MORPHOLOGICAL VARIATION IN THE SINALOAN MOUSE *Peromyscus simulus*

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ABSTRACT.- We examined geographic and non-geographic variation in 23 quantitative characters of the cranium and body for samples of *Peromyscus simulus* from throughout the range of the species in Sinaloa and Nayarit, Mexico. Univariate statistical analyses indicated little non-geographic variation associated with either sex or age. Geographic variation was evident among samples, with northern, inland representatives averaging smaller in size and showing some degree of distinction from southern, coastal samples. However, the degree of this differentiation is not sufficient to warrant the delineation of subspecies. Available evidence suggest *P. simulus* has a relative narrow preference for wetland and riparian habitats within its geographic range. These habitats are subject to increased development in this region of Mexico, and, for this reason, the conservation status of the species should be carefully monitored in the future.

RESUMEN.- Examinamos la variación geográfica y no geográfica de 23 caracteres cuantitativos del cuerpo y cráneo de muestras de *Peromyscus simulus* a lo largo de la distribución de la especie en los estados de Nayarit y Sonora, México. Análisis estadísticos univariados mostraron poca variación no geográfica asociada con el sexo o la edad. Fue evidente la variación geográfica en muestras de representantes de islas al norte, siendo estas de menor tamaño en promedio y mostrando una ligera diferencia con respecto a las muestras costeras y más sureñas. Sin embargo, el grado de esta diferenciación no es suficiente para garantizar el límite de una subespecie. La evidencia disponible, sugiere que *P. simulus* tiene, relativamente, una preferencia por hábitats riparios y humedales dentro de su rango geográfico. El desarrollo de estos hábitats se ha incrementado en las últimas décadas; por esta razón, en el futuro el estado de conservación de la especie debe ser monitoreado cuidadosamente.

Key words: *Peromyscus simulus*, morphological variation, Sinaloan mouse, Sinaloa, Nayarit, México.

INTRODUCTION

Peromyscus simulus is the smallest and most geographically restricted of the 11 species in the *P. boylii* species group (Carleton, 1977, 1979, 1989; Carleton et al., 1982; Schmidly et al., 1988). The species is characterized by a shorter rostrum, molar

toothrow, and glans penis than other species in the *boylii* species group (Carleton, 1977, 1979). Its entire range encompasses a narrow rectangular strip along the lowland tropical forest, coastal palm groves, and mangrove swamps on the coastal plains of Sinaloa and Nayarit at elevations ranging from sea level to generally less than 200 m (Carleton, 1989; Carleton et al., 1982).

Peromyscus simulus originally was described by Osgood (1904) as a subspecies of *P. spicilegus* because of the similarity in pelage color between the two taxa. Later, in his revision of *Peromyscus*, Osgood (1909) arranged both *spicilegus* and *simulus* as subspecies of *P. boylii*, referring to *simulus* as a coastal representative of the more montane form *spicilegus*. Carleton (1977) raised both *simulus* and *spicilegus* to species status for several reasons: their sympatric occurrence in Nayarit (Carleton, 1977, 1989; Carleton et al., 1982) with no indication of intergradation in contact areas (Baker and Greer, 1962; Carleton, 1989); their ready identification using characters of the skull (Hooper, 1955, 1958), phallus (Bradley and Schmidly, 1987; Carleton, 1977; Carleton et al., 1982), and karyotype (Schmidly and Schroeter, 1974; Smith et al., 1989); and their occupation of different elevational zones (*simulus* in the lowland tropical forest and thorn scrub of the coastal plains and *spicilegus* in both the coastal lowlands and the higher elevations of the Sierra Madre Occidental; Carleton, 1977, 1989).

The studies of Carleton (1977, 1979) and Carleton et al., (1982) sustained the differences between *P. simulus* and *P. spicilegus* and suggested that the former belonged to an assemblage within the *P. boylii* species group comprised of the taxa *attwateri*, *boylii*, *pectoralis*, and *stephani*, whereas the latter formed an assemblage with *aztecus* and *winkelmani*. A phylogenetic study of the phallus (Bradley and Schmidly, 1987) showed *P. simulus* and *P. spicilegus* to be distantly related, in support of Carleton's (1977) interpretation.

Carleton (1989), in his review of systematics and evolution in the genus *Peromyscus*, described *simulus* as a monotypic species with morphological and karyological affinities to *P. madrensis* on the Tres Marias Islands and *P. boylii rowleyi* in the higher elevations of the Sierra Madre Occidental and adjacent Mexican Plateau. Earlier, Carleton et al., (1982) had argued for a close phylogenetic relationship between *simulus* and *madrensis* on zoogeographic grounds as well as on the basis of cranial, phallic and karyotypic similarities.

