

LAND MAMMALS
OF THE SOUTHERN CALIFORNIA ISLANDS

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Although the fauna of the Southern California Islands has long attracted the attention of western naturalists, there has been no single paper published which discusses all of the kinds of Recent mammals known to occur on, and in the vicinity of, these islands. Instead, the available information is widely scattered in the literature in more than forty separate publications, many of which are principally concerned with taxonomic descriptions of new subspecies or geographic races of island endemics.

To my knowledge the earliest specific reference made to any of the native mammals of the islands of California is contained in Dr. Spencer F. Baird's monumental tome (1857). The island fox (*Urocyon littoralis*) was originally described in that general report although the species was therein assigned to the genus *Vulpes*. *The Mammals of North America*, by Drs. E. Raymond Hall and Keith R. Kelson (1959), includes comprehensive distributional records of 29 species and subspecies of mammals from the Southern California Islands. Detailed accounts of the systematic status and natural history of the island spotted skunk (*Spilogale gracilis amphialus*), southern sea otter (*Enhydra lutris nereis*), and island foxes (*Urocyon littoralis*) are documented in the work of Joseph Grinnell, Joseph S. Dixon, and Jean M. Linsdale (1937). Grinnell and Dixon (1918) presented ecological data on the island ground squirrel (*Spermophilus beecheyi nesioticus*) in their publication on the ground squirrels of California. With few exceptions, little else has been published on the natural history and ecology of the mammals of the offshore islands of California. However, important distributional data are contained in the papers by Grinnell (1933), Nelson and Goldman (1931), Pearson (1951), and von Bloeker (1940, 1941a).

The presently known Recent land mammal fauna of the Southern California Islands totals 34 species. Of these, only 14 are native to California, and but one is endemic to the islands. The remaining 20 include man and 19 species which were either purposely, or accidentally, introduced as a result of human activities. These mammals which are not native to the islands include the European

hare (*Lepus europaeus*), on East Anacapa Island; the European rabbit (*Oryctolagus cuniculus*), on Santa Barbara Island; a California mainland subspecies of the harvest mouse (*Reithrodontomys megalotis*), and one of the meadow mouse (*Microtus californicus*), on San Clemente Island; the black and roof rats (*Rattus rattus*), on Anacapa and Santa Catalina islands; the brown rat (*Rattus norvegicus*), and the house mouse (*Mus musculus*), on Santa Catalina Island; the dog (*Canis familiaris*), originally a companion of the native Indians on the six largest islands; the house cat (*Felis catus*), living during recent time in a feral state on at least eight of the islands; the horse (*Equus caballus*), occurring as a feral species on San Clemente Island and as work or riding animals on Santa Catalina, Santa Cruz, and Santa Rosa islands, and formerly on San Nicolas and San Miguel islands; the burro (*Equus asinus*), about 16 presently wild on San Miguel Island; swine (*Sus scrofa*) living in a wild state on Santa Catalina, Santa Cruz, and Santa Rosa islands; dwarf elk (*Cervus nannodes*), and snow deer (*Capreolus pyargus*), on Santa Rosa Island; mule deer (*Dama hemionus*), on Santa Catalina and Santa Rosa islands; feral goats (*Capra hircus*), descendents from Spanish stock abandoned on Santa Catalina and San Clemente islands; sheep (*Ovis aries*), presently on San Clemente, Santa Catalina, Santa Cruz, and San Miguel islands, and formerly on San Nicolas, Santa Barbara, East Anacapa, Middle Anacapa, and Santa Rosa islands; buffalo (*Bison bison*), on Santa Catalina Island; and cattle (*Bos taurus*), intermittently in large herds of fattening beef stock on Santa Catalina, Santa Cruz, and Santa Rosa islands, and formerly in small numbers as a source of milk for human consumption on San Clemente, San Nicolas, and San Miguel islands. While it is recognized that these non-native mammals have had in the past and, in large measure, still do have important roles in the ecology of the islands on which they occur, space limitations do not permit more than this cursory mention of them in the present report. In the remainder of this paper attention will be given primarily to the native land mammals. This information constitutes an abstraction from my manuscript covering all the terrestrial and aquatic mammals of the island region of southern California, which is to be published at a future date by the Western Foundation of Vertebrate Zoology.

SPECIES ACCOUNTS

Sorex ornatus Merriam

Adorned Shrew

An adult male shrew was collected by Miss Ruth B. Eaton in Avalon Canyon, Santa Catalina Island, 25 April 1941. It is the

only specimen of the genus *Sorex* recorded from any of the Southern California Islands at the present time, insofar as I am aware.

