Peromyscus boylii and *Peromysus californicus* Differ in Physical Characteristic Measurements

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Abstract

I provide a comparison of physical characteristics between *Peromyscus boylii* and *Peromyscus californicus*. All mice compared were captured in the dominant regions of the Los Padres National Forest during three different years – 2005, 2011, and 2014. The dominant regions of the Los Padres National Forest include Riparian, Woodlands, and Chaparral. All characteristics, ear (from notch), head and body, hind foot, tail, and weights, were compared between males of each species and then between females of each species. All data were analyzed in JMP 12. Out of all the characteristics, tail and weight had the greatest difference between the species. As predicted, *Peromyscus californicus* were found to be overall larger than *Peromyscus boylii*.

Introduction

Physically, mice, especially those within the same genus, are difficult to differentiate (Seifert, 2016). *Peromyscus boylii (P. boylii),* commonly known as the brush deermouse, and *Peromyscus californicus (P. californicus),* commonly known as the California mouse, overlap in habitat areas particularly along the Central and Southern Californian coast (Kalcounis-Rueppell, 2009; Merrit, 1978). These species, like other species of mice, are difficult to differentiate from each other. Therefore, these two species not only co-occur, but they are also difficult to distinguish from each other when individuals are captured in the wild. In order to assist researchers, it is important to develop methods that allow researchers working in the wild to differentiate between various *Peromyscus* species. Our study considered *Peromyscus* captured in the Hi Mountain area of the Los Padres National Forest, which include the San Luis Obispo, Santa Barbara, Ventura, Kern, and a part of the Los Angeles County. The Hi Mountain area includes some areas of overlap between these two species. The dominant communities in the Los Padres National Forest are Riparian, Woodlands, and Chaparral, so we observed *Peromyscus* from these various communities in order to sample some of the potential diversity or variation in these two species.

Although *P. boylii* and *P. californicus* physically look alike, I hypothesize that various physical measurements of each species will help in distinguishing *P. boylii* from *P. californicus*. Because *P. californicus* males are more aggressive and territorial (Merrit, 1978), I predict *P. californicus* will be physically larger than *P. boylii.* In addition, I evaluated the utility of standard measurements that are normally taken from rodents when working to identify them to species. Therefore, our results should have relevance and seem applicable to any researcher working with either of these species in the wild.

Methods

All data analyzed was provided by Dr. Francis Villablanca from California Polytechnic State University, San Luis Obispo. Data provided were divided into various Hi Mountain habitat types (Riparian, Woodlands, and Chaparral) and years (2005, 2011, 2014). Data were collected from live captured rodents. Captures were completed on small mammal trapping grids. Ten grids were sampled per habitat type. Three habitat types, sampled with ten plots each, with 18 traps per plot, and traps run for three consecutive nights, yielded a total of 1,620 trap-nights. For more information on field data collection methods of *Peromyscus* see A Comparison of Small

Mammal Abundance and Diversity in chaparral, oak woodland and riparian habitats before and during the historic California Drought of 2013-2014 (Saldo, 2015) and Effect of the 2013-2015 California Drought on Small Mammal Abundance and Diversity in Chaparral, Oak Woodland and Riparian Habitats (Desideri, 2016).

P. boylii and *P. californicus* data were separated out from the rest of the data set. Some of the individuals were captured more than once; however, those individuals were only retained once in our dataset, such that each individual contributes an equal amount of information to the analysis. The subadults were also taken out of the dataset and then *P. boylii* and *P. californicus* were separated by species and the species were separated into males and females. Therefore the analysis is of adults of each species, while also potentially considering sexual dimorphism.

A one-way ANOVA was conducted on each of the physical measurements of ear (from notch), head and body, hind foot, tail, and weight comparing *P. boylii* and *P. californicus* of the same sexes. All measurements were in millimeters except for weight which was recorded in grams. A student's t test was conducted on data that was found to be significant using the one-way ANOVA. These two tests have different assumptions and we wanted to see if there was any potential effect of violating these assumptions. All statistics were analyzed using JMP 12.

Results

The total number of unique individual adults and sub-adults found in the Hi Mountain region over 1,620 trap-nights was 188 for *P. boylii* and 152 for *P. californicus.* Without the sub-adults, the total number of individuals remaining in the data set for *P. boylii* was 135 and for *P. californicus* was 104 (Table 1). All characteristics – ear length, head and body length, hind foot length, tail length, and weight – were compared between *P. boylii* and *P. californicus* of the same sex.

