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Myotis californicus.

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Myotis californicus Audubon and Bachman, 1842

California Bat

Vespertilio californicus Audubon and Bachman, 1842:285. Type locality "Monterey, California, U.S.A."

Vespertilio mexicanus Saussure, 1860: 282. Type locality "unspecified portion of the desert Mexico, Mexico."

Vespertilio nitidus Allen, 1862:247. Type locality "Monterey, California."

Vespertilio oregonensis Allen, 1864:61. Based on specimens from Old Fort Yuma, California and Cabo San Lucas, "Baja California Sur, Mexico". It would seem important to fix the type locality to Cabo San Lucas, since otherwise the name *oregonensis* would antedate *M. c. stephensi*, though Miller and Allen (1928) in effect did this when they synonymized *oregonensis* with *M. c. stephensi.*

Vespertilio agilis Allen, 1866:282. Type locality "Mirador, Veracruz, Mexico".

Vespertilio exilis Allen, 1866:283. Type locality "Cabo San Lucas, Baja California Sur, Mexico".

Vespertilio tenuidorsalis Allen, 1866:283. Type locality "Cabo San Lucas, Baja California Sur, Mexico".

CONTEXT AND CONTENT. Order Chiroptera, Suborder Microchiroptera, Family Vespertilionidae, Subfamily Vespertilioninae, Genus *Myotis*, Subgenus *Selysius*, *leibii* group (Findley, 1972). There are four currently recognized subspecies (Bogan, 1974):

M. c. californicus Audubon and Bachman, 1842:285. Type locality, see above (*nitidus*, *exilis*, and *tenuidorsalis* are synonyms, also *oregonensis* if type locality is fixed at Cabo San Lucas).

M. c. caurinus Miller 1897:72. Type locality "Massett, Graham Island, Queen Charlotte Islands, British Columbia".

M. c. mexicanus Saussure 1860:282. Type locality, see above (*agilis* is a synonym).

M. c. stephensi Dalquest 1946:67. Type locality "Vallecito, San Diego County, California".

DIAGNOSIS. Members of the subgenus *Selysius*, *leibii* group are distinguished from other North American *Myotis* predominantly by their relatively small feet, short rostrum, low coronoid processes and small sagittal and lambdoidal crests (Findley, 1972). *Myotis californicus* (Figs. 1, 2) differs from *M. ciliolabrum*, with which it is sympatric, in cranial morphology by having a more rounded skull, narrower rostrum, and lower coronoid process (van Zyll de Jong, 1984). The two species can be discriminated by bivariate plots of cranial depth versus rostral breadth (Bogan, 1974), or height of the coronoid process versus cranial depth measurements (van Zyll de Jong, 1984). *M. californicus* can be distinguished from *M. leibii* by a greater cranial depth and shorter least interorbitol width. In the field, *M. californicus* can be distinguished from *M. ciliolabrum* by the pattern of hair covering the snout. Viewed from above, the naked part of the snout of *M. californicus* is only as long as the width of the nostrils, while the naked part of the snout of *M. ciliolabrum* is approximately 1.5 times the nostril width (van Zyll de Jong, 1985).

Myotis californicus can be distinguished from *M. findleyi* by the black mask, ears, and claws. In addition, the pelage of *M. californicus* has a red tinge which is lacking in *M. findleyi* (Bogan, 1978). *M. californicus* is distinct from *Myotis yumanensis* by the short hind feet and lack of hair at the base of the uropatagium (Glass and Baker, 1965).

GENERAL CHARACTERS. The hind feet of *M. californicus* are small, slender, and weak which is characteristic of the *leibii* group (Findley, 1972). Usually, the hind foot is <50% the length of the tibia (Miller and Allen, 1928). The calcar ends in a projecting lobule, and is slender and prominently keeled (Miller and Allen, 1928). Adult body mass for samples of both sexes range from 3.3 to 5.4 g in *M. californicus* (van Zyll de Jong, 1985). Average measurements (in mm) for *M. californicus* with ranges in parentheses are: total length, 81.8 (74-95); length of tail, 36.7 (34-41); length of hind foot, 6.3 (5-8); length of ear, 12.9 (11-15); length of forearm, 33.3 (32-35; van Zyll de Jong, 1985). Farney and Fleharty

