MORPHOLOGICAL DIFFERENCES BETWEEN TWO WHITE-FOOTED MICE, *PEROMYSCUS BOYLII* AND *PEROMYSCUS CALIFORNICUS*, IN OAK WOODLANDS OF FRESNO COUNTY, CALIFORNIA

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ABSTRACT: Identification of *Peromyscus* species in the field can often be time consuming and inaccurate. Determination of several morphological characteristics is usually required for reliable identification. Characteristics may differ only slightly, can be highly variable, or can overlap among species. In oak woodlands of the southern Sierra Nevada in Fresno county, most identifying characteristics of the two dominant *Peromyscus* species, brush mouse *(P. boylii)* and California mouse *(P. californicus)* overlapped considerably. Weight, body length, tail length, hind foot length, dorsal tail-stripe width, and ear length were usually sufficient for accurate species identification. Hind foot length and dorsal tail-stripe width were the most reliable of the identification criteria examined. For hind foot length, no significant difference was found between juveniles and adults within each species. Hind foot lengths overlapped slightly between species, ranging from 20 to 25 mm for brush mice and 24 to 28 mm for California mice. Dorsal tail-stripe width had the lowest overlap between species. All of the brush mice had dorsal tail-stripes less than or equal to half the tail circumference, and 98 percent of the California mice had dorsal tail-stripes greater than half. Use of hind foot length and dorsal tail-stripe width as key field identifiers was an expedient and accurate approach for distinguishing these two species.

Key words: brush mouse, California mouse, characteristics, identification, measurements, morphology, *Peromyscus boylii, Peromyscus californicus,* white-footed mice.

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Morphological characteristics (e.g., tail length, hind foot length) of small mammals are often used to identify species. For capture/release studies, species determination is dependent solely on these kinds of external measurements, and must be accomplished with minimal handling of animals. Therefore, it is important that identification be accurate and timely.

The various species of white-footed mice (*Peromyscus* spp.) can be difficult to distinguish. External differences among some species may be so subtle that the criteria applied in a field situation may lead to inaccurate species identification, especially for inexperienced observers. Morphological characteristics can also be extremely variable with a high degree of overlap among species. Identification becomes even more difficult when dealing with immature animals where most morphological features are not fully developed, and often do not fit published species descriptions.

Our objectives in this paper are to: (1) report on the morphological characteristics of brush mice (*Peromyscus boylii*) and California mice (*P. californicus*) in the oak woodlands of the southern Sierra Nevada, and (2) determine if there are key identification characteristics that quickly and reliably differentiate between these two species in field situations.

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STUDY AREA

Our study area consisted of three 6.25-hectare oak woodland sites in the foothills of the Sierra Nevada in eastern Fresno County. Elevation ranged from 300 m to 450 m. All three sites were within 2 km of the Kings River. Vegetation composition varied somewhat from site to site, but in general, overstories were dominated by oaks (*Quercus wislizenii and Q. douglasii*), with some gray pine (*Pinus sabiniana*) and California buckeye (*Aesculus californica*). Understories were dominated by ceanothus (*Ceanothus* spp.), poison oak (*Toxicodendron diversiloba*), and manzanita (*Arctostaphylos* spp.) with some chaparral honeysuckle (*Lonicera interrupta*), and redberry (*Rhamnus crocea*). Canopy closure varied from a very dense over story and understory to a relatively open overstory and understory.

METHODS

We livetrapped small, nocturnal mammals from midspring to early summer and from late summer to midautumn in 1993 and 1994. Tomahawk No. 201 steel mesh traps (12.7 cm x 12.7 cm x 40.6 cm.) and Sherman XLK

folding traps (7.7 cm x 9.5 cm x 30.5 cm) were set on the ground and low in trees on 7 x 7 trap grids with traps spaced 15 m apart. We also trapped at woodrat houses.

Each small mammal captured was ear-tagged and specific measurements were taken. We also recorded species, age (juvenile, subadult, adult), sex, and reproductive condition. Measurements taken (to the nearest gram or millimeter) were weight, body length, tail length, hind foot length (toe-nails included), and ear length (measured from the base of the ear notch to the tip of the ear). Qualitative information collected on the pigmentation of the tail were degree of tail bicoloration (none, indistinct, moderate, distinct) and width of dorsal tail-stripe (<, =, or > half the tail circumference). Qualitative information measures were based on those found in the literature and were determined visually.

