by considerable grass. Yuccas and agaves are plentiful. This plateau leads downslope through ever more desert-like growth (washes with more mesquites and *Acacia greggii,* fewer junipers) to El Palmarito.

La Suerte, 3,400 feet ±, 40 miles ENE San Quintín. April 25. A house surrounded by a few cottonwoods and palms was inhabited by at least one person. The area is very barren, and high rocky hills rise beyond the house to the east. Platyopuntias and a few poor specimens of *Lophocereus schottii* were found in the very open upland desert nearby. The wash at La Suerte is that leading southwest to Rancho Nuevo, joining the stream bed from El Palmarito between the latter and Rancho Nuevo. Between the barren open desert at La Suerte and the juniper-mesquite woodland north of El Palmarito is an extensive area of sagebrush (*Artemisia* sp.).

Rancho Nuevo, 2,900 feet ±, 1 mile S El Palmarito. April 26. An abandoned house with several tamarisk trees adjoins the main stream bed (leading west to Rancho Rosarito), just east of its junction with the tributary from El Palmarito and La Suerte. The desert slopes here are very barren. Dense brush borders the east side of old agricultural land around the house. The main stream bed is about 50 yards wide at this point. A dense growth of mesquites lines the stream bed where it receives the El Palmarito-La Suerte tributary. There is a lone, small cardón (*Pachycereus pringlei*) on a slope above the stream bed two miles west of Rancho Nuevo; this was the eastern-most cardón observed.

Rancho San Miguel, 3,100 feet ±, 5 miles SW El Palmarito. April 21. This small, occupied ranch is reached by a winding road from the main stream bed a little more than three miles west of Rancho Nuevo. It is surrounded by a few palms and cottonwoods in upland yucca-agave-opuntia desert. A few junipers are scattered about on the desert. The main stream bed at the junction of the roads from Rancho San Miguel and Rancho Nuevo is lined with mesquites and an extensive stand of creosote bush (*Larrea tridentata*), the easternmost occurrence noted for this plant.

Rancho Rosarito, 2,500 feet ±, 34 miles E San Quintín. April 21, 26 to 28. A half dozen or so abandoned buildings, barren fields and an orchard of dead trees attest to the difficulties of human existence in the region. One old man inhabited a building east of the stream apart from the other buildings. The stream flows through dense brush and a good stand of cottonwoods and willows for about one-third of a mile to the southwest. Scattered large trees, many of them dead, extend toward the southwest for at least three-quarters of a mile. There are two additional abandoned buildings in that direction along the dry stream bed. Near one of these buildings was the only specimen of palo verde (*Cercidium microphyllum*) that we encountered on the trip (planted here?). North and east of the buildings, back from the stream, a dense mesquite grove grows on up the stream toward Rancho Nuevo. About one-half mile in that direction is a large area of saltbush (*Atriplex* sp.). Large platyopuntias form hedges near the buildings. The surrounding rocky slopes and low hills are agave-opuntia desert. Senitas (*Lophocereus schottii*) and catclaw (*Acacia greggii*) are common therein. No cardóns were noted at this locality.

El Salto, 2,000 feet ±, 30 miles E San Quintín. April 21, 28. In open upland desert one-quarter of a mile north of the main road at the east base of two large hills is an abandoned building. East of El Salto the Rancho Rosarito-La Suerte branch of the stream joins a larger branch, which originates in the Sierra San Pedro Mártir north of La Suerte. The stream bed at El Salto is broad, and lined by dead cottonwoods. The slopes are brush-covered and steep, especially west of the building. A little over a mile north of El Salto we saw the eastern-most small group of cardóns (*Pachycereus pringlei*), and the eastern-most cirio (*Idria columnaris*). The southern and western slopes of the hills west of El Salto supported large stands of cardóns, and one slope south of El Salto bore a group of ocotillos (*Fouquieria splendens*), which were flowering on April 28. The ten miles west from El Salto (to four miles E El Ciprés) is an open desert plain, with the following plants conspicuous:

cylindropuntias
platyopuntias
Yucca sp.
senita
cardóns (scattered groves)
juniper (few)
cirio (scattered groups)
ocotillo (few)
jojoba (*Simmondsia chinensis*)
creosote bush

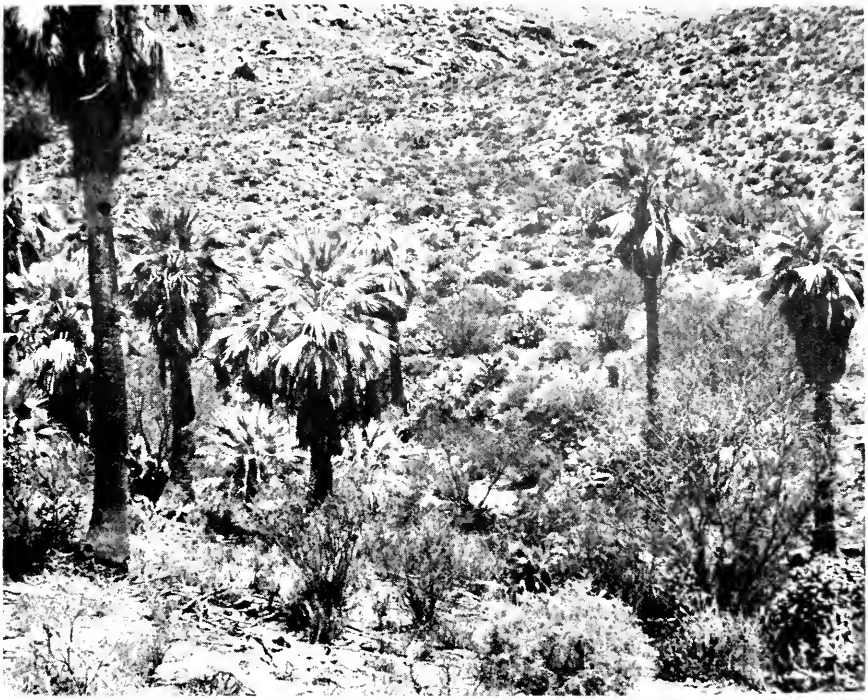

Fig. 2. Palm filled arroyo at El Palmarito.

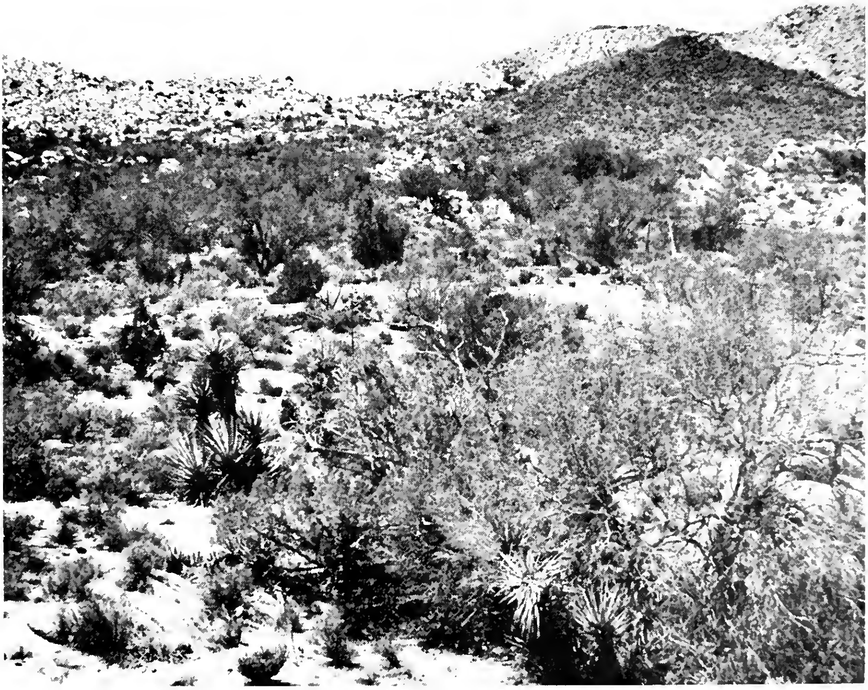

Fig. 3. Vegetation one mile N El Palmarito.

EL CIPRÉS, 1,500 feet ±, 21 miles ESE San Quintín. April 21, 28. A small, well-watered and occupied ranch nestles here at the base of a hill. Within 3 to 4 miles east from El Ciprés there is a relatively high area containing mostly chaparral. Chaparral vegetation diminishes west of El Ciprés, occurring only on slopes to about four and one-half miles west of the ranch. Westwardly, opuntia-agave desert, with scattered cardóns, becomes dominant, until the road passes down into the coastal lowlands six miles west of El Ciprés.

FOUR MILES E EL SOCORRO, 300 feet ±, 17 miles SE San Quintín. April 20-21. A deserted one-room building occurs here in the cañon of the Arroyo del Socorro. Mesquites, acacias, agaves and opuntias line the floor of the cañon. Groves of cardóns occur on several slopes just to the east. A number of dead sycamore (*Platanus racemosa*) stubs were found along the stream bed.

The vegetation observed at all localities except El Ciprés and one mile north of El Palmarito meets the criteria cited by Shreve (1936:258) for desert, rather than chaparral, communities.

SPECIES ACCOUNTS

The following is a complete list of the bird species observed in the area of desert-chaparral ecotone, although not all species are discussed in detail. In the briefer accounts, an asterisk (*) after a locality designation indicates that a specimen was secured.

Cathartes aura. Turkey Vulture. — El Palmarito, La Suerte, Rancho Rosarito.

Accipiter striatus. Sharp-shinned Hawk. — Three miles E El Ciprés, El Palmarito, Rancho Rosarito.

Buteo jamaicensis. Red-tailed Hawk. — Melanistic Red-tailed Hawks were noted on a number of occasions, and the composite of the sightings presented here suggests a high incidence of melanism in the northwestern Baja Californian population. On April 21 a melanistic bird was flushed from its nest in a cardón approximately two miles southwest of El Salto. Another dark-phase red-tail was observed on April 24 at El Palmarito. This individual's tail was red dorsally, and there appeared to be some light coloration on the underside of its wings near the tips; otherwise it appeared all black. At La Suerte we encountered another melanistic red-tail on April 25; this bird also had a red tail. The distances involved suggest that these melanistic hawks were different individuals. On April 29 another dark-phase red-tail was seen near the coast south of Arroyo Salada, southeast of San Vincente. Red-tails in the normal color phase were noted about eight miles east of El Socorro on April 21, at El Palmarito on April 22 and 23, and five miles east of El Ciprés on April 28. Assuming that the melanistic birds were different individuals, about half the red-tails we encountered were of that color phase.

Buteo albonotatus. Zone-tailed Hawk. — This species was observed over the hills north of El Palmarito on April 25, and above the hills south of Rancho Rosarito on April 28.

Parabuteo unicinctus. Harris' Hawk. — Single individuals of this desert riparian species were observed at Rancho San Miguel on April 21 and at El Palmarito on April 24. Three Harris' Hawks were seen at once above the cottonwoods and willows at Rancho Rosarito on April 27. Two birds were seen there also on April 21, and we suspect they were nesting, although no nest was found.

Falco sparverius sparverius. Sparrow Hawk. — At least two pairs of Sparrow Hawks were located along the arroyo at El Palmarito. One pair was apparently nesting in an old flicker hole in a dead palm stub when we arrived at El Palmarito. We took the female of this pair (146.6 gm.; ovary large, ova to 14 mm., and ruptured follicle; remains of a lizard [*Cnemidophorus* sp.] in throat) on April 22. Within two days another female appeared, and was collected (121.6 gm.; ovary 9 × 5 mm., ova to 1 mm.) as it was displaying in a dead mesquite tree to the mate of the earlier female. Both the male and the new female were observed at the former pair's nest hole in the palm. We then secured the male (103.6 gm.; testes 7 × 6 mm.; lizard remains in stomach). On April 26 another male was taken (81.9 gm.; testes 5 × 4 mm.) down the arroyo from the other birds, as it perched on an agave stalk.

Wing lengths (flattened wing) of the four birds are: females, 179 and 195 mm.; males, 176 and 170 mm. All these measurements fall within the range ascribed to intergrades between *Falco s. sparverius* and *F. s. peninsularis* by Bond (1943:table 7). On the basis of Bond's tables 3 and 4, only the larger female is well within the range of *sparverius*, whereas the other three birds are in the upper portion of the range of variation he ascribes to *peninsularis*. Since our birds are considerably worn, we tentatively assign them to *F. s. sparverius* while recognizing the intermediate nature of the population.

Lophortyx californicus plumbeus. California Quail. — Birds of this chaparral and desert species were seen daily, and were common to abundant everywhere; the birds were in coveys as well as in pairs. We secured a pair on April 25 in juniper-mesquite woodland north of El Palmarito. Several coveys of quail were in the immediate vicinity, but these two birds were alone. The male weighed 159.9 gm. and had enlarged testes (11 × 7 mm.). The female weighed 192.5 gm.; there was an egg in her oviduct and but one follicle scar, indicating that the bird was just commencing to lay.

Zenaidura macroura. Mourning Dove. — All localities.

Columbigallina passerina. Ground Dove. — Several individuals were observed in the agricultural area around San Quintín on April 28. Grinnell (1928:105) listed the species as occurring no farther north than El Rosario, 30 miles south of San Quintín. This apparent northward range extension suggests that Ground Doves nesting in coastal San Diego County, California (Sams, 1959:155), may have come from the south rather than across the mountains from the deserts of extreme eastern California.

Geococcyx californianus. Roadrunner. — 2 miles E El Salto, 5 miles W El Salto.

Phalaenoptilus nuttallii. Poor-will. — 4 miles E El Socorro, Rancho Rosarito.

Aeronautes saxatalis saxatalis. White-throated Swift. — El Palmarito*, El Salto.

Calypte costae. Costa's Hummingbird. — El Palmarito*, Rancho Rosarito*, El Salto. Breeding.

Colaptes auratus brunnescens × *C. a. collaris.* Flicker. — Gilded Flickers showing only yellow underwing and undertail surfaces (= "shafts") were observed: east of San Quintín; 4 miles east of El Socorro; in the upland desert west of El Ciprés; in cardóns west of El Salto; in cottonwoods at El Salto; in palms, junipers and yuccas about Rancho San Miguel; in open agave-opuntia upland desert just north of El Palmarito; and in the uplands and along the palm-lined arroyo at El Palmarito. Nests were situated in cardóns (5 miles W El Salto, three slightly incubated eggs on April 21), palms (El Palmarito) and cottonwoods (El Salto); the occurrence of flickers in open upland desert lacking trees or large cacti suggests that they may nest also in large yuccas or possibly agaves.

Short (in press) has discussed hybridization between the *cafer* and *chrysoides* groups of *Colaptes auratus* in Arizona, and suggested the possibility that these groups similarly meet and interbreed in northern Baja California. Although we were unable to establish whether or not breeding populations of the two groups are in direct contact, we did locate an introgressed Gilded Flicker population at El Palmarito, within 5 to 6 miles of the 6,000 foot elevation at the south end of the Sierra San Pedro Mártir.

We obtained 13 adult breeding flickers from the population at El Palmarito. These birds tend away from *C. a. brunnescens* and toward *C. a. collaris* in the following: rump less heavily marked; wings average 3 millimeters longer than comparably plumaged *brunnescens;* breast spots less transverse, more rounded; black of tail less extensive; crown color browner (one has crown of *collaris*, six are intermediate or more like *collaris* than *brunnescens*); and "shafts" more strongly orange or red (eight of 13 El Palmarito birds and none of 20 *brunnescens* examined show strong orange or red "shaft" color). These tendencies toward the *cafer* group of races are similar to those exhibited by the San Pedro Valley hybrid swarm in Arizona (Short, in press). The El Palmarito birds are peculiar in two other respects. The bulk of the birds not having *collaris*-like crowns are more like *C. a. mearnsi* than *C. a. brunnescens* in crown color. Even taking into account the worn condition of the birds, the crown color is less cinnamon brown than *brunnescens* and more buffy cinnamon like *mearnsi*. Additionally, the El Palmarito birds have narrower back bars like *C. a. mearnsi* or *C. a. chrysoides*, rather than broader bars typical of *C. a. brunnescens*. Whether this is an effect of hybridization, or is indicative of the past occurrence of less *brunnescens*-like Gilded Flickers in northern Baja California is not known.

The El Palmarito flicker population (and probably others elsewhere in the southwestern San Pedro Mártir foothills) may receive frequent infusion of Red-shafted Flicker genes when montane flickers (*C. a. collaris*) move downslope for the winter, and are attracted to local foothill flickers by the latter's early courtship activities. An occasional *C. a. collaris* so attracted may mate with a foothill bird, thus causing the tendencies toward that form evident in the El Palmarito population.

The ten El Palmarito males weighed from 94.5 to 117.6 gm. (mean 104.66 gm.), and all had enlarged testes (7 to 11 mm. long). The three females weighed 95.9, 93.3 and 102.3 gm., and each had a large ovary, with maximum length of ova 3, 2 and 5 millimeters, respectively. Territorial defense was at a high level, and the birds were noisy, conspicuous, and chasing each other about. We judge that egg-laying commenced about a week after we left the site. It is significant that all the birds collected were at about the same stage of gonadal development, regardless of their morphological attributes.

Centurus uropygialis cardonensis. Gila Woodpecker. — Gila Woodpeckers were observed only at Rancho Rosarito, where they occur along the stream in cottonwoods and willows, and sparingly at El Palmarito, where they were noted only in scattered palms along the arroyo. A male (77.5 gm.; testis 7 × 5 mm.; tapeworm in body cavity) was collected while calling beside a hole in a dead palm tree at El Palmarito on April 22. At Rancho Rosarito a female (64.0 gm.; ovary 13 × 8 mm., and ova to 3 mm.) was secured as it called from a willow stub on April 27.

Dendrocopos scalaris eremicus. Ladder-backed Woodpecker. — Ladderbacks were common at El Palmarito and Rancho Rosarito, and were noted also 4 miles east of El Socorro. Around El Palmarito they were observed in mesquite groves, about agaves and yuccas in the upland desert and in juniper-mesquite woodland north of El Palmarito. They did not frequent the palms along the arroyo. At Rancho Rosarito they were noted in agaves on the rather barren upland desert, in mesquite groves back from the stream, in cacti and an old orchard near abandoned buildings, and in cottonwoods and willows along the stream. Three males, all with enlarged (6 to 7 mm. long) testes, were collected at El Palmarito; they weighed 40.3, 39.2 and 38.5 gm. A male weighing 39.7 gm. and a female weighing 33.6 gm. were collected from willows at Rancho Rosarito. These birds were probably a mated pair, and both had large gonads (ovary 8 × 6 mm.; testis 8 × 4 mm.). This desert species narrowly overlaps with the Nuttall's Woodpecker, which generally replaces it in riparian situations in chaparral to the northward.

Dendrocopos nuttallii. Nuttall's Woodpecker. — This close relative of the ladder-back was observed only in riparian habitat (cottonwoods, willows) at Rancho Rosarito, where it was sympatric with the ladder-back. A male and a female collected on April 27 in the same vicinity several hours apart may have been a mated pair. The female had an active brood patch and weighed 40.9 gm., while the male weighed 43.1 gm. and had testes 5 × 4 mm. The weights of these birds are greater than those of the *D. scalaris* specimens we collected; the reverse is usually the case (Short, pers. obs.). The male Nuttall's Woodpecker was collected as it alternately called and drummed at a dead stub in the top of a large cottonwood. No other individuals of this species were observed in the limited riparian area available around Rancho Rosarito. The southernmost previously reported occurrence of this species is Santo Domingo, Baja California (Huey, 1926; Grinnell, 1928:123), some 35 miles to the northwest.

Tyrannus verticalis. Western Kingbird. — Rancho Rosarito, El Salto.

Myiarchus cinerascens. Ash-throated Flycatcher. — All localities. Breeding.

Sayornis saya quiescens. Say's Phoebe. — El Salto*, Rancho Rosarito*. Breeding.

Empidonax difficilis cineritius. Western Flycatcher. — El Palmarito*, Rancho Rosarito*. Migrating.

Empidonax sp. — El Palmarito, Rancho Rosarito.

Contopus sordidulus. Western Wood Pewee. — Rancho Rosarito. Migrating.

Pyrocephalus rubinus. Vermilion Flycatcher. — Vermilion Flycatchers were noted only at Rancho Rosarito, where they were common. There was some indication that the birds were paired; for example, on April 27 a male and a female perched beside each other, and acted together in chasing down a butterfly. The riparian situation at Rancho Rosarito seems optimal habitat for the species.

Eremophila alpestris. Horned Lark. — W of El Ciprés, Rancho Rosarito.

Tachycineta thalassina. Violet-green Swallow. — El Palmarito, Rancho Rosarito.

Aphelocoma coerulescens. Scrub Jay. — El Ciprés, N of El Palmarito.

Corvus corax. Common Raven. — All localities.

Auriparus flaviceps. Verdin. — Scattered Verdins were observed in mesquites along the stream from El Palmarito to Rancho Nuevo, and several were noted in juniper-mesquite woodland north of El Palmarito.

Psaltriparus minimus. Common Bush-tit. — N of El Palmarito, Rancho Rosarito.

Troglodytes aedon parkmanii. House Wren. — El Palmarito*.

Thryomanes bewickii charienturus. Bewick's Wren. — Bewick's Wrens were found wherever suitable brush and trees occurred. They were observed at El Salto, Rancho Rosarito, and in juniper-mesquite woodland north of El Palmarito. A pair engaged in mutual displaying was collected on April 25 north of El Palmarito. The male weighed 9.0 gm. and had testes measuring 6 × 4 mm.; the female weighed 10.7 gm., had a developing brood patch and an ovary 7 × 3 mm. with very small ova. Three males were collected on April 27 at Rancho Rosarito. One of these, weighing 8.5 gm., was feeding young that had left the nest. The other two weighed 9.4 and 10.1 gm., and were secured as they sang from willows along the stream; each had testes 8 mm. long.

Campylorhynchus brunneicapillus bryanti. Cactus Wren. — Cactus Wrens were common throughout the upland desert, and we observed them at all localities. Five birds were collected at El Palmarito from April 22 to 26. The two males weighed 38.6 and 39.4 gm. and had testes 7 and 8 mm. long. The three females weighed 34.6, 37.2 and 36.3 gm.; all had small ova (2 mm. or less). One of these females was engaged in nest building.

Catherpes mexicanus. Cañon Wren. — El Palmarito.

Salpinctes obsoletus. Rock Wren. — El Palmarito, La Suerte. Breeding.

Mimus polyglottos. Mockingbird. — El Palmarito, Rancho Nuevo, Rancho Rosarito.

Toxostoma cinereum mearnsi. Gray Thrasher. — Gray Thrashers were observed only in the vicinity of El Palmarito. This desert species seems to require less dense brush than *T. redivivum*. Two males were collected; these weighed 62.6 and 58.6 gm. and had enlarged testes (11 × 7, 10 × 6 mm., respectively). Each had irides and mouth-lining colored golden-yellow. The song of this species is not particularly thrasher-like, as it contains no repetitive phrases and has the quality of that of the Bell's Vireo.

Toxostoma redivivum redivivum. California Thrasher. — This thrasher was more widespread than the preceding species in the region visited. One was observed on April 21 four miles east of El Socorro, one was noted at El Salto on April 28, and several inhabited dense brush along the stream at Rancho Rosarito. At least one pair occurred at Rancho Nuevo, and the species was common in juniper-mesquite woodland north of El Palmarito. Three males were secured. One taken in juniper-mesquite north of El Palmarito weighed 89.6 gm. and had a cloacal protuberance and testes measuring 9 × 5 mm. A male from Rancho Nuevo weighed 84.7 gm. and had testes measuring 8 × 5 mm. The other, from Rancho Rosarito, weighed 87.8 gm. and had testes 8 × 5 mm. The iris of this species is chestnut and the mouth-lining very pale yellow, in contrast to *T. cinereum*.

Turdus migratorius. Robin. — El Ciprés, Rancho Rosarito. Probably migrating.

Hylocichla guttata. Hermit Thrush. — El Palmarito, north of El Palmarito, Rancho Rosarito. Migrating.

Hylocichla ustulata ustulata. Swainson's Thrush. — This species was observed commonly at Rancho Rosarito on April 27 and 28, and sparingly at El Palmarito, where a male (testes 3 mm.; moderate fat) was taken in a mouse trap. Individuals of this species were observed feeding like robins in open areas around the buildings, and even in barren fields with Horned Larks. On April 27 we watched one feeding in the open beside an abandoned building. The bird ran several feet, stopped, cocked its head, appeared to search, then moved several feet ahead and repeated the procedure. Occasionally it appeared to pick something from the ground. This bird was observed systematically feeding in this way over about 150 square feet of open ground for 20 minutes.

Polioptila caerulea amoenissima. Blue-gray Gnatcatcher. — This species was found along with the Black-tailed Gnatcatcher at El Salto, Rancho Rosarito, El Palmarito, and in the juniper-mesquite woodland north of El Palmarito. In the latter locality, where the birds appeared paired, three males were collected on April 25. One of these weighed 5.2 gm., and was calling with a female when it was secured; its testes measured 5 × 4 mm. Another, weighing 5.6 gm., was singing when it was collected; it, too, had large testes (6 × 4 mm.). The third male weighed 5.3 gm. and had smaller (3 × 2 mm.) testes. A male collected on April 27 at Rancho Rosarito weighed 5.4 gm. and had testes 5 × 3 mm.

Polioptila melanura californica. Black-tailed Gnatcatcher. — This desert gnatcatcher outnumbered the Blue-gray Gnatcatcher in more arid brushy situations, as at El Palmarito. It was observed in the desert four miles east of El Socorro, at El Salto, at Rancho Rosarito, along the road from Rancho Rosarito to Rancho Nuevo and on to El Palmarito. It was also found in pairs in juniper-mesquite woodland north of El Palmarito, although there outnumbered by *P. caerulea.* Two males were secured at El Palmarito. These weighed 5.6 and 6.0 gm., and had testes 4 mm. long; the former appeared to be developing a brood patch.

Regulus calendula. Ruby-crowned Kinglet. — Rancho Rosarito.

Phainopepla nitens lepida. Phainopepla. — Phainopeplas occurred along our route into the upland desert beginning at 5 miles east of El Ciprés. Several were seen at El Salto, a few were present at Rancho Rosarito, they were abundant at El Palmarito, and they were common north of El Palmarito. Males were singing and aggressive toward one another. A nest found at El Palmarito on April 22 held one young bird estimated to be 3 or 4 days old. Another nest at that locality contained 2 eggs on April 26. A male collected at El Palmarito on April 26 weighed 24.6 gm. and had enlarged (7 × 4 mm.) testes; six mistletoe berries were found in its throat.

Lanius ludovicianus. Loggerhead Shrike. — East of El Ciprés, El Palmarito.

Sturnus vulgaris. Starling. — The Starling was first reported in Baja California by Edwards and Morton (1963), who saw birds near Ensenada. Udvardy (in press) found the species nesting in that area in March, 1964. On April 20, 1964, we saw a Starling fly into a hole in a signboard at El Sauzal, just north of Ensenada. On that same day we observed at least four birds carrying food into the dead fronds of a palm at Santo Tomás, approximately 30 miles south of Ensenada. One of these birds was collected (SDNHM 30808) and proved to be a female with a brood patch.

On April 24, four miles west of El Ciprés, or about 25 miles southeast of San Quintín, we saw a Starling fly from a hole in a cardón. There were four eggs in what appeared to be an abandoned flicker nesting cavity. The slightly incubated eggs were collected and are now in the San Diego Natural History Museum. This extends the known breeding range of the Starling approximately 180 miles to the southeast from Ensenada.

This nesting site was in typical upland desert, dominated by several species of cactus. To our knowledge there is no open water available for several miles. Elsewhere, Short has observed Starlings nesting in saguaros (*Carnegiea gigantea*) away from water in the Sonoran

Desert of Arizona (10 miles SE Ehrenberg, Yuma Co., May, 1963; 15 miles SE Florence, Pinal Co., April and May, 1963). These observations suggest that this highly adaptable species may soon occupy much of the Sonoran desert region.

Vireo bellii pusillus. Bell's Vireo. — This vireo was common at Rancho Rosarito, where males were singing and some of the birds appeared paired. We also noted several Bell's Vireos at El Salto on April 28. Two males were collected on April 27 at Rancho Rosarito; these weighed 8.2 and 8.5 gm., respectively, and had enlarged testes (5 × 3, 6 × 4 mm.).

Vireo solitarius. Solitary Vireo. — Rancho Rosarito.

Vireo gilvus. Warbling Vireo. — Rancho Rosarito.

Vermivora celata. Orange-crowned Warbler. — Rancho Rosarito, El Palmarito, north of El Palmarito. Migrating.

Vermivora ruficapilla. Nashville Warbler. — Rancho Rosarito.

Dendroica petechia. Yellow Warbler. — Rancho Rosarito. Breeding?

Dendroica auduboni auduboni. Audubon's Warbler. — Rancho Rosarito*.

Dendroica nigrescens. Black-throated Gray Warbler. — North of El Palmarito*, Rancho Rosarito.

Dendroica townsendi. Townsend's Warbler. — El Palmarito.

Dendroica occidentalis. Hermit Warbler. — North of El Palmarito, Rancho Rosarito.

Seiurus motacilla. Louisiana Waterthrush. — One male of this species was collected (USNM 480452) at Rancho Rosarito on April 27. This first record for Baja California is discussed elsewhere (Short and Banks, 1965).

Icteria virens. Yellow-breasted Chat. — Rancho Rosarito. Breeding?

Wilsonia pusilla. Wilson's Warbler. — El Palmarito, north of El Palmarito, Rancho Nuevo, Rancho Rosarito. Migrating.

Passer domesticus. House Sparrow. — El Ciprés, Rancho Rosarito.

Molothrus ater. Brown-headed Cowbird. — Rancho Rosarito. Breeding?

Icterus cucullatus. Hooded Oriole.—El Palmarito, La Suerte, Rancho Rosarito. Breeding.

Icterus parisorum. Scott's Oriole. — This oriole is widely distributed in the upland desert from west of El Ciprés to La Suerte. It was common at El Palmarito, where it sang in the same palms utilized by males of *I. cucullatus*, in juniper-mesquite woodland north of El Palmarito, and in the desert around Rancho Rosarito. A male was collected (testes 8 × 4 mm.) at El Palmarito on April 22.

Piranga ludoviciana. Western Tanager. — El Palmarito, north of El Palmarito, Rancho Rosarito.

Carpodacus mexicanus frontalis. Linnet. — Linnets were observed about buildings at La Suerte and Rancho Rosarito. They occurred in desert washes and in stream-side vegetation at El Palmarito and El Salto. A female with an egg in her oviduct was collected (23.6 gm.; two other large ova) on April 26 at El Palmarito.

Spinus tristis. American Goldfinch. — West of El Ciprés (in chaparral).

Spinus psaltria. Lesser Goldfinch. — El Palmarito, La Suerte, Rancho Rosarito.

Spinus lawrencei. Lawrence's Goldfinch. — At least two males and two females were feeding and calling near the stream at Rancho Rosarito on April 27. A small group of them was encountered on April 28 at El Salto. These occurrences are the southernmost recorded for the species in Baja California (Grinnell, 1928).

Pheucticus melanocephalus. Black-headed Grosbeak. — El Palmarito, Rancho Rosarito.

Passerina amoena. Lazuli Bunting. — Rancho Rosarito.

Chlorura chlorura. Green-tailed Towhee. — North of El Palmarito.

Pipilo fuscus senicula. Brown Towhee. — East of El Socorro, El Palmarito*, north of El Palmarito, Rancho Rosarito.

Calamospiza melanocorys. Lark Bunting. — West of El Ciprés.

Passerculus sandwichensis. Savannah Sparrow. — Rancho Rosarito.

Chondestes grammacus. Lark Sparrow. — Rancho Rosarito, west of El Ciprés.

Aimophila ruficeps. Rufous-crowned Sparrow. — El Palmarito, Rancho Rosarito.

Amphispiza bilineata deserticola. Black-throated Sparrow. — This common sparrow was observed throughout the upland desert area east of San Quintín. Two females of this race were secured at El Palmarito on April 22 and 26. One, weighing 17.0 gm., had an early brood patch and an ovary with ova to 7 mm. and one collapsed follicle; the other (14.2 gm.) had a brood patch and ovary 5 mm. long with no ruptured follicles.

Junco oreganus thurberi. Oregon Junco. — North of El Palmarito*; identity of specimen determined by Alden H. Miller.

Spizella passerina. Chipping Sparrow. — Rancho Rosarito.

Spizella breweri. Brewer's Sparrow. — El Palmarito, El Salto.

Spizella atrogularis. Black-chinned Sparrow. — East of El Socorro, probably breeding.

Zonotrichia leucophrys. White-crowned Sparrow. — El Salto, Rancho Rosarito.

Melospiza melodia. Song Sparrow. — Rancho Rosarito, probably breeding.

SUMMARY

Observations and results of examination of bird specimens obtained on a brief foray into the upland desert east of San Quintín, Baja California, are presented. Many migrants were encountered. The breeding avifauna consisted of riparian and desert species. The vast area occupied by predominantly desert plants and birds suggests that the boundary of the Sonoran Desert is actually somewhat north of where it is customarily mapped, if the desert-chaparral ecotone is not recognized as a separate entity.

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NOTES ON BATS FROM THE CAPE REGION OF BAJA CALIFORNIA

BY

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From July 6 to July 15, 1963, a field party from the Museum of Natural History of The University of Kansas collected vertebrates in the Cape region of Baja California. Among the mammals obtained by the party were representatives of 11 species of bats, which are the basis of the present report. The bats of Baja California have been the subject of several taxonomic studies and general reviews, but relatively little detailed information has been published concerning their distribution and ecology. The following observations augment, therefore, other published information on bats from this interesting area.

Funds to defray the cost of field work were provided by a contract (DA-49-193-MD-2215) between the Medical Research and Development Command, Office of the Surgeon General, of the U. S. Army and The University of Kansas. All measurements in the accounts that follow are in millimeters. Catalogue numbers, given in parentheses for all specimens mentioned, are those of the Museum of Natural History at Kansas.

Mormoops megalophylla rufescens Davis and Carter, 1962. — The leaf-chinned bat has been reported from Baja California only from 1/4 mi. S Mulegé and from Santa Ana (Davis and Carter, 1962:66). One of us (Alvarez) found a mummified specimen (94029) of this species in a small, abandoned mine 3 km. S San Antonio. No live bats of any kind were found in the mine.

Macrotus waterhousii californicus Baird, 1858. — This leaf-nosed species evidently is one of the commonest bats in southern Baja California. We collected 38 specimens, all from caves or abandoned mines, as follows: 1 km. S Las Cuevas, 2 (94056-57); 2 km. S and 6 km. W Miraflores, 16 (94058-73); San Antonio, 375 m., 10 (94036-45); 2½ km. N San Antonio, 375 m., 10 (94046-55).

In an abandoned mine south and west of Miraflores (known locally as "Quelele") where leaf-nosed bats occurred, the odor of ammonia was so pungent that we could remain inside for only a few minutes at a time. On only one occasion did we find another species (*Natalus stramineus*) occupying the same retreat as *Macrotus*. Each of five females from the vicinity of San Antonio (July 7 and 8) carried a single embryo; embryos averaged 30.0 (29-31) in crown-rump length and appeared to be near term. Several females with nursing young were seen at San Antonio and also at "Quelele" on July 12.

We follow Anderson and Nelson (1965) in arranging *californicus* as a subspecies of *M. waterhousii*.

Natalus stramineus mexicanus Miller, 1902. — This funnel-eared bat is widely distributed in the Cape region of Baja California. We obtained 73 specimens as follows: 1 km. S Las Cuevas, 2 (94190-91); 5 km. SE Pescadero, 65 (94192-256); 2½ km. N San Antonio, 375 m., 6 (94184-89). Additionally, six females (27315-20) from Las Cuevas, collected by Lloyd Tevis on May 24, 1948, are housed in the Museum of Natural History. The type locality of *N. s. mexicanus* is at Santa Anita.

All of the funnel-eared bats taken by us were found in caves or mines, which they usually occupied jointly with (but did not mingle with) at least one other species of bat — *Macrotus waterhousii*, *Myotis velifer*, or *Tadarida brasiliensis*. A nursery colony consisting of an estimated 10,000 individuals was discovered on July 10 in a narrow tunnel about 80 feet below the surface in an abandoned gold mine located 5 km. SE Pescadero. Naked young nearly covered one section of wall that was approximately 10 feet high and five feet wide. The stomach contents of a bullsnake (*Pituophis vertebralis*) that was captured near the colony consisted entirely of remains of *Natalus*, at least four adults and two young. Several adult males were among the bats taken at or near the nursery colony, but these may have roosted elsewhere in the mine before we entered and disturbed the occupants. About 300 adult males were found in a small adjacent mine.

Despite the large number of young observed, 19 of 41 females taken 5 km. SE Pescadero still were pregnant, each with a single embryo. The embryos averaged 19.7 (17.7-22.3) in crown-rump length. The six females collected at Las Cuevas by Tevis on May 24 also carried one embryo each, but these averaged only 12.3 (8-15) in length. We noted young on July 14 in a cave 1 km. S Las Cuevas where *Natalus* occupied a small chamber apart from the nursery colonies of *Myotis velifer* and *Tadarida brasiliensis* also found there.

Myotis californicus californicus (Audubon and Bachman, 1842). — The small California myotis is widely distributed in Baja California. We shot five specimens (94260-62, 94323, 94328), all females, as they foraged in the evening along the wooded edges of a pasture adjacent to a dry river bed at Miraflores. One female was lactating; the others evidenced no gross reproductive activity.

Myotis velifer peninsularis Miller, 1898. — The cave myotis is known in Baja California only from the Cape region, where it is represented by the endemic *M. v. peninsularis*. It may be the commonest of the kinds of *Myotis* that occur in the southern part of the peninsula. Thirty specimens were obtained as follows: 1 km. S Las Cuevas, 4 (94263-66); Miraflores, 225 m., 22 (94267-88); 5 km. SE Pescadero, 4 (94291-94).

At Las Cuevas, an estimated 5000 females and young occupied a large cave in company with, although roosting separately from, a nursery colony of *Tadarida brasiliensis* and a hundred or more *Natalus stramineus*. In Miraflores, a nursery colony containing approximately 100 females and young sought retreat in a crevice above the doorsill of an abandoned adobe house. The largest of the young were capable of limited flight. The bats from 5 km. SE Pescadero were part of a group of about 25 males that roosted in two adjacent pockets in the ceiling of the mine tunnel mentioned in the account of *Natalus stramineus*.

The two "color phases" of *M. v. peninsularis* discussed by Miller and Allen (1928:94) are apparent in our series. Adult males have a brighter (more yellowish or orangish) dorsum than do females and are noticeably more yellowish orange ventrally. Sixteen young from 1 km. S Las Cuevas (July 14) and Miraflores (July 12) averaged 26.4 (18.1-36.5) in length of forearm.

Myotis volans volans (H. Allen, 1866). — Two females (94289-90) of this species were shot as they foraged at dusk at Miraflores on July 11 and 13. One (July 11) had enlarged uteri, but no indication otherwise of reproductive activity. The other carried a single embryo that measured 21 (crown-rump).

Measurements of only a few individuals of *M. v. volans* are on record (Miller and Allen, 1928:146-147). The subspecies is restricted to the southern part of Baja California, evidently having been reported previously only from Cabo San Lucas (type locality) and San Jorge. External and cranial measurements of our two specimens, which confirm the small size of the subspecies *volans*, are, respectively: total length, 92, 95; length of tail, 48, 42; length of hind foot, 9, 8; length of ear, 12, 12.5; length of forearm, 34.8, 37.6; greatest length of skull, 12.2, 12.5; zygomatic breadth, ---, 8.2; interorbital constriction, 3.4, 3.5; breadth of braincase, 6.5, 6.6; mastoid breadth, 6.9, 7.2; length of maxillary tooth-row, 4.4, 4.5. The non-pregnant specimen weighed 5.3 grams, whereas the pregnant female weighed 8.3.

Pipistrellus hesperus australis Miller, 1897.— The western pipistrelle occurs throughout Baja California, but the subspecies *australis* is restricted on the peninsula to approximately the southern half. We took 13 specimens as follows: Miraflores, 225 m., 7 (94321-22, 94324-27, 94329); San Antonio, 375 m., 2 (94315-16); Todos Santos, 5 m., 4 (94317-20).

All of our specimens were shot as they foraged at dusk. None of five females examined was pregnant or lactating.

Eptesicus fuscus peninsulae (Thomas, 1898).— This subspecies of the big brown bat, which occupies the southern part of Baja California north at least to Comondú (Engels, 1936:658), differs from other races of the species in western North America by being darker or smaller, or both. A female (94330), which was shot at Todos Santos on July 10 as it foraged at dusk among trees in a garden, carried a single embryo measuring 12 (crown-rump). Five specimens (94331-35), all females, were taken at Miraflores between July 11 and 14. One of these was shot as it foraged in the evening over a pastured area bordered by trees; the remaining four were taken in a mist net as described in the account of *Lasiurus ega*. Three of the five were lactating.

Engels (*op. cit.*:657) gave external and cranial measurements only for males of this subspecies. Average and extreme measurements of our six females are: total length, 108.2 (101-115); length of tail, 44.5 (39-49); length of hind foot, 9.7 (9-11); length of ear, 15.5 (15-16); length of forearm, 43.4 (41.8-45.4); condylobasal length (including incisors), 16.7 (16.3-17.3); zygomatic breadth, 11.6 (10.9-12.0); interorbital constriction, 3.7 (3.5-3.9); length of maxillary tooth-row, 6.2 (5.9-6.4). Four non-pregnant females weighed 13.6, 16.3, 17.1, and 19.8 grams.

Lasiurus ega xanthinus (Thomas, 1897).— The southern yellow bat has been recorded from Baja California only from four localities in the southern part of the peninsula (Handley, 1960:474-475; Hall and Jones, 1961:91). We collected thirteen adults (94336-48), three males and ten females, at Miraflores between July 11 and July 14. Seven bats were shot at dusk as they foraged over an open pasture or along trees that bordered the pasture. Six were trapped in a mist net stretched across a spring-fed pool in the otherwise dry bed of a tributary of the Río San José on the night of July 13-14 (two were netted between 1945 and 2100, two between 2100 and midnight, and two more sometime after midnight). All were captured at or near water level. *Myotis velifer, Eptesicus fuscus,* and *Tadarida brasiliensis* were taken in the same net.

Table 1. External and cranial measurements of *Lasiurus ega xanthinus.*

Measurement	94338, ♂	94342, ♂	94346, ♂	Average (and extremes) of 10 ♀♀
Total length	116	123	120	123.8 (120-128)
Length of tail	47	48	44	50.3 (46-58)
Length of hind foot	10	10	10	9.8 (8-11)
Length of ear	14	15	15	14.9 (14-16)
Length of forearm	——	46.5	44.9	47.2 (46.4-49.3)
Weight in grams	——	14.0	15.1	18.6 (16.0-21.5)[1]
Condylocanine length	15.4	15.6	15.8	16.1 (15.5-16.7)
Zygomatic breadth	10.7	11.2	11.3	11.5 (10.9-12.4)
Interorbital constriction	4.6	4.5	4.7	4.4 (4.0-4.5)
Mastoid breadth	8.6	9.0	8.9	9.2 (8.8-9.6)
Breadth of braincase	7.9	7.7	8.3	8.3 (8.0-8.5)
Length of max. tooth-row	5.3	5.3	5.4	5.7 (5.4-5.9)
Breadth across M3-M3	7.3	7.6	7.6	7.9 (7.5-8.2)

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[1] Seven non-pregnant females only.

Our specimens average slightly larger than *L. ega* available to us from the mainland of northern México. As in other lasiurine bats, females are somewhat larger than males (see table 1). Of the ten females taken, three were pregnant (each with two embryos) and four were lactating. Embryos (one from each pregnant bat) measured 22, 23, and 28 in crown-rump length.

Antrozous pallidus minor Miller, 1902. — We collected 15 pallid bats (94349-63) at Miraflores in holes and crevices above doorsills in abandoned adobe houses. Five of six adult females from a small nursery colony were lactating; five young bats, approximately three-fourths the size of adults, averaged 50.1 (45.8-52.7) in length of forearm. A group of males occupied crevices above a doorsill in a house not far distant from the one occupied by females and young.

Tadarida brasiliensis mexicana (Saussure, 1860). — According to Huey (1964:98) this free-tailed bat is found "the length of the peninsula," although Hall and Kelson (1959:206) mapped the species as occurring only in the northern part. On July 14, we collected 33 adults (12 males and 21 females), of which eight (94364-72) were preserved, in a cave 1 km. S Las Cuevas. Additionally, a single male (94373) was netted at Miraflores as described in the account of *Lasiurus ega.*

Two caves were visited at Las Cuevas, both located in the high-walled (75 feet in some places) sides of a dry wash and both apparently formed by water. A colony of approximately 3000 *Tadarida* containing young and adults of both sexes was located in one of the caves. Of the 21 females examined, one was pregnant with a single embryo (26 in crown-rump length) and the remainder were lactating. Many small, hairless young were observed. In addition to the free-tailed bats, approximately 5000 *Myotis velifer* and 100 *Natalus stramineus* occupied this same cave. Only *Macrotus waterhousii* was found in the second cave.

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A NEW SPECIES OF ELK KELP

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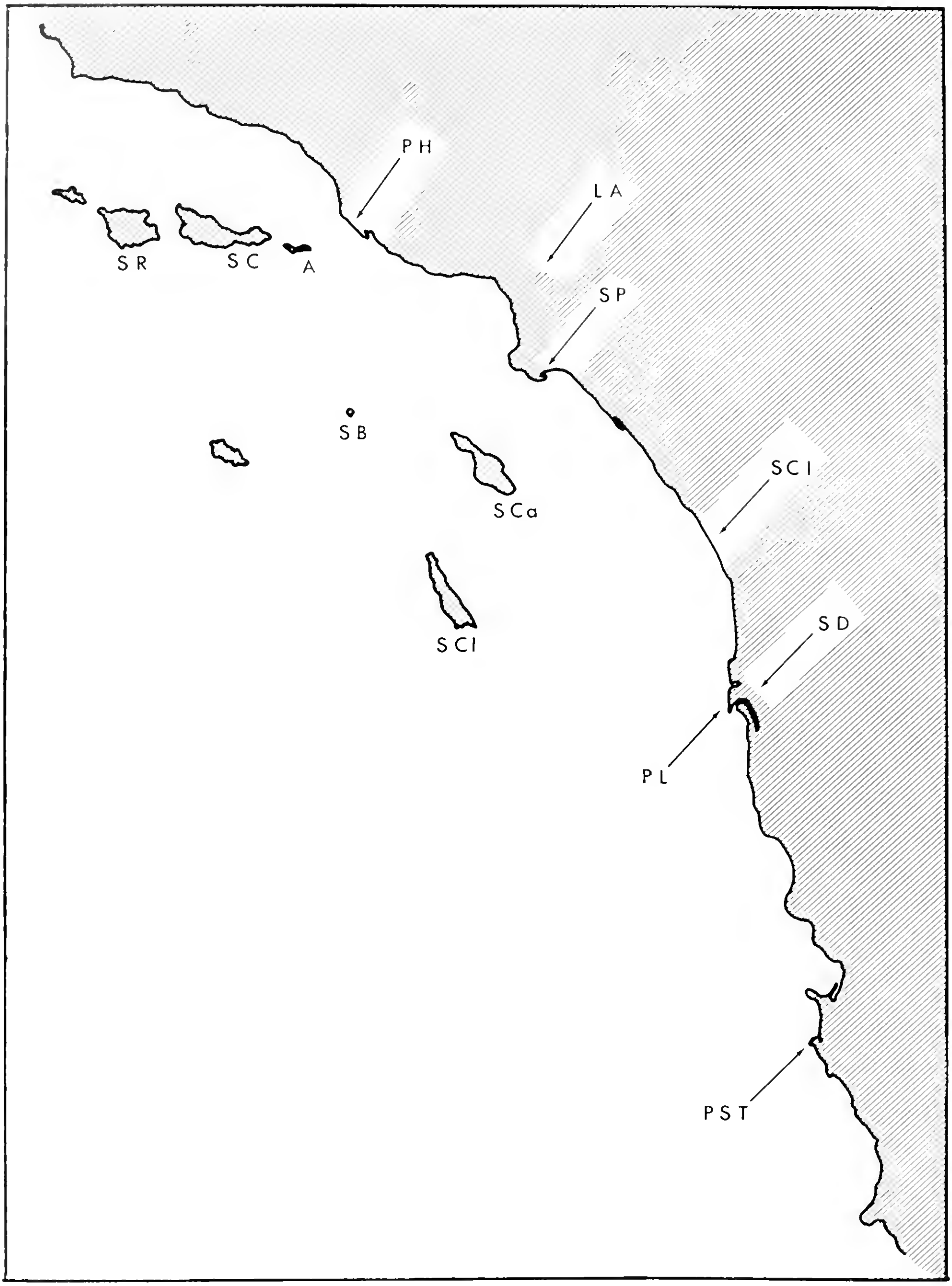

Fig. 1. Map of coastline and Channel Islands from Santa Barbara, California, to Punta Santo Tomás, Baja California.

SR, Santa Rosa Island; SC, Santa Cruz Island; A, Anacapa Island; PH, Port Hueneme; LA, Los Angeles; SP, San Pedro; SB, Santa Barbara Island; SCa, Santa Catalina Island; SCl, both San Clemente and San Clemente Island; SD, San Diego; PL, Point Loma; PST, Punta Santo Tomás, Baja California.

A NEW SPECIES OF ELK KELP

BY

BRUCE C. PARKER AND JOHN BLECK

The elk kelp, *Pelagophycus*, is one of the giant seaweeds of Pacific North America belonging to the family Lessoniaceae. The genus now contains two species, *P. porra* (Leman) Setchell and *P. giganteus* (Areschoug) Areschoug, the characteristics of which have been reviewed and discussed recently by Parker and Dawson (1964). We have continued the search for new populations of this genus with Scuba (Self-contained underwater breathing apparatus), and have collected specimens from several of the Channel Islands off the coast of southern California and from the coast of Baja California, Mexico, where specimens had not been collected previously. In this report we shall summarize the data from these new collections and the former ones, an analysis of which has led to the recognition of a new species. All localities discussed in this report are shown in figure 1.

Santa Catalina Island Population

Among the known localities for *Pelagophycus*, Santa Catalina Island has received the most thorough sampling. Several hundred plants have been observed or collected from various locations on the northeast (lee) side of the island, including Avalon Bay, Whites Cove, Long Point, Isthmus, and Emerald Bay. The genus has never been found on the southwest side of the island, although Dr. Wheeler North searched five locations from Catalina Harbor to Eagle Rock (Dawson, 1962) and we have searched the area near Silver Canyon and Farnsworth Bank.

For one and one-half years we have investigated the growth, development, and reproduction of *Pelagophycus giganteus* at Long Point. Observations of numerous plants during all seasons reveal that the morphological characteristics used in the classification of this species are stable on a year-round basis in spite of differences in several measured environmental factors. Mature, reproductive plants from Santa Catalina typify *P. giganteus* (fig. 2a) as recognized by Parker and Dawson (1964). At Long Point, plants occur in depths of 50 to at least 125 feet. (Catalina specimen nos. 1-1 to 6-3, 9-1 to 11-2)

San Clemente Island Population

Parker and Dawson (1964) reported the characteristics of only two plants from San Clemente Island. On January 8, 1964, we located a large population of *Pelagophycus* at White Rock on the eastern (lee) side of the island. More than 20 plants were observed, eight being collected for measurements and subsequent preservation. On the same day we found a single floating specimen at Northwest Harbor but failed to locate any attached plants. The San Clemente Island plants closely resemble *P. giganteus* from Santa Catalina Island (fig. 2a). There was a tendency for the stipe length to exceed that of most Catalina specimens, but only one specimen was more than three meters. Although the original two specimens reported by Parker and Dawson possessed cylindrical antlers and spherical pneumatocysts like *P. porra*, none of the specimens collected later revealed these features; like the Catalina plants, antlers were more or less flattened and pneumatocysts elliptical. (Clemente specimen nos. 7-1, 7-2, 12-5 to 13-1)

Santa Cruz Island Population

On October 17, 1964, we located a large number of plants at Yellow Banks Anchorage, in 65 to 70 feet of water, a location suggested earlier in Dawson's paper (1962). Approximately 20 mature, reproductive plants were collected, twelve of which were retained for preservation. These specimens were intermediate in every principal character between the two known species of *Pelagophycus* (fig. 2b). A more complete sample of about 25 mature specimens was collected during a second visit to Yellow Banks Anchorage on February 26, 1965. (Cruz specimen nos. 14-1 to 14-12, 17-1 to 17-14)

Point Loma, San Diego, Population

No further collections have been made from Point Loma since those reported by Parker and Dawson (1964). (Loma specimen nos. 8-1 to 8-7)

Punta Santo Tomás, Baja California, Population

A detached specimen of *Pelagophycus* collected by Dr. Wheeler North from San Ysidro, Baja California, Mexico, with a stipe 85 feet long, indicated the need for further comparative examination of the elk kelp in this region. From December 21 to 23, 1964, a large number of specimens was collected from depths of 110 feet at Punta Santo Tomás. Although closely resembling plants from Point Loma, this population had some mature plants with longer stipes, a few approaching the maximum of 27 meters described for *P. porra* (fig. 2c). (Tomás specimen nos. 16-0 to 16-18)

Statistical Analysis

The stipe length and holdfast diameter of *Pelagophycus* were selected for statistical analysis because these features could be measured accurately. However, as the holdfast is sometimes partly removed during collection, we excluded from the samples any plants whose holdfasts showed obvious damage. The statistical analysis presupposes a random sample. Because divers were unable to see the plants before descending to the bottom, locating a population, and collecting individuals of all sizes from the nearest cluster, and because several divers descended at different locations, we have assumed that our collections represent random samples. Once plants are brought to the surface, those bearing fertile blades are selected from the sample and the number of blades from each of these reproductive plants are noted. Thereafter, mature plants within that population are considered either as plants possessing fertile blades or having the number of blades equal to or exceeding the least number of blades on plants bearing fertile blades.

Methods of statistical analysis included calculation of means, standard deviations, and confidence limits for the means, as well as the method of least squares for calculating regression lines. Table 1 gives some of the data from this analysis. The data demonstrate that no overlap occurs at the 99 per cent confidence limits for the mean stipe length between Santa Catalina Island, Santa Cruz Island, and Punta Santo Tomás populations. In contrast, significant overlap occurs between populations from Santa Catalina and San Clemente islands and also between Point Loma and Punta Santo Tomás. In fact, on the basis of all other morphological characteristics, there is no reason to expect the populations from Santa Catalina and San Clemente Islands to be separate species; they both typify *P. giganteus*. Similarly Point Loma and Baja California populations are considered as one species, *P. porra* (Dawson, 1962; Parker and Dawson, 1964). If the data for Santa Catalina and San Clemente Islands are statistically treated as a unit, and the data from Point Loma and Punta Santo Tomás are similarly combined into one sample, there is no overlap at the 99 per cent confidence limits for the mean stipe length either between the Santa Catalina-San Clemente complex and the Santa Cruz Island population or between Santa Cruz Island and the Point Loma-Santo Tomás complex.

As to the holdfast data in table 1, we have no statistical reason to consider the Santa Catalina and San Clemente populations or the Point Loma and Punta Santo Tomás populations to differ significantly in mean holdfast diameter. The 95 per cent confidence limits for the mean holdfast diameters indicate that the Santa Cruz Island population is distinct from and intermediate between the Santa Catalina-San Clemente island species on the one hand the Point Loma-Santo Tomás species on the other.

Plotting the data for the holdfast and stipe with their least squares has indicated that the Santa Catalina and San Clemente Island populations are closely related, as are also the populations from Point Loma and Punta Santo Tomás. In contrast, the regression line for the Santa Cruz Island plants is distinctly separate from and intermediate between the other populations.

Although other features — pneumatocyst size and shape, antler length and shape, blade number, blade length and width, holdfast attachment — have not been treated statistically, it is clear from our data that these features reflect the same trends indicated in the analysis of stipe length and holdfast diameter.

Discussion

The data collected from five populations of *Pelagophycus* have led us to conclude that the Santa Cruz Island population constitutes a new species. The morphological features of mature plants from Santa Catalina and San Clemente Islands exhibit the characteristics of *P. giganteus* (Areschoug) Areschoug, while plants from Point Loma and Punta Santo Tomás fit well the limits previously described for *P. porra* (Leman) Setchell. The plants from Yellow Banks Anchorage, Santa Cruz Island, are remarkably intermediate in nearly every characteristic between the other two species. For this new species we propose:

Pelagophycus intermedius, species nova

Hapteron typice 20-40 cm. diam. saxo affixum, in arenam conchasque vicinas patens. Stirps in speciminibus maturis reproductivis 4-10 cm. long. Laminae 6-12, in plantis maturis perumque 8, omnes 5-8 (raro 10) m. long., 0.27-0.42 m. lat. Pneumatocystis aliquantulum elliptica, plerumque, autem, non omnino spherica, 8-17 cm. diam. Cornua paululum applanata ad fere cylindrica.

Type specimen, No. 17-6, is deposited in the herbarium, Missouri Botanic Garden, St. Louis, Missouri, as are the other specimens cited in this paper.

The three species of *Pelagophycus* may be distinguished as follows:

	P. giganteus	*P. intermedius*	*P. porra*
Holdfast	To 60 or more cm. broad, spreading into sand and shell	20-40 cm., attached to a rock, often spreading into sand and shell	10-20 cm., rarely more, attached to a rock
Stipe	Short, reaching a maximum of 2.5-3 meters	Intermediate, 4-10 meters in adults	Long, 7-27 meters
Blades	Large, usually 6 at maurity, rarely to 9, 6-10 or more meters long and over 0.4 meters wide	Typically 8, up to 12, each 5-8 meters (rarely 10) long and 0.27-0.42 meters broad	12-20 in adults, to 5.5 meters long and to 0.4 meters wide
Pneumatocyst	Usually elliptical, 6.4 × 7.6 to 11.4 × 13.4 cm.	Slightly elliptical or nearly spherical, 8-17 cm.	Predominently spherical, 10-20 cm. diameter
Antlers	Pronouncedly flattened to subcylindrical, usually less than 1 meter in length	Commonly subcylindrical, rarely more than 1 meter	Cylindrical, frequently more than 1 meter in length

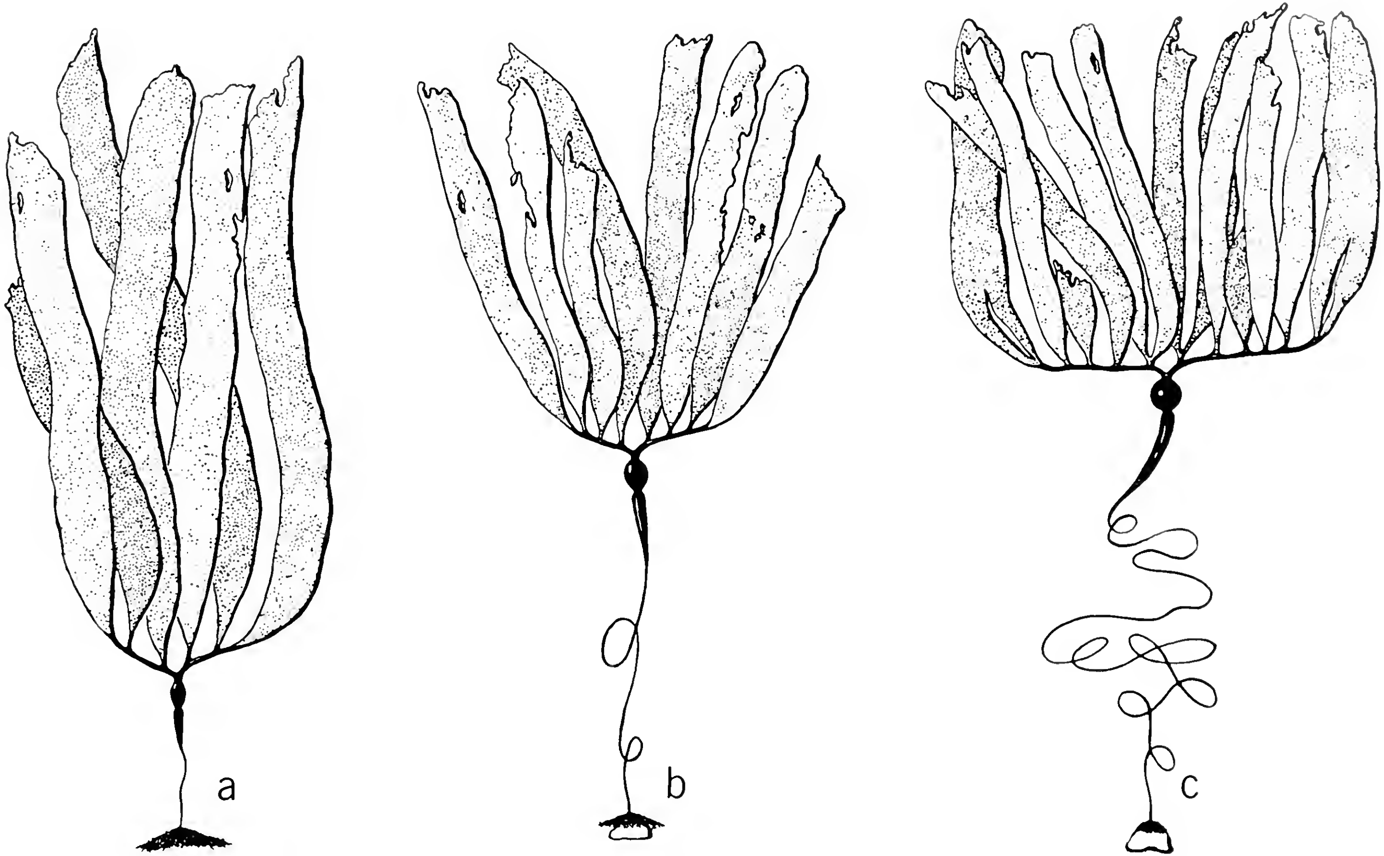

Fig. 2. The three species of *Pelagophycus*. a, *P. giganteus* (Areschoug) Areschoug; b, *P. intermedius* sp. nov.; c, *P. porra* (Leman) Setchell. × 0.01.

Table 1. Statistical analysis of stipe length and holdfast diameter.

Population	Organ[1]	N	Mean[2]	Range	Standard deviation	Confidence limits for mean (S, 99%; H, 95%)
Santa Catalina Island	S	17	1.43	0.6-2.7	0.55	1.04-1.82
	H	14	43.9	23-63	10.1	43.58-44.22
San Clemente Island	S	8	2.13	0.7-5.5	1.63	0.11-4.15
	H	6	39.4	25-50	9.9	9.96-46.64
Santa Catalina-San Clemente complex	S	25	1.66	0.6-5.5	1.69	0.71-2.61
	H	20	42 6	23-63	10.0	37.93-47.27
Santa Cruz Island	S	28	4.83	1.5-10 3	2.29	3.63-6.03
	H	20	28.3	14-44	8.3	24.42-32.18
Point Loma	S	5	9.23	7.2-10.3	1.46	6.22-12.24
	H	4	18.5	8.9-33	11.2	0.69-36.31
Punta Santo Tomás	S	15	14 3	7.7-25.9	6.67	9.19-19.45
	H	16	18.5	5.0-30.5	7.1	14.72-22.28
Point Loma-Santo Tomás complex	S	20	13.0	7.2-25 9	4.72	10.03-16 05
	H	20	18.1	5.0-33	7.8	14.46-21.74

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[1] S=stipe, H=holdfast.

[2] Stipe length in meters, holdfast diameter in centimeters.

That all three species of *Pelagophycus* are self-reproducing and not sterile is indicated by the occurrence of mature plants with fertile blades and accompanying juveniles in all populations so far sampled. The sexual life cycle is essential to the perpetuation of the genus since there is no means of asexual reproduction. The chances of frequent hybridization among the species are slight since all the species are separated by distances of more than 60 miles and depths exceeding 3000 feet. Floating plants may travel great distances; however, evidence is lacking that such detached plants remain potentially reproductive. At one time, a relatively continuous population of *Pelagophycus* probably occurred from Santa Cruz Island to nearby Anacapa Island, connecting with the coastline of California near Port Hueneme, and extending southward to Los Angeles, San Pedro, San Diego, and into Baja California at least as far as San Quintín. Today the continuum is broken at several locations where the elk kelp formerly thrived (e.g., San Pedro). The occurrence of this genus at Anacapa Island today is suggested by the collection of a single floating plant previously reported by Parker and Dawson (1964). It is now clear that the features of this Anacapa plant were like those of *P. intermedius* from Santa Cruz Island.

Were plants still in existence there, the population at San Pedro, California, would be one of the most interesting for studies of possible hybridization, because at this point *P. porra* came within 15 miles of the currently thriving *P. giganteus* at Santa Catalina Island. Noteworthy are the reports of Setchell (1896, 1908, 1912) and Herbst and Johnstone (1937) on the characteristics of *P. porra* from San Pedro. Setchell described the antlers as "pronouncedly flattened" and Herbst and Johnstone described holdfasts of plants dredged from 15 fathoms, 5 to 7 miles southwest of San Pedro Harbor, which exceeded 60 cm. in diameter. These two features are like those of *P. giganteus* from Santa Catalina Island, while in all other characteristics the San Pedro plants resembled *P. porra* from Point Loma and Baja California. Thus, some hybridization may have occurred between the Santa Catalina and San Pedro populations. From the work of Herbst and Johnstone (1937) we know that the San Pedro plants were capable of self-reproduction, although they reported that the spores were non-motile and non-flagellated, a feature rare among the brown algae and inconsistent with the known production of zoospores by *P. giganteus* (Parker, unpubl.).

In describing the new species, genetically different populations have been assumed. This assumption is based on the apparent self-fertility of all populations, as mentioned earlier, the failure of *P. giganteus* at Santa Catalina Island to exhibit seasonal changes in morphology, in spite of changes in environmental factors such as temperature and light intensity, and differences in the sizes of nuclei between *P. giganteus* and *P. porra*. With respect to the last point, it has been found recently that the meristoderm nuclei in stipes of *P. giganteus* have exactly twice the volume of nuclei in *P. porra* (Parker and Fu, unpubl.). It is, therefore, probable that *P. intermedius* is an autoallopolyploid derived from the hybridization of *P. giganteus* and *P. porra*, but further studies will be needed to confirm this suspicion.

Acknowledgements

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BIOLOGICAL OBSERVATIONS ON THE WHALESUCKER, *REMILEGIA AUSTRALIS* ECHENEIFORMES : ECHENEIDAE

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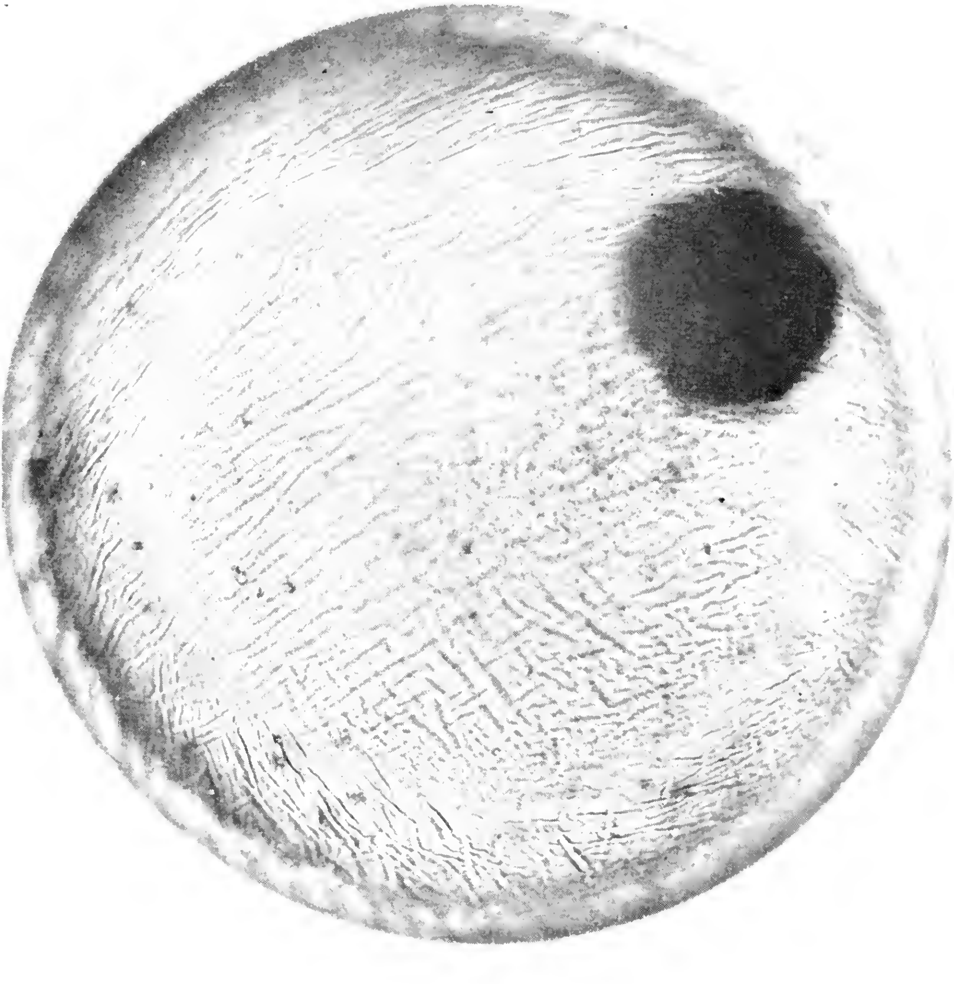

Fig. 1. Photomicrograph of the egg of *Remilegia australis* (Bennett); courtesy of Brian P. Boden. × 50.

BIOLOGICAL OBSERVATIONS ON THE WHALESUCKER, *REMILEGIA AUSTRALIS* ECHENEIFORMES : ECHENEIDAE[1]

BY

KEITH W. RADFORD AND WITOLD L. KLAWE

Fourteen large specimens (327 to 578 mm., standard length) of the cosmopolitan whalesucker, *Remilegia australis* (Bennett), were recently collected between Turtle Bay, Baja California Sur, Mexico, and Costa Rica. Follett and Dempster's synopsis (1960) of *Remilegia* was based on 18 specimens 105 to 399 mm. in standard length. Because of the scarcity of records of large specimens, our data are intended to supplement their compilation and to present additional biological information.

Five specimens (SIO 62-397-42A) were collected by Klawe aboard the M/V "Independence" on April 27, 1962, off Punta Burica, Costa Rica (08° 14′ N, 84° 17′ W). These specimens were removed from a purse-seine set on a school of yellowfin tuna, *Thunnus albacares* (Bonnaterre), which was accompanied by a school of Pacific common dolphins, *Delphinus bairdii* Dall. Several jumping porpoises were observed with whalesuckers attached to their flanks. A faint impression of the sucking disc was observed posterior to a flipper on a drowned host.

One specimen (SIO 63-1057-42A), presented by Julius Chiappe, was taken in July, 1963, in a purse-seine, 40 miles west of Turtle Bay, Baja California (approximately 27° 31′ N, 115° 52′ W). This individual was swimming with several smaller ones near a large manta ray. Some were reported to have been observed in the mouth of the ray (J. Chiappe, pers. comm.).

Two specimens (SIO 64-276-42A) were collected in a purse-seine by Don Green of the M/V "Southern Queen" on May 20, 1964, 77 miles SSW of Cape San Lucas, Baja California (approximately 21° 55′ N, 110° 44′ W). They had been attached to a "whitebelly porpoise" (D. Green, pers. comm.; presumed by us to be *Delphinus bairdii*).

Six specimens (SIO 64-389-42A) were collected in a purse-seine by José Machado of the M/V "Larry Roe" sometime between June 19 and 25, 1964, southeast of Cape San Lucas, Baja California (22° 15′ to 22° 50′ N, 108° 03′ to 107° 41′ W); these were removed from *Delphinus bairdii.*

Meristic data and disc-length measurements (tables 1 and 2) were obtained by the methods of Follett and Dempster (1960). Most of our counts lie within the range of published data for this species. Two specimens have 28 disc laminae, a number previously reported for only one specimen as representing the upper count. One specimen has 27 dorsal soft-rays, one more than previously recorded for this species. The number of denticles (counted on the last lamina on both sides) increases with increased size of the fish, as noted by Maul (1956) and Follett and Dempster (1960); the relation is curvilinear (fig. 2).

We interpret the vertebral formula in all but two of our specimens to be 13 precaudal and 14 caudal (the fourteenth vertebra bears a definite hemal spine), rather than 12 + 15 as stated by Follett and Dempster (1960). Our two specimens with a 12 + 15 formula (SIO 64-389, 327 and 334 mm.) have a hemal spine and no ribs on the thirteenth vertebra. The first four interhemals point to this ribless vertebra (interhemals 2 and 3 impinge on the first hemal spine; 5 and 6 impinge on the second hemal spine). The remaining specimens have ribs on the thirteenth vertebra. The first three interhemals point to this ribbed vertebra, the

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[1] Contribution from the Scripps Institution of Oceanography, University of California, San Diego, and the Inter-American Tropical Tuna Commission, La Jolla, California.

Table 1

Standard length, disc length, and selected counts of 14 specimens of *Remilegia australis*.

Figures to the left side of the hyphens represent counts from the left side of the specimen.

Character	SIO 64-389-42A	SIO 64-389-42A	SIO 62-397-42A	SIO 62-397-42A	SIO 64-389-42A	SIO 64-389-42A
Standard length, mm.	327	334	432	446	456	458
Disc length/standard length	.465	.488	.491	.493	.482	.479
Discal laminae	24	27	26	28	25	27
Dorsal soft-rays	23	27	25	26	24	24
Anal rays, total	22	26	24	25	22	23
Pectoral rays	23-23	23-23	22-22	23-24	23-23	24-24
Pelvic rays	I,5-I,5	I,5-I,5	I,5-I,5	I,5-I,5	I,5-I,5	I,5-I,5
Caudal rays						
Principal	9+8	9+8	9+8	9+8	9+8	9+8
Procurrent	13-14	14-14	14-13	15-14	13-14	12-12
Gill-rakers						
First arch						
Anterior	2+16-2+16	2+17-2+19	3+17-2+17	2+17-1+14	2+17-2+17	3+16-2+17
Posterior	2+18-1+19	2+16-1+16	2+18-2+19	2+17-1+19	1+20-1+20	1+17-1+17
Second arch						
Anterior	2+18-2+19	2+19-2+19	2+20-2+18	2+19-2+17	2+17-3+19	2+17-2+17
Posterior	2+19-2+18	1+17-2+18	2+21-2+20	2+18-2+16	2+19-2+18	1+18-1+16
Third arch						
Anterior	2+19-2+20	2+18-2+19	2+21-2+20	1+18-2+17	2+18-2+18	2+17-2+16
Posterior	1+16-1+17	1+17-2+16	1+16-1+18	1+18-2+17	1+21-1+17	1+17-1+15
Fourth arch						
Anterior	2+17-1+18	2+18-2+16	2+18-1+18	2+17-1+18	1+18-2+18	2+16-1+17
Posterior	1+14-1+14	1+12-1+13	1+12-1+12	1+15-1+14	1+15-1+13	1+12-1+11
Branchiostegals	9-9	9-9	10-10	10-10	10-10	10-10
Denticles on last pair of laminae	158-162	156-162	180-155	157-154	-168	152-162
Weight in grams, frozen or after preservation	368	468	1205	1354	1304	1616

TABLE 1, continued

SIO 63-1057-42A	SIO 64-389-42A	SIO 64-276-42A	SIO 64-389-42A	SIO 64-276-42A	SIO 62-397-42A	SIO 62-397-42A	SIO 62-397-42A
459	475	484	499	504	514	548	578
.481	.499	.488	.497	.486	.492	.498	.484
26	25	26	27	26	26	26	28
26	26	24	24	25	26	24	25
24	24	23	24	23	24	23	25
23-24	24-24	23-23	23-23	23-23	24-23	23-21	23-23
I,5-I,5	I,5-I,5	I,5-I,5	I,5-I,5	I,5-I,5	I,5-I,5	I,5-I,5	I,5-I,5
9+8	9+8	9+8	9+8	9+8	9+8	9+8	9+8
-14	14-	13-14	-14	-13	13-15	13-12	13-14
2+15-2+15	2+15-2+18	2+16-2+17	-2+17	3+16-2+18	2+16-2+17	2+15-1+13	-2+18
1+19-2+19	2+18-2+18	2+19-2+17	2+20-2+20	2+18-2+18	1+17-1+17	1+18-1+18	1+19-1+17
2+18-2+17	2+18-2+22	2+16-2+17	2+19-2+19	2+17-3+17	2+17-1+17	2+18-2+18	2+19-1+17
2+17-2+18	2+19-2+18	2+18-3+17	2+17-2+18	2+19-2+20	1+17-2+18	2+17-2+18	1+17-3+18
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1+15-1+17	2+16-1+17	2+18-2+16	2+16-2+17	2+16-1+17	2+16-1+18	1+16-1+18	1+19-1+17
2+18-2+16	2+19-2+18	1+18-3+18	2+18-2+17	2+18-2+17	2+18-2+17	1+17-1+17	2+19-1+17
1+14-1+15	2+13-1+13	1+13-1+14	1+15-1+14	1+13-1+13	1+14-1+12	2+12-1+14	1+13-1+14
10-10	10-10	10-10	10-10	10-10	10-10	10-10	10-10
159-159	164-177	176-173	178-175	124-123	156-141	170-172	191-189
1262	1304	1332	1857	1644	1942	2218	2920

TABLE 2

Frequencies of gill-raker counts (both sides counted) in 14 specimens of *Remilegia australis*.

All rudimentary gill-rakers are counted. The raker in the angle of the arch is included in the count of the lower limb.

	Upper limb			Lower limb											
	1	2	3	11	12	13	14	15	16	17	18	19	20	21	22
First arch															
Anterior	2	20	4			1	1	4	6	10	3	1			
Posterior	14	14							2	7	7	7	5		
Second arch															
Anterior	2	23	3							10	6	8	3		1
Posterior	5	21	2					1	5	6	1	2	1		
Third arch															
Anterior	3	22	2						1	3	13	7	2	1	
Posterior	19	9						2	9	10	5	1		1	
Fourth arch															
Anterior	9	18	1						3	9	14	2			
Posterior	26	2		1	6	8	9	4							

fourth and fifth impinging on the first hemal spine. The ribs on the thirteenth vertebra are usually abruptly slender, and are shorter and more strongly curved than those on preceding vertebrae.

The relationship between the disc length and standard length is isometric (fig. 2). The disc length is very nearly half (0.465-0.499) the standard length in our specimens, and averages 0.494 of the standard length (including Follett-Dempster data).

The specimens from Costa Rica were slate blue when retrieved from the purse-seine. The other specimens were similar in color when received frozen. With preservation they all became darker and duller. The apex of each lobe of the caudal fin is white.

Stomach contents of seven specimens were examined. The only material present was a white, granular, mushy substance that was not identifiable. A few nematodes were removed from one stomach.

Thirteen of the specimens are females (the sex of the smallest specimen could not be determined). Those specimens from Costa Rica exuded ripe eggs when captured. The freshly expelled eggs (fig. 1) were spherical, nearly transparent (becoming milky when preserved), uniform in size and shape, and contained a single, highly refractive, light-amber oil globule. The surface of the preserved egg has minute, more or less linear rugosities of varying sizes. The eggs resemble those of *Remora remora* (Linnaeus) and *Echeneis naucrates* Linnaeus, as illustrated and described by Sanzo (1927, 1928). The egg, 2.12 mm. in diameter, is intermediate in size between those of *R. remora* and *E. naucrates*. The oil globule, 0.47 mm. in diameter, is much larger than those reported by Sanzo in the two species he studied. A very narrow perivitelline-like space is evident.

An accurate estimate of the number of eggs in the ovary was impossible. The wall of the ovary was highly convoluted, and the eggs were in various stages of development and attachment to the ovarian wall. The number of free eggs in the lumen of the ovary was only a small proportion of the visible total. The weight of the preserved ovaries of our largest specimen was 349 grams, or nearly 12 per cent of the total weight of the frozen specimen. In contrast, the ovaries of the 432 mm. specimen weighed only 19 grams, or 1.6 per cent of the frozen weight. Each ovary of the larger specimen was 190 mm. long and 55 mm. in greatest width. The ovaries of the smaller specimen measured 80 × 8 mm.

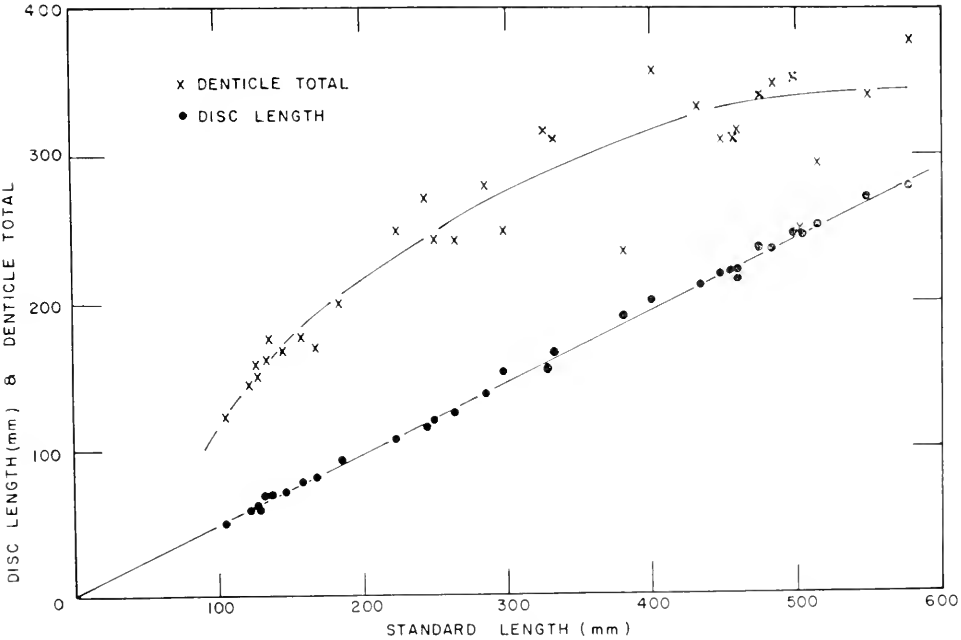

Fig. 2. Disc length and denticle number (last lamina, both sides) in relation to standard length. Data from Follett and Dempster (1960) are included.

Several parasitic copepods, *Lepeophtheirus crassus* (Wilson and Bere), were removed, primarily from around the disc, from the specimens from Costa Rica (Shiino, 1963), west of Turtle Bay and southeast of Cape San Lucas. This copepod has also been recorded on *Echeneis albescens* [=*Remorina albescens*] (Temminck and Schlegel) from the Bay of Bengal, and on *Rhombochirus osteochir* (Cuvier) from the Gulf of Mexico (Yamaguti, 1963).

Several cephalothoraxes (with three chitinous unbranched horns) of the copepod *Pennella* were imbedded in the muscle of the body wall near the coelomic peritoneum of one of the Costa Rican specimens. One representative of this genus, *P. remorae* (Murray), has been recorded by Yamaguti (*op. cit.*) from *Echeneis remora* [=*Remora remora* (Linnaeus)].

We are indebted to Dr. Sueo M. Shiino, Faculty of Fisheries, Prefectural University of Mie, Japan, for identification of the *Lepeophtheirus*, to Dr. Charles O. Handley of the United States National Museum for the identification of the Costa Rican *Delphinus*, to Vito Zottolo, Girolamo Gangitano, Julius Chiappe, Don Green, and José Machado of San Diego for aid in providing specimens, and to Dr. Carl L. Hubbs of the Scripps Institution of Oceanography for reviewing the material presented.

SUMMARY

Meristic data are presented from 14 specimens (327-578 mm. standard length) of *Remilegia australis* (Bennett) collected in the eastern Pacific off Baja California Sur, Mexico, and Costa Rica. One specimen was observed swimming near a large manta ray; the remainder were removed from *Delphinus bairdii*. The mature egg, with a large single oil globule, is intermediate in size between that of *Remora remora* and *Echeneis naucrates*. The sex of the smallest individual could not be determined; the others were females, generally with well-developed ovaries. Representatives of the two parasitic copepods, *Pennella* sp. and *Lepeophtheirus crassus*, were removed from the specimens. The relationship between disc length and standard length is isometric. Stomach contents were unidentifiable.

RESUMEN

Se presentan datos merísticos tomados de 14 especímenes (de 327 a 578 mm. de longitud estándar) de *Remilegia australis* (Bennett) recolectados en al Pacífico oriental frente a Baja California, México y Costa Rica. Un espécimen se observó nadando cerca a una manta grande; el resto de los especímenes fueron removidos del *Delphinus bairdii*. El huevo maduro, que posee un glóbulo de aceite grande, es de un tamaño intermedio entre aquel de *Remora remora* y el de *Echeneis naucrates*. No pudo ser determinado el sexo del espécimen más pequeño; el resto eran hembras con ovarios generalmente bien desarrollados. De éstos, se removieron copépodos parasíticos tales como *Pennella* sp. y *Lepeophtheirus crassus*. La relación que existe entre la longitud del disco y la longitud estándar es isométrica. No fue posible identificar el contenido estomacal.

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PINNIPED POPULATIONS AT ISLAS GUADALUPE, SAN BENITO, AND CEDROS, BAJA CALIFORNIA, IN 1965

BY

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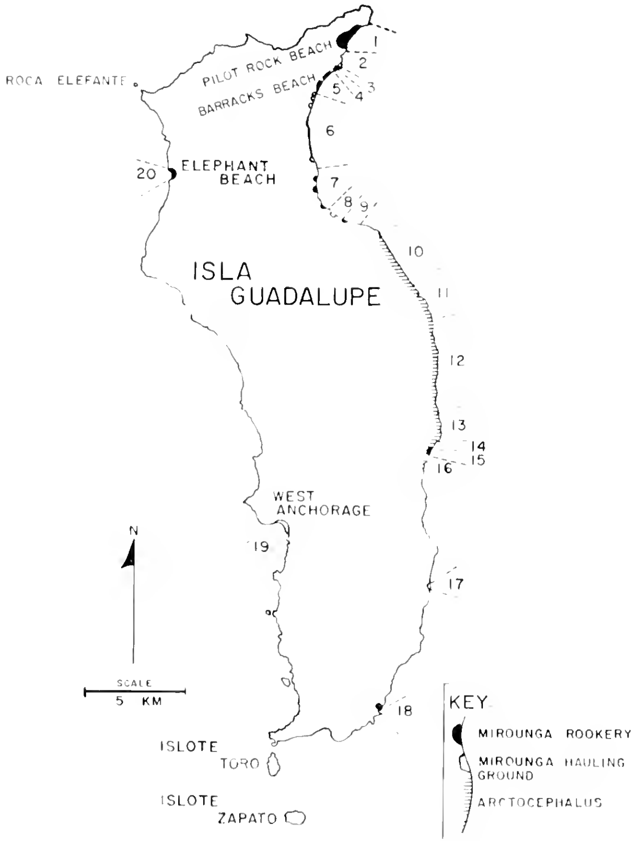

Fig. 1. Isla Guadalupe, Baja California, showing the census areas listed in table 2, the location of elephant seal rookeries and hauling grounds, and the area occupied by fur seals.

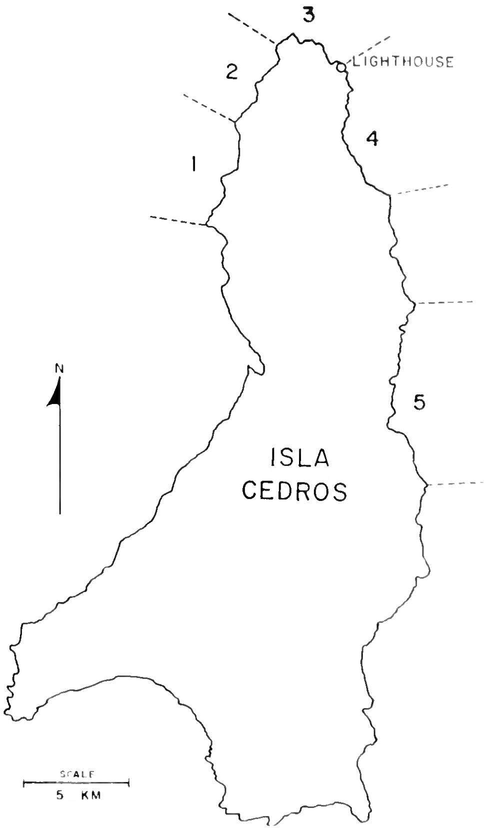

Fig. 2. Isla Cedros, Baja California, showing the census areas listed in table 2.

PINNIPED POPULATIONS AT ISLAS GUADALUPE, SAN BENITO, AND CEDROS, BAJA CALIFORNIA, IN 1965

BY

DALE W. RICE, KARL W. KENYON, AND DANIEL LLUCH B.

Between January 28 and February 3, 1965, we made censuses of the northern elephant seals, *Mirounga angustirostris*, Guadalupe fur seals, *Arctocephalus philippii townsendi*, and California sea lions, *Zalophus californianus californianus*, inhabiting Isla Guadalupe, the Islas San Benito, and Isla Cedros, Baja California, Mexico. This project was a cooperative effort of the Mexican Instituto Nacional de Investigaciones Biológico Pesqueras (INIBP) and the U. S. Fish and Wildlife Service (FWS). The censuses were made during whale-marking cruises of the whale catcher boats *Lynnann* and *Sioux City*, under charter from the Golden Gate Fishing Company of Richmond, California.

These three species of pinnipeds are of particular interest to biologists and conservationists. The elephant seal, nearly extinct before the turn of the century, has experienced a rapid population growth. The population may now be leveling off on Guadalupe, where regulated exploitation is being considered. Over 90 percent of the northern elephant seal population breeds on Isla Guadalupe and the Islas San Benito. The Guadalupe fur seal was heavily exploited during the last century, and until 11 years ago was feared extinct. The population apparently has only recently entered a phase of rapid growth. The fur seal is known to breed only on Isla Guadalupe. The California sea lion is abundant and unexploited (except for a small number taken in the Gulf of California). There has been agitation, especially in California, for reduction of its numbers because of alleged damage to fisheries. The feasibility of rational exploitation of sea lions is now being considered. Islas San Benito and Isla Cedros harbor some of the largest rookeries and hauling grounds of this species.

Our censuses are particularly useful for determining population changes, because they were made at exactly the same time of year as censuses made 15 years previously by Bartholomew and Hubbs (1952). The number of pinnipeds hauled out on any rookery or hauling ground may change markedly throughout the year, depending on migrations and phases of the breeding cycle. Daily variations must also be considered.

ACKNOWLEDGMENTS

We wish to acknowledge the indispensable help of the crew members of the vessels: Captain Loyd Newton, Ernesto Gonzales, and Robert Young of the *Lynnann;* and Captain Donald Gamble, Gordon Holmes, and Julio Ninayahuar of the *Sioux City*. Joaquin Arvizu M. of the INIBP and Kenneth Balcomb III of the FWS assisted in making the counts. Lt. Pablo Vásquez V., commanding officer of the naval garrison on Isla Guadalupe, and his men offered valuable assistance. Carl L. Hubbs supplied much valuable information concerning pinnipeds on these islands, and made many useful criticisms of the manuscript. George A. Bartholomew supplied information on elephant seals in the Channel Islands, and reviewed the manuscript. Richard A. Jennings provided the elephant seal count for Año Nuevo Island. Victor B. Scheffer and Ford Wilke reviewed the manuscript.

METHODS

We made our counts in three ways, depending upon terrain and sea conditions: (1) by walking the beaches; (2) by following the shoreline in outboard-powered skiffs; or (3) by cruising as closely as possible along shore with the *Lynnann* and *Sioux City*, which are 41 m. (135 ft.) long and draw about 3 m. (10 ft.).

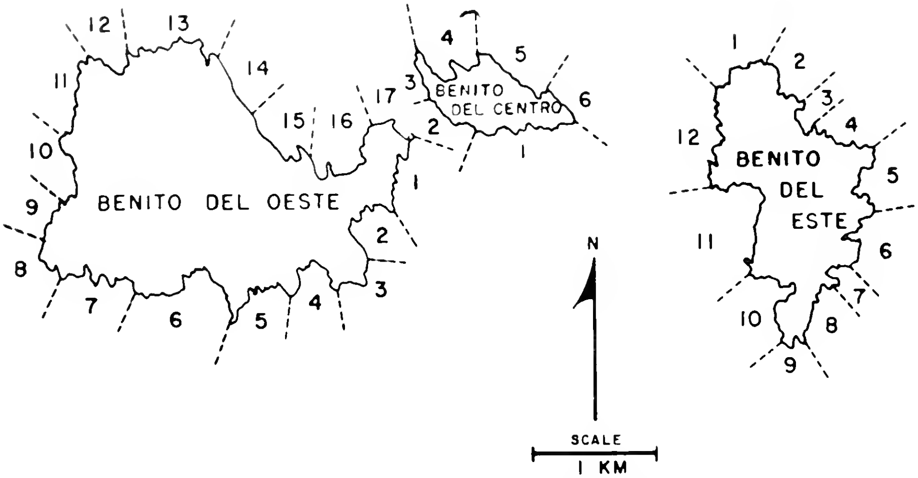

Fig. 3. Islas San Benito, Baja California, showing the census areas listed in table 2; these areas are the same as those used by Bartholomew and Hubbs (1952).

When it was impossible to count every individual in large compact masses of sea lions and elephant seals, we counted sample sectors containing 10 to 100 animals, and estimated the total number by visually dividing the total occupied area into sectors equivalent to the counted sample areas.

Isla Guadalupe, January 28-31. — We covered on foot all portions of the east shore inhabited by fur seals, except for certain small areas (see below) that were too precipitous; in such areas we used a small boat. We also covered on foot the largest elephant seal rookeries — those at Pilot Rock Beach and the Barracks Beaches. The sector between these two rookeries was observed from a small boat. We followed the remainder of the east shore and all of the west shore in the *Lynnann*, about 0.5 to 1 km. offshore. We circled Islote Zapato in a small boat. Islote Toro, which we observed from the *Lynnann*, apparently is not used by pinnipeds, as it has no suitable hauling-out areas.

Islas San Benito, February 2-3. — We walked almost entirely around Benito del Oeste, except for a short sector at the west end of the south shore that was impassable. The latter we observed from a skiff. The surf prevented us from landing on Benito del Centro and Benito del Este, but we circumnavigated them in a small boat less than 0.25 km. off shore.

Isla Cedros, February 3. — The entire east shore and the southern half of the west shore were followed with the vessels *Lynnann* and *Sioux City*, respectively. The northern half of the west shore was observed from a small boat.

RESULTS

The counts are summarized in table 1; details for each island appear in table 2 and figures 1 to 3. Because Bartholomew and Hubbs (1952, 1960) and Hubbs (1956) reviewed the history of the pinniped populations on these islands and cited the earlier literature, we have alluded only briefly to past censuses.

Elephant Seals. — January is the height of the breeding season of the northern elephant seal (Bartholomew, 1952). At the time of our observations nearly all the pups had probably been born, and the number of breeding adults was probably near maximum. When censusing large groups of elephant seals, we found it impossible to count all the pups, because many were concealed by the much larger adults. We made complete counts of living pups at two

TABLE 1

Summary of 1965 pinniped censuses on Isla Guadalupe (Jan. 27-31), Islas San Benito (Feb. 2-3) and Isla Cedros (Feb. 3).

Island	*Mirounga*			*Arctocephalus*	*Zalophus*
	1 year old and older	Pups	Total		
Isla Guadalupe	6,721	3,668[1]	10,389	285	585
Islas San Benito					
Benito del Oeste	967	376	1,343		2,596
Benito del Centro	448	174[1]	622		2,236
Benito del Este	645	250[1]	895		2,326
San Benito subtotal	2,060	800	2,860		7,158
Isla Cedros	47		47	3	8,407
Grand total	8,828	4,468	13,296	288	16,150

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[1] Calculated number; see text.

rookeries and found the ratio of adults to pups. At the North Barracks Beach rookery at Isla Guadalupe, the ratio was 1 : 0.57. At the other large rookeries on Isla Guadalupe we counted only the animals older than pups, and estimated the number of pups by assuming that the ratio was the same as found at the North Barracks Beach rookery. If hauling grounds as well as rookeries are included, the ratio of older animals to pups on Guadalupe is estimated at 1 : 0.55. Along the entire shoreline of Isla Benito del Oeste, the ratio of older animals (including those on hauling grounds as well as those on rookeries) to pups was 1 : 0.39. Among the many groups of elephant seals on Benito del Centro and Benito del Este, we did not distinguish between rookeries and hauling grounds; to estimate the number of pups, we applied the Benito del Oeste proportion.

In the early 19th century, according to Scammon (1874), elephant seals occupied many rookeries and hauling grounds along the coast and on offshore islands, from Point Reyes, California (38°00′ N) south to Cabo San Lazaro, Baja California (24°48′ N). Subsequently, they were nearly exterminated, and by 1892, as far as is known, only 20 to 100 animals remained, all on Isla Guadalupe. In the following 68 years they increased to an estimated 15,000 (Bartholomew and Hubbs, 1960) and recolonized parts of their former range (see below).

In January and February, 1950, Bartholomew and Hubbs (1952) counted 4,548 elephant seals on Guadalupe. This count included only animals one year old and older (Bartholomew, *in litt.*). In January, 1960, Bartholomew and Hubbs (1960) counted 9,000 elephant seals on the east shore of Guadalupe, and estimated 11,000 on the entire island, including pups. We counted 6,721 seals older than one year, and estimated 3,668 pups, for a total of 10,389. These counts suggest that the Guadalupe population reached a peak by 1960, and has stopped growing.

One factor tending to limit further population growth may be increased mortality of pups because of crushing by the adults (see Bartholomew, 1952:392) on the crowded rookeries (fig. 4). Although we did not count the dead pups, there were many on the upper edges of the beaches (fig. 5) above the breeding aggregations, where some of the moribund pups crawl. Many other dead pups could be seen when the tightly packed adults moved about. Some were almost completely buried in the sand. Several dead pups were seen floating in the water off the rookeries. These observations indicate that only a small percentage of the pup carcasses was visible. Studies should be made to determine the extent and causes of pup mortality in relation to population density on the rookeries.

Fig. 4. Female elephant seals on the rookery at North Barracks Beach, Isla Guadalupe. Such dense crowding results in many pups being crushed to death, as the one in the lower left. January 28, 1965. (KWK 65-2-15)

Elephant seals re-established themselves on the Islas San Benito by 1918; in 1950, Bartholomew and Hubbs (1952) counted 908, excluding pups. Our count of 2,060, excluding pups, suggests that the San Benito population is still increasing at about the same rate as the Guadalupe population did during its phase of rapid growth (Bartholomew and Hubbs, 1960).