Although originally named as a new species, *Sorex willetti* von Bloeker (1941b), it was indicated in the original description that this shrew is closely related to the *S. ornatus* group. Careful restudy of the holotype in comparison with specimens of shrews from the nearby mainland has revealed that the Santa Catalina Island shrew should henceforth be recognized as a geographic race, *S. o. willetti*. This unique specimen differs from those of *S. o. ornatus* from southern California upland regions in having a slightly larger than average size and in having a darker coloration and longer skull. It is darker dorsally, paler ventrally, and larger throughout in all measurements than specimens of *S. o. salicornicus* from the southern California salt marshes. It shows nothing more than generic relationship to *S. trowbridgii*, which reaches its southern limit of distribution in the vicinity of Santa Barbara, and only family relationship to *Notiosorex crawfordi*, which is widely distributed on the mainland, including southern California.

It is possible that this shrew may be found in any of the larger stream-bearing canyons of Santa Catalina Island, although not necessarily close to water. Specimens of *Sorex ornatus* have been captured on dry chaparral-covered hillsides of the California mainland. Normally, however, shrews of the genus *Sorex* appear to prefer marshy spots, damp streambanks, and seepage areas where ground-dwelling arthropods commonly occur.

Future field work on Santa Cruz and Santa Rosa islands may result in the discovery of shrews there. The need for trapping in the canyons and mountain areas of these islands is indicated. It seems less likely that shrews may occur on San Clemente Island and almost certain that they do not exist on San Nicolas, San Miguel, or on any of the smaller islands.

Myotis evotis (H. Allen)

Big-eared Myotis

Three species of little brown, or mouse-eared, bats (*Myotis*) are presently known to occur on some of the Southern California Islands, although two of these are here recorded for the first time. The big-eared myotis may be readily distinguished from the other two by the yellowish tinge of its dorsal pelage and by the fact that the ears, when laid forward, extend from 7 to 10 millimeters beyond the nostrils. There are other differences, but the color and size of ears are sufficient for differentiation of specimens in hand in the field.

The first specimen of *Myotis evotis* from any of the islands of southern California was captured along with two *M. californicus*

in a crevice on the outside of a bungalow at Prisoners' Harbor, Santa Cruz Island, 18 August 1939, by Dr. John A. Comstock. The second was taken by Fred Ziesenhenné and me from a crevice under a corrugated iron roof on an old building at White's Landing, Santa Catalina Island, 26 October 1941. I procured the third from a rafter supporting the roof over the old winery building in Canada del Medio, Santa Cruz Island, 15 December 1943. This latter specimen was hanging head downward in a dormant condition and became active only after being handled for several minutes. These three specimens are typical examples of *M. evotis evotis*, as they fall well within the range of variation of that subspecies, which is fairly common and widely distributed on the California mainland.

Myotis thysanodes Miller

Fringed Myotis

The fringed myotis may be distinguished by the tan color of its dorsal fur and the fringe of short, stiff hairs along the free edge of the interfemoral membrane. While the color of the ventral pelage and the size of the hind foot are about the same as in the big-eared myotis, the ears are smaller, extending only three to five millimeters beyond the nostrils when laid forward.

To the best of my knowledge, only one example of this species has been taken on any of the California Islands; this is an adult female, which I captured with the aid of an insect collecting net while the bat was in flight inside of a U. S. Marine Corps mess hall near Wilson's Cove, San Clemente Island, on 25 August 1943. It is typical of the geographic race, *M. thysanodes thysanodes*.

In California and throughout most of its known range the majority of the specimens of this bat apparently have been obtained as single individuals from old abandoned buildings; and for this reason, it is sometimes referred to as the solitary bat. However, in recent summers I have encountered it in great abundance in several abandoned mines in the Santa Rita Mountains of south-central Arizona. In one of these colonies there were over two thousand individuals.

Myotis californicus (Audubon and Bachman)

California Myotis

The California myotis is the smallest in size of the seven species of bats known to occur on the Southern California Islands. Specimens from these islands vary in color of the pelage from

dark brown to reddish brown, though in general the ones from Santa Cruz and Santa Rosa islands are darker than those from San Clemente, Santa Catalina, and San Nicolas islands. The ventral pelage is usually almost as dark as the dorsal, not presenting the sharp contrast in color of these two areas as in *Myotis evotis* and *M. thysanodes*. Also, the hind feet and ears are smaller, the latter extending only one to three millimeters beyond the nostrils when laid forward.

The species is a common resident on the four largest islands, is rare on San Nicolas Island, and may occur on most of the other islands under consideration here. Reports of small bats occasionally seen at dusk flying in the vicinity of buildings on Santa Barbara, East Anacapa, and San Miguel islands may be referable to this species. Sixty specimens have been available for study: 43 from Santa Cruz Island, 5 from Santa Rosa Island, 6 from Santa Catalina Island, 5 from San Clemente Island, and 1 from San Nicolas Island. Those from the Northern Channel Islands are referred to the northwest coastal race, *M. californicus caurinus*, while the specimens from the Southern Channel Islands are typical of *M. c. californicus*.