All characteristics of females were different using a one-way ANOVA and a student's t-test with $p < 0.0001$ and $0.025 < p < 0.05$ respectively (Table 2). The range of each trait between the females of each species overlap; however, a greater difference in mean is seen in tail length and weight compared to all other traits. The results for males were the same; all characteristics were significantly different (Table 3). Likewise, the range of each trait between the males of each species overlap; however, a greater difference in mean is seen in tail length and weight compared to all other traits. Overall, for all characteristics the mean value was longer or larger in *P. californicus* than in *P. boylii* (Figures 1-4).

Table 1. The number of adult *Peromyscus boylii* and *Peromyscus californicus* captured in the High Mountain area and used in an analysis of body measurements.

Species	Males	Females	Total
Peromyscus boylii	65	70	135
Peromyscus californicus	64	40	104

Table 2. The p-values for one-way ANOVA and student's t-test comparing mensural characteristics of female *Peromyscus boylii* and *Peromyscus californicus.* The mensural traits are standard traits used to differentiate between species of rodents.

Characteristics	One-way ANOVA p-value	Student's t-test p-value
Ear	$p<0.0001$	$0.025<p<0.05$
Head and Body	$p<0.0001$	$0.025<p<0.05$
Hind Foot	$p<0.0001$	$0.025<p<0.05$
Tail	$p<0.0001$	$0.025<p<0.05$
Weight	$p<0.0001$	$0.025<p<0.05$

Table 3. The p-values for one-way ANOVA and student's t-test comparing characteristics of male *Peromyscus boylii* and *Peromyscus californicus.* The mensural traits are standard traits used to differentiate between species of rodents.

Characteristics	One-way ANOAVA p-value	Student's t-test p-value
Ear	$p<0.0001$	$0.025<p<0.05$
Head and Body	$p<0.0001$	$0.025<p<0.05$
Hind Foot	$p<0.0001$	$0.025<p<0.05$
Tail	$p<0.0001$	$0.025<p<0.05$
Weight	$p<0.0001$	$0.025<p<0.05$