The elephant seals apparently have only recently recolonized Isla Cedros. Hubbs and Bartholomew (1952) found none there in 1950, but they did not examine the west coast. We saw 36 elephant seals hauled out on a small beach on the west side of the island 1 km. south of the north end; we were too far offshore to see if any pups were present. Eleven solitary males were seen around the north end of the island.

Over 90 per cent of all breeding northern elephant seals breed on Guadalupe and the Benitos. Elsewhere, elephant seals breed or regularly haul out on the Islas Los Coronados, Baja California, and on Santa Barbara, San Nicolas, San Miguel, Santa Rosa, and Anacapa islands of the Channel Islands off southern California. In central California, they have recently established a rookery on Año Nuevo Island north of Santa Cruz, and they sometimes haul out on the Farallon Islands, on Point Reyes, and on Seal Rock near Monterey (Radford, Orr, and Hubbs, 1965). Studies now under way by George A. Bartholomew in the Channel Islands, and by the Stanford Research Institute on Año Nuevo Island (Orr and Poulter, 1962, 1965), along with our observations, provide a census of the total elephant seal population in January-February, 1965 (table 3). The counts total 9,221 adults and 4,851 pups, for a total of over 14,072 on all known rookeries and hauling grounds. To this number may

Fig. 5. The carcasses of at least 25 elephant seal pups are visible here on the landward side of the North Barracks Beach rookery, Isla Guadalupe, January 28, 1965. (KWK 65-2-18)

be added 20 per cent (Bartholomew and Hubbs, 1960) as a conservative estimate of the animals, mostly immature, at sea, for a grand total of about 17,000 at the high point of the year. This value may be compared with the Bartholomew and Hubbs (1960) estimate of 15,000 animals in 1960. In summary, the population of northern elephant seals seems to have leveled off on Isla Guadalupe, but elsewhere this species is still expanding its range and increasing its numbers.

Guadalupe Fur Seals.—We counted 285 fur seals on Isla Guadalupe. Fur seals regularly occupy only a 13 km. sector of the eastern shore of Guadalupe. We covered this entire sector on foot, except for the northernmost 2 km. (a section with very few seals), which we surveyed from a small boat. We also covered by small boat at least 1 km. of shoreline to the north and south beyond the last observed seals. Although we may have missed a few seals that were hidden behind boulders, we believe that the total number of animals hauled out at the time of our visit did not exceed 300.

In 1950, Bartholomew and Hubbs (1952), despite a careful search by small boat along most of the east coast, failed to find any fur seals on Isla Guadalupe, and the species was thought to be extinct. A few fur seals must have been present at that time, but the population was certainly much smaller than now. The east shore of the island was closely navigated by small boat everywhere except along the very sector where the fur seals now occur, as shown on fig. 1 (Hubbs, *in litt.*). The species was rediscovered in November, 1954, by Hubbs (1956), when 14 fur seals were located at the northernmost point of their present range, after none were seen in running close along the entire east coast from the south end to the point

TABLE 2

Details of 1965 pinniped censuses on Islas Guadalupe, San Benito, and Cedros.

The area numbers refer to the maps (figs. 1-3).

Area	Date	*Mirounga*		*Arctocephalus*	*Zalophus*
		1 year old and older	Pups		
Isla Guadalupe					
1	Jan. 28	2,700	1,550[1]		
2	'' ''	18			
3	'' ''	97	56[1]		
4	'' ''	37			
5	'' ''	1,255	720[1]		
6	'' ''	55			
7	'' ''	1,100	631[1]		
8	'' ''	35			
9	'' ''	7	3		
10	Jan. 29			8	
11	'' ''			17	
12	'' ''			184	
13	'' ''			25	
14	'' 30			41	
15	'' 28	19	9		
16	'' 30			10	
17	'' 28	1			
18	'' ''	28	10		
19	'' 31	169			
20	'' ''	1,200	689[1]		
I. Zapato	'' 30				585
Totals		6,721	3,668	285	585
Isla Benito del Oeste					
1	Feb. 2	19	7		24
2	'' ''	6			29
3	'' ''	148	58		85
4	'' ''	190	74		100
5	'' ''	29	14		338
6	'' ''	64	7		559
7	'' ''	13			115
8	'' ''	7	1		325
9	'' ''	50	24		270
10	'' ''	235	116		335
11	'' ''	61	22		275
12	'' ''	43	14		113
13	'' ''	7			
14	'' ''	1			
15	'' ''				
16	'' ''	84	39		
17	'' ''	10			28
Totals		967	376		2,596

Table 2 (Continued)

Area	Date	*Mirounga*		*Arctocephalus*	*Zalophus*
		1 year old and older	Pups		
Isla Benito del Centro					
1	Feb. 2	79	No data		456
2	'' ''	14	''		230
3	'' 3	208	''		885
4	'' ''	132	''		415
5	'' ''	14	''		145
6	'' ''	1	''		105
Totals		448	174[1]		2,236
Isla Benito del Este					
1	Feb. 2	3	No data		136
2	'' ''	2	''		134
3	'' ''	1	''		72
4	'' ''	1	''		102
5	'' ''	51	''		337
6	'' ''	16	''		111
7	'' ''	46	''		255
8	'' ''	1	''		68
9	'' ''	12	''		96
10	'' ''	161	''		335
11	'' ''	342	''		404
12	'' ''	9	''		276
Totals		645	250[1]		2,326
Isla Cedros					
1	Feb. 3				1,340
2	'' ''	3			1,396
3	'' ''	43			1,441
4	'' ''	1			4,230
5	'' ''			3	
Totals		47		3	8,407

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[1] Calculated number; see text.

of discovery (Hubbs, *in litt.*). Counts made between 1954 and 1963 are not fully comparable with our count, because along most of the shore they were made from small boats, rather than by consistently walking the shoreline. We have found that observers in small boats miss many seals. The shoreline of Guadalupe where the seals haul out is largely a jumble of enormous, blackish boulders, of essentially the same color as the seals, at the foot of rugged volcanic cliffs that are undercut by many sea caves. The seals are scattered singly and in small groups, and hide in the caves and in the crevices and tide-pools beneath and behind the boulders and ridges. Many seals can be found only by an observer on shore who carefully searches all these hiding places. However, the repeated censuses by parties from Scripps Institution of Oceanography have definitely shown a marked increase, because many more have been seen recently from a skiff than were formerly observed (Hubbs, *in litt.*).

TABLE 3

World population of the northern elephant seal in 1965.

Island	Year reoccupied[1]	Population in 1965			Authority[2]
		1 year old and older	Pups	Total	
Isla Guadalupe		6,721	3,668	10,389	Present paper
Islas San Benito	1918	2,060	800	2,860	Hanna, 1925; present paper
Isla Cedros	1965	47	0	47	Present paper
Islas Los Coronados	1948	1	0	1	Bartholomew, 1950; present paper[3]
Santa Barbara Island	1948	4	0	4	Bonnot, 1951; present paper[4]
San Nicolas Island	1949	No data	No data		Bartholomew, 1951
San Miguel Island	1925	252	311	563	Rett, 1952; present paper[5]
Santa Rosa Island	1965	?	14	14	Present paper[6]
Anacapa Island	1958	No data	No data		Bartholomew and Boolootian, 1960
Año Nuevo Island	1955	136	58	194	Orr and Poulter, 1962; Jennings, *in litt.*[7]
Totals		9,221	4,851	14,072	

[1] Year of first published observation; reoccupation may have occurred somewhat earlier. In most localities the year of first breeding is unknown.

[2] Where two references are cited, the first refers to the year of reoccupation, the second to the 1965 population.

[3] Incomplete count made March 15 by Rice.

[4] Count made March 20 by Balcomb.

[5] Count made March 20 and 21 by Balcomb.

[6] Count made April 11 by Balcomb.

[7] Count made January 30 by Jennings.

Three other counts are comparable with ours, having been made on foot. Lluch and Pilson (Lluch, Irving, and Pilson, 1964) found 240 seals in February, 1964. Hubbs (*in litt.*) and party counted 252 in November, 1964, and 211 in March, 1965.

About two-thirds of the seals that we saw appeared to be less than a year old. Some were very small, though none had black natal pelage. Analogy with the northern fur seal, *Callorhinus ursinus*, suggests that the breeding season had terminated at least 15 weeks previously (Bauer, Peterson, and Scheffer, 1964). The only published observations on the breeding season of the Guadalupe fur seal are Scammon's (1874) statement that they bring forth their young between May and August on the California coast, and Townsend's (1899) reference to an unnamed sealing vessel in 1880 that "reported that the young were born about the middle of June" on Guadalupe. These observations agree with those of parties from Scripps Institution (Hubbs, *in litt.*).

Because of the scarcity of adults, especially males, we believe that most of them were at sea at the time of our count. We saw several individuals at sea within 22 km. of the island, and on January 31 Balcomb identified one at 29°16′ N, 117°24′ W, 88 km. ENE from Guadalupe. A. W. Anthony (in Thoburn, 1899) wrote: "In conversation with those who sealed there [Guadalupe] when the species was common I learn that the old bulls left the females and pups as soon as the latter were a week or so old, and were not seen again until the following year. It is thought that they go to sea . . . ." In the northern fur seal, young of the year constitute about one-third of the population (Kenyon, Scheffer, and Chapman, 1954). If the same holds true for the Guadalupe fur seal, 200 young animals would suggest a total population of about 600. The population seems to be entering a phase of rapid logarithmic growth.

At Isla Cedros on February 3, 1965, we observed three Guadalupe fur seals in shallow water 25 m. off the beach about half way down the eastern shore. None was hauled out. On March 12 and 13, 1965, Rice revisited the site and saw possibly 10 small otariid seals in the water near the beach. Because they were very shy, and surfaced only momentarily, it was impossible to ascertain whether they were fur seals or young sea lions. At least 10 km. of the adjacent shoreline was carefully scrutinized, but no animals were hauled out. Prior to our visit, fur seals had not been found on Cedros for over a century. We do not know whether these fur seals represent a resident colony or whether they are wanderers from Guadalupe.

California Sea Lions. — Sea lions breed during the summer; at the time of our counts, the young of the year were well grown and we did not attempt to record them separately. Our counts of sea lions, compared with the 1950 counts of Bartholomew and Hubbs (1952), revealed an increase from 165 to 585 in the population at Islote Zapato off Isla Guadalupe, a decrease from 9,700 to 7,200 at the Islas San Benito, and an increase from 340 to 8,400 at Isla Cedros (the count for Cedros in 1950 included only the east shore). The total for all these islands had increased from about 10,000 to about 16,000.

One possible explanation is that the San Benito population, following heavy exploitation in 1939, has increased enough to occupy all the available habitat, and that the surplus animals have moved to Cedros. Other possibilities are that California sea lions may alternately use several different hauling grounds, or that they spend variable periods at sea and on shore. On March 13, 1965, on the east side of Cedros south of the north lighthouse, Rice counted only 2,850 sea lions, compared with 5,671 in the same area 38 days earlier.

The seasonal movements of California sea lions are poorly understood. As did Bartholomew and Hubbs (1952), we found few adult males. Many adult males move north during the winter. Over 10,000 males annually congregate at that season on Año Nuevo Island near Santa Cruz, California, north of the breeding range of the species (Orr and Poulter, 1965), and a few males are seen regularly in winter as far north as Sea Lion Caves, Oregon (Kenyon and Scheffer, 1962; Rice, unpublished field notes), and occasionally off Washington (Kenyon and Scheffer, 1962) and Vancouver Island, British Columbia (Cowan and Guiguet, 1956). Some adult males remain in the south, however, as we saw several at sea; we also saw one hauled out at Cabo San Lucas, the southern extremity of the present range of the species. Hubbs (*in litt.*) has found that Isla Guadalupe is often invaded in the winter by adult males, possibly from the San Benitos. At Guadalupe, as elsewhere, however, we saw very few adult males.

SUMMARY

We made a census of northern elephant seals, *Mirounga angustirostris*, Guadalupe fur seals, *Arctocephalus philippii townsendi*, and California sea lions, *Zalophus c. californianus* on Isla Guadalupe, the Islas San Benito, and Isla Cedros, Baja California, Mexico, between January 28 and February 3, 1965, exactly 15 years after a similar census by Bartholomew and Hubbs. According to our counts and estimates, there were 6,700 elephant seals older than one year and 3,700 pups on Guadalupe; 2,100 older animals and 800 pups on the San Benitos; and 47 adults on Cedros. The population appears to have leveled off on Guadalupe; crushing of pups on overcrowded rookeries may be one factor. Elephant seals are increasing on the San Benitos, and were found on Cedros for the first time in recent years. The world population is about 17,000. We counted 285 fur seals on Guadalupe, and 3 at Cedros; as far as is known they breed only on Guadalupe. With an allowance for adults at sea, the total fur seal population is estimated at 600, and it appears to be rapidly growing. We counted 585 sea lions on Guadalupe, 7,200 on the Benitos, and 8,400 on Cedros.

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TRANSACTIONS

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CHARLES RUSSELL ORCUTT, PIONEER CALIFORNIAN MALACOLOGIST, AND *THE WEST AMERICAN SCIENTIST*

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Fig. 1. Charles Russell Orcutt, 1864-1929

CHARLES RUSSELL ORCUTT, PIONEER CALIFORNIAN MALACOLOGIST, AND *THE WEST AMERICAN SCIENTIST*

BY

EUGENE COAN

Charles Russell Orcutt, who resided in San Diego, California, from 1879 until his death in 1929, was a collector of natural history specimens and the publisher of *The West American Scientist.* Because Orcutt is important to the history of western American malacology, I have prepared a brief biography and a bibliography of his writings on mollusks. I have also provided collations of five of his journals which contain molluscan articles in order to put the rarer of these on record and to unscramble the erratic numbering and dating of *The West American Scientist.*

Charles Russell Orcutt was born in Hartland, Vermont, April 27, 1864, the son of Heman Chandler Orcutt and Eliza Eastin Gray Orcutt. He moved to San Diego with his parents and his brother, John Heman, arriving January 18, 1879. He married Dr. Olive E. Eddy, and they had four children: Charles Eddy, Mary (Mrs. Mary Bisbee), Eunice (Mrs. Eunice Ivec), and Heman Cortis. Further details about the early history of the family may be found in Orcutt (1893) and Anon. (1929).

Throughout his life, Orcutt's main interests were botany and malacology. Jepson (1929) and Ewan (1963) have discussed his contributions to the former field. Self-educated, he was extremely devoted to science. He accumulated a large collection of Recent and fossil mollusks. He was especially anxious to see that the material he collected was used; when he sent specimens to an institution, he was very unhappy if they were not studied. He often advertised material for sale, as he made his living partly as a dealer in books and specimens, but he would gladly give away specimens and literature to interested students.

Orcutt traveled extensively throughout his life, usually by himself. His biological explorations carried him through southern California, Baja California, the mainland of Mexico, Central America, and the Caribbean. Collecting for the United States National Museum, he went to Jamaica in early 1927 and to Haiti in early 1929. He died in Haiti on August 24, 1929, at the age of 65. He was buried in that country, according to his wishes.

After his death the major part of Orcutt's shell collection was deposited in the San Diego Natural History Museum. Many specimens were from type lots of species that had been described by Dr. W. H. Dall and Dr. H. A. Pilsbry. Some material, which went into the hands of a dealer in shells, was probably lost. His library also went to the San Diego Society of Natural History.

In December, 1884, at the age of 20, he began publication of *The West American Scientist.* This journal which was affiliated with the San Diego Society of Natural History for some time, continued sporadically into 1921, largely through his efforts alone. It contained about 180 numbers in 22 volumes. The most nearly complete set is that in the library of the San Diego Society of Natural History. There is a collation with that set and the present one has been checked against it.

Orcutt also started many other journals. *West American Mollusca,* consisting of 13 issues, appeared from 1900 to 1902, and *California Art & Nature,* consisting of 12 issues, appeared in 1901 and 1902. They are further discussed below. While in Mexico during late 1913, he published *Orcutt's Mexico,* and during his stay in Jamaica he edited the *Jamaica Naturalist.* Sets of the latter two journals are in the library of the California Academy of Sciences.

Several of his articles on mollusks were reprinted in *West American Mollusca.* The first few numbers of that journal are exact reprints from *The West American Scientist,* but the later numbers contain only short reprinted passages, the rest being new material. An incomplete set (missing numbers 7, 8, and 11) has been deposited in the California Academy of Sciences, and there is a photostatic copy of it at Stanford University. As far as I know there are no other copies extant, but perhaps one will turn up. I have prepared a collation of it and also treat each of the 13 numbers as a separate article in the bibliography.

In terminating publication of *West American Mollusca,* Orcutt stated that he planned to continue the molluscan descriptions in a new journal, *California Art & Nature.* There is a set of that periodical, perhaps the only one still in existence, in the library of the San Diego Society of Natural History.

His book, *Molluscan World,* volume 1, was essentially volume 20 (whole numbers 140 to 157) of *The West American Scientist* and is here treated as such. He nearly completed the second volume of this work, and it appeared serially as volume 21 of *The West American Scientist* in 1919.

He added at least three names to molluscan literature: *Haliotis cracherodii bonita, Haliotis cracherodii rosea,* and *Haliotis corrugata diegoensis* Orcutt, 1900c (see bibliography). The types of these forms are in the United States National Museum, numbers 162008, 162010, and 162007, respectively. These taxa are not currently regarded as distinct subspecies.

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CONVENTIONS AND ABBREVIATIONS

The following conventions and abbreviations are used in the bibliography and in the collations: comments in brackets [ ] are mine; numbers in parentheses ( ) are issue numbers, while those in brackets [ ] are whole numbers; other numbers refer to pages unless a "c." is present; dates are those given on the publications unless information to the contrary has been found; the entries in brackets [ ] in the bibliography are the issues of *West American Mollusca;* c. = column(s); prob. = probably; repr. = reprinted in; WAM = *West American Mollusca* (the journal, not to be confused with several articles of the same title); WAS = *The West American Scientist.*

BIBLIOGRAPHY OF ORCUTT'S WRITINGS ON MOLLUSKS

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1885b. American pearls. WAS 1(2): 7. (January)
1885c. Zoological notes. [mainly on mollusks] WAS 1(4): 24. (March)
1885d. Notes on the mollusks of the vicinity of San Diego, Cal., and Todos Santos Bay, Lower California. [with comments by W. H. Dall] Proc. U. S. Nat. Mus. 8(34-35): 534-552; pl. 24. (September 30)
1886a. Land shells of San Diego. WAS 2 [12]: 1-2. (January)
1886b. Mollusks of San Diego. WAS 2 [12]: 3-4. (January)
1886c. Mollusks of San Diego II. WAS 2 [15]: 29-30. (April)

1886d. Mollusks of San Diego III. WAS 2 [16]: 43. (June)
1886e. On Lower California shells. [comments on a letter from W. G. Binney] WAS 2 [17]: 62. (July)
1886f. Mollusks of San Diego IV. WAS 2 [17]: 63-64. (July)
1886g. Mollusks of San Diego V. WAS 2 [18]: 78-79. (September)
1886h. Something new. [on *Coralliochama*] WAS 3 [20]: 8-11; pl. 1-2. (December)
1889a. Our abalone fisheries. WAS 6 [42]: 12. (April)
1889b. Some notes on Tertiary fossils of California. WAS 6 [45]: 70-71. (July)
1889c. Some notes on the Tertiary fossils of California II. WAS 6 [46]: 84-87. (August)
1889d. Recent and sub-fossil shells of the Colorado desert. WAS 6 [46]: 92-93. (August)
1890. West American notes. Nautilus 4(6): 67-68. (October 14)
1891a. Contributions to West American Mollusca I. WAS 7 [62]: 222-224. (September)
1891b. Contributions to West American Mollusca II. WAS 7 [63]: 269-270. (October)
1895. Mexican shells. [non-marine mollusks] WAS 9 [79]: 2-3. (August)
1896. Notes on mollusks. [shells of San Quintin Bay] WAS 10 [81]: 1. (November)
1900a. Catalog of fossils in the Orcutt collection. WAS 11(2) [84]: 15-16. (January)
1900b. The desert. [mentions marine mollusks; may be reprint from the San Diego Sun] WAS 10(5) [88]: 25-29. (March)
1900c. Shells California pearl shells. WAS 10(5) [88]: 30-31. (March) [repr. WAM 1(5): 19-20. (September 1900)]
1900d. West American Mollusca. WAS 11(4) [89]: 27-34. (May) [pp. 27-30 repr. WAM 1(1): 1-4. (May 1900); pp. 31-34 repr. WAM 1(2): 5-8. (June 1900)]
1900e. Catalog of fossils in the Orcutt collection. WAS 11(4) [89]: 36-38. (May)
[1900f. WAM 1(1): 1-4. (May)]
1900g. West American Mollusca. WAS 11(5) [90]: 41-49. (June) [pp. 41-44 repr. WAM 1(3): 9-12. (July 1900); pp. 44-47 repr. WAM 1(4): 13-16. (August 1900); pp. 48-49 repr. WAM 1(5): 17-18. (September 1900)]
[1900h. WAM 1(2): 5-8. (June)]
1900i. West American Mollusca III. WAS 11(6) [91]: 63-69. (July) [pp. 63-66 repr. WAM 1(6): 21-24. (October 1900)]
[1900j. WAM 1(3): 9-12. (July)]
1900k. West American Mollusca IV. Shells of Lagoon Head. WAS 11(7) [92]: 74-76. (August) [prob. repr. in 1901d]
[1900l. WAM 1(4): 13-16. (August)]
[1900m. WAM 1(5): 17-20. (September)]
[1900n. WAM 1(6): 21-24. (October)]
1901a. West American Mollusca. WAS 11(8) [101]: 78-80. (May) [p. 78 repr. WAM 1(9): 33. (September 1901)]
1901b. Some desert fossils. WAS 12(1) [102]: c. 11-13. (June)
1901c. Shells of western lake and river. WAS 12(2) [103]: c. 33-40. (July)
[1901d. WAM 1(7): 25-28. (pre-August)]
[1901e. WAM 1(8): 29-32. (pre-September)]
1901f. West American Mollusca. WAS 12(4) [105]: c. 67-68. (September) [c. 67-68 repr. WAM 1(10): c. 37-38. (prob. October 1901)]
[1901g. WAM 1(9): 33-36 (September)]
[1901h. WAM 1(10): c. 37-44. (prob. October 1901)]
1901i. West American Mollusca. WAS 12(6) [107]: 105-108. (November)
[1901j. WAM 1(11): c. 45-52. (prob. November 1901)]
[1901k. WAM 1(12): c. 53-60. (prob. December 1901)]
[1902a. WAM 1(13): c. 61-68. (prob. 1902)]
1902b. West American Mollusca. Calif. Art & Nature 1(2): c. 27-32. (January)
1902c. West American Mollusca. Calif. Art & Nature 1(3): c. 38-40. (February)
1902d. West American Mollusca. Calif. Art & Nature 1(5): c. 67-71. (prob. after August)

1913. Mexican shells. [a checklist of marine mollusks from the Oaxaca area] Orcutt's Mexico 1(1): 5. (August)
1915a. Molluscan world [a short article] WAS 19(1): 1-2. (July)
1915b. Molluscan world. volume 1 [the book] WAS 20 [140-157]: 1-208 + 1-62. (printed after August 1)
1918a. Magdalena Bay shells. WAS 22(1) [158]: c. 8. (April)
1918b. *Helix areolata*. Nautilus 32(2): 55-58 (October 22)
1919a. entire volume 21 of WAS devoted to mollusks. See collation below.
1919b. Shells of La Jolla, California. Nautilus 33(2): 62-67. (November 6)
1921a. Paradise lost. [about San Quintin Bay] WAS 19(2): 18-20 (April 27)
1921b. Pleistocene beds of San Quintin Bay Lower California. WAS 19(3): 23-24. (June 15)
1922. Mollusks dredged from San Diego Bay. Nautilus 36(1): 33-34. (July 24)
1927. [untitled notes on mollusks and molluscan literature of Jamaica] Jamaica Naturalist 1(1): 3. (September)
1928a. Shells of Jamaica (fresh water). Jamaica Naturalist 1(3): 11-12. (March)
1928b. Shells of Jamaica (fresh water). [continued] Jamaica Naturalist 1(4): 13-15. (August)

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COLLATIONS OF ORCUTT'S JOURNALS

I. THE WEST AMERICAN SCIENTIST (1884-1921)

Volume	Number	Whole Number	Pages	Date	Comments
1	1		1-4	December 1884	also reissued as a reprint
	2		5-12	January 1885	
	3		13-20	February 1885	
	4		21-28	March 1885	
	5		29-36	April 1885	
	6		37-44	May 1885	
	7		45-52	June 1885	
	8		53-60	July/August 1885	
	9		61-68	September 1885	
	10		69-76	October 1885	
	11		77-84	November 1885	
2		12	1-12	January 1886	
		13	13-20	February 1886	
		14	21-28	March 1886	
		15	29-36	April 1886	
		16	37-52	June 1886	
		17	53-68	July 1886	
		18	69-90	September 1886	
		19	91-106	October 1886	
3		20	1-23	December 1886	
		21	24-44	January 1887	
		22	45-68	February 1887	
		23	69-92	March 1887	
		24	92-116	April 1887	
		25	117-134	May 1887	
		26	135-152	June 1887	first page says: "May No. 25"
		27	149-152	July 1887	page numbers repeated
		28	153-176	August 1887	
		29	177-200	September 1887	
		30	201-212	October 1887	
		31	213-222	November 1887	
		32	223-250	December 1887	cover says "Vol. 4"
4		33	1-18	January 1888	issued in February
		34	19-36	February 1888	issued in late April; first page says "No. 33"

Volume	Number	Whole Number	Pages	Date	Comments
		35	37-52	March 1888	prob. issued in May
		36	53-63	April 1888	prob. issued in May
		37	64-68	May 1888	
		38	69-74	June 1888	
	Index to volumes 1-4	(1884-1888)	TP + 1-6		probably issued in July or August
5	1	39	1-8	September 1888	
	2	40	9-16	October 1888	
	3	41	17-24	November 1888	
	4	42	27-28	December 1888	suppressed (never issued publicly)
6		42	1-20	April 1889	
		43	21-40	May 1889	
		44	41-60	June 1889	
		45	61-82	July 1889	
		46	83-98	August 1889	
		47	99-120	September 1889	
		48	121-146	October 1889	
		49	147-164	November 1889	
7		50	1-14	June 1890	
		51	15-26	July 1890	
		52	27-42; 1-20	August 1890	extra pages 1-38 in whole numbers 52, 53, & 55 comprise a "Literary and Educational Supplement," nos. 1-3
		53	43-54; 21-30	September 1890	
		54	55-62	October 1890	
		55	63-72; 31-38	December 1890	
		56	73-104	January 1891	
		57	105-136	February 1891	
		58	137-152	March 1891	
		59	153-168	April 1891	
		60	169-184	May 1891	
		61	185-216	August 1891	
		62	217-248	September 1891	
		63	249-276	October 1891	
8		64	1-30	March 1892	
		65	31-46	July 1893	
		66	47-62	August 1893	
		67	61-74	September 1893	
		68	75-81	October 1893	
		69	82-89; 1-16	January 1894	16 page advertisement for Orcutt Seed & Plant Co.
		70	90-93	February 1894	
		71	94-97	March 1894	

Volume	Number	Whole Number	Pages	Date	Comments
		72	98-101	April 1894	
		73	102-105	May 1894	
		74	106-109	June 1894	
		75	110-115	July 1894	
		76	113-116	October 1894	
		77	117-120	November 1894	
"4"		78	65-80	June 1895	present only as covers in many sets
9		79	1-4	August 1895	
		80	5-8	September 1895	
10	[1]	81	1-4	November 1896	
	[2]	82	5-8	November 1897	
	3	85	9-16	January 1900	
	4	85	17-24	February 1900	
	5	88	25-32	March 1900	
			Columns		
	6	93	33-64	September 1900	whole numbers 93-100 comprise "Botany of Southern California"
		94	65-80	October 1900	
		95	81-88	November 1900	
		96	89-96	December 1900	
		97	97-104	January 1901	
		98	105-110	February 1901	
		99	111-142	March 1901	107-108 are plates
		100	142-172	April 1901	
			Pages		
11	[1]	83	1-8	January 1899	vol. 11 started before vol. 10 completed
	[2]	84	9-16	January 1900	
	3	87	17-24	April 1900	
	4	89	25-40	May 1900	
	5	90	41-56	June 1900	
	6	91	57-72	July 1900	
	7	92	73-76	August 1900	
	8	101	77-80	May 1901	
			Columns		
12	1	102	1-32	June 1901	
	2	103	33-48	July 1901	
	3	104	49-64	August 1901	
	4	105	65-80	September 1901	

Volume	Number	Whole Number	Columns	Date	Comments
	5	106	81-104	October 1901	
	6	107	105-112	November 1901	
	7	108	113-128	December 1901	
	8	109	129-136	January 1902	
	9	110	137-144	February 1902	
	10	111	145-152	March 1902	
	11	112	151-156	April 1902	
	12	113	161-168	May 1902	
	13	114	169-176	June 1902	
	14	115	177-184	July 1902	
13	1	116	1-20	August 1902	5-6, 15-16 are plates
	2	117	21-36	September 1902	whole numbers 116-119 are "Cactaceae"
	3	118	37-52	October 1902	
	4	119	53-68	November 1902	
14	1	120	1-8	December 1902	
	2	121	9-16	January 1903	
	3	122	17-24	February 1903	
	4	123	25-30	March 1903	
	5	124	31-38	April 1903	
	6	125	39-46	May 1903	
	7	126	47-54	July 1903	
15	1	127	1-24	August 1903	
	2	128	25-36; 38-49	September 1903	
	3	129	50-57	January 1906	
	4	130	58-61	June 1906	
16		131	1-8	December 1906	
		132	9-14	January 1908	
			Pages		
17		133	1-16	August 1908	
			Columns		
18		134	1-8	August 1911	whole numbers 134-136 are "Cactus Index"
		135	9-40	September 1911	
		136	41-68	May 1912	
		137	69-76	December 1913	
		138	77-84	January 1914	
		139	85-92	February 1914	
			Pages		
19	1	[179]	1-16	July 1915	
	2	[180]	17-20	April 27, 1921	
	3	[181]	21-24	June 15, 1921	

Volume	Number	Whole Number	Pages	Date	Comments
20	"Molluscan World"	140-153	1-208	After August 1, 1915	
	Index to 20	154-157	1-62	After August 1, 1915	
21	1	165	1-8	January 1919	
	2	166	9-16	February 1919	
	3	167	17-24	March 1919	
	4	168	25-32	April 1919	
	5	169	33-40	May 1919	
	6	170	41-48	June 1919	
	7	171	49-56	July 1919	
	8	172	57-64	August 1919	
	9	173	65-72	September 1919	
	10	174	73-80	October 1919	
	11	175	81-88	November 1919	
	12	176	89-108	December 1919	
	Index to 21	[177-178]	109-124	? 1919 or 1920	
			Columns		
22	1	158	1-8	April 1918	
	2	159	?	May 1918	not seen
	3	160	?	June 1918	not seen
	4	161	2 pp.	July 1918	
	5	162	?	?	not seen
	6	163	?	?	not seen
	7	164	?	?	not seen

II. WEST AMERICAN MOLLUSCA (1900-1902)

Volume	Number	Pages	Date	Comments
1	1	1-4	May 1900	
	2	5-8	June 1900	
	3	9-12	July 1900	
	4	13-16	August 1900	
	5	17-20	September 1900	
	6	21-24	October 1900	
	7	25-28	Before August 1901	not seen
	8	29-32	Before September 1901	not seen
	9	33-36	September 1901	
		Columns		
	10	37-44	prob. October 1901	
	11	45-52	prob. November 1901	not seen
	12	53-60	prob. December 1901	
	13	61-68	1902 (?)	

III. CALIFORNIA ART & NATURE (1901-1902)

Volume	Number	Columns	Date	Comments
1	1	1-16	December 1901	
	2	17-37	January 1902	
	3	38-51	February 1902	
	4	52-67	March 1902	
	5	68-91	April 1902	prob. published after August
	6	92-115	May 1902	prob. published after August
	7	116-138	June 1902	prob. published after August
	8	139-162	July 1902	prob. published after August
	9	1-20	August 1902	nos. 9-12 are "Cacteacea," see *The West American Scientist*, vol. 13
	10	37-52	September 1902	
	11	21-36	October 1902	
	12	53-68	November 1902	

IV. ORCUTT'S MEXICO (1913)

Volume	Number	Pages	Date
1	1	1-16	August 1913
	2	17-32	September 1913
	3	33-48	October 1913

V. JAMAICA NATURALIST (1927-1928)

Volume	Number	Pages	Date
1	1	1-4	September 1927
	2	5-8	February 1928
	3	9-12	March 1928
	4	13-20	August 1928

TRANSACTIONS

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TYPE SPECIMENS OF FOSSIL INVERTEBRATES IN THE SAN DIEGO NATURAL HISTORY MUSEUM

BY

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INTRODUCTION

This catalogue is published in compliance with Recommendation 72D of the International Code of Zoological Nomenclature, which states (ICZN, 1964:75): "Institutional responsibility. — Every institution in which types are deposited should . . . (4) publish lists of type-material in its possession or custody . . ."

The main part of the catalogue is arranged systematically by phyla and a few subordinate categories. Within these, the genus and species-group names, as originally published, are listed alphabetically. A simple cross-index ("see") refers the reader from one name to others if more than one name has been applied to the same type. Each entry also contains, respectively, the author of the lowest species-group name cited, a bibliographic reference for the publication in which the name appeared, the type category and type number (with literal suffixes if specimens are of more than one piece) of the specimen in the San Diego Natural History Museum, the geological age of the type and the formation from which it was obtained, and the general locality from which the type was collected. In most entries, age and formation are given as they were in the original publication.

"Missing" following a type number means that the specimen seems once to have been in the collection but it cannot be found now.

Inclusion or omission of figure references in the citation indicates that the type was or was not figured, respectively, except where this line is enclosed by parentheses. Such parentheses declare the specimen to be an unfigured plastotype and the reference applies to the specimen from which the cast was made. A question mark following a figure citation indicates uncertainty that this figure was made from the specimen in our collection.

A species index is included to facilitate location of species-group names in the catalogue. Varieties are listed by both the varietal name and the next higher species-group name.

Definitions of type categories and apposite discussions of their use in paleontology were presented by Schenk *et al.* (1956:5-9) and Bell (1962:vii-viii). Their definitions and concepts are followed here.

CATALOGUE

PROTOZOA

Amphistegina californica Cushman and Hanna

Cushman and Hanna, 1927, p. 56, pl. 6, fig. 3, 4, 5.

Syntype; 68 (fig. 3), 726 (fig. 4), 727 (fig. 5); Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Actinocyclina aster Woodring

Woodring, 1930, p. 152, pl. 14, fig. 4, pl. 16, fig. 1, 3, pl. 17, fig. 2.

Paratype; 332 (pl. 14, fig. 4), 333 (pl. 16, fig. 1), 334 (pl. 16, fig. 3), 335 (pl. 17, fig. 2); Eocene; 332-334: Canada de los Sauces; 335: Jalama Creek, both Santa Barbara Co., Calif.

Bulimina subacuminata Cushman and R. E. Stewart

Cushman, Stewart, and Stewart, 1930, p. 65.

Paratypes; 9, 710-716; Pliocene; Bear River, Humboldt Co., Calif.

Bulimina subcalva Cushman and K. C. Stewart

Cushman, Stewart, and Stewart, 1930, p. 65.

Paratypes; 8, 705-709; Pliocene; Scotia Bluffs, Humboldt Co., Calif.

Cibicides sandiegensis Cushman and Hanna

Cushman and Hanna, 1927, p. 55, pl. 6, fig. 1?, 2?.

Syntype; 67 (fig. 1?, 2?), 725 (fig. 1?, 2?); Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Discocyclina californica Schenck

Schenck, 1929, p. 224, pl. 28, fig. 6, pl. 29, fig. 2.

Holotype; 75 (fig. 6); paratype; 76 (fig. 2); Eocene, 1¼ miles northeast New Almaden Mine, Santa Clara Co., Calif.

Discocyclina psila Woodring
Woodring, 1930, p. 148, pl. 14, fig. 4, pl. 17, fig. 2.
Paratype; 332 (pl. 14, fig. 4), 335 (pl. 17, fig. 2), 336, 337, 388; Eocene; 332, 336, 337: Canada de los Sauces; 334: Jalama Creek, both Santa Barbara Co., Calif.

Elphidium fax barbarense Nicol
Nicol, 1944, p. 178.
Paratype; 619; Pleistocene, Santa Barbara Formation; Bathhouse Beach, Santa Barbara, Santa Barbara Co., Calif.

Elphidium hughesi Cushman and Grant
Cushman and Grant, 1927, p. 75.
Paratype; 74, 732-740; Pliocene, Poncho Rico Formation; Pine Valley, Monterey Co., Calif.

Epistomina eocenica Cushman and Hanna
Cushman and Hanna, 1927, p. 53, pl. 5, fig. 4, 5.
Syntype; 63 (fig. 5), 723 (fig. 4); Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Eponides mexicana (Cushman)
Cushman and Hanna, 1927, p. 54, pl. 5, fig. 8, 9?.
Hypotype; 66 (fig. 8), 724 (fig. 9?); Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Gaudryina convexa Cushman var. *sandiegensis* Cushman and Hanna
Cushman and Hanna, 1927, p. 50, pl. 4, fig. 1.
Holotype; 55; Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Gyroidina soldanii d'Orbigny var. *octocamerata* Cushman and Hanna
Cushman and Hanna, 1927, p. 56, pl. 5, fig. 7.
Hypotype; 65; Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Marginulina sp. ?
Cushman and Hanna, 1927, p. 51, pl. 4, fig. 5.
Hypotype; 59; Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Nodosaria (*Dentalina*) *communis* (d'Orbigny)
Cushman and Hanna, 1927, p. 52, pl. 4, fig. 11?, 12.
Hypotype; 61 (fig. 12), 720 (fig. 11?); Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Nodosaria (*Dentalina*) *consobrina* (d'Orbigny)
Cushman and Hanna, 1927, p. 52, pl. 4, fig. 7, 8.
Hypotype; 60 (fig. 7), 719 (fig. 8); Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Nodosaria latejugata Gumbel
Cushman and Hanna, 1927, p. 52, pl. 5, fig. 1-3.
Hypotype; 62 (fig. 1), 721 (fig. 2), 722 (fig. 3); Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Nonion cf. *umbilicatulus* (Montagu)
Cushman and Hanna, 1927, p. 57, pl. 6, fig. 6.
Hypotype; 69; Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Quinqueloculina triangularis d'Orbigny
Cushman and Hanna, 1927, p. 57, pl. 6, fig. 8?, 9?
Hypotype; 71 (fig. 8?, 9?), 29 (fig. 8?, 9?); Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Robulus inornatus d'Orbigny
Cushman and Hanna, 1927, p. 51, pl. 4, fig. 4, 6.
Hypotype; 58 (fig. 4), 718 (fig. 6); Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Robulus mexicanus (Cushman) var. *nudicostatus* (Cushman and Hanna)
Cushman and Hanna, 1927, p. 50, pl. 4, fig. 2?
Hypotype; 56; Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Siphonina cf. *jacksonensis* Cushman and Applin
Cushman and Hanna, 1927, p. 53, pl. 5, fig. 6?
Hypotype; 64; Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Textularia labiata Reuss, var.
Cushman and Hanna, 1927, p. 50, pl. 4, fig. 3.
Hypotype; 57; Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

Triloculina inornata d'Orbigny
Cushman and Hanna, 1927, p. 58, pl. 6, fig. 10, 11.
Hypotype; 70 (fig. 10), 728 (fig. 11); Eocene, Rose Canyon Formation; 3.5 miles north of La Jolla, San Diego Co., Calif.

COELENTERATA

Dendrophyllia hannibali Nomland

Nomland, 1916, p. 67.

Syntype; 926, 927; Oligocene, Lincoln Formation; 1.5 miles above Porter, Grays Harbor Co., Washington.

Oculina panzana Loel and Corey

Loel and Corey, 1932, p. 275.

Paratype; 801; Miocene, Vaqueros Formation; Carrizo Creek, west of the Carrizo ranch house, La Panza Mountains, San Luis Obispo Co., Calif.

Turbinolia clarki Quayle

Quayle, 1932, p. 100.

Paratype; 356, 357; Eocene, Domengine Formation; Parsons Peak, Fresno Co., Calif.

Turbinolia dickersoni Nomland

Quayle, 1932, p. 98, pl. 6, fig. 1-5.

Hypotype; 378 (fig. 3), 379 (fig. 1, 4), 380 (fig. 5), 381 (fig. 2); Eocene, Meganos Formation; branch of Salt Creek about 16 miles north of Coalinga, Fresno Co., Calif.

Turbinolia imbulata (Hanna)

Quayle, 1932, p. 103, pl. 6, fig. 11, 12, 15, 16.

Hypotype; 358 (fig. 15, 16), 359 (fig. 11, 12); Eocene, Rose Canyon Shales; 358: tributary to San Clemente Creek; 359: Rose Canyon, both San Diego Co., Calif.

Turbinolia pusillanima Nomland

Quayle, 1932, p. 101, pl. 6, fig. 9, 10.

Hypotype; 376; Eocene, Meganos Formation; T. 1 S., R. 1 E., Diablo Quadrangle, wash near creek below 1250-hill, Contra Costa Co., Calif.

Turbinolia sulcata Lamarck

Quayle, 1932, p. 109, pl. 6, fig. 13.

Hypotype; 382; Eocene; Parnes (Oise), France.

ANNELIDA

Serpula careyi Wiedey

Wiedey, 1928, p. 155, pl. 20, fig. 1.

Holotype; 42; Miocene, Vaqueros Formation; Junction of Cantinas Creek and Nacimiento River, San Luis Obispo Co., Calif. See: *Serpula coreyi* Wiedey.

Serpula coreyi Wiedey

Loel and Corey, 1932, pl. 65, fig. 9.

Holotype; 42; Miocene, Vaqueros Formation; Junction of Cantinas Creek and Nacimiento River, San Luis Obispo Co., Calif. See: *Serpula careyi* Wiedey

BRACHIOPODA

Eohemithiris alexi Hertlein and Grant

Hertlein and Grant, 1944, p. 55.

Paratype; 907, 908; Eocene; near headwaters of west branch of Agua Media Creek, McKittrick Quadrangle, Temblor Range, California.

Laqueus vancouveriensis diegensis Hertlein and Grant

Hertlein and Grant, 1960, p. 97, pl. 20, fig. 16,17.

Paratype; 349; Pliocene, San Diego Formation; Pacific Beach, San Diego, San Diego Co., Calif.

MOLLUSCA

Pelecypoda

Adontorhina cyclia Berry

Berry, 1947, p. 260 (6).

Paratype; 320, 321; Pleistocene; "Hilltop Quarry", San Pedro, Los Angeles Co., Calif.

Amiantis callosa (Conrad)

Grant and Gale, 1931, p. 348, pl. 17, fig. 7, 9, 12, 13.

Hypotype; 162 (fig. 7), 163 (fig. 9), 165 (fig. 12), 166 (fig. 13); Pliocene, Pico Formation; 162: Holser Canyon; 163: west of Fernando Pass; 165-166: Elsmere Canyon, all Los Angeles Co., Calif.

Amiantis callosa (Conrad) variety *stalderi* (Clark)

Grant and Gale, 1931, p. 349, pl. 17, fig. 8a, 8b.

Hypotype; 164; Miocene; well core near Bakersfield, Kern Co., Calif.

Anatina (*Raeta*) *plicatella* (Lamarck) variety *longior* Grant and Gale

Grant and Gale, 1931, p. 408, pl. 23, fig. 1a, 1b.

Holotype; 192; Miocene; 4525 feet deep from oil well northwest of Bakersfield, Kern Co., Calif.

Anomia peruviana d'Orbigny

Grant and Gale, 1931, p. 240, pl. 12, fig. 2.

Hypotype; 118; Pleistocene, edge of mesa west of Newport, Los Angeles Co., Calif.

Anomia vaqueroensis Loel and Corey
Loel and Corey, 1932, p. 203.
Paratype; 782; Miocene, Vaqueros Formation; along NE-SW ridge west of mouth of Wiley Canyon, Ventura Co., Calif.

Antigona carrizoensis Loel and Corey
Loel and Corey, 1932, p. 221.
Paratype; 784-786; Miocene, Vaqueros Formation; "V" bend in Carrizo Creek, San Luis Obispo Co., Calif.

Antigona vaqueroensis Loel and Corey
Loel and Corey, 1932, p. 221.
Paratype; 787; Miocene, Vaqueros Formation; divide between Reliz and Vaqueros canyons, Monterey Co., Calif.

Arca (*Andara*) *santaclarana* Loel and Corey
Loel and Corey, 1932, p. 184.
Paratype; 776; Miocene, Vaqueros Formation; along NE-SW ridge west of mouth of Wiley Canyon, Ventura Co., Calif.

Arca (*Andara*) *santana* Loel and Corey
Loel and Corey, 1932, p. 185.
Paratype; 777; Miocene, Vaqueros Formation; west side of Plano Trabuco opposite south end of hill on plain, Santa Ana Mountains, Orange Co., Calif.

Arca (*Arca*) *multicostata* Sowerby variety *camuloensis* Osmont
Grant and Gale, 1931, p. 139, fig. 5a-c.
Hypotype; 85; Pliocene, Pico Formation; southeast of Pico Canyon, Los Angeles Co., Calif.

Arca (*Barbatia*) *strongi* Loel and Corey
Loel and Corey, 1932, p. 183.
Paratype; 775; Miocene, Vaqueros Formation; west side of Laguna Canyon on spur in large turn, Orange Co., Calif.

Arca galei Wiedey
Wiedey, 1928, p. 129, pl. 13, fig. 8.
Holotype; 21; Miocene; Temblor Formation; Benedict Canyon, Santa Monica Mtns., Los Angeles Co., Calif.

Arca hamelini Wiedey
Wiedey, 1928, p. 126, pl. 13, fig. 2.
Holotype; 18; Miocene, Vaqueros Formation; Little Sespe Creek, Ventura Co., Calif.

Arca impavida Wiedey
(Wiedey, 1928, p. 130, pl. 14, fig. 2, 3.)
Plastoholotype; 368, 369; Miocene, Temblor Formation; Barker's Ranch, Kern Co., Calif.

Arca lakei Wiedey
Wiedey, 1928, p. 127, pl. 13, fig. 4, 5.
Holotype; 19; Miocene, Temblor Formation; 2 miles west of Simmler, San Luis Obispo Co., Calif.

Arca (*Navicula*) *terminumbonis* Grant and Gale
Grant and Gale, 1931, p. 142, pl. 1, fig. 18a-c, 19a-c, 20a-c, 22.
Holotype; 79 (fig. 18a-c), paratype; 80 (fig. 19a-c), 81 (fig. 20a-c), 82 (fig. 22), 83, 741; Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.

Arca perdisparis Wiedy
Wiedey, 1928, p. 131, pl. 13, fig. 6.
Holotype; 23; Miocene, Monterey Formation; Santa Cruz Mountains, Monterery Co., Calif.

Arca procumbens Wiedey
Wiedey, 1928, p. 132, pl. 13, fig. 10.
Syntype; 24; Miocene; 5 miles north of Yaquina Head, Lincoln Co., Oregon.

Arca rivulata Wiedey
Wiedey, 1928, p. 128, pl. 13, fig. 3.
Holotype; 20; Miocene, Temblor Formation; 2 miles west of Simmler, San Luis Obispo Co., Calif.

Arca sespeensis Wiedy
Wiedy, 1928, p. 125, pl. 13, fig. 1.
Holotype; 17; Miocene, Vaqueros Formation; Little Sespe Creek, Ventura Co., Calif.

Arca vancouverensis Meek
(Meek, 1857, p. 40.)
Plastoparatype; 624; Cretaceous, Komooks Formation; Vancouver Island, British Columbia, Canada.
See: *Parallelodon* (*Nanonavis*) *vancouverensis* (Meek)

Atrina stephensi Hanna
Hanna, 1926, p. 461, pl. 27, fig. 3, 4.
Holotype; 2; Pliocene, Imperial Formation; Coyote Mountain, Imperial Co., Calif.

Basterotia (*Basterotella*) *hertleini* Durham

Emerson and Hertlein, 1964, p. 355, fig. 4g-4j.

Hypotype; 811 (4g, 4h), 812 (4i), 813 (4j); Pliocene; Puerto Ballandra, Isla Carmen, Baja California, Mexico.

Cardita (*Carditamera*) *carpenteri* Lamy

Lamy, 1921, p. 264.

See: *Glans minuscula* Grant and Gale

Cardita ventricosa Gould

Grant and Gale, 1931, p. 272, pl. 13, fig. 9a, 9b, 11.

Hypotype; 124 (fig. 11), 125 (fig. 9a, 9b); 124: Pliocene, Pico Formation; Sulphur Canyon, Ventura Co., Calif.; 125: Pleistocene, ridge between Casitas Creek and the sea, Ventura Co., Calif.

Cardium arcumbona Wiedey

Wiedey, 1928, p. 142, pl. 17, fig. 5.

Holotype; 31; Miocene, Temblor Formation; 2 miles west of Simmler, San Luis Obispo Co., Calif.

Cardium schencki Wiedey

Wiedey, 1928, p. 143, pl. 17, fig. 3, 4.

Paratype; 32; Miocene, Temblor Formation; 2 miles south of Calabasas, Los Angeles Co., Calif.

Chione juanensis Loel and Corey

Loel and Corey, 1932, p. 223.

Paratype; 788; Miocene, Vaqueros Formation; near head of west branch of Anderson Creek, San Luis Obispo Co., Calif.

Chione sechurana Pilsbry and Olsson

Pilsbry and Olsson, 1935, p. 17.

Paratype; 580, 928; Pleistocene; Tric Trac Point, near Bayover, Bay of Sechura, Peru.

Chione valentinei Wiedey

Wiedey, 1929, p. 282, pl. 32, fig. 1.

Paratype; 53; Miocene, Temblor Formation (?); 2 miles south of Mayfield, Santa Clara Co., Calif.

Chlamys (*Argopecten*) *abietis* (E. K. Jordan and Hertlein)

Emerson and Hertlein, 1964, p. 354, fig. 4a-4e.

Hypotype; 805 (4a), 806 (4b), 807 (4c), 808 (4d), 809 (4e); 805, 808, 809: Pliocene, Isla San José; 806, 807: Pliocene; Isla Monserrate, both Baja California, Mexico.

Clementia (?) *elongata* Wiedey

Wiedey, 1928, p. 147, pl. 18, fig. 6.

Holotype; 35; Miocene; Temblor Formation; 2 miles west of Simmler, San Luis Obispo Co., Calif.

Clementia inequalis Wiedey

Wiedey, 1928, p. 146, pl. 18, fig. 4.

Holotype; 34; Miocene, Vaqueros Formation; South Mountain, Ventura Co., Calif.

Clementia (*Compsomyax*) *subdiaphana* Carpenter

Grant and Gale, 1931, p. 334, pl. 17, fig. 10a, 10b.

Hypotype; 167; Pleistocene, San Pedro Formation; Deadman Island, Los Angeles Co., Calif.

Corbula (*Corbula*) *gibbiformis* Grant and Gale

Grant and Gale, 1931, p. 420, pl. 19, fig. 4-6.

Holotype; 172 (fig. 5); paratype; 171 (fig. 4), 173 (fig. 6); Pliocene, Etchegoin Formation; 3951-52 feet deep in oil well, Kern Co., Calif.

Corbula (*Lentidium*) *luteola* Carpenter

Grant and Gale, 1931, p. 421, pl. 19, fig. 2, 7.

Hypotype; 168 (fig. 2), 169 (fig. 7); Pleistocene; south of Seacliff Station, Ventura Co., Calif.

Crassatellites antillarum (Reeves)

Grant and Gale, 1931, p. 271, pl. 13, fig. 7a, 7b.

Hypotype; 122; Pliocene; near Santa Rosalia, Baja California, Mexico.

Cryptomya californica (Conrad)

Grant and Gale, 1931, p. 417, pl. 21, fig. 7, 11.

Hypotype; 185 (fig. 7), 315 (fig. 11); Pleistocene; 185: southwest of Goleta, Santa Barbara Co., Calif.; 315: Barlow Canyon, Ventura Co., Calif.

Cumingia lamellosa Sowerby

Grant and Gale, 1931, p. 378, pl. 14, fig. 23, pl. 19, fig. 1.

Hypotype; 143; Pliocene; Maria Ygnacia Creek, Santa Barbara Co., Calif.

Donax gouldii Dall

Grant and Gale, 1931, p. 380, pl. 13, fig. 12.

Hypotype; 127; Pleistocene; west of Newport, Los Angeles Co., Calif.

Dosinia (*Dosinidia*) *margaritana* (Wiedey) *projecta* Loel and Corey

Loel and Corey, 1932, p. 217.

Paratype; 783; Miocene, Vaqueros Formation; head of north fork of Corral de Piedra Creek, about 5 miles east of San Luis Obispo, San Luis Obispo Co., Calif.

Dosinia margaritana Wiedey
Wiedey, 1928, p. 145, pl. 18, fig. 1, 3.
Holotype; 33; Miocene, Vaqueros Formation; 0.4 miles east of La Panza, San Luis Obispo Co., Calif.

Dosinia ponderosa (Gray) variety *jacalitosana* Arnold
Grant and Gale, 1931, p. 352, pl. 15, fig. 2a, 2b, 3.
Hypotype; 144 (fig. 2a, 2b), 145 (fig. 3); Pliocene, San Diego Formation; Balboa Park, San Diego, San Diego Co., Calif.

Dosinia ponderosa (Gray) variety *longidens* Grant and Gale
Grant and Gale, 1931, p. 353, pl. 15, fig. 4.
Holotype; 146; Miocene; core from oilwell northwest of Bakersfield, Kern Co., Calif.

Glans minuscula Grant and Gale
Grant and Gale, 1931, p. 277, pl. 13, fig. 10a, 10b.
Holotype; 126; Pleistocene; Seacliff, Ventura Co., Calif.
See: *Cardita (Carditamera) carpenteri* Lamy

Glycymeris septentrionalis (Middendorff)
Grant and Gale, 1931, p. 134, pl. 1, fig. 21a-b.
Hypotype; 84; Pleistocene; ridge at northwest corner El Conejo land grant, Ventura Co., Calif.

Irus lamellifer (Conrad) variety *prelamellifer* Grant and Gale
Grant and Gale, 1931, p. 332, pl. 18, fig. 7.
Holotype; 157; Miocene; well core near Bakersfield, Kern Co., Calif.

Laevicardium (Cerastoderma) corbis (Martyn)
Grant and Gale, 1931, p. 307, pl. 19, fig. 17.
Hypotype; 176; Recent; Seven Mile Beach, San Mateo Co., Calif.

Laevicardium (Nemocardium) centifilosum (Carpenter)
Grant and Gale, 1931, p. 311, pl. 19, fig. 9, 10.
Hypotype; 174 (fig. 9), 175 (fig. 10); Pliocene, Etchegoin Formation; 3951-52 feet deep in oil well, Kern Co., Calif.

Lucina (Here) excavata Carpenter
Grant and Gale, 1931, p. 290, pl. 14, fig. 2, 5, 10.
Hypotype; 131 (fig. 2), 132 (fig. 3), 133 (fig. 10); Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.

Lucina (Miltha) xantusi (Dall)
Grant and Gale, 1931, p. 291, pl. 14, fig. 20a, 20b.
Hypotype; 140a (fig. 20a, 20b), 140b; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.

Lucina (Myrtea) acutilineata Conrad
Grant and Gale, 1931, p. 286, pl. 14, fig. 22a, 22b.
Hypotype; 141; Pleistocene; San Pedro, Los Angeles Co., Calif.

Lucina (Myrtea) californica Conrad
Grant and Gale, 1931, p. 285, pl. 14, fig. 15a, 15b, 21a, 21b.
Hypotype; 138 (fig. 15a, 15b), 142 (fig. 21a, 21b); 138: Pleistocene, San Pedro, Los Angeles Co., Calif.; 142: Pliocene, Santa Barbara, Santa Barbara Co., Calif.

Lucina (Myrtea) nuttallii Conrad
Grant and Gale, 1931, p. 288, pl. 14, fig. 18.
Hypotype; 139; Pliocene, Pico Formation; east of Fernando Pass, Los Angeles Co., Calif.

Lucina (Myrtea) tenuisculpta Carpenter variety *approximata* (Dall)
Grant and Gale, 1931, p. 289, pl. 14, fig. 8a, 8b.
Hypotype; 136; Pleistocene, San Pedro Formation; San Pedro, Los Angeles Co., Calif.

Macoma balthica (Linnaeus)
Grant and Gale, 1931, p. 371, pl. 14, fig. 6a, 6b, pl. 20, fig. 7a, 7b.
Hypotype; 134a (fig. 6a, 7a), 134b (fig. 6b, 7b); Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

Macoma copelandi Wiedey
Wiedey, 1928, pl. 149, pl. 19, fig. 2.
Holotype; 37; Miocene, Temblor Formation; 2 miles west of Simmler, San Luis Obispo Co., Calif.

Macoma moesta (Deshayes) variety *acolasta* Dall
Grant and Gale, 1931, p. 371, pl. 14, fig. 7.
Hypotype; 135; Pleistocene: near Goleta, Santa Barbara Co., Calif.

Macoma nasuta (Conrad)
Grant and Gale, 1931, p. 365, pl. 20, fig. 11a, 11b.
Hypotype; 178; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

Macoma panzana Wiedey
Wiedey, 1928, p. 150, pl. 19, fig. 1.
Holotype; 38; Miocene, Temblor Formation; 2 miles west of Simmler, San Luis Obispo Co., Calif.

Macoma secta (Conrad)
Grant and Gale, 1931, p. 374, pl. 20, fig. 6a, 6b.
Hypotype; 177; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.

Macoma sespeensis Loel and Corey
Loel and Corey, 1932, p. 228.
Paratype; 789; Miocene, Vaqueros Formation; one mile up Little Sespe Creek from junction with Sespe Creek, Ventura Co., Calif.

Macrocallista stantoni Waring
Waring, 1917, p. 77.
Paratype; 623; Eocene, Martinez Formation; Martinez area, Simi Hills, Ventura Co., Calif.

Mactra (*Mactra*) *orthomorpha* Grant and Gale
Grant and Gale, 1931, p. 391, pl. 23, fig. 2a-2c, 6, 7.
Holotype; 193 (fig. 2a-2c); paratype; 194 (fig. 6), 195 (fig. 7), 746 (fig. 2b, *pars*, "fragment of another specimen"); Pliocene, Etchegoin Formation; oil well near Tipton, Tulare Co., Calif.

Mactra (*Spisula*) *albaria* Conrad
Grant and Gale, 1931, p. 395, pl. 23, fig. 3a, 3b.
Hypotype; 189; Miocene; 4575 feet deep in oil well northwest of Bakersfield, Kern Co., Calif.

Mactra (*Spisula*) *catilliformis* (Conrad)
Grant and Gale, 1931, p. 398, pl. 23, fig. 4, 10.
Hypotype; 196 (fig. 4), 197 (fig. 10); Pliocene, Etchegoin Formation; oil well 3229-3230 feet deep, northwest of Bakersfield, Kern Co., Calif.

Mya (*Mya*) *arenaria* Linnaeus variety *japonica* Jay
Grant and Gale, 1931, p. 412, pl. 21, fig. 13.
Hypotype; 188; Pliocene, Etchegoin Formation; 2877 feet deep in oil well, Kern Co., Calif.

Mya (*Platyodon*) *cancellata* Conrad
Grant and Gale, 1931, p. 415, pl. 24, fig. 3a, 3b.
Hypotype; 202; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

Nucula (*Acila*) sp. Grant and Gale
Grant and Gale, 1931, p. 115, text-fig. 4.
Hypotype; 374; Pliocene; 1¼ miles west of San Martinez Grande Canyon, Los Angeles Co. and Ventura Co., Calif., boundary line.

Nucula (*Acila*) *gettysburgensis* Reagan
Grant and Gale, 1931, p. 113, text-fig. 1.
Hypotype; 375; Oligocene; Twin Rivers Shales; one mile west of the mouth of West Twin River, Clallam Co., Wash.

Nucula (*Acila*) *semirostrata* Grant and Gale
Grant and Gale, 1931, p. 113, text-fig. 2a, 2b, 3a, 3b.
Holotype; 370 (fig. 2a, 2b); paratype; 371 (fig. 3a, 3b), 372, 373; Pliocene; 1¼ miles west of San Martinez Grande Canyon, Los Angeles Co. and Ventura Co., Calif., boundary line.

Nucula (*Ennucula*) *birchi* Keen
Keen, 1943, p. 41.
Paratype; 611, 933; Miocene, Round Mountain Silt; Caliente Quadrangle, Kern Co., Calif.

Nucula (*Ennucula*) *microsperma* Berry
Berry, 1947, p. 258 (4).
Paratype; 318, 319; Pleistocene, Lomita Formation; 2nd and Pacific Streets, San Pedro, Los Angeles Co., Calif.

Nuculana taphria (Dall)
Grant and Gale, 1931, p. 121, pl. 1, fig. 8, 9.
Hypotype; 77 (fig. 8), 78 (fig. 9); 77: Pliocene; Holser Canyon, Los Angeles Co., Calif.; 78: Pleistocene; near Goleta, Santa Barbara Co., Calif.

Ostrea angelica Rochebrune
Emerson and Hertlein, 1964, p. 353, fig. 3a, 3b.
Hypotype; 802; ?Pliocene; Isla Angel de la Guarda, Baja California, Mexico.

Ostrea ashleyi Hertlein
Hertlein, 1934, p. 1.
Paratype; 429; Miocene, Temblor Formation; Kern Co., Calif.

Ostrea eldridgei (Arnold) *ynezana* Loel and Corey
Loel and Corey, 1932, p. 189.
Paratype; 779; Miocene, Vaqueros Formation; El Jaro Creek, Santa Ynez Mountains, Santa Barbara Co., Calif.

Ostrea haleyi Hertlein
(Hertlein, 1933, p. 277, pl. 18, fig. 5, 6.)
Plastoholotype; 425 (fig. 5), 426 (fig. 6); paratype 427; Eocene; Santa Cruz Island, Calif.

Ostrea howelli Wiedey
Wiedey, 1928, p. 135, pl. 15, fig. 1, 2.
Holotype; 26; Miocene; 5½ miles northeast of Wheeler's Hot Springs, Ventura Co., Calif.

Ostrea tayloriana Gabb
(Gabb, 1869, p. 34, pl. 12, fig. 60, 60a.)
Plastoholotype; 190, 742; Eocene; San Marcos Pass, Santa Barbara Co., Calif.

Ostrea vaquerosensis Loel and Corey
Loel and Corey, 1932, p. 192.
Paratype; 780; Miocene, Vaqueros Formation; 2.6 miles north 21 degrees east of Abalone Point, Orange Co., Calif.
Ostrea venturana Loel and Corey
Loel and Corey, 1932, p. 193.
Paratype; 781; Miocene, Vaqueros Formation; ridge north of Coyote Creek fork of Ventura River, Ventura Co., Calif.
Ostrea vespertina Conrad
Grant and Gale, 1931, p. 152, pl. 12, fig. 1a, 1b.
Hypotype; 116; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.
Pandora punctata Conrad
Grant and Gale, 1931, p. 262, pl. 13, fig. 2a, 2b.
Hypotype; 121; Pleistocene, San Pedro Formation; Palos Verdes, Los Angeles Co., Calif.
Panope (*Panope*) *generosa* Gould
Grant and Gale, 1931, p. 424, pl. 21, fig. 12a, 12b.
Hypotype; 187; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.
Panope tenuis Wiedey
Wiedey, 1928, p. 154, pl. 20, fig. 4.
Holotype; 41; Miocene, Temblor Formation; 2 miles west of Simmler, San Luis Obispo Co., Calif.
Paphia restorationensis Frizzell
Frizzell, 1930, p. 120.
Holotype; 386; Pleistocene; near Port Blakely, Jefferson Co., Wash.
See: *Venerupis* (*Protothaca*) *restorationensis* (Frizzell)
Parallelodon (*Nanonavis*) *vancouverensis* (Meek)
Reinhart, 1937, p. 171.
See: *Arca vancouverensis* Meek
Pecten (*Aequipecten*) *andersoni* Arnold
Grant and Gale, 1931, p. 202, pl. 4, fig. 4, 5.
Hypotype; 93 (fig. 4), 94 (fig. 5); Miocene; Barker's Ranch, Kern Co., Calif.
Pecten (*Aequipecten*) *deserti* Conrad, type variety
Grant and Gale, 1931, p. 212, pl. 5, fig. 3.
Hypotype; 98; Pliocene, Carrizo Creek beds, Imperial Co., Calif.
Pecten (*Aequipecten*) *deserti* Conrad variety *invalidus* Hanna
Grant and Gale, 1931, p. 213, pl. 5, fig. 5a-c, 6a-c.
Hypotype; 100 (fig. 5a-c), 101 (fig. 6a-c); Pliocene, Pico Formation; between Holser and San Martinez Grande Canyons, Los Angeles Co., Calif.
Pecten (*Aequipecten*) *discus* Conrad
Grant and Gale, 1931, p. 200, pl. 4, fig. 7.
Hypotype; 96; Miocene, Santa Margarita Formation; 4655 foot depth in Ansolabehere No. 1 oil well, northwest of Bakersfield, Kern Co., Calif.
Pecten (*Aequipecten*) *latiauratus* Conrad variety *monotimeris* Conrad
Grant and Gale, 1931, p. 204, pl. 4, fig. 3, 6.
Hypotype; 92 (fig. 3), 95 (fig. 6); Pleistocene; ½ mile south of Southern Pacific station at Seacliff, Ventura Co., Calif.
Pecten (*Aequipecten*) *percarus* Hertlein
Hertlein, 1925a, p. 13.
Paratype; 630; Pliocene, Salada Formation; northwest of Elephant Mesa west of Arroyo, Scammons Lagoon Quadrangle, Baja California, Mexico.
Pecten (*Aequipecten*) *purpuratus* Lamarck variety *callidus* Hertlein
Grant and Gale, 1931, p. 211, pl. 5, fig. 4.
Hypotype; 99; Pliocene, Pico Formation; west of Fernando Pass, Los Angeles Co., Calif.
Pecten (*Aequipecten*) *purpuratus* Lamarck variety *subdolus* Hertlein
Grant and Gale, 1931, p. 211. pl. 5, fig. 1.
Hypotype; 97; Pliocene, Pico Formation; summit of ridge over Fernando Pass railroad tunnel, Los Angeles Co., Calif.
Pecten (*Camptonectes*) *harfordus* Davis
Davis, 1913, p. 456.
Paratype; 634, 938, 939; Jurassic, San Luis Formation; 6 miles north of Port Harford, San Luis Obispo Co., Calif.
Pecten (*Chlamys*) *erici* Wiedey
Wiedey, 1928, p. 137, pl. 16, fig. 1.
Holotype; 27; Miocene, Vaqueros Formation; South Mountain, Ventura Co., Calif.
Pecten (*Chlamys*) *hodgei* Hertlein
Hertlein, 1925b, p. 42.
Paratype; 632; Miocene, Santa Margarita Formation; Coalinga region, Fresno Co., Calif.

Pecten (*Janira*) *bellus* (Conrad) variety *coalingaensis* Arnold
Grant and Gale, 1931, p. 227, pl. 2, fig. 2.
Hypotype; 86; Pliocene, Pico Formation; southeast of Pico Canyon, Los Angeles Co., Calif.

Pecten (*Janira*) *bellus* (Conrad) variety *hemphilli* Dall
Grant and Gale, 1931, p. 226, pl. 3, fig. 1a, 1b.
Hypotype; 88a (fig. 1a), 88b (fig. 1b); Pliocene, San Diego Formation; Pacific Beach, San Diego, San Diego Co., Calif.

Pecten (*Janira*) *bellus* (Conrad) variety *slevini* Dall and Ochsner
Grant and Gale, 1931, p. 227, pl. 2, fig. 3.
Hypotype; 87; Pliocene; north of Santa Clara Valley and east of San Martinez Chiquito Canyon, Los Angeles Co., Calif.

Pecten (*Janira*) *stearnsii* Dall variety *bakeri* Hanna and Hertlein
Grant and Gale, 1931, p. 224, pl. 4, fig. 1a, 1b.
Hypotype; 91; Pliocene, Santa Rosalía, Territorio de Sur de Baja California, Mexico.

Pecten (*Janira*) *stearnsii* Dall variety *diegensis* Dall
Grant and Gale, 1931, p. 223, pl. 3, fig. 4.
Hypotype; 89; Pliocene, Pico Formation?; Smith Canyon, Ventura Co., Calif.

Pecten (*Janira*) *stearnsii* Dall variety *stearnsii*, s. s.
Grant and Gale, 1931, p. 223, pl. 3, fig. 2b (not 2a).
Hypotype; 90; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.

Pecten (*Lyropecten*) *estrellanus* (Conrad)
Grant and Gale, 1931, p. 185, pl. 8, fig. 4.
Hypotype; 106; Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.

Pecten (*Lyropecten*) *estrellanus* (Conrad) variety *cerrosensis* Gabb
Grant and Gale, 1931, p. 187, pl. 8, fig. 1a, 1b, 2a, 2b, pl. 9, fig. 2.
Hypotype; 107 (pl. 8, fig. 1a, 1b), 108 (pl. 8, fig. 2a, 2b), 109 (pl. 9, fig. 2); Pliocene, Los Angeles Co., Calif.; 107: Pico Formation, southeast of Pico Canyon; 108: Pico Formation, Holser Canyon; 109: ridge north of Junction of Tomsley and Wiley Canyons.

Pecten (*Pallium*) *swiftii* Bernardi
Grant and Gale, 1931, p. 171, pl. 10, fig. 2, 5.
Hypotype; 110 (fig. 2), 113 (fig. 5); Pliocene, Pico Formation, Holser Canyon; Los Angeles Co., Calif.

Pecten (*Pallium*) *swiftii* Bernardi variety *etchegoini* Anderson
Grant and Gale, 1931, p. 173, pl. 10, fig. 3a, 3b.
Hypotype; 111; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.

Pecten (*Patinopecten*) *caurinus* Gould
Grant and Gale, 1931, p. 194, pl. 6, fig. 4.
Hypotype; 105; Pliocene, Purisima Formation; Purisima Creek, San Mateo Co., Calif.

Pecten (*Patinopecten*) *healeyi* Arnold
Grant and Gale, 1931, p. 196, pl. 6, fig. 2a, 2b.
Hypotype; 103a (fig. 2a), 103b (fig. 2b); Pliocene, San Diego Formation; Pacific Beach, San Diego, San Diego Co., Calif.

Pecten (*Patinopecten*) *healeyi* Arnold variety *lohri* Hertlein
Grant and Gale, 1931, p. 197, pl. 6, fig. 1a, 1b.
Hypotype; 102; Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.

Pecten (*Patinopecten*) *marquerensis* (Durham)
Emerson and Hertlein, 1964, fig. 4f.
Hypotype; 810; Pliocene; Isla San José, Baja California, Mexico.

Pecten (*Patinopecten*) *purisimaensis* Arnold
Grant and Gale, 1931, p. 194, pl. 6, fig. 3.
Hypotype; 104; Pliocene, Purisima Formation; mouth of San Gregorio Creek, San Mateo Co., Calif.

Pecten (*Pecten*) *beringianus* Middendorff
Grant and Gale, 1931, p. 165, pl. 11, fig. 2.
Hypotype; 114; Pliocene, Pico Formation; Sulphur Canyon, Ventura Co., Calif.

Pecten (*Pecten*) *islandicus* Muller variety *jordani* Arnold
Grant and Gale, 1931, p. 164, pl. 11, fig. 4.
Hypotype; 115; Pliocene; Packard's Hill, Santa Barbara, Santa Barbara Co., Calif.

Pecten (*Plagioctenium*) *cristobalensis* Hertlein
Hertlein, 1925a, p. 19.
Paratype; 631; Pliocene, Salada Formation; 3 miles southeast of Turtle Bay, San Cristobal Bay Quadrangle, Baja California, Mexico.

Pecten (*Plagioctenium*) *hakei* Hertlein
Hertlein, 1925a, p. 18.
Paratype; 638; Pliocene; Ballenas Quadrangle, Baja California, Mexico.

Pecten (Pseudamusium) vancouverensis fernandoensis Hertlein

Hertlein, 1925b, p. 43.

Paratype; 635; Pliocene, Fernando Formation; on Ventura River, 1.5 miles north of Ventura, Ventura Co., Calif.

Pecten vanwinkleae Clark

Clark, 1925, p. 82.

Paratype; 636; Oligocene, Lincoln Formation; along Porter Creek about 3/4 miles above Porter, Grays Harbor Co., Wash.

Pedalion panzana Loel and Corey

Loel and Corey, 1932, p. 187.

Paratype; 778; Miocene, Vaqueros Formation; branch of Carrizo Creek about 100 yards west of Carrizo ranch house, La Panza Mountains, San Luis Obispo Co., Calif.

Petricola carditoides (Conrad)

Grant and Gale, 1931, p. 355, pl. 13, fig. 14a, 14b.

Hypotype; 128; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

Pholadidea (Pholadidea) penita (Conrad)

Grant and Gale, 1931, p. 434, pl. 24, fig. 1a, 1b.

Hypotype; 200; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

Pholadomya kernensis Wiedey

(Wiedey, 1928, p. 141, pl. 17, fig. 1, 2.)

Plastoholotype; 191, 743-745; Miocene, Temblor Formation; north of Poso Creek, Kern Co., Calif.

Pholas (Zirfaea) gabbi (Tryon)

Grant and Gale, 1931, p. 432, pl. 24, fig. 2.

Hypotype; 201; Pliocene, Etchegoin Formation; 3900-18 feet deep in oil well near McFarland, Kern Co., Calif.

Pinna latrania Hanna

Hanna, 1926, p. 476.

Paratype; 1; Pliocene, Imperial Formation; Coyote Mountain, Imperial Co., Calif.

Pododesmus macroschisma (Deshayes)

Grant and Gale, 1931, p. 241, pl. 12, fig. 3.

Hypotype; 120; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.

Pteria jordani Wiedey

Wiedey, 1928, p. 134, pl. 14, fig. 4.

Holotype; 25; Miocene, Temblor Formation; 2 miles south of Calabasas, Los Angeles Co., Calif.

Sanguinolaria (Nuttallia) orcutti Dall

Dall, 1921, p. 17.

Syntype; 940-950; Pleistocene; San Quintin Bay, Baja California, Mexico.

Saxidomus nuttalli Conrad variety *giganteus* (Deshayes)

Grant and Gale, 1931, p. 342, pl. 18, fig. 4, 10.

Hypotype; 156 (fig. 4), 158 (fig. 10); 156: Pleistocene, 1 to 1¼ miles west of Goleta Point, Santa Barbara Co., Calif.; 158: Pliocene, 100 yards west of the bathhouse, Santa Barbara, Santa Barbara Co., Calif.

Schizothaerus nuttallii (Conrad)

Grant and Gale, 1931, p. 404, pl. 22, fig. 6a, 6b, pl. 23, fig. 8a, 8b, 9.

Hypotype; 198 (pl. 23, fig. 8a, 8b), 199 (pl. 23, fig. 9), 330 (pl. 22, fig. 6a, 6b); 198, 199: Pleistocene, southwest of Goleta, Santa Barbara Co., Calif.; 330: Pliocene, Purisima Formation, Pt. Año Nuevo, San Mateo Co., Calif.

Semele decisa (Conrad)

Grant and Gale, 1931, p. 376, pl. 14, fig. 13a, 13b.

Hypotype; 137; Pleistocene, San Pedro Formation; San Pedro, Los Angeles Co., Calif.

Semele verrucosa Mörch

Emerson and Hertlein, 1964, p. 359, fig. 3i, 3j.

Hypotype; 803; Pleistocene; Isla Coronados, Baja California, Mexico.

Siliqua cf. *patula* (Dixon)

Grant and Gale, 1931, p. 924, pl. 21, fig. 9.

Hypotype; 186; Pliocene, Etchegoin Formation; oil well near McFarland, Kern Co., Calif.

Siliqua lucida (Conrad)

Grant and Gale, 1931, p. 389, pl. 21, fig. 6.

Hypotype; 184; Pliocene, Etchegoin Formation; 3000-18 feet deep in well near McFarland, Kern Co., Calif.

Solen sicarius Gould

Grant and Gale, 1931, p. 385, pl. 21, fig. 4.

Hypotype; 183; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

Sphaerium (Amesoda) rogersi Hannibal

Hannibal, 1913, p. 131.

Paratype; 633; Eocene, Tejon Formation; ¼ mile above Carnegie Pottery in Western Pacific Railway cut, Corral Hollow, Tesla, Alameda Co., Calif.

Spisula abbotti Wiedey
Wiedey, 1928, p. 151, pl. 19, fig. 4, 5.
Holotype; 39; Miocene, Temblor Formation; 2 miles northwest of powerhouse at mouth of Kern Canyon, Kern Co., Calif.

Spisula granti Wiedey
Wiedey, 1928, p. 152, pl. 20, fig. 2, 3.
Holotype; 40; Miocene, Vaqueros Formation; Vaqueros Creek, Monterey Co., Calif.

Spondylus inezana Wiedey
Wiedey, 1928, p. 139, pl. 16, fig. 2, 3.
Holotype; 29; Miocene, Vaqueros Formation; Head of Wiley Canyon, Ventura Co., Calif.

Spondylus perrini Wiedey
Wiedey, 1928, p. 138, pl. 17, fig. 6, 7.
Holotype; 28; Miocene, Vaqueros Formation; Head of Wiley Canyon, Ventura Co., Calif.

Tagelus californianus (Conrad)
Grant and Gale, 1931, p. 384, pl. 21, fig. 2a, 2b, 3.
Hypotype; 181 (fig. 2a, 2b), 182 (fig. 3); Pleistocene; San Pedro, Los Angeles Co., Calif.

Tellina bodegensis Hinds
Grant and Gale, 1931, p. 362, pl. 20, fig. 13.
Hypotype; 180; Pleistocene; west of Newport, Los Angeles Co., Calif.

Tellina idae Dall
Grant and Gale, 1931, p. 358, pl. 20, fig. 12.
Hypotype; 179; Pliocene, Pico Formation; above Newhall railroad tunnel, Los Angeles Co., Calif.

Tellina oldroydi Wiedey
Wiedey, 1928, p. 148, pl. 19, fig. 3.
Holotype; 36; Miocene, Temblor Formation; 2 miles south of Calabasas, Los Angeles Co., Calif.

Thracia (Thracia) trapezoides Conrad
Grant and Gale, 1931, p. 257, pl. 13, fig. 8.
Hypotype; 123; Miocene; 2 or 3 miles south of Mayfield, Santa Clara Co., Calif.

Thyasira bisecta (Conrad) variety *nipponica* Yabe and Nomura
Grant and Gale, 1931, pl. 13, fig. 15.
Hypotype; 129; Pliocene or Pleistocene, Kawabata Series; Japan.

Tivela gastoensis Clark
Clark, 1925, p. 93.
Paratype; 627; Oligocene; county quarry, Scroggins Canyon, Gaston, Washington Co., Oregon.

Tivela stultorum (Mawe)
Grant and Gale, 1931, p. 340, pl. 19, fig. 3a, 3b.
Hypotype; 170; Pleistocene; west of Newport, Los Angeles Co., Calif.

Venerupis (Protothaca) restorationensis (Frizzell)
Frizzell, 1931, p. 321, pl. 22, fig. 2-4.
Holotype; 386; Pleistocene; near Port Blakely, Jefferson Co., Wash.
See: *Paphia restorationensis* Frizzell

Venerupis (Protothaca) staminea (Conrad)
Grant and Gale, 1931, p. 329, pl. 18, fig. 1a, 1b, 2a, 2b.
Hypotype; 153 (fig. 1a, 1b), 154 (fig. 2a, 2b); Pleistocene; beach southwest of Goleta, Santa Barbara Co., Calif.

Venerupis (Protothaca) staminea (Conrad) variety *ruderata* (Deshayes)
Grant and Gale, 1931, p. 331, pl. 18, fig. 3a, 3b.
Hypotype; 155; Pleistocene; 1 to 1¼ miles west of Goleta Point, Santa Barbara Co., Calif.

Venus (Chione) elsmerensis (English)
Grant and Gale, 1931, p. 319, pl. 16, fig. 6a, 6b, 7.
Hypotype; 151 (fig. 6a, 6b), 152 (fig. 7); Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.

Venus (Chione) securis Shumard variety *fernandoensis* (English)
Grant and Gale, 1931, p. 321, pl. 17, fig. 4a, 4b, 5, 6.
Hypotype; 159 (fig. 4a, 4b), 160 (fig. 5), 161 (fig. 6); Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.

Venus (Chione) succincta Valenciennes
Grant and Gale, 1931, p. 321, pl. 16, fig. 1a, 1b, 2a, 2b, 3, 4.
Hypotype; 147 (fig. 1a, 1b), 148 (fig. 2a, 2b), 149 (fig. 3), 150 (fig. 4); Pleistocene; 5 miles ENE of Newport Beach, Orange Co., Calif.

Gastropoda

Acanthina spirata (Blainville)
Grant and Gale, 1931, p. 720, pl. 32, fig. 6, 7.
Hypotype; 293 (fig. 6), 294 (fig. 7); Pleistocene; 293: San Pedro, Los Angeles Co., Calif.; 294: Sexton Canyon, Ventura Co., Calif.

Acmaea instabilis (Gould)
Grant and Gale, 1931, p. 813, pl. 32, fig. 32.
Hypotype; 313; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.
Acmaea lepsima Berry
Berry, 1940, p. 9.
Paratype; 353, 354, 355; Pleistocene; Hilltop Quarry, San Pedro, Los Angeles Co., Calif.
Acteon (Rictaxis) painei Dall variety *grandior* Grant and Gale
Grant and Gale, 1931, p. 444, pl. 24, fig. 12.
Holotype; 208; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.
Admete modesta (Carpenter)
Grant and Gale, 1931, p. 622, pl. 27, fig. 5.
Hypotype; 267; Pliocene, Pico Formation; Sulphur Canyon, Ventura Co., Calif.
Amphissa columbiana Dall
Grant and Gale, 1931, p. 701, pl. 26, fig. 39.
Hypotype; 250; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.
Amphissa versicolor Dall
Grant and Gale, 1931, p. 702, pl. 26, fig. 53.
Hypotype; 259; Pleistocene; California State Highway 1500 feet north of Rincon Creek, Santa Barbara Co., Calif.
Architectonica compressa Wiedey
Wiedey, 1928, p. 109, pl. 9, fig. 1, 2.
Holotype; 12; Miocene, Temblor Formation; 2 miles southeast of El Modena, Orange Co., Calif.
Architectonica nobilis Bolten variety *discus* Grant and Gale
Grant and Gale, 1931, p. 786, pl. 32, fig. 27.
Holotype; 308; Pliocene?; one mile southwest of Yuha drill hole, south of Dixieland, Imperial Co., Calif.
Astraea (Pachypoma) inaequalis (Martyn)
Grant and Gale, 1931, p. 820, pl. 31, fig. 4a, 4b.
Hypotype; 284; Pliocene; Bath-House Beach, Santa Barbara, Santa Barbara Co., Calif.
Astraea (Pomaulax) gradata Grant and Gale
Grant and Gale, 1931, p. 818, pl. 31, fig. 1a, 1b, 3a, 3b, 5, 8, 9.
Holotype; 286 (fig. 8); paratype; 282 (fig. 1a, 1b), 283 (fig. 3a, 3b), 285 (fig. 5), 287 (fig. 9); Pliocene, Pico Formation; 282, 285, 287: Holser Canyon; 283: west of Fernando Pass; 286: between Pico Canyon and Fernando Pass; all Los Angeles Co., Calif.
Balcis (Balcis) clavella Berry
Berry, 1954, p. 5.
Paratype; 413; Pleistocene; Long Wharf Canyon, Santa Monica, Los Angeles Co., Calif.
Balcis (Balcis) tersa Berry
Berry, 1954, p. 7.
Paratype; 395, 396, 397; Pleistocene; "Hilltop Quarry", San Pedro, Los Angeles Co., Calif.
Balcis conchita Keen
Keen, 1943, p. 43.
Paratype; 617, 936; Miocene, Round Mountain Silt; Caliente Quadrangle, Kern Co., Calif.
Balcis (Vitreolina) ebricanus Berry
Berry, 1954, p. 11.
Paratype; 410, 411, 412; Pleistocene; "Hilltop Quarry", San Pedro, Los Angeles Co., Calif.
Balcis (Vitreolina) incallida Berry
Berry, 1954, p. 10.
Paratype; 404-409; Pleistocene; "Hilltop Quarry", San Pedro, Los Angeles Co., Calif.
Balcis (Vitreolina) obstipa Berry
Berry, 1954, p. 8.
Paratype; 398, 399, 400, 401, 402, 403; Pleistocene; "Hilltop Quarry", San Pedro, Los Angeles Co., Calif.
Bathytoma clarkiana Rivers
Rivers, 1913, p. 29, 2 figures on unnumbered plate.
Syntypes; 10 (figured on left side of plate), 11 (figured on right side of plate); age and locality uncertain.
Bittium (Lirobittium) asperum (Gabb) variety *dilatatum* Grant and Gale
Grant and Gale, 1931, p. 760, pl. 24, fig. 14.
Holotype; 210; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.
Bittium (Semibittium) rugatum Carpenter
Grant and Gale, 1931, p. 762, pl. 24, fig. 8.
Hypotype; 205; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.
Calliostoma canaliculatum (Martyn)
Grant and Gale, 1931, p. 833, pl. 32, fig. 23.
Hypotype; 306; Pleistocene; San Pedro, Los Angeles Co., Calif.

Calliostoma gemmulatum Carpenter
Grant and Gale, 1931, p. 835, pl. 32, fig. 21.
Hypotype; 305; Pleistocene; one half mile south of Seacliff Station, Ventura Co., Calif.
Calyptraea mamillaris Broderip
Grant and Gale, 1931, p. 794, pl. 32, fig. 24a, 24b.
Hypotype; 307; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.
Cancellaria clavatula Sowerby
Grant and Gale, 1931, p. 615, pl. 27, fig. 2.
Hypotype; 264; Pliocene, Pico Formation; east of Fernando Pass, Los Angeles Co., Calif.
Cancellaria hemphilli Dall
Grant and Gale, 1931, p. 621, pl. 27, fig. 3, 15a, 15b.
Hypotype; 265 (fig. 3), 272 (fig. 15a, 15b); Pliocene; 265: Pico Formation, Holser Canyon, Los Angeles Co., Calif.; 272: between Pico Canyon and Fernando Pass, Los Angeles Co., Calif.
Cancellaria obesa Sowerby variety *planospira* Grant and Gale
Grant and Gale, 1931, p. 613, pl. 27, fig. 4.
Holotype; 266; Pliocene, Pico Formation; east of Fernando Pass, Los Angeles Co., Calif.
Cancellaria tritonidea Gabb variety *fernandoensis* Arnold
Grant and Gale, 1931, p. 618, pl. 27, fig. 1.
Hypotype; 263; Pliocene, Pico Formation; east of Fernando Pass, Los Angeles Co., Calif.
Cantharus fortis (Carpenter)
Grant and Gale, 1931, p. 647, pl. 28, fig. 2.
Hypotype; 273; Pleistocene; Santa Paula Creek, Ventura Co., Calif.
Cantharus humerosus (Gabb)
Grant and Gale, 1931, p. 647, pl. 28, fig. 3.
Hypotype; 274; Pliocene; between Pico Canyon and Fernando Pass, Los Angeles Co., Calif.
Cerithidea californica (Haldeman)
Grant and Gale, 1931, p. 763, pl. 24, fig. 6,7.
Hypotype; 203 (fig. 6), 204 (fig. 7); Pleistocene; San Pedro, Los Angeles Co., Calif.
"Cerithium" simplicius Grant and Gale
Grant and Gale, 1931, p. 757, pl. 24, fig. 11.
Holotype; 207; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.
Chicoreus (Murithais) wilkesanus (Anderson)
Grant and Gale, 1931, p. 730, pl. 32, fig. 12.
Hypotype; 298; Miocene; oil well northwest of Bakersfield, Kern Co., Calif.
Chrysallida rotundomontana Keen
Keen, 1943, p. 43.
Paratype; 610; Miocene, Round Mountain Silt; Caliente Quadrangle, Kern Co., Calif.
Clathurella conradiana Gabb
Grant and Gale, 1931, p. 606, pl. 26, fig. 11.
Hypotype; 236; Pliocene, Pico Formation; Sulphur Canyon, Ventura Co., Calif.
Clathurella (Glyphostoma) tridesmia Berry
Berry, 1941, p. 8.
Paratype; 384, 385, 393; Pleistocene; "Hilltop Quarry"; San Pedro, Los Angeles Co., Calif.
Clavus (Clathrodrillia) coalingensis (Arnold)
Grant and Gale, 1931, p. 580, pl. 26, fig. 14a, 14b, 15.
Hypotype; 232 (fig. 14a, 14b), 233 (fig. 15); Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.
Clavus (Crassispira) sp.
Grant and Gale, 1931, p. 582, pl. 26, fig. 10.
Hypotype; 231; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.
Clavus (Cymatosyrinx) pallidus (Sowerby)
Grant and Gale, 1931, p. 576, pl. 26, fig. 16a, 16b, 17.
Hypotype; 234 (fig. 16a, 16b), 235 (fig. 17); Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.
Conus californicus Hinds
Grant and Gale, 1931, p. 472, pl. 24, fig. 21.
Hypotype; 216; Pleistocene; Santa Paula Quadrangle, Ventura Co., Calif.
Conus californicus fossilis Oldroyd
Oldroyd, T. S., 1921, p. 116.
Paratype; 361, 362; Pleistocene; San Pedro, Los Angeles Co., Calif.
Conus juanensis Wiedey
Wiedey, 1928, p. 123, pl. 9, fig. 3.
Holotype; 16; Miocene, Temblor Formation; 2 miles west of Simmler, San Luis Obispo Co., Calif.
Conus oweniana (Anderson) *ynezanus* Loel and Corey
Loel and Corey, 1932, p. 237.
Paratype; 794; Miocene, Vaqueros Formation; 2.5 miles southwest of Buellton, Santa Barbara Co., Calif.

Crepidula onyx Sowerby

Grant and Gale, 1931, p. 790, pl. 32, fig. 34.

Hypotype; 314; Pliocene, Pico Formation; Canada de Aliso, Ventura Co., Calif.

Cylichna ? loismartinae Keen

Keen, 1943, p. 44.

Paratype; 608; Miocene, Round Mountain Silt; Caliente Quadrangle, Kern Co., Calif.

Cylichna temblorensis Keen

Keen, 1943, p. 44.

Paratype; 609, 930, 931, 932; Miocene, Round Mountain Silt; Caliente Quadrangle, Kern Co., Calif.

Cypraea spadicea Swainson

Grant and Gale, 1931, p. 752, pl. 27, fig. 13.

Hypotype; 270; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.

Drillia merriami Arnold

(Arnold, 1903, p. 207, pl. 8, fig. 7.)

Plastoholotype; 637; Pleistocene, San Pedro Formation; Deadman Island, San Pedro, Los Angeles Co., Calif.

Epitonium (Opalia) varicostatum (Stearns)

Grant and Gale, 1931, p. 853, pl. 24, fig. 20.

Hypotype; 215; Pliocene, San Diego Formation; Pacific Beach, San Diego Co., Calif.

Ferminoscala whitei Keen

Keen, 1943, p. 46.

Paratype; 607, 929; Miocene, Round Mountain Silt; Caliente Quadrangle, Kern Co., Calif.

Ficus (Trophosycon) ocoyana (Conrad)

Grant and Gale, 1931, p. 743, pl. 30, fig. 11.

Hypotype; 281; Miocene; southwest of Mayfield, Santa Clara Co., Calif.

Ficus (Trophosycon) ocoyana (Conrad) variety *contignata* Grant and Gale

Grant and Gale, 1931, p. 749, pl. 29, fig. 1a, 1b, pl. 30, fig. 2, 4, 9a, 9b.

Holotype; 4 (pl. 29, fig. 1a, 1b, pl. 30, fig. 2); paratype; 278 (pl. 30, fig. 4), 279 (pl. 30, fig. 9a, 9b); Pliocene, Pico Formation; 4, 279: Elsmere Canyon; 278: south of Humphrey's Station; both Los Angeles Co., Calif.

Ficus (Trophosycon) ocoyana (Conrad) variety *ruginodosa* Grant and Gale

Grant and Gale, 1931, p. 746, pl. 29, fig. 2a, 2b, pl. 30, fig. 10a, 10b.

Holotype; 3 (pl. 29, fig. 2a, 2b); paratype (pl. 30, fig. 10a, 10b); Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.

Forreria magister (Nomland)

Grant and Gale, 1931, p. 727, pl. 27, fig. 14a, 14b.

Hypotype; 271; Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.

Fusinus barbarensis (Trask)

Grant and Gale, 1931, p. 639, pl. 27, fig. 11.

Hypotype; 268; Pliocene; betwen Pico Canyon and Fernando Pass, Los Angeles Co., Calif.

Galeodea apta Tegland

Tegland, 1931, p. 415.

Paratype; 366, 367; Oligocene, Twin Rivers Shales; 1½ miles west of mouth of West Twin River, Clallam Co., Wash.

Galeodea rex Tegland

Tegland, 1931, p. 413.

Paratype; 363-365; Oligocene, Blakeley Formation; Bainbridge Island, Jefferson Co., Wash.

Gyrineum (Bechtelia) strongi Jordan

Emerson and Hertlein, 1964, p. 360, fig. 5g.

Hypotype; 818; Pleistocene; Isla Monserrate, Baja California, Mexico.

Gyrineum lewisii Carson

Carson, 1926, p. 53.

Paratype; 628; Pliocene, Fernando Formation; Fugler's Point, Santa Barbara Co., Calif.

Hastula gnomon Keen

Keen, 1943, p. 47.

Paratype; 606; Miocene, Round Mountain Silt; Caliente Quadrangle, Kern Co., Calif.

Hyalina (Cystiscus) jewettii (Carpenter)

Grant and Gale, 1931, p. 630, pl. 24, fig. 17.

Hypotype; 213; Pleistocene; San Pedro, Los Angeles Co., Calif.

Kelletia (Kelletia) kelletii (Forbes)

Grant and Gale, 1931, p. 642, pl. 28, fig. 7.

Hypotype; 276; Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.

Lacuna divaricata (Fabricus) variety *solidula* Lovén

Grant and Gale, 1931, p. 782, pl. 32, fig. 19.

Hypotype; 303; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

Littorina scutulata Gould
Grant and Gale, 1931, p. 782, pl. 32, fig. 16-18.
Hypotype; 300 (fig. 16), 301 (fig. 17), 302 (fig. 18); Pleistocene; San Pedro, Los Angeles Co., Calif.
Margarites (*Lirularia*) *aresta* Berry
Berry, 1941, p. 13.
Paratype; 73; Pleistocene; "Hilltop Quarry", San Pedro, Los Angeles Co., Calif.
Melampus olivaceous Carpenter
Grant and Gale, 1931, p. 461, pl. 24, fig. 16.
Hypotype; 212; Pleistocene; San Pedro, Los Angeles Co., Calif.
Miopleiona weaveri Tegland
(Tegland, 1933, p. 127, pl. 11, fig. 1, 2.)
Plastoholotype; 360; Oligocene, Blakeley Formation; Bainbridge Island, Jefferson Co., Wash.
Mistostigma punctulum Berry
Berry, 1947, p. 264 (10).
Paratype; 322-324; Pliocene; Bath-house Cliff, Santa Barbara, Santa Barbara Co., Calif.
Mitra catalinae (Dall)
Grant and Gale, 1931, p. 636, pl. 28, fig. 4.
Hypotype; 275; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.
Mitrella carinata (Hinds)
Grant and Gale, 1931, p. 692, pl. 26, fig. 35.
Hypotype; 248; Pleistocene; ½ mile south of Seacliff Railway Station, Ventura Co., Calif.
Mitrella carinata (Hinds) variety *gausapata* (Gould)
Grant and Gale, 1931, p. 693, pl. 26, fig. 44.
Hypotype; 253; Pleistocene; south of Seacliff Railway Station, Ventura Co., Calif.
Mitrella grandior Grant and Gale
Grant and Gale, 1931, p. 696, pl. 26, fig. 46.
Holotype; 6; Pliocene, Pico Formation; Canada de Aliso, Ventura Co., Calif.
Mitrella (*Mitrella*) *anchuela* Keen
Keen, 1943, p. 48.
Paratype; 612; Miocene, Round Mountain Silt; Caliente Quadrangle, Kern Co., Calif.
Mitrella tuberosa (Carpenter)
Grant and Gale, 1931, p. 697, pl. 26, fig. 45.
Hypotype; 254; Pliocene, Pico Formation; Sulphur Canyon, Ventura Co., Calif.
Mitromorpha galeana Berry
Berry, 1941, p. 12.
Paratype; 54, 394; Pleistocene; "Hilltop Quarry", San Pedro, Los Angeles Co., Calif.
Moniliopsis chacei Berry
Berry, 1941, p. 6.
Paratype; 347, 348; Pleistocene; "Hilltop Qarry", San Pedro, Los Angeles Co., Calif.
Moniliopsis graciosana (Arnold) variety *mercedensis* (Martin)
Grant and Gale, 1931, p. 569, pl. 26, fig. 30.
Hypotype; 245; Pleistocene, Las Posas Formation; north of Arroyo Santa Rosa, Ventura Co., Calif.
Moniliopsi incisa (Carpenter) variety *incisa* s.s
Grant and Gale, 1931, p. 566, pl. 26, fig. 21.
Hypotype; 238; Pleistocene, La Posas Formation; north of Arroyo Santa Rosa, Ventura Co., Calif.
Moniliopsis incisa (Carpenter) variety *quinquecincta* Grant and Gale
Grant and Gale, 1931, p. 568, pl. 26, fig. 33.
Hypotype; 247; Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.
Morula (*Morunella*) *lugubris* (C. B. Adams)
Emerson and Hertlein, 1964, p. 361, fig. 3k.
Hypotype; 804; Pleistocene; Isla Coronados, Baja California, Mexico.
Nassarius hildegardae Kanakoff
Kanakoff, 1956, p. 113.
Paratype; 341; Pliocene, Pico Formation; ½ mile south of Humphreys Railway Station, Los Angeles Co., Calif.
Nassarius (*Schizopyga*) *californianus* (Conrad)
Grant and Gale, 1931, p. 672, pl. 26, fig. 49.
Hypotype; 255; Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.
See: *Nassarius* (*Tritia*) *californianus* (Conrad)
Nassarius (*Schizopyga*) *fossatus* (Gould)
Grant and Gale, 1931, p. 675, pl. 26, fig. 55, 56.
Hypotype; 261 (fig. 55), 262 (fig. 56); Pleistocene; Southwest of Goleta, Santa Barbara Co., Calif.
See: *Nassarius* (*Tritia*) *fossatus* (Gould)
Nassarius (*Schizopyga*) *mendicus* (Gould)
Grant and Gale, 1931, p. 674, pl. 26, fig. 54.
Hypotype; 260; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

See: *Nassarius* (*Tritia*) *mendicus* (Gould)

Nassarius (*Schizopyga*) *mendicus* (Gould) variety *cooperi* (Forbes)
Grant and Gale, 1931, p. 674, pl. 26, fig. 40, 50.
Hypotype; 251 (fig. 40), 256 (fig. 50); Pleistocene, southwest of Goleta, Santa Barbara Co., Calif.
See: *Nassarius* (*Tritia*) *mendicus* (Gould) variety *cooperi* (Forbes)

Nassarius (*Schizopyga*) *perpinguis* (Hinds)
Grant and Gale, 1931, p. 673, pl. 26, fig. 51, 52.
Hypotype; 257 (fig. 51), 258 (fig. 52); 257: Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.; 258: Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.
See: *Nassarius* (*Tritia*) *perpinguis* (Hinds)

Nassarius (*Tritia*) *californianus* (Conrad)
Grant and Gale, 1931, p. 941, pl. 26, fig. 49.
See: *Nassarius* (*Schizopyga*) *californianus* (Conrad)

Nassarius (*Tritia*) *fossatus* (Gould)
Grant and Gale, 1931, p. 675, pl. 26, fig. 55, 56.
See: *Nassarius* (*Schizopyga*) *fossatus* (Gould)

Nassarius (*Tritia*) *mendicus* (Gould)
Grant and Gale, 1931, p. 674, pl. 26, fig. 54.
See: *Nassarius* (*Schizopyga*) *mendicus* (Gould)

Nassarius (*Tritia*) *mendicus* (Gould) variety *cooperi* (Forbes)
Grant and Gale, 1931, p. 941, pl. 26, fig. 40, 50.
See: *Nassarius* (*Schizopyga*) *mendicus* (Gould) variety *cooperi* (Forbes)

Nassarius (*Tritia*) *perpinguis* (Hinds)
Grant and Gale, 1931, p. 673, pl. 26, fig. 51, 52.
See: *Nassarius* (*Schizopyga*) *perpinguis* (Hinds)

Nassarius stoeki Kanakoff
Kanakoff, 1956, p. 110.
Paratype; 340; Pliocene, Pico Formation; ½ mile south of Humphreys Railway Station, Los Angeles Co., Calif.