Although only three species of *Myotis* are known to occur on the Southern California Islands, the Yuma myotis (*Myotis yumanensis*) and the long-legged myotis (*M. volans*) eventually may be found on the four largest islands. Also, the little brown myotis (*M. lucifugus*) may be discovered on the northern group of islands, and the small-footed myotis (*M. subulatus*) may occur on Santa Catalina and San Clemente islands. In addition, it is quite possible that the western pipistrelle (*Pipistrellus hesperus*) may be found in the course of time on several of the islands.

Eptesicus fuscus (Beauvois)

Big Brown Bat

Except for its greater size, the big brown bat (*Eptesicus fuscus*) superficially resembles bats of the genus *Myotis*. The dorsal pelage varies in color from dark brown to rich reddish brown while the ventral pelage is lighter, often buff-colored, or even cinnamon brown.

A single individual of this species was collected in an attic of an old building at Prisoners' Harbor, Santa Cruz Island, 15 December 1943. It was torpid when found but soon became active in the warmth of my hand and protested its capture vigorously by squeaking or chirping loudly and biting my index finger mercilessly before I succeeded in confining it in a cloth bag for the purpose of transporting it back to the mainland where it was later prepared as a scientific specimen. It is representative of the geographic

race *Eptesicus fuscus bernardinus*, which is common throughout most of California.

This is the only record known to me of the occurrence of this species of bat on the Southern California Islands. However, more intensive efforts on the part of collectors undoubtedly will reveal that the big brown bat is a common inhabitant on all of the larger islands of this area.

Plecotus townsendii Cooper

Lump-nosed Bat

The lump-nosed bat (*Plecotus townsendii*) may be identified readily by its extremely long ears, which measure between 32 and 36 millimeters from the basal notch; by the long, acutely pointed tragus; and by the peculiar glandular swellings, or "lumps", on each side of the muzzle. Its dorsal pelage varies in color from light buff to dark gray, and the ventral fur is always lighter than the back.

Specimens are now known from four of the islands, but the species may also occur on Santa Barbara, Anacapa, Santa Rosa, and San Miguel islands. I have examined one hundred and forty specimens from the northern and southern Channel Islands. Most of these (134) are from Santa Cruz Island, 4 from Santa Catalina Island, and 1 each from San Clemente and San Nicolas islands. All are referable to *Plecotus townsendii intermedius* which is common on the California mainland.

The discovery of a large colony of these bats by Arthur Woodward, on 11 August 1939, in the attic of an old two-story building that formerly had been operated as a hotel at Prisoners' Harbor, marks the first time this species was found on Santa Cruz Island. There were well over 300 individuals in the colony at the time. Judging from the series of 111 specimens preserved from this colony by Granville P. Ashcraft and myself between 11 and 19 August 1939, there were 3.5 females to each male present. When Drs. Frank A. Pitelka and Oliver P. Pearson visited the colony in September, 1948, they estimated it comprised about 200 adult males and grown young, constituting a nursery colony (Pearson, 1951). They also found two adult males in buildings near the west end of Santa Cruz Island.

Lump-nosed bats emerge from their roosting places somewhat later than *Myotis* and *Eptesicus*; and like the latter, they may be seen flying high above the ground, well out of shotgun range. Later, after it has become too dark to see them clearly, they descend to forage closer to the ground for insects and to drink from ponds and streams.

Antrozous pallidus (LeConte)

Pallid Bat

The pallid bat (*Antrozous pallidus*) is the largest and heaviest-bodied of the seven kinds of bats known to occur on the Southern California Islands. It is a large-eared species, being exceeded in length of ear among the bats of these islands only by *Plecotus townsendii*. From the latter it differs in its shorter and darker fur, darker and heavier wing membranes, and its greater size throughout, excepting the length of ears which measure from 28 to 31 millimeters from notch to tip.

One hundred and twenty-eight specimens from the Southern California Islands have been available for study. An adult female was captured while it was roosting under the eaves of a house on the hillside above Avalon Bay, Santa Catalina Island, 30 May 1935. The remaining 127 specimens were taken from a single location, the main building of the old winery in Canada del Medio, Santa Cruz Island. Granville P. Ashcraft discovered this colony, comprising several thousand individuals, roosting on the rafters and underside of the roof, 2 August 1938. I first visited the colony in August, 1939, and prepared 80 study skins-with-skulls between 11 and 17 August. On return trips to Santa Cruz Island in April, 1941, and in December, 1943, no *Antrozous* were found there. However, Dr. Oliver P. Pearson found the colony to include several hundred individuals in August and September, 1948, and preserved a series of 16 specimens at that time. From this, it appears possible that the pallid bat migrates to the islands in late spring and returns to the mainland in late fall. All of the specimens examined are typical of the subspecies *Antrozous pallidus pacificus*, which is widely distributed throughout the Pacific slope region of California.