There have been no comprehensive studies of population variation (non-geographic or geographic) in *P. simulus*, nor is much known about its biology. As part of a research project to asses the systematics of the *P. boylii* species group in Mexico, we had the opportunity to collect *P. simulus* in many parts of its range and to examine most specimens already in collections. This material constitutes the basis for a statistical assessment of morphological variation within and among populations of the Sinaloan mouse as well as providing first-hand knowledge about the conservation status of this species.

METHODS AND MATERIALS

A total of 164 adult specimens of *P. simulus* and *P. boylii* from the coastal region of western Mexico, including type and topotype specimens of *P. simulus*, were examined for 23 quantitative characters (see Specimens Examined for locality information). Adult specimens were examined and placed into three adult ages classes (IV, V, and VI) based on tooth wear (see Schmidly, 1973). Five external characters were recorded from specimens as follows: total length (TOL), length of tail (TAL), length of body (BDL), length of hind foot (HFL), and length of ear (EAL). Eighteen characters of the cranium were measured (as described by Carleton et al., 1982) either with dial calipers or an ocular micrometer. These were: greatest length of skull (GSL), length of rostrum (LR), length of nasal bones (LN), postpalatal length (PPL), zygomatic breadth (ZB), breadth of braincase (BB), mastoid breadth (MB), least interorbital width (LLW), length of molar toothrow (LMR), length of incisive foramen (LIF), length of auditory bullae (LAB), depth of braincase (DDB), length of braincase (DB), length of mesopterygoid fossa (LMF), length of bony palate (LBP), breadth of rostrum (RB), greatest breadth across molars (BAM), postdental palatal breadth (PDB), and width of mesopterygoid fossa (WMF).

Specimens were grouped into 12 locality samples (Fig. 1), based on geographic proximity and similarity of habitat and elevation, for purposes of statistical evaluation of population variation. Sample 1 from Pericos, Sinaloa, was included as a reference sample of *P. boylii rowleyi* to assess the degree of morphological distinction between that taxon and *P. simulus*. Samples 4 (n = 21) and 8 (n = 39) of *P. simulus*, which contained the largest number of adult individuals, were used to assess the extent of variation in external and cranial measurements among the three adult age classes in that species. ANOVA and Duncan's multiple range tests of the Statistical Analysis System (SAS, 1985) were used to determine if significant variation existed among age classes or between sexes. A three-level nested analysis (Varicomp option of SAS, 1985) was used to estimate the variance components of morphological characters attributed to differences: 1) among localities; 2) between sexes within localities; 3) among age classes within sexes within localities; 4) interactions of localities, sex and age; and 5) residual or error variation. The residual effects represent random factors, such as environmental and seasonal influences, which cannot be attributed to locality, sex or age variation alone. ANOVA and Duncan's multiple range test were used to evaluate geographic variation among individual characters.

Several multivariate statistical procedures from the Numerical Taxonomy Program (NT_SYS) of Rohlf and Kispaugh (1972) were used to evaluate the relationships of samples in multivariate character space. The first three principal components were calculated from the character correlation matrix of standardized means and projected in a three-dimensional diagram to visually assess the morphological relationship among samples. A minimum spanning tree analysis was superimposed on the principal components analysis to depict the shortest path connecting all samples in