Nassarius (*Uzita*) *arnoldi* (Anderson) variety *whitneyi* (Trask)
Grant and Gale, 1931, p. 679, pl. 26, fig. 48a, 48b.
Hypotype; 7; Pliocene, Etchegoin Formation; near Tipton, Tulare Co., Calif.

Neptunea (*Colus*) *jordani* (Dall)
Grant and Gale, 1931, p. 663, pl. 28, fig. 11.
Hypotype; 277; Pleistocene (Pliocene?), Elk River Formation; north of mouth of Elk River, Curry Co., Oregon.

Neptunea (*Neptunea*) *andersoni* (Martin) variety *hawleyi* (Carson)
Grant and Gale, 1931, p. 655, pl. 28, fig. 9a-9c.
Hypotype; 317; Pliocene, Pico Formation; Sulphur Canyon, Ventura Co., Calif.

Ocenebra squamulifer (Carpenter)
See: *T.*[*rophon*] *squamulifer* Carpenter

Odostomia cf. (*Amaura*) *avellana* Carpenter
Grant and Gale, 1931, p. 954, pl. 32, fig. 20.
Hypotype; 304; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

Odostomia cf. (*Evalea*) *phanea* Dall and Bartsch
Grant and Gale, 1931, p. 933, pl. 24, fig. 25.
Hypotype; 218; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

Olivella biplicata Sowerby
Grant and Gale, 1931, p. 625, pl. 24, fig. 15.
Hypotype; 211; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

Olivella ischnon Keen
Keen, 1943, p. 50.
Paratype; 613, 937; Miocene, Round Mountain Silt or Olcese Sand; Caliente Quadrangle, Kern Co., Calif.

Olivella pedroana (Conrad)
Grant and Gale, 1931, p. 626, pl. 24, fig. 10.
Hypotype; 206; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.

Olivella santana Loel and Corey
Loel and Corey, 1932, p. 240.
Paratype; 795, 796; Miocene, Vaqueros Formation; north of Coal Mine on south side of 1332′ hill, Santa Ana Mountains, Orange Co., Calif.

Pseudomelatoma penicillata (Carpenter) variety *semiinflata* Grant and Gale
Grant and Gale, 1931, p. 561, pl. 26, fig. 19.
Holotype; 237; Pleistocene; Santa Monica, Los Angeles Co., Calif.

Puncturella punctocostata Berry
Berry, 1947, p. 265 (11).
Paratype; 325, 326; Pleistocene, Lomita Formation; near 2nd and Pacific Streets, San Pedro, Los Angeles Co., Calif.

Puncturella ralphi Berry
Berry, 1947, p. 267 (13).
Paratype; 327; Pleistocene; 2nd and Pacific Streets, San Pedro, Los Angeles Co., Calif.
Purpura (Jaton) eldridgei (Arnold)
Grant and Gale, 1931, p. 708, pl. 32, fig. 1, 2a, 2b.
Hypotype; 288 (fig. 1), 289 (fig. 2a, 2b); Pliocene, Pico Formation; east of Fernando Pass, Los Angeles Co., Calif.
Purpura (Jaton) festiva (Hinds)
Grant and Gale, 1931, p. 708, pl. 32, fig. 3.
Hypotype; 290; Pleistocene; San Pedro, Los Angeles Co., Calif.
Ranella (Priene) oregonensis (Redfield)
Grant and Gale, 1931, p. 737, pl. 27, fig. 12.
Hypotype; 269; Pliocene, Pico Formation; Sulphur Canyon, Los Angeles Co., Calif.
Rapana serrai Wiedey
Wiedey, 1928, p. 116, pl. 9, fig. 4-6.
Holotype; 13; Miocene, Vaqueros Formation; Kavanaugh Creek, San Luis Obispo Co., Calif.
Retusa (Acteocina) culcitella (Gould)
Grant and Gale, 1931, p. 447, pl. 24, fig. 13.
Hypotype; 209; Pleistocene; Harmon Canyon, Ventura Co., Calif.
Scissurella lyra Berry
Berry, 1947, p. 268 (14).
Paratype; 328, 329; Pleistocene; 2nd and Pacific Streets, San Pedro, Los Angeles Co., Calif.
Searlesia branneri Clark and Arnold
(Clark and Arnold, 1923, p. 159, pl. 30, fig. 3a, 3b).
Plastoholotype; 22, 717; Oligocence or Miocene; Sooke Formation; Vancouver Island, British Columbia, Canada.
Solenosteira merriami Loel and Corey
Loel and Corey, 1932, p. 242.
Paratype; 797; Miocene, Vaqueros Formation; ridge between Vaqueros and Reliz creeks, Monterey Co., Calif.
Spirotropis (Antiplanes) cf. *bulimoides* (Dall)
Grant and Gale, 1931, p. 557, pl. 26, fig. 26.
Hypotype; 243; Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.
Spirotropis (Antiplanes) perversa (Gabb)
Grant and Gale, 1931, p. 553, pl. 26, fig. 22, 23a, 23b.
Hypotype; 239 (fig. 22), 240 (fig. 23a, 23b); Pleistocene; San Pedro, Los Angeles Co., Calif.
Spirotropis (Antiplanes) perversa (Gabb) variety *fernandoensis* (English)
Grant and Gale, 1931, p. 557, pl. 26, fig. 25.
Hypotype; 242; Pliocene, Pico Formation; Elsmere Canyon, Los Angeles Co., Calif.
Spirotropis (Antiplanes) perversa (Gabb) variety *pedroana* (Arnold)
Grant and Gale, 1931, p. 556, pl. 26, fig. 24, 32.
Hypotype; 241 (fig. 24), 246 (fig. 32); Pleistocene; San Pedro, Los Angeles Co., Calif.
Spirotropis (Typhlomangelia) cf. *renaudi* (Arnold)
Grant and Gale, 1931, p. 549, pl. 26, fig. 29.
Hypotype; 244; Pliocene, Pico Formation; Sulphur Canyon, Ventura Co., Calif.
Strombina recurva (Sowerby)
Grant and Gale, 1931, p. 699, pl. 26, fig. 38, 41.
Hypotype; 249 (fig. 38), 252 (fig. 41); Pleistocene?; Albemarle Island, Galapagos Islands.
Surculites (Megasurcula) carpenterianus (Gabb)
Grant and Gale, 1931, p. 497, pl. 25, fig. 4a, 4b.
Hypotype; 228; Pleistocene; east of Sexton Canyon, Ventura Co., Calif.
Surculites (Megasurcula) remondii (Gabb)
Grant and Gale, 1931, p. 495, pl. 25, fig. 5, 6.
Hypotype; 229 (fig. 5), 230 (fig. 6); Pliocene, Pico Formation; east of Fernando Pass, Los Angeles Co., Calif.
Tegula (Chlorostoma) funebralis (A. Adams)
Grant and Gale, 1931, p. 826, pl. 32, fig. 28, 29a, 29b.
Hypotype; 309 (fig. 28), 310 (fig. 29a, 29b); Pliocene, Pico Formation; 309: between Santa Paula Creek and Timber Canyon; 310: Canada de Aliso; Ventura Co., Calif.
Tegula (Chlorostoma) gallina (Forbes)
Grant and Gale, 1931, p. 827, pl. 32, fig. 30, 31.
Hypotype; 311 (fig. 30), 312 (fig. 31); Pliocene, Pico Formation; west (311) and east (312) of Fernando Pass, Los Angeles Co., Calif.
Terebra (Strioterebrum) cf. *dislocata* (Say)
Grant and Gale, 1931, p. 468, pl. 24, fig. 19.
Hypotype; 214; Pleistocene; Ventura, Ventura Co., Calif.

Terebra (subgenus —?) *santana* Loel and Corey
  Loel and Corey, 1932, p. 236.
  Paratype; 790-793; Miocene; Vaqueros Formation; west side of Plano Trabuco, Orange Co., Calif.
Thais (*Nucella*) *elsmerensis* Grant and Gale
  Grant and Gale, 1931, p. 719, pl. 32, fig. 13.
  Holotype; 299; Pliocene, Pico Formation; east of Fernando Pass, Los Angeles Co., Calif.
Thais (*Nucella*) *shumanensis* Carson
  Carson, 1926, p. 56.
  Paratype; 629; Pliocene, Fernando Formation; railway cut ½ mile north of Schuman, Santa Barbara Co., Calif.
Tritonalia foveolata (Hinds)
  Grant and Gale, 1931, p. 709, pl. 32, fig. 11.
  Hypotype; 297; Pleistocene; Adams Canyon, Ventura Co., Calif.
Tritonalia lurida (Middendorff) variety *aspera* (Baird)
  Grant and Gale, 1931, p. 711, pl. 32, fig. 4.
  Hypotype; 291; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.
Tritonalia lurida (Middenorff) variety *munda* (Carpenter)
  Grant and Gale, 1931, p. 712, pl. 32, fig. 5.
  Hypotype; 292; Pleistocene; southwest of Goleta, Santa Barbara Co., Calif.
Tritonalia poulsoni (Nuttall in Carpenter)
  Grant and Gale, 1931, p. 712, pl. 32, fig. 10.
  Hypotype; 296; Pleistocene; San Pedro, Los Angeles Co., Calif.
Tritonalia ynezana Loel and Corey
  Loel and Corey, 1932, p. 248.
  Paratype; 798-800; Miocene, Vaqueros Formation; 2.5 miles southwest of Buellton, Santa Barbara Co., Calif.
Trophon (*Boreotrophon*) *orpheus* (Gould)
  Grant and Gale, 1931, p. 722, pl. 32, fig. 9.
  Hypotype; 295; Pliocene, Pico Formation; Sulphur Canyon, Ventura Co., Calif.
T. [*rophon*] *squamulifer* Carpenter
  Carpenter *in* Gabb, 1869, p. 44.
  Plastoholotype; 952a, 952b, 953; Pleistocene; Santa Barbara, Santa Barbara Co., Calif.
  See: *Ocenebra squamulifer* (Carpenter)
Turbonilla (*Pyrgiscus*) *bravoensis* Keen
  Keen, 1943, p. 51.
  Paraype; 614, 934; Miocene, Round Mountain Silt; Caliente Quadrangle, Kern Co., Calif.
Turbonilla (*Pyrgolampros*) *idae* (T. S. Oldroyd)
  Grant and Gale, 1931, p. 869, pl. 24, fig. 23.
  Hypotype; 316; Pleistocene; Kalorama Canyon, Ventura, Ventura Co., Calif.
Turbonilla (*Pyrgolampros*) *mariposa* Keen
  Keen, 1943, p. 52.
  Paratype; 615, 935; Miocene, Round Mountain Silt; Caliente Quadrangle, Kern Co., Calif.
Turcicula santacruzana Arnold
  Arnold, 1908, p. 373.
  Paratype; 625; Oligocene, San Lorenzo Formation; on San Lorenzo River 3 miles above town of Boulder Creek, Santa Cruz Co., Calif.
Turritella bosei Hertlein and Jordan
  Wiedey, 1928, p. 117, pl. 10, fig. 7, pl. 11, fig. 1, 2.
  Hypotype; 44 (fig. 7), 45 (fig. 1), 46 (fig. 2); Miocene, Temblor Formation; 44: Barker's Ranch, Kern Co., Calif.; 45, 46: 2 miles southeast of El Modena, Orange Co., Calif.
Turritella cooperi Carpenter
  Grant and Gale, 1931, p. 771, pl. 24, fig. 28-34.
  Hypotype; 221 (fig. 28), 222 (fig. 29), 223 (fig. 30), 224 (fig. 31), 225 (fig. 32), 226 (fig. 33), 227 (fig. 34); Pleistocene; San Pedro, Los Angeles Co., Calif.
Turritella inezana Conrad
  Wiedey, 1928, p. 120, pl. 12, fig. 2.
  Hypotype; 48; Miocene, Vaqueros Formation; 5 miles east of San Luis Obispo, San Luis Obispo Co., Calif.
Turritella inezana Conrad var. *pertumida* Wiedey
  Wiedey, 1928, p. 119, pl. 12, fig. 1.
  Holotype; 14; Miocene, Vaqueros Formation; Canyon de Piedra, San Luis Obispo Co., Calif.
Turritella inezana Conrad var. *sespeensis* Arnold
  Wiedey, 1928, p. 121, pl. 12, fig. 4.
  Hypotype; 49; Miocene, Vaqueros Formation; Squaw Flat, Ventura Co., Calif.
Turritella jewettii Carpenter
  Grant and Gale, 1931, p. 770, pl. 24, fig. 26, 27.
  Hypotype; 219 (fig. 26), 220 (fig. 20); Pleistocene; San Pedro, Los Angeles Co., Calif.

Turritella montereyana Wiedey
Wiedey, 1928, p. 123, pl. 21, fig. 3.
Syntype; 51; Miocene, Monterey Formation; 1.5 miles south of San Antonio River, Monterey Co., Calif.

Turritella ocoyana Conrad
Wiedey, 1928, p. 120, pl. 10, fig. 1, 3.
Hypotype; 43 (fig. 3; missing), 47 (fig. 1); Miocene, Temblor Formation; 2 miles west of Simmler, San Luis Obispo Co., Calif.

Turritella temblorensis Wiedey
Wiedey, 1928, p. 122, pl. 11, fig. 4.
Holotype; 14; Miocene, Temblor Formation; Santa Monica Mtns., Los Angeles Co., Calif.

Turritella vanvlecki Arnold
Grant and Gale, 1931, p. 773, pl. 24, fig. 22.
Hypotype; 217; Pliocene, Pico Formation; Holser Canyon, Los Angeles Co., Calif.

Turritella variata Conrad
Wiedey, 1928, p. 120, pl. 12, fig. 8.
Hypotype; 50; Miocene, Vaqueros Formation; 5 miles east of San Luis Obispo, San Luis Obispo Co., Calif.

Vasum (Vasum) pufferi Emerson
Emerson, 1964, p. 11.
Homeotype; 703, 747; Pliocene, Imperial Formation; Coyote Mountain (= Carrizo Mountain), Imperial Co., Calif.

Vexillum (Uromitra) healeyi Fargo
Fargo, 1948, p. 110.
Paratype; 909-913; Pliocene; north part of St. Petersburg, Pinellas Co., Florida.

Viviparus washingtonianus Arnold and Hannibal
Hannibal, 1913, p. 194.
Paratype; 626; Eocene, Tejon Formation; on Olequa Creek 2 miles north of Little Falls, Washington.

Volvulella gluma Keen
Keen, 1943, p. 54.
Paratype; 616; Miocene, Round Mountain Silt; Caliente Quadrangle, Kern Co., Calif.

ARTHROPODA

Trilobita

Achatella carleyi (Meek)
Howell, 1951, p. 287, pl. 8, fig. 5.
Hypotype; 877; Ordovician?, Fairmount Formation?; Cincinnati, Ohio.

Anchiopsis anchiops (Green)
Howell, 1951, p. 286, pl. 8, fig. 3.
Plastoholotype; 875; Devonian; Ulster Co., New York.
See: *Calymene anchiops* Green

Bathyurus extans (Hall)
Howell, 1951, p. 264, pl. 1, fig. 5-7.
Hypotype; 828 (fig. 5), 829 (fig. 6), 830 (fig. 7); Ordovician, Black River Formation; Great Bend, Jefferson Co., New York.

Brachymetopus cuyahogae (Claypole)
Howell, 1951, p. 274, pl. 6, fig. 1.
Hypotype; 854; Mississippian, Cuyahoga Formation; Akron, Ohio.

Bumastus armatus (Hall)
Howell, 1951, p. 268, pl. 3, fig. 4-6.
Hypotype; 840 (fig. 4), 841 (fig. 5), 842 (fig. 6); Silurian, Racine Formation; Bridgeport, Illinois.

Bumastus chicagoensis (Weller)
Howell, 1951, p. 267, pl. 3, fig. 3.
Hypotype; 839; Silurian, Racine Formation; Bridgeport, Illinois.

Bumastus cuniculus (Hall)
Howell, 1951, p. 269, pl. 3, fig. 7, pl. 5, fig. 1.
Hypotype; 843 (fig. 7); 847 (fig. 1); Silurian, Racine Formation; Wauwatosa, Wisconsin.

Bumastus ? vogdesi Howell
Howell, 1951, p. 269, pl. 3, fig. 2.
Holotype; 838; Silurian; Dug Gap, Walker Co., Georgia.

Calymene anchiops Green
Green, 1832, p. 35.
Plastoholotype; 875; Devonian; Ulster Co., New York.
See: *Anchiopsis anchiops* (Green)

Calymene clintoni (Vanuxem)

Vogdes, 1880, p. 178, fig. 3.

Hypotype; 865; Taylor's Ridge near Catoosa Station, Catoosa Co., Georgia.

See: *Calymene vogdesi* Foerste

Vogdes, 1886, p. 5, fig. 3.

Hypotype; 865; Taylor's Ridge near Catoosa Station, Catoosa Co., Georgia

Calymene rostrata Vogdes

Vogdes, 1879, p. 477.

Syntype; 868-872; Silurian, Clinton Group; Taylor's Ridge, Catoosa Station, Catoosa Co., Georgia.

See: *Calymenella rostrata* (Vogdes)

Vogdes, 1880, p. 176, text-fig. 1, 2.

Syntype; 868 (fig. 1), 870 (fig. 2); Silurian, Clinton Group; Taylor's Ridge, Catoosa Station, Catoosa Co., Georgia.

Vogdes, 1886, p. 2, text-fig. 1, 2.

Syntype; 868 (fig. 1), 870 (fig. 2); Silurian, Clinton Group; Taylor's Ridge, Catoosa Station, Catoosa Co., Georgia.

Calymene vogdesi Foerste

Foerste, 1887, p. 95.

See: *Calymene clintoni* (Vanuxem)

Howell, 1951, p. 280, pl. 7, fig. 5-7.

Hypotype; 865 (fig. 5), 866 (fig. 6), 867 (fig. 7); Silurian; 865: Taylor's Ridge near Catoosa Station, Catoosa Co., Georgia; 866, 867: Dug Gap, Walker Co., Georgia.

Calymenella rostrata (Vogdes)

Howell, 1951, p. 283, pl. 7, fig. 8-10.

Syntype; 868 (fig. 8), 869 (fig. 9), 870 (fig. 10), 871, 872; Silurian, Clinton Group; Taylor's Ridge, Catoosa Station, Catoosa Co., Georgia.

See: *Calymene rostrata* Vogdes

Ceratocephala anchoralis (Miller)

Howell, 1951, p. 277, pl. 7, fig. 2.

Hypotype; 861; Ordovician, Maysville Formation; Cincinnati region, Ohio.

Ceratocephala longispina (Mitchell)

Howell, 1951, p. 305, pl. 13, fig. 1-2.

Hypotype; 900 (fig. 1), 901 (fig. 2); Silurian, Bowning Series; Bowning Village, County Harden, New South Wales, Australia.

Ceraurus pleurexanthemus Green

Howell, 1951, p. 284, pl. 8, fig. 1, 2.

Hypotype; 873 (fig. 1), 874 (fig. 2); Ordovician; 873: Trenton Formation?, New York; 874: Trenton Formation, Trenton Falls, New York.

Corycephalus dentatus (Barrett)

Howell, 1951, p. 286, pl. 8, fig. 4.

Hypotype; 876; Devonian; Port Jervis, New York.

Cyphaspis christyi Hall

Howell, 1951, p. 274, pl. 5, fig. 7, 8.

Hypotype; 852; Silurian, Niagaran Group; ?Waldron Formation; ?Waldron, ?Indiana.

Cyphaspis yassensis Etheridge and Mitchell

Howell, 1951, p. 303, pl. 12, fig. 1-2.

Hypotype; 895 (fig. 1), 896 (fig. 2); Silurian, Bowning Series; Belle Vale, New South Wales, Australia.

Encrinurus americanus Vogdes

Vogdes, 1886, p. 1.

Syntype; 862, 863; Plastosyntype; 864; Silurian, Clinton Group; Taylor's Ridge, west of Catoosa Station, Catoosa Co., Georgia.

Howell, 1951, p. 278, pl. 7, fig. 3, 4.

Syntype; 862 (fig. 3), 863; plastosyntype; 864 (cast from 863) (fig. 4); Silurian, Clinton Group; Taylor's Ridge, west of Catoosa Station, Catoosa Co., Georgia.

Eophacops catoosaensis Howell

Howell, 1951, p. 289, pl. 10, fig. 2-4.

Holotype; 882 (fig. 2); paratype; 883 (fig. 3), 884 (fig. 4), 885; Silurian, Clinton Group; bank of Chicamauga River at the Ringgold end of the bridge on the road from Catoosa Station to Ringgold, Georgia.

Griffithides bufo Meek and Worthen

Howell, 1951, p. 277, pl. 6, fig. 6; pl. 7, fig. 1.

Hypotype; 859 (pl. 6, fig. 6); Plastohypotype; 860 (pl. 7, fig. 1); Mississippian, Keokuk Group; Crawfordsville, Indiana.

Griffithides conwayensis Wheeler

(Wheeler, 1935, p. 52, pl. 6, fig. 4, 5.)

Plastoholotype; 388; Pennsylvanian, Atoka Formation; Conway Co., Arkansas.

See: *Griffithides ornata* Vogdes

Griffithides nosoniensis Wheeler
(Wheeler, 1935, p. 51, pl. 6, fig. 6, 7.)
Plastoholotype; 389; Permian, Nosoni Formation; ridge between Potter and Marble Creeks, Shasta Co., Calif.
Griffithides ornata Vogdes
(Vogdes, 1895, p. 589, text-fig.)
Plastoholotype; 388; Pennsylvanian, Atoka Formation; Conway Co., Arkansas.
See: *Griffithides conwayensis* Wheeler
Isotelus gigas Dekay
Howell, 1951, p. 265, pl. 2, fig. 3, pl. 3, fig. 1, pl. 4, fig. 1.
Hypotype; 835 (pl. 2, fig. 3); 837 (pl. 3, fig. 1); 846 (pl. 4, fig. 1); Ordovician; 835: Trenton Formation, Herkimer Co., New York; 837: Kentucky; 846: "probably Kentucky or Cincinnati region".
Lloydia parva Howell
Howell, 1951, p. 263, pl. 1, fig. 3, 4.
Holotype; 825 (fig. 3), 826 (fig. 4), 827; Cambrian, Levis Conglomerate (Cambrian pebble in Ordovician conglomerate); Point Levis, Quebec, Canada.
Loganellus macropleurus Rasetti
Howell, 1951, p. 263, pl. 1, fig. 2.
Hypotype; 824; Cambrian, Levis Conglomerate (Cambrian pebble in Ordovician conglomerate); Point Levis, Quebec, Canada.
Odontopleura jenkinsi Etheridge and Mitchell
Howell, 1951, p. 304, pl. 12, fig. 4.
Hypotype; 898; Silurian, Bowning Series; "presumably" Bowning railway station yard, Bowning Village, County Harden, New South Wales, Australia.
Odonotopleura rattei Etheridge and Mitchell
Howell, 1951, p. 304, pl. 12, fig. 3.
Hypotype; 897; Silurian, Bowning Series; Bowning Village, County Harden, New South Wales, Australia.
Ogygites canadensis (Chapman)
Howell, 1951, p. 265, pl. 1, fig. 8, pl. 2, fig. 1, 2.
Hypotype; 831 (fig. 8), 833 (fig. 1), 834 (fig. 2); Ordovician, Collingwood Formation; Georgian Bay, Ontario, Canada.
Phacops cacapona Hall
Howell, 1951, p. 288, pl. 9, fig. 2-4.
Hypotype; 879; Devonian ?, Hamilton Group ?; Capon Springs, West Virginia.
Phacops crossleii Etheridge and Mitchell
Howell, 1951, p. 307, pl. 13, fig. 3-4.
Hypotype; 902 (fig. 3), 903 (fig. 4); Silurian, Bowning Series; Bowning Village, County Harden, New South Wales, Australia.
Phacops hudsonica Hall
Howell, 1951, p. 288, pl. 9, fig. 5, pl. 10, fig. 1.
Hypotype; 880; Devonian; western Tennessee.
Phacops rana (Green)
Howell, 1951, p. 288, pl. 9, fig. 1.
Hypotype; 878; Devonian, Hamilton Group; London, Ontario, Canada.
Phacops serratus Foerste
Howell, 1951, p. 307, pl. 12, fig. 5.
Hypotype; 899; Silurian, Bowning Series; near the railway station, Bowning, County Harden, New South Wales, Australia.
Phillipsia insignis Winchell
Howell, 1951, p. 275, pl. 5, fig. 9.
Hypotype; 853; Mississippian, ?Burlington Limestone; Curryville, Missouri.
Phillipsia major Shumard
Howell, 1951, p. 275, pl. 6, fig. 2, 3.
Hypotype; 855 (fig. 2), 856 (fig. 3); Pennsylvanian; Kansas City, Missouri.
Phillipsia sampsoni Vogdes
Howell, 1951, p. 276, pl. 6, fig. 4.
Hypotype; 857; Mississippian, Chouteau Formation; Banks, Pettis Co., Missouri.
Phillipsia stevensoni Meek
Howell, 1951, p. 276, pl. 6, fig. 5.
Hypotype; 858; Mississippian, Chester Group; Monongalia Co., West Virginia.
Proetus, Species undetermined
Howell, 1951, p. 270, pl. 5, fig. 2.
Hypotype; 848; Silurian; Taylor's Ridge near Catoosa Station, Catoosa Co., Georgia.
Proetus bairdensis Wheeler
(Wheeler, 1935, p. 49, pl. 6, fig. 1-3).
Plastoholotype; 390 (fig. 1, 3); plastoparatype; 339 (fig. 1, 2); Pennsylvanian?, Baird Formation;

Redding Quadrangle, Shasta Co., Calif.
Howell, 1951, p. 272, pl. 5, fig. 6.
Hypotype; 851; Pennsylvanian?, Baird Formation; Redding Quadrangle, Shasta Co., Calif.

Proetus crassimarginatus (Hall)
Howell, 1951, p. 271, pl. 5, fig. 3.
Hypotype; 849; Devonian, Onondaga Formation; Kelly Island, Lake Erie.

Proetus doris Hall
Hall, 1860, p. 112.
Plastosyntype; 845; Carboniferous, Goniatite Limestone; Rockford, Indiana.
Howell, 1951, p. 271, pl. 3, fig. 8, 9.
Plastohypotype; 844 (fig. 8); plastosyntype; 845 (fig. 9); Carboniferous, Goniatite Limestone; Rockford, Indiana.

Proetus haldemani Hall
Howell, 1951, p. 272, pl. 5, fig. 4, 5.
Hypotype; 850; Devonian, Hamilton Formation; Judd's Falls, on the road betwen Cherry Valley and Sharon Springs, New York.

Proetus parviusculus Hall
Howell, 1951, p. 270, pl. 1, fig. 9, 10.
Hypotype; 832; Ordovician, Corryville Formation; Cincinnati, Ohio.

Proetus rattei Etheridge and Mitchell
Howell, 1951, p. 303, pl. 11, fig. 5.
Hypotype; 894; Silurian, Bowning Series; Bowning, County Harden, New South Wales, Australia.

Richardsonella unisulcata Rasetti
Howell, 1951, p. 263, pl. 1, fig. 1.
Hypotype; 823; Cambrian, Levis Conglomerate (Cambrian pebble in Ordovician conglomerate); Point Levis, Quebec, Canada.

Scutellum bowningense (Etheridge and Mitchell)
Howell, 1951, p. 301, pl. 10, fig. 7.
Hypotype; 888; Silurian, Bowning Series; Bowning Creek, County Harden, New South Wales, Australia.

Scutellum jenkinsi (Etheridge and Mitchell)
Howell, 1951, p. 302, pl. 10, fig. 8; pl. 11, fig. 1-3.
Hypotype; 889 (fig. 8), 890 (fig. 1), 891 (fig. 2), 892 (fig. 3); Silurian, Bowning Series; Bowning Creek, County Harden, New South Wales, Australia.

Scutellum longispinifex (Mitchell)
Howell, 1951, p. 302, pl. 11, fig. 4.
Hypotype; 893; Silurian, Bowning Series; Bowning, County Harden, New South Wales, Australia.

Scutellum partschi (Barrande)
Howell, 1951, p. 293, pl. 10, fig. 5, 6.
Hypotype; 886 (fig. 5), 887 (fig. 6); Silurian; Lochkow, Bohemia.

Vogdesia vigilans (Meek and Worthen)
Howell, 1951, p. 267, pl. 2, fig. 4.
Hypotype; 836; Silurian, Maquoketa Formation; Fayette County, Iowa.

Arachnida

Calcitro fisheri Petrunkevitch
Petrunkevitch, 1945, p. 323, pl. 1, right fig.; text-fig. 6.
Paratype; 1137; Middle Cenozoic or younger; Bonner Quarry, north side of Black Mesa, about 10 miles southwest of Ashfork, Yavapai Co., Arizona.

Crustacea

Actinocythereis allisoni Holden
Holden, 1964, p. 418, text-fig. 22a, 22b.
Holotype; 1004 (fig. 22a); paratype; 1005 (fig. 22b); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Amphicytherura iniqua Holden
Holden, 1964, p. 414, text-fig. 19a, 19c, 19e-19g.
Holotype; 994 (fig. 19a); paratype; 995 (fig. 19c); 996 (fig. 19e, 19f); 997a (fig. 19g); 997b; Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Argilloecia constricta Holden
Holden, 1964, p. 403, text-fig. 9a-9c.
Holotype; 971; Cretaceous Rosario Formation; near Carlsbad, San Diego Co., Calif.

Bairdoppilata cretacea Holden
Holden, 1964, p. 400, text-fig. 7a-7c, 7f-7i
Holotype; 965 (fig. 7a-7c); paratype; 966 (fig. 7f), 967 (fig. 7g), 968 (fig. 7h), 969 (fig. 7i); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Brachycythere darensis Swain
Holden, 1964, p. 405, text-fig. 11a-11c, 11e.
Hypotype; 973 (fig. 11a); 974 (fig. 11b); 975 (fig. 11c); 976 (fig. 11e); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Callianassa stephensi Rathbun
Rathbun, 1926, p. 122.
Paratype; 920-925; Pleistocene; Spanish Bight, San Diego, San Diego Co., Calif.

Cancer branneri Rathbun
Rathbun, 1926, p. 63.
Paratype; 915; Pleistocene; San Pedro, Los Angeles Co., Calif.

Cythereis brooksi Holden
Holden, 1964, p. 419, text-fig. 23a-23c.
Holotype; 1006 (fig. 23a, 23b); paratype; 1007 (fig. 23c); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Cytherella elliotti Holden
Holden, 1964, p. 397, text-fig. 4b, 4c.
Holotype; 958; Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Cytherella terminopunctata Holden
Holden, 1964, p. 396, text-fig. 3a, 3c, 3d.
Holotype; 955 (fig. 3c); paratype; 956 (fig. 3a); 957 (fig. 3d); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Cytherelloidea directiangula Holden
Holden, 1964, p. 399, text-fig. 6a-6e.
Holotype; 963 (fig. 6a-6c); paratype; 964 (fig. 6d, 6e); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Cytherelloidea milowi Holden
Holden, 1964, p. 398, text-fig. 5a-5e.
Holotype; 959 (fig. 5a); paratype; 960 (fig. 5b); 961 (fig. 5c); 962a (fig. 5d); 962b (fig. 5e); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Cytheropteron coryelli carlsbadensis Holden
Holden, 1964, p. 409, text-fig. 14a-14e.
Holotype; 981 (fig. 14a, 14c, 14d); paratype; 982 (fig. 14b); 983 (fig. 14e); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Cytherura (?) *divaricata* Holden
Holden, 1964, p. 407, text-fig. 13a, 13b, 13e.
Holotype; 978 (fig. 13a); paratype; 979 (fig. 13b); 980 (fig. 13e); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Eocytheropteron turgidulum Holden
Holden, 1964, p. 410, text-fig. 15a-15c.
Holotype; 984; Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Eucytherura planolata Holden
Holden, 1964, p. 412, text-fig. 17a-17c.
Holotype; 988 (fig. 17a, 17b); paratype; 989 (fig. 17c); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Eucytherura spinata Holden
Holden, 1964, p. 413, text-fig. 18a-18e.
Holotype; 990 (fig. 18a, 18b); paratype; 991 (fig. 18c); 992 (fig. 18d); 993 (fig. 18e); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Eucytherura versabilis Holden
Holden, 1964, p. 410, text-fig. 16b-16e.
Holotype; 985 (fig. 16b); paratype; 986 (fig. 16c); 987 (fig. 16d, 16e); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Idiocythere triebeli Holden
Holden, 1964, p. 422, text-fig. 25a-25c.
Holotype; 1012 (fig. 25a, 25b); paratype; 1013 (fig. 25c); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Isocythereis carlsbadensis Holden
Holden, 1964, p. 423, text-fig. 26a-26f.
Holotype; 1014 (fig. 26a-26c); paratype; 1015 (fig. 26d-26f); 1016; Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Krithe cushmani carlsbadensis Holden
Holden, 1964, p. 406, text-fig. 12a-12c.
Holotype; 977; Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Neocythere (*Physocythere*) *fornicata* Holden
Holden, 1964, p. 404, text-fig. 10a-10e.
Holotype; 972 (fig. 10a-10c); paratype; 1066 (fig. 10d); 1067 (fig. 10e); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Paijenborchella pseudotrigona Holden
Holden, 1964, p. 415, text-fig. 20a, 20b, 20d, 20e.
Holotype; 998 (fig. 20a, 20b); paratype; 999 (fig. 20d); 1000 (fig. 20e); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Paracypris fragilis Holden
Holden, 1964, p. 402, text-fig. 8a.
Holotype; 970; Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Platycosta oena Holden
Holden, 1964, p. 421, text-fig. 24d-24g.
Holotype; 1008 (fig. 24g); paratype; 1009; 1010 (fig. 24d); 1011 (fig. 24e, 24f); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Randallia pleistocenica Rathbun
Rathbun, 1926, p. 77.
Paratype; 916-919; Pleistocene; San Pedro, Los Angeles Co., Calif.

Trachyleberis acuminata Holden
Holden, 1964, p. 416, text-fig. 21a-21d.
Holotype; 1001 (fig. 21a); paratype; 1002 (fig. 21b); 1003 (fig. 21c, 21d); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Unidentified ostracod
Holden, 1964, p. 426, text-fig. 28a-28b.
Hypotype; 1023 (fig. 28a); 1024 (fig. 28b); Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

Xestoleberis minuta Holden
Holden, 1964, p. 425, text-fig. 27a-27c.
Holotype; 1017a (fig. 27a, 27c); 1017b (fig. 27b); paratype; 1018-1022; Cretaceous, Rosario Formation; near Carlsbad, San Diego Co., Calif.

ECHINODERMATA

Cidaris sp.
Grant and Hertlein, 1938, p. 7.
Hypotype; 351; Pliocene, San Diego Formation; Pacific Beach, San Diego, San Diego Co., Calif.
See: *Hesperocidaris perplexa* H. L. Clark

Dendraster casseli Grant and Hertlein
Grant and Hertlein, 1938, p. 81.
Paratype; 30; Pliocene; about 6 miles slightly north of west of Newhall, Los Angeles Co., Calif.
Emerson and Hertlein, 1964, p. 365, fig. 5a-5c.
Hypotype; 814 (5a), 815 (5b), 816 (5c); Pliocene; Isla San José, Baja California, Mexico.

Dendraster cf. *D. granti* Durham
Emerson and Hertlein, 1964, p. 365, fig. 5f.
Hypotype; 817; Pliocene; Isla San José, Baja California, Mexico.

Dendraster vizcainoensis Grant and Hertlein
Grant and Hertlein, 1938, p. 90, pl. 8, fig. 1-3.
Holotype; 881; Pleistocene; Punta Santa Rosalia, Bahía de Sebastian Vizcaino, Baja California, Mexico.

Encope californica Verrill
Emerson and Hertlein, 1964, p. 365, fig. 6a-6e.
Hypotype; 819 (6a-6c); 820 (6d-6e); Pleistocene; Isla Monserrate, Baja California, Mexico.

Encope grandis L. Agassiz
Emerson and Hertlein, 1964, fig. 6f-6i.
Hypotype; 821 (6f), 822 (6g-6i); Pleistocene; Isla Monserrate, Baja California, Mexico.

Encope tenuis Kew
Hertlein and Grant, 1960, p. 126, pl. 25, fig. 4.
Hypotype; 352; Pliocene, San Diego Formation; 31st St. and Logan Ave., San Diego, San Diego Co., Calif.

Hesperocidaris perplexa H. L. Clark
Hertlein and Grant, 1960, p. 105, pl. 24, fig. 12.
Hypotype; 351; Pliocene, San Diego Formation; Pacific Beach, San Diego, San Diego Co., Calif.
See: *Cidaris* sp.

Megapetalus lovenioides Clark
(Clark, 1929, p. 260, pl. 31, fig. 1-6).
Plastoholotype; 72, 730, 31; Miocene; divide between Sulphur and Coche canyons, Ventura Co., Calif.

Merriamaster cf. *M. israelskyi* E. K. Jordan and Hertlein
Hertlein and Grant, 1960, p. 122, pl. 23, fig. 10.
Hypotype; 350; Pliocene, San Diego Formation; Cabrillo Canyon, Balboa Park, San Diego, San Diego Co., Calif.

Oligopygus putnami Israelsky
(Israelsky, 1933, p. 275, pl. 18, fig. 1, 2, 4).
Plastosyntype; 422 (fig. 1), 423 (fig. 2), 424 (fig. 4); Eocene; 12 kilometers northeast of Abasola, Tamaulipas, Mexico.

Scutaster vaquerosensis var. *kewi* Loel and Corey
Loel and Corey, 1932, p. 180.
Paratype; 774; Miocene, Vaqueros Formation; west side of Grimes Canyon, about one mile from the mouth, Ventura Co., Calif.

Spatangus tapinus Schenck
Schenck, 1928, p. 198, pl. 24, fig. 1, 3, 4.
Holotype; 52; Eocene, Tejon Formation; Timber Canyon, Ventura Co., Calif.

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SPECIES INDEX

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME 14, No. 10, pp. 133-136 JUNE 10, 1966

LIFE HISTORY OF *PHILOTES MOHAVE* (LEPIDOPTERA: LYCAENINAE)

BY

JOHN ADAMS COMSTOCK

Del Mar, California

Very little has been recorded of the life histories, ranges and host plants of the species and subspecies of the *Philotes battoides* and *P. enoptes* complex.

Philotes mohave was described by Frank E. Watson and William P. Comstock (1920). McDunnough (1938) listed *mohave* as well as *ancilla* and *dammersi* as subspecies of *Philotes enoptes*. Mattoni (1954) listed *mohave* as a separate species.

The range of *Philotes mohave* is given by Mattoni: "California; Colorado and Central Mohave deserts." Specific localities are south of Walker Pass, (April 26-30); Pinyon Crest Junction, Palms to Pines Highway, (elevation 3400 ft.); Juniper Hills, Mohave Desert, Los Angeles County, (elevation 3700 ft., May 3); southwest of Lucerne Valley, San Bernardino County.

From these scanty references in the literature, and the generous assistance of cooperators, records can be made of some of the essentials of the metamorphosis of this rare lepidopteron. Examples of various immature stages of *Philotes mohave* have been provided by Fred Thorne and Christopher Henne, and host plant records were determined by Dr. Reid Moran, Botanist of the San Diego Museum of Natural History.

Egg (fig. 1A).—Diameter, 0.50 mm.; height, 0.25 mm.; form, echinoid, the top deeply depressed with a minute micropyle in the center; color, ivory white.

The surface is covered with a reticulation of small pits, surrounded by raised walls running diagonally upward from the flattened base to the micropyle. It is similar to the egg of *Philotes enoptes dammersi*, recently described by Comstock and Henne (1965).

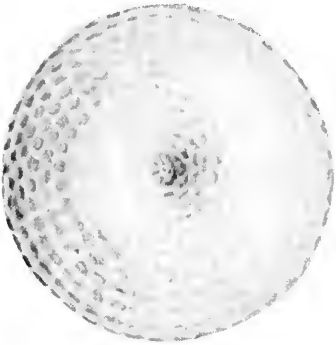
First Instar Larva.—Length, 4 mm.; head measurements not recorded; head very small in comparison with body segments and retracted most of the time. Color of head, jet black.

First body segment, relatively long. Second to ninth segments topped by transverse protruding ridges, cleft in the center by a depressed longitudinal middorsal line which is deep pink in contrast to the yellow-green body color. The protruding ridges are covered by minute yellow nodules. On the remainder of the dorsal and ventral surfaces these nodules are predominantly black. A few are prolonged into short white setae.

Legs, black. Prolegs and ventral surface, yellow-green.

Second Instar (fig. 1B).—Length, 5 mm.; width through center of body, 1.5 mm. Head width, 0.45 mm. (partially retracted); head jet black.

Body robust, and thrown into conspicuous segmental folds. The first segment is larger longitudinally than any other segment. Ground color, yellow. A depressed dark red middorsal line is widest on the second segment, and narrows progressively as it approaches the cauda. Legs, dark. Prolegs, yellow. Under magnification the body is seen to be covered with minute raised nodules, some of which are black. There are numerous short white setae.



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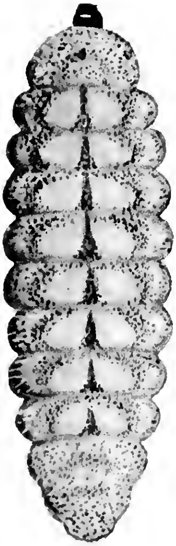

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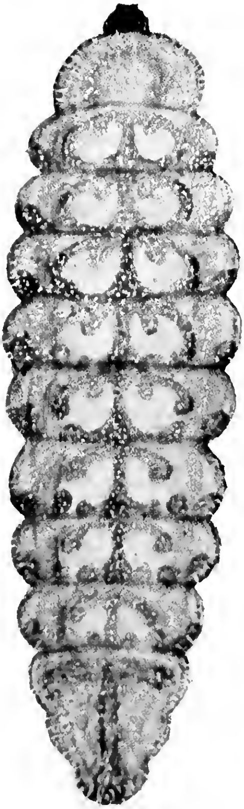

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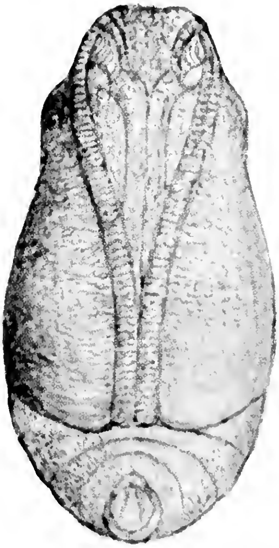

D

Final Instar (fig. 1C). — Length, 11 mm. Head, jet black (no head measurements were taken). The shape corresponds to the earlier instars, but the color is very different.

Body ground color, yellow, heavily overlaid with bars, dashes and spots of deep rose, arranged in regular patterns. The illustration shows the most heavily marked of three specimens. The small black nodules noted in prior instars have been replaced by a heavy vestiture of minute white setae. The venter is pale yellow, as are also the legs and prolegs.

Prior to pupation the larva loses all of its deep rose color and markings, and becomes a uniform deep yellow. Pupation of the first example occurred May 19, 1964, on the floor of the rearing cage.

The larval food plant is *Eriogonum pusillum* Torrey and Gray.

Pupa (fig. 1D). — Length, 6.3 mm.; greatest width, 3.5 mm. Form robust, head and cauda evenly rounded, antennae extending to margin of wing cases. There are no protrusions at the cremasteric end. The entire body is delicately ridged or flecked with fine striations and punctae, running predominantly in a transverse direction, and hardly discernible without a lens.

Color, brown, with a slight yellow tinge on the abdominal segments.

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Fig. 1. Early stages of *Philotes mohave.*

A. Egg, superior surface, × 88. B. Larva, second instar, dorsal surface, × 14. C. Mature larva, × 9½. D. Pupa, ventral aspect, × 12. Reproduced from a colored drawing by the author.

TRANSACTIONS

OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME 14, NO. 11, pp. 137-156

BIOGEOGRAPHY AND DISTRIBUTION OF THE REPTILES AND AMPHIBIANS ON ISLANDS IN THE GULF OF CALIFORNIA, MEXICO

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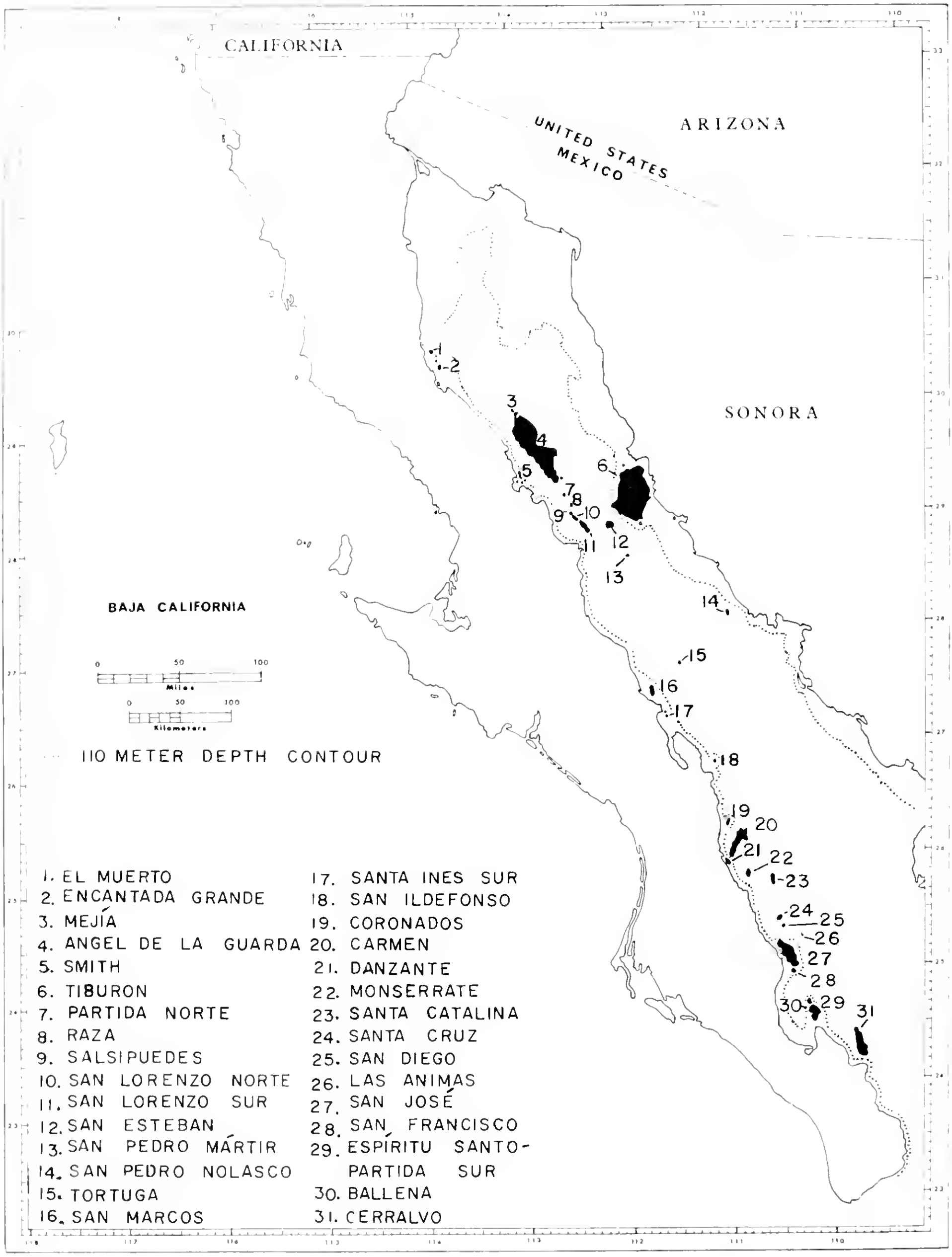

Fig. 1. Islands in the Gulf of California referred to in this report.

BIOGEOGRAPHY AND DISTRIBUTION OF THE REPTILES AND AMPHIBIANS ON ISLANDS IN THE GULF OF CALIFORNIA, MEXICO

BY

MICHAEL SOULÉ AND ALLAN J. SLOAN

Introduction

The first comprehensive analysis of the herpetofauna of the islands in the Gulf of California was that by Schmidt (1922); in his report of the results of the 1911 "Albatross" expedition, 54 records of island reptiles are given. In 1921 most of the islands were visited by the California Academy of Sciences' "Silvergate" expedition under the leadership of Joseph Slevin. Van Denburgh's (1922) tabulation of 127 records from the Gulf islands includes the material collected by the "Silvergate" personnel. Cliff (1954a) studied the Gulf island herpetofauna and published on the snakes (1954b). At that time the total known reptile fauna amounted to some 200 insular populations. Since then about 50 new records have accumulated. Responsible for the acquisition of much of this new material was the Belvedere expedition to the Gulf in the spring of 1962. Lindsay (1962) provided an account of the Belvedere expedition in which he mentioned many of the new records which are formally presented here.

Many persons and institutions have made important contributions to this project. Charles E. Shaw, of the Zoological Society of San Diego, and the senior author were responsible for the collection of reptiles obtained on the Belvedere expedition, although all the biologists contributed. Permits to collect reptiles in the Republic of Mexico were granted by the late Luis Macias Arellano, and Rodolfo Hernandez Corzo, Dirección General de Caza, Departamento de Conservación de la Fauna Silvestre. Field work has been supported by grants from the Belvedere Scientific Fund and the National Science Foundation (G-14426, GB-2317), and donations from Richard M. Adcock, Richard F. Dwyer, and Roy E. Marquardt.

Basis for Taxonomic Decisions. — Many of the Gulf populations are known by two or more names. The majority of these taxonomic uncertainties stem from differences of opinion as to whether a population deserves specific or subspecific recognition. Where decisions as to specific or subspecific rank of insular populations have been necessary, we have in general followed the suggestion of Mayr (1942:121): "If we examine the 'good' species of a certain locality we find that the reproductive gap is associated with a certain degree of morphological difference. If we find a new group of individuals at a different locality, we use the scale of differences between the species of the familiar area to help us in determining whether the new form is a different species or not. These scales of differences are empirically reached and differ in every family and genus."

Comments on Distribution Table.—The distribution of reptiles and amphibians on islands in the Gulf of California is shown in table 1. The table includes 15 new records reported in this paper (see below). The islands are arranged approximately from north (left side of table) to south. Several very small islands close to the mainland on either side of the Gulf, as those in Bahías de los Angeles, Concepción, and Kino, and near Mazatlán, are not listed. Several very small satellite islands from which only one or two lizards are known are also omitted. References for the table are: Banks and Farmer, 1963; Banta and Leviton, 1963; Cliff, 1954a, 1954b, 1958; Crippen, 1962; Dickerson, 1919; Dixon, 1964; Etheridge, 1961; Figg-Hoblyn and Banta, 1957; Klauber, 1956, 1963; Lowe and Norris, 1955; Savage and Cliff, 1954; Schmidt, 1922; Shaw, 1945; Smith and Taylor, 1945, 1950; Soulé, 1961 and in preparation; Van Denburgh, 1922; Zweifel and Norris, 1955. The location of the islands is shown in figure 1.

New Records of Snakes

This section contains data on a number of snakes which appear to represent new Gulf island records. Except as noted, the specimens referred to are in the collection of the San Diego Society of Natural History (SDSNH).

TABLE 1

Distribution of reptiles and amphibians on islands in the Gulf of California.

C = mainland form; R = subspecies endemic to this, or to this and nearby island(s); S = species endemic to this, or to this and nearby island(s).

	El Muerto	Encantada Grande	Mejía	Angel de la Guarda	Smith	Tiburon	Partida Norte	Raza	Salsipuedes	San Lorenzo Norte	San Lorenzo Sur	San Esteban	San Pedro Mártir	San Pedro Nolasco	Tortuga	San Marcos	Santa Inés (Sur)	San Ildefonso	Coronados	Carmen	Danzante	Monserrate	Santa Catalina	Santa Cruz	San Diego	Las Animas	San José	San Francisco	Espiritu Santo-Partida	Ballena	Cerralvo
Area in square kilometers	0.9	7	3.5	632	4.5	1212	2.1	1.1	1.8	8.5	44.5	43	1.8	3.2	6.3	31.5	<.5	2.6	8.5	151	4.9	19.4	43	11.6	1.3	<.5	194	2.6	99	<.5	163
Maximum altitude in meters	192	223	262	1316	465	1218	122	31	114	200	485	431	320	326	309	271	9	117	283	479	106	223	470	457	220	27	633	210	576	69	767
Species of native land mammals[1]	1	—	2	3	—	12	—	—	1	2	2	2	1	1	1	2	—	—	3	4	2	2	1	1	1	—	7	2	6	—	2
Coleonyx variegatus peninsularis																											C				
Coleonyx variegatus slevini																R	R														
Coleonyx variegatus sonoriensis						C																									
Phyllodactylus homolepidurus nolascoensis														R																	
Phyllodactylus unctus[2]																													C	C	C
Phyllodactylus xanti ssp.[3]				C		C	C	C	C	C	C	C				C		C	C	C	C	C	C	C	C	C	C	C			
Callisaurus draconoides carmenensis																C	C		C	C							C	C			
Callisaurus draconoides draconoides																													C		C
Callisaurus draconoides inusitatus						C																									
Callisaurus draconoides rhodostictus		C																													
Callisaurus draconoides splendidus				R																											
Crotaphytus collaris dickersonae						C																									
Crotaphytus collaris insularis				R																											
Crotaphytus wislizeni wislizeni						C																									
Ctenosaura hemilopha conspicuosa[6]												R																			
Ctenosaura hemilopha hemilopha														C																	
Ctenosaura hemilopha insulana																															R

Dipsosaurus dorsalis catalinensis																							R								
Dipsosaurus dorsalis dorsalis		C		C												C															
Dipsosaurus dorsalis lucasensis																			C	C		C					C		C		C
Petrosaurus mearnsi mearnsi	C																														
Petrosaurus mearnsi slevini			R	R																											
Petrosaurus thalassinus																					C								C		
Phrynosoma solare						C																									
Sator angustus																								S	S						
Sator grandaevus																															S
Sauromalus ater ater																								R	R		R	R	R		
Sauromalus ater klauberi																							R								
Sauromalus ater shawi																R															
Sauromalus hispidus[7]			S	S	S					S	S																				
Sauromalus obesus townsendi						C																									
Sauromalus slevini																			S	S		S									
Sauromalus varius[8]												S																			
Sceloporus clarki clarki						C								C																	
Sceloporus magister lineatulus																							R								
Sceloporus magister magister						C																									
Sceloporus magister monserratensis																				C		C					C				
Sceloporus magister zosteromus																													C		
Sceloporus orcutti licki																													C	C	
Sceloporus orcutti orcutti															C	C		C	C	C							C	C			
Urosaurus nigricaudus microscutatus																C			C	C	C					C	C	C			
Urosaurus nigricaudus nigricaudus[2]																													C	C	
Urosaurus ornatus schotti						C																									
Uta palmeri													S																		
Uta stansburiana sensu lato[9]	C		Ra	Ra	C	C	Ra	R	Rb	Rb	Rb	R		R	C	C		C	Rc	Rc	Rc	C	R				C	C	C	C	
Cnemidophorus ceralbensis																															S
Cnemidophorus hyperythrus danheimae																											R				
Cnemidophorus hyperythrus hyperythrus																C			C	C								C	C		
Cnemidophorus hyperythrus pictus																						R									
Cnemidophorus maximus[4]																													C		
Cnemidophorus tigris bacatus														R																	
Cnemidophorus tigris canus									R	R	R																				
Cnemidophorus tigris catalinensis																							R								

TABLE 1 (Continued)

	El Muerto	Encantada Grande	Mejía	Angel de la Guarda	Smith	Tiburon	Partida Norte	Raza	Salsipuedes	San Lorenzo Norte	San Lorenzo Sur	San Esteban	San Pedro Mártir	San Pedro Nolasco	Tortuga	San Marcos	Santa Inés (Sur)	San Ildefonso	Coronados	Carmen	Danzante	Monserrate	Santa Catalina	Santa Cruz	San Diego	Las Animas	San José	San Francisco	Espíritu Santo-Partida	Ballena	Cerralvo
Area in square kilometers	0.9	7	3.5	632	4.5	1212	2.1	1.1	1.8	8.5	44.5	43	1.8	3.2	6.3	31.5	< .5	2.6	8.5	151	4.9	19.4	43	11.6	1.3	< .5	194	2.6	99	< .5	163
Maximum altitude in meters	192	223	262	1316	465	1218	122	31	114	200	485	431	320	326	309	271	9	117	283	479	106	223	470	457	220	27	633	210	576	69	767
Species of native land mammals[1]	1	—	2	3	—	12	—	—	1	2	2	2	1	1	1	2	—	—	3	4	2	2	1	1	1	—	7	2	6	—	2
Cnemidophorus tigris celeripes																											R	R			
Cnemidophorus tigris dickersonae[5]				R	R		R																								
Cnemidophorus tigris estebanensis												R																			
Cnemidophorus tigris gracilis						C																									
Cnemidophorus tigris martyris													R																		
Cnemidophorus tigris rubidus																C			C	C	C										
Leptotyphlops humilis slevini																				C											C
Lichanura trivirgata gracia			C	C																											
Lichanura trivirgata trivirgata						C										C															
Chilomeniscus cinctus																C						C					C				
Chilomeniscus punctatissimus[4]																													S		
Chilomeniscus savagei																															S
Eridiphas slevini																															C
Hypsiglena ochrorhyncha ssp.																							R								
Hypsiglena ochrorhyncha gularis							R																								
Hypsiglena ochrorhyncha ochrorhyncha						C																					C	C	C		
Hypsiglena ochrorhyncha tortugaensis															R																
Hypsiglena ochrorhyncha venusta												C				C				C											
Lampropeltis getulus californiae				C					C	C												C									C
Lampropeltis getulus catalinensis																							R								

Masticophis bilineatus bilineatus						C																								
Masticophis bilineatus slevini												R																		
Masticophis flagellum piceus						C												C	C	C	C					C		C		C
Masticophis lateralis barbouri																												R		
Phyllorhynchus decurtatus arenicola																					R									
Phyllorhynchus decurtatus decurtatus																										C				
Phyllorhynchus decurtatus perkinsi				C																										
Pituophis melanoleucus affinis						C																								
Rhinocheilus lecontei lecontei																														C
Salvadora hexalepis hexalepis						C																								
Salvadora hexalepis klauberi																										C				
Sonora mosaueri																										C				
Tantilla planiceps																				C										
Trimorphodon lyrophanes																														C
Micruroides euryxanthus euryxanthus						C																								
Crotalus atrox[10]						C							C										C							
Crotalus catalinensis																						S								
Crotalus cerastes cercobombus						C																								
Crotalus enyo cerralvensis																														R
Crotalus enyo enyo																				C						C	C	C		
Crotalus mitchelli angelensis				R																										
Crotalus mitchelli mitchelli																				C	C					C		C		C
Crotalus mitchelli muertensis	R																													
Crotalus mitchelli pyrrhus					C																									
Crotalus molossus estebanensis												R																		
Crotalus molossus molossus						C																								
Crotalus ruber lucasensis																										C				
Crotalus ruber ruber[5]				C							C					C					C									
Crotalus tortugensis															S															
Gopherus agassizi						C																								
Bufo punctatus						C																						C		C
Scaphiopus couchi																												C		

[1] Excluding bats; information courtesy of Richard C. Banks. [2] Also occurs on Gallina. [3] Also occurs on Pond, Pelicáno, Cayo, and Coyote. [4] Questionable status. [5] Also occurs on Pond. [6] Also occurs on Lobos. [7] Also occurs on Granite and Pond. [8] Also occurs on Lobos (sight record), and Pelicáno. [9] Also occurs on Cholludo, Coloradito, Granite, Patos, Pelicáno, Las Galeras, and Coyote. Lower case letters indicate similar populations (Soulé, in prep.). [10] Also occurs on Turners.

Leptotyphlops humilis slevini Klauber. The single blind snake collected during the Belevedere expedition constitutes an addition to the herpetofauna of Isla Carmen. A female (SDSNH 44386) was found near Bahía Marquer by Charles E. Shaw and George E. Lindsay, April 4, 1962. The total length is 221 mm., the tail length, 8 mm. There are 14 scale rows at midbody, 14 subcaudals, 240 scales between the rostral and tail spine, and 12 scale rows around the tail. The first four median dorsal scales are nearly equal in size. The seven dorsal scale rows are medium brown.

This specimen is assigned to the subspecies *slevini* until additional specimens are available to determine the variation in this island population. Most characters are within the range of variation ascribed to this subspecies by Klauber (1940a:133). The number of dorsal scales is lower, and is very close to the mean number for *dugesi*. This specimen is darker than typical *slevini*, although not nearly as dark as coastal *humilis*.

The only previous report of worm snakes on Gulf islands is that by Banks and Farmer (1963) for Isla Cerralvo.

Lichanura trivirgata gracia Klauber. An adult female (SDSNH 51999) was collected by Howard E. Everette at Puerto Refugio, on the north end of Isla Angel de la Guarda, March 19, 1963. It was found about two hours after sundown.

This specimen has a total length of 724 mm., and a tail length of 90 mm. There are 235 ventrals, 49 subcaudals, and 41 scale rows at midbody. The three longitudinal stripes are orange-brown, and adhere closely to the edges of the limiting scales. Unlike typical specimens of this subspecies, which have drab ground color, the dorsal ground color is light to medium gray, and the stripes tend to be outlined in black. This black outline is particularly prominent on the lower edge of each lateral stripe, and is composed of a concentration of minute black spots on the inner edges of adjacent scales. This specimen is similar in coloration to one from six miles south of Socorro, in northern Baja California (considered a possible intergrade by Klauber, 1931a:312), and to recently collected material from the peninsula opposite the island.

The ovary of this snake contains eggs of three distinct size classes. Five eggs average 6.8 × 7.2 mm., six average 2.5 × 3.2 mm., and eight others are less than 1 mm. in greatest diameter.

The desert rosy boa was expected to occur on Isla Angel de la Guarda since a dried example was collected on nearby Isla Mejía by Joseph R. Slevin in 1921 (Van Denburgh, 1922:633).

Lichanura trivirgata trivirgata Cope. Two specimens of this subspecies were collected during the Belvedere expedition, and represent the first insular records of this subspecies.

An adult male (SDSNH 52898) was secured in Arroyo Sausal, on the southwest side of Isla Tiburon, March 20, 1962, by Charles F. Harbison. This snake is 678 mm. long, including the 84 mm. tail. There are 222 ventrals, 45 subcaudals, and 37 scale rows at midbody. The second specimen is also an adult male (SDSNH 44389), collected in Arroyo de los Chivos, on the northwest side of Isla San Marcos, March 29, 1962, by Richard C. Banks. The total length is 627 mm., the tail length, 79 mm. There are 217 ventrals, 41 subcaudals, and 39 scale rows at midbody.

Both specimens have the typical coloration and contrasting pattern (dark brown stripes on a cream colored background) of southern Baja California material; however, the San Marcos snake has exceptionally wide stripes.

Lampropeltis getulus californiae (Blainville). The California king snake is tentatively added to the faunas of three islands in the Gulf of California, Islas Angel de la Guarda, Salsipuedes, and San Lorenzo Norte, on the basis of one shed skin from each. The first (SDSNH 19989) was collected in Arroyo Estatón, on the west side of Isla Angel de la Guarda, by Chris Parrish, June 6, 1961. This shed skin is nearly complete, with only a few of the head scales and the tip of the tail missing. It has 248 ventrals, 61+ subcaudals, and 23 scale rows at midbody. The skin is 1480 mm. long.

The second shed skin (SDSNH 45150) was found by Soulé on Isla San Lorenzo Norte, March 24, 1962, and the third (SDSNH 45003) by Richard C. Banks on Isla Salsipuedes

October 23, 1964. Both are incomplete, and the identifications are questionable. However, the characters of smooth scales in 23 rows, paired scale pits, undivided anal, divided subcaudals, and an alternating dark and light pattern eliminated other kinds of snakes considered possible by us. No snakes have previously been reported from these two islands.

Two living specimens have recently been collected on Isla Monserrate. An immature male (SDSNH 44631) was found in sand dunes on the northeast side of the island by Sloan on the evening of April 28, 1964. The total length is 482 mm., and the tail length is 67 mm. It has 235 ventrals, 54 subcaudals, 25 scale rows at midbody, 7-7 supralabials, and 10-11 infralabials. There are 38 light rings on the body and eight on the tail. An immature female (SDSNH 44632) was collected at the north end of the island by Richard C. Banks on June 24, 1964. This snake has a total length of 452 mm , and tail length of 56 mm. It has 243 ventrals, 49 subcaudals, 25 scale rows at midbody, 7-7 supralabials, and 11-10 infralabials. There are 37 light rings on the body and eight on the tail. Both snakes have light rings 1-2 scales long which are separated by 4-6 dark scales. These specimens are very similar to those found on the desert slopes of San Diego County, California.

Phyllorhynchus decurtatus decurtatus (Cope). An immature male (SDSNH 44682) was collected in Arroyo de Aquada, on the northeast side of Isla San José, by George E. Lindsay on June 26, 1964. The total length of this snake is 230 mm., and the tail length is 30 mm. There are 153 ventrals, 33 subcaudals, and 19 scale rows at midbody. There are 23 dark blotches on the body and five on the tail. The blotches near the head are rectangular, those near the anus are square. Most of them are rounded diamonds, 3-4 scales (end to end) long, occupy 6-7 scale rows, and are separated by three scales (end to end).

Except for the low number of ventrals and the shape of the blotches, this specimen agrees with the description of *P. d. decurtatus* (as redefined by Klauber, 1940b:206), but it keys out to *P. d. norrisi* (Savage and Cliff, 1954:74). This snake is abnormal in having the first infralabial on the right side split transversely, and the frontal incompletely separated from the single scale occupying the prefontal area. This is the first insular record for this subspecies.

Phyllorhynchus decurtatus perkinsi Klauber. An immature female (SDSNH 52000) was collected on a sand dune at the northeast end of Isla Angel de la Guarda by Sloan, March 20, 1963. It was found about one hour after sundown among the exposed roots of *Atriplex polycarpa.* This is the first island record for this subspecies.

The total length of this snake is 263 mm., the tail length, 24 mm. It has 183 ventrals, 29 subcaudals, and 19 scale rows at midbody. There are 43 dark blotches on the body and four on the tail. The blotches near midbody are two scales (end to end) long and are separated by 2-3 scales (end to end). The length of the interspaces is less than in typical specimens of this subspecies (Klauber, 1935), and in this respect this snake is similar to a specimen of *P. d. decurtatus* from central Baja California reported by Murray (1955:45). The high ventral and blotch counts, however, indicate a close relationship to populations in northeastern Baja California and southeastern California rather than to those in southern Baja California.

Pituophis melanoleucus affinis Hallowell. An adult female (SDSNH 44387) was collected by Soulé at Bahía Aqua Dulce, on the north end of Isla Tiburon, March 18, 1962. This snake is 1555 mm. long, including the 175 mm. tail. There are 240 ventrals, 61 subcaudals, and 33 scale rows at midbody. There are 46 dark body blotches, and 11 tail blotches. The supralabials are 9-9 (the fifth enters the orbit on each side), and the infralabials are 14-14; there are two pre- and four postoculars on each side.

In meristic characters, and in general appearance, this specimen is readily assigned to the subspecies *affinis*, which occurs on the adjacent mainland of Sonora, Mexico. Some peculiarities, however, seem worthy of note. The anterior nasal on each side is divided transversely, and there are creases on several head scales including the frontal, rostral, some infralabials and genials. A single shortened, irregularly shaped scale occupies the parietal region. There are three loreals on each side; the lower one is very small and does not contact the nasal or preocular. There are two series of scales in the prefrontal area, an anterior row of four followed posteriorly by a row of three.

This appears to be the first definite Gulf record of a gopher snake; it is surprising that such a large diurnal snake could have escaped detection for so many years, but perhaps it is a recent immigrant.

Rhinocheilus lecontei lecontei Baird and Girard. An adult male was collected by Richard C. Banks and Soulé near the former Ruffo Ranch, on the southwest side of Isla Cerralvo, October 29, 1961. Due to misidentification, this specimen was reported as *Lampropeltis getulus conjuncta* (Banks and Farmer, 1963). The genus *Rhinocheilus* has not previously been reported from any Gulf island. Cerralvo is approximately 540 miles southwest of Cape Colnett, the southernmost record for the genus in Baja California considered reliable by Klauber (1941:300).

The total length of this snake is 1100 mm., including the 146 mm. tail. There are 210 ventrals, 53 subcaudals (the first 35 are entire), and 23 scale rows at midbody. There are 25 dark blotches on the body, and nine on the tail.

This specimen (Calif. Acad. Sci. 98095) is reported through the courtesy of A. E. Leviton.

Tantilla planiceps (Blainville). One of the more interesting discoveries made during the Belvedere expedition was the presence of a black-headed snake on Isla Carmen. The single female (SDSNH 44388) was collected near Bahía Marquer by Charles E. Shaw and George E. Lindsay, April 4, 1962. It is 284 mm. long including the 66 mm. tail. There are 179 ventrals, 65 subcaudals, and 15 scale rows at midbody. In preservative, the specimen is uniform brown posterior to the head, all scale rows being pigmented. The black head cap extends down approximately to the angle of the mouth. The light nuchal band is one scale wide, and is bordered behind by four small dark brown spots.

Crotalus atrox Baird and Girard. The discovery of two specimens on Isla Santa Cruz is a new insular record for this species. They were collected on the west side of this island by Reid Moran and Chris Parrish on April 18, 1962.

An adult male (SDSNH 44350) has a total length of 909 mm., a tail length of 70 mm., and a head length of 41 mm. It has 183 ventrals, 22 subcaudals, 25 scale rows at midbody, 16-15 supralabials, 16-16 infralabials, 39 body blotches, and four tail blotches. An adult female (SDSNH 44351) has a total length of 737 mm., a tail length of 48 mm., and a head length of 34 mm. It has 181 ventrals, 17 subcaudals, 25 scale rows at midbody, 15-15 supralabials, 18-18 infralabials, 31 body blotches and four tail blotches. Both have 12 scales bordering the proximal rattle segment, and 15 scale rows at the middle of the tail.

The male was heavily infested with the parasitic linguatulid *Porocephalus crotali*. These were present nearly the entire length of the respiratory tract, with one actually occluding the glottis. The majority, including females heavily laden with eggs, were found in the anterior portion of the lung, which was distended and nearly filled the body cavity. Only a few parasites were found in the posterior portion of the lung; these included an attached individual opposite ventral 104.

Cliff (1954b:80) reported the first specimen of *Crotalus atrox* from Isla San Pedro Mártir. Members of the Belvedere expedition collected six additional specimens on the east side of this island on March 21, 1962. Measurements and scale counts are summarized in table 2. Cliff mentioned the possibility of this being a dwarf population on the basis of the single individual. It is true that these additional specimens also have relatively shorter heads than mainland specimens, but in the absence of other differences the recognition of an insular subspecies is not warranted.

Crotalus catalinensis Cliff. Two specimens of this recently described species (Cliff, 1954b:80) were collected on Isla Santa Catalina by members of the Belvedere expedition. During 1964, 10 additional specimens were secured by various individuals. Data now being accumulated on this interesting rattlesnake will be published separately.

Crotalus enyo enyo (Cope). An immature male (SDSNH 44355) was collected at Los Ostiones, on the northwest side of Isla San José by Richard C. Banks and William K. Emerson, April 12, 1962. This subspecies had been known previously from Islas San Francisco, Carmen, and Espíritu Santo (including Partida portion) in the Gulf of California (Klauber, 1956:122).

TABLE 2

Measurements (in mm.) and scale counts for *Crotalus atrox* from Isla San Pedro Mártir

SDSNH Catalog Number	44344	44345	44346	44347	44348	44349
Sex	Male	Male	Male	Female	Male	Male
Total length	1410	911	1369	940	1390	1293
Tail length	104	73	101	59	107	108
Head length	48	35	48	36.5	51.5	45
Ventrals	182	182	183	185	182	185
Subcaudals	28	27	28	22	28	28
Scale rows	25	25	25	26	25	25
Supralabials	15-15	15-15	15-15	15-14	16-16	15-15
Infralabials	16-17	18-17	17-17	17-17	17-17	17-17
Scales bordering rattle	11	11	12	11	10	10
Scale rows at mid-tail	13	15	15	13	14	15

The total length of this snake is 659 mm.; the tail length is 69 mm. There are 174 ventrals, 27 subcaudals, 25 scale rows at midbody, and 13 scale rows at the middle of the tail. There are 13-13 supralabials, and 14-14 infralabials. The proximal rattle segment is black, and is bordered by 10 scales. There are 36 body blotches and six tail blotches.

This specimen seems to fall within the range of variation of the subspecies *enyo* as defined by Klauber (1931b:363) in meristic characters and coloration, but it lacks preciliary scales and the lower loreal is slightly larger than the upper on both sides. The presence of of this species was expected on Isla San José since it has been known to occur on nearby Isla San Francisco for many years.

Crotalus mitchelli mitchelli (Cope). An adult male (SDSNH 45002) was collected at the north end of Isla Monserrate by Richard C. Banks, June 24, 1964. The total length of this snake is 810 mm., and the tail is 60 mm.; the head is 29 mm. long (contained in the total length 27.9 times). There are 173 ventrals, 24 subcaudals, and 23 scale rows at midbody. There are 14-14 supralabials (the last conspicuously larger than the one preceding), and 15-15 infralabials. The body has 37 blotches, and the tail, five. Speckled rattlesnakes have not previously been reported from this island.

Klauber (1956:38, 122) listed *C. m. mitchelli* on Isla Santa Cruz. This appears to be an error, and Klauber (personal communication) advises us to delete this island from the range.

THE ENVIRONMENT

Climatic and Vegetational Patterns.—The Gulf of California is a roughly rectangular body of water about 1400 km. long and from about 100 km. to 200 km. wide. It lies between the peninsula of Baja California to the west and the mainland Mexican states of Sonora and Sinaloa to the east. Although geographically the Gulf is in the Temperate Zone, its marine biota is predominantly Panamic (eastern tropical Pacific), reflecting the isolation of the Gulf from the cool water and air masses of the northern Pacific. The marine inlet to the Gulf is at 23° North Latitude, 50 km. south of the Tropic of Cancer.

The almost complete encirclement by land imposes on the Gulf and its islands a climate like that of an inland body of water, marked by extreme seasonal variation in air and water temperatures. This is especially true at the northern end of the Gulf, as illustrated by the annual variation of the surface temperatures of its waters. At Puerto Peñasco in the north, the annual range is 16° C (14.9° C in January to 31.2° C in August); at Cabo San Lucas in the south, on the Pacific side, the annual range is about 9° C (19.8° C in January to 29.1° C in August) (Roden and Groves, 1959). Similarly, air temperature extremes are greater in the northern Gulf coast area than in the southern (Roden, 1958).

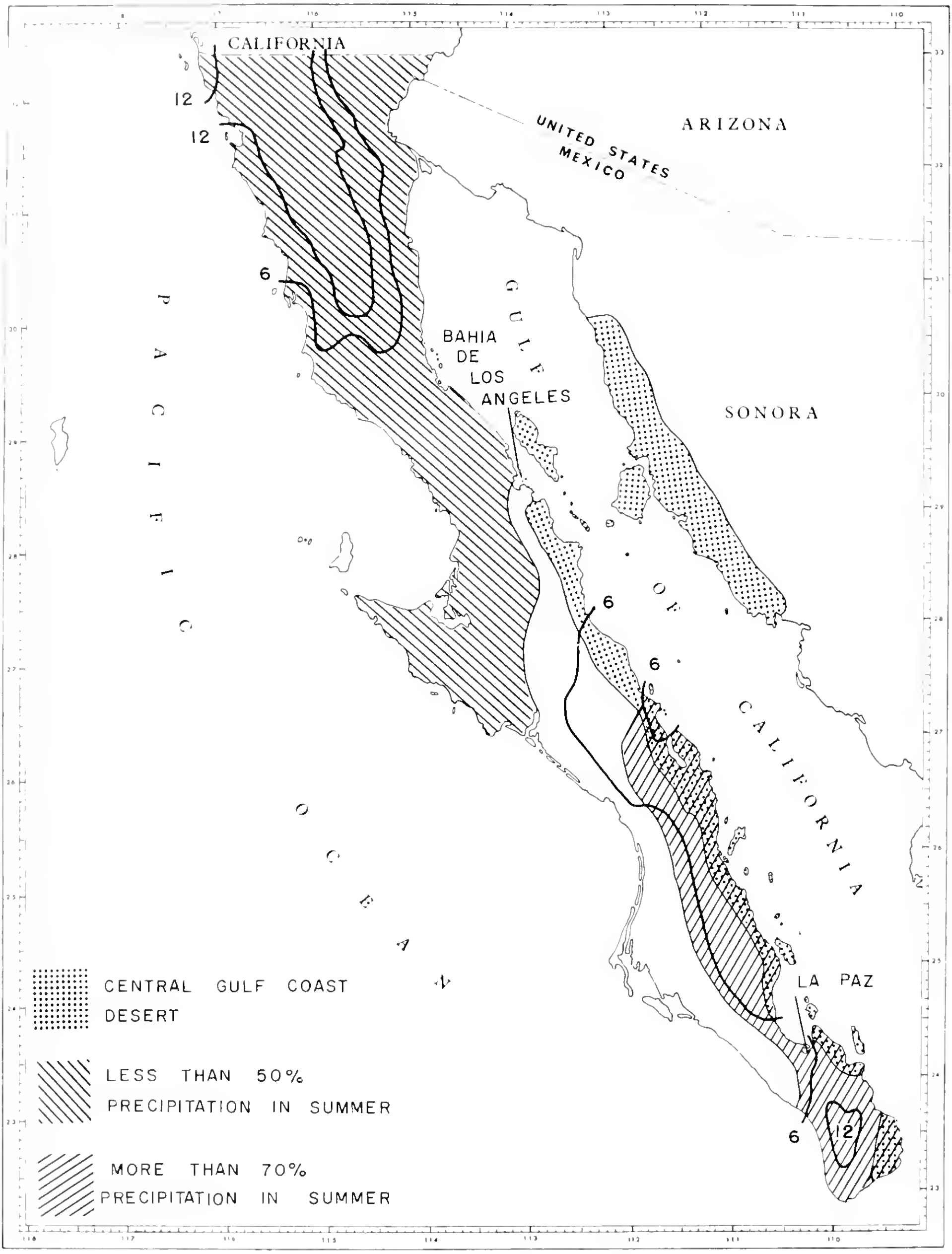

Fig. 2. Baja California and the Gulf of California. Precipitation belts are indicated by isoprecipitation lines. Numbers refer to inches of rainfall per year. (Adapted from Aschmann, 1959, and Shreve and Wiggins, 1964.)

The Gulf islands and the surrounding continental areas are extremely arid. Except for part of the Cape Region and the southernmost 400 km. of the mainland coast, the Gulf coast and adjacent areas lie entirely within the boundaries of the Sonoran Region of the North American Desert (Shreve and Wiggins, 1964). All but the southernmost parts of the Gulf probably receive less than seven inches of rain annually (fig. 2), although occasional hurricanes, known locally as "chubascos", may bring more than this amount within a few hours. At such times the typically dry arroyos become torrents.

The data pertaining to the rainfall pattern over the peninsula have been summarized by Aschmann (1959). He found that in the northern peninsular area to Bahía de los Angeles (29° N. Lat.), most of the precipitation is from Pacific cyclonic storms, and occurs in the winter. The actual amount of precipitation from these storms is slight, however, because this part of the Gulf coast is in the rain shadow of the lofty Sierra San Pedro Mártir and Sierra Juárez. Aschmann pointed out that most of the precipitation from the vicinity of Santa Rosalía (27° 20′ N. Lat.) southward is from convectional showers and chubascos and occurs in the summer (fig. 2). The central part of the peninsula lies between the northern winter storm belt and the southern summer storm belt. Few records are kept in this area, but it seems that some parts may receive less than three or four inches annually, and even this meager amount is not dependable. In fact, droughts lasting a year or longer have been reported.

With the exception of the Islas Las Encantadas group in the north, Shreve and Wiggins (1964) considered all of the Gulf islands studied here to be in the Central Gulf Coast subdivision of the Sonoran Desert (fig. 2). In emphasizing the vegetational uniformity of this region, Shreve states: "Throughout the two parts of this area [the central regions of both Gulf coasts] the vegetation is almost identical in physiognomy, and a large number of its component species are the same" (Shreve and Wiggins, 1964: 53). As in desert areas in general, vegetation is tallest and thickest in arroyos and at the bottoms of canyons. It is generally true that the larger the water course, the lusher the vegetation along its banks. Hillsides on some of the northern islands are completely barren of seed plants.

Shreve designated this desert the *Bursera-Jatropha* region because of the relative abundance of these thick-trunked, deciduous trees. Other common genera of shrubs and trees of the area are *Olneya*, *Cercidium*, *Fouquieria*, *Prosopis*, *Larrea*, *Viscainoa*, *Maytenus*, *Stegnosperma*, *Encelia*, *Lycium*, *Euphorbia*, *Atriplex*, *Franseria*, and *Fagonia*. In some areas cacti are very abundant and may be the dominant plants locally. The most common of the larger forms of cacti are *Pachycereus pringlei*, *Machaerocereus gummosus*, *Lophocereus schottii; Lemaireocereus thurberi*, cylindrical forms of *Opuntia*, and species of *Ferocactus*.

Granting the overall vegetational uniformity of the Central Gulf Coast and the adjacent islands, there are, nevertheless, two vegetational gradients associated with the seasonal differences in the amount and pattern of precipitation. First, the amount of rainfall increases from the central Gulf area to the southern Gulf area. This produces a denser and taller vegetational aspect, especially in the large arroyos, southward from about Isla San Marcos to Isla Cerralvo. A possible faunistic concomitant of this north-south precipitation gradient is the restriction of amphibians to the southernmost islands, Islas Espíritu Santo-Partida Sur and Cerralvo (table 1). Second, the farther south one goes in the Gulf, the more the precipitation tends to be restricted to the summer months. The result is a higher proportion of plants in the south whose germination and flowering depend on this periodicity of the tropical weather pattern.

Geological History. — Biogeographic analysis is facilitated if the area under study has had a relatively quiet and unspectacular geological history. Such is not the case with the Gulf and the adjacent peninsular region. Recent geological and oceanographic research has shown that the shoreline of the Gulf basin has long been a dynamic physiographic feature. Apparently there has been extensive tectonic activity in the region, at least since the mid-Cretaceous orogeny (Durham and Allison, 1960). For the present purpose, however, it is unnecessary to trace the geological developments occurring before the late Cenozoic since the biogeographic and evolutionary patterns found in the islands today are probably interpretable, in large part, as the result of Pleistocene events.

The most far-reaching Pleistocene events were the cyclic glaciations. Changes in the eustatic sea level associated with the advance and retreat of Pleistocene continental ice sheets must have repeatedly modified the shoreline of the Gulf, alternately creating and drowning islands. It is generally agreed by geologists that the water trapped in ice sheets during the last glaciation accounted for a drop in sea level of approximately 110 meters. These ice sheets began to recede about 17,000 years ago, the sea level having risen to its present level about 6,000 years ago (Fairbridge, 1960; Godwin, Suggete and Willis, 1958). This last eustatic rise inundated large parts of the coast and created many of the offshore islands in the Gulf. Eustatic fluctuations have probably not amounted to more than a foot or so for the last 4,000 years (Russell, 1963). If crustal movements are ignored, it is reasonable to assume that those islands separated from the mainland by less than 110 meters depth (fig. 1) are less than 17,000 years old.

This category of probable recent or young shallow-water islands includes Islas Tiburon, San Marcos, Coronados, San José, San Francisco, and Espíritu Santo, as well as many small coastal and satellite islands.

The apparent tectonic instability of the region around the islands of Carmen, Monserrate and Danzante precludes accurate dating of these islands at this time. This instability is strikingly shown by Pleistocene wave-cut terraces at elevations of 250 to 300 feet in the vicinity of Santa Rosalía and on Islas Carmen and Monserrate (Anderson, 1950; Wilson and Rocha, 1955). Edward C. Wilson (personal communication) found evidence for a recent uplift amounting to about 250 feet on Salsipuedes. Tectonic activity is further evidenced by faulting and warping of Pleistocene sediments along the western margin of the Gulf (Anderson, 1950) accompanying the elevation of this area (Durham and Allison, 1960). All in all, eustatic changes can serve only as a very rough approximation of island age.

Some recent oceanographic investigations suggest that the great amount of volcanism, tectonic mobility, and overall geological diversity of the Gulf area are probably related to its geographical coincidence with the crest of the East Pacific Rise. The crest disappears at the southern end of the Gulf, but the exceptionally high flow of heat through the crust, as well as the frequency of shallow earthquakes in the Gulf area, both characteristic of the crest, attest to its extension into the Gulf (Menard, 1960). In fact, Menard's description (1960:1745) of the topography near the crest could easily be a description of the submarine topography of the Gulf: ". . . it appears to consist of volcanoes, low domes, and troughs with adjacent tilted fault blocks trending at various angles to the crest of the rise." Shepard (1950) concluded that the coastal and submarine scarps, as well as the extensive system of basins in the Gulf, are the result of faulting, some of it rather recently.

Endemicity and its Biogeographical Correlates

Johnston (1924) found that less than one per cent of the plants on the islands in the Gulf were endemic, and Gentry (1949) remarked, "The most striking aspect of the island floras is the apparent lack of divergent evolution." The terrestrial vertebrates, however, present quite a different picture. Nearly all of the mammals have been considered taxonomically distinct from their closest mainland relatives. In general, the reptiles also show a high degree of differentiation, although the percentage of endemics (about 20 per cent) is much lower than that for mammals.

Any comparison of endemicity between plants and animals must be subjective. Nevertheless, the striking difference in the frequency of endemics seems worthy of comment. Two reasons are suggested for this difference. First, dispersal in plants is generally more efficient over short stretches of water; accordingly, the relatively high rates of gene flow from mainland populations of plants to island populations would impede differentiation. Peter H. Raven suggested the second reason in conversation. Edaphic and climatic factors are probably paramount in the evolution of most plant species; since the islands and adjacent mainland coasts are apparently very similar in soil type and climate, little evolutionary adjustment would be expected.

It is probable that the difference in evolutionary divergence between the mammals and the reptiles, as indicated by taxonomic designation, is explicable partly as a difference in the characters used by the taxonomists dealing with the respective groups. Mammalogists rely heavily upon coat color differences in making taxonomic decisions about races; in rodents, especially, coat color is usually correlated with the substrate color (Dice and Blossom, 1937). Substrate-matching is common in reptiles as well, but herpetologists often ignore color because of the metachromatic capacities of many reptiles, and because reptile colors fade or are altered by preservation.

Populations of reptiles often seem to react to insular environments in predictable ways. Among the most frequently observed of these evolutionary tendencies is gigantism and "melanism" in lizards, and dwarfism in snakes (Klauber, 1963; Mertens, 1934). Insular gigantism, here meaning a larger mean body size than typically found in mainland populations, occurs in a number of forms on the deep-water, distant islands. Two species of chuckwallas, *Sauromalus varius* on Isla San Esteban and *S. hispidus* on most of the islands in the Isla Angel de le Guarda-San Lorenzo chain are bigger than the mainland forms. The Cerralvo Island whiptail lizard, *Cnemidophorus ceralbensis*, seems to be a gigantic insular derivative of the orange-throated whiptail lizard, *C. hyperythrus*. One of us (Soulé, 1966) studied gigantism in the side-blotched lizards (*Uta stansburiana*, sensu lato) of the Gulf islands. The largest utas occur on Isla San Pedro Mártir and on the Islas San Lorenzos; *Uta* is the only sceloporine lizard on those islands. It was concluded that the presence of other sceloporine lizards somehow inhibits an evolutionary increase in body size, and that the level of inhibition is inversely proportional to the square root of the number of sympatric sceloporine species. The large speckled rattlesnake of Isla Angel de la Guarda, *Crotalus mitchelli angelensis*, is an exception to the typical tendency for dwarfism in insular rattlesnakes in the Gulf (Klauber, 1963).

Insular melanism, or more generally, a dark albedo relative to the color of continental forms, is characteristic of some of the same populations mentioned in the discussion of gigantism. The utas on Islas San Pedro Mártir, San Pedro Nolasco, San Lorenzos, and Salsipuedes are noticeably darker than those on shallow-water islands or on the mainland. Similarly, the whiptail lizards on Islas San Lorenzos, San Pedro Mártir, and San Pedro Nolasco are relatively dark. The chuckwalla, *Sauromalus hispidus*, that is endemic to the Salsipuedes archipelago[1], is uniformly dark brown or black when adult. The significance of insular "melanism" is not definitely known, although the high rate of heat transference provided by a dark albedo would seem to be advantageous to ectotherms (see Kramer, 1949; Mertens, 1952).

SPECIES-AREA RELATIONSHIP

Population biologists have recently paid increasing attention to the challenging question of species diversity. Quantitative models capable of predicting the number and the relative abundance of species in a given area (with varying degrees of success) have been proposed by a number of authors (MacArthur, 1957; MacArthur and Wilson, 1963; Preston, 1962; Hairston, 1959; Hamilton *et al.*, 1963). Some of these models are more or less a matter of curve-fitting, while others rest on a combination of curve-fitting and theoretical considerations. It is the purpose of this section to describe the species-area phenomenon as it pertains to the vertebrate fauna of the Gulf islands. This analysis must be considered preliminary since it is only semi-quantitative and since new records of snakes are still being reported rather frequently.

The positive relationship between the numbers of species and the areas of islands is shown for terrestrial vertebrates (excluding birds and bats) in figure 3. A notable feature of this figure is the relative paucity of species on the deepwater, distant (from the mainland) islands.

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[1] The occurrence of this and other deep-water island forms of chuckwallas on shallow-water islands adjacent to the peninsula, *e.g.*, on Islas Smith, Año Nuevo, Cabeza de Caballo, and Coronados, is very likely a reflection of the gustatory significance of these animals to the Indians that once occupied the region (see Aschmann, 1959).

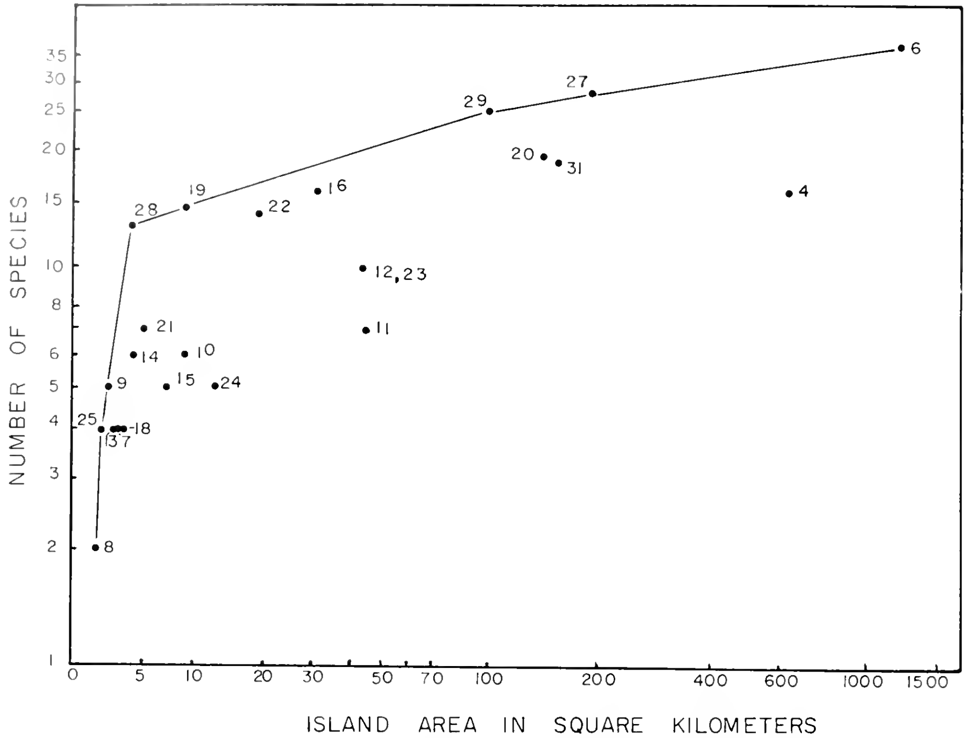

Fig. 3. Species-area relationship of terrestrial vertebrates (excluding bats and birds) on the major islands in the Gulf of California.

The line drawn through the upper points is a conservative "saturation curve" (see text). See fig. 2 for island-number key.

The curve drawn in this figure between the highest points (the greatest species abundance for their area) is a conservative estimate of the relationship between maximum species abundance and island area for terrestrial vertebrates in the Gulf.

MacArthur and Wilson (1963) have treated such data in an original way to demonstrate the "distance effect." Their method is applied to our data in figure 4; the abscissa represents the distance from the land mass that is the likeliest source of immigrants. The ordinate represents the percentage "saturation"; that is, the ratio of the number of species known on an island to an estimate of the maximum number of species possible (the curve in fig. 3). The obvious negative association is consistent with the findings of MacArthur and Wilson (1963) that the "equilibrium" number of species on an island is a function of its distance from the source of immigrants.

Recently, Preston (1962) has emphasized a most important point in distinguishing between the biotas of islands and of mainland areas. The biota of any mainland area is essentially a sample of the biota of a much larger region. Many of the species are represented by only a few individuals or by migrants and would not be expected to survive long if they were not periodically replenished from outside. On islands, replenishment is obviously less frequent than it is on most continental regions of equal size. As such, islands more closely approach the "correct" number of species for their areas. The view of MacArthur and Wilson is in general agreement with that of Preston, but emphasizes (1) the dynamic nature of the equilibrium—the actual equilibrium number for any island would be a biogeographical constant, but the species composition is constantly changing—and (2) the effect of distance from the source(s)

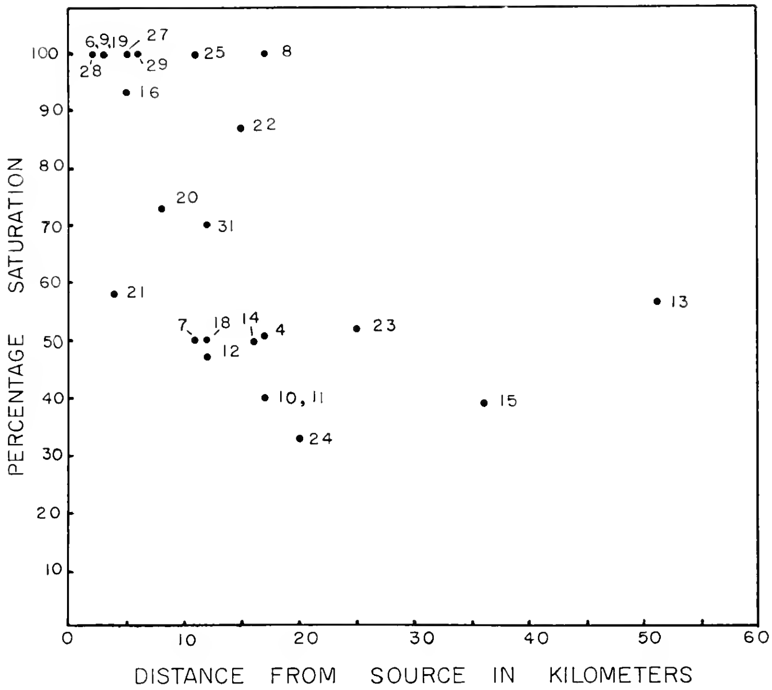

Fig. 4. Percentage saturation of terrestrial vertebrate faunas (excluding bats and birds) on major islands in the Gulf of California.

For Islas Partida Norte, San Esteban, San Diego, and San Francisco, the distance from the source is estimated from the nearest large island. For all other islands, the distance is measured from the mainland. See fig. 2 for island-number key.

of immigrants on the equilibrium number. Hamilton and Rubinoff (1963) demonstrate a distance effect relative to endemicity of Darwin's Finches on the Galápagos Islands.

Most quantitative studies of insular biogeography have concerned oceanic islands. During the colonization of such islands the equilibrium number of species is approached from below by the gradual accumulation of successful colonizers. In contrast, continental islands are formed with their biotas intact. At the time of isolation the biota of a continental island is a sample of the mainland biota and includes more species than would be predicted for a biotically equilibrated island of comparable size and distance from the source(s) of immigrants. For continental islands, the approach to the equilibrium number of species would be from above, *i.e.*, extinction will proceed at a greater rate than will colonization. Consequently, the biotas of recently isolated continental islands are "supersaturated." It is problematical how long a biota will remain supersaturated. This depends on the organisms being considered, the nature and constancy of the physical environment, the size and ecological diversity of the island, and other factors.

With respect to the Gulf islands, the greater species abundance on the shallow-water islands could be attributed either to supersaturation or to the effect of distance on the equilibrium number. If further analysis confirms the fit of these data to the latter model, it would mean that equilibrium has been reached in the few thousands of years since these islands were formed.