Mr. Edwin L. Stanton informed me in August, 1939, that the bat colony inhabiting the old winery produces nearly two tons of guano each summer. The guano is collected each year in the fall and used in the flower and vegetable gardens maintained in the central valley of Santa Cruz Island.

A new genus and species of ischnopsyllid flea, *Myodopsyllodes piercei*, was described by G. F. Augustson (1941) from a collection of ectoparasites secured from the bats taken from this colony in 1938 and 1939 by Ashcraft, Augustson, and myself. Also, one specimen of this flea was obtained by Ashcraft from a specimen of the lump-nosed bat (*Plecotus*), collected at Prisoners' Harbor, 19 August 1939.

Although the red bat (*Lasiurus borealis*) and the hoary bat (*L. cinereus*) have never been recorded from the islands of southern California, these two species may pass through this area in the course of their north-south migrations. The need for additional

field work on the bats of the islands is apparent; I do not know of anyone who has made an attempt to capture them with the aid of mist nets, although this is a commonly employed field collecting technique elsewhere. Such a project on the islands may well prove rewarding.

Tadarida brasiliensis Geoffroy

Free-tailed Bat

The free-tailed bat (*Tadarida brasiliensis*) may be quickly identified, in comparison with any of the other bats found on the Southern California Islands, by its tail which projects conspicuously beyond the free edge of the uropatagium and by its long and relatively narrow wings. The ears, while large in relation to the head, are actually broader than long and are united basally across the forehead. The feet and legs are comparatively short and stout, and the membranes are thick and leathery. The dorsal pelage is dark grayish brown and the ventral pelage is somewhat paler. The total length, from end of snout to tip of tail, is about 100 millimeters; the tail length, about 35 millimeters.

Five bats of this species were collected by Granville P. Ashcraft and me in August, 1939. They were found in company with the large colony of pallid bats (*Antrozous pallidus*) on Santa Cruz Island. Only one of the five was alive, the other four being in mummified condition but still hanging onto the rafters. None were in evidence on return visits to this locality in April, 1941, and in December, 1943. An adult female was captured by Harry J. Fletcher at the U. S. Marine Corps training station on San Clemente Island, 25 August 1943. These specimens are representative of the common west American subspecies, *Tadarida brasiliensis mexicana*.

Because the free-tailed bat is a strong flier, ranging far and wide while foraging, the distance between the mainland and the islands would present no particular problem to this species. Its occurrence on San Clemente and Santa Cruz islands was to be expected; and doubtless, in the course of time, it will be found on most of the other islands.

All seven species of bats recorded from the Southern California Islands are insectivorous. Their importance in the ecology of the islands and their impact on the population of nocturnal insects is indicated by the quantity of guano produced each summer by the Santa Cruz Island colony of pallid bats.

Homo sapiens Linnaeus

Man

The first men to arrive on the islands were American Indians. It appears that these nesiotic people were humble, contented, and industrious insofar as their living needs were concerned; and they maintained good relationships with their mainland neighbors through exchange of products.

For the most part, the biota of the inland areas of the islands afforded no special attractions for the natives. But along the coasts, where marine mammals, birds, fish, and aquatic invertebrates abound, there was ample food as well as other resources such as skins for clothing, and bones and shells for tools. Consequently, the populations were concentrated along the coastal areas of the islands. In such situations, enormous shell mounds have been discovered and found to contain abundant evidence of the Indian way of life, in the form of artifacts and animal remains. Investigations of these "kitchen midden" sites have revealed that, in addition to many birds, fish, and shellfish, there were several forms of mammals which had an important influence in their lives. Among these were their large semiwild, wolf-like dogs; the then-abundant sea otters; the sea lions and seals; various porpoises, dolphins and whales; and, to a lesser extent, the endemic foxes, skunks (on Santa Rosa and Santa Cruz islands), and squirrels (on Santa Catalina Island). In addition to the obvious use of the flesh of nearly all these mammals for food and their hides for clothing and leather, the bones of many were often used, after modification, for tools and weapons such as awls, fishhooks, and harpoons.

The mode of life was communal; and village sites were situated near the mouths of canyons and around springs, indicating fresh water supply as a prime factor in determining the location of their communities. The number of Indians living on the islands at any one time seems never to have been very large. There was little change in their living habits until long after the arrival of the first European explorers in California in the early 16th century (Brandon, 1961). The later development of trade in sea otter furs, in which the moral rights of the natives were not even considered, soon led to the near extinction of these insular natives in the early part of the 19th century at the hands of the ruthless Aleuts of the northwest, who had been employed as hunters by various ship captains operating for the fur companies (Gleason, 1950). Eventually, in the 1830's, all but one of the few remaining Indians were taken from San Nicolas Island, their last landhold in the islands, to live with the Mission Indians on the mainland. The last one, a woman, was removed by George Nidever in

August or September, 1853, and taken to Santa Barbara where she died seven weeks later (Ellison, 1937).