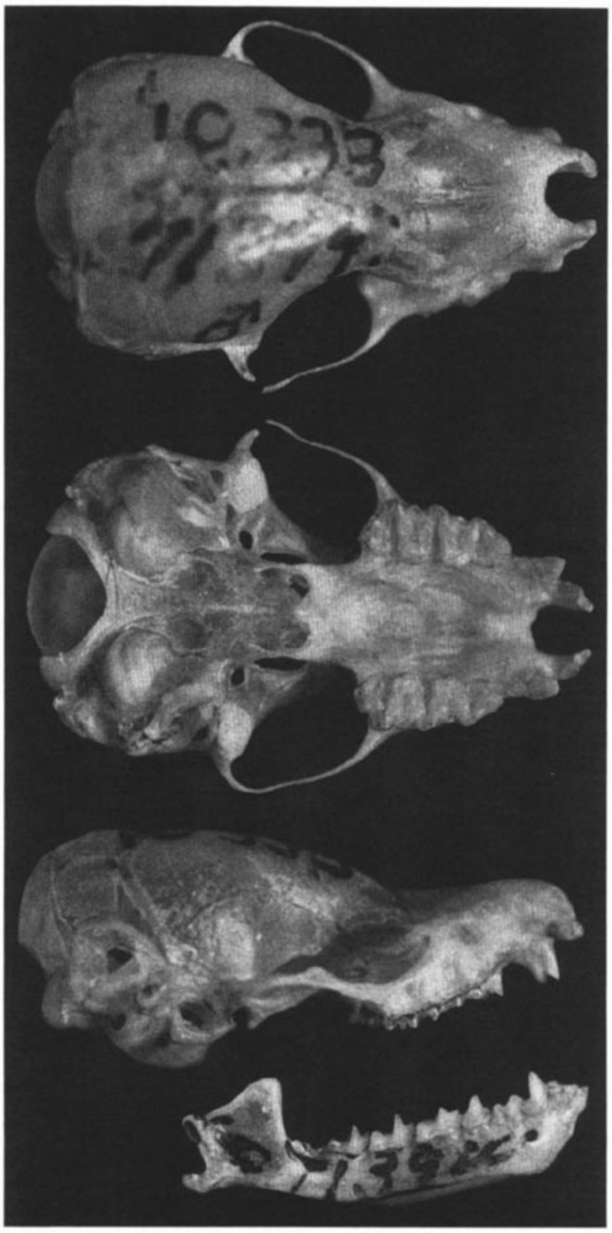

FIG. 1. Dorsal, ventral, and lateral views of the skull, and lateral view of the mandible of *Myotis californicus* (Royal Ontario Museum 10333, male, from Contre Parker County, California).

FIG. 2. *Myotis californicus* from Palmer Creek, Kootenay National Park, British Columbia. Photograph by M. B. Fenton.

(1969) provide measurements of wing span (242 mm), wing area (83.2 cm^2), and tail area (15.4 cm^2) for a single *M. californicus.* There is no distinct sexual dimorphism within this species, although female *M. californicus* average larger than males in most comparisons (Bogan, 1974). The dental formulae for *M. californicus* is: i 2/3, c 1/1, p 3/3, m 3/3, total 38. *M. californicus* has a south–north cline in skull size, with northern individuals having smaller skull dimensions than those in the south (van Zyll de Jong, 1984). Average skull measurements (in mm) for *M. californicus* with ranges in parentheses are: length of skull, 12.9 (12.0–13.5); mastoid width, 6.8 (6.6–7.0); cranial depth, 4.4 (4.2–4.8); length of maxillary tooth row, 5.0 (4.6–5.3; van Zyll de Jong, 1985). The pelage of *M. californicus* is usually rich-dark chestnut in color, but color varies from pale to dark. In high-altitude populations of *M. californicus* a darker pelage prevails (Bogan, 1974).

DISTRIBUTION. *Myotis californicus* ranges from the Alaskan panhandle to Baja California and Chiapas, Mexico (Fig. 3; Hall, 1981). The distribution of *M. californicus* is disjointed in many areas: *M. c. californicus* occurs in the southwestern U.S. and at low elevations in Mexico; *M. c. caurinus* occurs in the northwestern U.S., western Canada, and southern Alaska; *M. c. stephensi* occurs in the Colorado River and Great Basin regions; and *M. c. mexicanus* occurs at high elevations in Mexico (Bogan, 1974).

FORM AND FUNCTION. In renal morphology, the ratio of medulla to cortex, relative medullary area, percent medullary thickness and area are greater in *M. californicus* than in *M. ciliolabrum* (Geluso, 1978). These differences in renal morphology suggest differences in the urine-concentrating abilities of these two species (Geluso, 1978). Mean maximum urine concentrations for *M. californicus* and *M. ciliolabrum* are 3,560 and 3,170 mosmol/kg, respectively (Geluso, 1978). The renal morphology and associated urine-concentrating abilities of *M. californicus* and *M. ciliolabrum* reflect the arid and mesic environments they inhabit, respectively (Geluso, 1978). Habitat aridity explains 25% of the among-species variation in renal anatomy for 24 species of Nearctic, insectivorous bats (Bassett, 1986).