The effects of species interactions on distribution and species abundance of reptiles on the Gulf islands is discussed elsewhere (Soulé, 1966).

SUMMARY

The distribution table lists some 250 records of insular occurrences of reptiles and amphibians of 33 genera (2 anurans, 14 lizards, 16 snakes, and 1 tortoise), from 31 islands in the Gulf of California. Of these genera, only the lizard genus *Sator* is endemic to the Gulf. Most of the 60 species, including the two amphibians and the tortoise, are considered mainland forms. Twelve of the species are sufficiently divergent from the mainland species to be considered endemic to the Gulf. Most of the endemic subspecies are isolated populations of widely distributed mainland species.

Extensions of the known range to additional islands in the Gulf of California or first reports of occurrence on any Gulf island are given for 12 species of snakes.

Insular gigantism and melanism are discussed, and examples from the Gulf herpetofauna are given. The relationship of the number of terrestrial vertebrates to the size of the island, and to the distance from the probable source of immigrants, is discussed and illustrated. A positive correlation is demonstrated for the former, and a negative correlation for the latter.

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TRANSACTIONS

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SUPPLEMENTAL LIST OF BIRDS OF SAN DIEGO COUNTY, CALIFORNIA

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SUPPLEMENTAL LIST OF BIRDS OF SAN DIEGO COUNTY, CALIFORNIA

BY

R. Guy McCaskie and Richard C. Banks

This list is a supplement to, not a replacement for, the list of birds of San Diego County published in 1959 by Sams and Stott. In the seven years since the appearance of that paper, the occurrence in the county of 62 species or subspecies not previously reported has been detected. These occurrences have been documented either by the obtaining of specimens or photographs or by reliable sight records. In addition, work during these years, and especially since 1962, has shown that 64 species or subspecies are present in some status other than indicated by Sams and Stott (*op. cit.*). The changes, or apparent changes, in status result from one or a combination of the following factors. (1) Extensive field work has shown that a species occurs in greater or lesser numbers than previously thought. (2) Changes of environment, particularly those associated with the development of bays and marshes, have modified or reduced the habitat to such an extent that some species no longer occur. (3) The information concerning the occurrence of some species has led us to reevaluate their status.

Although we have, in general, followed the format and procedures of Sams and Stott (*op. cit.*), we have made one significant departure in the matter of listing species whose occurrences are not substantiated by the presence of specimens. Those authors listed such species only when the records had been published in a zoological journal. By including in the present paper a large number of previously unpublished sight records, we are essentially accepting for ourselves the responsibility, formerly left to others, of deciding on the validity of such records. (This also reflects, to an extent, a difference in roles of the Transactions and Occasional Papers of the Society.) We have, however, clearly indicated whether a record is one based on a sighting or on a specimen or photograph; species included on the basis of sight records only are enclosed by brackets [ ].

As a slight refinement of the earlier list, we are defining here the terms we use to designate the relative abundance of the birds considered. Always, of course, the implication is that both habitat and time of year are suitable to the occurrence of the species.

Abundant: Plentiful, seen in good numbers on all occasions.
Common: Seen in fair numbers on most outings.
Uncommon: Finding the bird may take some effort.
Rare: Few in number, and considerable search may be necessary.
Casual: Present on an irregular basis, but several records exist.
Accidental: Reported only once or twice, and well out of its normal range.

We have occasionally had to resort to the use of qualifying terms to establish intermediate categories, as "fairly common" between common and uncommon, but these should be self explanatory. We consider the term "vagrant" to be essentially the same as accidental, but referring more to the species' distribution pattern than to its abundance.

An asterisk (*) before the following accounts indicates that the species or subspecies was not on the list compiled by Sams and Stott (1959). Species appearing without that symbol have revised accounts presented here. References to the literature are given in the normal manner, but those to Audubon Field Notes are included in the text rather than in the Literature Cited. Where a citation appears without a publication date, the reference is to that individual's notes.

The senior author has been involved in most of the field work responsible for the new records and revisions reported herein. Others who have made major contributions include Alan and Jean Craig, Duane Carmony, and Eleanor Pugh. We wish to thank also all those, too numerous to mention individually, who have reported sightings to McCaskie for inclusion in Audubon Field Notes, or who have called reports in to the Natural History Museum. Fr.

Amadeo M. Rea has graciously permitted us to mention several unpublished records and has read the manuscript.

This report includes records through December 31, 1965.

Podiceps grisegena holbollii: RED-NECKED GREBE

Casual winter visitant.

*[**Podiceps dominicus:** LEAST GREBE]

One record. A bird was seen in San Diego on December 20, 1959 (Stott and Selsor, 1960).

*[**Puffinus carneipes:** PALE-FOOTED SHEARWATER]

May occur occasionally far off shore; one seen near San Clemente Island, September 1, 1958 (Small, 1959a).

*[**Puffinus bulleri:** NEW ZEALAND SHEARWATER]

Probably a regular fall migrant in limited numbers far off shore; three seen near San Clemente Island on November 2, 1957 (Aud. Field Notes 12, 1958:58).

Oceanodroma homochroa: ASHY PETREL

One inland record, for Balboa Park, San Diego.

*[**Sula leucogaster:** BROWN BOOBY]

One record. An individual seen off San Diego on December 5, 1959, by John Bishop (Aud. Field Notes 14, 1960:341).

***Bubulcus ibis ibis:** CATTLE EGRET

Two records, but expected to occur more often in the future. Two were present near Imperial Beach between March 7 and April 18, 1964, and one of these was collected (McCaskie, 1965); one or two seen in December, 1965.

Dichromanassa rufescens dickeyi: REDDISH EGRET

Casual visitant from Baja California in fall, winter, and spring (McCaskie, 1964).

Hydranassa tricolor ruficollis: LOUISIANA HERON

Rare winter visitor along coast (McCaskie, 1964).

***Nyctanassa violacea bancrofti:** YELLOW-CROWNED NIGHT HERON

Casual fall visitant from Baja California; seen and collected at Imperial Beach, and seen at Solana Beach (McCaskie, 1964).

Mycteria americana: WOOD IBIS

Much rarer than formerly; no longer seen every year, presumably a result of decreasing habitat.

*[**Branta bernicla:** (AMERICAN) BRANT]

Rare winter visitant. One or two individuals noted with the flocks of black brant on San Diego Bay during recent winters by McCaskie and others (Aud. Field Notes 17, 1963:358; 18, 1964:386).

Branta nigricans: BLACK BRANT

Stragglers recorded in summer.

***Branta ruficollis ruficollis:** RED-BREASTED GOOSE

One record. One was collected near Carlsbad on September 18, 1960 (Huey, 1961a).

Dendrocygna bicolor helva: FULVOUS TREE DUCK

No records in recent years; probably no longer occurs in the county.

*[**Anas crecca:** COMMON TEAL]

One record. An individual remained on the Sweetwater River in Bonita from January 29 to February 24, 1962 (seen by McCaskie and many others). This species has not previously been reported from California.

*[**Mareca penelope:** EUROPEAN WIDGEON]

Rare winter visitant. Individuals occasionally noted during the winter with flocks of American widgeon. Seen by McCaskie and others along the San Diego River during the winters of 1961-62, 1962-63, and 1963-64.

Aythya valisineria: CANVASBACK

Uncommon winter visitant.

Aythya marila nearctica: Greater Scaup

Rare winter visitant.

Bucephala clangula americana: Common Goldeneye

Fairly common in winter.

*[**Bucephala islandica:** Barrow's Goldeneye]

One record. An adult male was seen by McCaskie and Carmoney near Imperial Beach, March 7, 1964.

*[**Histrionicus histrionicus:** Harlequin Duck]

Two records. One was seen on San Diego Bay in November, 1953, by Alan Craig, and one was seen at Coronado between December 23, 1962, and March 18, 1963 by McCaskie, Eleanor Pugh, and others.

Melanitta perspicillata: Surf Scoter

Stragglers recorded in summer.

Accipiter gentilis atricapillus: American Goshawk

Accidental; only two records.

Parabuteo unicinctus superior: Harris' Hawk

One additional record; less likely to occur now than formerly.

Pandion haliaetus carolinensis: Osprey

Rare fall migrant and winter visitant.

*[**Meleagris gallapavo:** Turkey]

Birds of Texas origin have been introduced by the California Department of Fish and Game in the Corte Madera and Warner areas, where they are apparently established.

Grus canadensis: Sandhill Crane

Casual migrant, not recorded in recent years. No specimens available, and racial designation of former records not determinable.

***Porphyrula martinica:** Purple Gallinule

One record. A specimen taken on Point Loma on October 1, 1961 (Huey, 1962).

Charadrius wilsonia beldingi: Wilson's Plover

Accidental; only two records.

Eupoda montana: Mountain Plover

Uncommon fall migrant; less common as winter visitant. Seen as late as March 6 (Rea, pers. comm.).

Pluvialis dominica: Golden Plover

Uncommon fall migrant, rare winter visitant and spring migrant. Whether both subspecies are involved has not yet been determined.

Tringa solitaria cinnamomea: Solitary Sandpiper

Uncommon fall migrant; no recent spring records.

Erolia bairdii: Baird's Sandpiper

Rare fall migrant; no recent spring records.

*[**Micropalama himantopus:** Stilt Sandpiper]

Casual fall migrant. Two were seen at Solana Beach in the fall of 1962 and one was seen there in the fall of 1964, by McCaskie and others.

***Philomachus pugnax:** Ruff

Two records. One was collected at the mouth of the San Diego River on March 30, 1962, and one was seen at Solana Beach on September 21 and 22, 1962 (McCaskie, 1963).

Steganopus tricolor: Wilson's Phalarope

Common fall and spring migrant, casual winter visitant.

Lobipes lobatus: Northern Phalarope

Abundant fall and spring migrant, and casual winter visitor.

Stercorarius longicaudus: Long-tailed Jaeger

One recent spring sight record (McCaskie).

*[**Catharacta skua:** Skua]

Probably rare wanderer far off shore; seen near San Clemente Island on August 13, 1957, and August 29, 1957 (Small, 1959b).

***Larus hyperboreus barrovianus:** GLAUCOUS GULL

Rare winter visitant. McCaskie saw a second year bird on Sweetwater Reservoir on March 23, 1963, and another at the sanitary fill in Balboa Park on March 23, 1964. A first year bird was taken on Coronado Strand early in 1966. The specimen from San Diego mentioned by Johnston (1955:206) has recently been re-identified as *L. glaucescens*.

Larus glaucescens: GLAUCOUS-WINGED GULL

Fairly common in fall, winter, and spring. Stragglers occasionally remain in the summer.

*[**Larus occidentalis occidentalis:** WESTERN GULL]

One record. A bird that had been color banded on the Farallon Islands was seen in La Jolla in the late 1940's (Carl L. Hubbs, pers. comm.).

Larus occidentalis wymani: WESTERN GULL

Abundant resident along the coast.

*[**Larus atricilla:** LAUGHING GULL]

Casual visitant along the coast. Records are available for each year since 1962, with dates of observations in October, March, April, and May.

***Larus pipixcan:** FRANKLIN'S GULL

Rare fall migrant to the coast. There is a specimen from Imperial Beach, found on October 31, 1960 (McCaskie and Banks, 1964). It has also been noted on San Diego Bay, Solana Beach and Oceanside on dates ranging from September 6 to November 16 (McCaskie and Cardiff, 1965).

*[**Gelochelidon nilotica:** GULL-BILLED TERN]

One record of two seen on San Diego Bay on June 5, 1955 (Aud. Field Notes 9, 1955:360).

Sterna forsteri: FORSTER'S TERN

First reported breeding in South San Diego Bay in 1962 (Gallup, 1963); now common as a breeding bird in that area.

Sterna hirundo hirundo: COMMON TERN

Rare visitor in winter.

*[**Sterna paradisaea:** ARCTIC TERN]

Fairly common fall migrant and probably also spring migrant far off shore. Seen regularly in September of different years near San Clemente Island by McCaskie and others. One seen by McCaskie on San Diego Bay, September 13, 1962, and another seen at Imperial Beach on August 16, 1964.

Thalasseus maximus maximus: ROYAL TERN

One breeding record for South San Diego Bay (Gallup and Bailey, 1960).

Thalasseus elegans: ELEGANT TERN

Common from March through November in San Diego Bay; in late summer and fall, post-breeding wanderers move northward along the coast. The nesting colony in South San Diego Bay is the only one in the United States (Gallup and Bailey, 1960).

Chlidonias niger surinamensis: BLACK TERN

Rare spring and fall migrant, recorded from May to October, in coastal marshes.

Endomychura craveri: CRAVERI'S MURRELET

Status uncertain because of confusion with Xantus' Murrelet; no record since 1914, but no recent collecting offshore in the fall.

Zenaida asiatica mearnsi: WHITE-WINGED DOVE

Uncommon breeding bird in Colorado Desert portion of the county; rare wanderer west of the mountains, most often seen in fall.

*[**Streptopelia risoria:** RINGED TURTLE DOVE]

Resident in very limited numbers. Birds occasionally seen around San Diego may well be escaped cage birds, but the species has become naturalized in a wild state about Los Angeles.

Columbigallina passerina pallescens: GROUND DOVE

Uncommon resident in Tia Juana River Valley; casual elsewhere in the county.

Coccyzus americanus occidentalis: Yellow-billed Cuckoo

Formerly uncommon summer visitor; no recent records despite extensive search, and perhaps now gone from the county.

***Otus flammeolus flammeolus:** Flammulated Owl

One record. A bird was caught alive in San Diego on October 10, 1962 (Banks, 1964).

Chordeiles acutipennis texensis: Lesser Nighthawk

Common from March to November.

*[**Cynanthus latirostris:** Broad-billed Hummingbird]

Casual winter visitant. An adult male present at Mrs. M. Heraty's feeder in San Diego between November 10, 1961, and March, 1962, was seen by numerous observers including McCaskie. McCaskie, Eleanor Pugh and Marie Manns saw an adult male near Imperial Beach on October 14, 1962, and Richard Stallcup saw a pair near Imperial Beach on November 9, 1963. The species has not previously been reported in California.

***Tyrannus tyrannus:** Eastern Kingbird

Rare fall migrant; dates range from August 27 to October 3. One was collected near Carlsbad on August 29, 1961, by McCaskie and Richard Stallcup and one was collected at Solana Beach on September 28, 1963. The species has also been seen near Imperial Beach.

*[**Tyrannus crassirostris:** Thick-billed Kingbird]

One record. An individual was seen by McCaskie near Imperial Beach on October 19, 1965. This is the first report of this species in California.

***Tyrannus melancholicus occidentalis:** Tropical Kingbird

Rare northward wanderer along the coast, noted between September 12 and December 6. One was collected at Solana Beach on September 20, 1963, by McCaskie, and it has also been seen at Point Loma, National City, Coronado and Imperial Beach.

Muscivora forficata: Scissor-tailed Flycatcher

A total of three records, including one specimen, all in late fall and winter.

Hirundo rustica erythrogaster: Barn Swallow

Common migrant in October; casual in winter.

Parus gambeli baileyae: Mountain Chickadee

Occasionally found on coast (Point Loma).

Auriparus flaviceps acaciarum: Verdin

Casual in Tia Juana River Valley in fall and winter (McCaskie and Banks, 1964).

***Dumetella carolinensis:** Catbird

One record. McCaskie collected an individual near Imperial Beach on November 8, 1964.

Toxostoma rufum: Brown Thrasher

Casual in winter; fewer than half a dozen records.

***Toxostoma bendirei:** Bendire's Thrasher

Rare fall wanderer to the coast. One was seen by McCaskie at Solana Beach on August 27, 1964. Another was seen near Imperial Beach on November 16, 1962, and a specimen was taken there by McCaskie on October 2, 1964.

*[**Toxostoma curvirostre palmeri:** Curve-billed Thrasher]

One record. An individual was seen near Imperial Beach by McCaskie and others on September 6 and 19, 1965.

Turdus migratorius propinquus: Robin

This species recently has become a fairly common breeding bird in suitable habitat in San Diego.

***Anthus cervinus:** Red-throated Pipit

One record. A flock of up to 15 birds was present near Imperial Beach between October 12 and 27, 1964, and two specimens were taken (McCaskie, 1966).

Sturnus vulgaris: Starling

Common in winter, and fairly common as a breeding bird (Banks, 1965); increasing in abundance yearly.

Vireo bellii pusillus: BELL'S VIREO

Summer resident from April to early October; one winter record (McCaskie and Banks, 1964).

Vireo solitarius cassinii: SOLITARY VIREO

Casual in winter.

Vireo olivaceus: RED-EYED VIREO

Casual fall migrant; three October records are supported by specimens.

***Vireo philadelphicus:** PHILADELPHIA VIREO

One record. McCaskie collected a specimen near Imperial Beach on October 9, 1965.

***Helmitheros vermivorus:** WORM-EATING WARBLER

One record. A bird was found dead in San Diego on September 18, 1960 (Huey, 1961a).

***[Vermivora pinus:** BLUE-WINGED WARBLER]

Two records; McCaskie saw one on Point Loma on September 19, 1964, and another near Imperial Beach on September 26, 1964.

***Vermivora peregrina:** TENNESSEE WARBLER

Rare fall migrant between September 7 and November 9; seen at Solana Beach, along the Silver Strand and at Imperial Beach. One spring record, of two present at Imperial Beach on May 31 and June 1, 1964; one of these was collected.

Vermivora ruficapilla ridgwayi: NASHVILLE WARBLER

Common migrant in spring, less common in fall; rare winter visitor.

Vermivora virginiae: VIRGINIA'S WARBLER

Uncommon fall migrant on the coast (McCaskie and Banks, 1964); one winter record.

***Vermivora luciae:** LUCY'S WARBLER

Two records. One bird was seen by McCaskie and Alan Craig near Imperial Beach between September 11 and 19, 1965, and was collected on the latter date. Alan Craig banded an individual on Point Loma on November 5,1965.

***[Parula americana:** PARULA WARBLER]

One record of an individual seen near Imperial Beach by McCaskie on October 4, 1962.

***Dendroica magnolia:** MAGNOLIA WARBLER

Two records. A bird was banded on Point Loma by Alan Craig on September 23, 1965, and one was collected there on November 1, 1965.

***Dendroica caerulescens caerulescens:** BLACK-THROATED BLUE WARBLER

Casual fall migrant. One was collected and two other were seen by McCaskie near Imperial Beach between October 20 and November 9, 1962. One was seen by McCaskie and others near Imperial Beach on October 17, 1964, and Duane Carmony saw one in La Jolla on October 24, 1964.

***Dendroica virens virens:** BLACK-THROATED GREEN WARBLER

Casual fall migrant. One was found dead in San Diego on October 15, 1960 (Huey, 1961b). One was collected and three others were seen near Imperial Beach between September 23 and December 8, 1963, by McCaskie and others. Duane Carmony saw one at Yaqui Well on October 24, 1963. McCaskie and Carmony saw one near Imperial Beach on October 29 and 31, 1964.

Dendroica occidentalis: HERMIT WARBLER

Common spring migrant, uncommon fall migrant; casual in winter.

***Dendroica fusca:** BLACKBURNIAN WARBLER

Two records. One was collected near Imperial Beach by McCaskie on October 21, 1962, and another was seen there on October 15, 1964.

***Dendroica pensylvanica:** CHESTNUT-SIDED WARBLER

Three records. One was collected near Imperial Beach by Guy McCaskie on September 26, 1962, and another was photographed there on June 5 and 6, 1965. A specimen was taken at San Luis Rey on October 2, 1962 (Rea, 1964).

Dendroica castanea: BAY-BREASTED WARBLER

One additional record, for Imperial Beach, October 6, 1964 (McCaskie).

*__Dendroica striata:__ Blackpoll Warbler

Rare but regular fall migrant along the coast, noted between September 13 and October 27 (McCaskie and Banks, 1964). There are now five specimens from near Imperial Beach and at least 25 other sightings.

*__Dendroica discolor discolor:__ Prairie Warbler

Rare fall migrant, noted between September 5 and October 28. There are two specimens and five other sightings from Imperial Beach, and two sightings from Solana Beach.

Dendroica palmarum palmarum

Rare fall migrant, casual in winter (McCaskie and Banks, 1964).

*[**Seiurus aurocapillus:** Ovenbird]

Three records. One was seen by McCaskie and others on Point Loma on September 5 and 6, 1963. One was seen by McCaskie and Eugene Cardiff near San Diego Bay on May 31, 1964. A third was seen by McCaskie and Alan Craig near Imperial Beach, October 10, 1965.

Seiurus novaboracensis limnaeus: Northern Watertrush

Rare fall migrant, September and October; one winter record (McCaskie).

*__Oporornis agilis:__ Connecticut Warbler

One record; a bird was collected by McCaskie near Imperial Beach on September 27, 1963.

Setophaga ruticilla tricolora: American Redstart

Uncommon fall migrant; rare in winter and as spring migrant (McCaskie and Banks, 1964).

*__Dolichonyx oryzivorous:__ Bobolink

Rare fall migrant along the coast. Two were collected and at least 25 others were seen near Imperial Beach between September 21 and October 22, 1963. At least 25 were seen in the same area from September 29 to October 22, 1964, by McCaskie and others.

*__Icterus spurius:__ Orchard Oriole

Rare winter visitant. One was photographed in San Diego in late March, 1958 (Johnson, 1959). One was collected near Imperial Beach on October 19, 1962 (McCaskie and Banks, 1964). Birds have also been seen during the winters of 1963-64 and 1964-65 on Point Loma by McCaskie and Alan Craig.

Icterus pustulatus microstictus: Scarlet-headed Oriole

Casual northward wanderer in fall in addition to the one spring record.

*__Icterus galbula:__ Baltimore Oriole

Rare winter visitant, seen in the San Diego area each winter since 1962-63. One was collected near Imperial Beach on October 10, 1965.

*__Piranga flava hepatica:__ Hepatic Tanager

One record. A bird was collected in Poway on December 31, 1960 (Huey, 1961b).

Piranga rubra rubra: Summer Tanager

Rare fall and winter visitor; some of the sight records may be of *P. r. cooperi.*

*[**Richmondena cardinalis:** Cardinal]

Casual visitant. One spent part of the fall and winter of 1962-63 at a feeder in San Diego, and there are at least four sight records from the Imperial Beach area during the fall and winter (McCaskie, Eleanor Pugh, and others). Reported nesting once near Balboa Park, San Diego.

*__Pheucticus ludovicianus:__ Rose-breasted Grosbeak

Casual fall and winter visitant. There are several records for Imperial Beach, Point Loma, La Jolla, and near Balboa Park, with dates ranging from early October to April.

Pheucticus melanocephalus maculatus: Black-headed Grosbeak

Casual in winter.

Guiraca caerulea salicaria: Blue Grosbeak

Casual in winter.

*__Passerina cyanea:__ INDIGO BUNTING

Rare fall migrant. One or two have been seen by McCaskie and others each fall in the area around Imperial Beach; one was collected there on September 6, 1963. It has also been seen on Point Loma. One spring record, of a specimen obtained May 30, 1965, in San Diego.

Passerina amoena: LAZULI BUNTING

One winter record (Banks).

*[__Passerina ciris ciris:__ PAINTED BUNTING]

The specimen reported as this race (McCaskie and Banks, 1964) may actually be *P. c. pallidior* (McCaskie, DeBenedictis, and Stallcup, in press). This subspecies should be deleted from future lists unless further evidence is forthcoming.

*__Passerina ciris pallidior:__ PAINTED BUNTING

Casual fall vagrant. One was collected near Imperial Beach on September 28, 1963. Two additional sight records from the Imperial Beach area and another on Point Loma during the fall were most likely of this race.

*__Spiza americana:__ DICKCISSEL

Casual fall migrant; one winter record. A bird was collected and twelve others were seen near Imperial Beach by McCaskie and others between September 20 and October 3, 1963, and one was seen in that area by McCaskie on October 10, 1964. One bird was present at a feeder in San Diego from December 2, 1963, to March 16, 1964.

Calamospiza melanocorys: LARK BUNTING

Recent observations indicate that the species is now only a casual fall migrant; it probably does not occur in other seasons.

*__Ammospiza caudacuta nelsoni:__ SHARP-TAILED SPARROW

One was collected at Imperial Beach on November 2, 1963, by McCaskie. Also reported from San Luis Rey in winters of 1961-62 and 1962-63 (Rea).

Amphispiza bilineata deserticola: BLACK-THROATED SPARROW

Casual along the coast (Tia Juana River Bottom) in fall.

*__Junco oreganus oreganus:__ OREGON JUNCO

A specimen in the Santa Barbara Natural History Museum was taken by Rea at San Luis Rey on January 17, 1962 (Rea, in press).

*__Spizella pallida:__ CLAY-COLORED SPARROW

Rare fall migrant; one or two noted by McCaskie and others each fall since 1963. A specimen was taken at Imperial Beach on September 25, 1963.

Spizella breweri breweri: BREWER'S SPARROW

Uncommon fall migrant and rare winter visitor.

*__Spizella breweri taverneri:__ BREWER'S SPARROW

One record. A bird was collected near Mission San Luis Rey on February 14, 1962 (Rea, in press).

Zonotrichia querula: HARRIS' SPARROW

Casual winter visitor; only a few records for the county.

Zonotrichia albicollis: WHITE-THROATED SPARROW

Rare winter visitor.

Melospiza georgiana ericrypta: SWAMP SPARROW

Rare winter visitor.

*__Rhynchophanes mccownii:__ McCOWN'S LONGSPUR

One record. A bird was collected by McCaskie near Imperial Beach on November 6, 1965.

Calcarius lapponicus alascensis: LAPLAND LONGSPUR

Rare fall migrant.

*__Calcarius ornatus:__ CHESTNUT-COLLARED LONGSPUR

Rare fall migrant. Small numbers were noted by McCaskie and others near Imperial Beach in the fall of 1964 and 1965, and one was collected there on October 25, 1964.

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TRANSACTIONS
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PLEISTOCENE MOLLUSCA FROM THE SECOND TERRACE AT SAN PEDRO, CALIFORNIA

BY

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When a high school was being constructed at 15th and Leland Streets, San Pedro, Los Angeles County, California, in 1936, a stratum of beach rubble containing many fossil shells was exposed in one of the excavations. About 15 pounds of fossiliferous sediment was collected by the author before the pit was filled with concrete. A letter to Dr. W. P. Woodring of the U. S. Geological Survey informed him of the find. He mentioned this discovery in a paper published in 1946 (Woodring *et al.*), stating the deposit was an exposure of a remnant of a terrace which he correlated with the second terrace of the series of thirteen major, raised terraces of Late Pleistocene age that are cut into the Palos Verdes Hills. This stratum of rubble, with some large rocks, was about two feet below the surface of the surrounding ground, was approximately 18 inches thick and rested on poorly consolidated material that is similar to that of the Timm's Point Silt of Early Pleistocene age.

The site is about two miles north of the "Chiton Bed" exposure at Point Fermin, which was first reported by Chace and Chace (1919), and which Woodring (1935) initially assigned to the first terrace. Woodring *et al.* (1946) subsequently referred the "Chiton Bed" to the second terrace. Like the "Chiton Bed" exposure, the High School deposit represents a Late Pleistocene, outer coast or tidepool assemblage in which many chiton valves are preserved.

This collection, most of which is now housed at the San Diego Natural History Museum (locality L-2138), was recently sorted and identified. Because it contains more than twice as many species as were reported from the "Chiton Bed", I believe that a faunal list merits recording.

PELECYPODA

Aligena cerritensis Arnold, 2 valves
Amiantis callosa (Conrad), 1 piece
Apolymetis biangulata Carpenter, 1 valve
Cardita prolongata Carpenter, 2 valves
Cardita subquadrata Carpenter, 5 valves
Chama pellucida Carpenter, 9 valves
Chione californiensis Broderip, 6 valves
Chione picta Willett, 78 valves
Corbula luteola Carpenter, 69 valves
Cryptomya californica (Conrad), 27 valves
Cumingia californica Conrad, 1 pr. and 13 valves
Diplodonta cf. *D. orbella* Gould, 3 small valves
Dosinia dunkeri (Philippi), 2 pieces
Dosinia ponderosa (Gray), 3 pieces
Gari californica (Conrad), 1 valve
Glans carpenteri Lamy, 5 valves
Glycymeris corteziana Dall, 1 valve
Gouldia varians Carpenter, 7 valves
Hinnites multirugosus (Gale), 4 pieces
Lima sp., 3 small pieces

Lucina californica Conrad, 10 valves
Lucina nuttalli Conrad, 16 valves, many with bored holes
Macoma nasuta (Conrad), 11 valves
Mactra sp., 7 small valves and pieces
Milneria kelseyi Dall, 6 valves
Nucula exigua Sowerby, 91 valves
Nuculana taphria (Dall), 1 valve
Ostrea lurida Carpenter, 55 valves, many of them small
Pecten circularis aequisulcatus Carpenter, 4 valves and 4 pieces
Pecten vogdesi Arnold, 1 valve
Pecten hastatus Sowerby, 1 small specimen
Pecten latiauritus Conrad, 25 small valves
Pitar newcombiana (Gabb), 1 broken valve
Pholadidea penita Carpenter, 16 valves and 9 pieces
Pholadidea rostrata Valenciennes, 1 valve
Platyodon cancellatus Conrad, 4 pieces
Pododesmus macroschisma Conrad, 1 valve
Protothaca staminea (Conrad)
    and var. *ruderata* (Deshayes), 6 valves and pieces
Pseudochama exogyra (Conrad), 9 valves
Semele decisa (Conrad), 1 valve
Semele cf. *S. quintinensis* Dall, 3 valves
Semele rupicola Dall, 1 valve
Tagelus sp., 5 small pieces
Transenella tantilla Gould, 77 valves
Trachycardium quadrigenarium (Conrad), 9 valves and 6 pieces
Trigoniocardia biangulata Broderip & Sowerby, 15 valves
Zirfaea pilsbryi Lowe, 8 pieces

GASTROPODA

Acanthina lugubris (Sowerby), 1 specimen
Acanthina spirata (Blainville), 2
Acmaea insessa (Hinds), 20
Acmaea limatula Carpenter, 16
Acmaea paleacea Gould, 60
Acmaea scabra Reeve, 23, mostly small
Acteocina culcitella (Gould), 70
Acteocina inculta (Gould), 19
Acteocina cf. *A. planata* (Carpenter), 10
Acteon punctocaelatus (Carpenter), 93
Aesopus sanctus Dall, 2
Aletes squamigerus Carpenter, 3 pieces
Alvania cf. *A. acutilirata* Carpenter, 1
Amphissa versicolor Dall, 1
Anachis penicillata Carpenter, 3
Assiminea translucens (Carpenter), 3
Astraea undosa (Wood), 5 pieces and 2 opercula
Bulla gouldiana Pilsbry, 4 and 4 pieces
Caecum californicum Dall and Bartsch, 18
Caecum cf. *C. diegensis* Bartsch, 10
Caecum cf. *C. hemphilli* Bartsch, 3
Caecum licalum Bartsch, 1
Calliostoma gemmulatum (Carpenter), 3 small specimens and pieces of a large one
Calliostoma supragranosum Carpenter, 1
Cerithiopsis cf. *C. carpenteri* Bartsch, 3
Calyptraea contorta Carpenter, 7
Conus californicus Hinds, 20, some small
Crepidula coei Berry, 39
Crepidula onyx Sowerby, 18
Crepidula perforans (Valenciennes), 22
Crepipatella lingulata (Gould), 33
Cylichna cf. *C. fantasma* Baker and Hanna, 2
Cypraeolina pyriformis (Carpenter), 20
Cystiscus jewetti (Carpenter), 3
Cystiscus politulus (Dall), 12
Cytharella hexagona (Gabb), 3

Diodora densiclathrata (Reeve), 3 fragments
Epitonium caamani Dall and Bartsch, 4
Epitonium sp., 4 specimens and 2 pieces
Erato columbella Manke, 9
Fartulum cf. *F. hemphilli* Bartsch, 3
Fartulum orcutti Dall, 7
Fissurella volcano Reeve, 59
Haminoea virescens (Sowerby), 6
Hipponix antiquatus (Linné), 21
Hipponix tumens (Carpenter), 26
Homalopoma baccula (Carpenter), 1
Hyalina californica Tomlin, 20
Lacuna unifasciata Carpenter, 33
Lacuna variegata Carpenter, 58
Liotia acuticostata Carpenter, 2
Littorina scutulata (Gould), 44
Lucapinella callomarginata (Dall), 1
Mangelia barbarensis Oldroyd, 6
Mangelia pulchrior Dall, 2
Mangelia variegata Carpenter, 8
Margarites acuticostata (Carpenter), 42
Marginella polita Carpenter, 10
Melampus olivaceus Carpenter, 3
Megathura crenulata (Sowerby), 3 mature specimens and 3 juveniles
Metaxia diadema Bartsch, 1
Mitrella carinata Hinds, 249
Mitromorpha aspera (Carpenter), 1
Mitromorpha filosa (Carpenter), 1
Nassa cerritensis (Arnold), 2
Nassa cooperi Forbes, 2 fragments
Nassa fossata Gould, 1 very small specimen
Nassa perpinguis Hinds, 3
Norrisia norrisii (Sowerby), 2
Ocenebra foveolata (Hinds), 1 fragment
Ocenebra interfossa Carpenter, 4
Odostomia sp., 1
Olivella baetica Carpenter, 49
Olivella biplicata (Sowerby), 12
Pedipes unisulcata Carpenter, 1
Polinices recluziana (Deshayes), 20
Retusa harpa (Dall), 37
Seila montereyensis Bartsch, 1 specimen and fragments
Shaskyus festivus (Hinds), 5
Triphora cf. *T. catalinensis* Bartsch, 1
Terebra danai Berry, 1 small one
Tegula aureotincta (Forbes), 2
Tegula gallina Forbes, 4 specimens and pieces
Tegula ligulata (Menke), 1
Teinostoma invallata (Carpenter), 4
Teinostoma supravellata (Carpenter), 12
Trimusculus reticulata (Sowerby), 1
Trivia californiana (Gray), pieces
Trivia solandri (Gray), pieces
Truncatella californica Pfeiffer, 20
Turbonilla ambustus Dall and Bartsch, 4
Turbonilla annettae Dall and Bartsch, 1
Turbonilla buttoni Dall and Bartsch, 20
Turbonilla halia Dall and Bartsch, 2
Turbonilla laminata Carpenter, 3
Turbonilla pedroana Dall and Bartsch, 6
Turbonilla tenuicula Gould, 6
Vitrinella oldroydi Bartsch, 1
Williamia peltoides (Carpenter), 5
Zoila spadicea (Swainson), 3 pieces

AMPHINEURA

Acanthochites sp., 1 valve
Callistochiton crassicostatus Pilsbry, 1 head valve, 6 median valves, 5 tail valves
Callistochiton decoratus Pilsbry, 1 head valve
Callistochiton palmulatus (Carpenter), 1 head valve, 1 median valve, 3 tail valves
Cyanoplax hartwegi Carpenter, 3 head valves, 25 median valves
Ischnochiton sanctaemonicae Berry, 1 head valve, 1 median valve, 1 tail valve
Mopalia muscosa (Gould), 3 head valves, 12 median valves
Nuttallina californica Reeve, 1 head valve, 19 median valves, 2 tail valves
Lepidochitona keepiana Berry, 8 median valves
Stenoplax magdalenensis (Hinds), 14 head valves, 48 median valves, 19 tail valves

SCAPHOPODA

Dentalium neohexagonum Sharp and Pilsbry, 38
Dentalium sp., 52 worn and broken pieces

COMMENTS

One species in this list, *Ischnochiton sanctaemonicae* Berry is known only from fossil material. Five species — *Pecten vogdesi* Arnold, *Dosinia dunkeri* (Philippi), *Dosinia ponderosa* (Gray), *Acanthina lugubris* (Sowerby), and *Stenoplax magdalenensis* (Hinds) — are southern forms now known from Baja California but not now living in California. *Stenoplax* (formerly *Ischnochiton*) *magdalenensis* (Hinds) is not the species listed from the "Chiton Bed" under the name of *Ischnochiton magdalenesnsis*, which is now called *Stenoplax heathiana* (Berry, 1946).

The most significant comparison is to the "Chiton Bed" deposit. Only 28 species are common to both lists. Ten species (five Gastropoda and five Amphineura) that are now rare locally, but common in the Monterey, California, area are on the "Chiton Bed" list but not on the present one.

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TERRESTRIAL VERTEBRATES OF ANACAPA ISLAND, CALIFORNIA

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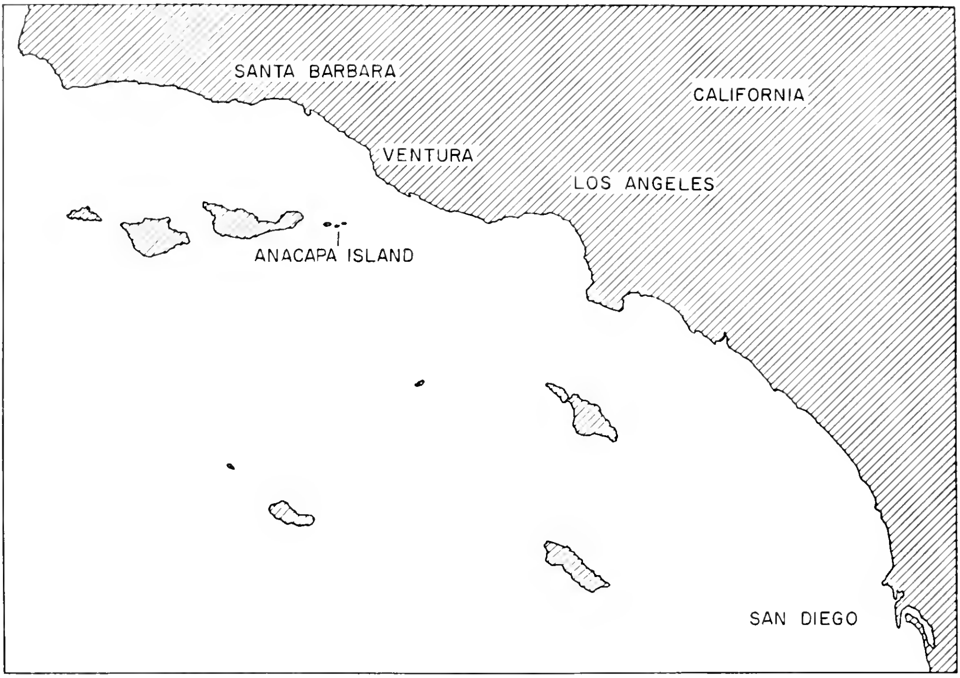

Fig. 1. Location of Anacapa Island, southern California.

TERRESTRIAL VERTEBRATES OF ANACAPA ISLAND, CALIFORNIA

BY

RICHARD C. BANKS

Introduction

This report results from an investigation of the nesting success of birds on Anacapa Island, with special study directed toward the effects of introduced predators. It was expanded to include accounts of all recent terrestrial vertebrate species known to have occurred on the island — 69 birds, five mammals, two reptiles, and one amphibian. The history and status of each is discussed; factors involved in the nesting of certain birds are given particular attention.

Because of a general interest in islands by biologists, and because the Channel Islands are fairly accessible, this group, including Anacapa, has been a focus of attention of scientists from southern California for many years. A number of persons particularly interested in birds visited Anacapa Island in the early decades of the twentieth century. Published reports of their field work and examination of the material they collected have provided the data to which more recent observations have been compared.

Anacapa Island is the northeastern member of the Channel Islands off southern California. It lies about 20 miles southwest of Ventura and 30 miles southeast of Santa Barbara (fig. 1). Anacapa is really a five mile long chain of three east to west trending islets, referred to herein as East, Middle, and West islands. The average width is about one-half mile. All three islets are rugged and steep, with most of the south sides being high cliffs. West Island is the largest and highest (rising to slightly over 900 feet), the one to which the major effort of field work was directed, and the most used by visitors to the Channel Islands National Monument, of which Anacapa Island constitutes the northern portion.

Canalino Indians lived on Anacapa Island when California was discovered and settled by Europeans. Since the Indians left the island, it has not been permanently inhabited. A fisherman lived on West Island for a number of years, and sheep herders occupied the island at least temporarily in the early part of this century. A lighthouse on East Island is presently manned by a small crew of Coast Guardsmen.

The steep south slopes of the islets are covered with dense growths of prickly-pear cactus, *Opuntia oricola.* There are also scattered clumps of this cactus on the tops of the islands, especially along the ridges, as on Middle Island. The northern slopes support moderately dense growths of shrubs, which seem to be spreading on the top of West Island. These shrubs are particularly conspicuous at the heads of the arroyos which lead down the north slopes (fig. 2). The relatively flat tops of the islands are grassland with stands of giant coreopsis, *Coreopsis maritima.* The larger stands of coreopsis (fig. 3), many of which extend onto moderately steep slopes, usually have little other vegetation in association. There are on the West Island a few tree-filled arroyos, with live oak, *Quercus tomentella*, being the most prominent species.

The vegetation of Anacapa Island is probably much disturbed from what must have been the original condition. The introduction of sheep was followed by the introduction of exotic grasses for forage. The combination of these factors probably has led to the elimination of some native plant species, and may have altered the soil conditions as well. A grove of eucalyptus trees on Middle Island certainly presents an environmental niche not present originally. Dunkle (1950) discussed the ecology of the Channel Islands in general, and commented on the various disturbing factors.

Anacapa Island was probably already considerably changed from its original state at the time the first biologists studied there; even the earliest information available does not deal with a "virgin" fauna. It is important to keep in mind that the changes that we can document are not related to change from the original to a disturbed environment, but from one disturbed environment to another.

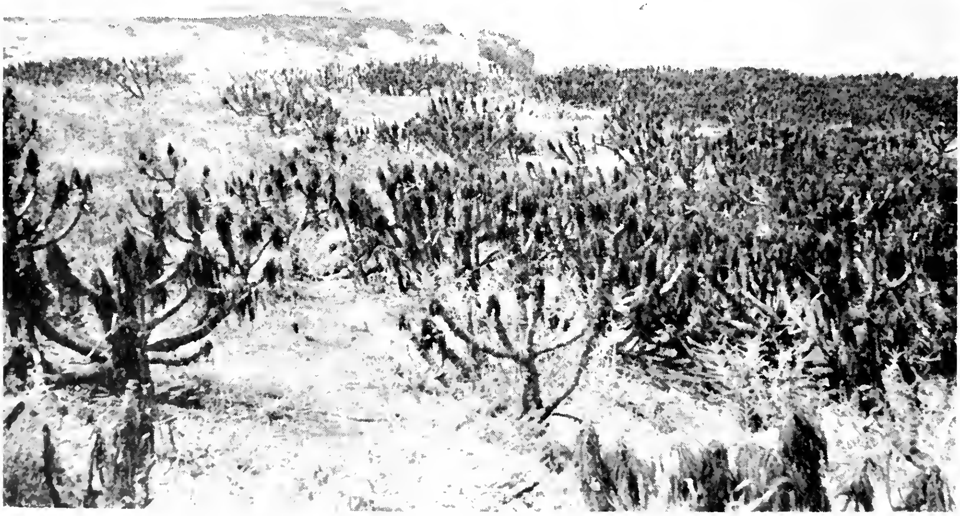

Fig. 2 (above). Heavy brush at head of tree-filled arroyo on West Anacapa Island. July, 1963.

Fig. 3 (below). Giant coreopsis and grassland on top of West Anacapa Island. July, 1963.

Abbreviations used in this report for depositories of specimens are as follows: LACM, Los Angeles County Museum of Natural History; LBSC, Long Beach State College; MVZ, Museum of Vertebrate Zoology, University of California, Berkeley; SDNHM, San Diego Natural History Museum; UCLA, Dickey Collection, University of California at Los Angeles. The number of specimens examined and their depositories are indicated at the end of the individual species accounts.

Acknowledgments

This study was carried out under contract with the Western Region of the National Park Service. I want particularly to thank the personnel of the Channel Islands National Monument for their assistance and cooperation during the study. Mr. Thomas Tucker, Superintendent, arranged for permits to collect on the island, and was helpful in providing both opportunities to get to the island and transportation. Rangers Thomas Hartman, Jerry Lee, Clinton Collier, and Stanley Williams were gracious hosts during my stays on the island in 1963 and 1964, and assisted in the gathering of data. Lionel Bienvenu provided much necessary historical background.

Dr. M. Dale Arvey, formerly of Long Beach State College, told me of the collection of birds which he had obtained on Anacapa Island, and gave me permission to use them freely; Dr. Ross Hardy of that institution made the specimens available for study. I was able to study the material in the Los Angeles County Museum of Natural History through the courtesy of Dr. Kenneth E. Stager and James R. Northern. I have also examined material in the Museum of Vertebrate Zoology and in the Dickey Collection at the University of California, Los Angeles.

I thank Waldo G. Abbott for sharing his observations. Sidney B. Peyton sent me data from egg sets in his collection. Allan J. Sloan provided me with references to the herpetofauna of the island. A calculator was made available by John Vreeland of Friden, Inc., San Diego.

Dr. Kenneth E. Stager carefully read the manuscript and made a number of helpful suggestions.

Biological Study of Anacapa Island

The earliest reference to Anacapa Island in the biological literature, as far as I have been able to determine, is that by Holder (1899), who reported the presence of a large pelican colony observed from his passing vessel. The first expedition on which biologists spent some time on the island was in June, 1899 (Swarth, 1899). From that time until at least 1915, trips to Anacapa and the other Channel Islands were made more or less regularly by southern California biologists. From references in the literature and from specimen evidence I have been able to determine that Anacapa was visited in the years 1903, 1906, 1909-1913, 1915, and 1917 (Willett, 1910, 1912, 1933; Van Denburgh, 1905; Burt, 1911; Wright and Snyder, 1913; Van Denburgh and Slevin, 1914; Howell, 1917). With a few minor exceptions, the ornithological work mentioned above was summarized in Howell's (1917) study of the birds of the Channel Islands. That paper has served as a taking-off point for the present survey.

After 1915 there is a long gap with no field work on Anacapa Island reported in the literature. The next evidence of any work there consists of specimens (SDNHM) taken by J. E. Green on May 6, 1938. Lowell Sumner and Richard M. Bond of the National Park Service visited Anacapa Island in April, 1939. Sumner's report of this trip, on file at the headquarters of the Channel Islands National Monument, San Diego, includes a list of the birds, mammals, and reptiles that they found on the island. Bond was also on the island May 15-17, 1940. A few specimens of vertebrates taken on each of these trips are deposited in the Museum of Vertebrate Zoology.

The Los Angeles County Museum Channel Islands Biological Survey, begun in 1939, included trips to Anacapa Island in mid-August, 1940, and mid-March, 1941. George Willett and Jack C. von Bloeker, Jr., collected both birds and mammals on these visits. This work led to the description of the endemic form of white-footed mouse (von Bloeker, 1941). Presumably also obtained on the expeditions of this survey were specimens of the slender salamander later discussed by Hilton (1945).

From November 22-24, 1956, and again from August 13-20, 1958, M. Dale Arvey led groups of students from Long Beach State College on trips to Anacapa Island. In the course of these two visits a collection of 63 bird specimens and 21 mammal specimens was amassed. Thirty-three species of birds were included in this collection, of which only eight had been listed in Howell's (1917) compilation. This collection has played an important part in the preparation of the present report.

In recent years, Waldo G. Abbott of the Santa Barbara Natural History Museum has led groups on trips to the vicinity of Anacapa and other Channel Islands, specifically for the observation of sea birds. As far as I am aware, none of these parties has landed on Anacapa. Abbott's observations from May 24, 1964, have been helpful in compiling this report.

My first visit to Anacapa Island, with rangers Thomas Hartman and Clinton Collier, extended from July 27 to August 2, 1963. Fourteen birds and 14 mammals were taken as specimens during the week (SDNHM), on West and Middle islands. In 1964, I spent the period July 22-29 on Anacapa, with rangers Jerry Lee and Stanley Williams. All three islets were visited during this time, with some collecting on each. Particular effort was directed toward surveying the islands for sign of rats, in order to judge the population level and distribution of that introduced rodent. Thus 57 mammal specimens were taken, but only five birds. In addition to work on the islets themselves, we twice during the week circuited the island to observe sea birds in the nearby waters. I spent two hours on East Island, May 5, 1965.

Although beyond the scope of this report, mention should be made of paleontological and geological work on Anacapa Island; for details and references, see Lipps, 1964. Dunkle (1950) summarized botanical researches on the Channel Islands in general.

Amphibians and Reptiles

Batrachoseps attenuatus pacificus. Slender Salamander. — This salamander is not common on the island, and may be restricted to a few canyons. Both Hilton (1945) and Hendrickson (1954) mentioned specimens from Anacapa, but with no detail on when, by whom, or where they were obtained.

Uta stansburiana hesperis. Side-blotched Lizard. — Although not common, this is the more abundant of the lizard species. I saw it in 1963 but not in 1964. Specimens were obtained as early as 1903 (Van Denburgh, 1905). (MVZ)

Gerrhonotus multicarinatus multicarinatus. Alligator Lizard. — This species is not common on the island. (MVZ)

Birds

An asterisk (*) before a name indicates that the species has not been reported from Anacapa Island previously.

Oceanodroma homochroa. Ashy Petrel. — Sumner listed this species in 1939, but without comment on its status. The remains of an unidentified petrel were noted on East Island in 1912 (Wright and Snyder, 1913). There is no evidence that any petrels have nested on the island.

Loomelania melania. Black Petrel. — This species was common at sea in June, 1910 (Willett, 1910); see comments under ashy petrel.

Pelecanus occidentalis. Brown Pelican. — These large birds are known to have nested on Anacapa since at least 1898 (Holder, 1899). Early reports mention colonies on East Island but, as Willett (1910) pointed out, the birds do not necessarily use the same colonial site in succeeding years and they may not nest on the island every year. Thus in 1899 and 1912, nesting was not attempted or was at a very low level, while in 1898, 1910, and 1911, the colony on East Island was active. Howell (1917) correctly summarized that "the island has been occupied by the birds in some years, and vacant in others."

Nesting begins in late spring. In March, 1911, "A number of pelicans were noted flying with long strips of sea weed in their bills, for mending the old nests, but none of them had begun to lay eggs" (Burt, 1911). In 1910, "eggs from fresh to advanced incubation, and young birds from newly hatched to nearly full grown" were found in early June (Willett, 1910). The colony "appeared to be occupied by old birds and two-thirds grown birds" in mid-August, 1898 (Holder, 1899). On July 29, 1963, and July 23, 1964, there were eggs and young in nearly all stages.

At present, pelicans do not nest on either East or Middle islands, the only colony being on West Island. The colony in 1964 seemed to be to the east of the center of activity in 1963. In 1964 the colony stretched over three arroyos and intervening ridges on the north side of the island, and several hundred occupied nests were observed. There has apparently been little change in the size of the population since the earliest reports.

Phalacrocorax spp. Cormorants. — The three species of southern California are lumped together here because of the general similarity of their nesting and other habits and because of the difficulty of certain identification, especially when the birds are seen at a distance. The three are the double-crested, *P. auritus*, Brandt's, *P. penicillatus*, and pelagic, *P. pelagicus*.

All three species were reported nesting on Anacapa Island in the early part of the century, but details are scanty. Estimates of abundance range from a few pairs to quite a number, depending on the season and year, but Brandt's seems to be the least commonly reported.

Cormorants typically nest on the steep cliffs of the island; ledges over the mouths of sea caves seem to be especially favored, according to early reports. In 1964 there were cormorant colonies on cliffs on the west end of West Island, but which species were involved could not be determined. My notes indicate that cormorants were fairly abundant around East Island.

Sumner listed both Brandt's and double-crested cormorants in 1939, but did not list the pelagic cormorant. My notes for late July of 1964 omit mention of *P. pelagicus*, whereas the other species were identified with certainty. W. G. Abbott saw both double-crested and Brandt's cormorants in May, 1964, but did not mention the pelagic. The latter species is distinctively marked during the breeding season, and should be noticed if present. Further observation on the composition of the population of cormorants on Anacapa Island would be desirable. It is doubtful that the overall population has changed much in recent years.

**Buteo jamaicensis*. Red-tailed Hawk. — This species was observed soaring over West Island on several occasions in 1963 and 1964; Stanley Williams saw three at once on July 23, 1964. The birds probably wander over from the larger islands to the west, and perhaps from the mainland.

Haliaeetus leucocephalus. Bald Eagle. — In 1917, Howell wrote that "Several pairs are resident on Anacapa . . ." More specifically, Willett (1910, 1912) found "several" nests with young in 1910, and Burt (1911) reported three occupied nests. There are no reports of eagles in recent years, and the species is certainly no longer resident. The date of elimination of eagles from Anacapa cannot be determined, and the reason for it can be little but conjecture.

Circus cyaneus hudsonius. Marsh Hawk. — Burt took a specimen on Anacapa on March 15, 1911 (Burt, 1911; Willett, 1933).

**Pandion haliaetus*. Osprey. — Sumner listed this bird among those observed in 1939.

Falco peregrinus. Peregrine Falcon. — Peregrines were never very abundant on Anacapa, to judge by early reports, although at least one pair probably nested there (Burt, 1911). The species was most recently reported by Sumner in 1939. It was not noted in 1963 or 1964.

Falco sparverius. Sparrow Hawk. — Burt (1911) reported a pair of these birds on Anacapa in March, 1911. I saw the species on all three islets in 1963 and 1964. Probably at least one pair, and perhaps two or three, are resident, although breeding by this species has never been established.

Haematopus palliatus. American Oystercatcher. — This species has been recorded but once on Anacapa Island, on May 24, 1964 (Abbott, 1965).

Haematopus bachmani. Black Oystercatcher. — Howell (1917) and writers before him reported this bird nesting on Anacapa in small numbers. Such is apparently still the case. In both 1963 and 1964, groups of two to five individuals were seen on numerous occasions in late July. Although Howell (1917:52) indicated that oystercatchers nest on the islands in mid-May, Swarth's (1899) original report of the species from Anacapa noted that specimens secured in early June were not breeding.

Arenaria melanocephala. Black Turnstone. — This bird is present as a spring and fall migrant, and probably throughout the winter. Specific records are for March, April, and late July. (LACM, 2)

Actitis macularia. Spotted Sandpiper. — This is a migrant in both spring and fall; records are for April and August. (LACM, 1)

**Tringa solitaria cinnamomea.* Solitary Sandpiper. — There is one record of this species on East Island in August. (LACM, 1)

Heteroscelus incanum. Wandering Tattler. — This species is a migrant and perhaps winter visitant, with records in April, July, and November. (LACM 1, LBSC, 1)

**Limnodromus griseus* ssp. Short-billed Dowitcher. — This species has been recorded once, on West Island in August. (LACM, 1)

Larus occidentalis. Western Gull. — Willett (1910) and Wright and Snyder (1913) found nesting colonies of this gull on Anacapa Island. The former found eggs and young in early June, and the latter reported only young in early July. W. G. Abbott reports that on May 24, 1964, "The western gulls were definitely on nests as we were able to view them at close range on the steep cliffs" (in litt). Birds were on nests as early as May 5, 1965. On my visits to Anacapa Island in late July I have seen many large, essentially full-grown young western gulls along the water's edge. In the absence of definite information on numbers, either earlier or present, it is impossible to comment on any change in the population. It is unlikely that there has been any significant change.

Cepphus columba. Pigeon Guillemot. — This bird formerly nested on Anacapa Island, perhaps in considerable numbers although no early population estimates are available. Wright and Snyder (1913) specifically mention four nests with partly grown young in early July, 1912. Howell (1917) quotes Dickey as finding guillemots "nesting in almost every tidal cave" with young in most of the nests in late June, 1913.

The pigeon guillemot was included on the list of birds seen by Sumner in 1939. I did not observe the species in late July of either 1963 or 1964, or in early May, 1965. W. G. Abbott did not mention it among the birds seen in May, 1964. The recent lack of observations of a conspicuous bird which would not likely be overlooked suggests that this species no longer inhabits Anacapa Island or does so in reduced numbers.

Endomychura hypoleuca scrippsi. Xantus' Murrelet. — There is some uncertainty in the literature as to the status of this bird on Anacapa Island in former years. Although Willett (1910) saw the birds in waters around the island in June, 1910, he could find no nests. Later (Willett, 1912), he reported that H. C. Burt took eggs of Xantus' Murrelet in May, 1911. The only other report is that D. R. Dickey and A. J. van Rossem found the bird to be "not uncommon" at Anacapa in the spring of 1913, but whether as a nesting bird is not indicated (Howell, 1917). There are three murrelet egg sets from Anacapa Island in Sidney B. Peyton's collection, with the following data: May 15, 1910, 3 eggs, H. B. Webster; May 15, 1911, 1 egg, H. C. Burt; June 11, 1915, 2 eggs, S. B. Peyton.

There are available four specimens (SDNHM) taken by J. E. Green on May 6, 1938, but there is no indication of the breeding status on the labels. This species was not listed by Sumner in 1939. W. G. Abbott recorded this species near the island in May, 1964. I saw no birds nor evidence of nesting on my visits to the island. This evidence suggests that Xantus' murrelet nests on Anacapa in some years, but perhaps not every year and probably only in small numbers. (SDNHM, 4).

Ptychoramphus aleutica. Cassin's Auklet. — There is no direct evidence that this bird ever nested on Anacapa Island. Willet found the birds common on the night of June 5, 1910, and surmised that they were breeding there, but he did not find the colony (Willett, 1910; Howell, 1917). Other authors have not reported the species on the island. Since the nesting season extends into mid-July (Howell, in Bent, 1919) one might well expect to note the species in the vicinity of a nesting colony in the late part of that month, the time that I visited Anacapa. Although I am familiar with the species' call as it comes to land at night, I have no record of the bird for either 1963 or 1964. This bird probably does not nest on Anacapa Island at present, and perhaps never did.

Lunda cirrhata. Tufted Puffin. — Willett (1910) reported that these birds were nesting on the cliffs on Anacapa Island on June 4, 1910, but does not mention specific areas. Wright and Snyder (1913) observed great numbers near the east end of the island in 1912; on July 5 the few nests that were accessible to them contained young birds, the egg season being past. Puffins are fairly large and conspicuous birds, and should be observed easily if nesting in cliffside colonies. However, Sumner did not list them in 1939, and I did not see them in either of my observation periods in late July, 1963 and 1964. The colony may no longer exist on Anacapa. (UCLA, 1)

**Zenaidura macroura marginella.* Mourning Dove. — The dove has been observed in small numbers, one or two individuals at a time, on each of the islets. They may nest on West or Middle Island. (LBSC, 1)

Tyto alba. Barn Owl. — Willett (1912) and Howell (1917) reported that one had been collected on Anacapa Island. Coast Guard personnel in 1963 mentioned having seen a large white owl, which was probably of this species. One or a few pairs may reside on the island, at least at times.

Speotyto cunicularia. Burrowing Owl. — Burt (1911) was told that burrowing owls had been seen on Middle Island on several occasions. There is no evidence that it occurred there as a nesting species. None was seen in 1963 or 1964, although Sumner saw some in 1939.

Phalaenoptilus nuttallii californicus. Poor-will. — There is a single record, for April. (LACM, 1)

**Chordeiles acutipennis texensis.* Lesser Nighthawk. — I flushed one on East Island, July 26, 1964. Specimens have been taken in August. This species may breed on the island. (LBSC, 2)

Aeronautes saxatalis saxatalis. White-throated Swift. — This species probably nests on Anacapa Island in small numbers. There are records available from March through late July. (LACM, 1)

Selasphorus sasin sedentarius. Allen's Hummingbird. — Hummingbirds are fairly common, especially in the canyons of West Island. (MVZ, 2; LBSC, 2; LACM, 14)

**Colaptes auratus.* Red-shafted Flicker. — This species was reported by Sumner in 1939. The nomenclature used here follows Short, 1965.

**Tyrannus verticalis.* Western Kingbird. — Kingbirds appear as vagrants in late summer. (LBSC, 1; SDNHM, 1)

**Myiarchus cinerascens cinerascens.* Ash-throated Flycatcher. — There are records of this species in April, late July, and August, probably all migrant individuals. (LBSC, 7)

**Sayornis nigricans semiatra.* Black Phoebe. — The black phoebe may be present the year around, but in very small numbers. A specimen from West Island, March 18, is marked as a breeding bird, and nesting probably occurs on East Island as well. Other records are for July and November. (LACM, 1; LBSC, 1)

**Sayornis saya saya.* Say's Phoebe. — Records from March and November are available for this migrant species. (LACM, 1; LBSC, 2)

**Empidonax traillii brewsteri.* Traill's Flycatcher. — This species has been recorded as a fall migrant. (LBSC, 2)

**Empidonax difficilis difficilis.* Western Flycatcher. — These birds were fairly common in the tree-filled ravines near the west end of West Island in 1963. The breeding population must be quite small, however, as the suitable habitat is limited to a few such canyons. The birds are present at least from April to August. Howell (1917) did not list this species, although Lelande had taken a specimen in 1906. (LBSC, 2; LACM, 1; SDNHM, 1)

**Contopus sordidulus* ssp. Western Wood Pe Wee. — This species is known on the island as a fall migrant. The one specimen available is a very dark individual whose racial allocation is uncertain. (LBSC, 1)

Eremophila alpestris insularis. Horned Lark. — Burt (1911) and Willett (1910) both reported the horned lark as among the most common land birds on Anacapa Island. The single specimen available, taken March 16, 1941, on Middle Island, is marked as a breeding bird. I heard larks on East Island in July, 1964, but could not locate what seemed to be a small flock. Horned larks probably still nest on Anacapa, but perhaps in numbers reduced from earlier years. The population level may vary from year to year depending on the condition of the vegetation on this and the other islands. (LACM, 1)

**Tachycineta thalassina.* Violet-green Swallow. — At least one individual of this species was flying over West Island with barn swallows on July 25, 1964.

Hirundo rustica erythrogaster. Barn Swallow. — This species was reported nesting on July 1, 1912, by Wright and Snyder (1913). A male marked "near breeding" was taken on West Island in mid-March. In 1963 and 1964 the barn swallow was common on all three islets, and was nesting just inside the entrance to Sea Lion Cave on West Island in late July. (LACM, 1; LBSC, 3; SDNHM, 1)

Corvus corax. Common Raven. — Burt found a nest ready for eggs on March 17, 1911, and was sure that there was only one pair on the island (Howell, 1917). I did not see this species on Anacapa; it is probably an occasional visitant and sporadic nester.

**Troglodytes aedon parkmanii.* House Wren. — This is a spring and fall migrant, with records in April and August. (LACM, 2; LBSC, 1)

**Thryomanes bewickii nesophilus.* Bewick's Wren. — Although O. W. Howard obtained specimens on Anacapa Island in 1906, this wren was not listed by Howell (1917) and there is no other indication of its presence until Sumner's list of 1939. Specimens of March, 1941, are marked as breeding birds. I found Bewick's wrens to be fairly common on West Island, especially in the denser brush near the top, in 1963, and considered it to be the most common land bird on that islet in 1964. Specimens obtained in late July were immature birds. (LACM, 5; SDNHM, 5)

Salpinctes obsoletus obsoletus. Rock Wren. — Howell's (1917) summary classed the rock wren as common, and reported a set of eggs taken April 30, 1906. Willett (1910) considered this one of the three commonest land birds in 1910. I saw rock wrens in both 1963 and 1964 on West Island, but did not consider them to be particularly common. (LACM, 4; LBSC, 2; SDNHM, 1)

Mimus polyglottos leucopterus. Mockingbird. — Howell (1917) reported only that the mockingbird occurs on Anacapa. There are records from July and August, probably of post-breeding wanderers. (LBSC, 1)

**Regulus calendula cineraceus.* Ruby-crowned Kinglet. — There is a record for November, 1957. (LBSC, 2)

Lanius ludovicianus anthonyi. Loggerhead Shrike. — A pair of these shrikes with a nest full of young on June 4, 1899 (Howell, 1917) is the only nesting record for Anacapa Island. There are additional reports for April, July, and August. Probably not more than one or two pairs are resident. (LACM, 1; LBSC, 1)

**Vireo gilvus swainsoni.* Warbling Vireo. — This vireo is recorded as a fall migrant. (LBSC, 3)

Vermivora celata sordida. Orange-crowned Warbler. — Howell (1917) reported that these birds nest on Anacapa Island in limited number, and records a set of eggs taken on April 6, 1906. Other records cover the period of March through August. I have seen them on all three islets. On May 5, 1965, a female with a brood patch flushed from a light growth of ice plant and coreopsis, but the nest could not be found. The nesting population on Anacapa is probably not large. (LACM, 13; LBSC, 3; MVZ, 2; SDNHM, 1)

**Dendroica petechia* ssp. Yellow Warbler. — This is apparently a fairly common fall migrant. (LBSC, 5)

**Dendroica nigrescens.* Black-throated Gray Warbler. — There is one August record for this species. (LBSC, 1)

**Oporornis tolmiei tolmiei.* MacGillivray's Warbler. — Migrants of this species have been noted in August. (LACM, 1; LBSC, 2)

**Wilsonia pusilla chryseola.* Wilson's Warbler. — This warbler is a migrant in both spring and fall, with records in April and August. (LBSC, 2; MVZ, 1)

Sturnella neglecta. Western Meadowlark. — Meadowlarks occur on all three islets, perhaps more commonly in winter. Howell (1917) quotes Burt as reporting meadowlarks to be very common in 1911. I saw a few on each islet in July of 1963 and 1964, but they were not common; in early May, however, this was the most conspicuous bird on East Island. A specimen taken in late July was in heavy molt. (LBSC, 2; SDNHM, 1)

**Xanthocephalus xanthocephalus.* Yellow-headed Blackbird. — This species has occurred as a vagrant, with one record in August. (LBSC, 1)

**Icterus cucullatus.* Hooded Oriole. — One individual of this species was seen on West Island in July, 1963.

**Icterus bullockii.* Bullock's Oriole. — There are two records of this species, in late July and August. (LBSC, 1)

**Molothrus ater obscurus.* Brown-headed Cowbird. — Cowbirds were seen on both West and Middle islands in July, 1963. (SDNHM, 1)

**Piranga ludoviciana.* Western Tanager. — This species has occurred in July and August. (LBSC, 1)

**Pheucticus melanocephalus maculatus.* Black-headed Grosbeak. — There is one fall record from East Island. (LACM, 1)

Carpodacus mexicanus frontalis. House Finch. — Howell (1917) considered the house finch to be an abundant resident on Anacapa as well as the other Channel Islands. Willett (1910) listed it as one of the three most common species. Although I saw or heard this species on West Island in both 1963 and 1964, I did not consider it to be particularly common. (LACM, 3; LBSC, 1)

**Passerculus sandwichensis* ssp. Savannah Sparrow. — This species occurs as a migrant, probably regularly, in both spring and fall. Records are available for March, April, May, and August. Howell (1911) did not list this species, although Lelande had taken a specimen in 1906. (LACM, 3; LBSC, 2; MVZ, 1)

**Aimophila ruficeps obscura.* Rufous-crowned Sparrow. — The first record for the island is for August, 1940; it may have been overlooked previously, or it may be a recent addition to the island's fauna. I found many of these birds on West Island in 1963 and 1964, and on Middle Island in 1964. At present I consider it to be among the more common passerine species. Several juveniles are among the specimens available. (LACM, 1; LBSC, 1; SDNHM, 5)

**Junco oreganus thurberi.* Oregon Junco. — A single individual of this species was seen on East Island, May 5, 1965. (SDNHM, 1)

**Spizella passerina arizonae.* Chipping Sparrow. — Like the rufous-crowned sparrow, the chipping sparrow was not reported on the island until 1940; in that year a specimen was taken on Middle Island. I saw chipping sparrows only on West Island where in late July of 1963 there seemed to be young of two ages. They were less frequently noted in 1964, but at least one family group was present. (LBSC, 2; MVZ, 1; SDNHM, 3)

**Zonotrichia leucophrys gambelii.* White-crowned Sparrow. — This is a regular visitor in spring and fall, with some perhaps spending the winter. This species was not listed by Howell (1917) although Lelande had taken a specimen in 1906. (LACM, 2; LBSC, 1)

**Zonotrichia atricapilla.* Golden-crowned Sparrow. — This species appears as a spring and fall migrant. (LACM, 1; LBSC, 1)

Terrestrial Mammals

Oryctolagus cuniculus. European Rabbit. — Rabbits were introduced on East Island, I am told, to serve as an emergency food supply for personnel of the Coast Guard Light Station there during World War II. It is also reported that the introduction resulted from escaped pets (K. E. Stager, pers. comm.). Their numbers have fluctuated widely over the years. In 1963 they were uncommon, and in 1964 and 1965 there were but a few rabbits on the cliffs near the east end of the island. The rabbits have done considerable damage to the original vegetation structure of the island (see Dunkle, 1950:263). There are no rabbits on the other two islets.

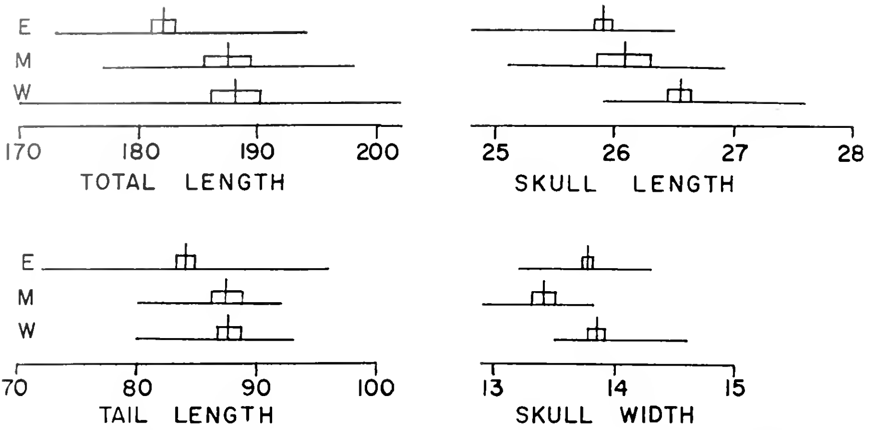

Fig. 4. Diagrammatic presentation of ceratin measurements of *Peromyscus maniculatus anacapae* on East, Middle, and West islets of Anacapa Island.

Horizontal lines indicate range, vertical lines are means. and boxes extend one standard error to either side of the mean.

Peromyscus maniculatus anacapae. White-footed Mouse. — This is the only mouse present on the island; it is common on all three islets, although its abundance may vary from year to year depending on rainfall and resultant vegetation. Mice seem to occur in all habitats. On West Island they were captured in heavy brush, grassy areas, and at the edge of the Opuntia-covered slope. They were least abundant in a dense stand of tall oats (*Avena*). Many trails through the grass atop West Island were originally attributed to rats, but traps set in or near the runways or in the holes to which they led captured only mice. Cut grass stems were abundant along the runways and in cracks and holes in the hard soil. On Middle Island the mice were apparently absent from the eucalyptus grove, but were captured both in grassy areas and coreopsis "forest." On East Island they were particularly common around clumps of prickly pear cactus.

In late July, 1963, the mice on West Island were breeding. One female had five 3 mm. embryos, although two were recorded as having none. A male had testes 10 mm. in length. Gray-pelaged young, about half grown, indicated that breeding had taken place for several weeks previously. Indications from the small sample obtained on Middle Island that year suggested the same timing of breeding. In 1964, however, breeding seemingly had ceased somewhat earlier on West Island. Four females taken July 23 were specifically recorded as having no embryos. Only one male had testes as large as 10 × 6 mm., whereas seven others had testes from 3 × 2 to 6 × 4 mm. Half-grown young indicated that breeding had taken place a month or six weeks previously. On Middle and East islands in 1964, breeding was actively in progress at the time it had ceased on West Island. Males had gonads in the 10 × 6 mm. size range, none showing the regression that had occurred on West Island. Some females were recorded with no embryos, but over two-thirds of the sample were pregnant or lactating; embryos ranged in size from 3 to 22 mm. Partly grown young, about the same size as those found on West Island, were also present. For some reason, then, breeding continued longer on East and Middle islands in 1964 than it did on West Island.

There is incipient differentiation between the populations of mice on the three islets (table 1, fig. 4). The mice on East Island average approximately 6 mm. shorter than those on the other two islands, the difference being a result of both a shorter tail and a shorter head and body. The populations on Middle and West islands are very similar to one another in all these measurements. Although the means of the measurements of body size set the population on East Island apart from the others, the extent of overlap and the rather high degree of variability within the populations on Middle and West islands, as indicated by the large standard errors, preclude any formal taxonomic recognition of the populations at present.

Table 1

Measurements (in mm.) of *Peromyscus maniculatus* on the islets of Anacapa Island. Adults of both sexes are included in the samples. N, sample size; M, mean; SE, standard error; R, range.

	EAST				MIDDLE				WEST			
	N	M	SE	R	N	M	SE	R	N	M	SE	R
Total length	43	182.0	.9	174-194	10	187.4	2.17	177-198	16	188.3	2.06	170-202
Tail length	43	84.05	.76	72-96	10	87.6	1.26	80 92	16	87.75	.99	80-93
Head and body length	43	97.91	.44	92-105	10	99.8	1.26	95-107	16	100.56	1.26	90-110
Skull length	43	25.90	.07	24.8-26.5	9	26.07	.23	25.1-26.9	16	26.55	.105	25.9-27.6
Skull width	40	13.77	.04	13.2-14.3	9	13.4	.105	12.9-13.8	15	13.85	.77	13.5-14.6

The measurements of the greatest length and greatest width of the skulls present a somewhat different pattern of variation, in that the population on Middle Island is not consistently similar to that on West Island. In fact, the Middle Island population has a distinctly narrower skull than the others, and the one on West Island has a distinctly longer one. Plotting these two characters on a scatter diagram reveals a fair separation, from 66 to 90 per cent, of any two of the populations. Eleven per cent of the measurements fall into the zone where all three populations overlap.

Although the differences between the populations do not seem great enough for formal recognition at present, they are interesting in relation to the presumed history of the island. The three islets are separated now, but undoubtedly were joined in the recent past. The gap between East and Middle islands is broader and deeper, and presumably older, than that between Middle and West islands. It is probably significant that, at least in external characters, the mice on East Island are the most distinct. This population rather obviously represents the first isolation from the original stock. However, the more recent and perhaps still incomplete isolation of the population on West and Middle islands has permitted some differentiation, as evidenced by the skull measurements.

It will be interesting to study these populations of mice at intervals in the future in an attempt to trace the progress of the changes noted here. (LACM, 89; LBSC, 19; MVZ, 1; SDNHM, 62)

Rattus rattus ssp. Black Rat. — This rat has been introduced on all three islets, but the time of the introduction cannot be determined. The first specimens were obtained by Bond (MVZ) in 1940, and there are no reports of their presence in the earlier literature.

In 1963, rats were abundant around the ranger station at Frenchy's Cove on West Island. On the coreopsis-covered slopes nearby, many of the mice and rats captured in traps during the night were badly chewed in the morning, presumably by rats. In this area in 1964, rats seemed to be less common, but several were seen at night in the vicinity of the station and the beach at Frenchy's Cove. Stanley Williams reportd his impressions that the rats in the vicinity of the ranger station were less abundant in 1963 and 1964 than they had been in the summer of 1962.

On Middle Island, rats were abundant in 1963 and 1964 at the edge of the eucalyptus grove, particularly in the tall grass and deep gullies. In shorter grass and in coreopsis, trapped mice showed none of the damage attributed to rats on West Island. However, on the ridge of Middle Island, in rather bare soil near the cactus-covered south slope, several trapped mice had been partly eaten.

The scanty information available from five skins saved from trapping in late July of 1963 and 1964 suggests a breeding season extending at least from June to August. Juveniles approximately one-sixth (45 gm.) and one-third (85 gm.) grown were captured in late July. An adult female taken at that time contained seven embryos 10 mm. long, and another was lactating. Males at that time had testes measuring from 21 × 11 to 25 × 12 mm. Weights of adult males ranged from 204 to 347 gm. (LBSC, 2; MVZ, 2; SDNHM, 6)

Felis domesticus. Cat. — "Frenchy", a fisherman who lived for many years at the cove on West Island which now bears his name, had a fondness for cats, and kept a number as pets. They remained on the island when he left, and presumably are the progenitors of the feral population now present. The population is probably not large, and awareness of its presence is based on the presence of scat rather than on observations of the animals.

Ovis aries. Sheep. — Sheep were grazed on the island for many years; exact dates are not available (see Dunkle, 1950:261, 268). Forage grasses were introduced for their benefit, considerably altering the vegetation structure of the islands. Additionally, the soil-compacting action of their sharp hooves probably changed the structure of the ground, which would also have an effect on the plants. The effect of grazing would be detrimental to ground-nesting birds, such as the Meadowlark and Horned Lark, and the soil compaction would be destructive to burrowing species.

Changes in Bird Populations

There have been a number of events in the recent history of Anacapa Island, related to man's activities, which could have had some effect on the resident or nesting avifauna. Among these are the introduction, and later the removal, of sheep, the introduction of rabbits and rats, and the presence of feral house cats. Since there are no good estimates of the sizes of the bird populations either from the early part of the century or from recent years, any comments on changes in populations must be considered conjectural.

It is somewhat difficult to say that an undisturbed condition ever existed on Anacapa Island. The Canalino Indians lived on the island for an unknown number of years (or centuries) before the coming of the white man, and it would be surprising if they did not feed to some extent on the eggs of some of the larger birds. Soon after the coming of the European settlers, sheep were introduced on the island. It is unfortunate that (apparently) sheep got there before the first biologists. It is impossible to determine what effect the sheep, or the exotic grasses introduced for their forage, had on the vegetation or fauna of the island. The sheep have been removed, and the vegetation is apparently still developing toward a new climactic expression, which will include elements of both the original and introduced floras. Whether the introduction of predators has had an effect on the avifauna or on other vertebrates cannot be determined, but some bird species that apparently did nest on Anacapa formerly apparently do not nest there now. Other environmental factors may bear, or at least share, the responsibility for these faunistic changes.

Increases. — The rufous-crowned sparrow and the chipping sparrow were among the most common land birds seen in 1963 and 1964, particularly on West and Middle islands, and both were breeding. I think it is significant that neither of these species was mentioned by writers who visited the island in the early part of the century; the species were first recorded there in 1940, although they may have been present for some years previous. Bewick's wren probably fits into the category of newcomers to the island, despite the fact that two specimens were obtained in 1906; this bird, which is now common, has not previously been mentioned in the literature on birds of the island.

It is probable that the presence of these three species in recent years represents an adjustment of the avifauna to vegetational changes resulting from the cessation of grazing on the island. Bewick's wren and the rufous-crowned sparrow are both primarily chaparral dwellers (Miller, 1951). The unforested habitat is not typical for the chipping sparrow (Grinnell and Miller, 1944:513), and it is probably significant that this is the least abundant of the three apparent newcomers. Very likely the end of grazing by sheep permitted recovery of the shrubby vegetation which provides suitable habitat for these birds (see Dunkle, 1950:268).

Decreases. — Several species of terrestrial passerines — the horned lark, rock wren, house finch, and western meadowlark — seem to be present on Anacapa in smaller numbers now than formerly. The first three were considered by Willett (1910) to be the commonest land birds on the island. The decrease in numbers of horned larks and meadowlarks, which nest in open grassy areas, may be considered a corollary to the increase of Bewick's wren and the sparrows discussed above. As the amount of brush increased after the cessation of grazing, the amount of open grass decreased. Peak numbers of these two species may have occurred when grazing was in progress, which was also when the early ornithological work was done on the island.

Decreases of the rock wren and house finch may be due to predation more than to habitat change. Situations favored by nesting rock wrens are those likely to be investigated by wandering rats. Anthony (1925) regarded cats as the principal factor responsible for the decline of closely related species of house finches on Guadalupe and the San Benito Islands in Baja California, and they may similarly be responsible on Anacapa.

Four species which are dependent on the sea for food seem to be absent from the island now although variably abundant previously. These are the pelagic cormorant, pigeon guillemot, Xantus' murrelet, and tufted puffin. Cassin's auklet may belong in this group also, although there is no convincing evidence that it ever nested on Anacapa. Compaction of the soil by grazing sheep and predation by rats would be detrimental to the murrelet and auklet. However, a change in the distribution of small fish species utilized as food could perhaps account for the decrease in all of these birds.

Two raptorial birds, the bald eagle and the peregrine falcon, are among those species which formerly nested on Anacapa Island but do not do so now. The population decline of these species is widespread and probably results from the interplay of a number of factors, including predation by man. Neither of these birds maintained high populations on Anacapa. Any decrease in the number of medium-sized seabirds, utilized as food, could contribute to the decline of peregrines.

Stable populations. — A few passerine species have apparently maintained fairly constant populations on Anacapa over the years. Their rather infrequent mention in the early literature may indicate rather low densities; if so, the present low numbers are not necessarily indicative of a population decline. The habitat of the western flycatcher and orange-crowned warbler, for example, is rather limited and probably has not changed greatly in extent in the past fifty years.

Among the larger and more aquatic birds, the brown pelican, western gull, double crested and Brandt's cormorants, and the black oystercatcher appear to be approximately as numerous now as formerly.

Summary

The known terrestrial vertebrate fauna of Anacapa Island includes one species of amphibian, two species of reptiles, 69 of birds, and five of mammals. The occurrence of 35 of the bird species is reported here for the first time. Only 28 species of birds are known or presumed to have occurred as nesting species. Only one species of mammal is native, the others having been introduced by man.

A number of factors in the recent history of Anacapa Island must have had important effects on the fauna and flora. The most severe have been the introduction of sheep, the introduction of exotic grasses for forage, the removal of sheep, and the introduction of predators. Several rather poorly documented changes in bird populations are discussed relative to these environmental changes.

There is incipient differentiation between the populations of native white-footed mice on the three islets of Anacapa, as shown by variation in measurements of the skull and external features.

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THE NIGHT SNAKES OF BAJA CALIFORNIA

BY

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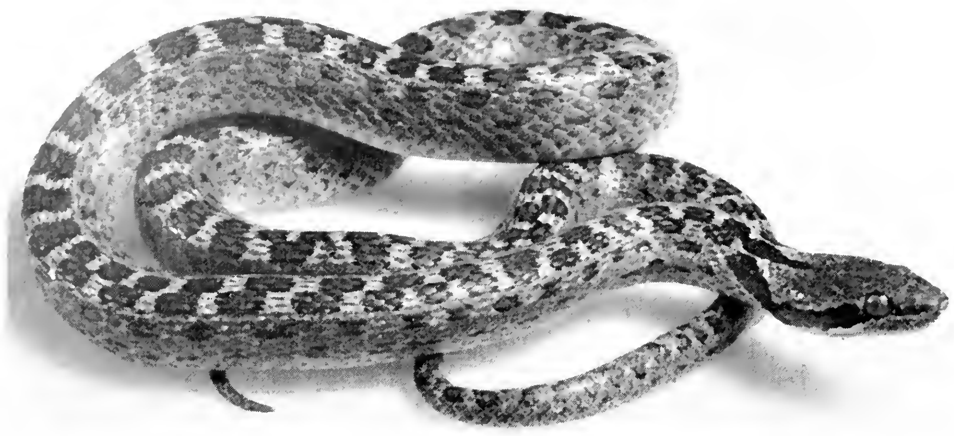

Fig. 1. The type specimen (SDSNH 44680) of *Hypsiglena torquata catalinae*. Photo by Dallas Clites.

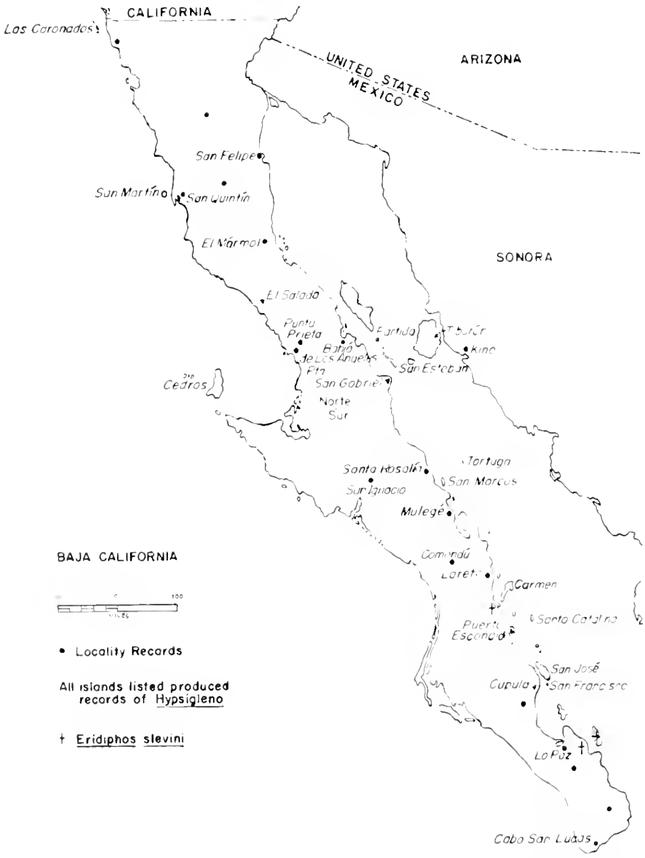

Fig. 2. Map of Baja California, showing the locality records for *Hypsiglena* and *Eridiphas*.

THE NIGHT SNAKES OF BAJA CALIFORNIA

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The genus *Hypsiglena* appears to range throughout all of peninsular and most of insular Baja California. Specimens are now available from the Los Coronados Islands, San Martín Island and Cedros Island on the Pacific coast and the following islands in the Gulf of California: Tiburón, San Esteban, Tortuga, San Marcos, Carmen, San José, Partida (Norte), and Santa Catalina. The size of an island or its distance from the peninsular coast does not appear to affect the distribution. Islands such as Tortuga and Santa Catalina are small and are among the islands farthest removed from the coastline. It is therefore expected that other islands not now known to be inhabited by *Hypsiglena* will be included in the area of distribution in the future.

Based on distribution alone, it is obvious that *Hypsiglena* is an old inhabitant of Baja California, arriving while the islands were still connected to the peninsula.

The concept that *Hypsiglena* and *Leptodeira* are closely related and probably derived from a common ancestor has been discussed by several authors (Dunn, 1936; Taylor, 1939; Tanner, 1946; Duellman, 1958; Leviton and Tanner, 1960). The hypothesis of Leviton and Tanner, that *Eridiphas* is not only an intermediate but also a more primitive genus than either *Hypsiglena* or *Leptodeira*, provides a new concept which may aid in understanding the geographical distribution of these genera, at least in the area of northwestern Mexico and southwestern United States. Seemingly, *Eridiphas* or its ancestral stock was extant in western Mexico and spread into Baja California at an early date, very likely before *Hypsiglena* or *Leptodeira* became serious competitors. Based on present-day distribution, however, *Hypsiglena* may never have been a serious competitor because of its preference for a more xeric habitat. *Leptodeira*, on the other hand, has a preference for mesic or streamside habitats, as does *Eridiphas*, and being an aggressive modern group, *Leptodeira* seemingly eliminated the ancestral *Eridiphas* from areas in which both formerly may have existed.

Anderson (1950) believed that the present Gulf of California north of latitude 25° N was land up to Late Miocene or Early Pliocene, at which time crustal deformations along its western edge caused the present depression. Durham and Allison (1960, fig. 3) also believed that the northern part of the Gulf of California was land as far south as San Esteban Island. They disagree, however, with Anderson as to time, fixing this stage earlier — in the Oligocene or Early Miocene. Thus the distribution of *Eridiphas* stock may have reached southern Baja California by a shorter route before the present Gulf of California was formed. Assuming this to be correct, *Eridiphas* is a relict of a once more widespread group of snakes in western Mexico.

Presumably *Leptodeira* did not reach Baja California before land connections between it and the mainland of Mexico were broken and has not extended its range far enough north to enter Baja California from California. It is really doubtful that the range of *Leptodeira* ever extended farther north than its present distribution because of the drier and/or cooler climates to the north. Indications are that its range has been recently extended north through adaptive radiation. Thus, migration of *Eridiphas* stock in Late Oligocene, Miocene, or Early Pliocene presumably reached Baja California over land bridges connecting the mainland to Baja California. This seems more plausible since we find no relict populations of *Eridiphas* or a similar mesic species north of the distribution of *Leptodeira*.

The cooler temperatures of the Pleistocene apparently prevented a movement north. As the climate changed from that of the Pleistocene to the present desert conditions over much of this area, only the distribution of *Hypsiglena* was favored. Since Pleistocene times, *Hypsiglena* has extended its distribution to include most of northern Mexico and much of adjoining southwestern and western United States.

The extensive distribution of *Hypsiglena*, however, raises some doubt that its ancestral stock remained in the southern warmer climates during the Pleistocene. Today these snakes are found in relatively cool habitats along the northern edge of the range. It would therefore seem logical to assume that *Hypsiglena* entered southwestern United States and Baja California before the close of the Pleistocene and was thus able to reach many offshore islands on both sides of peninsular Baja California before the land bridges between the peninsula and the islands were swamped by the rising sea level resulting from the melting ice. According to Wells and Jorgensen (1964) the climate from 8,000 to 40,000 years ago was significantly less arid than at present in southern Nevada and southeastern California.

Few species of North American snakes have a wider area of distribution than *Hypsiglena torquata*. This has permitted the development of many subspecies, with some appearing (or at least considered by some herpetologists) to be specifically distinct. The question of whether *torquata torquata* and *torquata ochrorhynca* are subspecies or distinct species presumably is not yet settled. Dixon (1965) suggests that two species exist. This is based on the fact that both forms coexist in Sonora and Sinaloa, Mexico. Although I am not prepared to discuss this problem in the present study, I have seen enough material from the critical areas to realize that much more material must be examined before accepting any additional changes in the taxa. It should be pointed out that *Hypsiglena* is an extremely variable and plastic group of snakes, fully capable of the presently reported variations. Therefore, until more material is examined, a change in the specific nomenclature of these snakes is not considered desirable.

Specimens used in this study were provided by Mr. Allan J. Sloan, assistant curator of reptiles and amphibians at the San Diego Society of Natural History (SDSNH); Drs. Clarence J. McCoy and T. Paul Maslin, University of Colorado Museum (UCM); Dr. James R. Dixon, New Mexico State University (NMSU); Dr. Alan E. Leviton, California Academy of Sciences (CAS); Dr. Robert C. Stebbins, University of California (MVZ); and Brigham Young University (BYU). The more recent SDSNH specimens were collected on two (1962, 1964) expeditions sponsored largely by the Belvedere Scientific Fund and the National Science Foundation and under the direction of Dr. George E. Lindsay. I am grateful to the above individuals and institutions for the opportunity to study their material.

Hypsiglena torquata catalinae, subsp. nov.

Type. — An adult male, San Diego Society of Natural History 44680, taken on Santa Catalina Island, approximately 25° 38′ N, 110° 47′ W, Gulf of California, Baja California, Mexico, by George E. Lindsay, June 25, 1964 (fig. 1).

Paratypes. — Topotypes, SDSNH 44376 and 44681; UCM 25949-51; BYU 23556.

Diagnosis. — This subspecies of *H. torquata* is most closely related to *H. t. venusta* and *H. t. ochrorhyncha* of the peninsula of Baja California. It is readily distinguished from *venusta* by the single series of large dorsal spots which are larger and fewer in number, by the presence of only two rather than three rows of lateral spots, and by the high ventral plus caudal total of 240 or more scutes. From *H. t. ochrorhyncha* of the Cape region, *catalinae* is distinguished by the greater number of caudals (up to 63 in males) and also by the much higher ventral plus caudal totals. From *tortugaensis* of Tortuga Island, *catalinae* is distinguished by having the lateral nape spot continuous from the nape anterior to the eye and by having the dorsal scale formula usually reduced to 21-21-17-15. In both *tortugaensis* and *catalinae* the ventral plus caudal totals are high (240 or more). All other subspecies occurring in Baja California, except *tortugaensis*, have a noticeably lower caudal count, usually less than 50, whereas the count in *catalinae* ranges from 52 to 63 scutes.

Description of Type. — Head and body proportions normal, total length 371 mm., tail 70 mm., ratio of tail to total length .188; dorsal scale formula 21-21-17-15, reduction to 19 rows occurring at ventral 118, to 17 rows at ventral 132 and to 15 rows at ventral 170; ventrals 182, with three pairs of gulars between the first ventral and the posterior chinshields; caudals 63, including tip; supralabials 8-8; infralabials 10-10; preoculars 3-3; postoculars 2-2; loreal single; temporals 1-2-3 right, and 1-3-4 left side.

Color pattern consisting of five longitudinal rows of dark brown spots on a grayish-brown ground color; dorsal row of 66 large spots, each spot involving 15-21 scales, outer edge margined with darker brown or black flecks; first lateral row of spots alternating with dorsal series, spots smaller and involving only four to six scales, center of spots lighter in color; second lateral row alternating with first lateral row and opposite dorsal series, spots smaller and involving three to four scales; scales between dorsal and first lateral row lighter in color, producing two narrow but distinct stripes.

Nape with three large spots; a median spot 9 scales long and about 4.5 scales wide, involving scale directly posterior to parietals and fused with first spot of dorsal series; lateral nape spots complete, covering most of last supralabials, upper edge of labial 5 and lower postocular, narrowly separated on each side from median spot by a narrow cream-colored edging which extends anteriorly along edges of lateral nape spots to eyes; head finely and uniformly flecked with darker gray-brown spots; gulars, chinshields and lateral edges of ventrals and caudals finely flecked, center of ventrals and caudals immaculate.

Variation. — The male paratypes are similar to the type in nearly all details. One female, UCM 25950, has 191 ventrals, which is in the usual range of eight to ten scales more than in the males. A second female, SDSNH 44681, has a low ventral count of only 182 scales. This low number of ventrals is either aberrant or it represents in this subspecies a lower ventral count than is usually found in females. The ventrals range from 181 to 184 (182.2) in males and from 182 to 191 in the females. Caudals range from 62 to 63 in males and from 52 to 54 in the females.

Variation in the head scales occurs in the number of preoculars, with three specimens having three scales on one or both sides and one with a single scale on one side; other specimens have two preoculars. The temporals vary from 1-2-2 to 1-3-3 or 1-2-4; the usual temporal formula appears to be 1-2-3. There is little variation in the ratio of tail to total length, with males averaging 18.5 per cent (18.2-18.8) and the females approximately three per cent lower at 15.4 per cent.

Little variation occurs in color pattern except that the nape spots may or may not be separated. In four paratypes, one or both lateral spots are fused with the median spot. The anterior part of the median spot is separated from the posterior part in only one paratype and reaches the scale posterior to the parietals in all specimens. A variation of ten dorsal body spots occurs in the series (56-66). Spots average about two to three times the length of the light intervening spaces. Perhaps a character not yet fully considered in *Hypsiglena* is the narrowness of the space between dorsal spots. In *catalinae* the spots are relatively large, yet there are as many or more spots as in some subspecies with smaller spots.

Discussion

A review of the taxonomic characters used to identify the subspecies of *Hypsiglena* indicates that the color pattern is highly variable and should be used on the basis of (a) body and (b) head and nape patterns. The body patterns may vary in: size and number of mid-dorsal spots; whether the dorsal spots form one or, as in *venusta*, two rows; presence of two or three rows of lateral spots.

The nape pattern usually consists of three large spots, one median and two lateral. Variation in the median spot may result in the following: (a) a long narrow stripe extending posteriorly from the parietal for 10 to 14 scales; (b) a narrow anterior projection with a greatly, often abruptly, expanded posterior part, usually 8 to 10 scales long; (c) the median spot united with the lateral spots to form an irregular nape collar. In all three pattern types the anterior part of the median spot may be divided from the posterior part and may or may not contact the parietals or the scales immediately posterior to the parietals.

Variation in the size and shape of the lateral nape spots is as follows: (a) an extension of the spot anterior to the eye; (b) the spot broken at or posterior to the angle of the jaw; (c) the spots united with the median spot to form an irregular nape collar.

At least six scale patterns now serve as key characters in separating the subspecies. They are as follows: (1) The dorsal scale rows are usually 21-21-17 in *tortugaensis*, but 23-21-19-17 in *martinensis* and usually 21-21-17-15 in *baueri, gularis, klauberi, catalinae, venusta* and *deserticola*. (2) In the ventrals the total range for Baja California specimens is 161-191, with the lower counts occurring in *klauberi* and the higher ones in *catalinae* and *tortugaensis*. (3) The caudals range from 38 to 65, with *gularis, klauberi, martinensis, deserticola* and *baueri* on the lower end of the range. In these subspecies the counts average less than 50 caudals, although a few males may range above 50. The highest counts are in *tortugaensis* (3 females, 57-59, and 1 male, 65; average 59.5) and *catalinae* (2 females, 52-54, and 5 males, 62-63, average 59.8). Intermediate between these extremes in males is *venusta* with an average of 57 scutes. (4) Ventral plus caudal totals provide a more reliable criterion than either the ventrals or caudals when taken alone. *Hypsiglena* specimens with high ventral counts normally have higher caudal counts (an exception to this may occur in *baueri* and *gularis*, where the ventrals in the females are high at 189 and 183-185 respectively, but the caudals are low at 45 or fewer); thus the total of these two counts usually provides a more reliable character. In this character *tortugaensis* and *catalinae* are above 240 combined ventral and caudal scutes, whereas all other subspecies are below, *klauberi* averaging females 227 and males 223, *venusta* females 235 and males 234, and *ochrorhyncha* females 227 and males 225. Other subspecies are not represented in sufficient numbers to provide data on variation in this characteristic; however, the specimens which are available indicate an approximate position in the subspecies series: *gularis*, 226-228; *baueri*, male 216 and females 209 and 234; *martinensis*, 237; and *deserticola*, based on specimens which appear to be intergrades between *deserticola* and *klauberi*, 230-235. (5) The loreals are variable. In *martinensis* and *loreala* the formula is 2-2; however, only the type is available for *martinensis*, and as an occasional specimen of other subspecies in Baja California shows an increase to two loreals, one might regard this character in *martinensis* with suspicion until additional specimens are available. (6) Gulars surrounding the chinshields are usually small and readily distinguishable from other adjoining scales. However, in *gularis* (Tanner, 1954) there is an exception in that those gulars posterolateral to the posterior pair of chinshields are enlarged and elongated so as to appear as a third pair of chinshields.

There is now little doubt that the subspecies *deserticola* enters northeastern Baja California. Specimens taken at El Mármol (SDSNH 41416 and 41583) and at Punta Prieta (SDSNH 11552 and 52918) represent intergrades between *klauberi* and *deserticola*. The nape pattern in all except SDSNH 11552 is like *deserticola;* however, the ventrals and caudals are lower (males, ventrals 173-174, caudals 46-46; females, ventrals 180-187, caudals 41-45), averaging approximately as reported by Tanner (1946:42) for *klauberi*. Geographically, this is as it should be, for the Sierra San Pedro Mártir terminates north of these localities and presumably permits the two subspecies to meet and intergrade south of that range. A female specimen from Bahía de los Angeles (SDSNH 38614) on the Gulf coast also indicates intergradation; the nape and head patterns are a combination of both subspecies. The median spot is shaped like that of *deserticola* but is three scales posterior to the parietals, and the lateral nape spots are divided at the angle of the jaws as in *klauberi*. Ventral and caudal counts (187 and 45) are in the lower part of the range of variation for *deserticola* and in the higher range for *klauberi*. With intergradation established in specimens taken at El Mármol to the north and Bahía de los Angeles and Punta Prieta to the south, it should be expected that *deserticola* would occur south along the Gulf coast, perhaps as far as the southern end of the Sierra San Pedro Mártir. Likewise, *klauberi* should range south a similar distance on the western slopes, along the Pacific side, before intergradation becomes apparent.