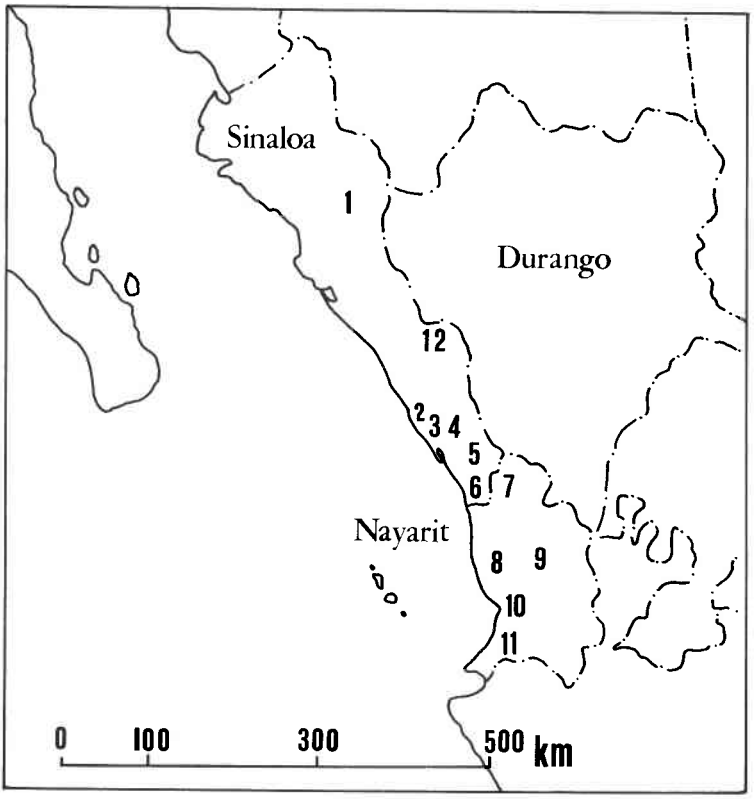

Figure 1.- Map of western Mexico indicating location of the 12 samples used in the univariate and multivariate analyses of morphological variation. Only the principal Mexican states (Sinaloa and Nayarit) are identified. Locality numbers correspond to those listed in Appendix. Sample 1 is a reference sample of *P. boylii rowleyi.*

the unreduced multivariate character space. Average taxonomic distances of standardized means were calculated and a phenogram depicted to cluster samples based on phenetic affinities using the method of unweighted pair-groups based on arithmetic averages (UPGMA).

RESULTS AND DISCUSSION

Averaging the variance components for the 23 characters, and expressing them as a percentage of the total, revealed that most of the morphological variation among samples of *P. simulus* was attributable to residual effects (65.44%; range, 40.91-86.19%) followed by interactions of locality, sex and age (22.70%; range, 1.52-

69.81%), locality (9.08%; range, 0.00-28.64%), age (2.16%; range, 0.00-6.79%), and sex (0.61%; range, 0.00-5.08%). Locality, sex, and age generally accounted for less than 10% of the variation among the total character set, although locality was responsible for 28.64% of the variation in TAL, 22.22% for PDB, and 16.55% for BAM, and age accounted for 15-10% of the variation in ZB.

The univariate and variance components analyses revealed little variation in *P. simulus* associated with either sex or age. In the variance components analysis, sex and age accounted for an average of only 0.61% and 2.16% of the variation associated with each character, respectively, and residual effects accounted for an average of more than 30 times the variation than did either sex or age. For these reasons, males and females, as well as individuals in age classes IV, V and VI, were combined for the purpose of assessing geographic variation. These data are typical for other taxa in the *P. boylii* species group, such as *P. beatae*, *P. boylii rowleyi*, *P. levipes levipes*, and *P. levipes ambiguus*, which also reveal small amounts of variation associated with either sex or age (Bradley et al., 1989, 1990; Schmidly et al., 1988). The coefficients of variation (CVs) for measurements of *P. simulus* (4.52 and 4.66 for samples 4 and 8, respectively) are comparable to similar data available for *P. eremicus* (4.75) and *P. pectoralis* (4.42), but considerably higher than the average CV for similar measurements (3.42) of *P. hooperi* (Schmidly et al., 1985).

Significant geographic variation was evident in 18 of 23 external and cranial measurements among the 12 samples (see Table 3). The most divergent specimens were those of sample 1 (*P. boylii rowleyi*) from near Picos, Sinaloa. This sample is separated by almost 200 km from the nearest samples of *P. simulus* to the south. In most measurements specimens from sample 1 were smaller in size compared to those of other samples, although a Duncan's multiple range mean test revealed statistical overlap between sample 1 and either sample 2 (Mazatlán, Sinaloa) or 12 (San Ignacio, Sinaloa) in many measurements. The largest mice were from two of the coastal samples of *P. simulus* (sample 6 from Teacapan, Sinaloa, and sample 11 from Las Varas, Nayarit).

All but five characters (BDL, LIF, LAB, LMF, and WMF) revealed statistical significant differences (ANOVA; $P < 0.05$) among localities. However, a Duncan's multiple range test on locality means revealed only two characters (HFl and LLW) with non-overlapping subsets. For HFL, sample 11 was significantly different from the other samples; and for LLW, sample 12 was significantly different. The remaining characters displayed overlapping subsets among populations, but a clear-cut geographic pattern was not evident. In the principal component analysis (PCA), the first component accounted for 43.18% of the phenetic variation; the second component, 14.53%; and the third component, 12.14% (Fig. 2). Component I revealed positive loadings for all characters (Table 2), reflecting size gradations among the samples. Component II had a positive loadings for all loadings for some measurements (LLW, LAB, PDB, and WMF), but negative loadings for others (LR, LN, and DB). This contrasting pattern, which is indicative of skull shape distinctions among the samples, also was evident for component III (LN, LMR, LMF, and LBP had a large positive loadings; LIF and RB had a large negative loadings).