Rectal body temperature varied directly with ambient temperature in *M. californicus* (O'Farrell and Bradley, 1977). Body temperature ranges from 25 to 38.4°C over ambient temperatures from −5.0 to 28.3°C. The magnitude of response in body temperature to ambient temperature in *M. californicus* was lower than that of *Pipistrellus hesperus* reflecting differences in insulation between the two species. The minimum body temperature at which *M. californicus* can fly is 26.2°C (O'Farrell and Bradley, 1977).

Temperature of chest muscles was lower than rectal temperature at low temperatures, and temperature of chest muscles in *M. californicus* did not exceed rectal temperature until 27°C (Hirshfeld and O'Farrell, 1976). Following initial flight, rectal, chest muscle, and brain temperatures are lower for *M. californicus* than for *Antrozous pallidus* and *Pipistrellus hesperus* (Hirshfeld and O'Farrell, 1976). After initiation of flight, rectal temperature averaged 25.6°C, whereas brain, interscapular, and chest muscle temperature tended to be higher at 28.8, 29.6, and 29.1°C, respectively.

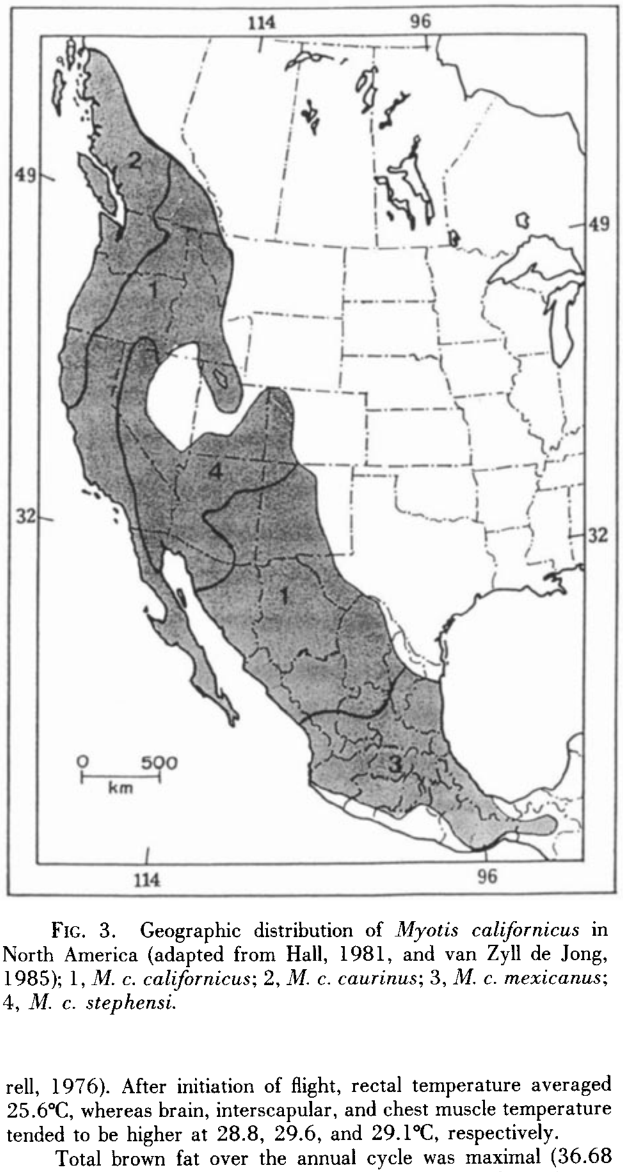

FIG. 3. Geographic distribution of *Myotis californicus* in North America (adapted from Hall, 1981, and van Zyll de Jong, 1985); 1, *M. c. californicus*; 2, *M. c. caurinus*; 3, *M. c. mexicanus*; 4, *M. c. stephensi.*

Total brown fat over the annual cycle was maximal (36.68 g/kg body mass) in January and declined progressively to August (9.44 g/kg); in autumn, deposits of brown fat increased rapidly (O'Farrell and Schreiweis, 1978). Interscapular deposits accounted for 50% or more of the total brown fat within this species, varying from 4 to 21.3 g/kg. Both carotid and squamo-occipito-cervical deposits showed little annual change. No difference was detected between the sexes in the annual pattern of brown fat deposition (O'Farrell and Schreiweis, 1978). Henny et al. (1982) determined that the average percent lipid in carcasses of *M. californicus* collected in August from Oregon was 6.34% (range, 2.6–10.0%).

The normal frequency of intrinsic gut contractions in *M. californicus* is 24.1 contraction cycles/min at 37°C (Studier et al., 1977). Intestinal contractions ceased in *M. californicus* at 6.2°C. This temperature is higher than observed in *Tadarida brasiliensis*, *Myotis lucifugus*, and *Eptesicus fuscus* in which gut contractions ceased at 0°C (Studier et al., 1977).