Zweifel (1958:15) discussed a male specimen (AMNH 75578) taken 5 miles north and east of Punta Santa Rosalía on the Pacific coast of Baja California. The scale characters (ventrals 181 and caudals 51) and the head and nape patterns (median spot to scale posterior to parietal and lateral blotches weakly continuous with stripes posterior to the eye) when compared with the specimens from Punta Prieta, a locality only 15 miles northeast, indicates that it is also an intergrade between *klauberi* and *deserticola*. The intergrades available to me do not show any influence of *venusta*, and I would not expect that subspecies in northern Baja California unless it extends north along the Gulf coast from Santa Rosalía to the vicinity of Punta San Gabriel (28° 26′ N. 112° 56′ W).

Two specimens (BYU 21992-3) taken 45 miles northwest of La Paz are *ochrorhyncha*, as are specimens from San Francisco Island (SDSNH 44377-8) and San José Island (SDSNH 44379). An area of intergradation between *ochrorhyncha* and *venusta* should lie between Loreto and Carmen Island in the north and the northern part of La Paz Bay and the coastal islands of San Francisco and San José to the south. The lack of material from the Vizcaíno Desert and the Pacific coastal uplands between it and the Magdalena Plain limits a further consideration of the peninsular subspecies. Until material is available from these areas, one cannot determine the northern distribution of *ochrorhyncha*, the western distribution of *venusta*, and the area of intergradation of the latter with *ochrorhyncha* or with the intergrading populations of *klauberi* and *deserticola* to the north. The presently known locality records indicating the distribution are listed on the map (fig. 2).

Material

Specimens examined other than the type series of *H. t. catalinae* are as follows:

H. t. ochrorhyncha. — 45 mi. NW La Paz, BYU 21992-3; San José Island, SDSNH 44379; San Francisco Island, SDSNH 44377-8.

H. t. venusta. — Carmen Island, CAS 51814, SDSNH 44382-3 and 44679.

H. t. tortugaensis. — Tortuga Island, SDSNH 44380-1.

H. t. baueri. — Cedros Island, SDSNH 17339.

H. t. klauberi × *deserticola.* — Bahía de los Angeles, SDSNH 38614; El Mármol, SDSNH 41416 and 41583; Punta Prieta, SDSNH 11552 and 59218.

Two specimens from San Esteban Island (NMSU 9038 and MVZ 74953) are not yet assigned to a subspecies.

Key to Subspecies of *Hypsiglena torquata* in Baja California

A. Lateral nape spot extending anteriorly to the eye. .... B
Lateral nape spot divided near the angle of the mouth, not extending as a single blotch from nape to eye. .... F

B. Dorsal spots divided into two rows, at least anteriorly, with three lateral rows of body spots; ventral plus caudal total averages 235. .... *venusta*
(Gulf coast of peninsula from Santa Rosalía south at least to Loreto, and on Carmen and San Marcos islands).
Dorsal spots not divided into two rows; two or three rows of lateral spots; ventral plus caudal total variable. C

C. One or more pairs of gulars enlarged, appearing as a third pair of caudo-lateral chinshields; caudals 43; ventral plus caudal total 225 to 228; median nape spot enlarged posteriorly, not reaching the parietals; lateral nape spots continuous to eyes. .... *gularis*
(Partida Island, 28° 53′ N, 113° 3′ W).
Gulars not enlarged; caudals usually more than 45; ventral plus caudal total variable; median nape spot enlarged or not. .... D

D. Median nape spot greatly enlarged posteriorly, anterior projection only 1 to 3 scales wide, extending back from parietal 4 to 7 scales, where it enlarges to cover nearly all of dorsal nape; ventral plus caudal total more than 230, average in United States specimens 240 or more. .... *deserticola*
(Eastern San Diego and Imperial counties, California, south in Baja California to El Mármol).
Median nape spot usually not greatly enlarged posteriorly, when enlarged not as above; ventral plus caudal total variable. .... E

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*In attempting to key out *baueri* I could not adequately separate it from *ochrorhyncha* found in southern Baja California. In both color pattern (nape spots, size, shape, and number of body blotches, 48) and in scale patterns (caudals few and ventrals variable, male 168, and females 171-189, one low and the other high, yet both within the range) the differences are not sufficient, at least not in the few specimens reported, to distinguish between these two subspecies. I am not at this time suggesting that *baueri* is not a valid subspecies, but cannot on the basis of the available material key it out.

E. Dorsal body spots large, average 60 to 61, only two rows of lateral spots; ventral plus caudal total 240 or more; caudals 52-54 in females, 62-63 in males. ....*catalinae*
(Santa Catalina Island, Gulf of California).
Dorsal body spots smaller, less than 60, usually three rows of lateral spots; ventral plus caudal total less than 240, average less than 230; caudals average 47 in females, 55 in males, usually fewer in the Cape area. ....*ochrorhyncha**
(Cape region north to area of Cupula, including San José and San Francisco islands).

F. Median nape spot in contact with parietals or scale immediately posterior; caudals 57-65; ventral plus caudal total 242 or more. ....*tortugaensis*
(Tortuga Island).
Median nape spot not in contact with the parietals or scale posterior, anterior part often divided from the larger posterior part; caudals 39-56, ventral plus caudal total less than 240. ....G

G. Loreals 2-2; dorsal scale formula 23-21-19-17; caudals 54 (based on one female specimen). ....*martinensis*
(San Martín Island).
Loreals usually 1-1, dorsal scale formula 21-21-19-17 (15); caudals in females 39-49. ....*klauberi*
(South from western San Diego County, California, into Baja California at least to the area immediately north of El Salado, and on the Los Coronados Islands).

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TRANSACTIONS

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GRAY WHALES NEAR YAVAROS, SOUTHERN SONORA, GOLFO DE CALIFORNIA, MEXICO

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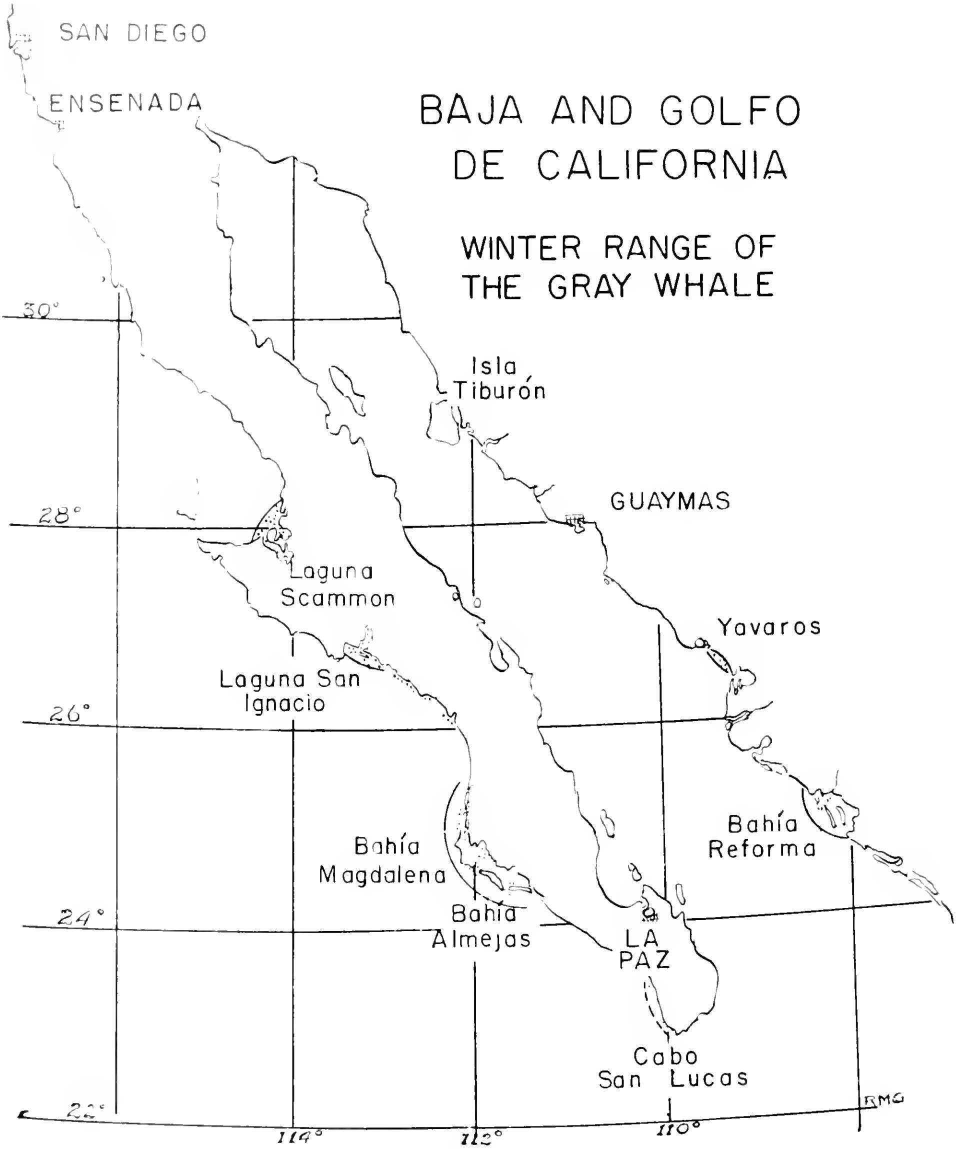
BAJA AND GOLFO DE CALIFORNIA
WINTER RANGE OF THE GRAY WHALE
SAN DIEGO
ENSENADA
Isla Tiburón
GUAYMAS
Laguna Scammon
Yavaros
Laguna San Ignacio
Bahía Magdalena
Bahía Reforma
Bahía Almejas
LA PAZ
Cabo San Lucas
30°
28°
26°
24°
22°
114°
112°
110°
RMG

GRAY WHALES NEAR YAVAROS, SOUTHERN SONORA, GOLFO DE CALIFORNIA, MEXICO

BY

RAYMOND M. GILMORE, ROBERT L. BROWNELL, JR.,
JAMES G. MILLS, AND AL HARRISON

ABSTRACT

California gray whales have calved annually, in the Golfo de California, only at Bahía Reforma and near Yavaros, on the east side. Details of calving and population at Bahía Reforma have been published (Gilmore and Mills, 1962). In this article, the authors have described the calving and population at Yavaros, 1954 through 1966. The authors concluded that: 1) calving has been the only activity there — pregnant and recently parturient females with calf were in the large majority; 2) two groups of females, an odd-year group and an even-year group, each about the same size, 8 to 10 individuals, have aggregated at Yavaros in alternate years; 3) most, if not all, of the Yavaros females have been the same in each group — returning to their regular calving ground; 4) absent were mating activity and many pairs and trios of adults, which meant that mating was done on the west side of Cabo San Lucas or in the Magdalena-area in alternate years for each group. The authors noted no clear feeding activities. They described the physical features of the unusual, open-coast, calving site, 5 to 7 nautical miles south of Yavaros and concluded that the whales could have trans-located their calving activities there, when a town and breakwater were built and boat-traffic increased heavily at the landlocked bay of Yavaros, just to the north. Strangely, the gray whales at Yavaros showed no increase in numbers, 1954-1966, as have the larger populations on the west side of Baja California and at Reforma.

This is a cooperative report by two professional cetologists, Gilmore and Brownell, and two amateurs, Mills and Harrison. In a previous report on the gray whales at Bahía Reforma (Santa María), Sinaloa, Golfo de California, Mexico, Gilmore and Mills (1962) found such cooperation productive, and they have expanded the idea here. Amateurs, especially when in consultation with professionals, can be particularly helpful in cetology, because whales, dolphins, and porpoises may appear on an infinity of shoreline and ocean, as well as in certain places at certain times, and no professional can cover the entire waterfront adequately.

Background — Gray whales (*Eschrichtius glaucus*, formerly *Rhachianectes glaucus*) from the Golfo de California were unreported in the literature prior to 1954. In early February of that year, however, Gilmore and Ewing (1954) found and later reported them in small concentrations in Bahía Reforma (Santa María) and near Yavaros on the east side of the Golfo. Gilmore and Ewing, on the discovery flight, covered the east side of the Golfo from Bahía Kino near Isla Tiburón, south 700 miles to Puerto Vallarta. Ewing, with Carl L. Hubbs, Andreas Rechnitzer, or Gilmore, had seen no concentrations of gray whales on three previous flights along the entire *west* side of the Golfo — the east coast of Baja California — in the winters of 1952 and 1953, and in the spring of 1953.

Gilmore and Ewing continued regular surveys from the air for gray whales along the east side of the Golfo — the mainland side — including Yavaros, in 1955, 1956, and 1957, usually in late February or early March. Subsequently, Mills, in 1962, made a vacation trip by small boat to the Yavaros concentration of gray whales. Harrison made many air-surveys of Yavaros from 1961 through 1966 while on regular flights in his plane from Nogales, Arizona, to Los Mochis, Sinaloa, on his melon-shipping business. Brownell, with Robert C. Boice surveyed Yavaros from a small boat in 1963, and, with Harrison in 1964 and 1966, aided in three air surveys.

Gilmore and Ewing worked with funds from the U. S. Fish and Wildlife Service. Brownell and Boice worked on Research Grant HE 07146 from the National Heart Institute through the U. S. Public Health Service.

These surveys have indicated that gray whales were at Yavaros from late January or early February through mid or late March. None was seen there during any survey in late December, early January, or early April.

In the nine months from April to the following January, gray whales have been absent not only at Yavaros, but also, according to our observations, from the entire Golfo. There is, however, one record from plane, for 16 May 1956 of a single gray whale going south at Isla Angel de la Guarda on the west side of the Golfo (Ewing, *in verbis*). To our knowledge, none of the many oceanographic and biological survey parties in the Golfo in the spring, summer, or fall and early winter seasons, has seen or reported any gray whales.

It may therefore be assumed that the gray whales in the Golfo in late winter have migrated from, and back to, Cabo San Lucas and the west coast of Baja California. Yet, no one, again to our knowledge, has seen any gray whales crossing the Golfo on migration, nor even moving along the east shore between Reforma and Yavaros. We have concluded that the observers and the gray whales in the Golfo have been too few, and the area too large, for adequate observations. Gilmore and Ewing, on 3 February 1954, thought that they saw a gray whale off the south end of Estero Navachiste, 30 miles south of Topolobampo and between Yavaros and Reforma, but, despite efforts, they failed to see this individual again from the plane.

The close similarity of counts over some short periods of time, notably the counts of Gilmore and Ewing on 4 February and that of Hubbs and Ewing on 16 February 1954, has led us to believe that, commonly, all whales at Yavaros were counted. Ordinarily, however, in making one sweep over a large lagoon with many deep channels, the air-surveyors have considered that they counted only one whale in three or four present. But, at Yavaros, the site of concentration was so limited and in such shallow water, that we could usually orbit the area several times, keeping nearly all whales in view, seeing some disappear underwater, and others reappear. Harrison was on personal business when flying, and was unable on all occasions to spend much time orbiting. At other times, the weather was not favorable.

The gray whales at Yavaros have been almost entirely calving females with a calf. Disregarding duplications in the counts of the same individuals, the total number of gray whales seen at Yavaros on all visits from 1954-1966 was 215. Of this number, 93 were cows, 93 were calves, and the other 29 were three pairs (6), a trio (3), and 14 singles, with the group-nature of 6 not noted. Presumably however, they also were singles, or would have been noted otherwise. We saw no courting or mating activities among any of the three pairs or the single trio. Some may have been immatures. The 14 singles — probably 20 — were either immatures, cows that had lost a calf or cows with a calf that was under water at the time of observations.

Nor has Bahía Reforma shown mating activity. The nearest area of mating has been the west side of Cabo San Lucas, 290-300 miles from Yavaros, and 200-210 miles from Reforma — southwest in both cases. The west Cabo area, however, has not been occupied annually, but apparently only when the entrance to Bahía Almejas, the south part of Bahía Magdalena and 120 miles north of the Cabo, was not occupied by breeders. Even so, the calving on the east side of the Golfo was a remarkable case of segregation from breeding on the west side of the Cabo. The nearest heavy *calving* ground to the Golfo has been Estero Soledad, a short distance north of Bahía Magdalena.

The number of gray whales at Yavaros has been relatively constant annually, except for the two years 1956 and 1957, when the counts were low. We had no explanation for this, especially in view of some increase at Reforma, 1954 to 1961, and even more increase of the main herd on the west side of Baja California and southern California between 1953 to 1966 (Gilmore, 1960; Gilmore and Mills, 1962).

If, as now seems probable, the female gray whale is usually a biennial breeder — as are most baleen-whales — we must conclude that the Yavaros cows have not gone there in successive years. They must have bred on the west side of southern Baja California. But the same females could have gone to Yavaros in alternate years because the site has had gray whales every year examined. And, as it seemed probable to us that these gray whales did not find Yavaros at random, we concluded that there have been two groups of females of about the same size, with largely the same females in each group, each of which has gone to Yavaros in alternate years. That is to say, there has been an even-year group and an odd-year group. Female gray whales could return to the site of their birth to calve, or to any lagoon in which they have accidentally established themselves at maturity. They could have done the latter by following others, or by the necessity of parturition at the moment.

Yavaros has been a unique place for calving gray whales to aggregate. The usual places are tidal bays and lagoons. A few females, however, have borne their calves on the open coast of southern California and western Baja California, particularly between Laguna San Ignacio and Magdalena.

The particular site of the gathering of the gray whales at Yavaros has been the straight, apparently unmarked, shallow coast, near the beach, 5 to 7 miles south of the town and landlocked bay of Yavaros. Flights by Gilmore and Ewing disclosed no special submarine, geomorphologic features. But Mills in 1960, noted, from the land, that the gray whales gathered off a small delta of sand that led from a small canyon in the low cliffs back of the beach. Brownell and Boice explored this area by small boat on 3 February 1963, and found the whales one-fourth to one-half mile off the beach in water 3 to 6 fathoms deep.

The proximity of this unusual, consistently used site of calving of the gray whales, to the almost landlocked bay of Yavaros a short distance north, led us to speculate that the building there of a fishing village and a breakwater, with subsequent increase in boat traffic, caused the whales to abandon the area and move a short distance farther south. With the steady and rapid occupation by man of breeding lagoons, especially on the west coast of Baja California at Lagunas Scammon, Guerrero Negro, Estero Soledad, and adjacent Bahía Magdalena to the south, we can expect more calving groups to establish themselves outside tidal lagoons and bays.

None of us saw any evidence of feeding by the gray whales at Yavaros. There were no "balls of bait", *i.e.*, schools of small fish, such as anchovetas and sardines, that we have seen further south near the coast in the same season. Sometimes we have seen a long, twisted trail of mud that we believed marked the swimming path of a gray whale close to the shallow bottom. And occasionally we have seen a whale near the surface at one end of the mud-trail. The great length of some of these mud-trails and their erratic course, led us to conclude that they were not trails of feeding activity by "ploughing" the bottom, but resulted from turbulence by the flukes in swimming, or even from rubbing on the bottom.

The gray whales at Yavaros have shown obviously interesting possibilities for observations and conclusions on population dynamics, territorialism, and segregation. Brownell and Harrison plan to continue their census there.

SUMARIO

La ballena gris de California cria todos los años en el Golfo de California, pero solamente en Bahía Reforma y cerca de Yavaros en la parte oriental del Golfo. Detalles sobre la cria y población ballenera en la Bahía Reforma ya han sido publicados (Gilmore y Mills, 1962). En el presente artículo, los autores se ocupan de la cria y población de ballenas en Yavaros, durante el período que abarca desde 1954 a 1966. Las conclusiones obtenidas son las siguientes: 1) En esta región la única actividad es la cria, de modo que la mayor parte de la población ballenera está integrada por hembras preñadas y parturientes con sus hijuelos. 2) Se han podido observar dos grupos de hembras, las de edad impar y par, presentándose cada grupo con el mismo número de individuos aproximadamente, aumentando de 8 a 10 individuos cada dos años, en la zona de Yavaros. 3) Todas o la mayor parte de las hembras de Yavaros están distribuidas de forma que hay igual cantidad para cada grupo, lo que indica que retornan siempre a su zona regular de cria. 4) Las hembras ausentes estaban aparejadas, presentándose así parejas o trios de individuos adultos. El apareamiento para cada grupo de edades lo realizan cada dos años, y tiene lugar ya sea en la parte occidental del Cabo San Lucas o en la zona de

Table 1. Counts of Gray Whales at Yavaros, Sinaloa, Mexico

Year	Date	Observed from	Observed by	Source of Data	Number of Whales Seen		
					Cow with calf	Others	Total
1954	Feb. 2	air	Gilmore & Ewing	Gilmore and Ewing, 1954	6[1]	1	13
	Feb. 16	"	Hubbs & Ewing	Hubbs, notes	6	0	12
1955	Feb. 14	"	Gilmore & Ewing	Gilmore, notes	7	3	17
1956	Jan. 26	"	Ewing & F. B. Phleger	Ewing, *in verbis*	4	1	9
1957	Jan. 12	"	" "	" "	1	0	2
	Feb. 28	"	Gilmore & Ewing	Gilmore, notes	2	0	4
1961	Feb. 23	"	Harrison	letter[2]	—	—	—
1962	Feb. 11	"	"	"	some	some	15?[3]
	Feb. 17	boat	Mills	"	3	3	9
	Mar. 8	air	Harrison	"	4	0	8
	Mar. 11	"	"	"	6	3	15
	Mar. 15	"	"	"	0	0	0
	Mar. 22	"	"	"	0	0	0
1962-1963	Dec. 14	"	"	"	0	0	0
	Dec. 20	"	"	"	0	0	0
	Dec. 30	"	"	"	0	0	0
	Feb. 3	boat	Brownell & Boice	Brownell, notes	7	3	17
	Feb.-Mar.	air	Harrison	letter	3-4	ca. 3	9-11
1964	Early Jan.	"	"	"	0	0	0
	Feb. 20	"	"	"	5	0	10
	Mar. 8	"	"	"	6	2	14
	Mar. 22	"	Brownell & Harrison	Brownell, notes	2	1	5
	Apr. 7	"	Harrison	letter	0	0	0
1965	Jan. 3	"	"	"	0	0	0
	Feb. 1	"	"	"	1	0	2
	Feb. 5	"	"	"	3	0	6
	Feb. 21	"	"	"	4-5	0	8-10
	Feb. 22	"	"	"	4-5	0	8-10
	Late Mar.	"	"	"	0	0	0
	Apr. 20	"	"	"	0	0	0
1966	Jan. 17	"	"	"	0	0	0
	Early Feb.	"	"	"	4	2	10
	Feb.[1]	"	"	"	4	2	10
	Mar. 6	"	"	"	3	0	6
	ca. Mar. 18	"	"	"	0	0	0
	Mar. 26	"	Brownell & Harrison	Brownell, notes	0	0	0
	Mar. 27	"	" "	"	0	0	0

[1] One of the cows with its calf was seen 9 miles south of the others at Yavaros. [2] "Some spouts seen" (Harrison had not begun to count the whales). [3] "Ten whales with some calves." [4] Mid- to late February.

la Bahía Magdalena. Los autores no observaron concretamente las actividades alimenticias de estos animales. Se describen las características físicas de esta región particular de cria, situada en costa abierta a unas 5 a 7 millas náuticas al sur de Yavaros. Se considera, que las ballenas han trasladado sus actividades de cria a esta zona, cuando la población humana de Yavaros con su bahía protegida aumentó, se construyó un rompeolas y así el tráfico marítimo incrementó enormemente en esa región al norte de la localidad actual de cria. Hay que señalar que las ballenas grises de Yavaros no aumentaron numericamente de 1954 a 1966, como sucedió a las poblaciones más importantes de la parte oeste de Baja California y de Bahía Reforma.

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BIRDS AND MAMMALS OF LA LAGUNA, BAJA CALIFORNIA

BY

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SAN DIEGO, CALIFORNIA
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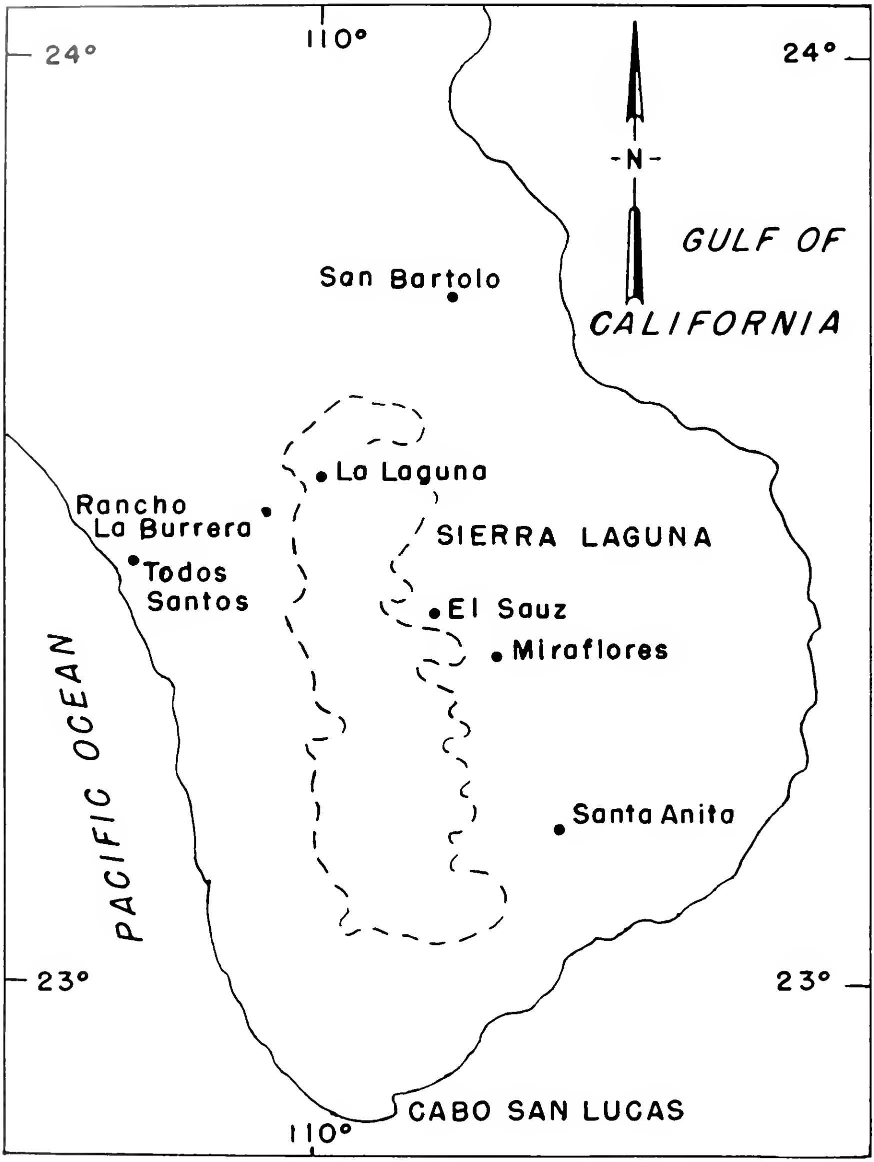

Fig. 1. Map of the Cape region of Baja California, showing localities mentioned in the text.

BIRDS AND MAMMALS OF LA LAGUNA, BAJA CALIFORNIA

BY

Richard C. Banks

Abstract

An annotated list of 69 species of birds and 18 species of mammals known to occur at La Laguna, in the mountains of the Cape region of Baja California, Mexico, presents information on their life histories, with special emphasis on breeding biology. The list was compiled from recent field work and from examination of literature and earlier collections. Previous work in the area is summarized.

Between half and two-thirds of the bird species are known or suspected to breed at La Laguna. Most of the others are migrants or vagrants to the area. Imprecise information does not permit categorization of all species. Fifteen of the 34 birds known to breed there are species or subspecies which breed only in the pinyon-oak forests atop the mountains of the Cape region, and eight others are restricted to southern Baja California.

Four mammals are represented by subspecies which are restricted to the forested area of the mountains of the Cape region; two of these have close relatives in the surrounding lowland, but two are far removed from related forms.

Introduction

In May 1965, a field party of vertebrate zoologists from the San Diego Natural History Museum visited La Laguna, a locality in the northern part of the mountain range known as the Sierra Laguna or Sierra Victoria, in the Cape region of Baja California, Mexico (fig. 1). This paper began as a report on the observations and specimens of the birds and mammals resulting from that trip. Inevitably, our observations were compared to those of others who had been in the area previously. The opportunity arose to examine specimens, in a number of museums, resulting from the earlier trips, and this led to the discovery of much unpublished information in the field notes of early collectors and on specimen labels.

The Cape region of the peninsula of Baja California has long been noted as a center of differentiation of birds (Grinnell, 1928b) and, to a lesser extent, of other vertebrates. Perhaps the isolated mountains with which this report deals, rather than the entire region, should have that distinction, at least for the avifauna. More than a third of the bird forms endemic to southern Baja California are restricted, at least in the breeding season, to the mountains, and several others have probably spread into the surrounding lowland deserts secondarily from the montane forest. Davis (1959) considered the Cape region to be an area of non-differentiation rather than of differentiation, but the fact remains that the southern part of the peninsula is the home of approximately 43 endemic birds (species and subspecies) and of many mammals and reptiles; precisely comparable figures are not available for these groups.

Despite widespread interest in the evolution and ecology of isolated faunas, remarkably little has been written on the biology of the vertebrates of the Cape region. In 1902, William Brewster commented (p. 1): "The simple truth is that the ornithologists who have thus far visited Lower California have devoted most of their attention to collecting and preparing specimens and but very little to making, or at least recording, field observations." Brewster's remarks applied equally well to other vertebrate zoologists, and, although a considerable amount of information has been reported in the intervening years, to a large extent they still apply.

This paper is designed to make but a small beginning toward a more complete understanding of the birds and mammals of the mountain range concerned. Obviously it is not possible, on the basis of a ten-day trip, to present life histories for all the species. The object of this report is to present, for the first time, a complete list of species of birds and mammals known to occur at La Laguna and to summarize the information presently available about each of them.

Acknowledgments

This paper results from field work supported by the San Diego Society of Natural History. Wayne Wilkinson and Norman C. Roberts provided additional support in the form of transportation. Collecting was done under permits from the Dirección General de la Fauna Silvestre; the continued cooperation of that Mexican agency in the Society's and the author's research in Baja California is appreciated.

Much of the material reported herein is housed in the Museum of Vertebrate Zoology, University of California, Berkeley, and I appreciate the courtesy of Seth B. Benson and Ned K. Johnson in making the material available. Dr. Benson graciously gave permission to examine and to report on material that he had collected at La Laguna and gave free access to his notes and those of other members of his field party. I was able to examine catalogs and specimens in the British Museum (Natural History) through the courtesy of the authorities in both the Bird and Mammal departments. Colleagues in the Bird and Mammal Laboratories of the Bureau of Sport Fisheries and Wildlife have been helpful in my examination of mammal specimens housed in the U. S. National Museum. Emmet R. Blake of the Field Museum of Natural History, Raymond A. Paynter, Jr., of the Museum of Comparative Zoology, and Lester L. Short, Jr., of the American Museum of Natural History, have all provided information on specimens housed in those institutions. James S. Findley and E. Lendell Cockrum provided information on the hoary bat.

This report would have been impossible without the cooperation and support, both in the field and museum, of my companions at La Laguna, Allan J. Sloan, Paul F. Ryan, and Thomas J. McIntyre. Their stimulating and helpful comments have added greatly to the report. Each of these three, as well as Richard P. Phillips and Edward C. Wilson, read a draft of the manuscript and made important suggestions.

Throughout this report the following abbreviations are used to designate specimen depositories: AMNH, American Museum of Natural History, New York; BMNH, British Museum (Natural History), London; CAS, California Academy of Sciences, San Francisco; FMNH, Field (Chicago) Museum of Natural History, Chicago; MCZ, Museum of Comparative Zoology, Harvard University, Cambridge; MVZ, Museum of Vertebrate Zoology, University of California, Berkeley; SDNHM, San Diego Natural History Museum; USNM, United States National Museum, Washington.

Previous Work in the Sierra Laguna

John Xantus may have been the first collector in the Sierra Laguna, but if so, his trip there was without practical result. All available specimens of the Baja California montane birds taken by Xantus apparently were wintering at lower elevations. Most of Xantus' trips away from Cape San Lucas, where he was a tide observer, took place in the latter half of 1859 (Madden, 1949:108). One shipment from Xantus to the Smithsonian Institution was lost (Madden, 1949:120) along with three letters describing his excursions inland. Nelson (1921:141) notes that Xantus' letters state that he visited the Sierra Laguna; in a summary letter to Spencer F. Baird, Xantus definitely indicated considerable activity at higher elevations in the Cape region (Madden, 1949:133).

Lyman Belding (1883) seems to have been the first to collect profitably at La Laguna, where he spent February 1-3, 1883. On this short visit he collected examples of 12 species of birds, including the types of several endemic forms. Later in the same month, February 17-22, Belding collected in the southern part of the Cape mountains. His specimens from this period are labeled both "Victoria Mountains" and "San Francisco Mountains"; 10 species are represented. Belding (1883) did not separate these areas in his report of his excursions. His specimens are in the USNM.

In 1887, M. Abbott Frazar spent several months collecting birds in Baja California for William Brewster. Frazar spent "the last few days of April, the whole of May, and the first week of June" in the Sierra Laguna (Brewster, 1902), apparently at La Laguna. He revisited that area from November 27-December 4. Brewster's major paper (1902) on the birds of the Cape region was based largely on Frazar's work and on his "disappointingly brief and inadequate" field notes. I have not examined those specimens, now in MCZ, but I have relied heavily on Brewster's report. Frazar also collected at least one mammal; a gopher, in alcohol, is in the USNM.

Walter E. Bryant was in the mountains of the Cape region for a few days in October, 1890 (Bryant, 1891), but he probably did not visit La Laguna. He collected a number of birds which were deposited in the CAS. In March, 1892, Bryant did some mammal collecting in the Sierra Laguna, but I have been unable to find any details of his work there. There are two skins of *Peromyscus truei lagunae* from that time in the CAS, which were on loan to the U. S. Bureau of Biological Survey when Bryant's collections were destroyed by the San Francisco earthquake and fire of 1906. Further details of these specimens are given in the account of that species.

J. E. McLellan, collecting for the U. S. Bureau of Biological Survey, was in the Victoria Mountains from May 24 to June 12, 1895. His notes indicate that he was at La Laguna for at least part of that time, although his 48 specimens of four species, in the USNM, are labeled only "Victoria Mountains."

In 1896, W. W. Price sent a party consisting of Dane Coolidge, Loye Miller, and J. F. Abbott to collect in the Cape region. They were at La Laguna during most of July. No complete report on their collection was made. "This expedition appears to have been purely commercial and the collections were sold and widely distributed, most of the mammals going to the British Museum" (Nelson, 1921:145). This seems to have been the first comprehensive collection of mammals in the Cape region, at least in the higher elevations. Several of the mammals were later described as new forms, mainly by Oldfield Thomas. I recently had the opportunity to examine the catalogs, and some of the specimens, of both birds and mammals in the BMNH. Of 176 Cape region mammals obtained from Price, 37 (including four subsequently made types) are from La Laguna. Thirty-six birds from La Laguna were also purchased. These collections include 11 species of mammals and 18 of birds. Two bats from the 1896 expedition, preserved in fluid, were formerly in the collection of Stanford University and are now at the CAS. Some bird specimens are in the AMNH and some are in MCZ. Other material from this trip has become widely scattered.

Abbott apparently revisited the Cape region in July and August, 1897, but the extent of his work at that time is unknown. He visited Santa Anita, at least. Nelson (1921) did not include this trip in his summary of scientific explorations of the peninsula.

In the course of their field work in Baja California for the U. S. Bureau of Biological Survey, E. W. Nelson and E. A. Goldman spent January 25-29, 1906, at La Laguna (Nelson, 1921:46-47). They made an important collection of 38 mammals of 6 species and 70 birds of 15 species. Their field lists report nine other species of birds seen; where record is made of those species here, the citation is to Nelson and Goldman without a publication citation. Their collection and notes are in the USNM.

W. W. Brown, collecting for J. E. Thayer, was at La Laguna from August 2 to September 2, 1908. Little was published concerning his efforts there (see Thayer, 1909). The specimens of birds and eggs are in the MCZ (Nelson, 1921:146).

During the course of the "Albatross" expedition of 1911, P. I. Osburn went overland from Cape San Lucas to La Paz to "make a month's trip into the Sierra Laguna for mammals, birds, and reptiles" (Townsend, 1916:431) He apparently did not get into the high mountains, however, as the only inland localities mentioned in Townsend's (1923) account of birds taken on the expedition are Miraflores and San Bartolo Mountain, neither in the main mountain mass.

The next collector to visit La Laguna was Chester C. Lamb, who spent much of 1923 and 1924 in southern Baja California, with at least part of the summer of 1923 and portions of four months of 1924 in the Sierra Laguna (Lamb, 1926). I do not know the disposition of the specimens Lamb took at La Laguna during this time. Some material from lower elevations is in the FMNH and some is in the H. H. Bailey collection, and the specimens from those years may have been widely scattered.

Lamb was again at La Laguna from July 4 to August 7, 1929. He made extensive collections during this period which, with his field notes, are in the MVZ. I have drawn heavily on data recorded on Lamb's specimen labels and in his notebooks; in the accounts of species, references to Lamb without publication dates are to his notes.

J. Stuart Rowley spent May 23-28, 1933 (Bent, 1942:254) at La Laguna. His report on the major results of that expedition (Rowley, 1935) indicates that eggs and skins taken were distributed to a number of institutions.

In the course of general mammal collecting in Baja California, Seth B. Benson, Keith L. Murray, Lloyd Tevis, and J. C. Quast spent June 10-12, 1948, at La Laguna. Dr. Benson has kindly permitted me to examine and report on their collection, which is in the MVZ.

Our Trip

Members of the expedition from the San Diego Natural History Museum to the Sierra Laguna in 1965 included Thomas J. McIntyre, Paul F. Ryan, Allan J. Sloan, and Richard C. Banks. Sloan collected and studied the reptiles and amphibians of the area and contributed a number of observations of birds and mammals which are incorporated into this report. Ryan and McIntyre concentrated particularly on small mammals, trapping and preparing specimens, gathering ectoparasites, and preparing blood smears. I worked mainly with birds, observing and collecting.

We flew from Tijuana to La Paz on May 16, and proceeded by taxi on the following day to Rancho la Burrera, at the foot of the Sierra Laguna. We arrived there late in the afternoon, and began to make arrangements for the pack trip into the mountains. We engaged the services of Trinidad Castillo, the rancher at La Burrera, who provided a variety of mules and horses for our use. On May 17 and 18, we did some field work around La Burrera. This ranch, at an elevation of approximately 1550 feet, is about 10 miles inland from Todos Santos, in an area of thorn forest. At that season it was extremely hot and dry. The area was heavily grazed by goats, cattle, mules, and horses.

On May 19 we ascended the mountain and made camp at La Laguna, where we remained until the morning of May 29. We were joined on May 27 by Norman C. Roberts and Wayne Wilkinson, who had flown from San Diego on the previous day. On May 29 we descended the mountain and returned to La Paz, where we spent the next day repacking our equipment. We returned to San Diego on May 31, in a plane piloted by Wilkinson.

Specimens obtained on this trip are in the San Diego Natural History Museum, with the exception of a representative series presented to the Dirección General de la Fauna Silvestre, Mexico City.

The Area

Nelson (1921:128) noted that "the tops of the Sierra Laguna and other parts of the Sierra Victoria, above about 4,500 feet, is well-marked Upper Sonoran" Life Zone. It should be noted, however, that in the "Cape District" of Nelson's faunal district breakdown, there is considerable overlapping of elements of the life zones. Thus many Lower Sonoran elements, both of fauna and flora, extend into the limited area of the Upper Sonoran zone in these mountains. For the most part, both the floral and faunal elements of the southern part of Baja California are northern rather than tropical in origin, as pointed out by Grinnell (1928b), Nelson (1921) and earlier writers. Davis (1959) has been the most recent to write about affinities of the birds of the Cape region.

The use here of the name "Sierra Laguna" for the northern portion of the mountains of the Cape region, which as a whole are referred to generally as the Sierra Victoria, follows Nelson (1921:64). Many collectors, particularly the earliest ones, were not precise in designating localities on specimen labels. Thus records from the Sierra Victoria or Victoria Mountains may or may not refer to the northern portion, the Sierra Laguna. This northern part of the mountain mass derives its name from the valley of La Laguna, which is the area specifically discussed in this report (fig. 1).

Nelson (1921:64) described the valley at La Laguna as follows: "La Laguna Valley is a small, flat-bottomed basin about a mile or more long in an easterly and westerly direction, and half a mile wide, located at an altitude of about 5,500 feet . . . It is surrounded by steep slopes rising from 100 to 500 feet above it, the highest slopes being on the south and west. Several little streams flow out of gulches at the head of the valley and unite in a small channel down the middle of the flat. The bottom of the valley is said to have been formerly occupied by a shallow lake, from which the name is derived, but a flood cut down the lower end and drained it. The lake, if it ever existed, had long been dry when Belding visited it in 1882. The bottom of the valley has a scanty growth of herbage, but the surrounding hill slopes are overgrown with a low forest of pinyon pines and oaks, the only mountain forest in the peninsula south of the San Pedro Martir Mountains."

The Sierra Laguna is an area of summer and autumn rainfall. Lamb's notes for 1929 record the first rain on July 6; on July 13 he noted that rain had been recorded nearly every day since the 6th. Nelson (1921:64) remarked that this range "has the greatest precipitation of any section in the southern end of the peninsula and is the source of practically all of the surface and underground waters in the region south of La Paz Bay." There is a weather station in the meadow at La Laguna, but it appears not to be attended.

Fig. 2. View of the rocky stream which drains La Laguna Valley at the eastern end.

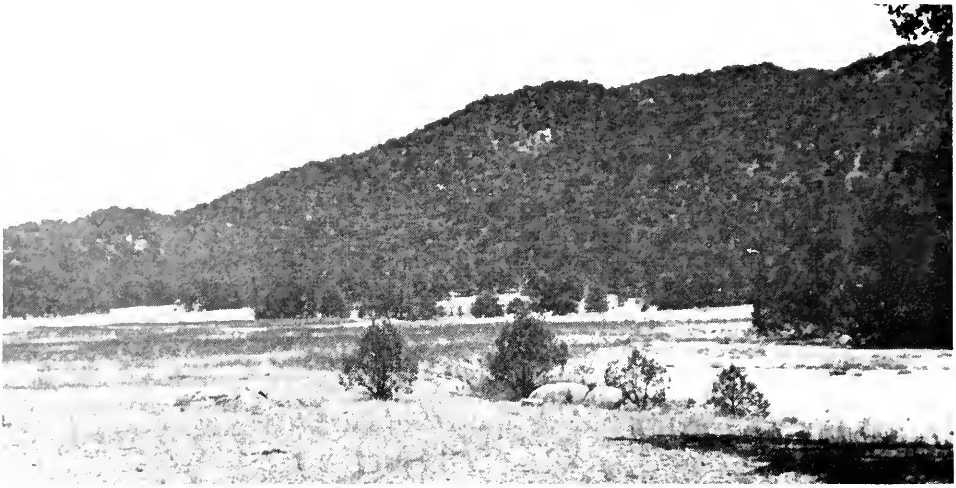

Fig. 3. A portion of La Laguna, showing the pinyon and oak covered slopes. The small pines in the foreground are growing at the edge of a dry stream channel.

Fig. 4. A closer view of the edge of the forest at La Laguna. Clumps of cactus (*Opuntia*) around piles of rock, as at center right, serve as homes for woodrats.

At the time of our visit, the streams in the upper, western end of the valley were mostly dry, with pools of water. Toward the lower, eastern end, the streams held more water and were flowing. A steep, narrow, rocky canyon provides the drainage from that end of the valley (fig. 2). There is another steep canyon leading from the northwest portion of the valley. The valley is close to the north edge of the mountain mass; beyond the rim of hills to the north of the valley there is a sharp drop of several thousand feet.

The hills surrounding the valley (figs. 3, 4) are covered with pine, oak and madrone, many of the trees being very large. There are numerous small meadows in the forest, and a number of streams which flow toward or into the meadow. There is generally a fairly thick, weedy ground cover in the forest, and seeding, especially of the pinyons, seems to be good.

Shortly before our visit a fire had swept the mountains to the northwest, up to the edge of the meadow in places. A few of the larger logs were still smoldering when we arrived. The fire had destroyed the undergrowth but did not seem to have damaged the larger trees.

One family was living in the valley at the time of our visit, but two new houses were under construction. Apolinar Leon Agundes, head of the family there, and his son, Alan Leon Villalobos, were extremely friendly and helped us on a number of occasions. They have lived there for some years and were able to provide much information about the presence and absence of various species in which we were interested. They maintain a few horses and cattle which graze in the meadow and adjacent forest.

Accounts of Bird Species

The order of species and nomenclature used here follow that of the A.O.U. Check-list (1957) except where otherwise noted. Subspecific names are given only where this has been verified by the examination of specimens. An asterisk (*) before a name indicates that the species is considered part of the breeding avifauna of La Laguna. The location of specimens, where not indicated, can be determined from the section on previous work.

Pelecanus occidentalis. Brown Pelican. — Sloan found the skeleton of a pelican in the meadow on May 22. This strictly coastal bird is surely not a normal part of the fauna of La Laguna.

**Cathartes aura.* Turkey Vulture. — We saw up to a dozen of these birds at one time. Strangely, most observers at La Laguna have not listed this species — perhaps because it is so commonly seen.

Accipiter striatus. Sharp-shinned Hawk. — Frazar reported this species as a winter visitor (Brewster, 1902).

Accipiter cooperii. Cooper's Hawk. — We saw a single bird on May 21. It soared quite high over the meadow, much in the fashion of a buteo. Frazar collected a male in immature plumage on May 9. Nelson saw one in January, 1906.

**Buteo jamaicensis.* Red-tailed Hawk. — We saw no more than one individual at a time, and our several sightings seemed to be of the same bird, one with a very pale tail. Brewster (1902:86) recorded six specimens from "Sierra de la Laguna."

Buteo regalis. Ferruginous Hawk. — Frazar obtained two specimens "on the summit of the Sierra de la Laguna" on November 28, 1887 (Brewster, 1902).

Circus cyaneus. Marsh Hawk. — Frazar saw this species in early December (Brewster, 1902).

Falco peregrinus. Peregrine Falcon. — Lamb included the "Duck Hawk" in his list of birds seen at La Laguna in the summer of 1929.

Falco sparverius. Sparrow Hawk. — Two specimens (BMNH) were taken June 26 and 29, 1896. One is cataloged as a juvenile female, an indication that this species might be considered a breeding bird at La Laguna. Nelson and Goldman saw the species in January, 1906. It has not been reported from La Laguna by others.

**Charadrius vociferus*. Killdeer. — Frazar found "some ten pairs" nesting "on top of the Sierra de la Laguna" in early May, with a few birds present in late November (Brewster, 1902:71). Lamb collected a female in heavy molt, weighing 85.7 gm., on August 2, 1929. We did not see killdeers in May, 1965.

Capella gallinago. Common Snipe. — There are two winter sight records for the Sierra Laguna — one by Frazar, November 28, 1887, and one by Nelson and Goldman, January 29, 1906.

**Columba fasciata vioscae*. Band-tailed Pigeon. — The available information on the life history of this endemic resident race of pigeon was summarized by Lamb (1926) and Bent (1932). One fact brought out by those accounts is that the nesting season is either quite prolonged or quite variable. Nests have been found in every month except March, October, and November. There appears to be considerable movement of flocks of these birds, and breeding may be exceptionally responsive to favorable local conditions.

Sloan noted that pigeons were extremely abundant at La Laguna in July, 1951, and we found band-tails to be abundant there in late May, 1965. At the latter time, they were particularly conspicuous and noisy in the early morning and evening around water. They visited the spring near our camp each afternoon at approximately the same time. We saw no evidence that nesting was under way, and most birds seen were in flocks. Calling took place during the day from conspicuous perches on dead snags or exposed branches of trees. The birds flew very slowly when about to land, and often gave, at that time, a hoarse, throaty, raven-like squawk. On May 27 one bird flew very low and rapidly into our camp, with a noise like a small jet.

We took two males as specimens on May 25. They weighed 295 and 320 gm., and had testes 15 x 7 and 13 x 7 mm., respectively. Weights of five males collected by Lamb (MVZ) averaged 323.4 gm., with extremes of 288.0 and 362.6 gm. Two females that he obtained weighed 292.8 and 293.0 gm. Two specimens taken in 1896 are in the BMNH. Specimens secured by Belding and by Nelson and Goldman are in the USNM.

**Zenaida asiatica mearnsi*. White-winged Dove. — This species was less common than the band-tailed pigeon but more abundant than the mourning dove at La Laguna in late May, 1965. We found no evidence that nesting had begun, although a male taken May 23 (weight 164 gm.) had testes 15 x 7 mm. A week earlier at Rancho la Burrera, some 4000 feet lower, white-winged doves were paired but not yet nesting; they were much more abundant at the lower elevation. Frazar reported that the doves were mated but not yet nesting at La Laguna in early June (Brewster, 1902). Lamb's notes mention that between July 4 and August 7 he found nests with eggs and young in all stages; he specifically noted a nest containing a large young on July 15. Breeding at this elevation is thus at least a month later than on Cerralvo Island, which is at approximately the same latitude (Banks, 1963b) and about three months later than on Carmen Island, 100 miles farther north in the Gulf of California (Banks, 1963a).

Zenaidura macroura. Mourning Dove. — A flock of 10 to 12 birds was seen daily in the meadow. Singing was first heard on May 21 and was more frequent by May 27, our last day of observation. Brewster (1902) reported that Frazar found them to be abundant on the Sierra Laguna in early May, but that they had left by the end of the month. Lamb, however, considered the mourning dove "common" and apparently saw them throughout the summer. He took a specimen (MVZ), a female weighing 102.8 gm., on July 10, 1929, but recorded nothing concerning the breeding of the species at La Laguna. This specimen, the only one taken in the breeding season in southern Baja California, was not seen by Aldrich and Duvall (1958:115), who followed earlier authors (Grinnell, 1928b; Friedmann, Griscom and Moore, 1950) in considering the southern limit of the breeding range of the species to be considerably farther north. It remains to be determined whether there actually is a breeding population in the mountains of the Cape region, and if so whether Ridgway's (1916:348) tentative diagnosis of a racially distinct population in that area is valid.

Coccyzus americanus. Yellow-billed Cuckoo. — Brewster (1902) reported that this species occurred in the higher Sierra Laguna in the rainy season of late summer, but Grinnell (1928b:119) discounted the rumors on which the report was based. Later, however, Lamb included "California Cuckoo" in his list of birds seen at La Laguna on July 22, 1929.

Geococcyx californianus. Roadrunner. — Lloyd Tevis noted seeing a roadrunner in the meadow on June 12, 1948. This is the only record for the high elevations of the Cape region.

Tyto alba. Barn Owl. — Frazar "obtained a number of its wing and tail feathers on the Sierra de la Laguna" (Brewster, 1902).

**Otus asio xantusi.* Screech Owl. — We heard screech owls occasionally at La Laguna, but were unable to obtain specimens. This was the least often noted of the three owls that we heard. On July 18, 1929, Lamb saw a screech owl "perched in a thick green tall leafy bush growing beside the stream in a canyon." That bird was a female which weighed 117.8 gm. A male taken at Rancho la Burrera on May 18, 1965, had testes 12 x 7 mm.

**Bubo virginianus.* Horned Owl. — We heard horned owls several times, but never more than one individual in an evening. Frazar often heard as many as three or four at once, and collected two specimens, one of which is the type of *B. v. elastichus* (Brewster, 1902:96). A specimen secured by Lamb on July 24, 1929, was a male weighing 647 gm.

**Glaucidium gnoma hoskinsii.* Pygmy Owl. — Frazar found this owl to be common, "for several were heard calling almost every night in May and early June" (Brewster, 1902); he also heard one on November 30. We also heard them often and considered the species common. Lamb, however, did not collect or list this species in July and August of 1929, and Rowley (1935) considered it to be rare, which suggests that there may be annual or local fluctuation in numbers.

Imitated calls of this species at any time of day immediately attracted large flocks of small passerines, including bush-tits, titmice, juncos, towhees, and vireos. On May 24 a pygmy owl responded to my calling in the late afternoon. The flock of small birds which had been swarming around me immediately turned its attention to the owl, ignoring me even though the bird and I "sang" antiphonally for several minutes. The owl was a male with testes 3 x 1.5 mm. It weighed 51.8 gm., and had the posterior half of a male lizard, *Urosaurus nigricaudus*, in its stomach.

Caprimulgus vociferus. Whip-poor-will. — The biggest surprise of our stay at La Laguna was hearing the unmistakable call of the whip-poor-will, and the biggest disappointment was not obtaining a specimen. Three individuals were heard on May 19, our first night in camp, and they were heard frequently until the morning we left. The birds were extremely wary; they ceased calling when approached, and flew long distances when disturbed.

This species has not previously been reported from Baja California. Belding (1883:349), however, in discussing some unidentified bird notes heard in the Sierra Laguna in the winter of 1882-3, says: "In a single instance, I think I heard a *Glaucidium*, and again a noise I referred to some unknown animal, but the guide said it was a 'Tapa Camino,' or Whipporwill. It may have been the notes of *Phalaenoptilus nuttallii* . . ." The closest reported breeding locality of the whip-poor-will is in the Sierra Madre Occidental of central eastern Sinaloa (Friedmann, Griscom, and Moore, 1950:157).

**Phalaenoptilus nuttallii dickeyi.* Poor-will. — We heard poor-wills calling nightly, and they seemed to be common. Frazar also found them to be common in the mountains, and reported that they did not begin to sing until about the middle of May (Brewster, 1902). On the other hand, Lamb considered them scarce, and heard them for only the first two weeks of his stay. On July 16 he noted: "One seldom hears the characteristic poorwill call here. The birds utter their call either sitting or flying, but when they are on the ground they give a sort of a clucking sound, this for only a short time just before it gets real dark." It appears that poor-wills have a short season of singing in this area.

Nesting seems to begin late here. A female that we collected on May 21 showed no indication of breeding readiness. Specimens taken on June 6 (Brewster, 1902) and June 8

(Rowley, 1935) were reported as not yet nesting. Lamb commented that the last specimen that he took, on August 5, showed signs of nesting soon.

The female that we secured on May 21 was flushed from a small pine at the edge of the meadow. It weighed 34.8 gm. Lamb collected four males (MVZ), ranging in weight from 35.4 to 44.7 gm. with an average of 40.6 gm.

Rowley (1935) reported L. B. Bishop's determination of two specimens, from Miraflores and San Fernando, as *P. n. dickeyi*, whereas two others, from Miraflores and La Laguna, were referred to *P. n. hueyi*, a race known only from the deserts around the lower Colorado River Valley. Emmet R. Blake (*in litt.*) tells me that the subspecific designations on the latter specimens (FMNH) were subsequently changed to *dickeyi*, but it is not known when or by whom. Grinnell's (1928a) characterization of *dickeyi* perhaps overemphasized the darkness of parts of the plumage. The small series of *dickeyi* in the SDNHM is in general closer to *hueyi* than to *californicus* in coloration.

Chordeiles acutipennis. Lesser nighthawk. — Frazar (Brewster, 1902) and Rowley (1935) saw this species at La Laguna, but they did not have evidence of it nesting at that elevation. Keith Murray listed it in his notes in 1948; we did not see nighthawks during our stay.

**Aeronautes saxatalis.* White-throated Swift. — We observed this species only during our descent from La Laguna on May 29. Frazar apparently found it to be somewhat more common, and took two specimens on May 19 that were in breeding condition (Brewster, 1902). There are two specimens in the BMNH that were collected in 1896. Lamb reported seeing the species on July 19, 1929.

**Hylocharis xantusii.* Xantus' Hummingbird. — This is the only hummingbird that we found at the top of the mountains. We saw it fairly commonly, as have most other observers, but not in the abundance indicated by Lamb (1925); I considered it more abundant at the lower elevation of Rancho la Burrera.

On May 24, I saw a hummingbird moving actively at about 5:20 a.m., well before the sun was up and while it was still quite cool. These birds stay at the high elevations during the winter; Frazar found them abundant on "the cold, sleety mountain" in late November and early December, and Nelson and Goldman took a specimen in January, 1906.

Lamb (1925) has summarized several aspects of the life history of this species from his observations at La Laguna and elsewhere in 1923 and 1924. He found the nesting season in the mountains to extend from mid-July to mid-September. In his notes for 1929, he reported finding the first nest ready for eggs on July 21, and the first nest with young on August 6. Although most nests were built at the ends of branches of small oak trees, one was found in a pine and two were in madrones.

Lamb recorded the weights of 11 females collected in 1929; they ranged from 3.2 to 3.9 gm., averaging 3.5 gm. A female that we took on May 25 weighed 3.0 gm. One male secured by Lamb weighed 4.0 gm. Male specimens in the BMNH were collected June 16 and July 7, 1896.

**Colaptes auratus chrysoides.* Flicker. — The gilded flicker is not as common high in the mountains as at lower elevations, but we saw it on several occasions. On May 26, Sloan found a nesting cavity in a *Nolina* along the stream in the meadow, and could hear young birds in it. That same day I collected the male of a pair nesting near a stream in the heavy forest. That bird (weight 137.3 gm.) had a brood patch and testes measuring 11 x 7 mm. Lamb noted that flickers had large young when he arrived in the mountains in early July. The nomenclature followed is that of Short (1965).

**Melanerpes formicivorus angustifrons.* Acorn Woodpecker. — This was one of the most common species at La Laguna in May, 1965; it was noisy and conspicuous, and was found in rather large groups. Frazar reported that the numbers declined perceptibly after the first week in May, and that it began breeding at La Laguna in June (Brewster, 1902). He also found a few birds there in the winter, but felt that large numbers had moved to lower elevations; Belding, and Nelson and Goldman took specimens in winter at La Laguna.

We obtained five specimens from May 21 to 28. A male had testes measuring 5 x 3 mm. One female had a brood patch and two collapsed follicles in the ovary. Ovaries of the other females contained no large ova.

Weights are available from our specimens and from Lamb's. Seven males ranged from 61.8 to 70.5 gm., averaging 66.1 gm. For eight females, extremes were 58.0 and 67.4 gm., with an average of 62.6 gm. Two females at the upper extreme were noted as being very fat.

Sphyrapicus varius nuchalis. Yellow-bellied Sapsucker. — This species has been found as a winter visitor at La Laguna. Belding (1883) took a specimen on February 1, and Nelson and Goldman obtained two in late January. All specimens are males.

**Dendrocopos scalaris lucasanus.* Ladder-backed Woodpecker. — This bird is much less common at La Laguna than in the lowlands of the Cape region. Frazar did not find it in the mountains, and we heard it only a few times. Nelson and Goldman obtained three specimens in late January, 1906, and Lamb took three in the summer, including an immature male on July 27. Weights on two adult male specimens secured by Lamb are 35.1 and 37.4 gm.

Tyrannus vociferans. Cassin's Kingbird. — Belding (1883) saw this species "around the meadow at Laguna" in winter, and considered it rare.

Myiarchus tuberculifer tresmariae. Olivaceous Flycatcher. — A specimen taken by Loye Miller on June 24, 1896, "in the Sierra Laguna" is now in the AMNH (Phillips, 1949). This form must be considered accidental in Baja California.

**Sayornis nigricans.* Black Phoebe. — Frazar found this species "to the summit of the Sierra de la Laguna" (Brewster, 1902). It is apparently uncommon at the higher elevations, however, as Lamb notes having seen only five, the first on July 17. Tevis saw one on June 12, 1948, and Sloan saw one on May 20, 1965. Lamb obtained two specimens, a female weighing 16.8 gm., and a male weighing 21.0 gm.

Sayornis saya. Say's Phoebe. — Nelson included this bird in his list of species seen on January 28, 1906.

Empidonax difficilis difficilis. Western Flycatcher. — A specimen taken by Belding on February 2, 1882, and now in the USNM, is probably best referred to this race although the age of the skin and the fact that it is unsexed make the basis for subspecific determination rather tenuous.

**Empidonax difficilis cineritius.* Western Flycatcher. — This form was described by Brewster on the basis of specimens taken by Frazar at La Laguna. Brewster later (1902) reported that Frazar had found it at La Laguna in the summer and at lowland localities (La Paz) in the winter. It was not noted at high elevations in winter by Nelson and Goldman, but visitors to the mountains in summer months have almost invariably reported it to be common.

In May, 1965, this species was abundant in the shade beneath large oaks and madrones, at the edges of the meadow, and in openings along the streams in the forest. We took six specimens. Weights of five birds ranged from 10.5 to 10.8 gm.

Nesting was actively under way during our visit. The testes of five male western flycatchers measured from 6 x 3 to 7 x 4 mm. Near the end of our stay at least one pair was seen feeding young out of the nest. Rowley also reported nesting in late May (Bent, 1942:245). Lamb reported active breeding in July, 1929; he found a nest ready for eggs on July 15, and two eggs well advanced in incubation on July 26, as well as large young.

**Contopus sordidulus peninsulae.* Western Wood Pewee. — According to Frazar, this species arrives in the sierra in mid-May, the males before the females, and is common in late May (Brewster, 1902). Lamb, however, considered it the rarest of the Sierra Laguna endemic forms, and to me it seemed decidedly uncommon in late May, 1965. I saw only four or five individuals during our stay.

This species seems to breed rather late, and had not yet begun by the end of May; a female taken May 23 had tiny ova and no brood patch. Frazar took an incubating bird, at a lower elevation, on June 20 (Brewster, 1902), and Lamb found a nest high up at the extremity of a limb in a large oak on July 15.

Weights of four males secured by Lamb ranged from 13.6 to 14.4 gm., with an average of 13.9 gm. Five females, four taken by Lamb, ranged from 12.5 to 14.1 gm., averaging 13.1 gm.

**Tachycineta thalassina brachyptera.* Violet-green Swallow. — Frazar found this species to be common in May and early June, at which time it was nesting (Brewster, 1902). We saw swallows on only a few days, usually flying high over the meadow. On May 28 two birds were captured in a mist net set across a small stream in the meadow, presumably as they came to drink. Both were males, with testes 8 mm. long; one had a cloacal protuberance. Weights were 12.0 and 12.3 gm. Frazar also found this bird high in the mountains in early December. This species is not included in Lamb's rather complete notes from 1929, and other observers have not commented on it. It seems to be less common than Frazar indicated.

Hirundo rustica. Barn Swallow. — This swallow has been reported in the Sierra Laguna in August (Grinnell, 1928b:189).

Progne subis. Purple Martin. — Frazar observed martins regularly at La Laguna from late April through early June, but apparently not as a breeding species (Brewster, 1902). We did not see this species, and others have not commented on its presence at La Laguna.

**Aphelocoma coerulescens hypoleuca.* Scrub Jay. — We observed only one small group of jays at La Laguna, in an area of rather heavy forest. Although this species nests from March to mid-May at lower elevations (Brewster, 1902; Rowley, 1935), Brewster reported that "the birds seen by Mr. Frazar on the Sierra de la Laguna in May and early June were in flocks and showed no signs of having bred that season or of being about to breed." Frazar did not see jays at La Laguna in November, and Brewster (*op. cit.*) suggested that they move to lower elevations in winter. However, Belding (1883) called the species moderately common in the mountains in winter, and Nelson and Goldman took a specimen at La Laguna in January.

**Corvus corax.* Common Raven. — Brewster (1902) mentions ravens with reference to the Sierra Laguna only in December, but the species is common there in the summer also. We saw as many as ten at once, and saw them nearly every day. On May 26 I found a nest in a tall tree in a heavily wooded canyon, in which there were at least two quite large young birds. Lamb saw a flock of at least 100 ravens on July 16. A male collected by Lamb on July 15 weighed 802.8 gm.

**Parus inornatus cineraceus.* Plain Titmouse. — This is one of the more abundant birds at La Laguna. Belding (1883) found it "common from 3,000 feet altitude upward" and Frazar "found it quite as numerous in December as in May and June" (Brewster, 1902). This race was described on the basis of specimens taken by Belding at La Laguna.

Frazar reported no evidence that titmice were breeding in May and June, and Brewster (*op. cit.*) surmised that the eggs "are probably not laid much before midsummer." Quite in contrast to this, we noted that the breeding season seemed to be drawing to a close in late May. Most of the birds we saw were in family groups, with adults feeding young out of the nest; this was true as early as May 21. Gonads of the males were already regressing; in adult birds taken May 21 and 24, testes were 4 and 2.5 mm. long, respectively. A female taken with a young bird she was feeding on May 27 had a brood patch. As Frazar found no reproductive activity in June, and Lamb made no comments on this species in his notes for July, it can be assumed that only a single brood is raised at La Laguna.

Adult males that we took as specimens in May weighed 14.1 and 15.5 gm.; adult females weighed 11.8 and 15.3 gm., and juvenile males, 12.1 and 14.1 gm. Lamb secured a series of 24 birds from July 6 to 24, 1929. Fifteen males ranged from 14.2 to 16.9 gm. (average 15.8 gm.), and nine females from 14.1 to 16.1 gm. (average 15.1 gm.); these weights are not separable by age. Most of the birds in Lamb's series are molting the primaries and are otherwise in very worn plumage.

**Psaltriparus minimus grindae.* Bush-tit. — This is one of the very common species in the Sierra Laguna, and another described as a result of Belding's collecting effort at La Laguna. Most of the birds we saw were in groups of up to eight individuals, presumed to be family groups. This species responded quickly and emphatically to imitated calls of the pygmy owl, but not to those of the screech owl.

The large family groups that we saw in mid-May, and the evidence of nesting at that time, suggest a protracted nesting season and double broodedness. Frazar found a nest, not quite completed, in a pine on May 24 (Brewster, 1902). I found two nests, both at the ends of drooping branches (one dead) of oak trees at heights of approximately 10 and 12 feet. Young were being fed in both nests on May 21. Lamb commented on the presence of large young following parents on his arrival in early July.

Weights of 17 specimens, 14 taken by Lamb and three by us, ranged from 4.9 to 6.7 gm., averaging 5.45 gm. Specimens taken by Lamb in July were molting inner primaries.

**Sitta carolinensis lagunae.* White-breasted Nuthatch. — Although not as abundant as either of the preceding two species, nuthatches were widespread in the forest. Frazar found them incubating early in May (Brewster, 1902), and we found them feeding young out of the nest later that month. Apparently there is but a single brood, as a mated male taken May 23 had testes only 3 x 2 mm., indicating post-breeding regression. Lamb commented that the nuthatches seemed to have nested before July, but he saw no young.

Weights of two adult females in May were 14.7 and 15.3 gm. A male weighed 15.2 gm., and an unsexed juvenile, 15.0 gm. A series taken by Lamb in July was considerably heavier; six females ranged from 15.7 to 16.7 gm., averaging 16.1 gm., and five males weighed from 15.5 to 18.1 gm., averaging 16.9 gm. Most of Lamb's series had completed the molt of the flight feathers in late July, but a few, which are perhaps birds of the year, retained worn primaries at that time.

**Catherpes mexicanus.* Cañon Wren. — Frazar noted that the number of cañon wrens increased steadily during his stay at La Laguna (Brewster, 1902). Nelson and Goldman took specimens in the winter, however, and the species is probably resident in the Sierra Laguna, as elsewhere. The apparent increase in numbers noted by Frazar may have been the result of increased singing or other activity. We heard this species singing in several canyons leading off the meadow, but we did not consider it to be common. On three occasions I noted wrens working over the trunks of oak trees much in the manner of creepers or nuthatches, flicking off bits of bark with the bill.

Lamb noted that cañon wrens had large young when he arrived at La Laguna early in July, and that two birds taken later that month were members of family groups. Weights of five specimens taken by Lamb ranged from 10.8 to 11.8 gm., averaging 11.2 gm.

**Turdus confinis.* San Lucas Robin. — Bent (1949) summarized the available information on the life history of this species, and I can add little to his account. The birds were common on our arrival at La Laguna, and we saw no evidence of an increase in numbers as was reported by Frazar (Brewster, 1902). Robins congregated along the streams in the meadow in early morning and in the evening. During the day they were abundant in forest openings and at the edge of the forest and meadow. All sounds given by these robins are similar to those of *Turdus migratorius*, except that they are much softer — neither as harsh nor as loud.

The testes of five males taken in late May ranged in size from 5 x 3 to 9 x 5 mm. The single female obtained had no enlarged ova in the ovary. We found no good evidence that nesting had begun by the end of May. Rowley (*in* Bent, 1949) found a nest early in June, and Bent (*op. cit.*) mentions another nest taken on June 13, by W. W. Brown. Most nesting apparently occurs later, however, with the peak of activity in July. Lamb wrote in his notes that these robins start laying eggs about July 1, usually making nests at the extremities of slender branches of large oaks. Lamb found his first nest with small young on July 10, and he found young ready to fly on July 15. All nests mentioned by Bent (*op. cit.*) contained three eggs, but Lamb found from two to four eggs in nests, and stated that most birds lay two eggs. He further noted that "of the many Robin nests with young seen, always there has been an infertile egg when three had been laid."

In two instances, Lamb's notes mention that robins were feeding on berries of the madrone.

The one female that we obtained weighed 67.0 gm.; weights of four males ranged from 66.4 to 79.1 gm., averaging 72.4 gm. Weights recorded by Lamb are somewhat heavier; six males ranged from 75.3 to 84.5 gm. (average 79.0 gm.), and eight females weighed from 73.2 to 89.5 gm. (average 81.8 gm.). I have excluded from this sample one female, weighing 90.3 gm., which contained a fully developed egg.

Hylocichla guttata. Hermit Thrush. — Grinnell (1928b) listed records for three presently accepted races of hermit thrush — *guttata*, *nanus*, and *auduboni* — in the Sierra Laguna, where the species is evidently fairly abundant as a migrant and winter visitor. Brewster (1902:212) thought that specimens referred to *auduboni*, taken by Frazar in June, were breeding at La Laguna, and he also suggested that one worn bird assigned to *nanus* might be breeding, although it was taken in April. Grinnell (*op. cit.*) accepted Brewster's evidence that *auduboni* bred in the Sierra Laguna, even though the latter had commented that "It is singular that no form of Hermit Thrush was found on [the Sierra] San Pedro Martir" in northern Baja California. Hellmayr (1934), Bent (1949), and Blake (1953) followed Grinnell in assigning *auduboni* breeding status in the Sierra Laguna, even though McCabe and McCabe (1932:33) suggested that the birds collected by Frazar did not represent a resident population. At the end of July, 1929, C. C. Lamb recorded in his field notes: "I have made especial search for Audubon Thrushes, but haven't seen any signs of them recent or present." The A.O.U. Check-list (1957) omits any mention of *H. g. auduboni* in Baja California, either as a breeding or wintering bird. Miller *et al.* (1957:189) regarded specimens taken up to June 8 (those taken by Frazar) in the Sierra Laguna as "probably late migrants" of *H. g. auduboni.* I consider the last treatment the most reasonable, as there is no good evidence that this species breeds anywhere in Baja California.

Hylocichla ustulata. Swainson's Thrush. — Frazar obtained specimens up to the middle of May, and Brewster (1902) thought that this species was nesting at La Laguna and at Triunfo, but Grinnell (1928b) pointed out that the species is merely a migrant in southern Baja California.

**Polioptila caerulea obscura.* Blue-gray Gnatcatcher. — This species is common at La Laguna, at least in summer. Belding (1883) saw it in the mountains in winter, but did not mention specific localities. Neither Belding nor Nelson and Goldman, who worked at La Laguna in winter, collected gnatcatchers which suggests that the montane population may move to lower elevations.

The nesting season is apparently quite extended. I found a nest on May 21, about three feet from the end of a horizontal branch of an oak, some 18 feet above the ground; both parents were feeding the young. A male taken on May 23 had testes measuring 6 x 4 mm. As late as July 19, Lamb found a nest on a bare branch of a dead pine which contained two small young. Frazar reported nests with fresh eggs in mid-July at lower elevations in the Cape region (Brewster, 1902).

Only two weights are available, 5.5 gm. for a male, and 4.9 gm. for a female. The latter bird, taken May 27, 1965, was molting. A male taken on May 18 at the lower elevation of Rancho la Burrera (weight 5.7 gm.; testes 5 x 5 mm.) was also in heavy body molt. The timing of molt of this species seems to be very irregular in southern Baja California.

Regulus calendula. Ruby-crowned Kinglet. — This species is a winter visitant to the mountains of the Cape region, as recorded by Brewster (1902) and Grinnell (1928b).

Anthus spinoletta. Water Pipit. — Belding (1883) saw a large flock of birds "supposed to be this species" at La Laguna. These birds winter commonly at lower elevations, also.

**Vireo huttoni cognatus.* Hutton's Vireo. — This race was named from specimens taken at La Laguna, where it is a common resident. We found it to be the most common vireo there, although it is quiet and easily overlooked. It responds quickly to imitated calls of the pygmy owl.

The nesting period of this species may be quite prolonged at La Laguna. We found no nests, but a female taken on May 26 had a brood patch. Males taken on May 21 and 23 had testes 4 x 2.5 and 4 x 4 mm., perhaps not quite maximum size. Frazar found no evidence of breeding in specimens that he obtained in May and early June (Brewster, 1902). Lamb found his first nest, suspended from two small twigs eight feet up in a slender oak sapling and ready for eggs, on July 28, but commented that at lower elevations this species has young by mid-June. W. W. Brown took eggs of this species at La Laguna in August (Thayer, 1909).

Weights of males taken in May, 1965, were 10.6 and 11.1 gm.; females weighed 11.2, 11.2, and 10.7 gm. Weights recorded by Lamb in July were somewhat heavier; eight males ranged from 10.8 to 12.3 gm., averaging 11.6 gm., and three females weighed 12.4, 12.7, and 13.1 gm., averaging 12.7 gm. The specimens taken in July are worn and are molting their inner primaries.

**Vireo solitarius lucasanus.* Solitary Vireo. — We found this to be the least common of the three vireos at La Laguna. Early observers failed to report this species from that locality (see Grinnell, 1928b), although two specimens in the BMNH were taken there in July, 1896. This bird may reach its greatest abundance at lower elevations. Lamb found a nest ready for eggs on July 30; Rowley (1935) reported "young flying about" in late May. The birds were singing during our visit, but no definite information on the stage of breeding was obtained. Testes of a singing male taken on May 20 were of unequal size, the left measuring 2 x 2 mm., the right, 4 x 4 mm. Another male, collected May 24, had testes 6 x 3 mm.

The last mentioned male weighed 13.3 gm. Lamb recorded weights of 13.4 and 14.5 gm. for males, and 12.4, 12.7, and 13.1 gm. for females. Specimens taken by Lamb in July are molting the inner primaries, but are not as far progressed in this as the specimens of *V. huttoni.*

**Vireo gilvus victoriae.* Warbling Vireo. — This is the most recently described of the endemic montane forms of southern Baja California, although Grinnell (1928b) had suspected that the population of the Sierra Laguna might be distinct. The final separation of this race was based on specimens taken by Lamb at La Laguna.

The numbers of this species increased noticeably during our stay at La Laguna, so that it was common at the end of May. The birds were singing and apparently mated by May 25. Testes of males taken then measured 5 x 3 to 7 x 4 mm. Brewster (1902) remarked, on the basis of Frazar's observations, that "the birds were paired and apparently about to breed by the middle of May." However, Lamb noted that warbling vireos were just ready to nest at the time of his departure on August 6, and Brown collected eggs in August (Thayer, 1909).

A total of 18 weights is available for males, mostly from Lamb's collecting; they range from 10.0 to 13.2 gm., and average 11.4 gm. Weights of seven females are between 10.5 and 12.4 gm., averaging 11.6 gm.

Dendroica auduboni. Audubon's Warbler. — This species has been reported in winter by Frazar (Brewster, 1902) and by Nelson and Goldman.

Dendroica nigrescens. Black-throated Gray Warbler. — Belding (1883), Frazar (Brewster, 1902), and Nelson and Goldman have all reported the presence of this bird as a winter visitor.

Wilsonia pusilla. Wilson's Warbler. — This species was found at La Laguna by Frazar in May (Brewster, 1902).

Icterus cucullatus. Hooded Oriole. — Frazar saw only one bird on the Sierra Laguna, but noted that this species was abundant at lower elevations (Brewster, 1902). Lamb remarked that it was "scarce" at La Laguna. We did not see it there, but it was common at Rancho la Burrera, where Sloan found a nest on May 18.

**Icterus parisorum.* Scott's Oriole. — This species seemed to become more common during our stay at La Laguna, and I assumed that birds were moving up from lower elevations. Nelson, however, reported seeing this oriole there in January. On May 25 a pair was investigating a *Nolina beldingi* as though selecting a nest site. The following day several were heard singing, always in close proximity to the yucca-like *Nolina.* Lamb noted that orioles were nesting in yuccas in July; he collected a male weighing 37.3 gm. and a female weighing 39.5 gm.

Pyrrhuloxia sinuata. Pyrrhuloxia. — Frazar obtained one individual of this lowland species "on the Sierra de la Laguna" (Brewster, 1902).

Pheucticus melanocephalus. Black-headed Grosbeak. — A specimen was taken by Frazar in the mountains on May 4 (Brewster, 1902).

**Carpodacus mexicanus ruberrimus.* House Finch. — There is no record that the early workers found this species at La Laguna; the first mention of it there is found in Lamb's notes for 1929. In our experience it was not common, but a small flock was seen several times feeding in the meadow. Two males taken on May 22 weighed 16.9 and 20.3 gm.; the heavier one had its crop and stomach full of seeds. The testes of these birds, which were in bright breeding plumage, measured 7 x 4 mm. A female collected by Lamb weighed 19.4 gm.

**Spinus psaltria.* Lesser Goldfinch. — Frazar found this species "on the Sierra de la Laguna, where it was common the last week in April and rare in May" (Brewster, 1902). Brown took eggs, as well as specimens, at La Laguna in August (Thayer, 1909). Lamb found a nest with young on August 1. I saw two individuals on May 22, which is our only record for the area.

Chlorura chlorura. Green-tailed Towhee. — "A single specimen (a female), taken on the Sierra de la Laguna on May 25, was probably a belated straggler . . ." (Brewster, 1902), and is the only record for the area.

**Pipilo erythrophthalmus magnirostris.* Rufous-sided Towhee. — This endemic race was described on the basis of specimens taken at La Laguna, where it is one of the more common species. We found towhees at the forest-meadow edge and in small openings in the forest; except in the center of the meadow, one was seldom out of sight or sound of towhees. They were usually in pairs, and many squabbles, presumed to be at the boundaries of territories, were noted. On the other hand, they seemed at times to be rather gregarious; when one would give an alarm note, several others would fly into the area. On some occasions, six or eight birds could be seen feeding peacefully in a small area.

Although I thought I saw a towhee carrying food in its bill on May 19, and a pair in that vicinity acted as though they had a nest, I found no definite evidence that breeding had begun. Testis size of four males ranged from 3 x 2 to 7 x 5 mm. Neither of two females taken had a brood patch or any enlarged ova in the ovary. Rowley (1935) found no nests in late May. Lamb noted that the towhees begin to nest early in July. He found nests with eggs on July 7, but the first nest with young was not located until July 27. He reported that there were no flying young by August 6. W. W. Brown took three sets of eggs during August (Thayer, 1909). Lamb noted clutch size in 10 nests; eight held two eggs, and two contained three eggs each. Of six nests for which Lamb noted location, four were on the ground and two were in trees, against the trunks 6 to 8 feet high.

Weights of eight males (Lamb's series combined with ours) ranged from 40.2 to 48.8 gm., and averaged 43.3 gm. Variation in weights of six females was from 34.5 to 46.7 gm., and the average was 40.5 gm.

Pipilo fuscus. Brown Towhee. — Frazar referred to this species as "rare on the top of the Sierra de la Laguna in May and early June" (Brewster, 1902). We did not see it at La Laguna, and others have not reported its occurrence there. This is a bird of lower elevations in the Cape region.

Passerculus sandwichensis. Savannah Sparrow. — Nelson and Goldman listed merely "*Passerculus*" in the account of birds seen on January 28, 1906.

Aimophila ruficeps. Rufous-crowned Sparrow. — Belding collected one of these birds at La Laguna on February 3, 1882, and Lamb included the species on his list of birds seen there in 1929. We did not see it, and all other reports are for lower elevations in the mountains.

**Junco bairdi.* Baird's Junco. — This species, which was described from specimens taken in the Sierra Laguna by Belding, is common in and characteristic of the area. We noted it as soon as we reached the pines on our ascent up the mountain.

All available information on the life history of this bird has been summarized recently (Banks, *in* Bent, in press), and need not be repeated here. Weights of five males taken by Lamb ranged from 17.5 to 19.0 gm., averaging 18.1 gm., slightly higher than the two weights (17.8, 16.7 gm.) reported earlier (*op. cit.*).

Spizella passerina. Chipping Sparrow. — Frazar took a specimen at La Laguna on April 30 (Brewster, 1902). Grinnell (1928b) says: "I have examined this specimen . . . and find that it shows certain individual features which account fortuitously for its presence so late in the spring," but he does not indicate what these features were.

Doubtful Bird Records

Belding (1883) included several other species in his list of "Birds of the Mountains," but with insufficient information to permit definite determination of localities. The elf owl, (*Micrathene whitneyi*) is a common resident of the Cape region, but seems to be restricted to habitats found only at the lower elevations. Four species — orange-crowned warbler (*Vermivora celata*), western tanager (*Piranga ludoviciana*), black-chinned sparrow (*Spizella atrogularis*), and Lincoln's sparrow (*Melospiza lincolnii*) — are migrants or winter visitors in the region. Belding collected specimens of the tanager and Lincoln's sparrow elsewhere in the mountains of the Cape region, but not at La Laguna.

Lamb's notes for 1929 comment that he had taken "gray flycatchers" in late August on his previous visit to La Laguna, which would have been in 1923 or 1924. The date seems too early for migrants of this species; Grinnell (1928b:142) records the earliest fall date from the Cape region as October 29 (under *Empidonax griseus*) and does not mention any specimens to which Lamb's notes might pertain. The occurrence of this species at La Laguna must be considered hypothetical until the specimens can be examined and their identity ascertained.

Both Tevis and Murray recorded seeing grasshopper sparrows (*Ammodramus savannarum*) at La Laguna in their notes for June 10 to 13, 1948. This species is known as a "rare winter visitant" to southern Baja California (Grinnell, 1928b), but I doubt its presence there in June and suspect a misidentification.

Analysis of the Avifauna

The foregoing list contains 69 species, one of which is represented by two subspecies present in different seasonal statuses. A breakdown of these 70 forms in terms of seasonal occurrence and breeding status at La Laguna is shown in the following table.

Breeding and resident	34 species	48.5%
Migrant and wintering	22 species	31.4%
Vagrant	4 species	5.7%
Status uncertain	10 species	14.3%

Many of the species whose status is uncertain may actually breed, or may have bred at one time, at La Laguna or nearby. Their status is not definitely known because of lack of observation or because there are no recent records. Only in two instances would breeding of these species represent rather surprising new records for the peninsula or for the latitude; these are the mourning dove and the whip-poor-will. Similarly, two species considered vagrants at La Laguna — the pyrrhuloxia and brown towhee — breed in the lowlands of the Cape region and may on rare occasion breed at the higher elevations. Only the brown pelican and olivaceous flycatcher are truly vagrant in a stricter sense. Thus a variation of the breakdown by breeding status could be as follows:

Breeding and possibly breeding	46 species	65.7%
Migrant and vagrant	24 species	34.3%

Relatively little work has been done in the mountains of the Cape region in the winter months, and it is virtually certain that the list of migrants and winter visitants could be expanded by additional study. On the other hand, it is unlikely that the number of species known to breed, or suspected to do so, will increase; when full information is available about some of the uncertain forms, the number of breeding birds will probably hold at about 40.

It is interesting to compare this analysis with one available for Cerralvo Island (Banks, 1963b), which is approximately 50 miles north of La Laguna. Although roughly at the same latitude, the two areas differ greatly in elevation and in vegetation; the vegetation of Cerralvo is desert scrub typical of the lowlands of southern Baja California. The total number of species recorded in the two areas is the same, 69, and the proportions of breeding birds (48.5 per cent at La Laguna, 46 per cent on Cerralvo Island) and migrants (31.4 per cent at La Laguna, 36 per cent on Cerralvo) are very similar. Other categories of occurrence are not comparable.

I have mentioned earlier the high degree of endemism among the birds of the Cape region of Baja California, and particularly in the mountains of that area. Of the 34 breeding species of La Laguna, 23 are endemic, as species or subspecies, to southern Baja California. Fifteen of these birds, or nearly half the breeding avifauna, breed only in the pinyon-oak forest of the mountains of the Cape region. Some of the other eight forms may have been restricted to the mountains originally, having spread into the adjoining lowlands only as they developed adaptations to cope with the harsh desert environment. Among the Cape region endemics which nest regularly at La Laguna, only the ladder-backed woodpecker (and perhaps the flicker) can be regarded as a desert form which has secondarily invaded the montane habitat. Is it easier to adapt from mesic to xeric conditions than the reverse?

Davis (1959) examined the problem of the origins of some of the Cape region endemics, with particular reference to those of the highlands. He concluded that the majority of the forms examined "show morphological resemblance to modern populations of Mexico and the southwestern United States east of the Colorado River" and that only a few are closely similar to populations of the Pacific coast of the United States. The remaining endemics have yet to be examined from this viewpoint.

Accounts of Mammals

Sorex ornatus. Ornate Shew. — Nelson and Goldman (1909) described *S. lagunae* from a single specimen taken by them on January 29, 1906, at La Laguna. When Jackson (1928:169) considered the form to be a race of the more northern *S. ornatus*, he still had only the type specimen, a female, available for examination. Keith Murray trapped a male shrew (MVZ) at La Laguna on June 11, 1948. Unfortunately, the skull was lost. Standard measurements of the specimen, as recorded on the label, are 108-43-12-8. The testes measured 4 x 3 mm. Murray's notes record that the shrew was captured "in a space hollowed out of the stream bank beside the water. The spot was partially covered by overhanging plants and had many dried leaves around. This was in one of the densely wooded parts of the stream shaded by overhanging oaks."

Sloan saw a shrew, briefly, in May, 1965, as he was searching for lizards. It was under a log forming part of a pile of trash at the base of a large poplar tree near camp. Despite extensive effort, we were unable to trap any shrews.

Myotis californicus californicus. California Myotis. — This bat is widespread at lower elevations in the Cape region (Miller and Allen, 1928; Jones, Smith, and Alvarez, 1965), but it has not previously been reported in the pine-oak zone of La Laguna. Benson obtained one specimen, a female with a 15 mm. embryo, on June 10, 1948. Two specimens formerly in the Stanford University collection, now in the CAS, were preserved in fluid by J. F. Abbott in July, 1896. They are cataloged as "*Myotis?*" and are probably this species.

Pipistrellus hesperus australis. Western Pipistrelle. — This species has been reported from several localities in the Cape region, including El Sauz in the Victoria Mountains (Hatfield, 1936; specimens taken by Lamb). Three specimens (one male, two females) were taken at La Laguna in 1896 (BMNH). Benson and his party took four males in June, 1948. We did not see this species in 1965.

Eptesicus fuscus peninsulae. Big Brown Bat. — This subspecies, endemic to southern Baja California (Engels, 1936), was described by Thomas (1898) on the basis of one female and three male specimens taken in the Sierra Laguna by Coolidge in 1896. Benson's party took eight males in June, 1948, and we obtained a series of eight males and two females in May, 1965. Neither of the females was pregnant, and all the males taken in May had small testes. Weights of five males ranged from 8.0 to 10.2 gm., and averaged 9.2 gm. These bats were fairly common over the meadow in the early evening. Specimens were shot or caught in a mist net stretched over a small stream.

Lasiurus cinereus. Hoary Bat. — We were surprised to discover large numbers of hoary bats at La Laguna in late May. They appeared very soon after sundown around the edges of the meadow and were easily distinguished, by their large size and slow wing beat, from the *Eptesicus and Tadarida*, the only other bats we saw.

We collected seven specimens by shooting and netting. Males had testes measuring from 2 x 4 to 4 x 6 mm. The two females obtained each contained two embyros, 4 mm. and 7 mm. long.

The attempt to interpret the ocurrence of these bats at La Laguna led to a review of the status of the species in Baja California. Several new records, and errors concerning old records, were found, and it may not be out of place here to present the results of the survey, listing the occurrences chronologically. There is a male specimen in alcohol in the USNM that was taken by J. F. Abbott at Santa Anita, in the lowlands of the Cape region, in July or August, 1897. This record has not, apparently, been published previously. Elliot (1903:230) reported a specimen (FMNH) taken by Edmund Heller at San Antonio, at 3,000 feet elevation on the western base of the Sierra San Pedro Mártir. This specimen, a male, was taken June 5, 1902. Findley and Jones (1964:fig. 6) erroneously mapped this locality in the Cape region of Baja California, where there is another ranch of the same name. Two male specimens, not previously reported, are in the MVZ; these were collected on April 17 and 19, 1925, by A. E. Borrell at Valladares, at 2,700 feet elevation on the western base of the Sierra San Pedro Mártir. Valladares and San Antonio are only a few miles apart. Huey (1964) reported a specimen taken October 11, 1926, at Laguna Hanson in the Sierra Juarez. Banks (1964) recorded another occurrence at Bahía de los Angeles, on the coast of the Gulf of California, April 26, 1962.

Thus there are five records of occurrence in Baja California prior to the present report from the Sierra Laguna. Four of these records are of certain or probable migrants in the northern third of the peninsula. The specimen taken by Abbott in the summer of 1897, along with our finding of both males and pregnant females in late May, suggests that there may be a breeding population of hoary bats restricted to this mountain range, but the evidence is far from conclusive for a number of reasons. Our specimens could be late migrants despite the fact that the species was noted throughout our 10-day stay. Several facts relating to Abbott's specimen raise some doubt about that record. The rather vague date, "July or August, 1897" does not instill confidence. Further, although Abbott certainly was in the Cape region in 1896, I know of no records of his activity there in 1897. Nelson (1921:140-147) summarized the scientific explorations in Baja California, apparently very thoroughly, but did not mention any work done there by Abbott in 1897. He certainly should have been aware of such activity, as the specimen in question, along with 16 other bats in alcohol with the same data, was in the Bureau of Biological Survey collection in the U. S. National Museum and one specimen from that collection had been made the type of a new species, *Natalus mexicanus*, by G. S. Miller (1902), in a paper cited by Nelson.

Abbott's specimen is from Santa Anita, a locality only a few hundred feet in elevation in the Arid Tropical Zone (Nelson, 1921). One would expect, however, that if there were a population of the essentially northern hoary bat in the Cape region, it would be at higher elevations, as at La Laguna. But other parties who collected bats there, in 1896 and 1948, did not take this species.

In view of this conflicting evidence, the status of the hoary bat in the Sierra Laguna must remain in doubt.

Lasiurus ega. Yellow Bat. — The race *xanthinus* was described by Thomas (1897) on the basis of specimens obtained by the Price expedition in 1896. One of the four specimens, taken July 10, 1896, is now in the USNM; the others, including the type, are in the BMNH. Tevis obtained a male on June 11 and a female with a 10 mm. embryo on June 12, 1948. The species has been reported from a number of localities of lower elevation in the Cape region (Jones, Smith, and Alvarez, 1965).

Tadarida brasiliensis mexicana. Free-tailed Bat. — These were the most common bats at La Laguna in late May, 1965. They began to appear just at sunset, usually flying very high and erratically. After dark they flew much lower and came to the stream in the meadow, where several were caught in the net or were shot. We obtained a total of 10 specimens, 3 females and 7 males. None of the females was pregnant; testes of the males were 2 to 3 mm. in length. One female weighed 10.5 gm.; weights of 4 males ranged from 8.5 to 11.6 gm., averaging 9.75 gm. Benson's group took 3 males and 1 female of this species in 1948.

Tadarida femorosacca. Pocketed Free-tailed Bat. — A male specimen taken by members of Price's expedition in 1896 is in the BMNH. This specimen, which apparently has not been reported previously, provides the only record for the higher elevations of the Cape region, where it was previously known from Santa Anita (Shamel, 1931:13).

Thomomys bottae alticola. Pocket Gopher. — McLellan's notes on this species state that "all over the higher portions of the mountains they are common, especially so at the 'Rancho Viejo,' the site of the old lagoon." We similarly found them to be abundant in May, 1965. Their mounds were much in evidence throughout the meadow, but particularly near the small watercourse. We did not see gopher sign in the forest.

A large number of specimens from La Laguna is available. McLellan collected a series of 33 in 1895 (USNM), Coolidge *et al.* took 9 in 1896 (BMNH), Nelson and Goldman 12 in 1906 (USNM), and Lamb got 25 in 1929 (MVZ). We took another 21 specimens in 1965.

Breeding may occur throughout the year in this population, although there seem to be slack periods which may vary from one year to another. All the males that we captured in May, 1965, had enlarged testes (6 x 7 to 11 x 16 mm.) but none of the females showed evidence of breeding. Some of our series appear, as judged by size and weight, to be subadult. Lamb's series contains several young animals taken in the last half of July. One young specimen in the SDNHM was captured by Sloan on April 4, 1961. McLellan obtained several small young in late May, 1895; Nelson and Goldman got only apparent adults in January, 1906.

Most of the gophers that we got in late May were rather fat. Weights of seven males ranged from 104 to 158 gm. (only two under 140 gm.) and averaged 137 gm., whereas those of 11 females varied from 70 to 128 gm. (only one under 100 gm.), averaging 112.5 gm. Of males in Lamb's series, weights were 92.5 to 129.5 gm., averaging 112 8; for females the weights range from 93.5 to 122.0 gm., averaging 105.7 gm.

This subspecies was named by Allen (1899) on the basis of specimens taken in the Sierra Laguna by Coolidge *et al.* It is apparently restricted to the higher elevations of those mountains, specimens being known only from La Laguna and El Sauz. Huey (1945) erred, I believe, in assigning three specimens from 7 miles northwest of San Bartolo to this race, because he had no true *alticola* for comparison. Only one of those three specimens is noticeably darker dorsally than Huey's series of "12" (actually 13) *T. b. anitae* from San Jose del Cabo, although all three are darker and more fulvous below. In this latter character the San Bartolo material tends away from *anitae* toward *alticola.* The darkest of the three specimens from San Bartolo is about the same color dorsally as the lightest of ours from La Laguna. Huey (*op. cit.*:265) said that the three specimens (all females) from San Batrolo were "smaller than *Thomomys bottae anitae*" but they in fact average larger than the nine females in his series from San Jose del Cabo — 208 vs. 202 mm. total length.

Allen (1899) noted that *alticola* is "much darker" than the lowland *anitae.* There is a strong tendency toward melanism in the population at La Laguna, with some evidence that that color variation is more common now than formerly. One of our specimens was approximately 50 per cent melanistic and at least six others show a considerable amount of black either dorsally or ventrally or both. One other recently taken specimen (SDNHM), from 1961, also shows much black dorsally. In Lamb's material from 1929, however, only 2 of 25 show a strong melantistic tendency. One of the 12 taken in 1906 tends to melanism, and 4 of 32 of McLellan's skins show the tendency, two quite strongly. McLellan commented in his notes that his series showed "a marked variation in color from light yellow to dark plumbeous." He took one that was "pure plumbeous in color," but it was destroyed.

Perognathus spinatus peninsulae. Spiny Pocket Mouse. — This mouse seems to be uncommon at the higher elevations. It has been missed by several collecting parties and taken in but small numbers by others. One of each sex in the BMNH was taken in 1896; Lamb obtained four females in 1929. We took a single specimen in 1965, which Ryan trapped among cactus near the juncture of the meadow and forest. This individual was a female, weighing 14.1 gm., with no embryos. Weights of three females taken by Lamb from July 31 to August 3 are 16.4, 16.8, and 17.3 gm.

Peromyscus eremiscus eva. Cactus Mouse. — This mouse is widespread in southern Baja California, but seems to be less abundant at the higher elevations than its congener *P. truei.* Several collectors at La Laguna have not obtained this species, and most others have obtained fewer *eremicus* than *truei.* The relative abundance of the species may change rapidly with altitudinal and vegetational change, however, as Lamb obtained more *eremicus* than *truei* at El Sauz, some 1,500 feet lower. Part of the series on which the description of this form was based (Thomas, 1898) was collected by Coolidge *et al.* at La Laguna in 1896. Lamb took 10 specimens in 1929, and Benson's group got 7 in 1948. We obtained only four of this species, at the forest-meadow edge, May 20-23.

Neither of two females trapped in May was pregnant, but one taken by Benson June 11, 1948, was lactating. Testis measurements of males in May were 2 x 4 and 3 x 5 mm., and of a male in June, 5 mm. Most breeding apparently takes place in late summer, as specimens from May, June, and July are all fully adult with worn molars.

Weights of seven males ranged from 14.4 to 20.0 gm., and averaged 17.5 gm. Weights of three females were 17.6, 18.9 and 19.0 gm.

Peromyscus truei lagunae. Piñon Mouse. — Bryant was probably the first mammalogist to collect this endemic subspecies of mouse. Two specimens (skins only) that he took in the Sierra Laguna on March 27, 1892, are in the CAS. These are perhaps the only specimens from that trip that survived the San Francisco earthquake and fire of 1906; they were on loan to the U. S. Bureau of Biological Survey, from which they were returned in 1915. Bryant apparently had recognized the distinctness of this population. The labels of these two specimens bear the name *"Sitomys monticola"* and the word "type," the latter written in red but crossed out. Presumably Bryant had intended to apply that name to the population, but deferred to Osgood (1909) who gave it the presently used name.

This mouse is the most common one at La Laguna. We trapped it abundantly in all habitats, from rock piles to forest. It was least common in the open meadow. All collecting teams at La Laguna have obtained this species, and over 100 specimens are available in museums. We took a series of 54 of these mice, about 60 per cent males and 40 per cent females.

There was considerable variation in the ages of the animals we trapped, as judged by tooth wear, but there were no very young individuals. None of the females was pregnant. One female, taken June 11, 1948 (MVZ), was lactating. One male in our May series had testes 15 mm. long, but the gonads of most measured about 4 x 7 mm.

Weights of 33 males in combined samples from May (ours) and July (Lamb's) ranged from 16.7 to 24.5 gm., averaging 20.0 gm. Figures for 24 females are 13.8 to 23.2 gm., averaging 19.5 gm. Lamb's males were slightly (0.3 gm.) and his females considerably (3.3 gm.) heavier than ours.

Neotoma lepida notia. Desert Woodrat. — This race was named by Nelson and Goldman (1931) from specimens obtained by them at La Laguna in 1906. All other mammal collectors have also taken the species at that locality, and more than 50 specimens are available. We found woodrats rather common in suitable habitats, such as large clumps of cactus in the meadow (fig. 4) and along the rocky stream banks in the forest.