We classified animals to species using published morphological characteristics (e.g., weight, tail length, body length, ear length, hind foot length, tail bicoloration, and dorsal tail-stripe width)(Ingles 1965, Burt and Grossenheider 1976, Merritt 1978, Hall 1981, Hoffmeister 1981, Jameson and Peeters 1988).

We analyzed measurements of 239 brush mice and 58 California mice. Not all animals were included in all analyses, however, because their measurements were not ascertainable in the field or were not useful, such as when part of the tail was missing.

We compared all measurements between the species and for sex and age groups within each species. In some cases, juveniles and subadults were grouped together for analyses, and were referred to as immatures. We used histograms to illustrate the overlap between the two species for each identifying characteristic. Scattergrams were used to display species overlap for two measurements combined. For scattergram comparisons, we replaced the dorsal tail-stripe width categories of <, =, and > half the tail circumference with 0.25, 0.5, and 0.75 respectively. We added a small amount of random noise to each variable to reduce the overlap of repeated values (Chambers et al. 1983). We used unpaired t-tests to determine if there were significant differences in the means of the measurements between sexes and ages of each species.

RESULTS

Using seven identification criteria was sufficient for differentiating 239 brush mice from 58 California mice out of a total of 300 animals. However, measurements overlapped considerably for five of the seven characteristics (Table 1). Adult brush mice and immature (juvenile and subadult) California mice accounted for 53 percent of the species overlap in ear length, 72 percent in body length, and 100 percent in tail length, weight, and tail bicoloration.

The two characteristics with the least overlap between species were hind foot length and dorsal tail-stripe width

Table 1. Range of measurements for external identifying characteristics of *Peromyscus boylii* and *P. californicus* in the southern Sierra Nevada, Fresno Co., CA

	Brush Mouse			California Mouse		
	Field Results		Literature[1]	Field Results		Literature
	Adults	All Ages	Adults	Adults	All Ages	Adults
Body Lgth (mm)	75-108	59-108	91-107	85-123	83-123	96-117
Tail Lgth (mm)	84-116	71-116	90-132	104-136	101-136	117-156
Hind Ft Lgth(mm)	20-25	20-25	17-26	24-28	24-28	24-31
Ear Lgth (mm)	12-24	12-24	15-20	19-25	16-25	20-28
Weight (gm)	20-37	12-37	22-36	32-49	23-49	33-55
Dor Tail Str[2]	<, =	<, =		>	>, =	
Tail Bicolor[3]	I, M, D	I, M, D		I, M, D	I, M, D	N, I

[1] Information in the literature from Ingles (1965), Burt and Grossenheider (1976), Merritt (1978), Hall (1981), and Jameson and Peeters (1988)

[2] Dorsal tail-stripe width relative to half of the tail circumference: < is less than half; = is equal to half; > is greater than half

[3] Intensity of tail bicoloration: I = indistinct; M = moderate; D = distinct; N = none

(Figs. 1, 2). Hind foot length ranged from 20 to 25 mm for brush mice and from 24 to 28 mm for California mice. Mean hind foot length was not significantly different between juveniles and adults within species ($P = .0577$ for brush mouse; $P = .1014$ for California mouse), whereas, mean weight, body length, and tail length were significantly different ($P = .0011$ for California mouse tail length; $P < .0001$ for all others).

The dorsal tail-stripe width of brush mice and California mice overlapped the least of any characteristic (Fig. 2). All but one California mouse had dorsal tail-stripe widths greater than half the tail circumference. All brush mice had dorsal tail-stripe widths less than or equal to half. The visual contrast between the tails of each species was quite apparent (Fig. 3, 4).

Scattergrams of paired characteristics showed low overlap between the species for most pairs that included hind foot length or dorsal tail-stripe width, but showed high overlap for all other comparisons. A scattergram of hind foot length and dorsal tail-stripe width, the two variables with the least amount of overlap between the two species, showed no overlap (Fig. 5).

DISCUSSION

The criteria available for identifying brush and California mice in the field clearly differentiated the two species, in almost all cases, when all criteria were used concurrently. However, several measurements exhibited a high degree of variability and overlap among species. Furthermore, when doing field work, it is desirable to minimize the number of measurements taken.