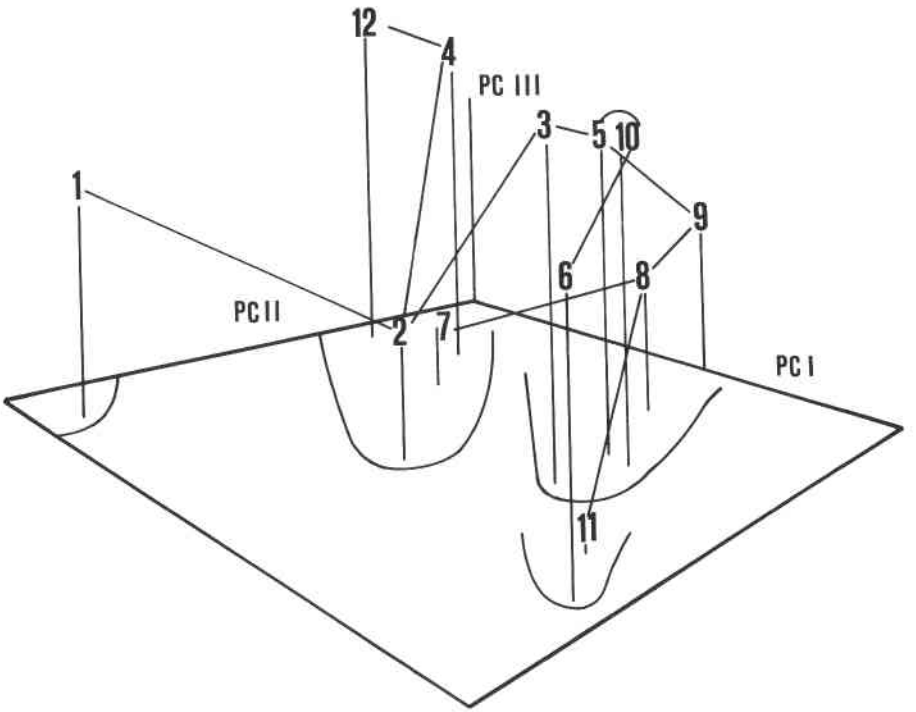

Figure 2.- Principal component projection of 12 samples of *Peromyscus* with the minimum spanning tree network superimposed. Identification of sample numbers as in Figure 1 and Appendix.

The multivariate analyses (UPGMA cluster analysis, PCA, and minimum spanning tree) produced similar arrangements of the samples as in the univariate analysis (Figs. 2 and 3). The sample of *P. boylii rowleyi* (1) was clearly distinct from the samples of *P. simulus* which were arranged into three groups: a coastal (2) and three inland (4, 7, and 12) samples from the northern part of the species range in Sinaloa (except for sample 7 for the Sinaloa/Nayarit border); two samples from southern Sinaloa (3 and 5), and three samples from Nayarit (8, 9, and 10), of which all but samples 8 and 10 are from inland localities; and two coastal samples from southern Sinaloa (6) and southern Nayarit (11).

Table 1.- Variance components analysis depicting the percentage of morphological variation attributed by Locality, Sex, Age, Interactions, and Residual Error for each of the 23 characters used in this study.

Character	Variables				
	Locality	Sex	Age	Interaction	Error
Total length	10.51	0.00	0.00	35.39	54.10
Length of tail	28.64	0.05	0.21	30.19	40.91
Length of body	0.00	0.00	0.00	52.78	47.22
Length of hind foot	9.59	0.00	0.00	16.21	74.20
Length of ear	13.22	0.00	0.00	28.36	58.41
Greatest length of skull	5.45	0.00	2.71	27.82	63.93
Lenght of rostrum	1.27	0.00	0.00	38.90	59.83
Length of nasal bones	12.58	1.48	2.40	16.82	66.72
Postpalatal length	4.02	0.00	0.51	37.00	58.47
Zygomatic breadth	13.81	0.00	15.10	14.01	57.08
Breadth of braincase	6.25	0.00	0.00	22.28	71.47
Mastoid breadth	14.20	0.00	0.00	18.24	67.56
Least interorbital width	12.14	0.00	0.00	13.40	74.46
Length of molar toothrow	10.94	5.08	1.48	14.29	68.21
Length of incisive foramen	4.63	0.00	0.00	28.12	67.25
Length of auditory bullae	0.00	3.20	0.00	27.02	69.78
Depth of braincase	6.06	0.00	0.00	24.51	69.43
Length of mesopterygoid fossa	0.00	0.00	0.52	24.05	75.34
Length of bony palate	5.50	0.00	6.79	1.52	86.19
Breadth of rostrum	11.32	3.44	6.73	10.21	68.30
Greatest breadth across molars	16.55	0.00	10.30	10.27	62.88
Postdental palatal breadth	22.22	0.69	2.99	1.55	72.55
Width of mesopterygoid fossa	0.00	0.00	0.00	29.12	70.88