The subsequent history of man on the islands has been largely concerned with agricultural interests (chiefly stock-raising), commercial fishing and whaling, naval personnel training, navigation aids (weather stations and a lighthouse), and recreation (swimming, boating, fishing, hunting, hiking, etc.).

Spermophilus beecheyi (Richardson)

California Ground Squirrel

Thirty-two specimens of the island ground squirrel (*Spermophilus beecheyi nesioticus*), all from Santa Catalina Island, have been available for study. They are superficially similar to specimens of the nearby mainland subspecies, *S. b. beecheyi*, but average larger throughout at comparative age levels. Also, the Catalina endemic geographic race is darker than *S. b. beecheyi*; and the gray shoulder patches are less distinct.

In habits, the Santa Catalina Island ground squirrel is very much like the mainland races of this species. It is widely distributed on Catalina, ranging from near sea-level, as at Johnson's Landing, to the summit of the highest peak, Orizaba Mountain (2,109 feet). This squirrel inhabits a variety of situations, such as grassy hillsides and mesas, open chaparral stands, oak-covered hills, large cactus patches, rocky outcrops on hillsides and flatlands, and even barren hills.

The reason for absence of ground squirrels from the other Southern California Islands is not immediately obvious. Conditions seem equally suitable for ground squirrel existence on all of these islands. A possible conclusion is that ground squirrels were later than deer mice and foxes in arriving in the area which became separated into the various islands and that Santa Catalina was the last of these islands to become isolated from the mainland. Evidence supporting this view is indicated in that the ground squirrel is represented in the Pleistocene fauna of the Rancho la Brea asphalt deposits (Kellogg, 1912; Dice, 1925; Stock, 1930, 1961) but, as yet, has not been discovered in fossil-bearing strata on any of the islands. Of course, this is inconclusive since it appears that much more fossilized material remains to be discovered on the islands. More significant is the fact that skeletal remains of *Spermophilus* have been found deep within Indian midden deposits on Santa Catalina Island by members of the Los Angeles Museum - Channel Islands Biological Survey expeditions, but never on any of the other islands.

Reithrodontomys megalotis (Baird)

Big-eared Harvest Mouse

The harvest mouse (*Reithrodontomys megalotis*) is the smallest of the species of rodents found on the Southern California Islands. It is distinguishable from the deer mouse (*Peromyscus maniculatus*) and the meadow mouse (*Microtus californicus*) by its smaller head and body size, its relatively much longer tail, and the grooves on the anterior face of the upper incisors.

The harvest mouse is known from three of the islands, San Clemente, Santa Catalina, and Santa Cruz; and 134 specimens have been available for this study. Seventy-four specimens from Santa Catalina Island represent the endemic subspecies, *Reithrodontomys megalotis catalinae*, which is differentiated from *R. m. longicaudus*, of the mainland, by its larger size and paler coloration. Dr. Oliver P. Pearson (1951) named and described another endemic island subspecies, *R. m. santacruzae*, on the basis of six specimens from Prisoners' Harbor, Santa Cruz Island. In making comparisons with other known geographic races of *Reithrodontomys*, Pearson stated, "The Santa Cruz Island specimens are grayer, less richly colored, and have smaller bodies, tails, feet, and skulls than specimens of *R. catalinae* from Santa Catalina Island, a form that I am inclined to consider as a subspecies of *R. megalotis*." The 36 specimens I have examined from San Clemente Island are indistinguishable from harvest mice of the mainland taxon, *R. m. longicaudus*, which apparently were inadvertently introduced along with the meadow mouse (*Microtus californicus*) in shipments of baled hay from San Diego County, California. In April, 1939, I obtained information which supports this suggestion from a conversation with Mr. Theodore Murphy, United States Marshal, who was stationed on the island at that time and was the recipient of the hay as feed for his horse which he used in patrolling the island.

The habits of harvest mice on the islands do not differ significantly from those on the mainland. They are found in patches of grass and forbs around springs and small streams, and in marshy areas dominated by growths of tules, bulrushes, and willows. Their food is mostly vegetable matter, chiefly seeds, leaves, and stems of grasses and forbs, although occasionally insects, such as grasshoppers, crickets, and beetles, may be eaten.

Peromyscus maniculatus (Wagner)

Deer Mouse

The deer mouse (*Peromyscus maniculatus*) is the most abundant and widely distributed rodent occurring on the Southern California

Islands. It differs from the harvest mice of the three islands mentioned in the preceding account in its larger head and body size, its longer and broader feet and ears, its actual and relative greater area of white underparts, its relatively shorter and more heavily haired tail, and the absence of grooves on the anterior facies of the upper incisor teeth.