ONTOGENY AND REPRODUCTION. *Myotis californicus* has delayed fertilization, produces one young/year (Krutzsch, 1954), and has a potential reproductive lifespan of 15 years (Duke et al., 1979). Breeding occurs in late autumn over most of the distributional range, or early spring in California, as indicated by cohabitation of males and females in diurnal roosts and the state of testicular development. Females gather in maternity colonies usually located in a narrow crevice during the season of birth. In southwestern California, no pregnant females were found after mid-June, females collected on 30 April and 1 May each contained developing embryos (Krutzsch, 1954).

ECOLOGY. Both scat and stomach analyses indicate that *M. californicus* consumes mainly lepidopteran and dipteran prey, with smaller amounts of Coleoptera and Hemiptera, in eastern Oregon (Whitaker et al., 1981). In British Columbia, *M. californicus* consumed primarily Trichoptera and some Coleoptera based on fecal analyses (Woodsworth, 1981). Hunting takes place primarily along margins of tree clumps, around the edge of the tree canopy, over water, and well above ground in open country (Woodsworth, 1981). *M. californicus* and *M. ciliolabrum* partition food resources spatially in areas where they are sympatric (Woodsworth, 1981). *M. californicus* forages over or near water, whereas *M. ciliolabrum* forages near rocky bluffs. *M. ciliolabrum* has been observed foraging over water, but only when not in association with *M. californicus* (Woodsworth, 1981).

Myotis californicus from Texas and New Mexico are infested with mites (*Chiroptonyssus robustipes*; Dooley et al., 1976). In southwestern California, *M. californicus* found roosting alone were free of parasites, while individuals from nursery colonies harbored mites of the genera *Ichoronyssus* and *Spinturnix* (Krutzsch, 1954). *M. californicus* infected with rabies have been found (Constatine, 1986). Constantine (1986) reported one fetal *M. californicus* free of rabies which was aborted by a rabies-infected dam.

During the summer *Myotis californicus* roosts alone or in small groups in narrow crevices on rocky hillsides, under bark, or on man-made structures (Krutzsch, 1954). This species also roosts on small desert shrubs, rock outcrops, and on the ground (Hirshfeld et al., 1977).

BEHAVIOR. Like many heterothermic species, *M. californicus* hunts for shorter times during cold weather. O'Farrell and Bradley (1970) observed *M. californicus* active at −8°C and noted the following temperature-induced changes in its activity pattern. *M. californicus* had a unimodal activity phase shortened to an average of 4–5 h at temperatures <15°C. At temperatures >15°C, *M. californicus* was active throughout the night with a bimodal flight pattern characteristic of insectivorous species (O'Farrell and Bradley, 1970). In British Columbia, the peak activity periods of *M. californicus* occurred from 2200 to 2300 h and 0100 to 0200 h (Woodsworth, 1981). Minimum body temperature at which flight occurs in *M. californicus* is 26.25°C (range, 22.4–29.6°C). *M. californicus* is most active during the early hours of the evening with foraging beginning soon after sunset. It hunts and feeds rapidly then retires to a night roost for a brief rest, after which it resumes hunting (Woodsworth, 1981). Foraging usually occurs <3 m above the ground (O'Farrell et al., 1967). In British Columbia, *M. californicus* emerged at 2145 h to hunt 5 m from a river's edge, at heights ranging from 1 m off the ground to the top of the tree canopy. Flight activity in *M. californicus* is reduced in gusty and strong winds. *M. californicus* is a short-range forager, flying slowly, with frequent abrupt changes in direction that coincide with pursuit of insects (Woodsworth, 1981). It resembles *M. lucifugus* in this respect. There is no indication of territorial behavior when hunting, nor has it been observed to hunt in groups (Fenton et al., 1980).

Echolocations of *M. californicus* have a sweep rate of 2 ms/division, and are dominated by steep frequency modulated sweeps with smooth transitions to the shallow frequency modulated components (Fenton et al., 1983). Call duration is 0.5–2.5 ms. When approaching a landing site, *M. californicus* produces a high-pulse repetition rate (Fenton and Bell, 1979).

GENETICS. Allele frequencies and levels of heterozygosity in *M. californicus* have been assayed for 21 proteins representing presumed loci by electrophoretic techniques (Straney et al., 1976). Three loci, esterase-1, 6-phosphogluconate dehydrogenase, and hemoglobin showed the greatest degree of heterozygosity in this species.

The karyotype of *M. californicus* conforms to that of most other species of *Myotis*. The autosomes consist of 4 metacentric pairs (three large, one small) and 17 acrocentric pairs. The X and Y chromosomes are submetacentric. Diploid and fundamental numbers are 44 and 50, respectively (Baker and Patton, 1967).

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