There were few differences in the arrangement of samples using the three multivariate analyses. In the cluster analysis (Fig. 3), sample 12 of *P. simulus* grouped with the sample of *P. boylii rowleyi*, although the average taxonomic distance between these two samples was greater than that between any two samples of *simulus*. The minimum spanning tree arrangement corresponded to the groupings derived from the PCA with two exceptions: sample 7 was connected with the group containing sample 8 instead of with the group containing samples 2, 4 and 12; and samples 6 and 11 connected to samples 10 and 8, respectively, rather than to each other.

The overall pattern of geographic variation, considering the results of both the univariate and multivariate analyses, revealed that mice from the northern and more inland samples of *P. simulus* were typically smaller in external and cranial measurements

Table 2.- Character loadings for the first three components of the principal components analysis using the 18 cranial characters.

Character	Component 1	2	3
Greatest length of skull	0.3471	-0.0925	0.0084
Lenght of rostrum	0.1083	-0.5530	0.0836
Length of nasal bones	0.2503	-0.2986	0.2275
Postpalatal length	0.3300	0.1025	-0.0823
Zygomatic breadth	0.3406	-0.0521	0.0412
Breadth of braincase	0.2961	-0.1539	-0.1892
Mastoid breadth	0.3288	-0.0409	-0.0849
Least interorbital width	0.1824	0.3400	0.0269
Length of molar toothrow	0.1384	0.0709	0.4943
Length of incisive foramen	0.2463	-0.0576	-0.2743
Length of auditory bullae	0.2528	0.2717	0.1226
Depth of braincase	0.1632	-0.2356	0.3660
Length of mesopterygoid fossa	0.2081	-0.0150	0.3768
Length of bony palate	0.0307	0.1749	0.5593
Breadth of rostrum	0.2656	0.1044	-0.2806
Greatest breadth across molars	0.1603	0.1277	-0.0858
Postdental palatal breadth	0.2008	0.3477	-0.1079
Width of mesopterygoid fossa	0.0043	0.3545	-0.0169

compared to those from the southern, coastal samples which are not sufficient to warrant any formal recognition of infraspecific taxonomic categories (i.e., subspecies). Consequently, *P. simulus* should be regarded as a monotypic species which has undergone relatively minor geographic differentiation. This is not surprising given the relatively small geographic range of the species, and the absence of substantial physiographic barriers in this region of Mexico.

Comments on the Distribution, Habitat and Conservation Status

Previously, the distributional limits of *P. simulus* were thought to be near the vicinity of Mazatlán, Sinaloa, in the north, and just below San Blas, Nayarit, in the south, where the foothills of the Sierra Madre Occidental approach the seacoast (Carleton, 1989). However, during the course of examining specimens housed at the University of Kansas for this study, we located specimens from localities which extend the range of the species approximately 100 km to the north in Sinaloa (San Ignacio) and approximately 50 km south of San Blas to near the border of Nayarit and Jalisco (vicinity of Las Varas). Thus, the geographic range of *simulus* is slightly larger than previously documented.

Having collected this species over a period of several years, we agree with Carleton et al. (1982) that *P. simulus* is a mouse of the lowland tropical forest in the Upper Arid Tropical Zone. The species appears to be most abundant in coastal wetland and mangrove swamp habitats and in mesic, riparian situations along the streamsides which traverse arroyos in the coastal regions of central and southern Sinaloa and along the entire coast of Nayarit. The species appears to be absent from the drier hillsides which extend above the streamsides along the coast. Populations of *simulus* penetrate