This species occurs on 12 separate islands of the southern California group. Eight insular subspecies have been named and described, each of which is differentiated by average, rather than absolute, characters from the geographically closest mainland representative of the species, *Peromyscus maniculatus gambelii*. In general, with certain notable exceptions, only by comparison of specimens in series can the differences between the several island races be detected. Detailed analyses of their characteristics are withheld for discussion in a later publication. Eight hundred and forty specimens have been available for study, as follows: *Peromyscus m. streatori*, San Miguel Island, 104; Prince Island (off San Miguel Island), 3; *P. m. sanctaerosae*, Santa Rosa Island, 118; *P. m. santacruzae*, Santa Cruz Island, 62; *P. m. anacapa*, West Anacapa Island, 19; Middle Anacapa Island, 45; East Anacapa Island, 33; *P. m. elusus*, Santa Barbara Island, 61; Sutil Island (off Santa Barbara Island), 1; *P. m. exterus*, San Nicolas Island, 123; *P. m. catalinae*, Santa Catalina Island, 17; *P. m. clementis*, San Clemente Island, 254.

Deer mice frequent every type of habitat on the islands, from the sandy beaches and rocky shores to the tops of the highest mountains. Their food comprises a great variety of seeds, leaves, twigs, bark, insects and other arthropods, and flesh of any kind they may find. Their young may be born in any month of the year with from three to eight in a litter.

A new species of ixodid tick (*Ixodes peromysci*) and a new species of dolichopsyllid flea (*Opisodasys nesioticus*) were named and described by G. F. Augustson (1939, 1941) from a collection of ectoparasites which I procured from *Peromyscus maniculatus elusus* on Santa Barbara Island in May, 1939. Also, Augustson (1941) named and described a new species of hystrihopsyllid flea (*Catallagia vonbloekeri*), which was collected from specimens of *P. m. sanctaerosae* on Santa Rosa Island in August, 1939.

The matter of origin of the deer mouse on the Southern California Islands is somewhat clouded by the fact that *Peromyscus maniculatus* has not been recorded in the Pleistocene deposits of Rancho la Brea and Carpinteria. *P. imperfectus*, named by Lee R. Dice (1925) on the basis of fossil remains from Rancho la Brea, may represent the Pleistocene ancestral form of this species; but further study is necessary before this can be definitely stated. Robert W. Wilson (1936) named and described *P. nesodytes* from the Pleistocene of Santa Rosa Island. However, its relationships are with the *P. californicus* group of white-footed mice,

which is not represented in the known Recent fauna of these islands.

Microtus californicus (Peale)

California Meadow Mouse

The meadow mouse (*Microtus californicus*) is the largest in head and body size and has the shortest tail of any of the species of mice known to occur on the Southern California Islands. The ears are relatively short and are nearly hidden in the pelage of the head and neck. The fur is long and soft, and has a grizzled appearance. The tail is well-haired and distinctly bicolored, dark brown above, whitish (cinereous) below.

The meadow mouse was apparently accidentally introduced on San Clemente Island along with the harvest mouse (*Reithrodontomys megalotis*) in shipments of hay, as stated earlier. Twenty-eight meadow mice were collected on San Clemente Island along with *Reithrodontomys* and *Peromyscus*. In April and in December, 1939, they were most abundant in the salt marsh at the mouth of Horse Beach Canyon, at the south end of the island. The specimens do not differ appreciably from *Microtus californicus sancti-diegi* of the southern California mainland. No mice of the genus *Microtus* have been found on any of the other islands under consideration herein.

Urocyon littoralis (Baird)

Channel Islands Fox

The diminutive island gray fox (*Urocyon littoralis*) is known to occur on the six largest islands. I have observed them in a variety of situations such as on open sandy soil, devoid of vegetation; in rock-walled ravines and stream-bearing canyons; on rocky ledges and cliffs facing the sea; on brush-covered hills and among cactus thickets on exposed mesas and old alluvial fans; in grasslands and more or less open woodlands; and along sandy beaches and rocky shores. Two hundred and six specimens have been examined by me in the course of this study, representing six endemic insular races, as follows: *U. l. littoralis*, San Miguel Island, 20; *U. l. santarosae*, Santa Rosa Island, 51; *U. l. santacruzae*, Santa Cruz Island, 20; *U. l. dickeyi*, San Nicolas Island, 65; *U. l. catalinae*, Santa Catalina Island, 26; and *U. l. clementae*, San Clemente Island, 24.

The food of these animals is greatly varied. Although basically carnivorous, they eat several kinds of fruits such as Cata-

lina cherry, toyon berries, elderberries, "prickly pears", and acorns. In addition, they devour thousands of insects, especially grasshoppers and beetles in spring and summer; they also eat crabs, dead fish, and carrion from carcasses of dead seals, sea lions, and sea birds often washed ashore after violent storms, in addition to small birds, birds' eggs, and nestling young, (even of sea birds like the cormorants, pelicans, gulls, auklets, murre, and murrelets). But the mainstay of their diet is without doubt the ever-present white-footed, or deer, mice.