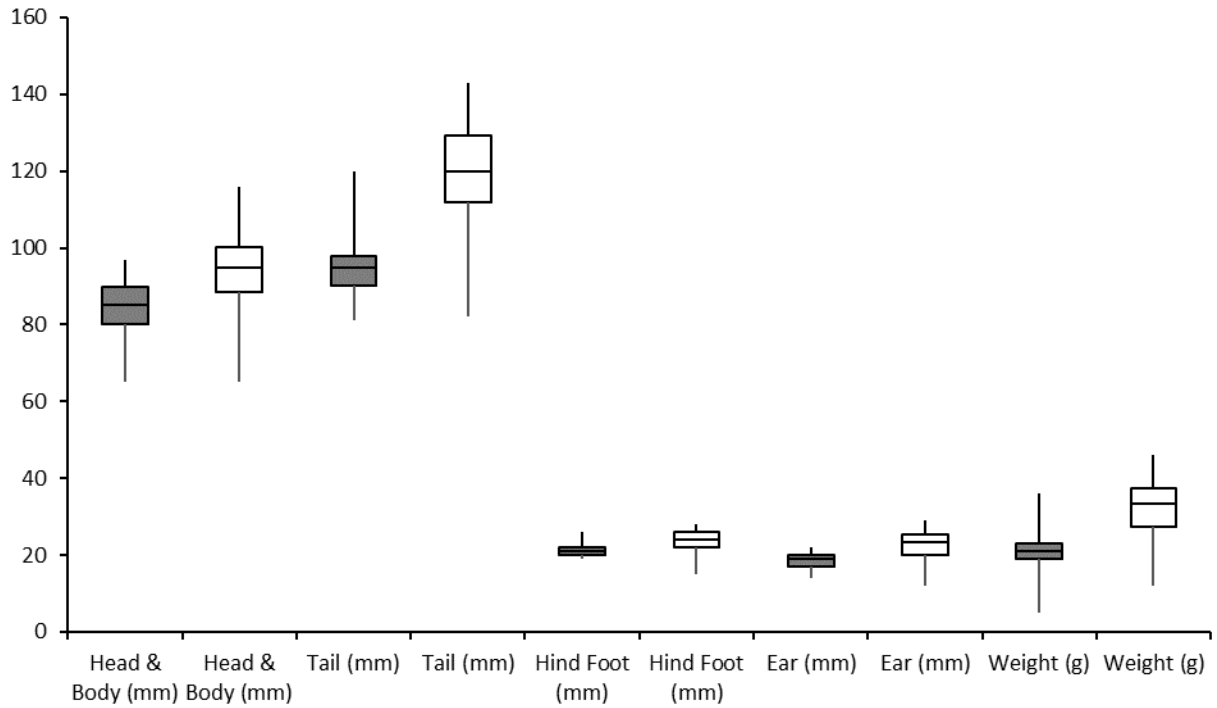

Figure 1: Head and body (mm), tail (mm), hind foot (mm), ear (mm), and weight (g) measurements for female *Peromyscus boylii* (n=70; gray) and female *Peromyscus californicus*

(n=40; white) of the Hi Mountain region. Female *P. californicus* are larger or longer than *P. boylii* for all measurements.

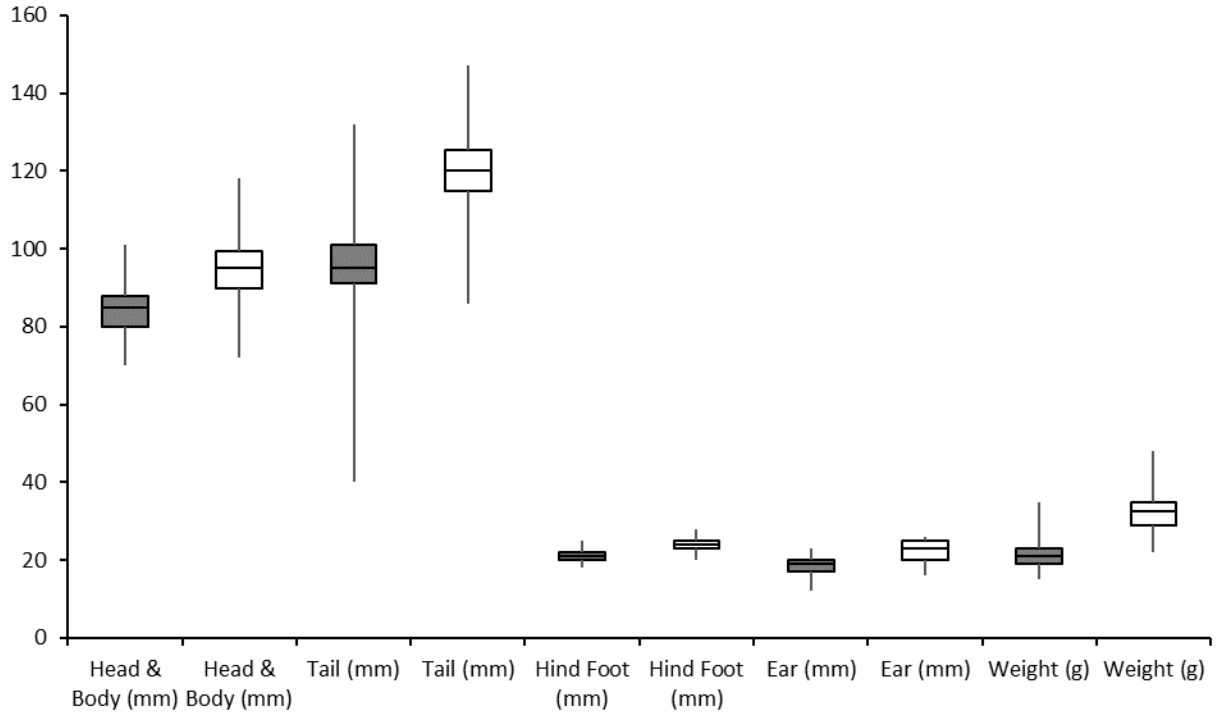

Figure 2: Head and body (mm), tail (mm), hind foot (mm), ear (mm), and weight (g) measurements for male *Peromyscus boylii* (n=65; gray) and male *Peromyscus californicus* (n=64; white) of the Hi Mountain regions. Male *P. californicus* are larger or longer than *P. boylii* for all measurements.