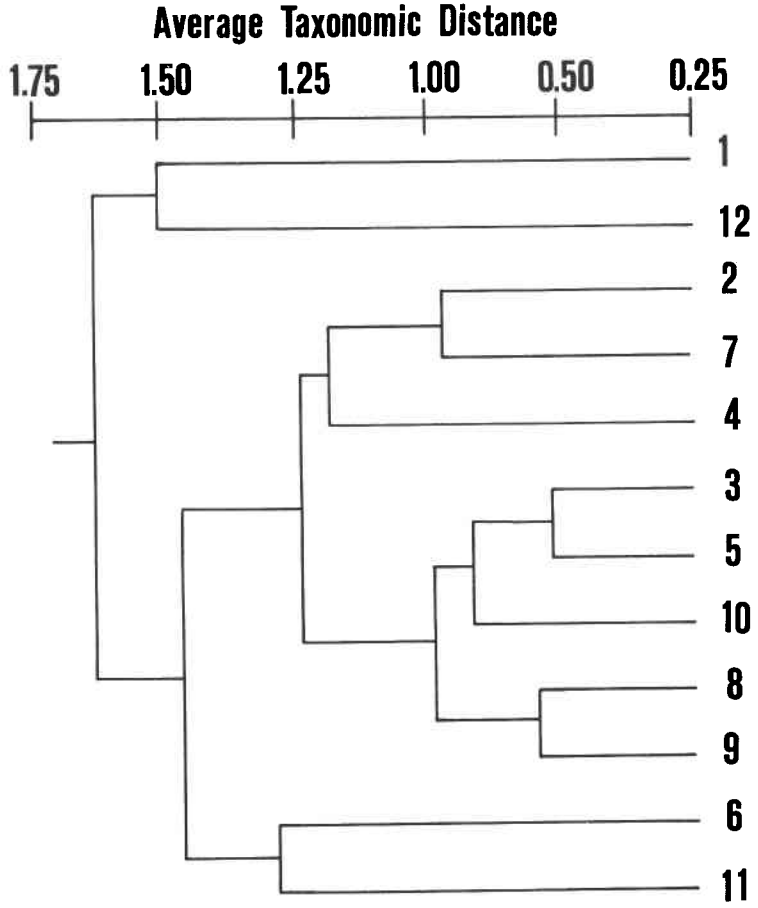

Figure 3.- Cluster analysis (UPGMA) of 12 samples of *Peromyscus* generated from the average taxonomic distance matrix using all 23 characters. Coefficient of cophenetic correlation = 0.79. Identification of sample numbers as in Fig. 1 and Appendix.

Table 3. Character means (in mm ± 1 SE) for samples examined in this study. Missing values are indicated by dashes (---).

Sample	CHARACTERS TOL	TAL	BDL	HFL	EAL	GSL	LR	LN
1	187.70 (5.86)	95.33 (4.33)	90.50 (2.02)	22.00 (0.00)	18.00 (0.71)	26.07 (2.81)	9.90 (1.48)	8.72 (2.11)
2	193.15 (2.09)	100.46 (1.55)	93.40 (0.90)	21.87 (0.26)	18.69 (0.24)	26.82 (1.51)	10.19 (9.30)	8.88 (0.71)
3	202.33 (4.18)	105.78 (3.10)	96.29 (1.60)	21.94 (0.17)	19.44 (0.28)	26.96 (1.85)	10.40 (1.24)	9.5 (0.91)
4	194.44 (1.74)	98.28 (1.20)	96.56 (1.35)	22.90 (0.14)	18.05 (0.19)	26.33 (1.84)	10.44 (1.21)	9.29 (1.00)
5	207.00 (5.52)	102.50 (4.70)	107.00 (2.97)	22.00 (0.41)	18.00 (0.58)	27.01 (1.43)	10.50 (1.49)	9.39 (1.18)
6	200.50 (6.30)	99.50 (4.92)	101.00 (1.78)	23.00 (0.41)	18.67 (0.67)	27.43 (1.63)	10.35 (1.72)	9.36 (1.28)
7	195.00 (3.71)	94.89 (2.50)	100.11 (1.70)	22.89 (0.20)	17.44 (0.18)	26.48 (1.78)	10.42 (1.26)	9.04 (1.27)
8	191.30 (2.03)	90.41 (1.00)	100.62 (1.43)	22.54 (0.12)	17.90 (0.13)	26.87 (1.28)	10.63 (0.80)	9.27 (0.78)
9	199.18 (2.21)	100.64 (1.40)	98.55 (1.45)	22.29 (0.19)	18.00 (0.23)	26.97 (1.77)	10.54 (1.00)	9.27 (1.22)
10	200.54 (1.69)	100.77 (1.76)	107.00 (7.76)	22.64 (0.27)	18.45 (0.34)	27.09 (2.28)	10.54 (1.31)	9.71 (1.86)
11	—— (—)	—— (—)	99.00 (—)	25.00 (—)	19.00 (—)	27.08 (2.85)	10.23 (1.46)	9.37 (0.45)
12	198.00 (6.56)	103.33 (4.10)	94.67 (3.53)	22.00 (0.58)	18.67 (0.88)	26.17 (5.21)	10.35 (5.27)	9.01 (2.43)