Contrary to the situation found in the other rodents at La Laguna, there was some reproduction occurring in this species in late May. One female was pregnant, with a single embryo

50 mm. long, and one apparently had given birth recently. Nine others had no embryos. Two females of June 11 and 12, 1948, are recorded as having no embryos. Testes of males taken in May were generally enlarged, measuring up to 11 x 9 mm.

Weights of nine males ranged from 139 to 226 gm., averaging 186.6 gm. Thirteen females varied from 120 to 186 gm., averaging 151.7 gm. These figures combine our sample and Lamb's; whereas the two sets of males averaged almost exactly the same, his five females averaged 160.9 gm. as opposed to 146.0 gm. for our series of eight.

Urocyon cinereoargenteus peninsularis. Gray Fox. — We saw considerable sign that we attributed to foxes, and the residents of La Laguna indicated that they were common. On May 25 they brought us a male fox, in very poor pelage, that they had trapped the preceding night.

There is one male specimen from La Laguna in the BMNH. Nelson and Goldman took one of each sex in 1906, and Lamb collected a female in July, 1929.

Spilogale putorius. Spotted Skunk. — McLellan's notes for 1895 record: "after we had left the mountains one of my men told me that one morning while there he killed a 'zorillo', but did not bring it into camp." Lamb smelled skunks at El Sauz, and we recorded them in like manner at La Laguna on several occasions. These records provide the only evidence of the occurrence of the species at the higher elevations of the Cape region; all localities listed by Van Gelder (1959:377-378) for the race *lucasana* are in the lowlands. His locality given as "Miraflores, 6130 ft." is probably based on an erroneous label, as the only Miraflores in southern Baja California is at the base of the mountains, at about 400 ft. (Nelson, 1921).

Felis concolor. Mountain Lion. — This species is apparently not abundant in southern Baja California, but the residents of La Laguna mentioned that it has been seen there. McLellan's notes state: "One night we were entertained by a pair of lions screaming to one another across the little valley in which we were camped." There is a skin in the CAS from an unspecified locality in the mountains of the Cape region.

Lynx rufus. Bobcat — Lamb saw a bobcat at La Laguna in July, 1929. It destroyed the nest of a Baird's Junco.

Odocoileus hemionus. Mule Deer. — McLellan's notes from 1895 contain the following account of this species "*Cariacus.* Above an altitude of 3000 feet more deer are to be found, in the open oak and grass covered hills, and the better protected summits of the mountains, than in any other locality ever visited by me. They live as they always have lived, almost undisturbed by hunters, as few hunters venture into these mountains. It was a beautiful sight to get up in the night after the moon had made its appearance, and go out to watch the deer feed in the meadow of the Sierra de la Laguna. During the first part of my stay a deer was secured each morning until five were taken. All that the animals could, with the other baggage, carry out of the mountains."

The situation seems to be quite different now. Deer are not common and the hunting pressure, mainly by residents of the mountains and foothills, is apparently both heavy and continual. We saw no deer during our stay at La Laguna, although the residents there did.

In addition to the five specimens taken by McLellan, available material includes two immature males in the BMNH, including the type of the southern peninsular race; a male (USNM) secured by Nelson and Goldman; and five males and three females in MVZ, most of the latter being skulls obtained from local hunters.

A female taken July 5, 1929, was carrying male and female fawns about to be born, according to Lamb's notes.

Mammals of Unverified Occurrence

Vulpes macrotis. Kit fox. — Apolinar Leon Agundes, resident at La Laguna, reported the presence of animals that seemed to us to be this species. He clearly distinguished between them and the gray fox. The nearest locality of record is in the lowlands of the Magdalena Plains.

Bassariscus astutus. Ringtail. — Lamb obtained a male of this species at El Sauz, but there are no specimens from the somewhat higher elevations of La Laguna. Regarding this species, McLellan's notes from the Victoria Mountains (including La Laguna) contain the comments "Said, by my guides, to occur."

Procyon lotor. Raccoon. — Lamb saw raccoon tracks at El Sauz in the winter of 1928. Apolinar Leon Agundes described animals from the vicinity of La Laguna that seemed to be this species.

Comments on the Mammal Fauna

It is interesting to note several species of mammals that are apparently absent from the higher parts of the Sierra Laguna although quite abundant at lower elevations. Among these are cottontails (*Sylvilagus bachmani*), jackrabbits (*Lepus californicus*), antelope ground squirrels (*Ammospermophilus leucurus*), deer mice (*Peromyscus maniculatus*), and coyotes (*Canis latrans*). These species seem not merely to have been overlooked at La Laguna. We asked Apolinar Leon Agundes specifically about rabbits, squirrels, and coyotes, and he indicated specifically that there were none there. McLellan's notes contain mention of some of these species as follows: "*Lepus*. None were seen above 3000 feet altitude." "*Ammospermophilus*. The antelope squirrel is nowhere to be found above the vegetation of the lowlands." "*Canis*. No coyotes were heard at night until we had descended half way down the mountain."

The absence of coyotes may result directly from the lack of suitable prey in the form of rabbits and ground squirrels, but presumably the absence of the other species at La Laguna is correlated with climatic and vegetational features related to elevation. However, both lagomorphs mentioned and the deer mouse occur in similar vegetation and at even higher elevations farther to the north. *Peromyscus maniculatus* occurs commonly with both *P. eremicus* and *P. truei* in a number of other areas; in fact, one might reasonably expect *maniculatus* rather than *eremicus* at La Laguna, considering the vegetational and climatic aspect.

The absence of these species at La Laguna suggests to me that *Sylvilagus bachmani*, *Lepus californicus*, and *Peromyscus maniculatus*, at least, have arrived in the Cape region since the isolation of the montane flora, and, having become adapted to desert conditions as they extended southward through Baja California, were unable to re-adapt to the more mesic and cooler mountain areas, although the latter are similar to areas where other members of their species live farther north.

Only two of the montane mammals, *Sorex ornatus* and *Peromyscus truei*, represent what may be considered truly isolated populations; the hoary bat may fit into this category also. If one may judge by the range of the species as a whole, the mouse fits well with the group of avian endemics that Davis (1959) considered to have been brought to the Cape region with the Madro-Tertiary forest, whereas the shrew fits better with the birds of coastal California origin. It is difficult to see, however, how a mesic adapted form like the shrew could have reached the Sierra Laguna unless it came with a primitive forest.

Neotoma lepida and *Thomomys bottae* are the only other species in which the populations of the Sierra Laguna are considered to be strictly endemic. Both of these are extremely plastic species which have proved to be readily responsive to the sometimes minor variations of climate and soil color throughout their extensive ranges. Both have closely related subspecies in the surrounding desert lowlands. A detailed examination of the relationships of the Sierra Laguna populations of these species might shed some light on whether they are truly differentiates of lowland forms or relict.

Sumario

Se incluye una lista con las 69 especies de aves y 18 especies de mamíferos que se encuentran en La Laguna y las montañas de la región del Cabo, en Baja California, México. Así mismo se presenta información sobre sus respectivos géneros de vida, particularmente sobre la biología de la reproducción y cria. Los datos incluidos han sido recopilados durante los recientes trabajos realizados en la región, las colecciones previas en los mismos parajes y el estudio de la bibliografía correspondiente.

Se supone que la mitad o las dos terceras partes de las especies de aves aquí indicadas, realizan la fase de cria en La Laguna. La mayor parte de las restantes son aves migratorias,

o errantes en esta región. La información de que se dispone no es lo suficientemente precisa para que permita una reseña categórica sobre cada una de las especies. De las 34 especies de aves que crian en esta zona, 15 son especies o subespecies que crian solamente en los bosques de robles piñoneros, que cubren las cumbres de las montañas de la región del Cabo; mientras que 8 especies más están restringidas a la región más meridional de Baja California.

Cuatro subéspecies dé mamíferos presentan un área de distribución restringida a la zona de bosque en las montañas de la región del Cabo; teniendo dos de éstos sus parientes más próximos en los terrenos bajos adyacentes; mientras que los otros están bién alejados de sus familiares más cercanos.

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TRANSACTIONS

OF THE

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LIFE HISTORY OF *GESTA GESTA INVISUS* (LEPIDOPTERA: HESPERIIDAE)

BY

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Del Mar, California and San Antonio, Texas

SAN DIEGO, CALIFORNIA
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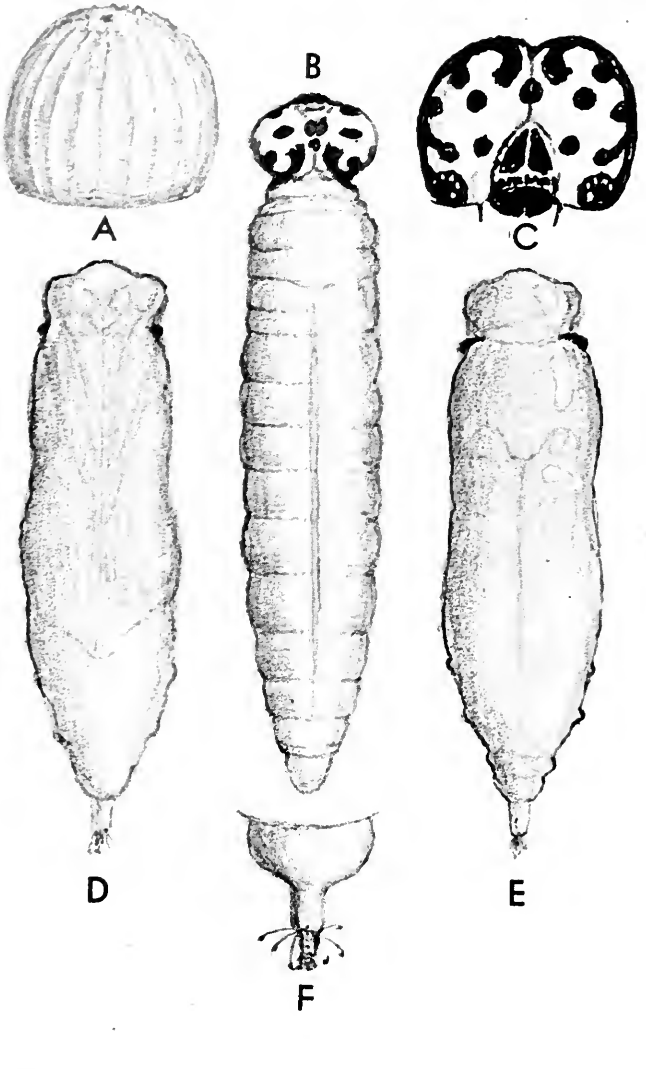

Fig. 1. Early stages of *Gesta gesta invisus.*

A. Egg, enlarged approx. × 50. B. Mature larvae, dorsal aspect, approx. × 5-1/3. C. Head of larva, × 10. D. Pupa, ventral aspect, × 5. E. Pupa, dorsum. F. Cremaster, dorsal aspect, enlarged.

Reproduced from water color drawing by Comstock.

LIFE HISTORY OF *GESTA GESTA INVISUS*
(Lepidoptera: Hesperiidae)

BY

JOHN ADAMS COMSTOCK AND ROY O. KENDALL

ABSTRACT

Several localities in Texas have been recorded by various collectors where the butterfly *Gesta gesta invisus* has been taken. Its range is through Cuba, Texas, and Mexico southward to Argentina. Part of the life history is here recorded by descriptions and illustrations of the egg, first and last larval instars, and pupa. The foodplants are *Indigofera lindheimeriana* Scheele and *I. suffruticosa* Miller.

INTRODUCTION

The hesperid *Gesta gesta invisus* (Butler and Druce, 1872:114) was reported by various authors to range from Mexico to Argentina. We supplement this with the following:

Dodge (1903:78) recorded it under the synonym *Nisoniades llano,* from Llano County, Texas. Skinner and Ramsden (1923:315) failed to list the parent species, *G. gesta,* from Texas, but reported it as ranging from Cuba to Brazil. Draudt (*in* Seitz, 1923:913) listed *G. invisus* as a junior synonym of *G. gesta* and pictured the parent species. Evans (1953:202) credited it to Texas under Dodge's synonym and reported the range as southward to Argentina. A brief account, with illustrations of the last instar larva and pupa, was published by the senior author and Vazquez (1960:444), in Spanish. Dos Passos (1964:21) placed it properly with relation to its subspecies and synonyms.

Eggs of *Gesta gesta invisus* were collected by the junior author on August 15, 1965 at the Frio River, on Farm to Market Road 1023, Uvalde County, Texas. They hatched August 22, 1965. Notes were made, but unfortunate circumstances prevented further work at the time. Additional eggs were taken on the larval foodplant, *Indigofera lindheimeriana* Scheele, at Lyons Park in Center Point, Kerr County, Texas, on May 15, 1966. The description which follows is based on these eggs and the larvae that hatched from them. *I. suffruticosa* Miller has been noted as another larval foodplant (Kendall, 1965:18).

The lack of information regarding the intermediate larval instars should prompt lepidopterists in Texas to fill in these blanks. In view of the absence of the foodplant *Indigofera* in California, and its presence in Texas and southward, our southern neighbors have every incentive to complete this fragmentary life history.

DESCRIPTION

Egg (fig. 1A). — Form, conical. Height, 0.6 mm. Base approximately the same. Color, at first, lustrous orange-yellow, changing to a dull ivory-yellow shortly before hatching. The surface is ridged vertically with 20-22 elevated white lines. Apparently there are no horizontal cross-striations between the ridges. Eggs hatched in 7 days.

A second lot of eggs was taken at Palmetto State Park, Gonzales County, Texas, September 25, 1966. These differed slightly in some respects from those of the first lot. They were slightly smaller, and the vertical ridges were from 15 to 18. These ridges showed minute nodules running along their edges that were not observed without high magnification. The very minute micropyle was encircled by a shallow circular trench. Eggs hatched October 1 to 3.

First Instar Larva. — Length, 1.5 to 2 mm. Head width, 0.33 to 0.4 mm. Color of head, orange. Ocelli, black. Body, yellow. Legs and prolegs, yellow, except for the black anal pair. Minute colorless setae over the body, those over the head, shortest, and those on cauda longest.

Difficulty in obtaining fresh foodplant, and scarcity of time made it impossible to carry through the notes and illustrations until the few remaining larvae had attained final instar.

Mature Larva (fig. 1B). — Length, 18 mm. Greatest width, 4 mm. Head width, 3 mm. Ground color of head, soiled white. Numerous round black spots, very conspicuous over the face and crown. Those near facial margin, irregular. (See Fig. 1C). Ocelli, yellow on a black field. Mandibles, black. Antennae, white proximally, dark distally. Neck bordered with black. High magnification shows head clothed with minute white setae. Lower magnification gives appearance of a granular texture.

Body ground color, yellow-green, more intense green on first three segments, and shading to nearly white on cauda. Middorsally, a narrow green stripe on the caudal two-thirds. Dorsolaterally, a line of bright yellow spots, one to a segment, these lacking on the first two thoracic segments. They disappear prior to pupation. Spiracles, relatively small, and yellow. Legs, black. Prolegs concolorous with body. Chrochets light brown. The segmental junctures are poorly defined.

Body clothed, like the head, with minute setae, but smaller, more sparsely scattered, and visible only with higher than 8 × magnification. However, on the last two caudal segments they are larger and less scattered.

The larvae feed mostly at night, and secrete themselves in leafy bowers by day. Pupation occurred May 21, 1966.

Pupa (figs. 1D, 1E).—Length, 15 mm. Greatest width through center, 4.25 mm. Body glistening green, with a slightly paler shade in the caudal area. All segmental junctures poorly defined. Two pear-shaped, jet black nodules occur at the side of the prothorax, placed at the site of the first thoracic spiracles, and are apparently modifications of them. The remainder of the spiracles are practically indistinguishable. The antennae appear to terminate about two-thirds the distance toward wing tips; maxillae reach to the edge of the wing margins and slightly protrude therefrom. Cremaster (fig. 1F) semi-translucent, finger-like, 0.5 mm long. Its tip clothed with a cluster of recurved red-brown spinules, which firmly hook into the previously spun anchorage button of white silk.

SUMARIO

La mariposa de la familia Hesperidos, *Gesta gesta invisus* (Butler y Druce) se la consideraba hasta ahora que habitaba las regiones que se extienden desde Cuba y México hasta la Argentina. Sin embargo, esta especie aparece también en Texas, en los condados, de Llano, Uvalde, Kerr y Gonzales. Se alimenta de *Indigofera lindheimeriana* Scheele, e *I. suffruticosa* Miller.

Algunas partes de los primeros estados de su desarrollo aparecen descritos aquí, conjuntamente con las ilustraciones correspondientes al huevo, la última fase larval y la pupa.

Los entomólogus deberían continuar los estudios sobre las primeras fases del desarrollo de este insecto, así como de las plantas que constituyen su alimento, las cuales se encuentran al sur de Texas, México y demás paises de Hispano-América.

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TRANSACTIONS

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SAN DIEGO SOCIETY OF NATURAL HISTORY

VOLUME 14, NO. 19, pp. 237-280

TYPE SPECIMENS OF RECENT INVERTEBRATES (EXCEPT ARACHNIDA AND INSECTA) IN THE SAN DIEGO NATURAL HISTORY MUSEUM

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SAN DIEGO, CALIFORNIA
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TYPE SPECIMENS OF RECENT INVERTEBRATES (EXCEPT ARACHNIDA AND INSECTA) IN THE SAN DIEGO NATURAL HISTORY MUSEUM

BY

EDWARD C. WILSON AND GEORGE L. KENNEDY

ABSTRACT

Type specimens of Recent Invertebrata belonging to the taxa Protozoa (Foraminferida), Brachiopoda, Mollusca (Pelecypoda, Scaphopoda, Gastropoda, Cephalopoda, Amphineura), and Arthropoda (Crustacea) in the San Diego Natural History Museum are listed by the original published names. The original reference, the museum type number, and the locality are given for each specimen. Illustrations published subsequently to the original descriptions are cited. Figured specimens not of the holotype or paratype groups and "types" of some named forms and varieties are included.

INTRODUCTION

This is the second catalogue of invertebrate type specimens in the San Diego Natural History Museum published in compliance with Recommendation 72D of the International Code of Zoological Nomenclature (1964: 75). The first (Wilson, 1966) listed the fossils.

The catalogue is arranged systematically by phyla and a few subordinate categories, as follows:

MOLLUSCA

Within each of these, the genus and species-group names, as originally published, are listed alphabetically. Each entry also contains the author and bibliograhic reference for the lowest species-group, variety, or form name, the type category and type number (with literal suffixes if specimens are of more than one piece), and the general locality. Inclusion or omission of figure references indicates that the specimen was or was not figured, respectively. Any specimens illustrated after the original description are cited under the names used in the later publication. These are cross-indexed with the names used in the original description, if different. A question mark after the figure citation indicates uncertainty that the figure was made from a specimen in our collection. "Missing" means that the specimen seems once to have been in the collection but now cannot be found.

An index is appended to facilitate location of species-group, variety, and form names.

Definitions of type categories and apposite discussions of their use by Schenk *et al.* (1956: 5-9), Bell (1962: vii-viii), and various parts of the International Code of Zoological Nomenclature (1964) are generally followed here. It should be noted that hypotype in this catalogue refers to a figured specimen not from the type-series; it is also used for "types" of varieties and forms, except where some evidence suggests that the author meant subspecies.

Our use of paratype follows the definition implied in the International Code of Zoological Nomenclature (1964: 79), which states:

> Recommendation 73D. Paratypes. — After the holotype has been labelled, each remaining specimen (if any) of the type-series should be conspicuously labelled "paratype", in order clearly to identify the components of the original type-series.

This implication is verified by their glossary, which states (*op. cit.*: 151) that paratypes include "every specimen in a type-series other than the holotype."

The same publication (*op. cit.* :75) clearly defines type-series:

> Article 72 . . . (b) Type-series. — The type-series of a species consists of all the specimens on which its author bases the species, except any that he refers to as variants, or doubtfully associates with the nominal species, or expressly excludes from it.

Some workers restrict application of the word paratype to specimens in the type-series from the same locality as the holotype. This usage is rejected here because it is confusing and does not serve to "clearly . . . identify the components of the original type-series".

To have annotated this catalogue would have made its length prohibitive. Inquiries about the history and validity of specimens may be addressed to the museum.

The writers have repeatedly examined alleged type specimens donated to the museum from private collections. Many of these have proven to be reliable but others are questionable and there seems no way now to verify their validity. *All type specimens should be placed with reliable institutions* immediately before or after publication so that they will be maintained in the best possible way for posterity.

All publications listed under Literature Cited, as well as many others, were examined closely by the writers during preparation of this paper. The patient assistance of the museum librarian, Mrs. Azalea Gorby, in obtaining many of them is gratefully acknowledged.

CATALOGUE

PROTOZOA: FORAMINIFERIDA

Elphidium concinnum Nicol
Nicol, 1944, p. 179.
Paratype 621; East Beach, San Quintín, Baja California, Mexico.

Elphidium excubitor Nicol
Nicol, 1944, p. 178.
Paratype 622; Punta Peñasco, Sonora, Mexico.

Elphidium fax fax Nicol
Nicol, 1944, p. 177.
Paratype 618; Dallas Bank, Straits of Juan de Fuca, Wash.

Elphidium fax pingue Nicol
Nicol, 1944, p. 177.
Paratype 620; Mussel Point, Monterey Bay, Monterey Co., Calif.

BRACHIOPODA

Argyrotheca lowei Hertlein and Grant
Hertlein and Grant, 1944, p. 104.
Paratypes 495a,b, 2413a,b-2420a,b; Isla Ángel de la Guarda, Baja California, Mexico.

MOLLUSCA: PELECYPODA

Adrana penascoensis (Lowe)
Keen, 1958b, p. 22, fig. 27 (syntype 468?).
See: *Leda* (*Adrana*) *penascoensis* Lowe.

Aligena redondoensis Burch
Burch, T., 1941, p. 50
Paratypes 451, 1478a,b-1480a,b; off Redondo Beach, Los Angeles Co., Calif.

Anadara (*Anadara*) *gordita* (Lowe)
Reinhart, 1943, p. 62, pl. 12, figs. 10, 11 (holotype).
See: *Arca gordita* Lowe.

Anadara baughmani Hertlein
Hertlein, 1951, p. 487.
Paratypes 1607a,b-1608a,b; southeast of Port Aransas, Aransas Co., Texas.

Anadara (*Caloosarca*) *biangulata* (Sowerby)
Olsson, 1961, p. 98, pl. 8, fig. 5b (holotype 470).
See: *Arca gordita* Lowe.

Anadara (*Scapharca*) *biangulata* (Sowerby)
Keen, 1958b, p. 36, fig. 59 (holotype 470).
See: *Arca gordita* Lowe.

Anadara (*Scapharca*) *reinharti* (Lowe)
Keen, 1958b, p. 38, fig. 65 (drawings) (holotype).
See: *Arca* (*Anadara*) *reinharti* Lowe.

Anodontites bartschi Baker
Baker, F., 1914, p. 668.
Paratype 1822a,b; Rio Tapajoz, Boim e Pinhel, Pará, Brazil.

Arca (*Anadara*) *mazatlanica* Hertlein and Strong
Hertlein and Strong, 1943, p. 156.
Paratypes 676a,b, 3321a,b-3323a,b; 19 miles west of Mazatlan, Sinaloa, Mexico (3321-3323); Gorda Banks, off southern end of Baja California, Mexico (676).

Arca (*Anadara*) *reinharti* Lowe
Lowe, 1935, p. 16, pl. 1, figs. 3a-3c.
Holotype 472a,b; Guaymas, Sonora, Mexico.
See: *Anadara* (*Scapharca*) *reinharti* (Lowe).

Arca (*Barbatia?*) *melanoderma* Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 105.
Paratypes 642a,b, 3180a,b; Montijo Bay, Panama.

Arca delgada Lowe
Lowe, 1935, p. 16, pl. 1, fig. 2.
Lectotype 469 (fig. 2); paralectotype 1861; Manzanillo, Colima, Mexico.
See: *Noetia* (*Sheldonella*) *delgada* (Lowe).
See: *Sheldonella delgata* (Lowe).

Arca gordita Lowe
Lowe, 1935, p. 16, pl. 1, fig. 1.
Holotype 470 (fig. 1); paratypes 471, 1862-1863; Acapulco, Guerrero, Mexico (holotype); Guaymas, Sonora, Mexico (paratypes).
See: *Anadara* (*Anadara*) *gordita* (Lowe).
See: *Anadara* (*Scapharca*) *biangulata* (Sowerby).
See: *Anadara* (*Caloosarca*) *biangulata* (Sowerby).

Astarte willetti Dall
Dall, 1917a, p. 11.
Paratypes 1977a,b-1979a,b; Forrester Island, Alaska.

Barbatia (*Acar*) *gradata* (Broderip & Sowerby)
Reinhart, 1939, p. 39, pl. 3, figs. 5a-b, 6a-e.
Hypotypes 1645a (fig. 5a), 1645b (fig. 5b), 1646a (fig. 6a-b), 1646b (fig. 6d-e), 1646a,b (fig. 6c); Mazatlan, Sinaloa, Mexico (1645); Taboga Island, Panama (1646).

Barbatia (*Acar*) *pernoides* (Carpenter)
Reinhart, 1939, p. 39, pl. 3, figs. 3a-d.
Hypotypes 1643a (fig. 3a-b), 1643b (fig. 3c-d); San Diego, San Diego Co., Calif.

Barbatia (*Acar*) *reticulata* (Gmelin)
Reinhart, 1939, p. 42, pl. 3, figs. 4a-d.
Hypotypes 1644a (figs. 4a-b), 1644b (figs. 4c-d); Key West, Monroe Co., Fla.

Botula cylista Berry
Berry, 1959, p. 107.
Paratype 1283a,b; Las Gaviotas Beach, near Mazatlan, Sinaloa, Mexico.

Cardita (*Cyclocardia*) *ventricosa montereyensis* Smith and Gordon
Smith, A. G., and Gordon, 1948, p. 212.
Paratypes 1640a,b, 1641; off Pt. Pinos, Monterey Bay, Monterey Co., Calif.

Cardita umnaka Willett
Willett, 1932, p. 87.
Paratypes 391-392; south shore of Umnak Island, Aleutian group, Alaska.

Cardita ventricosa redondoensis Burch
Burch, 1945, p. 14.
Paratypes 678a,b, 3346a,b; Redondo Beach, Los Angeles Co., Calif.

Cardium (*Laevicardium*) *clarionense* Hertlein and Strong
Hertlein and Strong, 1947, p. 144.
Paratypes 1547a,b, 1548-1549; Ceralbo Channel, Baja California (1547); south of Clarion Is., Revillagigedo group, Colima (1548-1549), both Mexico.

Chama frondosa Broderip
    Smith, M., 1944, p. 56, fig. 718.
    Hypotype 1131; Isla Espiritu Santo, Baja California, Mexico.
Chama sordida Broderip
    Smith, M., 1944, p. 56, fig. 717.
    Hypotype 1132; Isla San José, Baja California, Mexico.
Chama squamuligera Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 103.
    Paratypes 475a,b; 1921a,b; 1922-1924; San Juan del Sur, Nicaragua.
Chione (Chione) guatulcoensis Hertlein and Strong
    Hertlein and Strong, 1948b, p. 182.
    Paratypes 1552-1553; off Port Guatulco, Oaxaca, Mexico.
Chione metodon Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 100.
    Paratypes 480a,b, 2017a,b, 2018, 3426; Montijo Bay, Panama.
Diplodonta impolita Berry
    Berry, 1953c, p. 409.
    Paratype 1385; off Forrester Is., Alaska.
Ensis myrae Berry
    Berry, 1953b, p. 398.
    Paratype 1384a,b; Terminal Is., Los Angeles Co., Calif.
Ensis tropicalis Hertlein and Strong
    Hertlein and Strong, 1955, p. 203.
    Paratypes 1585-1588; South Passage, Pearl Islands, Panama.
Glycymeris guadalupensis Strong
    Strong, 1938, p. 213.
    Paratypes 3552-3557; Guadalupe Is., Baja California, Mexico.
Kennerlyia forresterensis Willett
    Willett, 1918, p. 134.
    (?) Syntypes 1662a,b, 1663a,?b, 1664-1665; Forrester Is., Alaska.
Laevicardium (Cerastoderma) corbis (Martyn)
    Grant and Gale, 1931, p. 307, pl. 19, fig. 17.
    Hypotype 176; Seven Mile Beach, San Mateo Co., Calif.
Lasaea cistula Keen
    Keen, 1938, p. 25.
    Paratype 671a,b; Moss Beach, San Mateo Co., Calif.
Lasaea nipponica Keen
    Keen, 1938, p. 26.
    Paratype 670a,b, 3320a,b; Watanoha, Rikuzen, northeast Matsusima, Japan.
Lada (Adrana) exoptata Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 107.
    Paratypes 465a,b, 1823a,b-1832a,b; Guaymas, Sonora, Mexico.
Lada (Adrana) penascoensis Lowe
    Lowe, 1935, p. 18, pl. 1, fig. 8.
    Syntypes 468 (fig. 8?), 1860; Punta Peñasco, Sonora, Mexico.
    See: *Adrana penascoensis* (Lowe).
Leda impar Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 106.
    Paratypes 466a,b, 1844a,b-1855a,b; Guaymas, Sonora, Mexico.
Leda laeviradius Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 106.
    Paratypes 467a,b; 1856a,b-1859a,b; Guaymas, Sonora, Mexico.
Leda (Saccella) acapulcensis Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 107.
    Paratypes 464a,b, 1770a,b, 1771a,b, 1772-1774; Acapulco, Guerrero, Mexico.
Lithophaga abbotti Lowe
    Lowe, 1935, p. 17, pl. 1, fig. 5.
    Holotypes 474a (fig. 5), 474b; Kino Bay, Sonora, Mexico.
    See: *Lithophaga (Leiosolenus) spatiosa* (Carpenter).
Lithophaga (Leiosolenus) spatiosa (Carpenter)
    Keen, 1958b, p. 52, fig. 95a (holotype 474a).
    See: *Lithophaga abbotti* Lowe.
Lucina (Pleurolucina) leucocymoides (Lowe)
    Keen, 1958b, p. 96, fig. 194 (paratype 1627).
    Olsson, 1961, p. 210, pl. 30, fig. 6 (paratype 1627).
    See: *Phacoides (Pleurolucina) leucocymoides* Lowe.

Macrocallista (*Chionella*) *omissa* Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 102.
Paratypes 477a,b, 1955a,b-1958a,b; San Juan del Sur, Nicaragua.
Macrocallista sorocula Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 143.
See: *Transenella sorocula* Pilsbry and Lowe.
Mactra (*Micromactra*) *isthmica* Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 89.
Paratypes 493a,b, 2330a,b-2333a,b; La Union, Gulf of Fonseca, San Salvador.
Mactra (*Micromactra*) *vanattae* Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 90.
Paratypes 494a,b, 2334a,b-2337a,b; La Union, Gulf of Fonseca, San Salvador.
Modiolaria laevigata (Gray)
Grant and Gale, 1931, p. 254, pl. 12, fig. 8.
Hypotype 119a (fig. 8), 119b; San Juan Island, Puget Sound, Wash.
Modiolus (*Modiolus*) *nonuranus* Pilsbry and Olsson
Pilsbry and Olsson, 1935, p. 16.
Paratypes 643a,b, 3181a,b; Nonura Bay, near Punta Aguja, Peru.
Modiolus (*Modiolus*) *tumbezensis* Pilsbry and Olsson
Pilsbry and Olsson, 1935, p. 16.
Paratype 1974; Rio Tumbez, Tumbes, Peru.
Modiolus neglectus Soot-Ryen
Soot-Ryen, 1955, p. 64.
Paratypes 1930a,b-1932a,b; San Diego, San Diego Co., Calif.
Musculus phenax Dall
Dall, 1915, p. 138.
Paratypes 2006a,b-2011a,b, 2012; St. George Is., Pribiloff group, Alaska.
Mytella speciosa (Reeve)
Soot-Ryen, 1955, p. 52, pl. 5, fig. 25.
Hypotype 1907a (fig. 25), 1907b; Magdalena Bay, Baja California, Mexico.
Mytilopsis zeteki Hertlein and Hanna
Hertlein and Hanna, 1949, p. 15.
Paratypes 1545a,b-1546a,b; Miraflores Locks, Panama Canal Zone, Panama.
Mytilus (*Hormomya*) *puntarenensis* Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 104.
Paratypes 473a,b, 1864a,b-1906a,b; Puntarenas, Costa Rica.
Mytilus (*Mytilus*) *californianus* Conrad
Grant and Gale, 1931, p. 245, pl. 12, fig. 6.
Hypotype 117; Seven Mile Beach, San Mateo Co., Calif.
Noetia (*Sheldonella*) *delgada* (Lowe)
Reinhart, 1943, p. 77, pl. 12, figs. 3-5.
Lectotype 469 (figs. 4-5), paralectotype 1861 (fig. 3).
Keen, 1958b, p. 40, fig. 71 (lectotype).
See: *Arca delgada* Lowe.
Nuculana lucasana Strong and Hertlein
Strong and Hertlein, 1937, p. 160.
Paratypes 677a,b, 3334a,b-3336a,b; 10 miles east of San José del Cabo, Baja California, Mexico.
Nuculana redondoensis Burch
Burch, 1944, p. 9.
Paratypes 679a,b, 3342-3345; Redondo Beach, Los Angeles Co., Calif.
Ostrea hiranoi Baker and Spicer
Baker and Spicer, 1930, p. 175, pl. 18, figs. 1-3.
Holotype 664a,b (fig. 1 [far left], 2, 3); paratypes 1077, 1078a,b, 1079-1085, 1086a,b, 1087, 1088a,b-1091a,b, 1092-1095, 1096a,b, 1097-1126 (some of these in fig. 1); off Bay of Obama, Japan.
Pecten (*Chlamys*) *lowei* Hertlein
Hertlein, 1935, p. 308.
Paratypes 644, 645a,b, 3182a,b, 3183-3198; Isla Carmen (645, 3182); Isla Ángel de la Guarda (644, 3183-3198), both Baja California, Mexico.
Pecten (*Chlamys*) *multirugosus* Gale
Gale, 1928, p. 92.
Holotype 5; San Diego, San Diego Co., Calif. Missing.
Pecten (*Pallium*) *swiftii* Bernardi
Grant and Gale, 1931, p. 171, pl. 10, figs. 4a, 4b.
Hypotype 112a,b; Notoro Bay, Hokkaido, Japan.
Periploma (*Albimanus*) *pentadactylus* Pilsbry and Olsson
Pilsbry and Olsson, 1935, p. 118.
Paratypes 579, 2998; Guanico Beach, Los Santos Peninsula, Panama.

Periploma planiuscula Sowerby
Grant and Gale, 1931, p. 255, pl. 13, figs. 1a, 1b.
Hypotype 130; Pt. Conception, Santa Barbara Co., Calif.
Petricola gracilis parallela Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 99.
Paratype 481a,b; Corinto, Nicaragua.
Phacoides (Pleurolucina) leucocymoides Lowe
Lowe, 1935, p. 17, pl. 1, fig. 4.
Holotype 1626, paratypes 1627 (fig. 4), 1628-1635; Islas Tres Marías, Nayarit (1626); Isla Carmen, Baja California (1627-1631); Isla Ángel de la Guarda, Baja California (1632-1635), all Mexico.
See: *Lucina (Pleurolucina) leucocymoides* (Lowe).
Pinna (Atrina) lanceolata Sowerby
Smith, M., 1944, p. 50, fig. 672.
Hypotype 1130; locality unknown.
Pinna (Atrina) maura Sowerby
Smith, M., 1944, p. 50, fig. 671.
Hypotype 1129; Punta Libertad, Sonora, Mexico.
Pitar (Lamelliconcha) frizzelli Hertlein and Strong
Hertlein and Strong, 1948b, p. 176.
Paratypes 1550-1551; Arena Bank, off Baja California, Mexico.
Pitar lenis Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 100.
Paratypes 478, 2013-2015; Acapulco, Guerrero, Mexico.
Pitar perfragilis Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 100.
Paratypes 479a,b, 2016a,b; San Juan del Sur, Nicaragua.
Plicatula anomioides Keen
Keen, 1958a, p. 241.
Paratypes 3615a,b-3616a,b; Guaymas, Sonora, Mexico.
Psammosolen guaymasensis Lowe
Lowe, 1935, p. 18, pl. 1, fig. 7.
Holotype 489 (fig. 7), paratype 490; Guaymas, Sonora, Mexico (489); Isla Ángel de la Guarda, Baja California, Mexico (490).
See: *Solecurtus guaymasensis* (Lowe).
Sanguinolaria vespertina Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 90.
Paratypes 488a,b, 2319a,b-2323a,b, 2324-2325; San Juan del Sur, Nicaragua.
Schizothaerus nuttallii (Conrad)
Grant and Gale, 1931, p. 404, pl. 22, fig. 9.
Hypotype 331a,b; Totten Inlet, Puget Sound, Wash.
Semele guaymasensis Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 92.
Paratypes 484, 2024-2025; Guaymas, Sonora, Mexico.
Semele simplicissima Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 93.
Paratypes 485a,b, 2026; Acapulco, Guerrero, Mexico.
Semele tabogensis Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 91.
Paratypes 486, 2316, 2317; Taboga Island, Panama.
Sheldonella delgata (Lowe)
Olsson, 1961, p. 103, fig. 3a (lectotype).
See: *Arca delgada* Lowe.
Siliqua sloati Hertlein
Hertlein, 1961, p. 14.
Paratype 1611a,b; near Point Bonita, Marin Co., Calif.
Solecurtus guaymasensis (Lowe)
Keen, 1958b, p. 192, fig. 469 (holotype).
Olsson, 1961, p. 354, pl. 63, fig. 8 (holotype).
See: *Psammosolen guaymasensis* Lowe.
Solen crockeri Hertlein and Strong
Hertlein and Strong, 1950, p. 225.
Paratype 1565a,b; La Union, Gulf of Fonseca, El Salvador.
Solen pazensis Lowe
Lowe, 1935, p. 17, pl. 1, fig. 6.
Holotype 491a,b (fig. 6); paratypes 492a,b, 2326a,b-2329a,b; La Paz, Baja California, Mexico.
See: *Solen (Solen) pazensis* Lowe.
Solen (Solen) pazensis Lowe
Keen, 1958b, p. 204, fig. 514 (holotype).
See: *Solen pazensis* Lowe.

Tellidorella cristulata Berry
Berry, 1963b, p. 140.
Paratypes 1337-1338; off Puerto Libertad, Sonora, Mexico.

Tellina (Angulus) erythronotus Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 94.
Paratypes 646a,b, 3199a,b-3204a,b, 3205-3206; Montijo Bay, Panama.

Tellina (Angulus) guaymasensis Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 94.
Paratvpes 482a,b, 2019a,b, 2020-2023; Guaymas, Sonora, Mexico.

Tellina (Macaliopsis) lyrica Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 94.
Paratype 483; Guaymas, Sonora, Mexico.

Tellina (Scissula) nicoyana Hertlein and Strong
Hertlein and Strong, 1949, p. 85.
Paratype 1564a,b; Ballena Bay, Gulf of Nicoya, Costa Rica.

Transenella sororcula Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 102.
Paratypes 476a,b, 1933a,b-1953a,b, 1954; San Juan del Sur, Nicaragua.
See: *Macrocallista sorocula* Pilsbry and Lowe.

Transennella gerrardi Abbott
Abbott, 1958, p. 130.
Paratypes 1537a,b-1538a,b; Georgetown Anchorage, Grand Cayman Is., British West Indies.

Transennella sororcula Pilsbry and Lowe
See: *Transenella sororcula* Pilsbry and Lowe.

Venerupis (Protothaca) restorationensis (Frizzell)
Frizzell, 1931, p. 321, pl. 22, fig. 1.
Hypotype 387; Little Beef Harbor, near Seabeck, Wash.

Volsella sacculifer Berry
Berry, 1953*c*, p. 407.
Paratype 1386; Long Beach, Los Angeles Co., Calif.

MOLLUSCA: SCAPHOPODA

Dentalium hannai Baker
Baker, F., 1925, p. 84.
Paratypes 1778-1789, 1811; Islas Los Coronados, Baja California, Mexico.

MOLLUSCA: GASTROPODA

Acanthina tyrianthina Berry
Berry, 1957, p. 78.
Paratypes 1266a,b-1269a,b, 1270; Man of War Cove, Bahía Magdalena, Baja California, Mexico.

"Acmaea" acutapex Berry
Berry, 1960, p. 117.
Paratypes 1296-1300; Punta Cholla, Sonora, Mexico.

Acmaea (Collisella) paradigitalis Fritchman
Fritchman, 1960, p. 53, pl. 9, figs. 2-9, 2a-9a (all lower figures).
Paratypes 2522, 2523 (figs. 2, 2a), 2524 (figs. 3, 3a), 2525 (figs. 4, 4a), 2526 (figs. 5, 5a), 2527 figs. 6, 6a), 2528 (figs. 7, 7a), 2529 (figs. 8, 8a), 2530 (figs. 9, 9a); Berkeley Yacht Harbor, Alameda Co., Calif. (2522); Anacortes, Skagit Co., Wash. (2523); Mukkaw Bay, Clallam Co., Wash. (2524); Tacoma Narrows, Pierce Co., Wash. (2525); Port Oxford, Curry Co., Ore. (2526); Pacific Grove, Monterey Co., Calif. (2527); Ford Point, Santa Rosa Is., Santa Barbara Co., Calif. (2528); Corona del Mar, Orange Co., Calif. (2529); 40 miles north of Ensenada, Baja California, Mexico (2530).

"Acmaea" concreta Berry
Berry, 1963b, p. 142.
Paratypes 1339-1341; Ensenada Blanca, Baja California, Mexico.

Acmaea fonsecana Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 87.
Paratypes 504, 2434-2453; La Union, Gulf of Fonseca, Salvador.

"Acmaea" gabatella Berry
Berry, 1960, p. 118.
Holotype 1301; paratypes 1302-1307; off Reef Point, Orange Co., Calif.

"Acmaea" goodmani Berry
Berry, 1960, p. 117.
Paratypes 1133-1135; Puertecitos, Baja California, Mexico.

Acmaea turveri Hertlein and Strong
    Hertlein and Strong, 1951*c*, p. 152.
    Paratypes 1582-1584; Punta Colorado, Sonora, Mexico.
Acmaea turveri fayae Hertlein
    Hertlein, 1957, p. 112
    Paratype 1613; San Felipe, Baja California, Mexico.
Acteocina culcitella intermedia Willett
    Willett, 1928, p. 38.
    Paratypes 1652, 1653a,b, 1654-1655; Ship Rock, Catalina Is., Los Angeles Co., Calif.
Aesopus fredbakeri Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 74.
    Paratypes 587, 3110-3111; Mazatlan, Sinaloa, Mexico.
Aesopus osborni Hertlein and Strong
    Hertlein and Strong, 1951a, p. 83.
    Paratypes 1570-1574; Port Guatulco, Oaxaca, Mexico.
Agaronia murrha Berry
    Berry, 1953*c*, p. 417, pl. 29, fig. 1.
    Holotype 1400 (fig. 1); paratypes 1401-1416; Corinto, Nicaragua.
    Keen, 1958b, p. 422, fig. 628 (holotype).
Alaba interruptelineata Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 81.
    Paratypes 648, 3229-3243; San Juan del Sur, Nicaragua.
Alabina veraguaensis Strong and Hertlein
    Strong and Hertlein, 1939, p. 218.
    Paratypes 3731-3752; Bahía Honda, Panama.
Allogona lombardii Smith
    Smith, A. G., 1943, p. 545.
    Paratypes 697, 3324-3329; south of Selway Falls, Idaho Co., Idaho.
Ammonitella yatesi allyni Chace
    Chace, 1951, p. 122.
    Holotype 1511; paratypes 1512-1513; near Boyden's Cave, Kings Canyon, Fresno Co., Calif.
Amnicola brandi Drake
    Drake, 1953, p. 27.
    Paratypes 3663-3671; Las Palomas, Distrito Galeana, Chihuahua, Mexico.
Amphithalamus stephensae Bartsch
    Bartsch, 1927, p. 28.
    Paratypes 672, 3403-3411; Turtle Bay, Baja California, Mexico.
Amphithalamus trosti Strong and Hertlein
    Strong and Hertlein, 1939, p. 228.
    Paratypes 2358, 3789-3796; Bahía Honda, Panama.
Anachis carmen Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 71.
    Paratypes 546, 2592-2611; San Juan del Sur, Nicaragua.
Anachis decimdentata Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 72.
    Paratypes 581, 2999; San Juan del Sur, Nicaragua.
Anachis (*Glyptanachis*) *hilli* Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 73.
    Paratypes 549, 582, 2654-2671, 3000-3025; San Juan del Sur, Nicaragua (582, 3000-3011); Mazatlan, Sinaloa, Mexico (549, 2654-2671, 3012-3025).
Anachis reedi Bartsch
    Paratypes 675, 3337-3341; Santa Elena, Ecuador.
Anachis ritteri Hertlein and Strong
    Hertlein and Strong, 1951a, p. 82.
    Paratypes 1567-1569; Port Guatulco, Oaxaca, Mexico.
Anachis sanfelipensis Lowe
    Lowe, 1935, p. 20, pl. 2, fig. 8.
    Holotype 583 (fig. 8); paratypes 584, 3026-3028; San Felipe, Baja California, Mexico.
    Keen, 1958b, p. 384, fig. 454 (holotype).
Angiola periscelida Dall
    Dall, 1926, p. 64.
    Paratypes 2338-2353; Waki, Satsuma, Japan.
Angitrema angulata Wetherby
    Wetherby, 1876, p. 11.
    Paratype 693; Stone River, Rutherford Co., Tenn.

Arene hindsiana Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 86.
Paratypes 654, 3262; Manzanillo, Colima, Mexico.

Arene winslowae Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 86.
Paratypes 655, 3263-3280; San Juan del Sur, Nicaragua (655, 3263-3273); Taboga Island, Panama (3274-3280).

Assiminea infima Berry
Berry, 1947, p. 5.
Paratypes 685, 3330; Bad Water, Death Valley, Inyo Co., Calif.

Astraea guadalupeana Berry
Berry, 1957, p. 77.
Paratypes 1262a,b, 1263; south of Isla Guadalupe, Baja California, Mexico.

Astraea (*Uvanilla*) *rupicollina* Stohler
Stohler, 1959, p. 425.
Paratype 1073a,b; southeast of Islas Los Coronados, Baja California, Mexico.

Austronoba oliveri Powell
Powell, 1927a, p. 542.
Paratypes 3655-3657; off Sunday Island, Kermadec Islands, New Zealand.

Barleeia zeteki Strong and Hertlein
Strong and Hertlein, 1939, p. 228.
Paratypes 3797-3815; Bahía Honda, Panama.

Bathytoma tremperiana Dall
Dall, 1911, p. 109.
Paratypes 506, 2455a,b-2456a,b; San Pedro, Los Angeles Co., Calif.

Beringuis eyerdami Smith
Smith, A. G., 1959, p. 5.
Paratype 1455; off Vancouver Is., British Columbia, Canada.

Berthelinia (*Edenttelina*) *chloris belvederica* Keen and Smith
Keen and Smith, 1961, p. 53.
Paratypes 1542a,b-1544a,b; Bahía Puerto Ballandra, Baja California, Mexico.

Bittium (*Lirobittium*) *arenaense* Hertlein and Strong
Hertlein and Strong, 1951a, p. 107.
Paratypes 1577-1580; Arena Bank, Baja California, Mexico.

Brephodrillia ella Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 48.
Paratypes 520, 2470-2472; San Juan del Sur, Nicaragua.

Brephodrillia perfectus Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 47.
Paratype 521; Manzanillo, Colima, Mexico.

Bulimulus carmen Pilsbry and Lowe
Pilsbry and Lowe, 1932b, p. 50.
Paratypes 3583-3589; Isla Carmen, Baja California, Mexico.

Bulimulus (*Naesiotus*) *albemarlensis* Dall
Dall, 1917b, p. 377.
Paratypes 2730-2785; Albemarle Is., Galapagos Is., Ecuador.

Bulimulus (*Naesiotus*) *cucullinus* Dall
Dall, 1917b, p. 377.
Paratypes 2692-2729; Hood Is., Galapagos Is., Ecuador.

Bulimulus (*Naesiotus*) *hemaerodes* Dall
Dall, 1917b, p. 376.
Paratypes 2672-2691; Cowley Mt., Albemarle Is., Galapagos Is., Ecuador.

Bulimulus (*Naesiotus*) *lycodus* Dall
Dall, 1917b, p. 379.
Paratypes 2786-2848; Indefatigable Is., Galapagos Is., Ecuador.

Bulimulus (*Naesiotus*) *ochsneri* Dall
Dall, 1917b, p. 380.
Paratypes 2849-2876; Indefatigable Is., Galapagos Is., Ecuador.

Bulimulus (*Naesiotus*) *rabidensis* Dall
Dall, 1917b, p. 381.
Paratypes 2877-2914; Jervis Is., Galapagos Is., Ecuador.

Bulimulus (*Naesiotus*) *tortuganus* Dall
Dall, 1893, p. 54.
Paratypes 1980-2000; La Tortuga, South Albemarle Is., Galapagos Is., Ecuador.

Bulimulus (*Naesiotis*) *ustulatus phlegonis* Dall and Ochsner
Dall and Ochsner, 1928, p. 159.
Syntypes 3043-3109; Charles Is., Galapagos Is., Ecuador.

Bulimulus (Rhinus) rochai Baker
Baker, F., 1914, p. 636.
Paralectotypes 1790-1801; Ceará-Mirim, Rio Grande do Norte, Brazil.
Bulimulus (Rhinus) rochai taipuensis Baker
Baker, F., 1914, p. 636.
Paralectotypes 1802-1810; Taipú, Rio Grande do Norte, Brazil.
Bulimulus sanmarcosensis Pilsbry and Lowe
Pilsbry and Lowe, 1932b, p. 49.
Paratypes 3590-3612; Isla San Marcos, Baja California, Mexico.
See: *Rabdotus (Leptobyrsus) lamellifer lamellifer* (Pilsbry).
Bulimulus Snodgrassi Dall
Dall, 1900, p. 90.
Paratypes 2359-2412; Hood Is., Galapagos Is., Ecuador.
Bursa californica sonorana Berry
Berry, 1960, p. 118.
Paratype 1308; near Guaymas, Sonora, Mexico.
Caducifer (?) tabogensis Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 67.
Paratype 566; Taboga Island, Panama.
Caecum bahiahondaense Strong and Hertlein
Strong and Hertlein, 1939, p. 219.
Paratypes 3753-3772; Bahía Honda, Panama.
Caecum orcutti Dall
Dall *in* Orcutt, 1885, p. 541.
Paralectotypes 2027-2315; San Diego, San Diego Co., Calif.
Caecum richthofeni Strong and Hertlein
Strong and Hertlein, 1939, p. 224.
Paratypes 3773-3780; Taboga Is., Panama.
Calliostoma angelenum Lowe
Lowe, 1935, p. 19, pl. 2, fig. 5.
Holotype 657; Bahía de Los Ángeles, Baja California, Mexico.
Keen, 1958b, p. 254, fig. 38.
Calliostoma gemmuloides Lowe
Lowe, 1935, p. 19, pl. 2, fig. 4.
Holotype 656 (fig. 4); paratypes 3281-3282; Tepopa Bay, Sonora, Mexico.
Calliostoma marshalli Lowe
Lowe, 1935, p. 19, pl. 2, fig. 3.
Holotype 659; paratypes 658, 3283-3290; San Felipe, Baja California, Mexico.
Calliostoma mcleani Shasky and Campbell
Shasky and Campbell, 1964, p. 117.
Paratype 1454; Saladita, Guaymas, Sonora, Mexico.
Calotrophon bristolae Hertlein and Strong
Hertlein and Strong, 1951a, p. 87.
Paratype 1576; Gorda Bank, Baja California, Mexico.
Carinifex jackonensis Henderson
Henderson, 1932, p. 133.
See: *Carinifex jacksonensis* Henderson.
Carinifex jacksonensis Henderson
Henderson, 1932, p. 133.
Paratypes 1614-1618; Jackson Lake, Teton Co., Wyo.
Carinodrillia dichroa Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 46.
Paratypes 517-519, 2469; Manzanillo, Colima, Mexico (517, 2469); Corinto, Nicaragua (518); Acapulco, Guerrero, Mexico (519).
Carinodrillia halis soror Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 45.
Paratypes 529, 2489-2494; Guaymas, Sonora, Mexico.
Carinodrillia jaculum Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 45.
Paratype 523; Manzanillo, Colima, Mexico.
Cerion (Strophiops) melanostomum Clench
Clench, 1934b, p. 212.
Paratypes 1709-1737; Eleuthera Is., Bahamas Islands.
Cerion (Strophiops) utowana Clench
Clench, 1933b, p. 92.
Paratypes 1739-1750; East Plana Cay, Bahamas Islands.

Cerion uva arubanum Baker
Baker, H. B., 1924, p. 104.
Paratypes 1959-1962; Aruba Is., Netherlands Antilles.
Cerithiopsis (Cerithiopsis) subgloriosa Baker, Hanna, and Strong
Baker, Hanna, and Strong, 1938, p. 218.
Paratype 1918; La Paz, Baja California, Mexico.
Cerithiopsis stephensi Bartsch
Bartsch, 1909, p. 399.
Paratype 3672; Mole Harbor, Alaska.
Cerithium stercusmuscarum Val. form *exaggeratum* Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 81.
Hypotypes 603, 3161; Montijo Bay, Panama.
Cerithium (Thericium) nicaraguense Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 82.
Paratypes 604, 3162; Corinto, Nicaragua.
Chilina oldroydae Marshall
Marshall, 1924, p. 4.
Paratypes 1755-1761; Lake Fetalafquen, Chubut, Argentina.
Chondropoma (Chondropoma) necopium necopium Bartsch
Bartsch, 1946a, p. 208.
Paratypes 3681-3682; Lightborn Creek, Grand Caicos, Bahama Islands.
Cingula eyerdami Willett
Willett, 1934, p. 103.
Paratypes 1666-1689; Elrington Is., Alaska.
Circulus bakeri Strong and Hertlein
Strong and Hertlein, 1939, p. 240
Paratypes 3857-3859; Bahía Honda, Panama.
Circulus madreënsis Baker, Hanna, and Strong
Baker, Hanna, and Strong, 1938, p. 236.
Paratypes 1925-1929; María Madre Is., Tres Marías group, Nayarit, Mexico.
Clathrodrillia (Clathrodrillia) pilsbryi Lowe
Keen, 1958b, p. 454, fig. 769 (holotype).
See: *Clathrodrillia pilsbryi* Lowe.
Clathrodrillia nautica Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 44.
Paratypes 524-525, 2477; Acapulco, Guerrero, Mexico (524, 2477); Guaymas, Sonora, Mexico (525).
Clathrodrillia pilsbryi Lowe
Lowe, 1935, p. 23, pl. 4, fig. 2.
Holotype 527 (fig. 2); paratypes 526, 2478-2488; Punta Peñasco, Sonora, Mexico.
See: *Clathrodrillia (Clathrodrillia) pilsbryi* Lowe.
Clathurella lowei Dall
Dall, 1903, p. 172.
Paratype 542, 2569-2570; Santa Catalina Island, Los Angeles Co., Calif.
Clavus (Elaeocyma) acapulcanus (Lowe)
Keen, 1958b, p. 450, fig. 745 (holotype).
See: *Elaeocyma acapulcana* Lowe.
Clavus (Imaclava) pembertoni Lowe
Keen, 1958b, p. 452, fig. 758, left (holotype).
See: *Clavus pembertoni* Lowe.
Clavus pembertoni Lowe
Lowe, 1935, p. 22, pl. 3, fig. 6.
Holotype 528; Bahía de Los Ángeles, Baja California, Mexico.
See: *Clavus (Imaclava) pembertoni* Lowe.
Cochliopa diazensis Morrison
Morrison, 1946, p. 27.
Paratypes 1691a,b, 1692; Rio Juan Diaz, east of Panama City, Panama.
Colubraria aphrogenia Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 62.
Paratype 565; Corinto, Nicaragua.
Colubraria jordani Strong
Strong, 1938, p. 212.
Paratypes 3550-3551; Socorro Is., Revillagigedo group, Colima, Mexico.
Coronadoa simonsae Bartsch
Bartsch, 1946b, p. 281.
Paratypes 673, 3376-3380; Islas Los Coronados, Baja California, Mexico.

Crassispira adamsiana Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 48.
Paratype 530; San Juan del Sur, Nicaragua.
Crassispira erebus Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 49.
Paratypes 531, 2495-2496; Corinto, Nicaragua.
Crassispira flavonodosa Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 51.
Paratypes 532-533, 2497-2499; Montijo Bay, Panama (532); Corinto, Nicaragua (533, 2497-2499).
Crassispira fonseca Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 50.
Paratypes 534, 2500-2516; La Union, Gulf of Fonseca, San Salvador.
Crassispira hermanita Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 53.
Paratype 535; Corinto, Nicaragua.
Crassispira loxospira Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 52.
Paratype 536; Manzanillo, Colima, Mexico.
Crassispira nymphia Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 51.
Paratypes 539, 2547-2555; La Paz, Baja California, Mexico.
Crassispira pluto Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 49.
Paratypes 537-538, 2531-2544; Guaymas, Sonora (537, 2531-2543); Mazatlan, Sinaloa (538, 2544), both Mexico.
Crassispira solitaria Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 53.
Paratype 540; Manzanillo, Colima, Mexico.
Crassispira trimariana Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 52.
Paratypes 541, 2556-2568; Islas Tres Marías, Nayarit, Mexico.
Crepidula coei Berry
Berry, 1950, p. 35.
Paratype 1250; near Sunset Beach, Orange Co., Calif.
Crepidula williamsi Coe
Coe, 1947, p. 241.
Paratype 694; Islas Los Coronados, Baja California, Mexico.
Crucibulum castellum Berry
Berry, 1963b, p. 143.
Paratypes 1342-1344; off Acapulco, Guerrero, Mexico.
Crucibulum personatum Keen
Keen, 1958a, p. 247.
Paratype 3654; near Panama City, Panama.
Crucibulum subactum Berry
Berry, 1963b, p. 144.
Paratypes 1348-1350; off Teacapan, Sinaloa, Mexico.
Cyclostrema bartschi Strong and Hertlein
Strong and Hertlein, 1939, p. 240.
Paratype 3834-3839; Bahía Honda, Panama.
Cyclostrema lowei Baker, Hanna, and Strong
Baker, Hanna, and Strong, 1938, p. 233.
Paratype 1920; Cabo San Lucas, Baja California, Mexico.
Cyclostrema mccullochae Strong and Hertlein
Strong and Hertlein, 1939, p. 239.
Paratypes 3840-3856; Bahía Honda, Panama.
Cylichna (Cylichnella) tabogaensis Strong and Hertlein
Strong and Hertlein, 1939, p. 191.
Paratypes 3683-3685; Taboga Is., Panama.
Cymatosyrinx arenensis Hertlein and Strong
Hertlein and Strong, 1951a, p. 76.
Paratype 1566; Arena Bank, off Baja California, Mexico.
Cytharella finitima Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 60.
Paratypes 512, 2461-2465; San Juan del Sur, Nicaragua.

Cytharella nereis Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 59.
  Paratypes 513, 2466; San Juan del Sur, Nicaragua.
Daphnella mazatlanica Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 61.
  Paratypes 507-509, 2457; Guaymas, Sonora (507); Cape San Lucas, Baja California (508, 2457); Islas Tres Marías, Nayarit (509); all Mexico.
Daphnella panamica Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 60.
  Paratypes 510-511, 2458-2460; Taboga Island, Panama (510, 2458); San Juan del Sur, Nicaragua (511, 2459-2460).
Delphinoidea hannai Strong and Hertlein
  Strong and Hertlein, 1939, p. 242.
  Paratypes 3860-3862; Bahía Honda, Panama.
Dinotropis harringtoni Pilsbry and Cockerell
  Pilsbry and Cockerell, 1937, p. 25.
  Paratype 3582; Rio Iguembe, above Rio Ingre, Bolivia.
Diodora pusilla Berry
  Berry, 1959, p. 109.
  Paratypes 1289-1293; off Acapulco, Guerrero, Mexico.
Discus (Gonyodiscus?) brunsoni Berry
  Berry, 1955b, p. 17.
  Paratype 1248; McDonald Lake, Mission Range, Lake Co., Mont.
Doryssa heathi Baker
  Pilsbry *in* Baker, F., 1914, p. 653.
  Paralectotypes 1812-1813; Rio Irirí, Pará, Brazil.
Doryssa iheringi Pilsbry
  Pilsbry *in* Baker, F., 1914, p. 654.
  Paratype 1814; Rio Jary, St. Antonio da Cachoeira, Amapá, Brazil.
Doryssa rex Pilsbry
  Pilsbry *in* Baker, F., 1914, p. 650.
  Paralectotypes 3433-3434; Rio Jary, St. Antonio da Cachoeira, Amapá, Brazil.
Doryssa rex regina Pilsbry
  Pilsbry *in* Baker, F., 1914, p. 651.
  Paralectotypes 3435-3436; Rio Jary, St. Antonio da Cachoeira, Amapá, Brazil.
Doryssa starksi Baker
  Pilsbry *in* Baker, F., 1914, p. 652.
  Paratypes 1815-1816; Rio Irirí, Pará, Brazil.
Doryssa transversa jaryensis Pilsbry
  Pilsbry *in* Baker, F., 1914, p. 649, pl. 24, fig. 2.
  Paralectotypes 3437 (fig. 2), 3438-3441; Rio Jary, St. Antonio da Cachoeira, Brazil.
Duplicaria (Duplicaria) crakei Burch
  Burch, R. D., 1965, p. 245.
  Paratypes 1534-1536; Cable Beach, Broome, Western Australia, Australia.
Elaeocyma acapulcana Lowe
  Lowe, 1935, p. 23, pl. 4, fig. 1.
  Holotype 514 (fig. 1), paratypes 515, 2467-2468; Acapulco, Guerrero, Mexico.
  See: *Clavus (Elaeocyma) acapulcanus* (Lowe).
Engina senae Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 63.
  Paratypes 563, 2915; Mazatlan, Sinaloa, Mexico.
Engina senae multa Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 64.
  Paratypes 564, 2916; Guaymas, Sonora, Mexico.
Epitonium (Asperoscala) slevini Strong and Hertlein
  Strong and Hertlein, 1939, p. 193.
  Paratypes 3686-3687; Taboga Is., Panama.
Epitonium (Nitidiscala) californicum Dall
  Strong, 1930, p. 195, pl. 20, figs. 12a, 12b.
  Hypotype 346; Alamitos Bay, Los Angeles Co., Calif.
Epitonium (Nitidiscala) cooperi Strong
  Strong, 1930. p. 194, pl. 20, figs. 6a, 6b.
  Holotype 345 (figs. 6a, 6b); paratypes 3386-3391; San Pedro, Los Angeles Co., Calif.
Epitonium (Nitidiscala) gaylordianum Lowe
  Lowe, 1932, p. 114.
  Paratypes 595, 3132-3136; Montijo Bay, Panama.

Epitonium (*Nitidiscala*) *gissleri* Strong and Hertlein
Strong and Hertlein, 1939, p. 194.
Paratypes 3688-3689; Taboga Is., Panama.

Epitonium (*Nitidiscala*) *indianorum* (Carpenter)
Strong, 1930, p. 192, pl. 20, figs. 2a, 2b.
Hypotype 343; Forrester Island, Alaska.

Epitonium (*Nitidiscala*) *strongi* Lowe
Lowe, 1932, p. 115.
Paratypes 596, 3137-3140; La Union, Gulf of Fonseca, San Salvador.

Epitonium (*Nitidiscala*) *tinctum* (Carpenter)
Strong, 1930, p. 193, pl. 20, figs. 5a, 5b.
Hypotype 344; Point Vincent, near San Pedro, Los Angeles Co., Calif.

Epitonium (*Nitidoscala*) *tinctum* var. *bormanni* Strong
Strong, 1941, p. 47.
Paratypes 452, 1521-1527; Mission Bay, San Diego Co., Calif.

Eucalodium (*Anisospira*) *orcutti* Dall
Dall, 1910, p. 34.
Paratypes 1362-1375; near Rio Verde, Oaxaca, Mexico.
See: *Eucalodium orcutti* Dall.

Eucalodium orcutti Dall
Drake, 1957, p. 309, fig. 1.
Paratypes 1362 (fig. 1, left), 1363 (fig. 1, right).
See: *Eucalodium* (*Anisospira*) *orcutti* Dall.

Fusinus cinereus (Reeve) variety *coronadoensis* Lowe
Lowe, 1935, p. 26.
Hypotypes 558, 1174-1188; Isla Coronados, Baja California, Mexico.

Fusinus cinereus (Reeve) variety *sonoraensis* Lowe
Lowe, 1935, p. 26.
Hypotypes 559-561, 1189-1201, 1203-1223; Tepopa Bay, off Tiburon Island (559, 1189-1201), San Pedro Nolasco Bay (560, 1203-1213), Miramar, near Guaymas (561, 1214-1223), all Sonora, Mexico.

Fusinus felipensis Lowe
Lowe, 1935, p. 25, pl. 4, fig. 6.
Holotype 552 (fig. 6); paratypes 553, 1160-1173; San Felipe, Baja California, Mexico.

Fusinus fredbakeri Lowe
Lowe, 1935, p. 24, pl. 4, fig. 5.
Holotype 557 (fig. 5); paratypes 551, 1138-1159; San Felipe, Baja California, Mexico.

Fusinus hertleini Lowe
Lowe, 1935, p. 25, pl. 4, fig. 7.
Holotype 554 (fig. 7); paratypes 555-556; Concepción Bay, Baja California (554); Sargent's Point, Sonora (555-556), both Mexico.
See: *Fusinus hertleini* variety *albescens* Lowe (555).
See: *Fusinus hertleini* variety *bruneocincta* Lowe (556).

Fusinus hertleini variety *albescens* Lowe
Lowe, 1935, p. 25.
Paratype 555; Sargent's Point, Sonora, Mexico.
See: *Fusinus hertleini* Lowe.

Fusinus hertleini variety *bruneocincta* Lowe
Lowe, 1935, p. 25.
Paratype 556; Sargent's Point, Sonora, Mexico.
See: *Fusinus hertleini* Lowe.

Galeomma (*Lepirodes* ?) *mexicanum* Berry
Berry, 1959, p. 108.
Paratype 1284; Bahía San Luis Gonzaga, Baja California, Mexico.

Gemmula hindsiana Berry
Berry, 1958, p. 86.
Holotype 1279; probably off San Jose Is., Baja California, Mexico.
Keen, 1958, p. 444, fig. 714.
Hypotypes 1280 (fig. 714, center), 1281 (fig. 714, right); near Isla Ángel de la Guarda, Baja California, Mexico.

Gibbula harrisi Baker and Spicer
Baker and Spicer, 1930, p. 177, pl. 19, figs. 3, 4.
Holotype 666 (figs. 3, 4); paratypes 3304-3318; Zamboanga, Mindanao, Philippines.

G.[*lyptostoma*] *p.*[*ilsbryanum*] *binneyanum* Berry
Berry, 1938c, p. 56.
Paratypes 463, 1764-1769; Dominguez Hills, Los Angeles Co., Calif.

Gonyodiscus clappi Pilsbry
Pilsbry, 1925, p. 417.
Paralectotypes 3475-3476; Jasper Point, Madison Co., Ala.
Gundlachia bakeri Pilsbry
Pilsbry *in* Baker, F., 1914, p. 670.
Paratypes 3442-3474 (3454-3474 are "nonseptate form"); Pará, Brazil.
Haliotis corrugata oweni Talmadge
Talmadge, 1966, p. 1.
Paratype 1625; Guadalupe Is., Baja California, Mexico.
Haliotis cracherodii var. *holzneri* Hemphill
Hemphill, 1907, p. 59.
Hypotypes 1074-1076; Baja California, Mexico.
Haliotis fulgens guadalupensis Talmadge
Talmadge, 1964, p. 375, fig. 1.
Holotype 1068 (fig. 1); paratype 1069-1072; Guadalupe Island, Baja California, Mexico.
Haminoea virescens, variety *rosacea* Spicer
Spicer, 1933, p. 52.
Hypotypes 663, 3298-3302; Ballast Point, San Diego, San Diego Co., Calif.
Hanetia macrospira Berry
Berry, 1957, p. 79.
Paratypes 1271a,b-1272a,b; Playa de Almejas, north of San Felipe, Baja California, Mexico.
Hanetia mendozana Berry
Berry, 1959, p. 111.
Paratype 1294; Magdalena Bay, Baja California, Mexico.
Hastula (Punctoterebra) betsyae Burch
Burch, R. D., 1965, p. 243.
Paratypes 1529-1533; Honolohau, Maui, Hawaii.
Helcion (Rhodopetala) rosea (Dall)
MacClintock, 1967, p. 81, figs. 75-79.
Hypotypes 707-710; Adak Island, Alaska.
Heliacus mazatlanicus Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 83.
Paratypes 605, 3163-3179; Mazatlan, Sinaloa, Mexico.
Heliacus planispira Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 83.
Paratypes 3613-3614; Mazatlan, Sinaloa, Mexico.
Helicostyla decorata jaroensis Smith
Smith, M., 1932, p. 103.
Syntypes (?) 3420-3421; Jaro, Panay Island, Philippines (?).
Helicostyla fulgetrum gigantea Smith
Smith, M., 1932, p. 104.
Syntype (?) 3422; Igbaras Mts., Panay Island, Philippines.
Helicostyla ticaonica iloilana Smith
Smith, M., 1932, p. 102.
Paratypes 3423-3425; Passi, Panay Island, Philippines.
Helminthoglypta arrosa humboldtica Berry
Berry, 1938a, p. 17.
Paratypes 428, 430; Bridge Creek Lumber Camp, south of Scotia, Humboldt Co., Calif.
Helminthoglypta arrosa mattolensis Smith
Smith, A. G., 1938, p. 83.
Paratypes 342, 414-415, 433; between Cape Mendocino and mouth of Mattole River, Humboldt Co., Calif.
Helminthoglypta arrosa williamsi Smith
Smith, A. G., 1938, p. 79.
Paratypes 434, 754; Hog Island, Tomales Bay, Marin Co., Calif.
Helminthoglypta crotalina Berry
Berry, 1928, p. 276.
Paratypes 437, 760-764, 1243-1245; Granite Mountains, San Bernardino Co., Calif.
Helminthoglypta cuyama Hanna and Smith
Hanna and Smith, 1937, p. 15.
Paratypes 435, 755-756; east of Santa Maria, Santa Barbara Co., Calif.
Helminthoglypta isabella Berry
Berry, 1938b, p. 42.
Paratypes 439, 767-768; east of Isabella, Kern Co., Calif.
Helminthoglypta jaegeri Berry
Berry, 1928, p. 274.
Paratypes 438, 765-766, 1239-1242; near Sweetwater Spring, Ord Mountains, San Bernardino Co., Calif.

Helminthoglypta mohaveana Berry
Berry, 1926, p. 492.
Paratype 1238; Victor Mts., San Bernardino Co., Calif.
Helminthoglypta similans Hanna and Smith
Hanna and Smith, 1937, p. 13.
Paratypes 436, 757-759; southeast of Oil City, Fresno Co., Calif.
Helminthoglypta thermimontis Berry
Berry, 1953a, p. 333, text-figs. 2-3; pl. 24, figs. 4-6, 10-11.
Holotype 1383; Hot Springs Mt., San Diego Co., Calif.
Helminthoglypta traski misiona Chace
Pilsbry, 1939, p. 174, fig. 86 (holotype).
See: *Helminthogypta traski misiona* Chace.
Helminthoglypta tudiculata angelena Berry
Berry, 1938a, p. 21.
Paratype 431; San Timoteo Canyon, San Bernardino Co., Calif.
Helminthoglypta tudiculata kernensis Berry
Berry, 1929b, p. 40.
Paratypes 1371-1373; Poso Creek, Kern Co., Calif.
Helminthoglypta tudiculata rex Church and Smith
Church and Smith, 1938, p. 119.
Paratypes 432, 1508; Tule River canyon, east of Springville, Tulare Co., Calif.
Helminthogypta traski misiona Chace
Chace, 1937, p. 60, pl. 4, fig. 2.
Holotype 1510; La Misión, Baja California, Mexico.
See: *Helminthoglypta traski misiona* Chace.
Hemisinus flammeus Baker
Baker, F., 1914, p. 657.
Paratypes 1817-1819; Rio Jamauchim, Pará, Brazil.
Hemitoma hermosa Lowe
Lowe, 1935, p. 24, pl. 4, fig. 4.
Holotype 660 (fig. 4); paratype 3291; Carmen Island, Baja California, Mexico.
See: *Hemitoma (Montfortia) hermosa* Lowe.
Hemitoma (Montfortia) hermosa Lowe
Keen, 1958b, p. 253, fig. 37 (holotype).
See: *Hemitoma hermosa* Lowe.
Hindsia acapulcana Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 66.
Paratypes 577, 2993-2996; Acapulco, Guerrero, Mexico.
Hindsia ariel Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 66.
Paratypes 578, 2997; Corinto, Nicaragua.
Homalopoma
Keen, 1958b, p. 264, center figure (holotype).
See: *Homalopoma concepcionensis* Lowe.
(?) *Homalopoma concepcionensis* Lowe
Lowe, 1935, p. 24, pl. 4, fig. 3.
Holotype 650 (fig. 3); paratypes 3244-3245; Concepción Bay, Baja California, Mexico.
See: *Homalopoma*.
Idiopyrgus pilsbryi Baker
Baker, F., 1914, p. 658.
Paralectotype 1820; Papary Lake, Rio Grande do Norte, Brazil.
Lacuna succinea Berry
Berry, 1953c, p. 411.
Paratypes 1388-1399; San Pedro, Los Angeles Co., California.
Lamellaria sharoni Willett
Willett, 1939, p. 123.
Paratypes 1649-1651; Newport Bay, Orange Co., Calif.
Latirus socorroensis Hertlein and Strong
Hertlein and Strong, 1951b, p. 76.
Paratype 1581a,b; Clarion Is., Revillagigedo Islands, Colima, Mexico.
Leptogyra alaskana Bartsch
Bartsch, 1910, p. 136.
Paratypes 3675-3680; Port Graham, Alaska.
Leptothyra engbergi Willett
Willett, 1929, p. 27.
Paratypes 651, 3246-3249; Olga, San Juan Co., Wash.

Liguus blainianus jaumei Clench and Aguayo
Clench and Aguayo, 1932, p. 99.
Paratype 1738; Mangas, Pinar del Rio, Cuba.
Liguus crenatus aurantius Clench
Clench, 1929, p. 19.
Paratypes 3415-3417; Pinecrest region, Dade Co., Fla.
Liguus crenatus barbouri Clench
Clench, 1929, p. 18.
Paratypes 1699-1703; near Pinecrest, Dade Co., Fla.
Liguus crenatus floridanus Clench
Clench, 1929, p. 20.
Paratypes 1707-1708; Pinecrest region, Dade Co., Fla.
Liguus fasciatus viridis Clench
Clench, 1934a, p. 105.
Paratypes 1695-1698; near Dolores, Soledad, Cienfuegos, Cuba.
Liguus fasciatus walkeri Clench
Clench, 1933a, p. 91.
Paratypes 3418-3419; Pinecrest region, Dade Co., Fla.
Lioglyphostoma acapulcanum Pilsbry and Lowe
Pilsbry and Lowe, 1932b, p. 54.
Paratypes 522, 2473-2476; Acapulco, Guerrero, Mexico.
Liotia balboai Strong and Hertlein
Strong and Hertlein, 1939, p. 236.
Paratypes 3817-3830; Taboga Is., Panama.
Liotia erici Strong and Hertlein
Strong and Hertlein, 1939, p. 237.
Paratype 3831; Bahía Honda, Panama.
Liotia heimi Strong and Hertlein
Strong and Hertlein, 1939, p. 238.
Paratypes 3832-3833; Bahía Honda, Panama.
Liotia lucasensis Strong
Strong, 1934, p. 441.
Paratypes 3397-3402; Cape San Lucas, Baja California, Mexico.
Liotia socorroensis Strong
Strong, 1934, p. 439.
Paratypes 3394-3396; Socorro Is., Revillagigedo group, Colima, Mexico.
Littoridina manni Baker
Baker, F., 1914, p. 658.
Paralectotype 1821; Papary Lake, Rio Grande do Norte, Brazil.
Lucapinella aequalis (Sowerby)
McLean, 1967, p. 351, pl. 49, figs. 7, 8.
Hypotype 2521; Taboga Island, Panama.
Lucapinella eleanorae McLean
McLean, 1967, p. 350.
Paratypes 2517-2520; Rey Island, Perlas Group, Santelmo Bay, Panama.
Lucapinella milleri Berry
Berry, 1959, p. 109.
Paratype 1288; Puertecitos, Baja California, Mexico.
Lymnaea idahoensis Henderson
Henderson, 1931, p. 75.
Paratypes 662, 3293-3297; Little Salmon River, north of New Meadows, Adams Co., Idaho.
Lymnaea mazamae Baily
Baily, 1933, p. 33.
Paratype 1597; Crater Lake, Klamath Co., Ore.
Macrene coronadensis Stohler
Stohler, 1959, p. 439.
Paratype 1919a,b; Islas Los Coronados, Baja California, Mexico.
Macrochlamys aufschnaiteri Blume
Blume, 1957, p. 1.
Paratypes 1519-1520; Dralthang Tal, northern Nepal.
"*Mangelia*" *antiochroa* Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 56.
Paratypes 543, 2571-2573; Montijo Bay, Panama.
"*Mangelia*" *cymatias* Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 56.
Paratypes 544, 2574-2575; Acapulco, Guerrero, Mexico.

"*Mangelia*" (*Steironepion*) *melanosticta* Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 56.
  Paratypes 545, 2576-2591; San Juan del Sur, Nicaragua.
Margarites helicinus, new variety *elevatus* Dall
  Dall, 1920, p. 366.
  Paratypes 661, 3292; Bear Bay, Baranoff Island, Alaska.
Megalomphalus hancocki Strong and Hertlein
  Strong and Hertlein, 1939, p. 235.
  Paratype 3816; Taboga Is., Panama.
Megomphix californicus Smith
  Smith, A. G., 1960, p. 1.
  Paratype 1642; Natural Bridge Cave, Trinity Co., Calif.
Melampus mousleyi Berry
  Berry, 1964, p. 152.
  Paratypes 1354-1359; Cholla Cove, Sonora, Mexico.
Melampus olivaceus californianus Berry
  Berry, 1964, p. 153.
  Paratypes 1360-1362; Mission Bay, Pacific Beach, San Diego Co., Calif.
Metula amosi Vanatta
  Vanatta, 1913, p. 22.
  Paratype 562; Panama City, Panama.
Micranellum lohri Strong and Hertlein
  Strong and Hertlein, 1939, p. 225.
  Paratypes 3781-3788; Taboga Is., Panama.
Micrarionta aquae-albae Berry
  Berry, 1922, p. 87.
  Paratypes 1378-1380; Whitewater Canyon, San Bernardino Mts., San Bernardino Co., Calif.
Micrarionta (*Eremarionta*) *avawatzica* Berry
  Berry, 1930c, p. 190.
  Paratypes 440, 769-770; south of Cave Springs, Avawatz Mountains, San Bernardino Co., Calif.
Micrarionta (*Eremarionta*) *borregoensis* Berry
  Berry, 1929b, p. 39.
  Holotype 639; paratypes 450, 1475-1477; Palm Canyon, Borrego Valley, San Diego Co., Calif.
  See: *Sonorelix borregoensis* (Berry).
Micrarionta (*Eremarionta*) *callinepius* Berry
  Berry, 1930b, p. 544.
  Paratypes 445, 1425-1427; Santa Rosa Mts., San Diego Co., Calif.
Micrarionta (*Eremarionta*) *melanopylon* Berry
  Berry, 1930c, p. 187.
  Paratypes 441, 771-772; Black Canyon, north of Hinkley, San Bernardino Co., Calif.
Micrarionta (*Eremarionta*) *micrometalleus* Berry
  Berry, 1930c, p. 189.
  Paratypes 443, 1419-1423; south of Petrified Forest, Kern Co., Calif.
Micrarionta (*Eremarionta*) *mille-palmarum* Berry
  Berry, 1930b, p. 543.
  Paratypes 442, 1417-1418; Thousand Palms, Riverside Co., Calif.
Micrarionta (*Eremarionta*) *morongoana* Berry
  Berry, 1929b, p. 39.
  Paratypes 444, 1363-1370, 1424; Morongo Pass, San Bernardino Co., Calif.
Micrarionta (*Eremarionta*) *rowelli bechteli* Emerson and Jacobson
  Emerson and Jacobson, 1964, p. 327.
  Paratype 951; Isla San Esteban, Sonora, Mexico.
Micrarionta rowelli bakerensis Pilsbry and Lowe
  Pilsbry and Lowe, 1934b, p. 68.
  Paralectotypes 446, 1429-1442; south of Baker, San Bernardino Co., Calif.
Micrarionta rowelli mexicana Pilsbry and Lowe
  Pilsbry and Lowe, 1934b, p. 67.
  Paratypes 447, 1443-1453; south of Sonoyta, Sonora, Mexico.
Micrarionta xerophila Berry
  Berry, 1922, p. 92.
  Paratypes 1381-1382; near Indian Well, Riverside Co., Calif.
Mitra lowei Dall
  Dall, 1903, p. 173.
  Paratype 550; Santa Catalina Island, Los Angeles Co., Calif.
Mitra semiusta Berry
  Berry, 1957, p. 80.
  Paratypes 1273-1274; off Point Conception, Santa Barbara Co., Calif.

Mitra (*Tiara*) *directa* Berry
    Berry, 1960, p. 120.
    Paratype 1311; off Cabo Haro, Sonora, Mexico.
Mitra (*Tiara*) *lindsayi* Berry
    Berry, 1960, p. 122.
    Holotype 1312; off Puerto Peñasco, Sonora, Mexico.
Mitrella granti Lowe
    Lowe, 1935, p. 20, pl. 2, fig. 7.
    Holotype 558 (fig. 7); paratypes 589, 3112-3125; San Felipe, Baja California, Mexico.
    Keen, 1958b, p. 389, fig. 480 (holotype).
Mitrella lalage Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 70, pl. 5, fig. 9?
    Paratypes 547-548, 2612-2653; Mazatlan, Sinaloa, Mexico (547, 2612-2642); San Juan del Sur, Nicaragua (548, 2643-2653).
Monadenia churchi Hanna and Smith
    Hanna and Smith, 1933, p. 79.
    Paratypes 2935-2938; east of Paynes Creek Station, Tehama Co., Calif.
Monadenia (*Corynadenia*) *hillebrandi mariposa* Smith
    Smith, A. G., 1957, p. 24.
    Paratypes 1969-1970; McLean Cave, Mariposa Co., Calif.
Monadenia (*Corynadenia*) *tuolumneana* Berry
    Berry, 1955a, p. 14.
    Paratypes 1246-1247; above Crystal Cave, Tuolumne Co., Calif.
Monadenia fidelis baxteriana Talmadge
    Talmadge, 1954, p. 52.
    Paratype 1762; Sister Rocks, Curry Co., Ore.
Monadenia fidelis beryllica Chace and Chace
    Chace and Chace, 1935, p. 48.
    Holotype 1509; near mouth of Pistol River, Curry Co., Ore.
Monadenia fidelis leonina Berry
    Berry, 1937, p. 29.
    Paratype 1377; Beaver Creek, Siskiyou Co., Calif.
Monadenia fidelis ochromphalus Berry
    Berry, 1937, p. 28.
    Paratype 1376; Etna Creek, Siskiyou Co., Calif.
Monadenia fidelis salmonensis Talmadge
    Talmadge, 1954, p. 54.
    Paratype 1763; near Salmon River, Siskiyou Co., Calif.
Monadenia fidelis smithiana
    Berry, 1940, p. 14.
    Paratype 1249; below Hiouchi Bridge, Del Norte Co., Calif.
Monadenia marmarotis Berry
    Berry, 1940, p. 3.
    Paratypes 462, 1752-1754; Marble Valley, Siskiyou Co., Calif.
Murex (*Homalocantha*) *anatomica zamboi* Burch and Burch
    Burch, J. Q., and Burch, R. L., 1960, p. 1.
    Paratype 1428a,b; Baring Point, Olango Is., Cebu, Philippines.
Nassa angulicostis Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 69.
    Paratypes 567-569, 2917-2934; Guaymas, Sonora, Mexico (567, 2917-2925); San Juan del Sur, Nicaragua (568, 2926-2930); Taboga Island, Panama (569, 2931-2934).
Nassa bailyi Pilsbry and Lowe
    Pilsbry and Lowe, 1932b, p. 51.
    Paratypes 571, 2941-2946; Mazatlan, Sinaloa, Mexico.
Nassa leucops Pilsbry and Lowe
    Pilsbry and Lowe, 1932b, p. 51.
    Paratypes 572, 2947-2976; Kino Bay estuary, Sonora, Mexico.
Nassarina atella Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 77.
    Paratypes 573, 2977-2978; Islas Tres Marías, Nayarit (2977-2978); Acapulco, Guerrero (573), both Mexico.
Nassarina poecila Pilsbry and Lowe
    Pilsbry and Lowe, 1932a, p. 76.
    Paratypes 574, 2979-2988; San Juan del Sur, Nicaragua.

Nassarina xeno Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 75.
  Paratypes 575-576, 2989-2992; San Juan del Sur, Nicaragua. (576, 2992 are color variety *N. x. albipes*).
  See: *Nassarina xeno albipes* Pilsbry and Lowe.
Nassarina xeno albipes Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 76.
  See: *Nassarina xeno* Pilsbry and Lowe.
Nassarina (*Zanassarina*) *anitae* Campbell
  Campbell, 1961, p. 26.
  Paratype 1482; off Cabo Haro. Guaymas, Sonora, Mexico.
Nassarius (*Caesia*) *delosi* (Woodring)
  Addicott, 1965, p. 10, pl. 1, figs. 23, 30.
  Hypotype 377 (fig. 23), 383 (fig. 30); Mission Beach, San Diego Co. (377); Balboa, Orange Co. (383), both Calif.
Nassarius howardae Chace
  Chace, 1958b, p. 333, fig. 1.
  Holotype 1516a (fig. 1, right), b; paratypes 1517-1518; Almejas Beach, San Felipe (1516); San Felipe (1517-1518), both Baja California, Mexico.
Natica idiopoma Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 84.
  Paratype 649; Taboga Island, Panama.
Neosimnia quaylei (Lowe)
  Keen, 1958b, p. 334, fig. 305 (holotype).
  See: *Simnia quaylei* Lowe.
Neosimnia vidleri tyrianthina Berry
  Berry, 1960, p. 118.
  Paratypes 1309-1310; Cholla Cove, Sonora, Mexico.
Nerita mitchelli Oldroyd
  Oldroyd, 1933, p. 205.
  Paratypes 1637-1639; Philippines.
Nomaeopelta myrae Berry
  Berry, 1959, p. 109.
  Paratypes 1285-1287; Las Gaviotas Beach, near Mazatlan, Sinaloa, Mexico.
Ocenebra carmen (Lowe)
  Keen, 1958b, p. 359, fig. 353 (holotype).
  See: *Tritonalia carmen* Lowe.
Ocenebra keenae Bormann
  Bormann, 1946, p. 40.
  Paratypes 684, 3331-3333; White Point, San Pedro, Los Angeles Co., Calif.
Ocenebra seftoni Chace
  Chace, 1958a, p. 331, fig. 1.
  Holotype 1514 (fig. 1, right); paratype 1515 (fig. 1, left); Melpomene Cove, Guadalupe Island, Baja California, Mexico. (The specimen labelled "paratype" in fig. 1 is the holotype.)
Ocenebra sloati Hertlein
  Hertlein, 1957, p. 108.
  Paratype 1609; off Cape San Lucas, Baja California, Mexico.
Odostomia (*Chrysallida*) *audax* Baker, Hanna, and Strong
  Baker, Hanna, and Strong, 1928, p. 230.
  Paratype 1839; Cape San Lucas, Baja California, Mexico.
Odostomia (*Chrysallida*) *swetti* Strong and Hertlein
  Strong and Hertlein, 1939, p. 206.
  Paratypes 3705-3709; Bahía Honda, Panama.
Odostomia (*Chrysallida*) *trimariana* Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 79.
  Paratypes 601, 3156-3160; Islas Tres Marías, Nayarit, Mexico.
Odostomia (*Evalea?*) *isthmica* Strong and Hertlein
  Strong and Hertlein, 1939, p. 208.
  Paratypes 3716-3720; Taboga Is., Panama.
Odostomia (*Evalea*) *martinensis* Strong
  Strong, 1938, p. 206.
  Paratypes 3517-3518; San Martin Is., Baja California, Mexico.
Odostomia (*Heida*) *kelseyi* Bartsch
  Bartsch, 1912, p. 288.
  Paratype 3674; San Diego, San Diego Co., Calif.

Odostomia (*Ividella*) *mendozae* Baker, Hanna, and Strong
Baker, Hanna, and Strong, 1928, p. 234.
Paratypes 1840-1842; Cape San Lucas, Baja California, Mexico.

Odostomia (*Miralda*) *azteca* Strong and Hertlein
Strong and Hertlein, 1939, p. 207.
Paratypes 3710-3715; Bahía Honda, Panama.

Odostomia (*Miralda*) *porteri* Baker, Hanna, and Strong
Baker, Hanna, and Strong, 1928, p. 236.
Paratype 1843; Gulf of California, Mexico.

Odostomia (*Salassia*) *hertleini* Strong
Strong, 1938, p. 205.
Paratypes 3513-3516; María Madre Is., Tres Marías group, Nayarit, Mexico.

Oliva rejecta Burch and Burch
Burch and Burch, 1962, p. 166.
Paratype 1460; La Paz, Baja California, Mexico.

Oliva trujilloi Clench
Clench, 1938, p. 111.
Paratype 1694; Puerto Plata, Santo Domingo.

Olivella (*Dactylidella*) *cymatilis* Berry
Berry, 1963b, p. 146.
Paratypes 1351-1353; Magdalena Bay, Baja California, Mexico.

Olivella (*Olivella*) *sphoni* Burch and Campbell
Burch and Campbell, 1963, p. 124.
Paratypes 1486-1504; Corinto, Nicaragua (1486-1497); off Acapulco, Guerrero, Mexico (1498-1504).

Olivella pycna Berry
Berry, 1935, p. 262.
Paratype 641; Bolinas Bay, Marin Co., Calif.

Opisthosiphon rivorum Aguayo
Aguayo, 1932, p. 95.
Paratypes 3427-3428; west of Holguin, Oriente Prov., Cuba.

Oreohelix californica Berry
Berry, 1931, p. 115.
Paratypes 449, 1467-1474; Clark Mt., San Bernardino Co., Calif.

Oreohelix handi jaegeri Berry
Berry, 1931, p. 118.
Paratypes 448, 1461-1466; Charleston Mts., Clark Co., Nevada.

Paludinella Newcombiana Hemphill
Hemphill, 1877, p. 49.
Paratypes 3620-3653; Humboldt Bay, Humboldt Co., Calif.

Parapholyx effusa diagonalis Henderson
Henderson, 1929, p. 82.
Paratypes 1619-1622; Crater Lake, Klamath Co., Ore.

Patella sanguinans Reeve
MacClintock, 1967, p. 81, text-figs. 71-74.
Hypotypes 704-706; South Africa (704); Port Rynie, Natal, Union of South Africa (705-706).

Pedicularia (*californica*? phase or form?) *ovuliformis* Berry
Berry, 1946b, p. 3.
Paratype 683; Santa Catalina Island, Los Angeles Co., Calif.

Persicula bandera Coan and Roth
Coan and Roth, 1965, p. 67.
Paratypes 904-906; Banderas Bay, Jalisco, Mexico.

Persicula (*Rabicea*) *adamsiana* Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 62.
Paratype 773; Montijo Bay, Panama.

Petaloconchus montereyensis Dall
Dall, 1919, p. 250.
Paratypes 1975-1976; Monterey, Monterey Co., Calif.

Philine alba Mattox
Mattox, 1958, p. 98.
Paratype 1690; Santa Catalina Is., Los Angeles Co., Calif.

Physa plena Clench
Clench, 1930, p. 311.
Paratypes 1704-1705; Reed Spring, Centerville, Reynolds Co., Mo.

Pisania englerti Hertlein
Hertlein, 1960, p. 19.
Paratypes 1610, 1623-1624; Easter Is., Chile.
Pleuroliria artia Berry
Berry, 1957, p. 82.
Paratypes 1276-1278; off Isla Ángel de la Guarda, Baja California, Mexico.
Pleuroliria parthenia Berry
Berry, 1957, p. 81.
Paratype 1275; off Islas Tortugas, Gulf of Nicoya, Costa Rica.
Polygyra decepta Clapp
Clapp, 1905a, p. 25.
Paratypes 1605-1606; Blount Springs, Blount Co., Ala.
Polygyra inflecta approximans Clapp
Clapp, 1905b, p. 74.
Syntypes 1600-1602; Marion, Perry Co., Ala.
Polygyra smithii Clapp
Clapp, 1905b, p. 73.
Syntypes 1598-1599; Monte Sano, near Huntsville, Madison Co., Ala.
Polygyra stenotrema seminuda Clapp
Clapp, 1904, p. 86.
Syntypes 1603-1604; Bangor, Blount Co., Ala.
Pseudomelatoma semiinflata var. *redondoensis* Burch
Burch, T., 1938, p. 21.
Paratype 460; Redondo Beach, Los Angeles Co., Calif.
Pterotyphis (Tripterotyphis) fayae Keen and Campbell
Keen and Campbell, 1964, p. 54.
Paratype 1136; Barra de Navidad, Jalisco, Mexico.
Punctum conspectum var. *pasadenae* Pilsbry
Pilsbry, 1896, p. 21.
Paralectotypes 3558-3581; Pasadena, Los Angeles Co., Calif.
Pyramidella (Pyramidella) hancocki Strong and Hertlein
Strong and Hertlein, 1939, p. 195.
Paratypes 3692-3694; Taboga Is., Panama.
Pyramidella (Triptychus) hermosa Lowe
Lowe, 1935, p. 22, pl. 3, fig. 4.
Holotype 597 (fig. 4); paratypes 3141-3142; San Felipe, Baja California, Mexico.
Pyramidella (Voluspa) linearum Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 79.
Paratype 598; Acapulco, Guerrero, Mexico.
Pyrene aureola Howard
Howard, 1963, p. 2.
Paratypes 1456-1457, 3961-4118; Isla Cedros (3961-3993), Cabo San Lucas (3994), La Paz (3995-4004), Isla Partida (4005-4007), Isla San Jose (4008-4019), Mulege (4020-4025), Isla San Marcos (4026-4037), Santa Rosalia (4038-4043), Rancho Barril (4044-4051), San Francisquito (4052-4069), Bahía de los Ángeles (4070-4078), all Baja California, Mexico; Punta Peñasco 1456-1457, (4079-4089), Puerto Libertad (4090-4107), Guaymas (4108,4118), all Sonora, Mexico.
Pyrgulopsis blakeana Taylor
Taylor, 1950, p. 30.
Paratypes 3660-3662; Pleistocene or Recent; shore of Salton Sea by Fish Springs, Imperial Co., Calif.
Pyrgulopsis imminens Taylor
Taylor, 1950, p. 28.
Paratypes 3658-3659; Pleistocene or Recent; shore of Salton Sea by Fish Springs, Imperial Co., Calif.
Rabdotus (Leptobyrsus) lamellifer lamellifer (Pilsbry)
Emerson and Jacobson, 1964, p. 321, figs. 2a-2c.
Paratypes (of *Bulimulus sanmarcosensis*) 3590 (fig. 2a), 3591 (fig. 2b), 3592 (fig. 2c).
See: *Bulimulus sanmarcosensis* Pilsbry and Lowe.
Rissoa (Alvania) grippiana Dall
Dall, 1908, p. 136.
Paratypes 2001-2005; San Diego, San Diego Co., Calif.
Rissoa kelseyi Dall and Bartsch
Dall and Bartsch, 1902, p. 94.
Paratypes 2354-2357; off Mission Bay, San Diego, San Diego Co., Calif.
Rissoella hertleini Smith and Gordon
Smith and Gordon, 1948, p. 224.
Paratype 696; Monterey Bay, Monterey Co., Calif.

Rissoina guadalupensis Strong
Strong, 1938, p. 208.
Paratypes 3519-3524; Guadalupe Is., Baja California, Mexico.
Rissoina hannai Smith and Gordon
Smith and Gordon, 1948, p. 226.
Paratypes 695, 3347-3349; Carmel, Monterey Co., Calif.
Rissoina lowei Strong
Strong, 1938, p. 209.
Paratypes 3525-3540; Guadalupe Is., Baja California, Mexico.
Rissoina melanelloides Baker, Hanna, and Strong
Baker, Hanna, and Strong, 1930, p. 31.
Paratype 1915; Cape San Lucas, Baja California, Mexico.
Rissoina porteri Baker, Hanna, and Strong
Baker, Hanna, and Strong, 1930, p. 30.
Paratypes 1908-1914; Gulf of California, Mexico.
Rissoina stephensae Baker, Hanna, and Strong
Baker, Hanna, and Strong, 1930, p. 33.
Paratypes 1916-1917; Cape San Lucas, Baja California, Mexico.
Rissoina willetti Strong
Strong, 1938, p. 209.
Paratypes 3541-3549; Guadalupe Is., Baja California, Mexico.
Scalina billeeana DuShane and Bratcher
DuShane and Bratcher, 1965, p. 160.
Paratype 914; Cerralvo Island, Baja California, Mexico.
S.[chismope] californica Dall
Dall, 1924, p. 4.
"Paratypes" 674, 3381-3383; Islas Los Coronados, Baja California, Mexico.
Segmentina paparyensis Baker
Baker, F., 1914, p. 662.
Paratypes 3036-3042; Papary Lake, Rio Grande do Norte, Brazil.
Simnia quaylei Lowe
Lowe, 1935, p. 22, pl. 3, fig. 5.
Holotype 602, San Felipe, Baja California, Mexico.
See: *Neosimnia quaylei* (Lowe).
Sinum cortezi Burch and Burch
Burch and Burch, 1964, p. 109.
Paratype 1459; between Mazatlan and Altata, Sinaloa, Mexico.
Solenosteira gatesi Berry
Berry, 1963b, p. 144.
Paratypes 1345a,b-1347a,b; northwest of Mazatlan, Sinaloa, Mexico.
Sonorelix borregoensis (Berry)
Berry, 1943, p. 9, pl. 1, figs. 4-6 (holotype).
See: *Micrarionta (Eremarionta) borregoensis* Berry.
Sonorella anchana Berry
Berry, 1948a, p. 154.
Paratypes 1233-1237; Reynolds Creek, Sierra Ancha, Gila Co., Ariz.
Speleodiscoides spirellum Smith
Smith, A. G., 1957, p. 34.
Paratypes 1971-1973; Violin Cave, Amador Co., Calif.
Stagnicola elrodi Baker and Henderson
Baker, F. C. and Henderson, 1933, p. 30.
Paratypes 1775-1777; Flathead Lake, Lake Co., Mont.
Strigatella (Atrimitra) coronadoensis Baker and Spicer
Baker and Spicer, 1930, p. 176.
Holotype 667; Islas los Coronados, Baja California, Mexico.
Strombiformis healeyi Strong and Hertlein
Strong and Hertlein, 1939, p. 195.
Paratypes 3690-3691; Bahía Honda, Panama.
Strombina carmencita Lowe
Lowe, 1935, p. 21, pl. 3, fig. 1.
Holotype 586; Isla Carmen, Baja California, Mexico.
Keen, 1958b, p. 393, fig. 505 (holotype).
Strombina pavonina (Hinds)
Keen, 1958b, p. 396, fig. 518.
Hypotype 1505; Mazatlan, Sinaloa, Mexico.