As a group, the island foxes are more distinctly differentiated from their present-day near relatives of the California mainland than any of the other indigenous mammals of the California Islands are from theirs. While the harvest mouse (on Santa Catalina and Santa Cruz islands), the deer mouse (on 12 islands), the ground squirrel (on Santa Catalina Island), and the spotted skunk (on Santa Cruz and Santa Rosa islands) all tend to be larger than their mainland counterparts, the island fox is much smaller than the California gray fox (*Urocyon cinereoargenteus californicus*). There is much to be learned of the island fox as concerns this character of small size. One might conclude that isolation on the islands led to degeneration in size. This seems especially logical in view of the fact that the exiled elephant (*Mammuthus exilis*), found in Pleistocene deposits on Santa Cruz, Santa Rosa, and San Miguel islands (specimens in California Institute of Technology, Los Angeles Museum of Natural History, and Santa Barbara Museum of Natural History), was also a dwarf species in comparison with its mainland representative, the imperial elephant (*Mammuthus imperator*) (Stock, 1935, 1943). However, there are other facts equally worthy of consideration. First, the island fox is not known from fossil deposits on the islands or elsewhere. This, obviously, is negative evidence and proves nothing more than the fact as stated. What is far more noteworthy is that in Yucatan, Mexico, and in Guatemala, there are three species of foxes which appear to be more closely related to the island fox than the latter is to the gray fox (*U. cinereoargenteus*). These Central American species (*U. fraterculus*, *U. parvidens*, and *U. guatemalae*) very closely approach *U. littoralis* in size and skull characters. The similarity is particularly noticeable in the ratios of breadth of skull to length, and height of braincase to length of skull; the shortness of rostrum; and the relatively large, inflated auditory bullae. In addition, there are other correlations; for example, there is a significant indication of relationship in the correspondence of measurements of adult specimens of these two groups of foxes. This does not occur in comparisons of either the Central American or the Channel Islands foxes with the mainland gray fox (*U. cinereoargenteus*).

These facts give one cause for speculation on the history of the distribution of the foxes. One view is that the original foxes

of North America were small. As they became dispersed outward from the center of origin, larger foxes developed progressively toward the north, and the smaller ones persisted only on the southern periphery of their distribution and on the Southern California Islands after separation from the mainland. Another view is that there were two separate origins of foxes in this genus (*Urocyon*): a small species in the southern part of North America and a large one in the north. In the course of dispersal, the northern species, by virtue of its greater size and strength, was better fitted for competition and survival. The Channel Islands foxes persisted, then, only as a result of the fortuity of isolation before the arrival of the larger species; and the Central American foxes survived because they existed on the edge of the southern range of the larger gray fox where conditions were less suitable for the latter. A third view is that the dwarf species developed from a larger form as a result of isolation on the islands in one case, and as a response to tropical conditions in the other. Further evidence is needed from the fossil record in order to show which, if any, of these various assumptions is the correct one. In addition, more conclusive data may be forthcoming from a comprehensive comparative study of the anatomy of these foxes, particularly the micro-anatomy of the hair.

Spilogale gracilis Merriam

Spotted Skunk

The spotted skunk, which is found on Santa Cruz and Santa Rosa islands, has been named and described as a separate subspecies, *Spilogale gracilis amphialus*. It differs from *S. g. microrhina* of the southern California mainland in larger head and body size, shorter tail, larger skull throughout, and proportionately less white and more black coloration in the pelage. Twenty-seven specimens have been available for this study, 18 from Santa Rosa Island, the type locality, and 9 from Santa Cruz Island.

Spotted skunks were once very common on the two largest of the Northern Channel Islands. In former years they caused some trouble in the vicinity of human dwellings through predation on domestic poultry (particularly on Santa Cruz Island) and the usual nuisance of their typical odor. These traits, however, are more than offset by their destruction of mice and insects which constitute the major portion of their diet. At the present time these mammals are only rarely found near any of the man-made structures on either Santa Cruz or Santa Rosa islands.

Sea Otter

The sea otter of California is recognized as a subspecies, *Enhydra lutris nereis*, which is distinguished from the northern subspecies by larger size and more brownish, as opposed to blackish, coloration. The type specimen of the southern subspecies was collected on San Miguel Island, 2 July 1904.

The sea otter formerly occurred in great numbers within the Southern California Island faunal area (Stephens, 1906). Today they are very near extinction in the vicinity of these islands, but occasional reports indicate that a few are still in existence. One was observed in a kelp bed off Santa Barbara Island in March, 1940, by Lloyd Martin, John R. Pemberton, and Kenneth E. Stager. Others have been reported in similar situations in recent years near San Miguel, San Nicolas, and San Clemente islands.