Sample	CHARACTERS PPL	ZB	BB	MB	LLW	LMR	LIF	LAB
1	8.91 (0.87)	13.31 (1.81	11.89 (1.07	11.07 (1.22)	4.32 (0.46)	3.92 (0.54)	4.66 (1.80)	5.12 (0.85)
2	9.20 (0.86)	13.55 (0.84)	12.06 (0.83)	11.14 (0.93)	4.32 (0.23)	3.90 (0.49)	4.70 (0.49)	5.13 (0.32)
3	9.23 (0.84)	13.75 (1.07)	12.08 (0.61)	11.20 (0.65)	4.33 (0.41)	3.99 (0.38)	4.79 (0.86)	5.19 (0.40)
4	8.72 (0.92)	13.21 (0.97)	11.91 (0.78)	11.01 (0.70)	4.24 (0.31)	4.01 (0.28)	4.84 (0.70)	5.12 (0.29)
5	9.18 (1.22)	13.69 (1.15)	12.20 (0.57)	11.27 (0.48)	4.25 (0.44)	3.91 (0.62)	4.83 (1.01)	5.15 (0.46)
6	9.44 (1.43)	14.08 (1.87)	12.41 (1.17)	11.54 (0.80)	4.32 (0.37)	4.07 (0.57)	4.88 (0.86)	5.30 (0.10)
7	8.97 (1.22)	13.37 (1.44)	12.16 (1.07)	11.04 (1.62)	4.18 (0.29)	3.80 (0.59)	4.76 (0.94)	5.06 (0.72)
8	9.06 (0.69)	13.77 (0.75)	12.21 (0.61)	11.35 (0.45)	4.19 (0.25)	3.90 (0.22)	4.93 (0.48)	5.11 (0.30)
9	9.19 (0.74)	13.85 (1.13)	12.44 (1.12)	11.46 (0.75)	4.19 (0.36)	3.89 (0.38)	4.80 (0.94)	5.02 (0.60)
10	9.16 (1.11)	13.87 (1.38)	12.27 (0.93)	11.39 (0.71)	4.28 (0.41)	4.02 (0.72)	4.87 (0.98)	5.13 (0.54)
11	9.35 (3.01)	13.75 (2.18)	12.41 (2.18)	11.50 (1.78)	4.29 (0.43)	3.94 (0.79)	5.23 (0.75)	5.16 (0.59)
12	8.82 (4.05)	13.28 (4.05)	12.02 (3.56)	11.03 (2.03)	4.02 (0.44)	3.98 (0.30)	4.60 (1.44)	4.91 (1.11)

Table 3. Cont....

Sample	CHARACTERS DB	LMF	LBP	RB	BAM	PDB	WMF
1	9.11 (0.96)	4.67 (1.43)	4.20 (1.32)	4.53 (0.87)	5.21 (0.40)	4.07 (0.46)	2.39 (0.66)
2	9.48 (0.45)	4.45 (2.69)	4.13 (0.79)	4.73 (0.42)	5.18 (0.42)	3.90 (0.38)	2.30 (0.35)
3	9.53 (0.59)	4.95 (0.62)	4.27 (0.62)	4.67 (0.47)	5.27 (0.45)	3.92 (0.42)	2.32 (0.31)
4	9.35 (0.46)	4.62 (0.71)	4.10 (0.65)	4.55 (0.50)	4.99 (0.56)	3.77 (0.45)	2.28 (0.34)
5	9.46 (0.57)	4.97 (2.01)	4.25 (0.64)	4.60 (0.49)	5.14 (0.32)	3.88 (0.50)	2.34 (0.54)
6	9.50 (0.88)	4.88 (0.90)	4.38 (1.08)	4.76 (0.61)	5.41 (0.87)	4.03 (0.54)	2.43 (0.42)
7	9.56 (0.93)	4.43 (1.02)	4.03 (1.25)	4.61 (0.65)	5.16 (0.49)	3.93 (0.37)	2.41 (0.75)
8	9.38 (0.47)	4.66 (0.45)	4.07 (0.38)	4.70 (0.34)	5.29 (0.40)	3.94 (0.25)	2.32 (0.21)
9	9.47 (0.80)	4.78 (0.68)	4.03 (0.62)	4.59 (0.44)	5.24 (0.56)	3.89 (0.44)	2.30 (0.28)
10	9.38 (0.77)	4.69 (0.84)	4.26 (0.96)	4.62 (0.42)	5.31 (0.48)	4.07 (0.46)	2.29 (0.36)
11	9.24 (1.88)	4.64 (2.11)	4.05 (0.79)	4.84 (0.55)	5.54 (0.47)	4.00 (0.84)	2.33 (0.75)
12	9.18 (2.40)	4.53 (0.67)	4.38 (2.19)	4.55 (1.04)	5.45 (1.50)	3.70 (0.87)	2.35 (0.76)