Strombina subangularis Lowe
  Lowe, 1935, p. 21, pl. 3, fig. 2.
  Holotype 585; Isla Carmen, Baja California, Mexico.
  Keen, 1958b, p. 396, fig. 523 (holotype).
Strombinoturris crockeri Hertlein and Strong
  Hertlein and Strong, 1951a, p. 84.
  Paratype 1575; Arena Bank, Baja California, Mexico.
Succinea ovalis chittenangoensis Pilsbry
  Pilsbry, 1908, p. 49.
  Paralectotypes 3491-3494; Chittenango Falls, Madison Co., N.Y.
Syntomodrilla cybele Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 46.
  Paratype 516; Acapulco, Guerrero, Mexico.
Tegula mariana mariamadrae Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 85.
  Paratypes 653, 3254-3261; Isla María Madre, Tres Marías group, Nayarit, Mexico.
Teinostoma hemphilli Strong and Hertlein
  Strong and Hertlein, 1939, p. 244.
  Paratypes 3863-3866; Bahía Honda, Panama.
Teinostoma ochsneri Strong and Hertlein
  Strong and Hertlein, 1939, p. 244.
  Paratypes 3867-3868; Bahía Honda, Panama.
Terebra (Microtrypetes) iola Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 43.
  Paratypes 498, 2421-2423; Mazatlan, Sinaloa, Mexico.
Terebra (Microtrypetes) mariato Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 43.
  Paratypes 503, 2428-2433; Montijo Bay, Panama.
Terebra roperi Pilsbry and Lowe
  Campbell, 1964, pl. 17, fig. 2.
  Paratype 2427.
  See: *Terebra (Strioterebrum?) roperi* Pilsbry and Lowe.
Terebra (Strioterebrum) brunneocincta Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 41.
  Paratype 497; Corinto, Nicaragua.
Terebra (Strioterebrum) churea Campbell
  Campbell, 1964, p. 134, fig. 17.
  Paratypes 1484 (fig. 17), 1485; Guaymas, Sonora, Mexico.
Terebra (Strioterebrum) ira Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 40.
  Paratypes 499, 2424-2426; Mazatlan, Sinaloa, Mexico.
Terebra (Strioterebrum) isopleura Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 41.
  Paratype 500; Mazatlan, Sinaloa, Mexico.
Terebra (Strioterebrum) ligyrus Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 40.
  Paratypes 496, 3029-3035; Guaymas, Sonora, Mexico.
Terebra (Strioterebrum) montijoensis Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 42.
  Paratype 501; San Juan del Sur, Nicaragua.
Terebra (Strioterebrum) ninfae Campbell
  Campbell, 1961, p. 27.
  Paratype 1483; near Puerto Madero, Chiapas, Mexico.
Terebra (Strioterebrum) puncturosa Berry
  Berry, 1959, p. 112.
  Holotype 1295; Bahía Santa María, Isla Magdalena, Baja California, Mexico.
Terebra (Strioterebrum?) roperi Pilsbry and Lowe
  Pilsbry and Lowe, 1932a, p. 41.
  Paratypes 502, 2427; Mazatlan, Sinaloa, Mexico (502); San Juan del Sur, Nicaragua (2427).
  See: *Terebra roperi* Pilsbry and Lowe.
Thais floridana haysae Clench
  Clench, 1927, p. 6.
  Paratypes 505, 1693, 2454; Grand Bayou, Mississippi delta, La.
Thais (Thaisella) langi Clench and Turner
  Clench and Turner, 1948, p. 1.
  Paratype 1833a,b; Lobito Bay, Lobito, Benguela, Angola.

Tiariturris spectabilis Berry
Berry, 1958, p. 87.
Holotype 1282; off Isla Ángel de la Guarda, Baja California, Mexico.
Keen, 1958b, p. 478, fig. 915 (holotype).
Trigonostoma milleri Burch
Burch, J. Q., 1949, p. 3.
Paratype 1528; Tambor, near Puntarenas, Costa Rica.
Triphora abbotti Baker and Spicer
Baker and Spicer, 1935, p. 39, pl. 5, fig. 4.
Holotype 1557; Ofu, Samoa.
Triphora cookeana Baker and Spicer
Baker and Spicer, 1935, p. 41, pl. 5, fig. 7.
Holotype 1560; Gulf of California, Mexico.
Triphora granti Baker and Spicer
Baker and Spicer, 1935, p. 40, pl. 5, fig. 5.
Holotype 1558; Ofu, Samoa.
Triphora harrisi Baker and Spicer
Baker and Spicer, 1935, p. 37, pl. 5, figs. 1, 2.
Holotype 1555; Ofu, Samoa.
Triphora marshi Strong and Hertlein
Strong and Hertlein, 1939, p. 214.
Paratypes 3727-3730; Bahía Honda, Panama.
Triphora ofuensis Baker and Spicer
Baker and Spicer, 1935, p. 38, pl. 5, fig. 3.
Holotype 1556; Ofu, Samoa.
Triphora palmeri Strong and Hertlein
Strong and Hertlein, 1939, p. 209.
Paratypes 3721-3726; Taboga Is., Panama.
Triphora peleae Baker and Spicer
Baker and Spicer, 1935, p. 40, pl. 5, fig. 6.
Holotype 1559; Ofu, Samoa.
Triphora stephensi Baker and Spicer
Baker and Spicer, 1935, p. 42, pl. 5, fig. 9.
Paratypes 1561 (fig. 9), 1562-1563; Gulf of California, Mexico.
Tritonalia carmen Lowe
Lowe, 1935, p. 20, pl. 2, fig. 6.
Holotype 590 (fig. 6); paratypes 591-592, 3126-3127; Isla Ángel de la Guarda (590-591, 3126-3127), Isla Carmen (592), both Baja California, Mexico.
See: *Ocenebra carmen* (Lowe).
Tritonalia fraseri Oldroyd
Oldroyd, 1920, p. 135.
Paratype 1636; Brandon Is., Departure Bay, British Columbia, Canada.
Trivia (*Pusula*) *elsiae* Howard and Sphon
Howard and Sphon, 1960, p. 41, fig. 1.
Holotype 1458; Punta Final, Baja California, Mexico.
Trivia (*Pusula*) *myrae* Campbell
Campbell, 1961, p. 25.
Paratype 1481; off Monserrate Is., Baja California, Mexico.
Trophon (*Boreotrophon*) *albospinosus* Willett
Willett, 1931, p. 66.
Paratypes 1656-1661; White's Landing, Santa Catalina Is., Los Angeles Co., Calif.
Trophon (*Boreotrophon*) *beebei* Hertlein and Strong
Hertlein and Strong, 1948a, p. 80.
Paratype 1554; Gorda Banks, off Baja California, Mexico.
Tudora megacheilos rondeklipensis Baker
Baker, H. B., 1924, p. 60.
Paratypes 1963a,b, 1964-1966; Seroe Boca (1963-1964); Hato Ridge (1965-1966); both Curacao, Netherlands Antilles.
Turbo mazatlanicus Pilsbry and Lowe
Pilsbry and Lowe, 1932a, p. 87.
Paratypes 652, 3250-3253; Mazatlan, Sinaloa, Mexico.
Turbonilla (*Careliopsis*) *israelskyi* Strong and Hertlein
Strong and Hertlein, 1939, p. 204.
Paratypes 3701-3702; Bahía Honda, Panama.
Turbonilla (*Cingulina*) *academica* Strong and Hertlein
Strong and Hertlein, 1939, p. 205.
Paratypes 3703-3704; Bahía Honda, Panama.

Turbonilla (Mormula) ambusta Dall and Bartsch
 Dall and Bartsch, 1909, p. 115.
 Paratype 3432; San Pedro, Los Angeles Co., Calif.
Turbonilla (Ptycheulimella) penascoensis Lowe
 Lowe, 1935, p. 21, pl. 3, fig. 3.
 Holotype 599 (fig. 3); paratypes 600, 3143-3155; Punta Peñasco, Sonora, Mexico.
Turbonilla (Pyrgiscus) azteca Baker, Hanna, and Strong
 Baker, Hanna, and Strong, 1928, p. 222.
 Paratype 1838; Bahía San Luis Gonzaga, Baja California, Mexico.
Turbonilla (Pyrgiscus) madriella Strong
 Strong, 1938, p. 204.
 Paratypes 3505-3512; María Madre Is., Tres Marías group, Nayarit, Mexico.
Turbonilla (Pyrogolampros) skogsbergi Strong
 Strong, 1937, p. 54.
 Paratypes 669, 3319, 3384-3385; Monterey Bay, Monterey Co., Calif.
Turbonilla (Strioturbonilla) asuncionis Strong
 Strong, 1949, p. 76.
 Paratypes 3392-3393; Ascuncion Is., Baja California, Mexico.
Turbonilla (Strioturbonilla) bakeri Bartsch
 Bartsch, 1912, p. 265.
 Paratype 3673; San Diego Bay, San Diego Co., Calif.
Turbonilla (Strioturbonilla) cayucosensis Willett
 Willett, 1929, p. 26.
 Paratypes 647, 3207-3228; Cayucos, San Luis Obispo Co., Calif.
Turbonilla (Strioturbonilla) chalcana Baker, Hanna, and Strong
 Baker, Hanna, and Strong, 1928, p. 212.
 Paratypes 1835-1837; Gulf of California, Mexico.
Turbonilla (Strioturbonilla) cowlesi Strong and Hertlein
 Strong and Hertlein, 1939, p. 196.
 Paratypes 3695-3700; Bahía Honda, Panama.
Turbonilla (Strioturbonilla) nahuana Baker, Hanna, and Strong
 Baker, Hanna, and Strong, 1928, p. 211.
 Paratype 1834; Gulf of California, Mexico.
Turbonilla (Strioturbonilla) zamboangoensis Baker and Spicer
 Baker and Spicer, 1930, p. 176, pl. 19, fig. 2.
 Holotype 665 (fig. 2); paratype 3303; Zamboanga, Mindanao, Philippines.
Turritella (Zeacolpus) ahiparana Powell
 Powell, 1927b, p. 297.
 Paratypes 594, 3350-3361; Ahipara Bay, New Zealand.
Turritella anactor Berry
 Berry, 1957, p. 78.
 Paratypes 1264a,b, 1265; north of San Felipe, Baja California, Mexico.
Turritella orthosymmetra Berry
 Berry, 1953c, p. 412.
 Paratype 1387; off Pebbly Beach, Santa Catalina Is., Los Angeles Co., Calif.
Typhis lowei Pilsbry
 Pilsbry *in* Pilsbry and Lowe, 1932a, p. 77.
 Paratypes 593, 3128-3131; Montijo Bay, Panama.
Urocoptis bacillaris petrophila Pilsbry
 Pilsbry, 1929b, p. 456.
 Paralectotypes 3495-3504; east of Florencia, Camagüey, Cuba.
Urocoptis delectabilis Pilsbry
 Pilsbry, 1929a, p. 80.
 Paralectotypes 3477-3490; east of Florencia, Camagüey, Cuba.
Vesperiocola karokorum Talmadge
 Talmadge, 1962, p. 28.
 Paratypes 3429-3431; east of Orleans Ranger Station, Humboldt Co., Calif.
Vitrea orotis Berry
 Berry, 1930a, p. 113.
 Paratypes 668, 1374-1375; Palomar Mts., San Diego Co., Calif.
Volvulella tenuissima Willett
 Willett, 1944, p. 71.
 Paratypes 1647-1648; off Redondo, Los Angeles Co., Calif.

MOLLUSCA: CEPHALOPODA

Loliolopsis chiroctes Berry
Berry, 1929a, p. 267, pl. 33, figs. 1, 2, 4.
Paratypes 1127 (fig. 1, 2, 4); 1128; Puerto Escondido, Baja California, Mexico.

MOLLUSCA: AMPHINEURA

Acanthochitona tabogensis Smith
Smith, A. G., 1961, p. 87, pl. 9, upper fig.
Holotype 1967 (Fig. 1); paratype 1968; Taboga Is., Bay of Panama, Panama.

Chaetopleura (*Pallochiton*) *euryplax* Berry
Berry, 1945, p. 491.
Paratype 680a-i; Bahía de Adair, Sonora, Mexico.

Chaetopleura raripustulosa Pilsbry
Pilsbry and Lowe, 1932a, p. 129.
Paratypes 1226a-i, 1227-1232; Guaymas, Sonora, Mexico.

Dendrochiton psaltes Berry
Berry, 1963a, p. 135.
Paratypes 1313-1336; near entrance to Mission Bay, San Diego Co., Calif.

Ischnochiton (*Lepidozona*) *californiensis* Berry
Berry, 1913, p. 255.
Paratype 640; La Jolla, San Diego Co., Calif.

Lepidochitona keepiana Berry
Berry, 1948b, p. 14.
Paratype 686; Newport Bay, Orange Co., Calif.

Lepidozona subtilis Berry
Berry, 1956, p. 74.
Paratypes 1257-1261; Puerto Peñasco, Sonora, Mexico.

Mopalia lowei Pilsbry
Pilsbry, 1918, p. 125.
Paratype 1591; San Pedro, Los Angeles Co., Calif.

Nuttallina crossota Berry
Berry, 1956, p. 71.
Paratype 1251; Puerto Peñasco, Sonora, Mexico.

Nuttallina mexicana Pilsbry
Pilsbry *in* Pilsbry and Lowe, 1932a, p. 129.
Paratypes 1252, 1253; Guaymas, Sonora, Mexico.

Stenoplax histrio Berry
Berry, 1945, p. 493.
Paratype 681; El Gallo, Mulegé, Baja California, Mexico.

Stenoplax (*Maugerella*) *conspicua sonorana* Berry
Berry, 1956, p. 73.
Paratypes 1254a-i, 1255-1256; Puerto Peñasco, Sonora, Mexico.

Stenoplax (*Stenoradsia*) *heathiana* Berry
Berry, 1946a, p. 161.
Paratype 682; Pacific Grove, Monterey Co., Calif.

Trachydermon lowei Pilsbry
Pilsbry, 1918, p. 127.
Paratype 1592; White Point, Los Angeles Co., Calif.

ARTHROPODA: CRUSTACEA

Alarcónia seaholmi Glassell
Glassell, 1938, p. 448, pl. 36, figs. 1-5.
Holotype 3941; Acapulco, Guerrero, Mexico.

Betaeus ensenadensis Glassell
Glassell, 1938, p. 416.
Holotype 3925; Estero de la Punta Banda, Ensenada, Baja California, Mexico.

Cyclograpsus escondidensis Rathbun
Rathbun *in* Glassell, 1933b, p. 336.
Paratypes 3872-3873; Puerto Escondido, Baja California, Mexico.

Dissodactylus lockingtoni Glassell
Glassell, 1935b, p. 100, pl. 16, fig. 1 (?).
Holotype 3892 (fig. 1?); paratype 3893; Punta Peñasco, Sonora, Mexico.

Dissodactylus xantusi Glassell
  Glassell, 1936, p. 299.
  Paratypes 3921-3922; Isla Espíritu Santo, Baja California, Mexico.
Ebalia magdalenensis Rathbun
  Rathbun *in* Glassell, 1933b, p. 334.
  Paratype 3871; Magdalena Bay, Baja California, Mexico.
Euceramus panatelus Glassell
  Glassell, 1938, p. 423.
  Holotype 3930; La Libertad, Ecuador.
Euceramus transversilineatus (Lockington)
  Glassell, 1938, p. 426.
  Neotype 3931; neoparatype 3932; Isla Tiburón (3931), Punta Peñasco (3932); both Sonora, Mexico.
Eurytium albidigitum Rathbun
  Rathbun, 1933, p. 148.
  Paratypes 3956-3959; San Felipe, Baja California, Mexico.
Fabia unguifalcula Glassell
  Glassell, 1936, p. 298.
  Holotype 3920; Punta Peñasco, Sonora, Mexico.
Glyptoxanthus felipensis Rathbun
  Rathbun, 1933, p. 147.
  Paratypes 3942-3949; San Felipe, Baja California, Mexico.
Hexapus williamsi Glassell
  Glassell, 1938, p. 445, pl. 35, figs. 1-4.
  Holotype 3940; San José, Guatemala.
Homoriscus macginitiei Glassell
  Glassell, 1938, p. 414.
  Holotype 3924; La Jolla, San Diego Co., Calif.
Minyocerus kirki Glassell
  Glassell, 1938, p. 430, pl. 31, fig. 3.
  Holotype 3933 (fig. 3); paratype 3934; San Felipe, Baja California, Mexico.
  Haig, 1960, pl. 37, fig. 1 (holotype).
Mithrax (Mithrax) sonorensis Rathbun
  Rathbun *in* Glassell, 1933b, p. 338.
  Paratype 3874; Miramar Beach, near Guaymas, Sonora, Mexico.
Neopanope peterseni Glassell
  Glassell, 1933b, p. 340.
  Paratypes 3875-3876; Puerto San Carlos, Sonora, Mexico.
Orthochela pumila Glassell
  Glassell, 1936, p. 296.
  Paratypes 3918 (missing), 3919; Magdalena Bay, Baja California, Mexico.
Pachycheles marcortezensis Glassell
  Glassell, 1936, p. 290.
  Paratype 3910; Isla Ángel de la Guarda, Baja California, Mexico.
Pachycheles sonorensis Glassell
  Glassell, 1936, p. 291.
  Paratypes 3911-3912; Miramar Bay, Sonora, Mexico.
Paguristes anahuacus Glassell
  Glassell, 1938, p. 421.
  Holotype 3928; paratype 3929; Punta Peñasco, Sonora, Mexico.
Paguristes sanguinimanus Glassell
  Glassell, 1938, p. 419.
  Holotype 3926; paratype 3927; Punta Peñasco, Sonora, Mexico.
Panoplax mundata Glassell
  Glassell, 1935b, p. 96, pl. 11, fig. 1.
  Holotype 3886 (fig. 1); paratype 3887; San Felipe, Baja California, Mexico.
Parapinnixa affinis Holmes
  Glassell, 1933a, p. 321, pl. 20, figs. 1, 3; pl. 21, fig. 1.
  Hypotype 3869; Newport Bay, Orange Co., Calif.
Parapinnixa nitida (Lockington)
  Glassell, 1933a, p. 324.
  Neotype 3870; San Felipe, Baja California, Mexico.
Petrolisthes nigrunguiculatus Glassell
  Glassell, 1936, p. 282.
  Paratypes 3901-3902; Isla Santa Catalina, Baja California, Mexico.

Petrolisthes sanfelipensis Glassell
Glassell, 1936, p. 281.
Paratypes 3899-3900; San Felipe, Baja California, Mexico.

Petrolisthes schmitti Glassell
Glassell, 1936, p. 280.
Paratypes 3897-3898; San Felipe, Baja California, Mexico.

Petrolisthes tiburonensis Glassell
Glassell, 1936, p. 284.
Paratypes 3903-3904; Isla Tiburón, Sonora, Mexico.

Pinnixa abbotti Glassell
Glassell, 1935a, p. 13.
Holotype 3877; paratypes 3878-3879, 3950-3955; San Felipe, Baja California, Mexico.

Pinnixa felipensis Glassell
Glassell, 1935a, p. 14.
Holotype 3881; San Felipe, Baja California, Mexico.

Pinnixa fusca Glassell
Glassell, 1935a, p. 13.
Holotype 3880; San Felipe, Baja California, Mexico.

Pinnixa huffmani Glassell
Glassell, 1935b, p. 103.
Holotype 3896 (missing); Punta Peñasco, Sonora, Mexico.

Pinnixa pembertoni Glassell
Glassell, 1935b, p. 102.
Holotype 3895; paratype 3960; San Felipe, Baja California, Mexico.

Pinnixa plectrophoros Glassell
Glassell, 1935b, p. 102.
Holotype 3984; Punta Peñasco, Sonora, Mexico.

Pinnixa richardsoni Glassell
Glassell, 1936, p. 301.
Holotype 3923; Balboa, Panama.

Pinnotheres angelicus Lockington
Glassell, 1935b, p. 99, pl. 14, fig. 1; pl. 15, fig. 1.
Neotype 3890 (pl. 14); neoparatype 3891 (pl. 15); Angeles Bay, Baja California, Mexico.

Pinnotheres clavapedatus Glassell
Glassell, 1935b, p. 97, pl. 13, fig. 1.
Holotype 3888 (fig. 1); paratype 3889; San Felipe, Baja California, Mexico.

Pisonella sinuimanus (Lockington)
Glassell, 1938, p. 437, pl. 34, fig. 2.
Neotype 3936 (fig. 2); neoparatype 3937; Puerto Escondido, Baja California, Mexico.

Pisonella tuberculipes (Lockington)
Glassell, 1938, p. 440, pl. 34, fig. 1.
Neotype 3938 (fig. 1); neoparatype 3939; Punta Peñasco, Sonora, Mexico.

Pisosoma erosa Glassell
Glassell, 1936, p. 289.
Paratypes 3908-3909; Magdalena Bay, Baja California, Mexico.

Pisosoma lewisi Glassell
Glassell, 1936, p. 287.
Holotype 3906; paratype 3907; Tenacatita Bay, Jalisco, Mexico.

Pisosoma smithi Glassell
Glassell, 1936, p. 286.
Paratype 3905; Miramar Beach, Sonora, Mexico.

Polyonyx quadriungulatus Glassell
Glassell, 1935b, p. 93, pl. 9, fig. 1.
Holotype 3882 (fig. 1); paratype 3883; Estero de la Punta Banda, Baja California, Mexico.

Porcellana cancrisocialis Glassell
Glassell, 1936, p. 292.
Paratypes 3913-3914; Punta Peñasco, Sonora, Mexico.

Porcellana magdalenensis Glassell
Glassell, 1936, p. 295.
Paratype 3917; Magdalena Bay, Baja California, Mexico.

Porcellana paguriconviva Glassell
Glassell, 1936, p. 293.
Paratypes 3915-3916; Punta Peñasco, Sonora, Mexico.

Speloephorus schmitti Glassell
Glassell, 1935b, p. 95, pl. 10.
Paratypes 3884 (pl. 10), 3885; San Felipe, Baja California, Mexico.

Ulloaia perpusillia Glassell
Glassell, 1938, p. 434, pl. 33, fig. 1.
Holotype 3935; Punta Peñasco, Sonora, Mexico.
Haig, 1960, pl. 37, fig. 2 (holotype).

SUMARIO

Se presenta una lista de los ejemplares tipo de los siguientes Phylums y Clases de Invertebrados existentes en el Museo de Historia Natural de San Diego, California. Protozoos (Foraminíferos), Braquiópodos, Moluscos (Pelecípodos, Escafópodos, Gasterópodos, Cefalópodos, Anfineuros), Artrópodos (Crustaceos). Se incluyen en la lista con la denominación indicada en la publicación original, así como la correspondiente referencia bibliográfica, el número del tipo en el Museo y la localidad geográfica correspondiente a cada ejemplar. También se citan las ilustraciones que se publicaron subsecuentemente a la descripción original, correspondientes a estos ejemplares. Se incluyen así mismo ilustraciones de otros ejemplares que no corresponden al holotipo, paratipo u otros tipos de las correspondientes formas y variedades.

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SPECIES INDEX

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NOTES ON THE AVIFAUNA OF NORTHWESTERN BAJA CALIFORNIA

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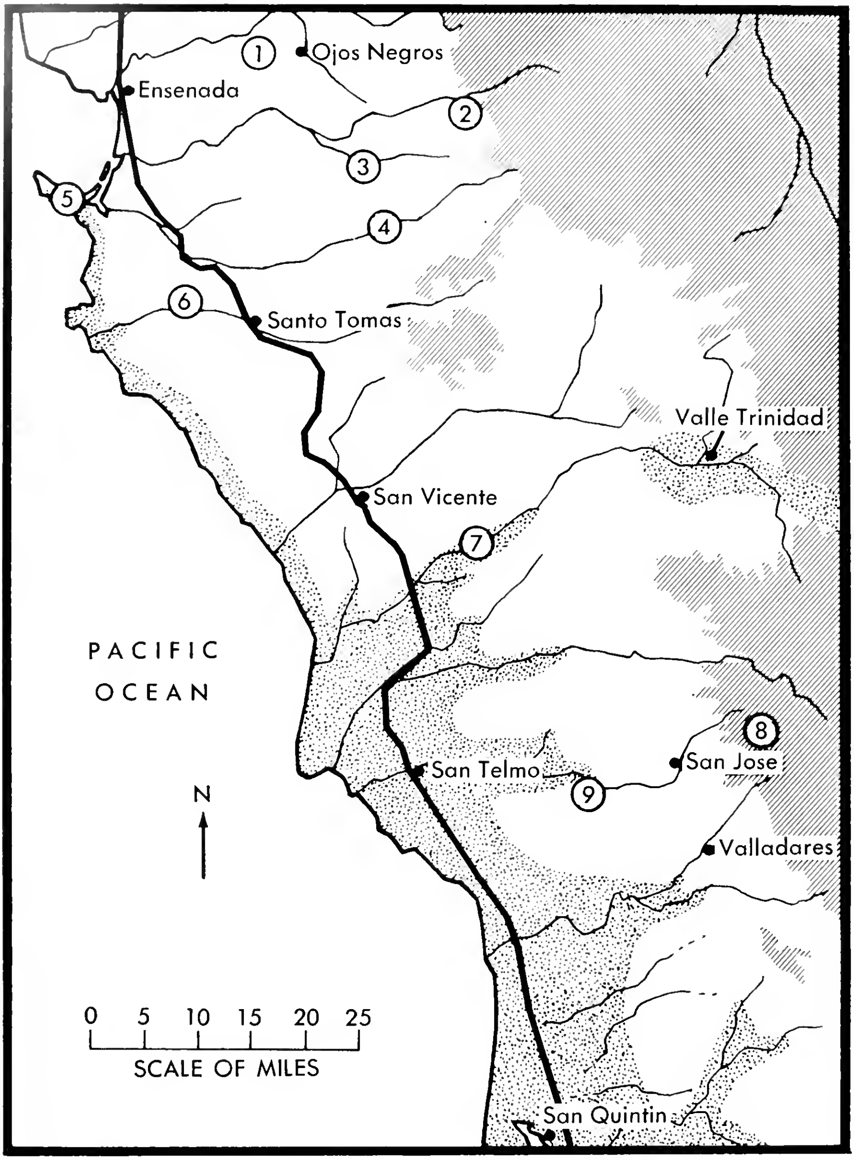

Figure 1. Northwestern Baja California. The numbered localities (see text) are: 1) Las Cruces; 2) study area 31 miles E Ensenada; 3) Rancho Escondido; 4) Rancho Santa Clara; 5) Punta Banda; 6) 6 miles WNW Santo Tomás; 7) La Calentura Valley; 8) Concepción; and, 9) Las Cabras. The diagonal lines indicate foothill and mountain areas above 4000 feet. The stippled area indicates our interpretation of the extent of the Sonoran Desert in this region. The main highway from Ensenada to San Quintín is shown, as well as all major streams in the area. The map is based on the U. S. Air Force Operational Navigational Chart H-22, 1965.

NOTES ON THE AVIFAUNA OF NORTHWESTERN BAJA CALIFORNIA

BY

Lester L. Short, Jr., and Richard S. Crossin

ABSTRACT

Results of about one month (April, 1967) of collecting and field study in Baja California are reported. Range extensions are noted for the Acorn Woodpecker, Verdin, Cactus Wren, and Ground Dove. A Black Hawk was observed for the first time in Baja California. Information is provided on the distribution, taxonomy and life history of various birds. The Chaparral-Sonoran Desert ecotone is discussed, and a boundary between these biomes (to be used when the ecotone is not mapped or considered) is suggested. An abundance of raptors in riparian woodland was a special feature of the region.

Northwestern Baja California, Mexico, is a biologically interesting and relatively little studied region. The coastal plain and the western slopes of the Sierra San Pedro Mártir and Sierra Juárez lie in the ecotone between the northern Chaparral Biome and the southern Sonoran Desert Biome (Huey, 1926; Shreve, 1936; Short and Banks, 1965). We were engaged in studies of woodpeckers (especially *Dendrocopos nuttallii* and *D. scalaris*) in this region from 30 March to 29 April 1967. This report gives information concerning the taxonomy, distribution, and life history of various birds observed and collected during our field work. We collected 117 specimens, 10 of which are deposited in the collection of the Dirección General de Caza, Mexico City; the remainder are in the American Museum of Natural History. We are indebted to Dr. Rodolfo Hernandez Corzo of the Mexican Dirección General de la Fauna Silvestre for permission to collect in Baja California.

DESCRIPTION OF LOCALITIES

31 miles E Ensenada, 3050 feet (Fig. 2).—Southeast of the plains bordering the Ojos Negros Valley commence the rocky foothills of the Sierra Juárez. About five miles into these foothills (at a point along the main Ensenada-San Felipe road that is 14 road miles east-southeast of Ojos Negroes and two road miles northwest of Rancho San Salvador) a spring-fed stream issues from barren hills. At least three miles of this stream, which ultimately joins the Arroyo San Carlos, contained water in April 1967. Where the stream exits from the hills, scattered live oaks and sycamores from upstream give way to a luxurious growth of willows and cottonwoods, which gradually diminishes downstream. Beyond a mile downstream only scattered willows and an occasional cluster of several willows and a cottonwood grace the streambed, which is invaded by cacti and acacias. At the base of the slopes around the major cottonwood-willow grove are small mesquite trees. The surrounding rocky slopes bear xeric vegetation dominated by catclaw acacias (*Acacia greggii*) and about six species of chollas and platyopuntias (*Opuntia* sp.). Scattered junipers occur on all these slopes, and downstream to the Ojos Negroes plains. South from the major riparian grove the land rises, and low chaparral vegetation dominated by greasewood (*Adenostoma sparsifolium*) replaces desert plants. Ruins of several adobe buildings were evident near the major willow-cottonwood grove. Portions of nine days were spent at this locality, principally along the stream, between 31 March and 19 April. A late snowstorm struck the area on 11-12 April, severely damaging the fully-leafed willows and cottonwoods, many of the upper branches and trunks of which were broken or left devoid of limbs.

Arroyo Santo Tomás, 350 feet, 6 miles WNW Santo Tomás (Fig. 3).—A rich riparian woodland borders the Arroyo Santo Tomás for much of the distance from just west of Santo Tomás to the coast. In places, such as from four to six miles west-northwest of Santo Tomás, the height of the trees and density and richness of the understory surpass those of all other riparian situations we encountered in Baja California. Groves of large oaks are interspersed

Figure 2. Riparian vegetation bordered by mesquite trees 31 miles east of Ensenada.

Figure 3. Oak woodland in the Arroyo Santo Tomás, 6 miles west-northwest of Santo Tomás.

Figure 4. The riparian woodland along Arroyo San José just south of San José.

with sycamores and streamside willows, cottonwoods, and an occasional eucalyptus tree. The ground cover varies from grassy open areas in the dense shade of the massive oaks to impenetrable thickets of poison oak (*Rhus toxicodendron*) and dwarf willows along the stream. West of this lush woodland the valley floor has been largely cut over, although scattered stands of trees (excluding oaks) occur downstream to the coast. In contrast to the arboreal vegetation, the ground cover becomes more dense and tangled toward the coast. The slopes of the arroyo are steep and occasionally almost vertical. Inland, their vegetation is chiefly low chaparral, with some trees in the ravines. The plants on the north side of the arroyo are lower and more widely spaced than are those on the south side. The vegetation of the slopes abruptly shifts to agave-dominated coastal scrub-desert about five miles inland on the north side of the arroyo, and about two miles from the coast on the south side. Field work was conducted along the Arroyo Santo Tomás on 13 and 14 April.

San José, 2200 feet (*at Rancho San José = the Meling Ranch*, Figs. 4, 5). — This locality, one of the late Chester Lamb's collecting stations, is the site of the Meling guest ranch. A one-half to one mile wide, flat valley (the Arroyo San José) extends northward and southward for about two miles in each direction from the ranch. Within a mile south of the ranch are interspersed cultivated fields and well-wooded swamps. According to Mrs. Aida Meling Barré, a trend of increasing aridity over the last half century has greatly reduced the swamps around the ranch, and riparian woodlands in the entire region. Dense undergrowth occurs along the borders of the cultivated fields and in the woods. These woods diminish to the north (upstream), and only widely scattered trees occur beyond two miles in that direction. Continuous woodland (cottonwoods, willows, sycamores) extends downstream from the ranch through the cultivated area and a narrow rocky ravine for three miles to the Arroyo San Telmo. From this stream junction, the woodland continues downstream for another three miles, then breaks up into scattered lone trees or small clusters of trees that finally disappear about one mile upstream from Las Cabras (at which locality trees once occurred). The lower

Figure 5. View looking eastward down on the Arroyo San José (center) and the main granitic mass of the Sierra San Pedro Mártir (background).

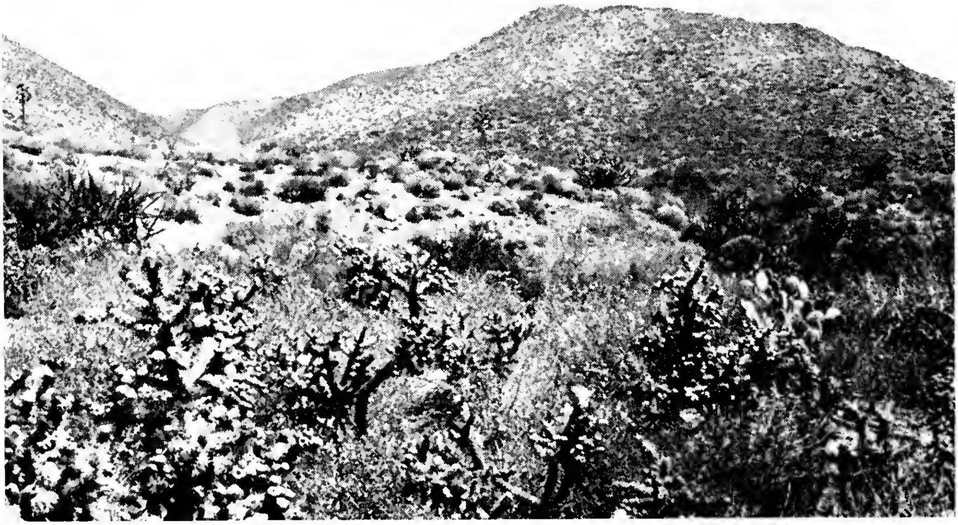

Figure 6. Desert vegetation 1.5 miles northwest of Las Cabras along the Arroyo San Telmo. A Ladder-backed Woodpecker nest and eggs were found in a cavity in the agave in the center of the photograph.

slopes of the hills around San José are desert-like in aspect (widely spaced low plants), but the plants are those of chaparral. The upper slopes (at 2800 feet to 3000 feet elevation) bear taller chaparral plants, including chamise (*Adenostoma fasciculatum*), greasewood, yuccas, and some junipers. Parts of nine days (from 20 to 28 April) were spent in the immediate vicinity of the ranch.

Concepción, 4700 feet. — This old collecting locality, the site of a small ranch, is along the Arroyo San José in the upper foothills of the Sierra San Pedro Mártir about 15 miles upstream from San José. Immediately east of Concepción arises the steep granitic slope forming the main mountain mass. The elevation for this locality is considerably less than the 6000 feet cited by Grinnell (1928:22), although that elevation is reached a mile or so east of the ranch. Groves of live oaks occur near and along the stream, which is also bordered by many willows and occasional cottonwoods. Extending westward from the ranch at a general elevation of 4000 feet is a vast rolling plateau, covered by an often dense cloak of tall chapparral (especially *Adenostoma fasciculatum*, *A. sparsifolia*, and scrub oaks) with occasional groves of live oaks along ravines. Scattered near the stream, and in clusters to the north, are Jeffrey pines (*Pinus jeffreyi*). Occasional steep slopes, especially those with southern exposure, exhibit a more desert-like aspect. This is increasingly true downstream a mile and more from the ranch, where the terrain is extremely rocky. A half day, on 26 April, was spent at this locality, which was reached over a rough road suitable only for four-wheel drive vehicles.

Valladares, 2500 feet. — This collecting locality of the late Chester Lamb is a ranch situated along a small stream that flows into the Arroyo Santo Domingo. It is reached by a fair road from the Arroyo San Telmo-San José road. Several scattered live oaks and a few solitary Jeffrey pines occur along the stream with willows, cottonwoods, and sycamores. An abundance of old dead stubs and tree trunks, sometimes considerably back from the stream, suggests that arboreal vegetation was formerly more extensive. The low slopes around the stream appear more arid and barren than those at San José, with cacti interspersed among low chaparral plants. Two days (24-25 April) were spent at this locality.

Rancho Escondido, 2400 feet, 23 miles ESE Ensenada. — This ranch is located along the upper Arroyo San Carlos on a poor road between Rancho Santa Clara and Ojos Negros, 14 road miles south of the latter. About 10 acres of tall riparian trees with poor undergrowth occur here. Many broken, dead, and cut trees give the woodland an appearance of a well-used farm woodlot. The surrounding hills are sparsely covered with low chaparral vegetation and some desert plants (e.g. opuntia). We collected here on 15 April.

Rancho Santa Clara, 2800 feet, 26 miles SE Ensenada. — The locality we visited is one mile southwest of the ranch buildings. Only a few willows grace the vicinity of the stream (the upper Arroyo Uruapan) near the ranch and eastward. The valley narrows west of the ranch, and there scattered willows and cottonwoods occur along the stream, while the lower hill slopes bear live oaks and scrub-oaks. The ranch is located along a poor road that leaves the Ensenada-San Felipe road at a point six miles southeast of San Salvador, proceeds west to Rancho Santa Clara, and then turns northward to Ojos Negros (via Rancho Escondido, seven road miles northwest of Rancho Santa Clara). This locality was visited on 15 and 18 April.

La Calentura Valley, 11 miles SE San Vicente. — This valley is that of the Arroyo Salado of some maps. It is reached by a road from the village of Llano Colorado, two miles to the north, and the main (Ensenada-Rosario) road just west of that village. In La Calentura Valley the road skirts the heavily cultivated (mostly vineyards) bottomland and tiny village of La Calentura, and then passes eastward up to the Valle de la Trinidad. Our vehicle was halted by sand about 10 miles east of the point where the road enters the valley. The surrounding hills bear decidedly desert-like vegetation, including many cacti, several species of which were not seen farther north. Large trees were absent, except in the vicinity of houses. We visited the valley on 7 April.

Punta Banda, 12 miles SW Ensenada. — This locality, visited on 8 April, is on the seaward (west) side of the point of land (Punta Banda proper) west of Todos Santos Bay.

Although labeled Arbolitos on some maps, it is called "Punta Banda" by the local inhabitants, and is so designated on road signs. The locality includes the hamlet itself (situated beside the ocean), and the surrounding agave-dominated hills of the coastal scrub-desert. It is reached by paved road from Maneadero, 10 miles south of Ensenada.

Las Cruces, 14 miles E Ensenada. — This locality, along the Ensenada-San Felipe road, is a small canyon with scattered, small live oaks in chaparral-covered hills. Several old buildings, gradually being reduced to rubble, attest to former human occupation of the canyon. We frequently passed this locality en route to Ojos Negros and our study area 31 miles east of Ensenada from 31 March to 18 April.

SPECIES ACCOUNTS

The following is a complete list of species observed in northwestern Baja California from 30 March to 28 April, 1967. Detailed accounts are provided for many species. Other species more briefly treated are included for the sake of completeness, and because recent records of any sort from northern Baja California are sparse. Asterisks denote species of which specimens were obtained. Numbers following the dates indicate the number of individuals noted. Where dates are not expressly stated, numbers refer to individuals seen on the date or dates listed above for the various localities. The sequence followed is that of the American Ornithologists' Union Check-list (1957). The taxonomic treatment departs from that of the A.O.U. in the case of the flicker (*Colaptes auratus*) and in several instances involving subspecies (see below).

Pelecanus occidentalis. Brown Pelican. — Coast near Ensenada (30 March, 2); mouth of the Arroyo San Telmo (28 April, 50+).

Ardea herodias. Great Blue Heron. — Todos Santos Bay (8 April, 2).

Leucophoyx thula. Snowy Egret. — Todos Santos Bay (8 April, about 6).

Cathartes aura. Turkey Vulture. — Ojos Negros Valley; La Calentura Valley (2); San José. During early and middle April up to 20 vultures were seen daily feeding with ravens on the carcass of a horse near Ojos Negros.

Elanus leucurus. White-tailed Kite. — Two kites were seen circling together, and perched in a dead tree, on 13 April along the Arroyo Santo Tomás about 14 miles WNW Santo Tomás. This species is listed as formerly occupying northwestern Baja California by the A.O.U. Check-list (1957), while Friedmann, *et al.* (1950) give 1903 as the last Baja California record of this species. Judged from the habitat in which White-tailed Kites reside in California, the Arroyo Santo Tomás seems very favorable for nesting, and this apparent pair may breed there. We cannot be certain of this, for although northern populations of this kite are usually resident, more southern (e.g., mainland Mexican) populations are migratory. The reoccurrence of this species in Baja California may be correlated with its recent increase in numbers in California.

Accipiter striatus. Sharp-shinned Hawk. — 31 miles E Ensenada (4 April, 2).

Accipiter cooperi. Cooper's Hawk. — 39 miles NE Ensenada, along road to Tecate (12 April, 1); Rancho Escondido (1); Rancho Santa Clara (1); 31 miles E Ensenada (common); 22 miles SE Ensenada (16 April, 1); 1 mile E Las Cruces (2 April, 1); San José (common); Valladares (common). A nest freshly lined with bark and green leaves was found about 30 feet up in a willow at 31 miles E Ensenada; it did not contain eggs on 9 April. Occupied nests were noted at San José (at least 2) and at Valladares (2). One of the nests at San José contained three heavily incubated eggs on 21 April.

Buteo jamaicensis. Red-tailed Hawk. — Red-tails were common and nesting at all major localities. A nest at Rancho Santa Clara contained three large, partially feathered young on 15 April. Most other nests contained eggs or small young (as indicated by the posture of the parent birds on the nests). At least two melanistic (all black, except for reddish on the upper surface of the rectrices) nesting birds were noted, one each at San José and Valladares; each was mated to a light-phased bird. A partially melanistic bird was noted at 31 miles E Ensenada. An albinistic hawk (all white except for a few dark primaries in one wing), identified as a red-tail, was noted 18 miles W San José on 28 April. Short and Banks (1965) noted that approximately half of the red-tails they sighted inland from San Quintín were melanistic birds. We judge that 15 to 20 per cent of the breeding population in the regions we visited were partially or completely melanistic.

Buteo lineatus. Red-shouldered Hawk. — A pair was regularly observed from 21 to 28 April near a nest in a large cottonwood near the ranch house at San José.

Buteogallus anthracinus. Black Hawk — An adult bird was seen north of La Calentura Valley (10 road miles NE Llano Colorado, 11 miles E San Vicente) on 7 April, and was studied for about 20 minutes under favorable viewing conditions. The authors, especially Crossin, are familiar with this species and similar southwestern and Mexican hawks such as the Zone-tailed Hawk (*Buteo albonotatus*). We have no doubt about the identity of the bird we observed. The Black Hawk has not previously been recorded in Baja California. It is a summer resident from central and southeastern Arizona and central and eastern Sonora south through Mexico.

Aquila chrysaetos. Golden Eagle. — One bird was noted 58 miles S Ensenada on 7 April, and another at 31 miles E Ensenada on 9 April; both were in immature plumage.

Circus cyaneus. Marsh Hawk. — Several adult males were noted along the road between Ensenada and Tijuana on 3 April.

Falco sparverius sparverius. Sparrow Hawk.* — This falcon was common at all major localities. Most birds were paired and in early stages of nesting during April. A female (151.3 g; ova to 12 mm, oviduct greatly enlarged = had already laid) was collected on 10 April at 31 miles E Ensenada. An adult male (104.9 g; testes 8 × 6 mm.) collected at San José on 21 April had a lizard (*Cnemidophorus* sp.), the legs of a warbler, and rodent hairs in its stomach. The wing lengths (♂ 188, ♀ 192 mm) and tail lengths (♂ 118, ♀ 126 mm) of these birds are well within the range ascribed to *F. s. sparverius* by Bond (1943), and decidedly larger than those of *F. s. peninsularis.* Although our specimens are paler on the breast than most western United States specimens of *F. s. sparverius*, they are not as pale as extreme individuals of that race that we have seen. Possible intergrades between *sparverius* and *peninsularis* from just south of the area where we worked were discussed by Short and Banks (1965).

Lophortyx californicus plumbeus. California Quail* — This species was present in extreme abundance throughout the region. Coveys of 200 to 300 birds were noted near San José and in the San Telmo Valley, whereas somewhat smaller coveys were encountered there and elsewhere. A tendency toward pair formation was noted at several localities throughout April, but most birds showed no signs of breeding (a result of unusually cold weather?). Nine specimens (6 ♂♂, 3 ♀♀) were obtained at various points throughout the area of study. We tentatively assign these to the race *L. c. plumbeus*, although we have misgivings about the validity of this and several other races of California Quail. This subspecies is distinguishable from nominate *californicus* of California solely on the basis of its slightly grayer coloration. The southern peninsular Baja California race, *achrusterus*, appears identical with *plumbeus*, except that it is smaller. However, *achrusterus* is separated from *plumbeus* by the very gray *decoloratus* of central Baja California. Thus, *plumbeus* is intermediate in color between the browner *californicus* and grayer *decoloratus*, but is distinguishable in no other way from these races.

Fulica americana. American Coot. — 4 miles WNW Santo Tomás (13 April, 2).

Charadrius vociferus. Killdeer. — A nesting pair was noted beside the stream at Valladares; the nest contained two half-incubated eggs of normal size, and one infertile "runt" egg only one-third normal size.

Aphriza virgata. Surfbird. — A flock of 10 was feeding on tide-washed rocks along the coast at Punta Banda (8 April).

Arenaria melanocephala. Black Turnstone. — Coast at the mouth of the Arroyo San Telmo (28 April, 2 or 3).

Capella gallinago. Common Snipe. — Valladares (1).

Numenius americanus. Long-billed Curlew. — Todos Santos Bay (8 April, 20+).

Catoptrophorus semipalmatus. Willet. — Todos Santos Bay (8 April, 150+); coast at mouth of Arroyo San Telmo (28 April, 3+).

Larus occidentalis. Western Gull. — Large numbers (at times in excess of 400 birds) of this species were consistently noted feeding at a local dump four miles inland from Ensenada.

Larus californicus. California Gull. — Coast at the mouth of the Arroyo San Telmo (28 April, 10+).

Zenaida asiatica. White-winged Dove. — Eight to 10 birds were seen regularly at San José. Mating calls were heard often, and the species almost certainly nests in the area.

Zenaidura macroura. Mourning Dove. — Common to abundant at all major localities.

Columbigallina passerina pallescens. Ground Dove*. — Three pairs of these doves were encountered at the east end of La Calentura Valley. One pair (♂, 47.6 g, testes 9 × 5 mm; ♀, 47.9 g, ovary destroyed) was collected as they fed in the desert near the edge of a cultivated field 14 miles ESE San Vicente. The previous northern record for this species in Baja California was near San Quintín (Short and Banks, 1965), 54 miles to the south. Increasing cultivation in the region should permit them to occupy (reoccupy? — they occur in coastal San Diego County) the coastal valleys northward at least to Ensenada.

Geococcyx californianus. Roadrunner. — From one to several individuals were noted at all major localities. One bird was seen carrying in its bill a live Red Rattlesnake (*Crotalus ruber*) about 20 inches long (10 miles W San José on 23 April).

Tyto alba. Barn Owl. — 31 miles E Ensenada (5 April, 1); 1 mile ESE Las Cruces (2 April, 1); 33 miles S Ensenada (30 March, 1 dead on the road).

Otus asio quercinus. Screech Owl.* — An adult male (110.3 g; testes 11 × 6 mm) was taken along the stream at Rancho Escondido. We tentatively assign this specimen to the race *O. a. quercinus*, although its general coloration (especially dorsally) is grayer than southern California specimens of this race.

Bubo virginianus. Great Horned Owl. — Great Horned Owls were found nesting at Valladares and San José. At the latter locality, two large, partially feathered young had ventured from the nest in a large cottonwood onto nearby branches by 21 April.

Speotyto cunicularia. Burrowing Owl. — Three birds were observed regularly in Ojos Negros Valley. Birds were seen near burrows of the numerous rock squirrels (*Citellus beecheyi*), and may nest in these burrows.

Asio otus. Long-eared Owl. — This species was common and nesting in all localities where suitable nest sites (abandoned hawk, raven, or squirrel nests) were available. The majority of nests contained large down-covered young. At least several young had left their nests at San José by 27 April.

Phalaenoptilus nuttallii. Poor-will. — At least two individuals were flushed from the coastal scrub-desert above Punta Banda.

Chordeiles acutipennis. Lesser Nighthawk. — Ensenada (3-5 birds downtown feeding low over the streets on 30 and 31 March); Valladares (24 April, 1).

Aeronautes saxatalis. White-throated Swift. — 31 miles E Ensenada (4 and 5 April, several); Punta Banda (2); San José (21 April, 3); Valladares (3-4).

Archilochus alexandri. Black-chinned Hummingbird. — 31 miles E Ensenada (4, 5, 6, and 15 April, single adult ♂).

Calypte costae. Costa's Hummingbird. — 31 miles E Ensenada (6 April, 2 ♂♂; 9 April, 3 ♂♂); La Calentura Valley (1 ♂); mouth of the Arroyo San Telmo (28 April, 1 ♂). Female hummingbirds noted at 31 miles E Ensenada and at San José may have been of this species.

Calypte anna. Anna's Hummingbird.* — Two males were noted five miles WNW Santo Tomás on 14 April. An adult female was collected from a nest (containing at least one fresh egg) 25 feet up in an oak tree five miles NNW of San José on 22 April. The bird had been gathering nesting material.

Selasphorus sasin sasin. Allen's Hummingbird.* — Ojos Negroes Valley (2 April, 6 ♂♂); 31 miles E Ensenada (5-6 April, 3 ♂♂); along the Ensenada-Tecate highway (12 April, 20+). An adult male (testes 1.5 × 1.5 mm) flew against our automobile seven miles ESE Ensenada. Birds were noted feeding at penstemon flowers in Ojos Negros Valley on 2 April.

Megaceryle alcyon. Belted Kingfisher. — San José (21 April, 1 ♀).

Colaptes auratus (= *cafer* of A.O.U. Check-list, 1957) *collaris.* Red-shafted Flicker.* — Arroyo Santo Tomás (common); San José (common); Concepción (several); Valladares (common); 31 miles E Ensenada (4, 5, 6 April, 1); La Calentura Valley (1); Rancho Escondido (12-14); Las Cruces (2 April, 1); 20 miles E Ensenada (4 April, 1); Rancho Santa Clara (19 April, 3). Although flickers have previously been known to nest only in the mountain portion of this region, we found evidence of their nesting in the Arroyo Santo Tomás (elevation 700 feet, within 10 miles of the coast), as well as at localities in the foothill region (San José, Concepción, Valladares, Rancho Escondido). Specimens were secured on 14 April at six miles WNW Santo Tomás (♀, ovary 12 × 7 mm, ova to 2 mm, incipient brood patch, light fat, 158 g), 15 April at Rancho Escondido (mutually displaying pair taken together: ♂, testes 14 × 7 mm, 151 g; ♀, ovary 18 × 12 mm, ova to 5 mm, enlarged oviduct, 150 g), and at San José (a ♂, testes 15 × 7 mm, with a brood patch, 137 g, engaged in display with a ♀; and a ♀, ovary 18 mm, ova to 7 mm, oviduct enlarging, brood patch, 138 g). Short (1965) discussed hybridization between the Gilded Flicker (*chrysoides* subspecies group of *Colaptes auratus*) and Red-shafted Flicker (*cafer* subspecies group of *C. auratus*), and Short and Banks (1965) described a hybrid population at El Palmarito, 42 miles southeast of San José. All 1967 specimens exhibit a slight tendency toward the Gilded Flicker in one or several characters (rufous crown color and narrow back bars, especially), but none is strongly like that form over-all. Grinnell (1927) separated the Red-shafted Flickers of the mountains of northern Baja California from those (*C. a. collaris*) of southern California as *Colaptes "cafer" martirensis.* Our Red-shafted Flickers differ from California birds only in having more rufous crown color, narrower back bars, and shorter wings. All three of these represent tendencies toward features of the Gilded Flicker. For this reason, as well as the insufficient magnitude of the differences, we concur in the general (all recent authors) rejection of the subspecies *martirensis.*

Melanerpes formicivorus bairdi. Acorn Woodpecker.* — 6 miles WNW Santo Tomás (13 April, 3; 14 April, 4); Valladares (25 April, 1); Uruapan Valley, 23 miles SE Ensenada (16 April, 7). This usually resident species has been known to occur in northern Baja California only on the western slopes of the Sierra Juárez and Sierra San Pedro Mártir (Grinnell, 1928). We found Acorn Woodpeckers preparing to breed in the Uruapan Valley (elevation 1200 feet, 21 miles inland), where we saw a courting group of seven birds, including a female that returned several times to a hole in a dead sycamore stub. They probably breed at the Arroyo Santo Tomás (elevation 350 feet, only eight miles inland), where we observed at least four Acorn Woodpeckers, including a displaying group of three birds. Six specimens were collected: three at the Arroyo Santo Tomás, two in the Uruapan Valley, and one at Valladares. The last locality is the southern limit for the species in northern Baja California; deteriorating habitat, including disappearance of oak trees, makes it unlikely that Acorn Woodpeckers will continue to persist there. Weights of two males from the Arroyo Santo Tomás were 78.7 and 80.3 g; both had enlarged testes (10 × 8 and 10 × 6 mm) and one had a defeathering brood patch. Three females weighed 81.7, 80.3 and 81.4 g, respectively. Their ovaries ranged in size from 7 × 5.5 mm (ova to 2 mm) for a Valladares female, to 11 × 5 and 12 × 7 mm (ova 3.5 mm in both) for a Santo Tomás and a Uruapan female, respectively. The latter two birds exhibited fully developed brood patches. All birds taken had pale pink irides. We assign these specimens to the race *bairdi*, which we find impossible to separate from *M. f. martirensis* Grinnell and Swarth (1926). The wing length difference cited by those authors is non-existent or weakly defined, as their data suggest. They give (1926: 176) an average wing length of 142.0 mm for a sample of 10 California specimens of *bairdi*, and 138.2 mm for that of five *martirensis*. However, their average for five females of *martirensis* (which they did not compare with a sample of *bairdi*) is 141.1 mm, barely less than the male *bairdi* average, despite the fact that females of this species have shorter wings than males. Our birds fit within the range of measurements of a sample of 39 comparably plumaged California specimens of *bairdi*, except that the bill length of one male (culmen 30.0 mm) is at the low extreme of that range. We are unable to discern the weaker bill of *martirensis* reported by Grinnell and Swarth (*loc. cit.*). Likewise, the difference in head markings of females of the two races reported by those authors is rendered useless by the wide range of variation evident in *bairdi*. Two of our four females show as much black in the crown as do extreme specimens of *bairdi*, while at least four of 17 available *bairdi* females matched our other two birds in head pattern. Any tendencies in these characters are thus masked by the variation exhibited. It should be noted that *M. f. angustifrons* of the Cape Region of Baja California mensurally overlaps (in wing, tail, and bill measurements) *M. f. bairdi*; it is hence impossible to mensurally define another race of Acorn Woodpecker having measurements intermediate between those of *bairdi* and *angustifrons*.

Dendrocopos villosus hyloscopus. Hairy Woodpecker.* — This species was observed only at Concepción (at least one pair in large oaks) and at San José (one pair). Grinnell (1928:120) reported this species "closely adherent to the coniferous forests" of the Sierra Juárez and Sierra San Pedro Mártir. The two pairs we observed were found principally in oaks at Concepción, where pines occur, and in cottonwoods and willows at San José, where no pines occur. Their previously reported (Grinnell, 1928) occurrence at Concepción (altitude 4700 feet) represented the lowest known station for the species in Baja California, so the presence of a pair of undoubtedly breeding birds at San José (2200 feet) constitutes a low elevation record. Hairy Woodpeckers may nest in other suitable (large tree) areas outside the mountain region. The pair at San José was observed in frequent encounters, sex for sex, with a pair of Nuttall's Woodpeckers. Tape recordings were obtained during several of these encounters. The male Hairy Woodpecker (64 g, testes enlarged but damaged by shot) was collected in riparian woodland on 26 April 1967, while the female Hairy Woodpecker and the male Nuttall's Woodpecker called nearby. The female of the pair disappeared after the male was obtained, and could not be found in the following two days. Seven Hairy Woodpeckers from Baja California in the American Museum of Natural History collection average slightly shorter-winged and barely shorter-tailed than comparable specimens from southern California. No color differences (including color of underparts) were detected between birds of the two regions. Hence, we agree with the merging (A.O.U., 1957; Miller, *et al.*, 1957) of *D. villosus scrippsae* Huey in *D. villosus hyloscopus* (Cabanis and Heine).

Dendrocopos scalaris. Ladder-backed Woodpecker.* — These woodpeckers were found in desert vegetation in the Arroyo San Telmo one to four miles NW Las Cabras (Fig. 6), and near the mouth of the Arroyo San Telmo. They occur in riparian timber in the absence of the related Nuttall's Woodpecker at 11 miles SSE Santo Tomás and 25.5 miles E Ensenada (elevation 2650 feet). Ladder-backed and Nuttall's woodpeckers were observed together at: 31 miles E Ensenada; Rancho Escondido (hybrid taken); Rancho Santa Clara; and Concepción. Hybridization, interactions, and the taxonomy of these two woodpeckers will be treated in a separate report. The specimens we collected are tentatively assigned to *D. scalaris*, but analysis may show that some exhibit hybrid characters. We were surprised to find Ladder-backed Woodpeckers common in riparian situations around the south end of Ojos Negros Valley. Previous records (Grinnell, 1928; Short, study of specimens from various museums) had indicated a distribution of this desert species in the breeding season north to the Valle de la Trinidad and, west of the mountains, to Concepción, the Arroyo San Telmo, and Colnett. Our brief attempts to locate Ladder-backs in coastal scrub-desert at the mouth of the Arroyo

Santo Tomás and at Punta Banda were unsuccessful (there exists a winter specimen from the vicinity of Ensenada). All pairs studied had partially or completely excavated presumed nesting cavities in trees. Eggs are probably laid throughout April. Definite egg dates are 6 April (25.5 miles E Ensenada, female with one ruptured follicle and large ova) and 23 April (1.5 miles NW Las Cabras. nest with four eggs in an agave stalk; Fig. 6). Birds with large ova (4 to 8 mm) were taken on 6 and 15 April.

Dendrocopos nuttallii. Nuttall's Woodpecker.* — Although essentially a chaparral-oak woodland counterpart of the desert Ladder-backed Woodpecker, this species was observed in Baja California only in riparian woodlands (both with and without oaks). Localities where these woodpeckers occur sympatrically with *D. scalaris* are cited above. Nuttall's Woodpeckers were found in the absence of Ladder-backed Woodpeckers at four to 13 miles WNW Santo Tomás, San José, Valladares, 18 miles S Ensenada, 22 miles SE Ensenada (Uruapan Valley), and 22 miles SSE Tecate. The specimens we obtained are only tentatively referred to this species, pending study of hybridization and interaction with Ladder-backed Woodpeckers. Most of the females had very large (over 5 mm) ova, ruptured ovarian follicles, or regressing ovaries with large oviducts. Ruptured follicles, indicating that eggs had been laid, were found in a female taken on 6 April. By the end of the month some birds were feeding young in the nest, although females of a few pairs had not yet laid eggs.

Tyrannus verticalis. Western Kingbird. — Migrants of this species were abundant everywhere in the region during April.

Tyrannus vociferans. Cassin's Kingbird. — Arroyo Santo Tomás (14 April, 5+); Valladares (24 April, 20+).

Myiarchus cinerascens. Ash-throated Flycatcher — 31 miles E Ensenada (5-6 April, 2); San Jose; Valladares (2).

Sayornis nigricans. Black Phoebe. — Two apparent pairs were present at Valladares, and also at 31 miles E Ensenada (nest building on 9 April). Black Phoebes were common at San José and nest construction was observed on 25 April.

Sayornis saya. Say's Phoebe. — Two birds (a pair?) were observed at 31 miles E Ensenada (5, 6, and 9 April). The species was encountered elsewhere only at San José, where it was common in the vicinity of buildings and corrals.

Empidonax flycatchers. — 31 miles E Ensenada (4 to 15 April, several); Valladares (20+); San José (20 April, 1; 23 April, several); 25 miles E Ensenada (31 March, 1); 24 miles S Ensenada (8 April, 1). Of these flycatchers, at least one bird seen daily on 4, 5 and 6 April at 31 miles E Ensenada, a number of the Valladares individuals, and one singing male at San José were Western Flycatchers (*E. difficilis*). The remainder were probably Traill's Flycatchers (*E. traillii*). White-breasted individuals, almost certainly of the latter species, were noted 31 miles E Ensenada (5 April, 1), at Valladares (24 April, about 10), and at San José (20-30 April, several).

Contopus sordidulus. Western Wood Pewee. — 31 miles E Ensenada (4 April, 1); Valladares (15+); San José (common).

Nuttallornis borealis. Olive-sided Flycatcher. — 31 miles E Ensenada (15 April, 1); San José (21 April, 1); Valladares (1).

Pyrocephalus rubinus. Vermilion Flycatcher. — Two males were observed in a cultivated area in the Valle de la Trinidad (2400 feet) on 11 April.

Eremophila alpestris actia. Horned Lark.* — Larks were abundant in both the Ojos Negros Valley and La Calentura Valley, while groups or pairs were noted elsewhere in less extensive grasslands and cultivated fields, e.g., in the lower San Telmo Valley (28 April, 20+), one mile ESE of Las Cruces (2 April, 2), and at Valladares (10+). A grassland pasture on a hill four miles W San José was the nesting site of about 20 birds. Two completed nests without eggs were discovered here on 25 April. We obtained three specimens in this pasture on 23 April, and two birds (a pair) that were flushed from the site of one of the completed nests on 25 April. Three males weighed 28.8, 28.2 and 28.2 g, and, respectively, had testes measuring 9 × 5, 10 × 8 and 10 × 7 mm. Two females weighed 29.8 and 26.6 g; the heavier bird had an egg in the oviduct, while the other had an ovary measuring eight mm.

Tachycineta thalassina. Violet-green Swallow. — Arroyo Santo Tomás (13-14 April, several hundred); La Calentura Valley (several); San José (hundreds); Valladares (50+).

Petrochelidon pyrrhonota. Cliff Swallow. — Ensenada (30 March, many); La Calentura Valley (20+); 31 miles E Ensenada (4-6 April, few); San José (common).

Aphelocoma coerulescens. Scrub Jay. — Common in chaparral and riparian trees at all localities where these were present.

Corvus corax. Common Raven. — Common at all localities, and abundant in the Ojos Negros Valley. At 31 miles E Ensenada on 5 April, one of a pair carried a stick in its bill for about eight minutes while circling overhead in display flight.

Parus inornatus. Plain Titmouse. — At least several birds (usually pairs) were noted at every riparian station.

Auriparus flaviceps acaciarum. Verdin.* — 25 miles E Ensenada (31 March, 4+); 31 miles E Ensenada (4, 5, 6, and 10 April) ; La Calentura Valley (at least 1). Nest-building was observed in mesquite trees 25 miles E Ensenada on 31 March, and a female was collected at a nest containing four heavily incubated eggs in a cholla 31 miles E Ensenada on 10 April. A male (testes 5 × 3 mm) was also collected at the latter locality on 6 April. Verdins have not previously been recorded in northwestern Baja California west of Valle de la Trinidad (A.O.U. Check-list, 1957) and north of El Palmarito (Short and Banks, 1965). They may have entered the desert on the south side of Ojos Negros valley from Valle de la Trinidad, or a population existing there may have escaped previous notice.

Psaltriparus minimus. Bushtit. — Common at all riparian localities. A nest containing five fresh eggs was found 31 miles E Ensenada on 4 April, and newly hatched young were seen there in another nest on 9 April. Newly constructed nests were also noted at San José (21 April) and 39 miles N Ensenada (12 April).

Chamaea fasciata. Wrentit. — Punta Banda (2); Arroyo Santo Tomás (13 April, 20+); Las Cruces (2 April, 5); 24 road miles S Ensenada (8 April, 2); San José (common in hills).

Troglodytes aedon. House Wren. — Common at all riparian localities. One individual, probably a migrant, was noted in coastal scrub-desert at Punta Banda. Males were singing at 31 miles E Ensenada on 4-6 April, and birds were observed investigating nest cavities in the willows and cottonwoods there and at San José.

Thryomanes bewickii. Bewick's Wren. — 31 miles E Ensenada (31 March, 3; 4 April, 2; 5 April, 4; 9 April, 1 singing); Arroyo Santo Tomás (14 April, 1); (21 April, common); Valladares (3-4).

Campylorhynchus brunneicapillum bryanti. Cactus Wren.* — 8 miles E Ojos Negros (2 April, 1 singing); Punta Banda (1 singing); La Calentura Valley (5+); 1 mile W Las Cabras (23 April, 1+); 11 miles WSW San José (23 April, 1 collected; 25 April, 2 collected); mouth of Arroyo San Telmo (28 April, 3). The specimens collected represent the very barred-tailed race *bryanti.* Birds observed in the eastern Ojos Negros Valley (in opuntias, *Yucca schidigera, Ephedra* [sp.]) and at Punta Banda were presumably *C. b. couesi*, which Miller, *et al.* (1957) cite as occurring south to Ensenada. These races may intergrade coastally between Arroyo Santo Tomás and San Antonio del Mar, and probably meet inland in the upper La Calentura Valley.

Catherpes mexicanus. Cañon Wren. — San José (23 April, 1).

Salpinctes obsoletus. Rock Wren. — 31 miles E Ensenada (31 March, 1; 5-6 April, 1), San José (20, 23 April, 2).

Mimus polyglottos leucopterus. Mockingbird.* — 26 miles S Tijuana (30 March, 1); Ojos Negros Valley (31 March, common; 2 April, 1; 4 April, 6+); 31 miles E Ensenada

(5-6 April, 2); La Calentura Valley (7 April, 20+); San José (common); Valladares (24 April, 8). A singing male was collected at San José on 21 April.

Toxostoma cinereum mearnsi. Gray Thrasher.*—1.5 miles W Las Cabras (23 April, 3+).

Toxostoma redivivum redivivum. California Thrasher.*—This species was present in low numbers in dense undergrowth at all major localities. Three specimens were obtained.

Oreoscoptes montanus. Sage Thrasher.*—Ojos Negros Valley (31 March, 50+); 4, 5, 6 April, 10+); 33 miles ESE Ensenada (15 April, 8-10); 12 miles SW San José (23 April, 2). Migrant Sage Thrashers were found in open, semi-arid, overgrazed pasture dotted with scattered clusters of low thorny plants, including *Ephedra* (sp.), and chollas. Four specimens were obtained. Two males taken in Ojos Negros valley weighed 56.7 and 48.9 g and had somewhat enlarged black testes (6 × 3, 5 × 3 mm., respectively); both were very fat. This species has a yellow iris and pale yellow mouth lining; the gape is dull pink bordered with dusky (see Short and Banks, 1965, for these data on soft-part coloration of the above two species of thrasher).

Turdus migratorius. Robin.—31 miles E Ensenada (up to 5 birds along stream 31 March-15 April); Arroyo Santo Tomás (13 April, 4); Valladares (1); San José (several).

Hylocichla guttata. Hermit Thrush.—31 miles E Ensenada (4 to 15 April, several); San José (few); Valladares (10-12); Concepción (several).

Hylocichla ustulata. Swainson's Thrush.—31 miles E Ensenada (5 April, 3+); San José (common); Valladares (5-6).

Sialia mexicana. Western Bluebird.—31 miles E Ensenada (31 March-10 April, common); La Calentura Valley (several); San José (common); Valladares (12+); 1 mile E Las Cruces (2 April, 2). Several bluebirds were investigating cavities in trees at 31 miles E Ensenada on 4 April, but the species was not seen there after 10 April.

Sialia currucoides. Mountain Bluebird.—25 miles E Ensenada (31 March. 1 ♂).

Polioptila caerulea. Blue-gray Gnatcatcher.—31 miles E Ensenada (4-15 April, up to 6 birds); 24 miles S Ensenada (8 April, 1); San José (1); Valladares (12+).

Polioptila melanura. Black-tailed Gnatcatcher.—Mouth of Arroyo San Telmo (28 April, 2).

Regulus calendula. Ruby-crowned Kinglet.—31 miles E Ensenada (31 March-15 April, 1 to 4 birds).

Bombycilla cedrorum. Cedar Waxwing.—Ensenada (4 April, 10+), Valladares (7).

Phainopepla nitens. Phainopepla.—25 miles E Ensenada (31 March, 20+); 31 miles E Ensenada (4-15 April, up to 16 birds); La Calentura Valley (7 April, abundant); San José (few); Valladares (30+). A few newly constructed nests were found 31 miles E Ensenada on 4 April. Phainopeplas were present only where mistletoe plants were abundant.

Lanius ludovicianus. Loggerhead Shrike.—Ojos Negros Valley (31 March, 4; 2 April 1+; 4 April, 4+); 31 miles E Ensenada (5-6 April, 2); Punta Banda (8 April, 2); La Calentura Valley (7 April, 6+); San José (20 April, 1+); Valladares (2).

Sturnus vulgaris. Starling.*—This species was present during April in varying numbers at all wooded localities visited. It was especially numerous at Arroyo Santo Tomás (20+) and San José (100+). One specimen (♂, 79.1 g, testes 15 × 9 mm) was taken from a displaying group of three at Valladares on 25 April. Short and Banks (1965) discussed the southward extension of this species into Baja California up to the spring of 1964. Apparently, Starlings have increased markedly within the past few years and now occupy virtually all suitable habitat in northern Baja California.

Vireo huttoni. Hutton's Vireo.—31 miles E Ensenada (4 April, 1); Arroyo Santo Tomás (14 April, 1); 24 miles S Ensenada (8 April, 2).

Vireo bellii. Bell's Vireo.—31 miles E Ensenada (4-15 April, up to 10 birds, singing and in conflict); San José (common); Valladares (6).

Vireo vicinior. Gray Vireo. — 31 miles E Ensenada (5-6 April, 1).

Vireo solitarius. Solitary Vireo. — San José (few).

Vireo gilvus. Warbling Vireo. — 25 miles E Ensenada (31 March, 1); 31 miles E Ensenada (9 April, 1); San José (20 April, few); Valladares (2).

Vermivora celata. Orange-crowned Warbler. — 31 miles E Ensenada (4-9 April, up to 6; 15 April, 50+); 24 miles S Ensenada (8 April, 1); Arroyo Santo Tomás (13 April, 1); San José (common); Valladares (common).

Vermivora ruficapilla. Nashville Warbler. — 31 miles E Ensenada (4 April, 3; 15 April, 3); Arroyo Santo Tomás (14 April, 1); 24 miles S Ensenada (8 April, 1); San José (20 April, few); Valladares (2).

Dendroica petechia. Yellow Warbler. — 31 miles E Ensenada (4 April, 1); Arroyo Santo Tomás (14 April, 1); San José (common).

Dendroica auduboni. Audubon's Warbler. — Common at all wooded localities throughout April.

Dendroica nigrescens. Black-throated Gray Warbler. — 31 miles E Ensenada (4-15 April, up to 6); 24 miles S Ensenada (8 April, 2); San José (20-21 April, few); Valladares (4-5); Concepción (5).

Dendroica townsendi. Townsend's Warbler. — 31 miles E Ensenada (15 April, 2); Arroyo Santo Tomás (13 April, 2); San José (21 April, few); Valladares (8-10).

Dendroica occidentalis. Hermit Warbler. — 31 miles E Ensenada (4 April, 1); San José (21 April, few); Valladares (1).

Oporornis tolmiei. MacGillivray's Warbler. — 31 miles E Ensenada (4 April, 1); San José (20 April, 1); Valladares (1).

Geothlypis trichas. Yellowthroat. — 31 miles E Ensenada (6 April, 1 ♂; 9 April, 1 singing); Arroyo Santo Tomás (13 April, 16+); San José (common, singing).

Icteria virens auricollis. Yellow-breasted Chat.* — 31 miles E Ensenada (15 April, 1 singing); Arroyo Santo Tomás (14 April, 1); 3 miles SW San José (27 April, 3). Three chats (two males fighting, one female) were found in a dense tangle three miles SW San José on 27 April. The males had engaged in a singing bout, and appeared highly territorial. One male (25.8 g, testes 13 × 8 mm) was collected.

Wilsonia pusilla. Wilson's Warbler. — Common at all wooded localities throughout April. They were especially numerous along with Orange-crowned Warblers at 31 miles E Ensenada on 15 April (50+) and at Valladares on 24 April (30+).

Passer domesticus. House Sparrow. — Restricted to the vicinity of human habitation at all localities. A nest with young was noted at San José on 20 April.

Sturnella neglecta. Western Meadowlark. — Ojos Negros Valley (common, all dates visited); Punta Banda (8 April, 1); La Calentura Valley (7 April, 20+); San José (common); mouth of Arroyo San Telmo (28 April, 1). Singing birds were noted at La Calentura Valley, Punta Banda, and at the mouth of the Arroyo San Telmo. At the last two localities they were occupying sparse grass in coastal scrub-desert along the ocean.

Agelaius phoeniceus. Redwinged Blackbird. — Ojos Negros Valley (4 April, 1 ♂), 35 miles S Tijuana (30 March, 1); Arroyo Santo Tomás (13 April, 1).

Icterus cucullatus. Hooded Oriole. — 31 miles E Ensenada (5 April, 1 ♂).

Icterus parisorum. Scott's Oriole. — 31 miles E Ensenada (6 April, 1 ♂ singing); Punta Banda (8 April, 4); 5 miles NNW San José (22 April, 1); mouth of Arroyo San Telmo (28 April, 1 ♂).

Icterus bullockii. Bullock's Oriole. — Uncommon to common at all major localities throughout April.

Euphagus cyanocephalus. Brewer's Blackbird. — 52 miles S Tijuana (30 March, 5); Ojos Negros Valley (31 March, 100+; 4 April, 100+); La Calentura Valley (7 April, 100+); San José (common); Valladares (8-10). Nest construction was noted at San José on 21 April.

Molothrus ater. Brown-headed Cowbird. — 31 miles E Ensenada (6 April, 1 ♂), San José (few).

Piranga ludoviciana. Western Tanager.* — 31 miles E Ensenada (15 April, 3); San José (abundant); Valladares (25-30). An adult male (27.0 g, testes 6.5 × 5.5 mm) was collected at Valladares. This species was migrating in considerable numbers during late April and was noted in all types of habitat. A male was observed flycatching from a fence post in a barren portion of the Arroyo San Telmo, far from any tree or large bush.

Pheucticus melanocephalus. Black-headed Grosbeak. — 31 miles E Ensenada (4 April, 1 ♂); Arroyo Santo Tomás (13 April, 20+); La Calentura Valley (4); San José (common); Valladares (8-10).

Guiraca caerulea. Blue Grosbeak. — This species was encountered only at San José, where it was first noted on 21 April, and then seen regularly through 28 April.

Passerina amoena. Lazuli Bunting. — 31 miles E Ensenada (4 April, 1 ♂; 5-6 April, 1; 15 April, 1); Punta Banda (8 April, 2); La Calentura Valley (5+); San José (few); Valladares (6-7).

Carpodacus purpureus. Purple Finch. — San José (20-21 April, 3).

Carpodacus mexicanus. House Finch. — Common to abundant at all major localities.

Spinus psaltria. Lesser Goldfinch. — Abundant at all riparian localities. In early April this species was noted at 31 miles E Ensenada in mixed feeding groups with *Spinus lawrencei.* A female Lesser Goldfinch was carrying nesting material into an oak at Valladares on 24 April.

Spinus lawrencei. Lawrence's Goldfinch. — At least a few birds were noted at all riparian localities. The species was abundant 25 miles E Ensenada and at San José.

Chlorura chlorura. Green-tailed Towhee. — 24 miles S Ensenada (8 April, 1), Valladares (3-4).

Pipilo erythrophthalmus. Rufous-sided Towhee. — 31 miles E Ensenada (4-15 April, few); 24 miles S Ensenada (8 April, 1); Arroyo Santo Tomás (14 April, 1); San José (few); Valladares (2).

Pipilo fuscus. Brown Towhee. — Common at all localities.

Calamospiza melanocorys. Lark Bunting. — One was observed in La Calentura Valley (7 April).

Passerculus sandwichensis. Savannah Sparrow. — Ensenada (30 March, 2), Ojos Negros Valley (31 March, 2-3).

Pooecetes gramineus. Vesper Sparrow. — Ojos Negros Valley (31 March, 2-3); La Calentura Valley (1); San José (21 April, 1); Valladares (2).

Chondestes grammacus. Lark Sparrow. — Ojos Negros Valley (31 March, 3); La Calentura Valley (4+); San José (21 April, 3).

Aimophila ruficeps. Rufous-crowned Sparrow. — 39 miles N Ensenada along Tecate Road (12 April, 1).

Amphispiza bilineata. Black-throated Sparrow. — 25 miles E Ensenada (31 March, 6+); Ojos Negros Valley (2 April, 1+); 31 miles E Ensenada (4-15 April, 6 to 20); La Calentura Valley (3-4); mouth of Arroyo San Telmo (28 April, at least 1).

Amphispiza belli. Sage Sparrow. — Punta Banda (2).

Junco oreganus. Oregon Junco. — Common to abundant at all localities; often encountered in large mixed flocks with White-crowned Sparrows, and, at 31 miles E Ensenada, with Chipping Sparrows also.

Spizella passerina. Chipping Sparrow. — 31 miles E Ensenada (common to abundant); La Calentura Valley (1), Valladares (10+).

Spizella breweri. Brewer's Sparrow. — 31 miles E Ensenada (31 March, at least 1); San José (few).

Spizella atrogularis. Black-chinned Sparrow. — 31 miles E Ensenada (4-9 April, 1 to 12); Punta Banda (1). Males were singing at 31 miles E Ensenada on 9 April.

Zonotrichia leucophrys. White-crowned Sparrow. — Abundant (often the most abundant species) at all localities. We noted individuals of *Z. l. oriantha*, and (probably) *Z. l. gambelii.*

Zonotrichia atricapilla. Golden-crowned Sparrow. — 24 miles S Ensenada (8 April, 1); Arroyo Santo Tomás (14 April, 10+); San José (20 April, few). This species was usually encountered amidst flocks of the ubiquitous White-crowned Sparrows and, hence, probably was present more often than our records indicate.

Melospiza lincolnii. Lincoln's Sparrow. — 31 miles E Ensenada (4-9 April, several along stream); Arroyo Santo Tomás (14 April, 1); San José (20 April, few); Valladares (3-4).

Melospiza melodia cooperi. Song Sparrow.* — 31 miles E Ensenada (15 April, 3+); Arroyo Santo Tomás (13-14 April, abundant); San José (abundant); Valladares (2). Three specimens were collected at San José, all of which are referable to *M. m. cooperi.* Young birds attended by parents were seen at San José on 20 April, and a nest with three heavily incubated eggs was found there on 25 April.

DISCUSSION

Previous field work in northwestern Baja California led Short and Banks (1965: 43) to suggest the Arroyo San Telmo as the boundary between Chaparral and Sonoran Desert biomes. However, the 1967 field work indicates that this boundary is a trifle too southerly. Using criteria applied by Shreve (1936: 258), Sonoran Desert vegetation extends northward through the San Quintín plain to the region bounded by the lower Arroyo San Telmo (to about four miles east of Las Cabras), the lower Río San Antonio, and the Arroyo Salado (inland from San Antonio del Mar to about five miles east of La Calentura). In immediate proximity to the coast, the Sonoran Desert extends northward in the form of the coastal scrub-desert at least to the mouth of the Arroyo Santo Tomás (where the epiphyte *Tillandsia recurvata* apparently reaches its northern limit), and probably to Punta Banda. This coastal strip varies from one to five miles in width.

The areas just discussed are within the Chaparral-Sonoran Desert ecotone, delimited by Shreve (1936) as the region between Arroyo Santo Tomás (south end of Chaparral) and 20 miles north of Rosario (the arroyo passing inland from El Socorro; north end of the Sonoran Desert). Most of the ecotonal area bears vegetation not fully typical of either biome, but if the ecotone is not delimited, a boundary must be determined which is based on the dominant forms and composition of the flora and fauna. Our suggested boundary is shown in Figure 1.

A predominantly desert biota extends eastward up La Calentura Valley beyond La Calentura; it probably does not make contact with the Sonoran Desert biota that enters the Valle de la Trinidad from the east. Ridges extending westward from the Sierra San Pedro Mártir (south of Valle de la Trinidad) separate the valleys and bear chaparral vegetation that is best developed in proximity to the mountains, as between San José and Concepción. The valleys tend to bear desert vegetation inland from the coast, as in the San Telmo Valley. Even close to the mountains (as high as Concepción at 4700 feet) there occur very xeric patches of chaparral and chaparral-desert vegetation which may attract desert birds like Ladder-backed Woodpeckers. Indeed, strongly desert-like vegetation occurs north of Shreve's northern ecotonal border along the southern and eastern edge of Ojos Negros Valley, where there occur desert birds such as Cactus Wrens, Verdins and Ladder-backed Woodpeckers.

Conditions are altering in the region due to human interference (cutting of trees, overgrazing, overuse of water) and the xeric trend of at least the past several decades. Doubtless this is disrupting portions of the ecotonal area.

A remarkable feature of the region, particularly exemplified at San José, was the abundance and variety of raptors. At San José we counted the following nesting individuals within a 1.5 by 0.25 mile extent of riparian woodland near the ranch: Cooper's Hawk - 2 pairs (possibly 3); Red-tailed Hawk - 2 pairs (possibly 3); Red-shouldered Hawk - 1 pair; Sparrow Hawk - at least 6 pairs; Great Horned Owl - 1 pair; and Long-eared Owl - 2 pairs (possibly 3). This list is undoubtedly incomplete, for we were assured by the ranch owner that both Screech Owls and Barn Owls were present (this seems likely), and Burrowing Owls could also occur there. An abundance of prey, especially gophers, ground squirrels, jack rabbits, cottontails, and California Quail, is undoubtedly responsible for the attainment of such a high raptor population. This situation prevailed to a lesser extent at all riparian localities.

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SUMARIO

Se discuten los resultados obtenidos durante un mes (Abril, 1967) dedicado a la recolección de material y a estudios realizados en Baja California. Se anota la distributión del Carpintero tigre, Valoncito, Matraca grande, y Mucuy. La Anguililla cangrejera ha sido observada por primera vez en Baja California. Se incluye información sobre la distribución, taxonomía y ciclo vital de varias aves. Se discute la zona ecotónica del Caparral y el Desierto de Sonora, y así mismo se trata de la zona limitante entre estas regiones bióticas (cuando la zona ecotónica no se tiene en cuenta y no se representa en el mapa). La característica especial de esta región es una abundancia de aves de presa en los bosques ribereños.

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OCCURRENCE OF THE PACIFIC LAMPREY, *ENTOSPHENUS TRIDENTATUS*, OFF BAJA CALIFORNIA AND IN STREAMS OF SOUTHERN CALIFORNIA; WITH REMARKS ON ITS NOMENCLATURE

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OCCURRENCE OF THE PACIFIC LAMPREY, *ENTOSPHENUS TRIDENTATUS*, OFF BAJA CALIFORNIA AND IN STREAMS OF SOUTHERN CALIFORNIA; WITH REMARKS ON ITS NOMENCLATURE[1]

BY

Carl L. Hubbs

ABSTRACT

A specimen of the anadromous Pacific lamprey, *Entosphenus tridentatus*, taken in a huge pelagic trawl in the cool, up-welled ocean water off Baja California, Mexico, represents a marked southward extension of the range of the genus and species, and of the family, in the eastern Pacific Ocean. The source from which it strayed is uncertain. Until their very recent local probable extirpation, this species and a probably unnamed nonparasitic species of *Lampetra* occurred in streams of the Los Angeles Basin. *E. tridentatus* still persists in streams of the Ventura Basin, also in southern California. Records of *E. tridentatus* at sea are relatively few, and none have pertained to the coast south of Monterey Bay, California. A racial analysis of the species is needed. The separation of a northern and a southern subspecies seems invalid. Proper designation of species and author names is *Entosphenus tridentatus* (Gairdner in Richardson). The separation of *Entosphenus* from *Lampetra* appears justified, and it seems advisable to recognize as genera the three taxa proposed by Creaser and Hubbs as subgenera of *Entosphenus,* namely *Tetrapleurodon* and *Lethenteron,* as well as *Entosphenus* proper, which includes an unnamed nonparasitic derivative.

This paper is an element in a study of the fishes of the "California Peninsula," which contains a distinctive fauna extending from near Point Conception in California southward for several hundred miles, with a sharp transition to the tropical fauna in the Cape region of Baja California, México. The program has been supported by the National Science Foundation (currently by Grant GB-1321).

Thanks are due H. C. Perkins, then of the U. S. Bureau of Commercial Fisheries laboratory at La Jolla, who preserved the range-extending specimen from off Baja California and brought it to me for study, and to the Exploratory Fishing staff of the same bureau, at Seattle, for supplementary data on the trawl and the gear. Thomas T. Harriss of Whittier College supplied information regarding lampreys collected prior to 1945 in San Gabriel River, California. James A. St. Amant and staff and Robert R. Bell of the California Division of Fish and Game, Keith W. Radford, formerly of Scripps Institution, and Robert Rush Miller, of The University of Michigan, have been among those who have helped me in obtaining material and data on lampreys in the streams of southern California. W. I. Follett, of the California Academy of Sciences, and Vadim D. Vladykov, of the University of Ottawa, have made helpful suggestions.

All specimens studied, with the exception of one in The University of Michigan Museum of Zoology (UMMZ), are deposited in the Marine Vertebrates collection of Scripps Institution of Oceanography (SIO).

Discovery off Baja California and Faunal Implications

The capture off western Baja California, Mexico, of a specimen of the anadromous Pacific lamprey, *Entosphenus tridentatus* (Gairdner in Richardson) represents a range extension, far to the southward in the Pacific Ocean, for the family Petromyzonidae, as well for

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[1] Contribution from the Scripps Institution of Oceanography, University of California, San Diego.

the genus and species. This discovery parallels recently reported range extensions to western Baja California of certain other West Coast anadromous fishes: salmon (Hubbs, 1946), sturgeons (Hubbs and Márquez Millán, MS) and shad (Claussen, 1959). Occurrence of northern fishes and other animals in the area of cold upwelling along the northwestern coast of Baja California is to be expected (Hubbs, 1960). A recent, rather startling range extension of this nature (Hubbs and Wilimovsky, 1964) is that of a Greenland halibut, *Reinhardtius hippoglossoides* (Reinhardt).

Lampreys (Petromyzonidae) have long been known from farther south in North America, but, south of the United States, only as a relict type landlocked in the highly distinctive fauna of the Río Lerma basin at the southern end of the Mexican Plateau. This type has generally been known as *Entosphenus spadiceus* (Bean), but Alvarez del Villar (1966) has recently described a second species from the same basin, *geminis*, the nonparasitic counterpart of *spadiceus*, and has referred the two species to a distinct genus, *Tetrapleurodon* (see also the section below on Nomenclature).

The lamprey from off Baja California, a juvenile male 170 mm in total length (SIO 67-22-4), was captured in a John N. Cobb pelagic trawl that was catching hake at 28° 58.6′ N., 115° 25.6′ W., 29.5 nautical miles southwesterly from Punta Canoas (the nearest place on the mainland) and 37.3 miles northerly from the north end of Isla Cedros. At the indicated point of capture Hydrographic Office Chart 1193 shows depth of water as 460 fathoms (841 m). Maximum depth of tow was 388 m, where temperature registered 7.2° C.; surface temperature was 15.6° C. The haul was made by the exploratory-fishing vessel John N. Cobb, of the U. S. Bureau of Commercial Fisheries, at Station 34 on Cruise 64, at 1400-1530 hrs. P.S.T., on March 9, 1964.

The capture of this specimen seems attributable to the remarkable capacity of the huge John N. Cobb pelagic trawl (McNeely, 1963) with "a measured opening of 80 feet horizontally and 90 feet vertically (7,200 sq. ft.)." This net engulfs fish too large or too active to be trawled ordinarily, even in the highly efficient 10-foot Isaacs-Kidd midwater trawl. However, Pearcy (1964: 87) reported capture of this lamprey by midwater trawl off Oregon.

The region from which this stray lamprey ranged to the far-southern station cannot be pinpointed, either by the circumstances of its capture or by its inherent characters (see below). It is rather plausible to assume that it hitch-hiked a ride on a hake, *Merluccius productus* (Ayres). The same haul took 158 hake weighing nearly 200 kg, along with a few juvenile jack mackerel, *Trachurus symmetricus* (Ayres), and several small species of bathypelagic fish, none of which was a likely host. Probably, this lamprey had spent its early life no farther south than one of the streams tributary to Monterey Bay, central California, the southernmost streams in which any massive spawning of the species has been recorded (Snyder, 1913: 56).

OCCURRENCE IN STREAMS OF SOUTHERN CALIFORNIA

Entosphenus tridentatus has long been known to migrate occasionally into the dwindling streams of southern California. Jordan and Evermann (1896: 12) indicated its range as extending to Santa Ana River at Riverside. Culver and Hubbs (1917: 83) reported it as anadromous in the same river, and mentioned taking ammocetes in Los Angeles River, which then flowed at the surface (however, these larvae may have been brook lampreys of the genus *Lampetra*, which may still inhabit the streams of the Los Angeles Basin). Fowler (1923: 286) listed *E. tridentatus* from "Los Angeles," without indicating the exact location, habitat, or life-history stage (if the record was based on an ammocete, it may have been referable to *Lampetra*; efforts to locate the material have failed). In their review of records of freshwater fishes in California, Evermann and Clark (1931: 47) listed, for southern California, only the report by Jordan and Evermann.

The most recent capture known to me of an adult lamprey in California south of Ventura County was reported by Ewy (1945):

> An adult lamprey measuring 514 mm. in length was found in an irrigation pipe-line by W. R. Newsom after it had passed through three miles of 30 inch pipe, along with water from Cate Dam, before it came through the head valve.

Although I was unable to check the identification of this specimen, now reportedly lost, its size seems to assure identification as *Entosphenus tridentatus*. Ewy further noted the collection in San Gabriel River during 1943-44 of 3 ammocetes (not yet identified). Several ammocetes from San Gabriel and Santa Ana rivers collected in the 1950's and earlier appear to represent an undescribed nonparasitic species of *Lampetra* with fewer than 65 trunk myomeres.

It seems probable that lampreys no longer persist in the dwindling Los Angeles, San Gabriel, and Santa Ana rivers (the somewhat interconnected "Santa Ana system of streams" of Culver and Hubbs, 1917), within which only pockets remain of the native fish fauna that these authors listed. An intensive effort by Keith W. Radford and party from Scripps Institution to collect any indigenous fishes in these streams, on the Los Angeles Plain, in May and June, 1962, yielded introduced fishes only. Here, as over much of the West, depletion of the waters and the introduction of more aggressive Eastern fishes have rapidly brought the native fish fauna to or beyond the brink. I have found no evidence of any lamprey occurrence at anytime in coastal streams south of the Los Angeles Plain.

Entosphenus tridentatus appears to have fared less badly in the streams of the Ventura Basin, through which the Ventura and Santa Clara "rivers" and several creeks flow, or once flowed, into the sea. Through the cooperation of James A. St. Amant, of the Chino Fisheries Base of the state Division of Fish and Game, Keith W. Radford secured three recently collected specimens from this basin in June, 1962. All came from Sespe Creek, a tributary of Santa Clara River, about 3 miles north of Fillmore (which is near the stream junction), in Ventura County. One, an advanced ammocete 124 mm long (SIO 62-273-4) had been taken by Don Haase on or about June 1, 1962, in mud at the base of a filter screen in an irrigation-diversion channel. Another, a spent male in early stage of necrosis (with tips of disc-tooth cusps worn through, and skin slightly damaged), 455 mm long (SIO 62-272-4), had been saved by Don Goodenough on April 29, 1962, from 1 mile below check dam. The third specimen, a spent male more advanced in necrosis (with disc-tooth cusps obliterated, posterior marginals and all but central posterior circumorals shed, laterals too eroded to count cusps, and skin rather massively damaged), 502 mm long (SIO 62-274-4), had been secured by Don Haase on or about May 25, 1962, in the creek near check dam.

The dates on which the males were taken suggest that this lamprey spawns in Sespe Creek in late March or in April, and that it migrates into and up Santa Clara River during brief periods in the winter, when the depleted surface waters reach the sea.

According to Sidney B. Peyton (personal communication to W. I. Follett, April 17, 1964), lampreys as long as two feet occurred many years ago in Sespe Creek upstream to about four miles above Henley's Camp (which is about four miles in a northerly direction from Fillmore). An adult specimen (UMMZ 133774) was seined by R. G. Miller and W. I. Follett on May 4, 1941 in the lagoon at the mouth of Santa Ynez River, Santa Barbara County.

OTHER RECORDS OF THE PACIFIC LAMPREY AT SEA

Considering the vast hordes of *Entosphenus tridentatus* that at various sizes migrate up many coastal streams of the North Pacific to spawn, there are relatively few records from the sea, and I have found none for south of Monterey Bay, the southernmost region of known major stream runs. Following are the reports I have noted, in order from south to north:

Monterey Bay, California: Jordan and Gilbert, 1881a: 30; 1881b: 458; Gilbert, 1895: 395; Rutter, 1908: 119.

San Francisco Bay, California: Girard, 1858: 378-379.

San Pablo Bay, California: Evermann and Latimer, 1910: 132.

Off Oregon (midwater-trawled): Pearcy, 1964: 87.

Puget Sound: Starks, 1911: 206.

Off Barkley Sound 24 miles, British Columbia: Clemens and Wilby, 1946: 47; 1961: 68-69.

Vicinity of Coal Harbour, British Columbia (4 in stomach of a sperm whale; unidentified, but presumably *E. tridentatus*): Pike, 1950: 27-28.

Strait of Georgia, British Columbia (preying on salmon): Fraser, 1921: 50.

Off Queen Charlotte Islands, British Columbia (large specimen from stomach of sperm whale): Pike, 1951: 279.

Vicinity of Skeena River mouth, British Columbia (in stomach of harbor seal): Fisher, 1952: 39.

Aleutian area (5 taken on high seas): Larkins, 1964: 288-289.

Bering Sea (5 from stomach of a fur seal): Lucas, 1899: 67-68; Jordan and Gilbert, 1899: 434.

Bering Sea, Soviet portion (in stomach of sperm whales): Svetovidova, 1948.

Further evidence on the oceanic activities of *Entosphenus tridentatus* off British Columbia has been provided by scars on various fishes and whales showing the imprint of the diagnostic dentition of this lamprey (Pike, 1951; 1953). Nemoto (1955) has also dealt with lamprey scars on whales in the northwestern Pacific. He attributed marks to *E. tridentatus*, and one of his figures does indeed seem to exhibit the characteristic dentition of this species. Trophic relations are complicated by the circumstance that the lamprey feeds on the blood of the sperm whale, which in turn eats the lamprey!

CHARACTERS OF THE BAJA CALIFORNIA AND SOUTHERN CALIFORNIA SPECIMENS

Characters of the Baja California juvenile, of the two spent adults and the one ammocete from Sespe Creek, California, and of the one maturing male from Santa Ynez River, were determined, in the hope that the data (Table 1) will prove useful when *Entosphenus tridentatus* is subjected to the urgently needed racial analyses. It is already evident that this species, like salmon and some other anadromous fishes, comprises a multitude of races, the members of which differ sharply in body size and to some extent in meristic and morphometric features. Methods of counting and measuring and the tooth nomenclature follow those promulgated by Hubbs and Trautman (1937: 27-40).

The juvenile from off Baja California differs markedly from the three adult specimens herein reported in the shorter tail, and smaller anterior parts (of head and branchial regions), except for the much larger eye, which is a holdover from the macrophthalmia stage. Because the anterior and posterior parts are smaller in the juvenile, the trunk must be relatively longer. Apparently the abdominal region grows with negative allometry, in contrast with the positive allometry of this region, seemingly related to fecundity, in many fishes, including the dwarf pelagic shark, *Euprotomicrus bispinatus* (Hubbs, Iwai, and Matsubara, 1967). Perhaps the relatively large abdomen of the juvenile lampreys represents an evolutionary response to the advantages of rapid growth due to occasional gorging with blood. The dorsal fins of the sea-caught juvenile are lower and less nearly contiguous, as expected. Most or all of these morphometric differences probably reflect ontogenetic change.

The incomplete tooth counts in the senile males prevent a full comparison with the ocean-taken juvenile. The cusps on the lingual laminae had remained sharp, presumably because the laminae are not rubbed against stones in the breeding activities.

The dentition of the sea-caught juvenile and the Santa Ynez River maturing male furnished complete tooth and cusp counts. In an unpublished variational analysis of dentition in the species I have found sharp racial difference in tooth and especially in cusp counts.

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[1] Methods of counting and measuring and nomenclature of teeth follow specifications of Hubbs and Trautman (1937: 27-43).

[2] Outermost teeth.

[3] Median cusp bifid.

[4] Including the 3 lingual laminae.

[5] Outermost on left side with small cusp at inner base, outermost on right side with median cusp slightly bicuspid at extreme tip.