Discussion

In this study, we found that all characteristics that are normally used to differentiate between rodent species, when analyzed one sex at a time, could be used to differentiate between two species of *Peromyscus, boylii and californicus.* In spite of the fact that some values did overlap, they were all significantly different at the population level. In the adult form, it was found that across all measurements *P. californicus* are generally larger than *P. boylii.*

Although all characteristics compared between the same sexes were different, a range of overlap is seen with all characteristics; therefore, it is important to note which characteristics would be best to compare between the species to accurately identify individuals of the species. For females, the greatest difference in mean values between the species was found in the tail with 94.7 mm for *P. boylii* and 118.6 mm for *P. californicus.* The second characteristic with the greatest difference in mean between the species in females was found to be weight with 21.4 g for *P. boylii* and 32.2 g for *P. californicus* (Table 4). Likewise, in males, the greatest difference in mean values between the species was found in the tail with 96.3 mm for *P. boylii* and 120 mm for *P. californicus*. The second characteristic with the greatest difference in mean between the species in males was found in weight with 21.9 g for *P. boylii* and 32.5 g in *P. californicus* (Table 5).

Therefore, a comparison between tail length and weight between *P. boylii* from *P. californicus* of the same sex could be enough to distinguish between the species. Keeping in mind that *P. californicus* are overall larger than *P. boylii* could also be a good indicator of the species. *P. boylii* and *P. californicus* are very similar in semblance; therefore, knowing certain physical characteristic, and especially those associated with sizes, could help in distinguishing between the species. The sub-adults were not analyzed in this study due to allometry – the idea that various parts of the body grow at different rates when maturing. Sub-adult *P. boylii* are thought to have longer tails when compared to adults; therefore, certain characteristics would have been skewed if sub-adults were analyzed in this study (Binder, 2009).

Table 4. The mean values and 95% confidence internals of each characteristic between females of *Peromyscus boylii* and *Peromyscus californicus.*

	P. boylii		*P. californicus*	
Characteristics	Mean	95% CI	Mean	95% CI
Head and Body (mm)	84.7	$82.99579 \leq x \leq 86.34701$	93.9	$90.32390 \leq x \leq 97.42610$
Tail (mm)	94.7	$93.01350 \leq x \leq 96.41490$	118.6	$113.90763 \leq x \leq 123.34237$
Hind Foot (mm)	21.1	$20.79833 \leq x \leq 21.43007$	23.5	$22.65424 \leq x \leq 24.32076$
Ear (mm)	18.4	$17.89976 \leq x \leq 18.87164$	22.9	$21.74095 \leq x \leq 24.00905$
Weight (g)	21.4	$20.42675 \leq x \leq 22.44465$	32.2	$29.82024 \leq x \leq 34.65476$

Table 5. The mean values and 95% confidence intervals of each characteristic between males of *Peromyscus boyii* and *Peromyscus californicus.*

	P. boylii		*P. californicus*	
Characteristics	Mean	95% CI	Mean	95% CI
Head and Body (mm)	84.4	$82.70285 \leq x \leq 86.15855$	94.3	$92.18586 \leq x \leq 96.37654$
Tail (mm)	96.3	$93.39274 \leq x \leq 99.13026$	120.0	$117.40821 \leq x \leq 122.55979$
Hind Foot (mm)	20.9	$20.60229 \leq x \leq 21.27451$	2.1	$23.65735 \leq x \leq 24.56125$
Ear (mm)	18.6	$18.03457 \leq x \leq 19.10383$	22.4	$21.72557 \leq x \leq 23.14943$
Weight (g)	21.9	$20.89865 \leq x \leq 22.85515$	32.5	$31.10354 \leq x \leq 33.95886$

There is a third species of *Peromyscus* in the Hi Mountain area, *P. maniculatus*, the deer mouse. (Saldo, 2015; Desideri, 2016). That species was not included in this analysis because it can easily be told from the two species being considered here. *P. maniculatus* has a tail that is shorter than the head and body (Villablanca *pers. comm.*). As can be seen in Figures 1 and 2, and Tables 4 and 5, the species considered here both have a tail that is longer than the head and body. If there are any *P. maniculatus* that were misclassified as *P. boylii* in this data set, then they would be the individuals in the sample with the shortest tails. A total of six *P. boylii* (five females and one male or 4.4% of the total *P. boylii*) analyzed had tails shorter than the head and body. It seems very unlikely that many *P. boylii* were misclassified as *P. californicus*, given that the statistical analysis asks - what is the probability that we would find this level of difference, by change alone, if the two samples were drawn from the same population (distribution)? Therefore, the analysis provided herein corroborate the identifications completed by the researchers in the wild,

and further identify and resolve which characteristics are the most useful and distinct between the two species with a tail longer than the head and body.

Sources

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