the interior of Nayarit and Sinaloa and contact other species of *Peromyscus* where river valleys provide access. But, again its distribution seems primarily to be confined to the riverine flood plains, and it is absent from the drier hillsides.

We are concerned that populations of *P. silmulus* may be declining or the species could be subject to drastic population fluctuations in parts of its range. The largest sample of the species collected at one time was reported by Carleton et al. (1982) from a coastal palm grove and a mangrove swamp near Cuautla, Nayarit. These authors reported 72% trap success in one night of collecting in this region, and they took a total of 127 specimens of this species in a few nights of collecting. We accompanied a collecting party of trained mammalogists to this exact same site in the summer of 1983 and did not obtain a single specimen of *P. simulus* in over 3,000 trap-nights of collecting. Similarly, in that same summer we visited many of the other localities where *P. simulus* had been reported and had great difficulty in obtaining specimens. Other species of rodents were collected in normal to abundant numbers.

Its preference for coastal wetland and inland riparian habitats, coupled with the small geographic range of the species and the possible indication of a population decline in some regions, is cause for concern about the status of *P. simulus*. In our opinion, this species should be carefully monitored in future years. Wetland and riparian habitats are rapidly disappearing throughout North America, and the coastal lowlands of western Mexico are becoming subjected to substantial development. As its habitat disappears or is altered, populations of the Sinaloan mouse could become fragmented and gradually decline.

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APPENDIX

Sample numbers are in parentheses and follow the designations in Fig. 1. Museum designations are in parentheses and follow Yates et al. (1987).

Specimens examined.- *P. simulus*. Nayarit: (Sample 7) Cucarachas, Rio Acaponeta, 100 m, 5 (UMMZ); 1.4 mi N Tacote, 15 m, 4 (USNM); (Sample 8) 1 mi S Cuatla, sea level, 38 (USNM); 4 km N Cuatla, sea level, 1 (USNM); (Sample 9) 1.2 mi S El Casco (Rio Chilte), 60 m, 3 (USNM); Platanares, 10 mi E Ruiz, 2 (KU); Teponahuaxtla, 50 m, 9 (USNM); (Sample 10) Navarete, 50 m, 1 (USNM); Paso de Soquilpa (8.8 mi E San Blas), 100 m, 2 (USNM); San Blas, sea level, 2 (USMN); 0.5 mi E San Blas, 50 ft, 5 (KU); 0.5 mi E San Blas, 10 ft, 1 (MSU); 2 mi E San Blas, 100 ft, 2 (MSU); 3.5 mi E San Blas, 100 ft, 2 (UMMZ); (Sample 11) 5 mi S Las Varas, 150 ft, 3 (KU); 8 mi SSW Las Varas, 1 (KU). Sinaloa: (Sample 2) Los Limones, 1 (AMNH); Mazatlán, 300 ft, 1 (USNM); 5 mi NW Mazatlán, 13 (KU); 5 mi WSW Mazatlán, 1 (AMNH); (Sample 3) 1 mi W Chupaderos, 3 (UMMZ); 4 mi E Concordia, 6 (TCWC); 5 mi E Concordia, 4 (TCWC); 5 mi SW Copala, 750 ft, 3 (MSU); 8 km N Villa Unión, 450 ft, 3 (KU); (Sample 4) Chele, 15 mi N Rosario, 300 ft, 21 (UMMZ); (Sample 5) 15 mi S Escuinapa, 300 ft, 7 (UMMZ); Rosario, 100 ft, 1 (USNM); 5 mi SSE Rosario, 100 ft, 2 (KU); (Sample 6) Teacapan, Isla Palmito del Verde, 15 ft, 2 (KU); 6 mi NNW Teacapan, 4 (KU); (Sample 12) San Ignacio, 700 ft, 2 (KU); 5 km W San Ignacio, 200 m, 1 (KU).

P. boylii rowleyi. Sinaloa: (Sample 1) 1 mi S Pericos, 4 (KU); 15 km N, 65 Km E Sinaloa, 3 (KU).