TABLE 1

Counts and measurements of specimens of *Entosphenus tridentatus* from southern part of its range[1]

Location	Off Baja Calif.	Sespe Creek, California			Santa Ynez R.
Catalog number	SIO 67-22-4	SIO 66-272-4	SIO 66-274-4	SIO 66-273-4	UMMZ 133774
Stage	Young adult male	Early necrotic male	Late necrotic male	Ammocete	Maturing male
Weight, g (preserved)	7.5	220	215	2.3	414
Total length, mm	170	455	502	124	575
Proportions (per mil):					
Tail length	285	308	299	315	327
Body depth	80	98	63	60	81
Eye length	30.0	21.2	21.7	—	13.2
Snout length	79	93	83	—	79
Disc length	59	70	62	—	50
Over gill-openings	109	134	129	148	111
Height first dorsal:					
With fleshy base	26	44	44	6	26
Without fleshy base	22	33	31	6	21
Height second dorsal:					
With fleshy base	38	70	57	10	35
Without fleshy base	34	59	51	10	45
Length first dorsal	152	154	165	148	158
Length second dorsal	208	275	261	—	276
Width supraoral (base)	21.2	23.3	23.9	—	19.3
Width infraoral (base)	30.0	28.4	28.3	—	23.0
Counts:					
Trunk myomeres	68	69	68	70	60
Supraoral cusps	3	3	3	—	3
Infraoral cusps	5	5	5	—	5
Cusps on laterals (each side)	2-3-3-2	2-3-3-2	—	—	2-3-3-2
Anterior circumorals	5	5	—	—	5
Posterior circumorals	19	18	—	—	17
Bicuspid posterior circumorals[2]	1 + 1	1 + 0?	—	—	1 + 1[5]
Total circumoral teeth	32	31	—	—	30
Total circumoral cusps	46	44	—	—	44
Outer disc teeth (all anterior)	8	—	—	—	8
Cusps on transverse lamina	8+2[3]+7	9+1+9	9+1+9	—	8+1+8
Cusps on longitudinal laminae	25—23	—	—	—	26—23
Marginals	53	58	—	—	54
Total teeth[4]	98	—	—	—	97
Total cusps[4]	180	—	—	—	180

Nomenclatural Considerations

The trunk myomere counts of 68 to 70 (Table 1) in the 4 southernmost specimens herein treated fall within the range of 68-74 ascribed by Creaser and Hubbs (1922: 6) to a northern, nominate subspecies (*E. t. tridentatus*) and outside the range of 57 to 67 ascribed by them to a southern subspecies, which they called *E. t. ciliatus* (Ayres), with an indicated geographical range from southern Oregon to southern California. But later I (1925: 592) found a range of 67 to 76, usually 70 to 74, in a series from Coyote Creek in central California. The low count of myomeres ascribed to a southern subspecies in 1922 now appears to be attributable in part to the inclusion of counts on ammocetes from southern regions that were wrongly referred to *Entosphenus tridentatus*, whereas they actually represent a few-segmented, as yet apparently unnamed, nonparasitic species of *Lampetra* that ranges (or until the last few years did range) southward into southern California. The low values that now seem erroneously to have been held characteristics of a southern form of *E. tridentatus* may also have resulted from miscounts of the myomeres in poorly preserved specimens, in which the number of muscle bands are extremely difficult to enumerate by counting the superficial folds. Reliable counts on the two somewhat necrotic males from Sespe Creek and the maturing adult from Santa Ynez River could not be obtained until the skin had been cut and reflexed far enough to expose the lateral muscles.

It will be found, I believe, that some races within the species do differ in the average number of muscle bands on the trunk, as some species of *Ichthyomyzon* do (Hubbs and Trautman, 1937: 28-29), but, as of now, there is no valid ground for separating a northern and a southern subspecies of *E. tridentatus*. After this prediction was made, an adult from Santa Ynez River (although located between Coyote Creek and Sespe Creek, wherein high counts seem to prevail) was found to have only 60 trunk myomeres, seemingly outside the range for the other stocks.

The species name *tridentatus* is commonly attributed to Richardson (1836: 293-294), but should, I agree with W. I. Follett (personal communication), be assigned to Gairdner. Richardson listed "Petromyzon tridentatus. Gairdner, *in lit.*" in the synonymy of "Petromyzon tridentatus. (Gairdner.)." He stated that "Dr. Gairdner gave it the name of *tridentatus*, from the upper side of the maxillary ring being armed with three conspicuous and contiguous teeth, of which the middle one is the smallest" [a main diagnostic feature of the species]; and directly quoted Gairdner's description of the color. These circumstances seem to fulfill adequately the stipulation of Article 50 of the International Code of Zoological Nomenclature that a person other than the author of the publication was "alone responsible both for the name and the conditions that make it available." Consequently, and in accordance with a not-too-felicitous provision in the International Code, the species name, when given with the author, should read *Entosphenus tridentatus* (Gairdner in Richardson).

In his revision of the lampreys of the Northern Hemisphere Berg (1931) restricted *Entosphenus* to *E. tridentatus* and referred to *Lampetra* other species having the circumoral row of teeth complete (with a posterior commissure joining the last pair of laterals). Bailey, et al. (1960: 6) carried the action farther by completely synonymizing *Entosphenus* with *Lampetra*. Berg's action was apparently taken on the assumed indication that the criterion of presence or absence of the posterior circumorals is unstable, but some of the very specimens figured by Berg to emphasize this point proved, after having been sent to me at The University of Michigan, to be incompletely transformed individuals in which the posterior circumorals had not yet erupted through the gum (but were visible on close inspection). The presence or absence of these teeth seems to provide a valid basis for generic separation, and it further seems advisable to recognize as genera the three taxa proposed as subgenera of *Entosphenus* by Creaser and Hubbs (1922: 6), namely (1) *Tetrapleurodon*, already so treated by Alvarez (1966), (2) *Lethenteron*, and (3) *Entosphenus* proper, comprising *E. tridentatus* (perhaps a species as well as racial complex) and its as yet unnamed nonparasitic geminate, of the Klamath and Sacramento river systems on either side of the Oregon-California line. The separation of these three phyletic lines seems to have been fundamental and of long standing, appropriately to be indicated by generic recognition.

SUMARIO

Un ejemplar de pez anádromo, la lamprea del Pacífico *Entosphenus tridentatus*, se recogió en una abundante pesca pelágica con trawl, frente a Baja California, México; en aguas oceánicas frias, de afloramiento. Este ejemplar indica una definida extensión meridional de la distribución en el Pacífico oriental, del género, la especie y también de la correspondiente familia. No es posible determinar con certeza la población original de donde procedería este ejemplar. Esta especie y una especie de *Lampetra* libre, no parásita (probablemente sin describir todavía) se encontraban en los riachuelos de la cuenca de Los Angeles, hasta que en fecha reciente han sido probablemente eliminados de esa región. Sin embargo, *E. tridentatus* se encuentra todavía en los riachuelos de la cuenca de Ventura, también en el Sur de California. Las observaciones de *E. tridentatus* en aguas oceánicas son muy escasas, y ninguna corresponde a la zona costera al Sur de la Bahía de Monterey, California. Se estima necesario llevar a cabo estudios sobre las razas de esta especie. La división de la especie en la subespecie septentrional y la meridional, no se considera aceptable. La designación adecuada de la especie y su autor es *Entosphenus tridentatus* (Gairdner en Richardson). Se encuentra justificado que el género *Entosphenus* se separe del género *Lampetra;* y así mismo se recomienda que se admitan como géneros junto con *Entosphenus* (que incluye un derivado no parásito todavía sin describir), a los subgéneros *Tetrapleurodon* y *Lethenteron*, que habían sido propuestos por Creaser y Hubbs como subgéneros de *Entosphenus*.

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BIOSYSTEMATICS OF *HEERMANNI* GROUP KANGAROO RATS IN SOUTHERN CALIFORNIA

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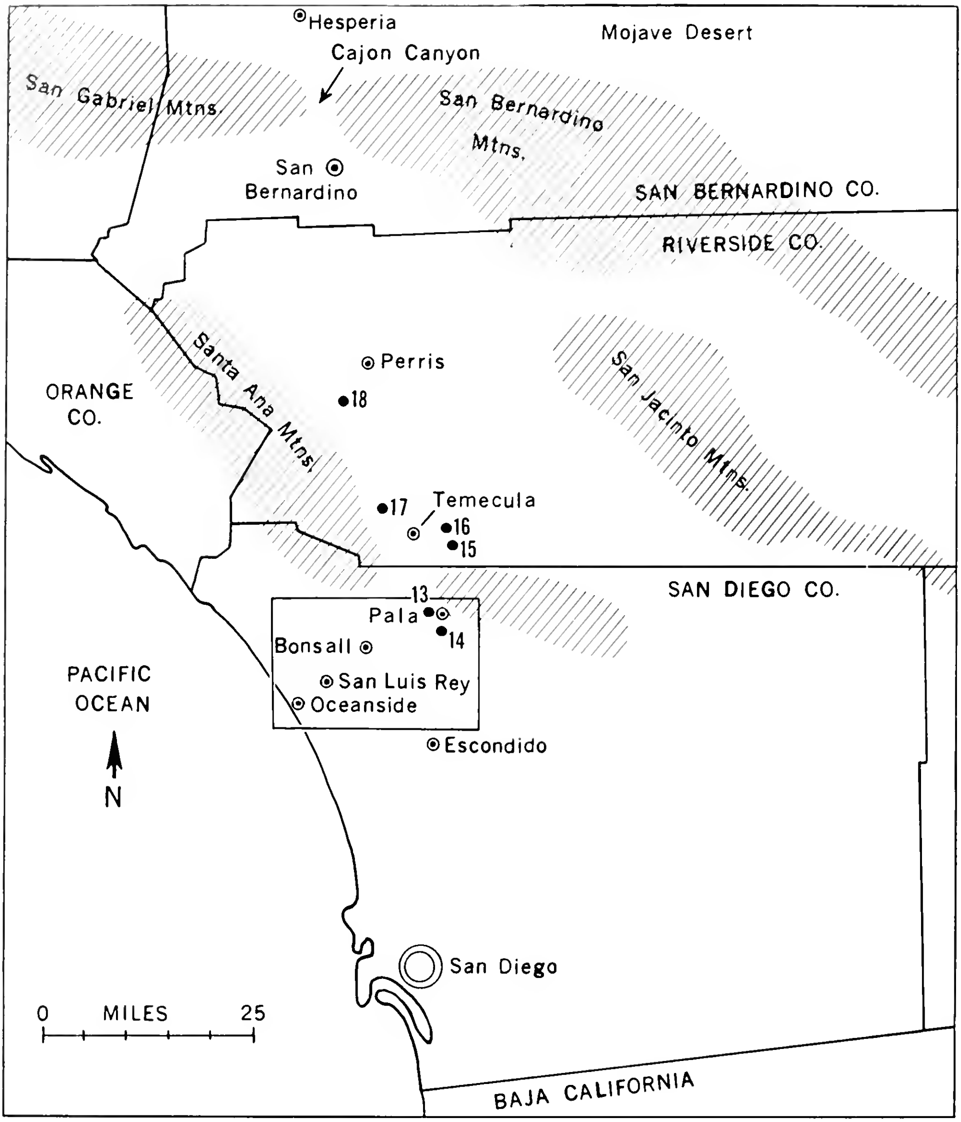

Figure 1. Region of Southern California showing major geographical features and several collecting localities. Numbers refer to localities listed in Table 2. Area within inset is shown in detail in Figure 2.

BIOSYSTEMATICS OF *HEERMANNI* GROUP KANGAROO RATS IN SOUTHERN CALIFORNIA

BY

JAMES A. LACKEY[1]

ABSTRACT

The relationships of *Dipodomys cascus*, *D. stephensi*, and *D. agilis* are analyzed statistically by a multiple range test; *D. antiquarius* is treated separately. Differentiation among the populations of *D. cascus* and *D. stephensi* is less than that between two subspecies of *D. agilis* that occur sympatrically with them. Thus, *D. cascus* is placed in synonymy with *D. stephensi*, which is considered a monotypic species. The populations of *D. cascus* and *D. stephensi* studied appear to have evolved independently; the most distinct populations are the closest geographically. Geographical designation for these populations is advocated. *Dipodomys antiquarius* should be placed in the same group of species as *D. agilis*, and not with *D. stephensi* as originally proposed. Cranial dimensions and qualitative characters of *D. antiquarius* suggest a close relationship with *D. peninsularis*.

Dipodomys stephensi occurs almost exclusively in open areas, but *D. agilis* occurs in chaparral. These species seldom occur together but sometimes are found abundantly in adjacent habitats. Probably vegetational change, rather than unsuccessful competition with *D. agilis*, accounts for the isolation of the *D. stephensi* populations. The narrow-faced group of kangaroo rats may have evolved from an arid-dwelling *heermanni* stock in Baja California. Increased adaptation to habitats with more vegetation allowed some species to invade the California chaparral community.

This investigation was undertaken initially to clarify the systematic relationships and distribution of the kangaroo rat species *Dipodomys cascus* and *D. stephensi*. These morphologically similar species occur as isolated populations restricted to small areas in northern San Diego County, western Riverside County, and southwestern San Bernardino County, California. The sympatry of these populations with those of the widely distributed *D. agilis* led to an ecological study of all three species.

Dipodomys cascus was described by Huey (1962) on the basis of two specimens from a locality in northern San Diego County. He considered this species a member of the *heermanni* group, characterized as "broad-faced," as defined by Grinnell (1922). The *heermanni* group arrangement has been modified by Lidicker (1960*a*) to include broad-faced and narrow-faced species, with broad-faced species constituting Subgroup A and narrow-faced species Subgroup B. Under this system, *D. cascus* would be included in Subgroup A, along with *stephensi*, *heermanni*, *ingens*, *panamintinus* and *gravipes;* Subgroup B includes *agilis*, *venustus*, *elephantinus*, *paralius* and *peninsularis*.

Dipodomys stephensi occupies a limited region in southwestern San Bernardino County and western Riverside County that is almost entirely encircled by mountain ranges (Fig. 1). This species was described by Merriam (1907) and named *Perodipus stephensi;* the generic name was changed to *Dipodomys* by Grinnell (1921), who considered all kangaroo rat species to represent a single genus.

Huey (1962) also described *D. antiquarius* from a series of eight specimens collected at a single locality in central Baja California. Since *D. stephensi* was believed to be the closest relative of both *D. cascus* and *D. antiquarius*, the latter would also be included in Subgroup A of Lidicker (1960*a*). A systematic study of *D. antiquarius* was undertaken because the disjunct nature of its distribution would have considerable bearing on an understanding of the systematics and biogeography of *heermanni* group species.

A sympatric relationship between broad-faced and narrow-faced species occurs frequently throughout much of the range of these groups. In Baja California, *D. gravipes* and *D. agilis*

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simulans are sympatric in the region of Santo Domingo and San Quintin; in California, *D. cascus* and *D. a. simulans* are found together in San Diego County; in Riverside County, *D. stephensi* and *D. agilis* are sympatric; along the western edge of the Mojave Desert the ranges of *D. panamintinus* and *D. agilis perplexus* overlap slightly; in Santa Barbara County the ranges of *D. heermanni arenae* and *D. agilis fuscus* overlap; farther north the narrow-faced species *D. elephantinus* and *D. venustus* are sympatric in parts of their ranges with subspecies of *D. heermanni*.

An ecological study conducted concurrently with the systematic investigation has clarified the over-all relationships of these groups and has allowed some speculation on the biogeography of the *heermanni* group and on the phylogeny of the narrow-faced species.

Analytical procedures in this study are based primarily on statistical and qualitative comparisons of both sympatric and allopatric populations. This analysis, which includes both intraspecific and interspecific variation, attempts to provide a basis for future systematic studies in this genus.

MATERIALS AND METHODS

Kangaroo rats were collected at 18 localities in northern San Diego and western Riverside counties, California, between December, 1962 and March, 1967. These localities were in areas of known occurrence of *Dipodomys cascus* and *D. stephensi*. but also included intervening areas from which specimens had not previously been taken. An attempt was made to sample the full range of habitats occupied by kangaroo rats in each area.

Animals were collected by hand nets and by trapping. Hand nets were used in areas where a vehicle could be driven at night. When a kangaroo rat was seen in the headlights, the vehicle was stopped and the animal was netted. The net had a fourteen-inch stiff wire hoop with a bag of muslin sewn to it, and a five-foot bamboo handle. This method was highly productive compared to trapping; as many as 36 animals were collected in seven hours. It also gave more information about specific areas of favorable habitat and periods of activity.

Collecting in areas inaccessible to vehicles was done by trapping, using aluminum Sherman live traps and Museum Special snap traps. Bait for live traps was rolled oats and for snap traps pieces of walnut. Live traps consistently yielded a relatively greater number of kangaroo rats.

Specimens collected during this study are now located in the collections of the San Diego Natural History Museum, San Diego State College, and the author. Additional specimens in the San Diego Natural History Museum were examined. The specimen of *D. cascus* from 5 miles northeast of Bonsall referred to by Huey (1962) and a series of *D. agilis simulans* were obtained from the Dickey Collection at the University of California, Los Angeles. A series of *D. panamintinus mohavensis* was loaned by the University of Michigan Museum of Zoology.

Only adult specimens were used in the study. Specimens were judged to be adult if the permanent premolars were worn sufficiently to obliterate the conspicuous juvenile folds and if the bullae were translucent.

The following external measurements, accurate to the nearest millimeter, were made on freshly collected specimens: total length, tail length, ear length (from notch) and hind foot length; body length was calculated by subtracting tail length from total length. Ear measurements of museum specimens usually were not considered, since this measurement was formerly taken from the crown to the tip of the ear, rather than from notch to ear tip. Skull measurements were made to the nearest 0.1 millimeter.

The bacula of nearly all males collected were cleared and stained in the manner described by Hooper (1958). A binocular microscope with ocular micrometer was used to measure bacula; readings were made to the nearest 0.01 millimeter. Illustrations of bacula were made with the aid of a camera lucida.

Skull measurement data for four broad-faced and two narrow-faced populations were analyzed by the multiple range test developed by Duncan (1955). With this technique it is possible to test simultaneously for significant differences between two or more means. Least significant ranges for a given number of means may be computed by first finding the standard error (square root of the residual mean square/number of specimens per sample) and multiplying this by the appropriate studentized value extracted from a multiple range table. The range is compared with the difference between the largest and smallest means in the group being considered. If the least significant range exceeds the difference between the extreme means, all the means are considered to be non-significant with respect to each other; that is, the samples for which the means were calculated could all have been drawn from the same population. If the least significant range is less than the difference between the largest and smallest means, the smallest mean is then eliminated and a new least significant range is then calculated for the remaining number of means. This new range is then compared with the difference between the remaining largest and smallest means; testing continues until the least significant range exceeds the difference between extreme means. This analysis leads to the identification of groups of means within which no significant differences exist and between which there are significant differences.

Means for the various skull measurements were analyzed and all populations were compared in pairs for each skull measurement. In the present study a 5 per cent level of significance was used. Critical values were extracted from the revised multiple range tables published by Harter (1960).

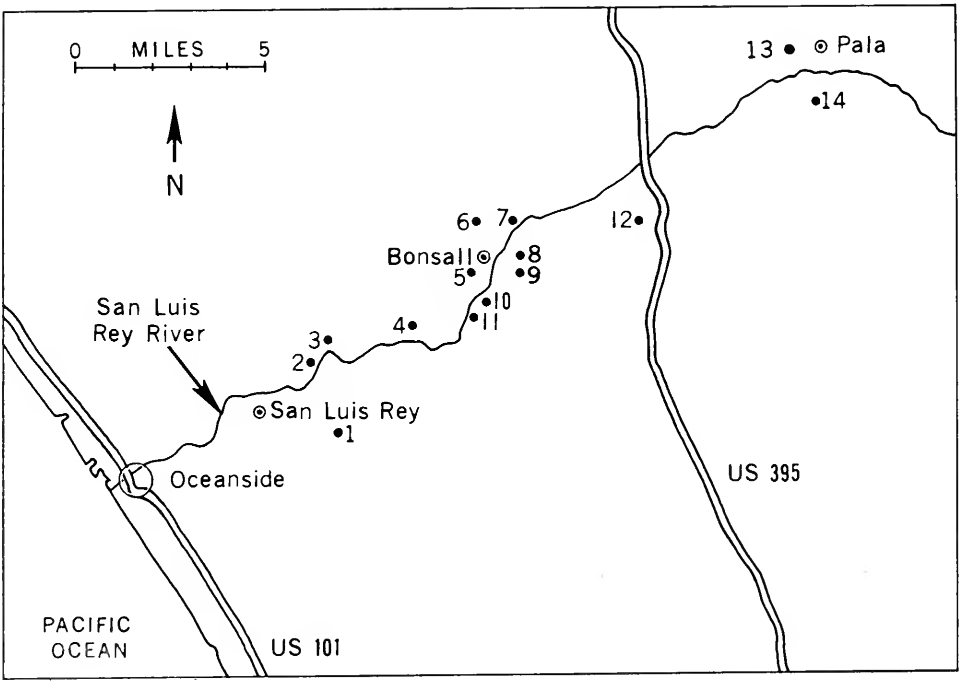

Figure 2. Collecting localities in northwestern San Diego County. Numbers refer to localities listed in Table 2.

RESULTS

Some of the 18 collecting localities from which specimens were obtained are shown in Figure 1 in relation to the major geographical features of the Southern California area. The region in which the remaining localities are found is shown on a smaller scale in Figure 2. The dates of collection at each locality are summarized by month and year in Table 1 (see Appendix I).

For this study 351 specimens were collected. Habitat characteristics and the number of individuals of each species collected are given in Table 2 for each of the 18 localities. Habitats were classified in the following categories to simplify ecological comparison of localities. (The term "chaparral" refers to vegetation consisting of evergreen, broad-leaved sclerophyll shrubs with chamise, *Adenostoma fasciculatum*, being the most abundant species.)

1. Vegetation consisting mostly of small, sparsely distributed annuals and grass, with widely spaced shrubs; topography flat to low, rolling hills; soil texture firm, neither extremely hard nor sandy.
2. Vegetation and topography as in 1; soil texture extremely hard but small areas of less dense soil.
3. Vegetation consisting of small annuals occasionally in dense patches, widely spaced shrubs, grassy areas; topography and soil texture as in 1.
4. Vegetation mixed, consisting of annuals, grasses, shrubs of various heights; topography flat; soil moderately to very sandy.
5. Vegetation consisting of both annuals and chaparral, with chaparral covering up to about twenty-five percent of the ground surface, space between shrubs sparsely filled with annuals; topography and soil texture as in 1.
6. Vegetation as in 5; topography hilly; soil texture as in 1.
7. Vegetation predominately chaparral, with shrubs covering up to approximately fifty percent of the ground surface; topography flat or hilly; soil texture as in 1.
8. Chaparral extremely dense and often tall (up to 2 meters), very few annuals, ground surface generally bare beneath shrubs; soil texture as in 1.

Precise locations of specimen capture at Bonsall (loc. 8) were recorded in most instances, but at other localities only habitat type was noted. Figure 3 illustrates the distribution of *D. agilis simulans* and *D. cascus* by habitat at locality 8.

In general, *D. cascus* and *D. stephensi* were found in habitats characterized by sparse vegetation, level or rolling topography, and soil that is neither extremely dense nor largely sand. In contrast, *D. agilis simulans* was most abundant where chaparral covers up to about half of the ground surface, and especially in those situations where the ground surface between shrubs is largely free of vegetation. *Dipodomys agilis simulans* was collected on steep hillsides as well as on level ground, and occasionally where the soil was very sandy. *Dipodomys cascus* and *D. stephensi* nowhere occurred in equal numbers with *D. agilis*. *Dipodomys agilis* was collected in all habitats except category two, but *D. cascus* and *D. stephensi* were found almost exclusively in categories one through three.

QUALITATIVE COMPARISONS OF THE POPULATIONS

Qualitative comparisons of various skull, baculum, and pelage characters were made for seven populations from which large samples were obtained and are summarized in Table 3. For these comparisons series of 10 males and 10 females were selected, randomly when more than 10 of each sex were available. The following localities were represented (numbers refer to localities listed in Table 2; specimens from localities not indicated by a number were obtained from the San Diego Natural History Museum): *D. cascus*, 1, 8; *D. stephensi*, 15 and 16 (grouped), 18 and 4 miles SW Perris (grouped); *D. agilis simulans*, 10 and 11 (grouped); *D. a. agilis*, 5 miles NW San Bernardino and 4 miles SW Perris (grouped); *D. antiquarius* (three males and three females), San Juan Mine, Sierra San Borja, Baja California, Mexico.

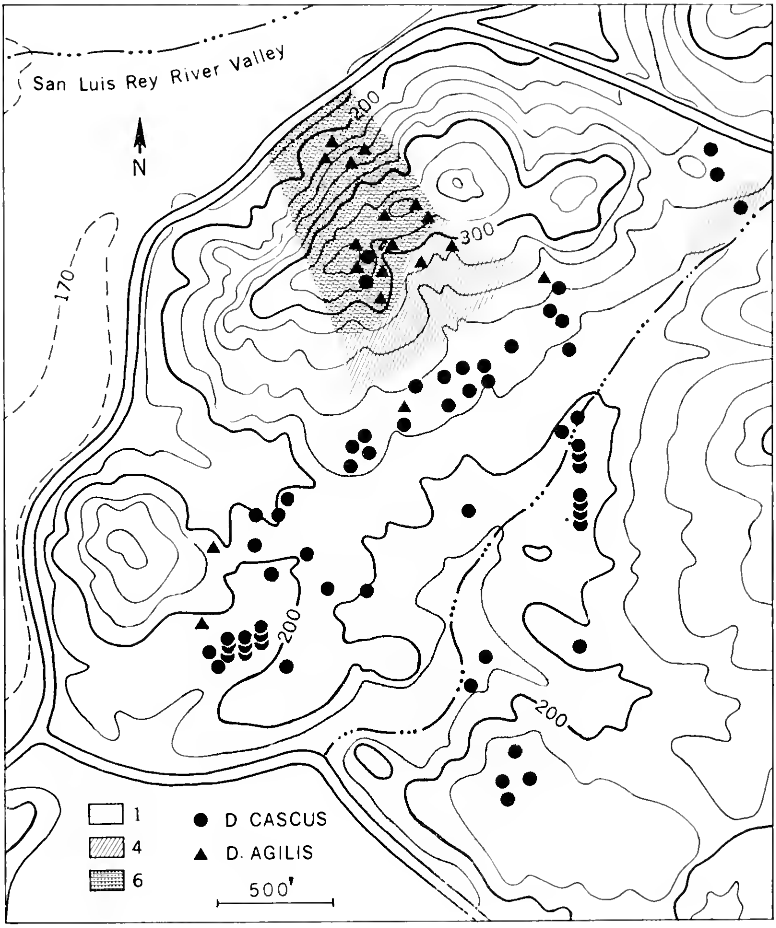

Figure 3. Habitat categories and sites of individual kangaroo rat captures one mile east of Bonsall (locality 8). Categories are described in the text. Collecting was undertaken only in shaded area.

Unless otherwise indicated, the series of *D. stephensi* from locality 18 and 4 miles SW Perris will hereafter be referred to as "loc. 18" or "Perris."

Primarily to facilitate discussion of the broad-faced populations, the San Luis Rey population will be referred to as *D. cascus*, as it is only six miles southwest of the type locality; the Temecula population will be referred to as *D. stephensi*, since it is immediately adjacent to the range of *D. stephensi* as described by several authors (Grinnell, 1933; Hall and Kelson, 1959; Huey, 1962).

Premaxillae and nasals. — In *D. agilis simulans* and *D. antiquarius* the suture between each nasal and the premaxilla lateral to it is straight in the caudal half of the rostrum; in *D. cascus* and *D. stephensi*, the extreme caudal portion of this suture and the premaxillae themselves curve medially (Fig. 4). Although the curvature in *D. stephensi* and *D. cascus* is somewhat variable, straight nasal-premaxilla sutures were not observed. The curvature in the Perris (loc. 18) and Temecula (loc. 15, 16) series is less pronounced than in the San Luis

Rey (loc. 1) and Bonsall (loc. 8) series. The suture is always straight in *D. agilis simulans*, but in half of the *D. a. agilis* specimens a very slight curvature was noted.

Auditory and mastoid bullae. — A qualitative characteristic used by Huey (1962) in describing *D. cascus* is the "squarish" outline of the mastoid and auditory bullae when viewed posteriorly. This appearance results from an extremely minor reduction of the lateral inflated portion of the auditory bullae. With more specimens from Bonsall (loc. 8) now available, it is evident that the degree of inflation is variable in *D. cascus* and should not be used as a criterion for distinguishing *D. cascus* from *D. stephensi*. A few specimens of *D. stephensi* from Perris (loc. 18) and *D. cascus* from San Luis Rey (loc. 1) show a similar reduction in inflation.

When viewed ventrally or dorsally, the bullae of *D. agilis* and *D. antiquarius* have an angular outline in contrast to the rounded outline in *D. cascus* and *D. stephensi*. This angularity arises in part from the ventrolateral inflation of the auditory bullae, particularly in the region immediately craniad to the auditory meatus. Also, each auditory bulla in *D. agilis* and *D. antiquarius* has a sharp craniolateral angle lateral to the base of the jugal, whereas the bullae in *D. cascus* and *D. stephensi* are rounded in this region. *Dipodomys antiquarius* showed the greatest auditory bulla inflation.

Jugals (malars). — The jugals of *D. cascus* show an outward curvature ranging from nearly straight, as in *D. agilis* and *D. antiquarius*, to strongly bowed. Jugal curvature is a characteristic used by Huey (1962) to distinguish *D. cascus* from both *D. stephensi* and *D. antiquarius*. The jugals of *D stephensi* from Perris (loc. 18) average less strongly curved than do those of *D. cascus* from Bonsall (loc. 8) but there is overlap in this character. In the *D. agilis* series from localities 10 and 11, the curvature in seven individuals is as strongly pronounced as in about half of the *D. cascus* from Bonsall; in the *D. agilis* series from locality 12 two individuals show this much curvature. Jugal curvature in *D. stephensi* from Temecula (loc. 15, 16) is identical to that in the *D. stephensi* from Perris.

Jugal base. — Except for approximately one-third of the specimens from Temecula (loc. 15, 16), all *D. cascus* and *D. stephensi* individuals have a broad, craniomedially directed posterior jugal base. *Dipodomys agilis* and *D. antiquarius* specimens have a narrow, cranially directed jugal base, even in those *D. agilis* which show jugal curvature.

Basioccipital. — In *D. cascus* and in *D. stephensi* from Perris (loc. 18), the basioccipital is narrow midway between the foramen magnum and the cranial end of the basioccipital. In contrast, in *D. agilis* and *D. antiquarius* the basioccipital flares laterally in this region, and is almost twice as wide as in *D. cascus* and *D. stephensi*. Basioccipital width in the *D. stephensi* series from Temecula (loc. 15, 16) varies from the *D. agilis* shape to the shape found in *D. cascus* and in *D. stephensi* from Perris.

Foramen magnum. — The shape of the foramen magnum dorsal to the occipital condyles differs among several of the populations studied. In *D. cascus* and *D. stephensi* this part of the foramen has a rounded dorsal perimeter, whereas in *D. agilis* and *D. antiquarius* the perimeter forms an acute angle. In each of the populations studied (except *D. antiquarius*) there were several exceptions.

Baculum. — Bacula of *D. antiquarius* were not available. There are no qualitative baculum differences between *D. cascus* and *D. stephensi* populations, but differences were found between the bacula of broad-faced and narrow-faced species. In *D. cascus* and *D. stephensi* the baculum (in natural position, with distal end of shaft directed upward, Fig. 5A, B) has an upward curvature near the middle of the shaft, followed distally by a downward curvature before the upturned tip is reached. In *D. agilis* (Fig. 5C), there is no discrete upward curvature in the middle of the shaft; rather, the shaft has a slight upward curvature throughout its length; the distal tip is more strongly recurved and lies at right angles to the main shaft axis.

PELAGE COLORATION AND PATTERN

Huey (1962) stated that *D. cascus* (from Bonsall) was darker than *D. stephensi* and had lighter colored sides than *D. agilis*. I consider the over-all pelage coloration of *D. cascus*

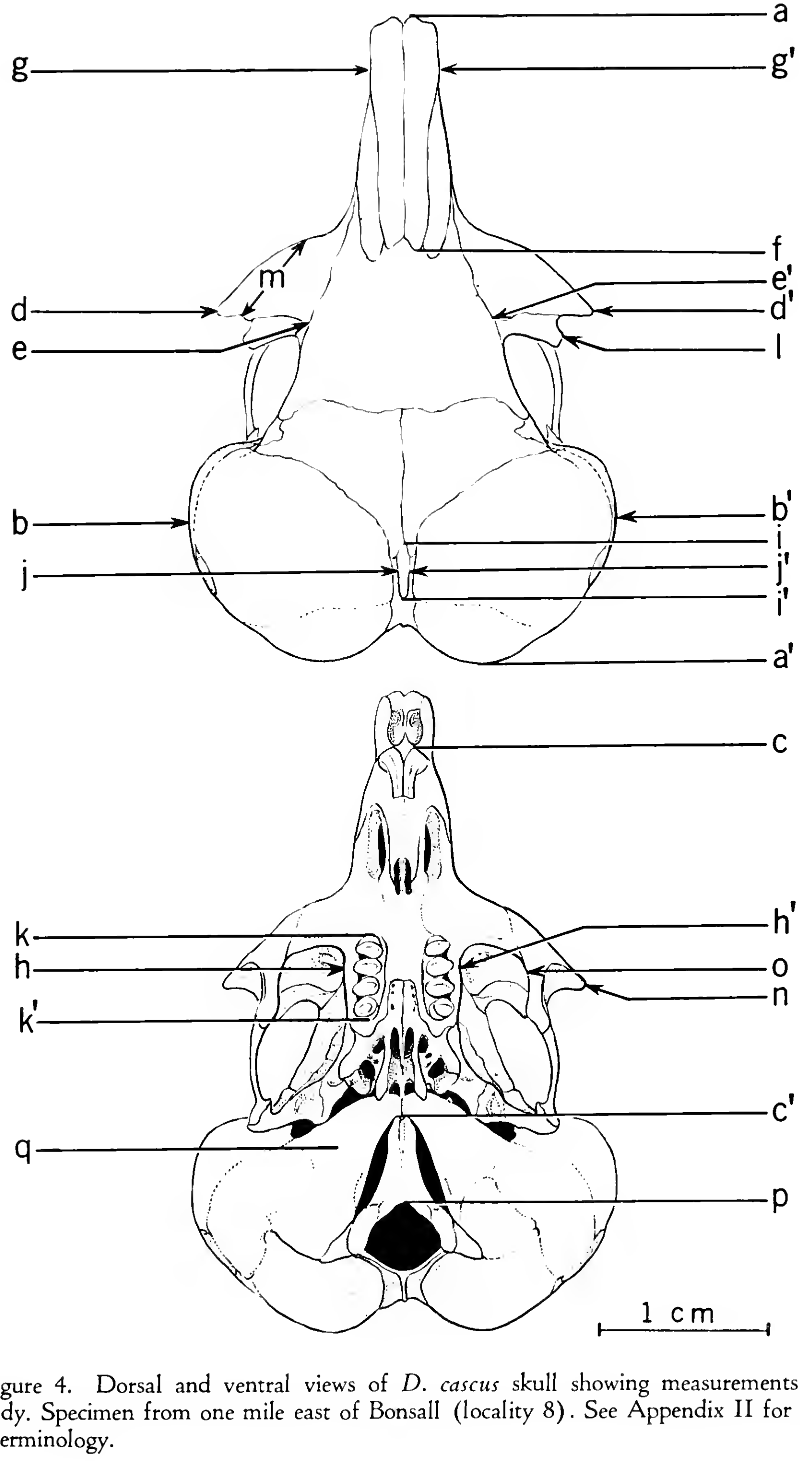

Figure 4. Dorsal and ventral views of *D. cascus* skull showing measurements used in the study. Specimen from one mile east of Bonsall (locality 8). See Appendix II for measurement terminology.

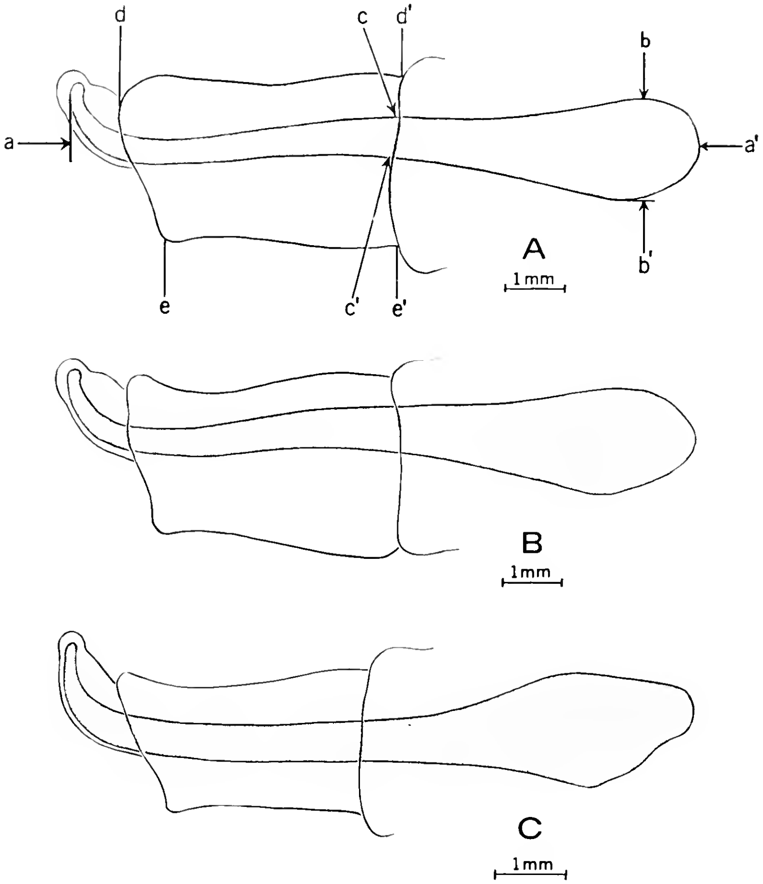

Figure 5. Bacula of (A) *D. cascus*, (B) *D. stephensi*, (C) *D. agilis simulans*. See Appendix II for measurement terminology.

and *D. stephensi* from all populations studied to be identical; both species have lighter colored sides than *D. agilis*. As reported by Huey (1962), the pelage coloration of *D. antiquarius* is much lighter than that of *D. agilis*, *D. cascus* or *D. stephensi*. The hind foot soles of *D. cascus* and *D. stephensi* are dusky, as described by Grinnell (1922) for *D. stephensi*; in *D. agilis* and *D. antiquarius* they are relatively dark.

A difference in tail coloration pattern was noted between some of the species. The dorsal and ventral black tail stripes in *D. cascus* and *D. stephensi* are indistinctly demarcated from the lateral white stripes, whereas in *D. agilis* and *D. antiquarius* the demarcation is sharp. Also, the lateral white stripes in *D. cascus* and *D. stephensi* are narrower than in *D. agilis* and *D. antiquarius*. The width of the white stripes in *D. cascus* from both populations is more variable than in the other species. Width ranged from that found in *D. agilis* to complete absence of the stripe in one specimen from each of the two main *D. cascus* populations. *Dipodomys* with solidly colored tails have not been previously reported (*cf.* Grinnell, 1922; Huey, 1962). The tail tuft in *D. cascus* and *D. stephensi* contains few white hairs, whereas in *D. agilis* and *D. antiquarius* there are many white hairs. The dorsal and ventral black stripes of *D. cascus* and *D. stephensi* contain many hairs with white bases, giving the stripes a faintly grizzled appearance; in *D. agilis* and *D. antiquarius* these stripes have at most only a few such hairs.

QUANTITATIVE COMPARISONS OF THE POPULATIONS

Quantitative comparisons, utilizing the multiple range test described earlier, were undertaken for four broad-faced and two narrow-faced populations. The small sample of *D. antiquarius* is treated separately. Significant differences of means as determined by the multiple range test are those occurring at the 5 per cent level of significance. With respect to baculum measurements, differences between sample means are considered significant when there is no overlap of two standard errors of one mean with two standard errors of another mean.

Table 4 summarizes external and skull measurements for the six Southern California populations studied in detail, and Table 5 gives the measurements for *D. antiquarius*. Tail length was frequently unusable because of damage during life or during specimen preparation. Ear length was sometimes not recorded in older museum specimens or was measured in a manner differing from current practice. The requirement of the multiple range test — that all samples contain the same number of variates — together with the large error associated with making external measurements, made statistical treatment of these data impossible. However, it is evident that ear length is greater in *D. agilis* than in *D. cascus* or *D. stephensi*. Also, it appears that tail length is greater and body length less in *D. agilis*, especially *D. a. agilis*. Mean hind foot length is greatest in the *D. a. agilis* sample.

Standard deviation and standard error calculations were made for baculum length, ratio of baculum base width to height, ratio of shaft width at middle to shaft height, and the ratio of glans penis ventral length to dorsal length (Table 6). Baculum data were not corrected for individual size variation among specimens, since body size differences did not appear to be of sufficient magnitude to materially alter baculum length differences between species; other baculum measurements were combined into ratios.

A striking distinction between the bacula of *D. agilis* and the broad-faced population is length, a difference noted by Boulware (1943) and Burt (1960) when they compared *D. agilis* and *D. heermanni*. There appear to be no statistically significant differences in baculum length among the samples of *D. cascus* and *D. stephensi*.

When baculum base width is compared to base height, *D. agilis simulans* is found to possess a nearly circular base (ratio is near 1.0). The Temecula (loc. 15, 16) and Bonsall (loc. 8) samples of *D. stephensi* and *D. cascus* differ significantly from *D. agilis simulans* in this respect, but the San Luis Rey (loc. 1) and, possibly, the Perris (loc. 18) samples do not. Therefore, base dimensions do not provide reliable criteria for distinguishing between populations in this study, although the base has been used in other studies of kangaroo rat systematics (Burt, 1936, 1960; Lidicker, 1960*b*).

Except for the Temecula sample, the shaft width-height ratio at the middle of the baculum is significantly different between the broad-faced populations and *D. agilis simulans*. In all samples, baculum height of shaft is much greater than width.

Dipodomys agilis simulans differs from *D. cascus* and *D. stephensi* in the ratio of glans penis ventral length to dorsal length, but there are no apparent differences among the broad-faced populations.

In comparing the populations of kangaroo rats I tried to correct for variation arising from normal size differences among individuals in a population and variation resulting from mean size differences between populations. Specific reasons for taking this measure and the procedures employed are discussed later. Analysis of variance results for actual measurements are presented in Table 7 and for corrected measurements in Table 8. Table 9 was prepared to permit comparison of means of corrected measurement data for the six populations studied.

Populations were compared in all possible combinations of pairs for significant differences for each of the sixteen measurements tested with the multiple range test. Differences between broad-faced populations and between narrow-faced populations are indicated in Table 10. In Table 11, broad-faced and narrow-faced populations are compared for significant differences, with the populations pairs arranged to show any interaction which might exist between species as a result of sympatry.

Since statistical treatment of *D. antiquarius* data was not feasible owing to small sample size, a comparison of ranges and means of measurements for three characters was made between *D. antiquarius* and some representative members of the broad-faced and narrow-faced groups occurring in Southern California and Baja California (Figs. 6 and 7). Data for the subspecies of *D. agilis* and *D. peninsularis* are from Huey (1951).

Huey (1962) considered *D. stephensi* to be the closest relative of *D. antiquarius*, basing his decision primarily on maxillary arch characteristics; however, *D. antiquarius* is shown here to differ markedly from *D. stephensi* in maxillary arch width, and, to a lesser extent, in spread of the maxillary arches. Mean skull breadth of *D. antiquarius* (and, therefore, bullar inflation) is nearly as great as that of any *D. peninsularis* subspecies; this is noteworthy because the bullae in *D. peninsularis* are considered to be extremely inflated (Huey, 1951). In his description of *D. antiquarius*, Huey (1962) pointed out the greater inflation of the bullae in this species than in *D. stephensi*, but did not compare *D. antiquarius* and *D. peninsularis* in this characteristic or any other.

DISCUSSION

CORRECTION FOR INDIVIDUAL SIZE VARIATION

A body-size correction was applied to all cranial measurements used in the multiple range tests, because much of the measured variation within and between populations is a simple function of body size differences of individuals. Although the growth rate of young kangaroo rats declines sharply at three months (Butterworth, 1961), individuals continue to grow at a slow rate throughout life. Since kangaroo rats may live five or six years, considerable variation in body size is possible. A few specimens deviating markedly in size from the average can contribute to a large residual variance in an analysis of variance test. Furthermore, collections made at different times of the year could show differences in average age and, thus, in size of individuals. To minimize this variation, each of the sixteen cranial measurements for each skull was divided by the basal length of the skull for that specimen. Basal length was selected as a standard for several reasons: (1) the measurement is large and can be determined accurately; (2) the measurement includes many greatly fused bones which, it would seem, are not as likely to vary individually as could bones near the skull periphery where contact between bones is minimal; (3) basal length did not vary significantly among the six populations examined (Table 7), suggesting that there are no population differences in size itself. Total skull length is not suitable because it includes the nasals and mastoid bullae, both of which vary significantly among the populations studied. Basioccipital length was not included in basal length for the same reason.

DIFFERENTIATION AMONG THE *D. cascus* AND *D. stephensi* POPULATIONS

The degree of morphological differentiation attained by each of the four broad-faced populations was determined by analyzing both quantitative and qualitative differences occurring among them. The multiple range test revealed significant differences in nine characters among the four broad-faced populations. When these populations were compared in the form of population pairs (Table 10) 25 differences out of a possible 96 were found. Eleven of these are attributable to variation in maxillary arch characters, which include spread of maxillary arch, lacrymal length, maxillary arch width, projection of maxillary arch and suborbital distance.

The Bonsall (loc. 8) and San Luis Rey (loc. 1) populations (A and B in Table 10), although closest geographically, are the most distinct. It is possible that the Bonsall population is the most distinct of the four, for if this population is not considered there are 10 differences among the remaining three population pairs. Other such combinations of three population

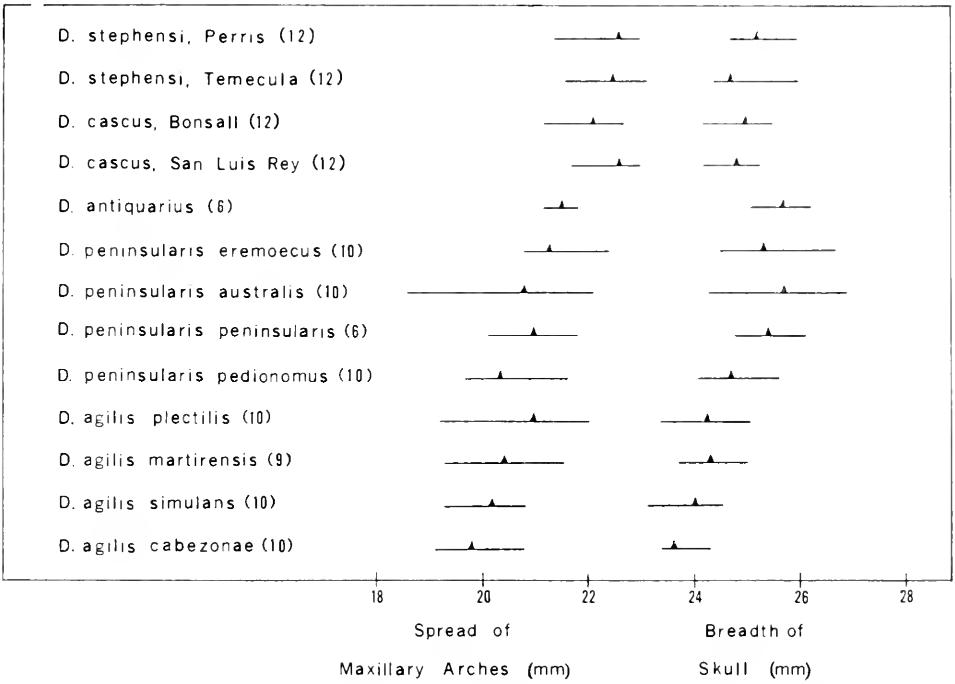

Figure 6. Comparisons of spread of maxillary arches and breadth of skull. Horizontal line, range of values; triangle, sample mean. Numbers in parentheses indicate sample sizes. Samples include approximately equal numbers of males and females.

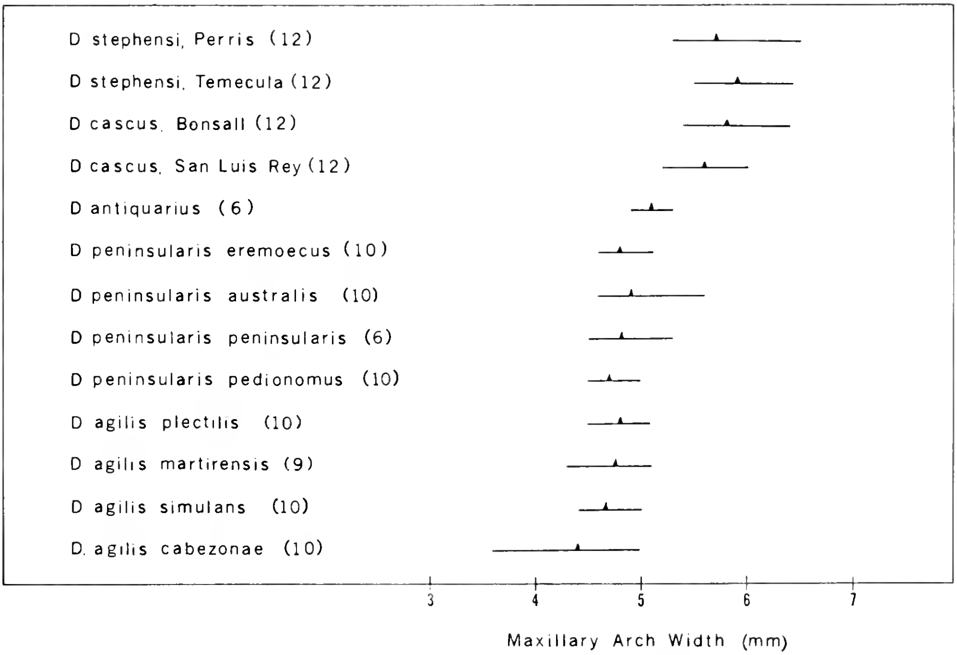

Figure 7. Comparison of maxillary arch width. Sample data as in Figure 6.

pairs include the Bonsall population and result in 12 to 14 differences. The Bonsall population is significantly different from the others in having shorter nasals and longer lacrymals. The San Luis Rey population differs from the others in having a shallower skull and wider interparietal.

Huey (1962) stated that the two specimens he had of *D. cascus* (loc. 8) had wider spreading maxillary arches than *D. stephensi* (from various localities in Riverside County). Measurements, not corrected for individual size variation, show a mean spread of 22.4 mm for both *D. cascus* (loc. 8) and *D. stephensi* (loc. 18). Means calculated from corrected values for the same populations do not differ significantly at the 5 per cent level of the multiple range test.

The baculum base ratio difference between the San Luis Rey and Bonsall populations of *D. cascus* is difficult to evaluate because few studies have been made previously on baculum morphology that include more than a few specimens. Although neither population is significantly different from the *D. stephensi* population at Temecula (loc. 15, 16) and, presumably, Perris (loc. 18) the ratios of the *D. cascus* populations relative to each other are significantly different. This same kind of relationship between the populations at San Luis Rey and Bonsall was also found in certain cranial measurements.

DIFFERENTIATION BETWEEN THE NARROW-FACED POPULATIONS

Dipodomys a. agilis and *D. agilis simulans* differ significantly in six cranial characters (Table 10). Nasal length is significantly greater in *D. a. agilis* than in *D. agilis simulans;* this represents part of the south-to-north cline in increasing nasal length in the narrow-faced group (see Grinnell, 1922, and Huey, 1951, for data on other species in this group). This cline extends, with few exceptions, from northwestern Baja California (*D. paralius*) to coastal central California (*D. elephantinus* and *D. venustus*).

Although nasal width is greater in *D. a. agilis* than in *D. agilis simulans*, this does not represent a south-to-north cline for increasing nasal width; the ratio of nasal width to nasal length shows no definite cline within the narrow-faced group.

Basioccipital length is greater in *D. agilis simulans* than in *D. a. agilis*, but intermaxillary distance is greater *in D. a. agilis.*

The general south-to-north trend for over-all increase in size in coastal narrow-faced species (data from Grinnell, 1922) is apparent in the present study when uncorrected means for *D. a. agilis* and *D. agilis simulans* are compared (Table 4).

Interparietal width is significantly greater in *D. a. agilis* than in *D. agilis simulans*, perhaps the result of greater mastoid bulla inflation in *D. agilis simulans*. Although the difference in bullar inflation between them is non-significant, the logical assumption that interparietal width is correlated with degree of bullar inflation may still be valid. Lidicker (1960*a*) pointed out that width of the supraoccipital region is reduced from two directions as bullar inflation increases. Hence, a small increase in bullar inflation might result in a large decrease in interparietal width.

Suborbital distance is greater in *D. agilis simulans* than in *D. a. agilis*, but the lesser width of the maxillary arch in *D. agilis simulans* reduces the projection of the maxillary arch to the point where spread of maxillary arches is not significantly different.

COMPARISON OF THE BROAD-FACED AND NARROW-FACED POPULATIONS

Significant differences between broad-faced and narrow-faced populations numbered 93 out of a possible 128 for the eight population pairs (Table 11). Selection of characters that maximized differences between narrow-faced and broad-faced forms was a major cause of this high number. Four of the six characters in which both *D. agilis* populations differed from the broad-faced populations are dependent upon maxillary arch configuration. Maxillary arch structure, however, is also important in comparisons among the broad-faced populations.

The number of differences in any given combination of narrow-faced and broad-faced populations is not greatly different from any other like combination (column totals in Table 11). The total number of differences between sympatric population pairs is 48 and for allopatric populations pairs is 45. Thus, there is no evidence of character displacement.

Interparietal length in both groups is generally correlated with bullar inflation: the greater the bullar width, the longer the interparietal. *Dipodomys a. agilis* has the least bullar breadth and the shortest interparietal; *D. agilis simulans* has the second least bullar breadth and the second shortest interparietal; *D. cascus* (loc. 8) has the greatest bullar breadth and the longest interparietal. Intermediate populations in this respect are not perfectly correlated.

Basioccipital length differences between narrow-faced and broad-faced populations result from the significantly longer basioccipital of *D. agilis simulans*.

Since interorbital distance is significantly greater in the broad-faced populations, whereas intermaxillary distance with one exception is non-significant, the central portions of the skulls of these two groups differ primarily in the greater dorsal width of broad-faced skulls.

SYSTEMATIC STATUS OF THE BROAD-FACED POPULATIONS

Comparisons between broad-faced and narrow-faced populations were made to clarify the systematic relationships between some representative members of Subgroups A and B of the *heermanni* group as arranged by Lidicker (1960*a*), and to permit a systematic evaluation of the closely related but allopatric broad-faced populations in San Diego and Riverside counties.

Specimens of *D. agilis simulans* and *D. cascus* collected from near Bonsall (loc. 8) are clearly sympatric. Pregnant females of both species have been collected at the same time at this locality and the two species occupy adjacent habitats here (Fig. 3). With the exception of a few *D. agilis simulans* individuals from this locality which exhibit some lateral curvature of the jugals, no evidence of intergradation was found in the large series collected here. I found no intergradation in the series of *D. a. agilis* and *D. stephensi* collected four miles southwest of Perris. Thus, there is no doubt that these narrow-faced and broad-faced forms represent distinct biological species.

The closeness of the broad-faced and narrow-faced relationships can be adequately evaluated only after similar studies in other kangaroo rat species. However, on the basis of bacular morphology, all members of the *heermanni* group appear to be closely related when compared to species in other groups (see Burt, 1960, for illustrations and measurements of bacula of other species.)

Criteria for judging the systematic relationships among the four broad-faced populations studied were difficult to develop, owing to the allopatric nature of the populations. One of the usual criteria, intergradation over a rather narrow zone, could not be used. Potential reproductive capabilities between populations are not known; other possible isolating mechanisms which would support or reject a statement as to specific status have not been studied in sufficient detail. The observed morphological similarities among the populations suggested subspecific differentiation and an analysis was undertaken to evaluate this possibility.

The broad-faced populations, with their observed slight morphological differences, homogeneity within populations, and occupation of a distinct geographical area, fulfill all criteria of subspecies except intergradation. This problem was dealt with by comparing the differentiation found among the broad-faced populations with that found between the two *D. agilis* subspecies, since the latter possess all the stated requirements for subspecies. Intergradation between the two subspecies was noted by Grinnell (1922: 89) at the southern side of the San Jacinto Mountains in southwestern Riverside County.

Outstanding qualitative differences could not be found among the four broad-faced populations nor between the two *D. agilis* populations. Among the possible population pairs (Table 10), the broad-faced populations differed quantitatively in a maximum of seven characters and the *D. agilis* populations in six. Although the Bonsall (loc. 8) and San Luis

Rey (loc. 1) populations share the greatest number of differences, seven, the fact that each population differs from each of the two remaining populations in not more than four characters lessens the importance of this distinctness. Also, the various broad-faced population pairs were found to differ in different sets of characters. Together, these findings suggest that the four populations have been evolving independently and that the directions of evolution happened to be most divergent in the geographically closest populations.

In his study of California kangaroo rats, Grinnell (1922) emphasized the similarity between *D. a. agilis* and *D. a. simulans*. Since his study included many species and subspecies of *Dipodomys*, it would seem that *D. a. agilis* and *D. a. simulans* are among the least differentiated subspecies meriting formal recognition. Since the *D. stephensi* and *D. cascus* populations are considerably less distinct (with the exception of the Bonsall and San Luis Rey combination) than the two *D. agilis* populations, they should be considered collectively as populations of the monotypic species *Dipodomys stephensi*. Statistical differences between populations does not necessarily entitle the populations to subspecific recognition. As pointed out by Lidicker (1962), "statistically significant differences can be found between the vast majority of the population pairs. This serves to emphasize what is really intuitively obvious, namely that the ability to prove that two populations are statistically different in one or several characters is only a measure of the persistence and patience of the systematist."

The problem of what to do with populations showing statistically significant differences in only a few characters has been discussed by Doutt (1961), who suggested giving them geographic names, rather than formal subspecific recognition. This avoids inconvenient multiplication of subspecific names but still gives recognition to these slightly differentiated populations. This method seems logical, particularly in species that comprise many isolated populations and where subspecies description is difficult to support on biological grounds. Since there undoubtedly exist other populations of *D. stephensi* that are as differentiated as "*D. cascus*", the populations of *D. stephensi* should be either given geographic names or be denied formal taxonomic recognition.

Throughout the remainder of this discussion, the broad-faced populations previously referred to as *D. cascus* will be called *D. stephensi.*

SYSTEMATIC STATUS OF *D. stephensi*

The scope of the present study was largely limited to analyzing *D. cascus-D. stephensi* relationships and to measuring the difference between certain populations of Subgroups A and B of the *heermanni* group. However, since data were collected for several other species in Subgroup A, an attempt was made to clarify the systematic status of *D. stephensi* within this group.

The status of *D. stephensi* as a distinct broad-faced species has been questioned by Hall and Kelson (1959), who feel that *D. stephensi* is possibly only subspecifically distinct from *D. panamintinus*, found to the north. A brief study was made of a series of 20 *D. panamintinus mohavensis* males from Hesperia, San Bernardino County, a locality immediately north of the mountain range that marks the northern limit of *D. stephensi* distribution. The ranges of *D. panamintinus mohavensis* and *D. stephensi* may meet in the region of Cajon Canyon, which separates the San Gabriel and San Bernardino Mountains. Grinnell (1922) cited a locality for *D. stephensi* 26 miles south of Hesperia. A character of *D. panamintinus mohavensis* that sets it apart from *D. stephensi* is the ratio of interparietal width to length; in *D. panamintinus* the ratio averaged 0.6, whereas in *D. stephensi* (loc. 18) the ratio averaged 0.3. Basal length was not measured in *D. panamintinus*, but condylobasal length (basal length plus basioccipital length) averaged 27.9 mm compared to 27.4 mm in *D. stephensi*. With skull sizes approximately equal, or slightly greater in *D. panamintinus*, the lesser bullar breadth of *D. panamintinus*, averaging 24.2 mm, becomes a distinctive difference when compared to 25.1 mm for *D. stephensi*. Maxillary arch width averaged 5.2 mm in *D. panamintinus*, but was 5.6 mm in *D. stephensi*. Baculum length of *D. panamintinus* was stated by Burt (1960) to average 10.7 mm with a range of 10.0-11.2 mm, based on nine specimens. In a total of 46 bacula from all four *D. stephensi* populations, only five were 11.2 mm or shorter, with the shortest measuring 10.9 mm. The shorter baculum length in *D. panamintinus* is not a natural consequence of smaller general body size, for body length in *D. panamintinus* from Hesperia averaged 123 mm, but was only 118 mm for *D. stephensi.* The abrupt differences between close populations of *D. panamintinus* and *D. stephensi* suggest more than subspecific differentiation. These character differences are distinct enough to allow detection of intergradation should it occur over a small geographical area. A study of populations in the region of Cajon Canyon might clarify the specific status of *D. stephensi* with respect to *D. panamintinus.*

Dipodomys stephensi appears to be more closely related to the southern subspecies of *D. heermanni* than to *D. panamintinus.* Skulls of *D. heermanni tularensis* were compared briefly with those of *D. stephensi* and were found to be similar in all but two of the qualitative characters listed in Table 3. Basioccipital width is greater and jugal curvature is less in *D. heermanni tularensis.* The *D. heermanni* study, though cursory, may be supplemented by Grinnell's (1922) data, which suggest that cranial differences between the southern subspecies of *D. heermanni* and *D. stephensi* are no greater than those between *D. panamintinus* and *D. stephensi.*

Baculum measurements of *D. stephensi* fall within the range of *D. heermanni.* The baculum of *D. heermanni,* as illustrated by Burt (1960), does not show the slight upward curve characteristic of *D. stephensi;* otherwise, the bacula appear identical. The average baculum length for three *D. heermanni* measured by Boulware (1943), as well as the three measured by Burt (1960), is 11.7 mm, essentially the same as that found in the present study for all four *D. stephensi* populations.

Habitats of the *D. heermanni* subspecies (Grinnell, 1933) far more resemble those of *D. stephensi* populations than does the extremely arid habitat of *D. panamintinus,* which suggests that *D. stephensi* may be more closely allied to *D. heermanni.*

Dipodomys gravipes, also a member of Subgroup A, is found in northwestern Baja California (Fig. 8). Individuals of this species are larger than those of *D. stephensi* in the following dimensions (average of 18 males): total length, 310 mm; hind foot length, 45 mm; greatest length of skull, 41.7 mm; condylobasal length, 29.1 mm; intermaxillary distance, 8.0 mm; spread of maxillary arches, 23.4 mm; nasal length, 14.9 mm. However, certain other measurements are approximately equal to, or smaller than, those in specimens of *D. stephensi*: interorbital distance, 11.3 mm; interparietal length, 3.5 mm; and interparietal width, 1.0 mm. Had these measurements been corrected for size differences between individuals of both populations, *D. gravipes* would be about as distinct from *D. stephensi* in skull characteristics as is *D. panamintinus* or *D. heermanni.* Since the baculum of *D. gravipes* has not been described previously, a brief statement is included here, based on a single baculum (Los Angeles County Museum no. 1425) obtained through the courtesy of Dr. Charles McLaughlin: length, 13.30 mm; base height, 1.58 mm; base width, 1.27 mm; shaft height at middle, 0.70 mm; shaft width at middle, 0.51 mm; ventral length of glans penis, 4.68 mm; dorsal length of glans penis, 5.70 mm. Ratios of these measurements fall within the ranges for the *D. stephensi* populations, leaving baculum length as an absolute difference. The greater length of the *D. gravipes* baculum, however, is correlated with the larger body size, for body length in *D. gravipes* specimens averaged 131 mm. The baculum of *D. gravipes* differs from that of *D. stephensi* in being more slender, particularly near the tip, and the shaft is straight as far as the tip. The tip has less tissue surrounding it than in *D. stephensi,* and is less recurved. Although the base is not as enlarged as usually observed in *D. stephensi,* the specimen may not be fully adult. Observations in this study revealed that the baculum base remains relatively small until the animal reaches full adult size. Baculum characters indicate that *D. stephensi* may be more closely related to *D. gravipes* than to *D. panamintinus.*

An inspection of qualitative characters in the *D. gravipes* sample did not permit conclusions as to its status within the broad-faced group, for certain characters, such as the wide

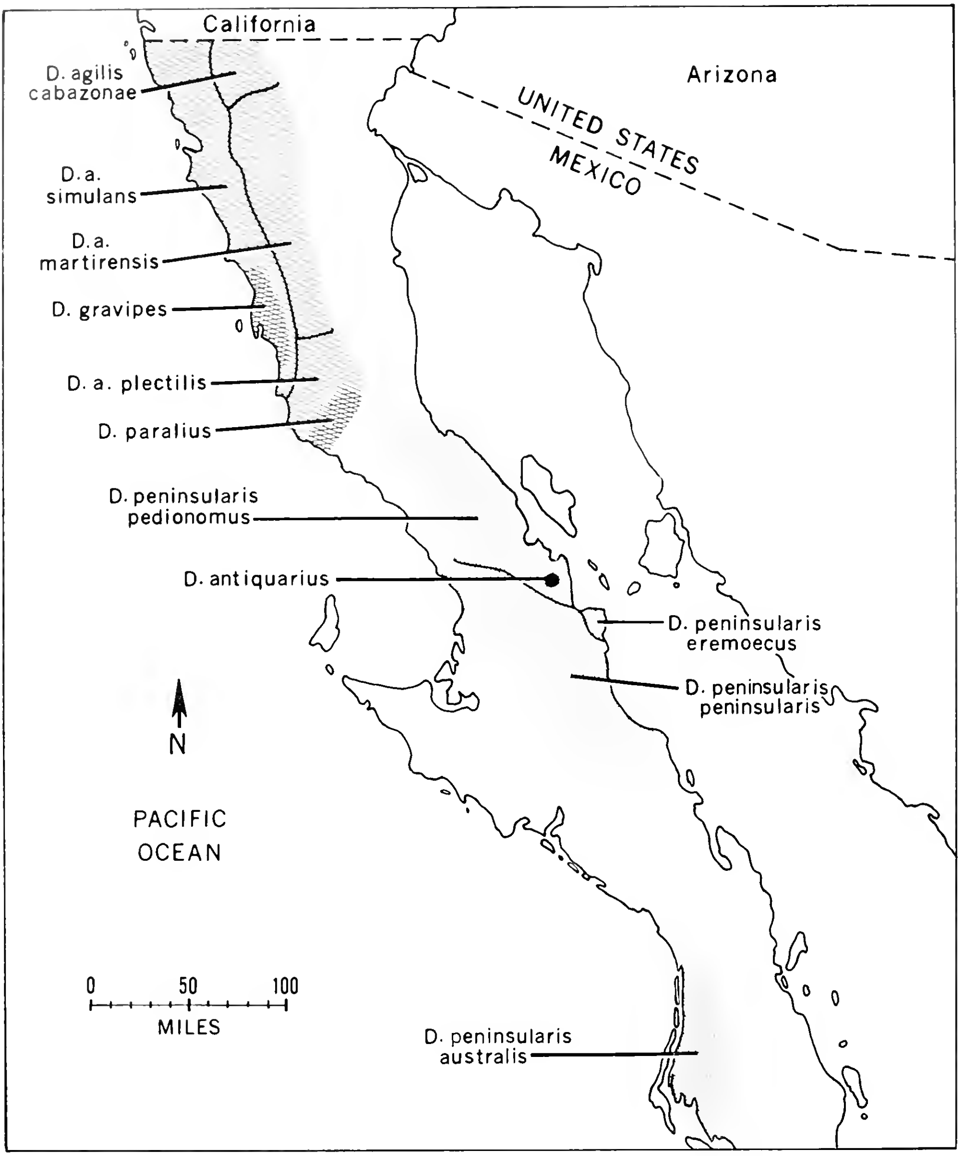

Figure 8. Distribution of *heermanni* group kangaroo rats in Baja California.

basioccipital, relate it to *D. panamintinus* and *D. heermanni*, but the narrow interparietal relates it to *D. stephensi* and *D. heermanni*.

SYSTEMATIC STATUS OF *D. antiquarius*

Except for auditory bulla inflation, *D. antiquarius* differs from the broad-faced populations in the same manner as do *D. a. agilis* and *D. agilis simulans* (Table 3). In this character *D. antiquarius* is similar to *D. peninsularis* and dissimilar to both the broad-faced and *D. agilis* populations. In all characters listed in Table 3, the sample of *D. antiquarius* and samples of all four subspecies of *D. peninsularis* show no important differences. In his original description, Huey (1962) did not compare *D. antiquarius* with *D. peninsularis*, but instead pointed out differences and similarities between it and *D. stephensi* and *D. gravipes*. If the distinctive qualitative characters of *D. a. agilis* and *D. agilis simulans* are considered to be criteria for narrow-faced species supplementary to others set forth by Grinnell (1922), *D. antiquarius* is more reasonably placed in the narrow-faced group than in the broad-faced group.

Detailed statistical treatment was impossible for *D. antiquarius* because of small sample size. However, I consider *D. antiquarius* closer to *D. peninsularis* than to *D. stephensi*. The slight tendency toward broad-faced dimensions precludes a categorical separation of *D. antiquarius* from that group, in spite of the qualitative evidence against close relationship. The parameters of three measurements for *D. antiquarius*, four subspecies of *D. peninsularis*, four subspecies of *D. agilis*, and the four *D. stephensi* populations are given in Figures 6 and 7.

ECOLOGICAL RELATIONSHIPS BETWEEN *D. stephensi* AND *D. agilis*

In northwestern San Diego County, areas of habitat favorable for *D. stephensi* are few. The occurrence of *D. stephensi* in open types of habitat is evident, for only a few specimens were taken in light chaparral immediately adjacent to a field in which *D. stephensi* was common. In contrast, *D. agilis* occurred in all but one of the habitats sampled; the exception (category 2) occurred at San Luis Rey (loc. 1) in an open area several miles square where the soil was extremely hard. Kangaroo rats were found only in several relatively small areas where the soil was less dense; here the chaparral cover required by *D. agilis* was absent.

In other *heermanni* group studies this precise ecological relationship between broad-faced and narrow-faced species has been noted. Boulware (1943), studying *D. heermanni arenae* and *D. agilis fuscus* habitats in Santa Barbara County, California, reported "the specimens of *D. heermanni* were all taken in open, sandy areas, relatively free of chaparral. Most of the *D. agilis* were collected in a low stand of mixed chaparral. The soil here is heavier than sand and bears some resemblance to clay. One specimen of *agilis* was taken in an open, sandy area along with *heermanni*."

The greater abundance of *D. agilis* in brushy habitats than in adjacent open ones that lack *D. stephensi* (locs. 9 and 11; Table 2) demonstrates that habit utilization by *D. agilis* is probably not a result of competitive exclusion by *D. stephensi*. It cannot be stated categorically that *D. stephensi* would not occupy chaparral of its own accord, or that *D. agilis* does not exclude *D. stephensi* from chaparral, for no locality was found where a *D. stephensi* population was present in an area adjacent to chaparral unoccupied by *D. agilis*. However, the failure to find more than a few *D. stephensi* in even light chaparral cover in all collecting undertaken is considered adequate evidence of the strong preference of this species for an open type of habitat. A summary of habitats occupied by various species of California kangaroo rats was compiled by Grinnell (1933). My findings agree with his habitat descriptions for *D. stephensi* and *D. agilis*.

In general, these data suggest that *D. agilis* does not greatly influence population size and distribution of *D. stephensi*, except perhaps indirectly by reducing the opportunity for *D. stephensi* to re-inhabit partially open areas it has abandoned for any reason.

CLIMATIC INFLUENCE ON *D. stephensi* DISTRIBUTION

Annual precipitation in the region of western Riverside County that *D. stephensi* occupies averages about twelve inches; in northwestern San Diego County the annual average is about sixteen inches. Since Munz (1959) allows a minimum annual precipitation of fourteen inches for the chaparral vegetation type, only a slight decrease in rainfall could alter the dominant flora of northwestern San Diego County to one like that found in western Riverside County. The occurrence of such an event in the relatively recent past could explain both the distribution and relatively slight differentiation in the isolated populations of *D. stephensi*.

Hansen (1947) suggests that a change of climate occurred during the Altithermal period, about 6,000 years ago, when temperatures were higher than at present. If the Altithermal was also characterized by greater precipitation, the chaparral cover in southwestern California would have been even more extensive. A reduction in chaparral cover would have had to occur since that time to account for the present distribution of *D. stephensi*. This does not seem likely because the current precipitation in northwestern San Diego County is greater than the minimum required to support chaparral.

However, if reduced rainfall accompanied the Altithermal, a range extension for *D. stephensi* would be expected, since the chaparral distribution would have been affected adversely both geographically and altitudinally. It may have been at this time that the San Diego County populations were established. A northward range expansion, from northwestern San Diego County into western Riverside County, is less likely to have occurred than a southward expansion, since the climatic conditions in the northern areas in the recent past have probably always been drier, owing to the partial blocking of ocean winds by the mountain ranges along the western and northern borders of Riverside County.

The isolation of *D. stephensi* and of *D. gravipes* from what presumably was once a continuous range in the broad-faced group probably occurred long before the Altithermal, for the differentiation of these species seems far greater than could take place in 6,000 years.

PHYLOGENY OF THE NARROW-FACED SPECIES

The evidence of clines and the continuous distribution in the narrow-faced group suggest a recent origin; information gathered in this study together with findings in previous studies permit some speculation on this group's phylogeny.

Differentiation in the northern members of the narrow-faced group is largely a matter of darker pelage, increased size, longer ears, greater nasal length and increased bullar inflation; this trend has been treated in detail by Grinnell (1922). According to Grinnell, the degree differentiation is not great. He felt that *D. elephantinus* is possibly only subspecifically distinct from *D. venustus* and that the latter species is but slightly differentiated from *D. agilis*. Thus, there exists a closely related group of narrow-faced forms extending from northwestern Baja California to the San Francisco Bay region.

In the present study, the major differences found between *D. agilis* and *D. peninsularis* are the more inflated bullae and the lighter pelage of *D. peninsularis*. Huey (1951) found that bullar inflation in *D. peninsularis* decreases from south to north, therefore, the difference in bullar inflation between the northernmost populations of *D. peninsularis* and the southernmost *D. agilis* subspecies is least where the two species are geographically closest. The pelage of the southernmost *D. agilis* subspecies and the closely related *D. paralius* is generally lighter than the northern narrow-faced forms, and, according to Huey (1951), the darkest *D. peninsularis* populations are in the northern part of this species range. Similarities between *D. peninsularis* and *D. agilis* in maxillary arch structure are shown in Figs. 6 and 7. In summary, I consider *D. peninsularis* a narrow-faced species, closely related to *D. agilis*.

If *D. peninsularis* is treated as a narrow-faced species, a trend in habitat type is evident in this group: the southern members occupy extremely arid regions in Baja California, the northern members the mesic region in central coastal California. In Baja California, the habitat of *D. peninsularis* is characterized by sparse vegetation, but the northernmost narrow-faced populations, according to Grinnell (1933), occupy areas of dense chaparral. A factor common to the two *heermanni* subgroups, therefore, is occurrence of at least some forms in an open, arid habitat; occupation of dense chaparral occurs only in the narrow-faced group.

In addition to habitat similarities with the broad-faced group, *D. peninsularis* shows a tendency toward the maxillary arch structure of *D. stephensi*, a broad-faced species, as suggested in Figs. 6 and 7; however, the differences between *D. peninsularis* and the broad-faced species are much greater than between it and *D. agilis*.

I consider the above evidence and interpretations to suggest: (1) that the narrow-faced group originated from an arid-dwelling *heermanni* group stock, probably in Baja California: (2) that *D. peninsularis* represents an early derivative of this stock; (3) that *D. agilis*, *D. paralius* and the northern species, *D. elephantinus* and *D. venustus*, were derived from the stock that gave rise to extant forms of *D. peninsularis*.

Once the narrow-faced group had achieved specific status and habitat requirements different enough to significantly reduce competition with broad-faced species, nothing would prevent its invading the chaparral community along the western region of California. No other kangaroo rats would be present in the chaparral in numbers sufficient to offer serious competition because the broad-faced species strongly prefer an open type of habitat.

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SUMARIO

Se estudian estadisticamente varios aspectos relacionados con las poblaciones de *Dipodomys cascus*, *D. stephensi* y *D. agilis*. Se discute separadamente el caso de *D. antiquarius*. Las diferencias que aparecen entre las poblaciones de *D. cascus* y *D. stephensi* son menores a las observadas entre las dos subspecies de *D. agilis*, que presenta una distribución simpátrica con aquellas. Por lo tanto, *D. cascus* se coloca junto con *D. stephensi*, que es una especie monotípica. Las poblaciones de *D. cascus* y *D. stephensi* que se han estudiado, al parecer han evolucionado independientemente; de forma que las poblaciones más diferenciadas son las que están más próximas geograficamente. Se proponen denominaciones geográficas para estas poblaciones.

Dipodomys antiquarius debería constituir un grupo con *D. agilis;* pero no con *D. stephensi*, como se propuso originalmente. Las dimensiones craneales y las características morfológicas de *D. antiquarius*, sugieren un parentesco *próximo* con *D. peninsularis*.

Dipodomys stephensi aparece casi exclusivamente en zonas despejadas; mientras que *D. agilis* habita el chaparral. Estas dos especies pocas veces se presentan juntas; pero en ciertas ocasiones se encuentran en habitats adyacentes. Es probable que el aislamiento de las poblaciones de *D. stephensi* ha sido ocasionado por un cambio en la vegetación, y no por la competencia infructuosa con *D. agilis*. El grupo de Ratas canguro de rostro estrecho, ha evolucionado probablemente de las poblaciones de *heermanni* que habitan las zonas áridas de Baja California. La adaptación progresiva de estos animales a zonas de mayor vegetación, ha permitido que algunas de estas especies invadieran la comunidad de chaparral de California.

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APPENDIX I

TABLES

Table 1. Dates of collecting activity

Locality Number*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1						66	64-5	65-6				
2									65			
3								65				
4								65				
5							66					
6							66					
7							66					
8		63				63-4-6	63-4-6			63		62
9			66									
10							66					
11		66					66					
12		63						65				
13										63		
14								65				
15			67									
16			67									
17		66										
18			66									

*Localities are described in Table 2.

Table 2. Summary of kangaroo rat collecting

		Habitat Category							
Locality	Species[1]	1	2	3	4	5	6	7	8
1. 2.0 mi. E., 0.6 mi. S. San Luis Rey Mission, San Diego Co., Elev. 400′	steph/casc		28						
	agilis		0						
2. 1.8 mi. NE San Luis Rey Mission, San Diego Co., Elev. 90′	steph/casc				0				
	agilis				7				
3. 2.4 mi. NE San Luis Rey Mission, San Diego Co., Elev. 90′	steph/casc				0				
	agilis				4				
4. 1.8 mi. W., 1.7 mi. S. Bonsall, San Diego Co., Elev. 280′	steph/casc			1					
	agilis			3					
5. 0.3 mi. W., 0.2 mi. S. Bonsall, San Diego Co., Elev. 440′	steph/casc			1					0
	agilis			15					6
6. 0.9 mi. N., 0.1 mi. E. Bonsall, San Diego Co., Elev. 300′	steph/casc	0					0	0	
	agilis	1[2]					5	3	
7. 1.0 mi. N., 0.8 mi. E. Bonsall, San Diego Co., Elev. 180′	steph/casc			2					
	agilis			9					
8. 1.0 mi. E. Bonsall, San Diego Co., Elev. 180-360′	steph/casc	59			0		2[4]		
	agilis	4[3]			2		13		
9. 1.0 mi. E., 0.5 mi. S. Bonsall, San Diego Co., Elev. 200-380′	steph/casc	0		0			0	0	
	agilis	2		2			3	5	
10. 1.0 mi. S. Bonsall, San Diego Co., Elev. 360-460′	steph/casc							0	
	agilis							7	
11. 1.3 mi. S., 0.3 mi. W. Bonsall, San Diego Co., Elev. 220-460′	steph/casc			0		0		0	
	agilis			11		6		47	
12. 3.6 mi. E., 2.0 mi. N. Bonsall, San Diego Co., Elev. 230′	steph/casc			0					
	agilis			18					
13. 0.5 mi. W. Pala, San Diego Co., Elev. 400′	steph/casc			0					
	agilis			6					
14. 1.0 mi. S. Pala, San Diego Co., Elev. 480′	steph/casc			0	0	0		0	
	agilis			0	7	9		7	
15. 5.2 mi. E., 0.8 mi. S. Temecula, Riverside Co., Elev. 1300′	steph/casc	8							
	agilis	3[5]							
16. 4.5 mi. E., 1.0 mi. N. Temecula, Riverside Co., Elev. 1250-1350′	steph/casc			23					
	agilis			0					
17. 1.6 mi. N., 0.6 mi. W. Murrieta, Riverside Co., Elev. 1200′	steph/casc			0					
	agilis			10					
18. 6.0 mi. SW Perris, Riverside Co., Elev. 1600′	steph/casc	23							
	agilis	0							

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[1] Occurrences of *D. stephensi* and *D. cascus* have been combined; *D. agilis* in localities 1-14 is *D. agilis simulans* and in localities 15-18 is *D. a. agilis.*

[2] *D. agilis* specimen was collected within 10 yds. of habitat category 7.

[3] *D. agilis* specimens were collected within 100 yds. of habitat category 7.

[4] *D. cascus* specimens were collected within 75 yds. of habitat category 1.

[5] *D. agilis* specimens were collected within 50 yds. of habitat category 6.

Table 3. Summary of qualitative characters in seven populations of kangaroo rats

	Premaxilla-Nasal Suture	Auditory Bulla Inflation	Jugals	Jugal Base Direction	Basioccipital Width
D. stephensi (loc. 18)** (Perris)	Curved medially	Reduced laterally	Curved laterally	Craniomedial	Narrow
D. stephensi (loc. 15 & 16) (Temecula)	"	"	"	"*	"*
D. cascus (loc. 8) (Bonsall)	"	"	"	"	"
D. cascus (loc. 1) (San Luis Rey)	"	"	"	"	"
D. a. agilis (Perris, San Bernardino)	Straight	Inflated laterally	Straight*	Cranial	Broad
D. a. simulans (loc. 10 & 11) (Bonsall)	"	"	"*	"	"
D. antiquarius (San Juan Mine)	"	Extremely inflated	"	"	"

	Dorsal Perimeter of Foramen Magnum	Baculum Shaft (at middle)	Baculum tip	Soles of Hind feet	Lateral White Tail Stripes
D. stephensi (loc. 18)** (Perris)	Rounded	Slight upward curve	Weakly recurved	Dusky	Usually Narrow*
D. stephensi (loc. 15 & 16) (Temecula)	"	"	"	"	"
D. cascus (loc. 8) (Bonsall)	"	"	"	"	"
D. cascus (loc. 1) (San Luis Rey)	"	"	"	"	"
D. a. agilis (Perris, San Bernardino)	Acute angle	Straight	Strongly recurved	Dark	Uniformly wide
D. a. simulans (loc. 10 & 11) (Bonsall)	"	"	"	"	"
D. antiquarius (San Juan Mine)	"	Not available	Not available	"	"

*See text for discussion of variation.

**Includes locality 4 mi. SW Perris.

Table 4. External and cranial measurements (in mm) for six populations of *Dipodomys*[1]

	D. cascus				D. a. agilis	
	San Luis Rey Mission (1)		Bonsall (8)		Perris and San Bernardino	
Character	Range	Mean	Range	Mean	Range	Mean
Total length	271-295	280[2]	261-308	283.	275-306	293.
Tail length	161-177	165[2]	154-184	168.	170-190	179.
Hind foot length	39-42	41[3]	40-43	41.	41-45	43.
Ear length	14-16	15[3]	14-16	15.	—	—
Basal length of skull	20.9-22.5	21.8	21.2-22.6	21.9	20.8-22.6	21.9
Greatest length of skull	37.3-39.9	38.7	38.0-39.9	38.9	38.3-40.8	39.7
Greatest breadth of skull	24.0-25.3	24.7	24.2-25.7	25.1	23.7-25.0	24.5
Spread of maxillary arches	21.6-23.0	22.4	21.1-23.2	22.4	19.4-23.2	20.8
Interorbital distance	10.5-11.8	11.2	10.6-11.9	11.3	10.0-11.0	10.6
Nasal length	13.2-14.9	14.1	13.3-14.3	13.9	13.8-15.3	14.5
Nasal width	3.9-4.4	4.1	3.8-4.5	4.1	3.6-4.6	3.9
Intermaxillary distance	7.2-7.8	7.5	7.3-7.8	7.5	7.3-7.8	7.6
Interparietal length	3.5-4.9	4.3	3.9-4.9	4.5	3.1-4.3	3.7
Interparietal width	0.9-2.0	1.5	0.8-1.7	1.2	1.1-2.0	1.6
Alveolar length	5.0-5.6	5.2	4.8-5.3	5.1	4.7-5.2	5.1
Lacrymal length	3.5-4.3	3.9	3.6-4.4	4.1	3.2-4.0	3.6
Maxillary arch width	5.0-6.0	5.5	5.5-6.3	5.9	4.2-5.6	4.9
Projection of maxillary arch	7.1-7.9	7.5	7.1-7.9	7.5	5.9-7.8	6.8
Suborbital distance	4.0-4.7	4.3	4.0-4.4	4.2	3.6-5.0	4.1
Basioccipital length	5.3-5.9	5.5	5.2-5.9	5.5	5.3-5.9	5.6
Depth of skull	12.9-13.6	13.3	13.0-13.9	13.6	12.9-13.8	13.3

	D. a. simulans		D. stephensi			
	Bonsall (11)		Temecula (15, 16)		Perris (18)	
Character	Range	Mean	Range	Mean	Range	Mean
Total length	267-295	280.	267-288	277[4]	273-301	286[5]
Tail length	155-180	170.	153-172	161[4]	156-186	167[5]
Hind foot length	39-42	41.	40-43	41.	39-43	41
Ear length	15-17	16.	14-16	15.	14-16	15[6]
Basal length of skull	20.7-22.3	21.6	21.5-23.0	22.1	20.9-22.6	21.9
Greatest length of skull	38.1-40.5	39.2	38.4-40.5	39.4	37.8-40.6	39.3
Greatest breadth of skull	23.4-25.3	24.5	24.4-26.0	25.1	24.1-26.0	25.1
Spread of maxillary arches	19.3-21.9	20.9	21.6-23.8	22.6	21.4-23.6	22.4
Interorbital distance	10.0-11.4	10.7	10.8-12.5	11.3	11.0-12.2	11.6
Nasal length	13.3-14.5	14.0	13.6-15.0	14.4	13.7-14.8	14.2
Nasal width	3.4-4.1	3.7	3.8-4.4	4.1	3.7-4.4	4.0
Intermaxillary distance	6.9-7.8	7.4	7.3-7.9	7.6	7.2-8.0	7.6
Interparietal length	3.0-4.2	3.8	3.5-4.8	4.2	3.6-5.2	4.3
Interparietal width	0.6-1.8	1.2	0.7-1.7	1.2	0.9-1.9	1.3
Alveolar length	4.7-5.5	5.1	4.8-5.6	5.2	4.9-5.5	5.3
Lacrymal length	3.3-4.0	3.7	3.7-4.3	4.0	3.2-4.5	3.9
Maxillary arch width	4.3-5.1	4.7	5.3-6.4	5.9	5.0-6.5	5.6
Projection of maxillary arch	5.9-7.0	6.7	7.1-7.8	7.5	6.8-8.0	7.4
Suborbital distance	3.6-4.6	4.2	4.0-4.8	4.4	3.9-4.6	4.2
Basioccipital length	5.3-6.6	5.9	5.1-5.8	5.6	5.1-5.8	5.5
Depth of skull	12.8-13.8	13.3	13.3-14.1	13.7	13.4-14.1	13.8

[1] For samples of 14 males and 6 females from each locality. Number in parentheses refers to exact locality description in Table 2.

[2] 12 males, 6 females

[3] 13 males, 6 females

[4] 12 males, 5 females

[5] 12 males, 4 females

[6] 9 males, 6 females

Table 5. External and cranial measurements (in mm) for *Dipodomys antiquarius**

Character	Range	Mean	Mean (corrected)
Total length	247-285	268	
Tail length	138-170	153	
Hind foot length	40-42	41	
Ear length	—	—	
Basal length of skull	21.0-22.2	21.5	
Greatest length of skull	38.5-41.0	39.5	1.8402
Greatest breadth of skull	25.1-26.2	25.7	1.1981
Spread of maxillary arches	21.2-21.8	21.5	1.0017
Interorbital distance	10.7-11.5	11.0	.5123
Nasal length	13.2-14.8	13.9	.6486
Nasal width	3.5-4.1	3.7	.1737
Intermaxillary distance	7.4-7.8	7.6	.3554
Interparietal length	3.8-4.4	4.1	.1909
Interparietal width	0.8-1.7	1.4	.0667
Alveolar length	4.8-5.4	5.2	.2404
Lacrymal length	3.7-4.0	3.9	.1808
Maxillary arch width	4.9-5.3	5.1	.2200
Projection of maxillary arch	6.7-7.0	6.8	.3182
Suborbital distance	3.7-4.1	3.9	.1793
Basioccipital length	5.1-5.8	5.6	.2599
Depth of skull	13.2-13.9	13.6	.6332

*Sample of three males and three females from San Juan Mine, Sierra San Borja, Baja California. Corrected means were computed from measurement data corrected for individual size variation (see text for explanation).

Table 6. Statistical analysis of baculum and glans penis measurements

Length of Baculum

Species	Locality	N	Range	Mean	S. D.	S. E.
D. stephensi	15 & 16	12	11.23-12.71	11.72	.40	.12
D. stephensi	18	8	11.20-12.31	11.68	—	—
D. cascus	8	15	10.92-12.64	11.69	.47	.12
D. cascus	1	11	11.14-11.89	11.57	.30	.09
D. a. simulans	11	15	9.39-10.05	9.89	.20	.05

Ratio of Baculum Base Width to Base Height

Species	Locality	N	Range	Mean	S. D.	S. E.
D. stephensi	15 & 16	12	.79-1.04	.91	.08	.02
D. stephensi	18	8	.83-1.00	.91	—	—
D. cascus	8	15	.80-1.14	.98	.09	.02
D. cascus	1	11	.78- .97	.88	.06	.02
D. a. simulans	11	15	.89-1.20	1.00	.07	.02

Ratio of Shaft Width to Shaft Height

Species	Locality	N	Range	Mean	S. D.	S. E.
D. stephensi	15 & 16	12	.58-.75	.65	.06	.02
D. stephensi	18	8	.57-.67	.64	—	—
D. cascus	8	15	.51-.75	.63	.06	.02
D. cascus	1	11	.56-.68	.61	.04	.01
D. a. simulans	11	15	.57-.80	.69	.07	.02

Ratio of Glans Ventral Length to Dorsal Length

Species	Locality	N	Range	Mean	S. D.	S. E.
D. stephensi	15 & 16	12	.83-.95	.89	.03	.01
D. stephensi	18	8	.80-.92	.86	—	—
D. cascus	8	15	.80-.96	.87	.05	.01
D. cascus	1	11	.76-.94	.87	.05	.02
D. a. simulans	11	15	.71-.83	.77	.04	.01

Table 7. Analysis of variance results for absolute measurements*

Character	Sum of Squares			Mean Squares		
	Total	Locality	Residual	Locality	Residual	F
Basal length of skull	25.02	1.68	23.34	.3360	.2047	1.64
Greatest length of skull	65.41	13.29	52.12	2.6580	.4572	5.81
Greatest breadth of skull	34.26	10.82	23.44	2.1640	.2056	10.52
Spread of maxillary arches	123.94	68.61	55.33	13.7220	.4854	28.27
Interorbital distance	32.78	15.60	17.18	3.1200	.1507	20.70
Nasal length	20.85	6.76	14.09	1.3520	.1236	10.94
Nasal width	5.76	1.88	3.88	.3760	.0340	11.06
Intermaxillary distance	5.30	1.11	4.19	.2220	.0368	6.05
Interparietal length	22.59	10.06	12.53	2.0120	.1099	18.31
Interparietal width	12.25	2.74	9.51	.5480	.0834	6.57
Alveolar length	4.51	.92	3.59	.1840	.0315	5.84
Lacrymal length	9.86	3.59	6.27	.7180	.0550	13.05
Maxillary arch width	36.24	26.64	9.60	5.3280	.0842	63.28
Projection of maxillary arch	28.07	14.76	13.31	2.9520	.1168	25.27
Suborbital distance	7.98	1.19	6.79	.2380	.0596	3.99
Basioccipital length	7.08	1.64	5.44	.3280	.0477	6.88
Depth of skull	12.63	6.29	6.34	1.2580	.0556	22.62

*Analysis is based on measurement data not corrected for individual size variation. Data are for 14 males and 6 females from each of the six localities listed in Table 4. Total degrees of freedom (df) are 119, locality df are 5, residual df are 114. Values of F above 2.29 are significant at the 5 per cent level of significance and above 3.18 at the 1 per cent level.

Table 8. Analysis of variance results for corrected measurements

Character	Sum of Squares			Mean Squares		
	Total	Locality	Residual	Locality	Residual	F
Greatest length of skull	.097662	.024015	.073647	.004803	.0006460	7.44
Greatest breadth of skull	.072675	.012756	.059919	.002551	.0005256	4.85
Spread of maxillary arches	.207142	.123074	.084068	.024615	.0007374	22.80
Interorbital distance	.067974	.028284	.039690	.005657	.0003481	16.25
Nasal length	.033116	.010831	.022285	.002166	.0001955	11.08
Nasal width	.010490	.003341	.007149	.000668	.0000627	10.65
Intermaxillary distance	.012275	.000967	.011308	.000193	.0000991	1.95
Interparietal length	.046345	.020172	.026173	.004034	.0002296	17.57
Interparietal width	.031003	.010750	.020253	.002150	.0001776	12.11
Alveolar length	.009707	.001530	.008177	.000306	.0000717	4.27
Lacrymal length	.017926	.006754	.011172	.001351	.0000980	13.78
Maxillary arch width	.069656	.051500	.018156	.010300	.0001593	64.66
Projection of maxillary arch	.050464	.028049	.022415	.005610	.0001966	28.53
Suborbital distance	.014122	.002244	.011878	.000449	.0001042	4.30
Basioccipital length	.018237	.004878	.013359	.000976	.0001172	8.32
Depth of skull	.030887	.008175	.022712	.001635	.0001992	8.21

Table 9. Means for corrected cranial measurements

	Broad-faced populations				Narrow-faced populations	
Character	San Luis Rey	Bonsall	Temecula	Perris	D. a. simulans	D. a. agilis
Greatest length of skull	1.7765	1.7814	1.7874	1.7930	1.8096	1.8154
Greatest breadth of skull	1.1339	1.1492	1.1392	1.1468	1.1302	1.1186
Spread of max. arches	1.0274	1.0252	1.0239	1.0216	.9614	.9526
Interorbital distance	.5162	.5170	.5133	.5286	.4923	.4842
Nasal length	.6491	.6334	.6526	.6471	.6436	.6649
Nasal width	.1884	.1863	.1840	.1860	.1728	.1792
Intermaxillary distance	.3426	.3436	.3459	.3484	.3400	.3463
Interparietal length	.1965	.2034	.1899	.1934	.1734	.1666
Interparietal width	.0676	.0544	.0553	.0585	.0567	.0826
Alveolar length	.2404	.2340	.2370	.2402	.2331	.2309
Lacrymal length	.1775	.1868	.1796	.1768	.1685	.1637
Maxillary arch width	.2544	.2682	.2676	.2568	.2170	.2216
Projection of max. arch	.3423	.3443	.3394	.3356	.3083	.3086
Suborbital distance	.1988	.1907	.1992	1915	.1950	.1872
Basioccipital length	.2545	.2530	.2512	.2514	.2696	.2541
Depth of skull	.6092	.6217	.6202	.6310	.6116	.6074

Table 10. Significant differences among six populations of kangaroo rats as determined by the multiple range test of corrected measurement data*

	Broad-faced populations						*D. agilis* populations
	A-B	A-C	A-D	C-D	B-D	B-C	E-F
Greatest length of skull							
Greatest breadth of skull							
Spread of maxillary arches							
Interorbital distance				X			
Nasal length	X				X	X	X
Nasal width							X
Intermaxillary distance							X
Interparietal length						X	
Interparietal width	X	X	X				X
Alveolar length	X				X		
Lacrymal length	X				X	X	
Maxillary arch width	X	X		X	X		
Projection of maxillary arch							
Suborbital distance	X		X	X		X	X
Basioccipital length							X
Depth of skull	X	X	X	X			
Total differences:	7	3	3	4	4	4	6

*Letters in column headings represent populations: A, *D. cascus* (loc. 1); B, *D. cascus* (loc. 8); C, *D. stephensi*, (loc. 15 & 16); D, *D. stephensi*, (loc. 18); E. *D. agilis simulans* (loc. 10 & 11); F, *D. a. agilis* (Perris & San Bernardino). The letter X represents a significant difference between populations being compared.

Table 11. Significant differences between narrow-faced and broad-faced populations as determined by the multiple range test of corrected measurement data

	Sympatric Populations				Allopatric Populations			
	A-E	B-E	C-F	D-F	A-F	B-F	C-E	D-E
Greatest length of skull	X	X	X	X	X	X	X	
Greatest breadth of skull		X	X	X		X		
Spread of maxillary arches	X	X	X	X	X	X	X	X
Interorbital distance	X	X	X	X	X	X	X	X
Nasal length		X	X	X	X	X		
Nasal width	X	X		X	X	X	X	X
Intermaxillary distance							X	X
Interparietal length	X	X	X	X	X	X	X	X
Interparietal width	X		X	X	X	X		
Alveolar length	X			X	X			X
Lacrymal length	X	X	X	X	X	X	X	X
Maxillary arch width	X	X	X	X	X	X	X	X
Projection of maxillary arch	X	X	X	X	X	X	X	X
Suborbital distance			X		X			
Basioccipital length	X	X					X	X
Depth of skull		X	X	X		X		X
Total differences:	11	12	12	13	12	12	10	11

Meaning of letters in column headings explained in Table 10.

APPENDIX II

MEASUREMENT TERMINOLOGY

Terminology used in skull measurements (Figure 4) is as follows:

a - a′, Greatest length of skull
b - b′, Greatest breadth of skull
c - c′, Basal length of skull
d - d′, Spread of maxillary arches
e - e′, Interorbital distance
a - f, Nasal length
g - g′, Nasal width
h - h′, Intermaxillary distance
i - i′, Interparietal length
j - j′, Interparietal width
k - k′, Alveolar length
e′- l, Lacrymal length
m, Maxillary arch width
h′- n, Projection of maxillary arch
h′- o, Suborbital distance
c′- p, Basioccipital length
q, Petrosal region of auditory bulla

Depth of skull is vertical distance from ventral surface of petrosal region of auditory bulla to dorsal surface of skull immediately craniad of interparietal. Maxillary arch width is measured across the middle of arch, from immediately lateral to lacrymal and at right angles to suture between lacrymal and maxillary arch.

Terminology used in baculum and glans penis measurements (Figure 5) are as follows:

a - a′, Baculum length
b - b′, Height of baculum base
c - c′, Height of baculum shaft at middle
d - d′, Dorsal length of glans penis
e - e′, Ventral length of glans penis

Width of baculum base is greatest width of base at right angles to base height. Width of baculum shaft at middle is shaft width measured at right angles to shaft height.