Variability can result from differences in individuals within a species, or from varying measuring techniques. Tail lengths reported for California mouse were 117-148 mm (Ingles 1965), 127-147 mm (Burt and Grossenheider 1976), and 117-156 mm (Merritt 1978)(Table 1). Measuring techniques often vary between investigators. Ear pinnae are easily distorted; measurements are dependent on how much and in which direction the ear is "stretched," or held. Body length can also vary greatly depending on how the body is held during measuring. Of newborn white-footed mice, Layne (1968: 170) states "... total length [body length plus tail length] is a more difficult measurement to take than that of tail or hind foot..." thus producing "... inaccuracies in the available data." Biological factors can also affect measurements. Weight can vary depending on the animal's health, stomach content, amount of body fat, and reproductive condition. Tail length and ear length can be substantially reduced as a result of partial or complete loss of the appendage. Of all criteria examined, hind foot length and dorsal tail-stripe width were the most accurately measured. They are not easily distorted or affected by the manner in which held, and are rarely altered from injuries.

The amount of species overlap for each measurement, whether a result of measurement variability or just a product of size similarities between species, is also important when determining which characteristics are accurate

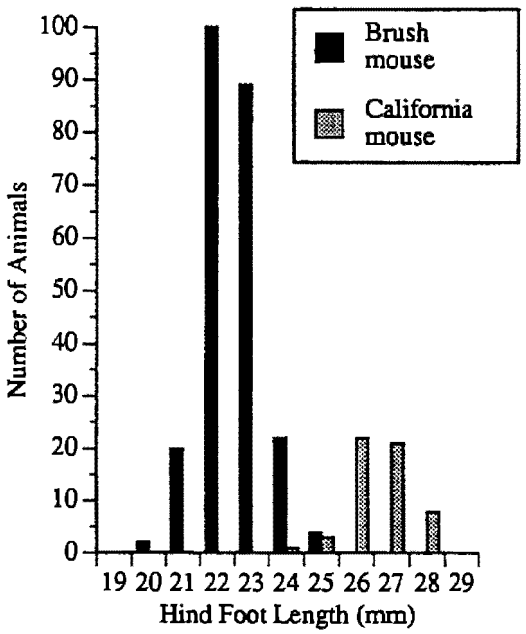

Fig. 1. Hind foot lengths (mm) of brush mice and California mice.

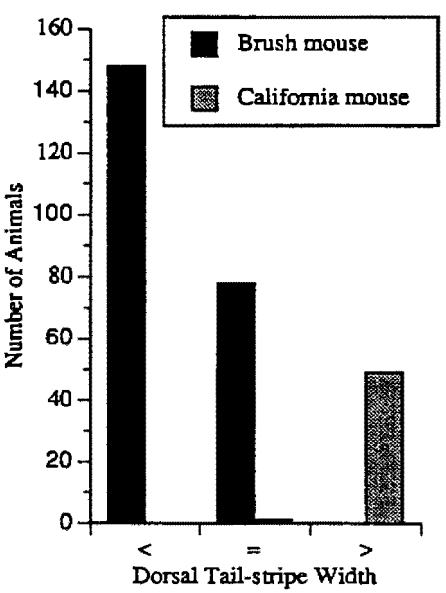

Fig. 2. Dorsal tail-stripe width relative to half the tail circumference of brush mice and California mice.

Within the Sierra Nevada foothills of eastern Fresno county, hind foot length and dorsal tail-stripe width proved to be the most useful external criteria for species identification. Our findings warrant further investigation to determine the extent to which these same criteria can be used in other areas.

LITERATURE CITED

Burt, W.H., and R.P. Grossenheider. 1976. A Field Guide to the Mammals. Houghton Mifflin Co., Boston, MA. 289pp.

Chambers, J.M., W.S. Cleveland, B. Kleiner, and P.A. Tukey. 1983. Graphical methods for data analysis. Wadsworth & Brooks/Cole Publishing Co., Pacific Grove, CA. 395pp.

Hall, E.R. 1981. Mammals of North America. 2nd ed. John Wiley & Sons, New York, NY. 1181pp.

Hoffmeister, D.F. 1981. *Peromyscus truei*. Mammal. Species 161.

Ingles, L.G. 1965. Mammals of the Pacific States: California, Oregon, and Washington. Stanford University Press., Stanford, CA. 506pp.

Jameson, Jr., E.W. and H.J. Peeters. 1988. California mammals. University of California Press, Berkeley and Los Angeles, CA. 403pp.

Layne, J.N. 1968. Ontogeny. *In* J.A. King, (ed.) Biology of *Peromyscus* (Rodentia). Amer. Soc. of Mammal., Spec. Publ. No. 2:148-253.

Merritt, J.F. 1978. *Peromyscus californicus*. Mammal. Species 85.