Specimens of skulls and skeletal fragments have been preserved from Indian midden deposits on the six largest islands. That these animals played an important role in the lives of the island Indians is shown in the quantity of this material, and also by the leather thongs and fragments of fur, discovered in various Indian burial sites. Later, the presence of these sea otters attracted the Russian traders and their fur-hunting Aleuts. Over-hunting by the latter, more than anything else, resulted in the almost complete extermination of the sea otter.

The sea otter spends most of its time in the water and seldom comes to land. Its food is procured entirely from the sea and consists chiefly of sea-urchins, abalones, and crustaceans. To a lesser extent it feeds on fish, squid, octopi, and other marine invertebrates. Since it is so rare, the total sum of its predations can scarcely be regarded as of significant economic importance.

DISTRIBUTIONAL AND EVOLUTIONARY IMPLICATIONS

Whatever the true condition of the Southern California Island area may have been in pre-Pliocene times, it is doubtful whether it has great significance with regard to the present-day fauna of the islands. Insofar as the land mammals are concerned, none of the genera native to the islands antedates the Pliocene epoch. It seems to be generally accepted by mammalogists that none of these genera could have originated or evolved, as such, on these several islands. In other words, as genera, these mammals are products of evolution on the mainland. Because they are unknown in pre-Pliocene times and appear most likely to be products of the Pliocene, it is only logical to assume they would not have reached the islands prior to the Pliocene. Therefore, the geological history of these islands subsequent to the Miocene is of primary

concern in any attempt to explain the present-day distribution of land mammals on the islands.

The means by which the marine mammals (sea otters and pinnipeds) and the bats (seven species in five genera) may continue periodically to visit and leave the islands are too obvious to merit more than mere mention. However, one species each of the genera *Sorex*, *Spermophilus*, *Reithrodontomys*, *Peromyscus*, *Urocyon*, and *Spilogale* remain to be accounted for with regard to their probable mode of transmission to the respective islands on which they occur. Because of their differential distribution among the several islands, it appears that the islands may have been connected to the mainland in different ways. That is, it is doubtful that certain of the islands were directly connected to each other since the close of the Miocene and possible that they were only remotely and indirectly connected thereafter through the mainland.

Sorex and *Spermophilus* are presently known to exist as natives on one island only — Santa Catalina; *Reithrodontomys* occurs naturally on two islands — Santa Cruz and Santa Catalina; *Peromyscus* is widely distributed, being known from 12 separate islands of the group — San Miguel, Prince, Santa Rosa, Santa Cruz, the three Anacapas, Santa Barbara, Sutil, San Nicolas, Santa Catalina, and San Clemente; *Urocyon* is found on six islands — San Miguel, Santa Rosa, Santa Cruz, San Nicolas, Santa Catalina, and San Clemente; and *Spilogale* occurs on two islands — Santa Rosa and Santa Cruz. How can this differential occurrence of contemporary forms within such a narrowly separated group of continental islands be explained? A possible answer may be found by determining the way in which the islands could have been formerly connected to the mainland through analysis of the known distribution of certain segments of the terrestrial fauna.

The differential distribution of the six genera of land mammals among the several islands indicates to me that the islands might have been connected by three separate peninsular extensions from the mainland with well-defined embayments between them at the time of colonization. I have found additional evidence in support of this conclusion in the present distribution of reptiles, amphibians, and land snails on the islands. A complete presentation of these findings is not possible here, but they are discussed in full in the manuscript referred to in my introductory remarks and of which this paper is an abstract. The sum of this evidence suggests the possibility that in the early Pliocene, the northern islands were broadly joined to the mainland as a westward extension of the Santa Monica Mountains; Santa Catalina to the Palos Verdes area; and Santa Barbara, San Nicolas, and San Clemente islands to Baja California by a long peninsula which also encompassed Guadalupe, Cedros, the San Benitos, and Natividad islands. Gradual recession of the coastline of this great peninsula and increase in size of the embayment between the Santa Barbara region

of the mainland and the area destined to become the Northern Channel Islands occurred in the middle Pliocene and proceeded so that by the beginning of late Pliocene the northern island mass, "Anacapia", as conceived by R. D. Reed (1933), was completely separated from the mainland. Also, San Clemente Island, then nearly double its present size, was separated from the long peninsula projecting northward from Baja California; and Santa Barbara and San Nicolas islands were part of another huge insular mass, "Guadalupia" (Reed, 1933), which was by that time separated from the mainland somewhere between present-day Cedros Island and Guadalupe Island. By the close of the Pliocene, Santa Cruz Island was still connected to Anacapa, San Miguel to Santa Rosa, and Santa Catalina to the mainland; but San Clemente, San Nicolas, and Santa Barbara islands were all separated, although much larger than they are today. The complete separation of the northern islands from each other, and of Santa Catalina from the mainland occurred in the early Pleistocene. The subsequent accumulation of hereditary differences in the populations of land mammals isolated on the Southern California Islands has resulted in the evolution of insular subspecies differentiated from each other and from their mainland counterparts.

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