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VARIATION IN *PAPPOGEOMYS* *CASTANOPS* (GEOMYIDAE) ON THE LLANO ESTACADO OF TEXAS AND NEW MEXICO

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ABSTRACT. Nongeographic and geographic variation in the yellow-cheeked pocket gopher, *Pappogeomys castanops*, were analyzed in specimens collected in northwestern Texas and eastern New Mexico. Univariate and multivariate methods of analysis were utilized to assess variation in morphometric characters among 12 samples of *P. castanops*. Because of significant variation with age, only adult specimens were used in analyses. Adult males were significantly larger than females in all 13 characters studied. Our analyses of geographic variation reveal that those specimens previously assigned to the subspecies *P. c. simulans* are not sufficiently distinct to warrant subspecific designation.

Two subspecies of the yellow-cheeked pocket gopher, *Pappogeomys castanops*, were recognized by Russell (1968) as occurring on the High Plains of Texas. *Pappogeomys castanops perplanus* originally was described by Nelson and Goldman (1934) based on material from Tascosa, Oldham Co., Texas, and included specimens from the panhandle of Oklahoma, eastern New Mexico, and western Texas. Russell (1968) described *P. c. simulans* from 17 mi SE Washburn, Armstrong Co., Texas. Both *perplanus* and *simulans* apparently occupy broad areas of the Llano Estacado of Texas and New Mexico and are in contact along a zone in West Texas.

Because the physiography and environmental conditions of the Llano Estacado are relatively homogeneous, we undertook a study of *P. castanops* in this area to elucidate morphological variation in these populations. Our first objective was to provide a detailed analysis of nongeographic and geographic variation. These results were used to clarify the taxonomic status of the nominal taxa in that region.

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METHODS AND STUDY AREA. The Llano Estacado of Texas and New Mexico is a remnant of the High Plains, which encompasses an area of approximately 20,000 square miles (see Fig. 3). The land surface slopes slightly from the northwest (elevation 4,800 feet near Tucumcari, New Mexico) to the southeast (2,700 feet east of Midland, Texas). Precipitation averages between 17 and 19 inches per year, and varies widely from one year to the next (Wendorf 1970). Soils range from deep and sandy to shallow with a high incidence of caliche. *Pappogeomys castanops* was found primarily in deep, friable soils, although specimens were collected in areas where the soil was hard, with extensive amounts of caliche, especially in areas where *Geomys bursarius* occupied the sandy soils.

A total of 473 specimens was examined from 12 sample areas on the Llano Estacado. In some instances, specimens from several localities were pooled to obtain sufficient sample sizes. Sample areas are shown in Fig. 3. Extensive field work was conducted in 1975 and 1976, and the resulting specimens, together with those already in museum collections, formed the basis for this study. Specimens examined included those housed at Angelo State University, San Angelo, Texas (ASVRC); Museum of the High Plains, Fort Hays State University, Hays, Kansas (MHP); Texas Cooperative Wildlife Collections, Texas A&M University, College Station (TCWC); Texas Memorial Museum, University of Texas, Austin (TNHC); National Museum of Natural History, Washington, D.C. (USNM); and Wayland Baptist College, Plainview, Texas (WBC), as well as those in the collection of mammals, The Museum, Texas Tech University. All specimens examined were preserved either as skins and skulls or as skeletons.

External measurements—total length (character number 1), length of tail (2), and length of hind foot (3)—were taken from original skin tags. Cranial measurements were taken with dial calipers to the nearest 0.1 mm. Ten cranial characters were used, identical to those used by Russell (1968:591), as follows: condylobasal length (character number 4), zygomatic breadth (5), palatofrontal depth (6), length of palate (7), length of nasals (8), breadth of braincase (9), squamosal breadth (10), breadth of rostrum (11), length of rostrum (12), and alveolar length of maxillary tooththrow (13). These mensural characters are referred to in tables by their numbers.

Five age categories were recognized for the specimens examined. Those categories, similar to those used by Russell (1968) and Hendricksen (1973) for geomyids, are based on cranial characters as follows: juvenile—deciduous premolar present, temporal ridges absent, bones of cranium porous, cranial sutures unfused; young—permanent premolar present, temporal ridges absent or faintly present, supraoccipital-exoccipital suture unfused, bones of cranium porous; subadult—temporal ridges present but not touching, supraoccipital-exoccipital suture fused, basisphenoid-basioccipital suture unfused, some bones of cranium still porous; adult—temporal ridges touching one another or forming a sagittal crest, basisphenoid-basioccipital suture fused, no bones of cranium porous; old adult—skull rugose, sagittal crest well-developed, especially in males. For this study, old adults were grouped with adults.

Statistical analyses were performed using the IBM 370 computers at the computing centers of Fort Hays State University and Kansas State University. Univariate analyses of both nongeographic and geographic variation were performed using UNIVAR, a program developed by Power (1970). This program computes

standard statistics (mean, range, standard deviation, standard error, and coefficient of variation), and utilizes a single-classification analysis of variance (F-test, .05 level of significance) in comparing means of two or more groups (Sokal and Rohlf 1969). When significantly different, means were arranged in maximally nonsignificant subsets using the Sums of Squares Simultaneous Testing Procedure (SS-STP) of Gabriel (1964).

Multivariate analyses were performed using both the NT-SYS programs (Rohlf and Kishpaugh 1972) and Statistical Analysis System (SAS) developed by Barr and Goodnight (Service 1972). Matrices of correlation and phenetic distance coefficients were derived from standardized character values. NT-SYS was used to perform cluster analyses of the correlation and distance matrices by means of the unweighted pair-group method using arithmetic averages (UPGMA), and phenograms were generated. Matrices and phenograms were compared and a coefficient of cophenetic correlation was computed for each. A matrix of correlation among characters was calculated and the first three principal components were extracted.

To determine the degree of divergence among samples, a multivariate analysis of variance (MANOVA) and canonical analysis programs of SAS were used. Canonical analysis provides weighted combinations of characters, which maximize distinctions between groups. The program extracts characteristic roots and vectors and computes mean canonical variates for each sample. New orthogonal axes (canonical variates) are constructed to extract the next best combination of measurements, and to emphasize those measurements with the least within-sample and the greatest between-sample variation. Each eigenvalue and its canonical variate (characteristic root) represent an identifiable part of the total variation. Means of samples were plotted on the two canonical variates, which account for the greatest percentages of the total variation. The relative importance of each character to a particular canonical variate was determined by multiplying the variable coefficient for a vector by the median value of the dependent variable, summing all variable values for a vector, and computing the percent relative importance of each variable for a particular vector. Analysis utilizing these methods was used in similar studies by Schmidly and Hendricks (1976) and Yates and Schmidly (1977).

NONGEOGRAPHIC VARIATION. *Variation with age.*—Samples of 71 females and 56 males from Lubbock Co., Texas, were selected for analysis of age variation (selected measurements given in Table 1). No juveniles were represented in this sample. All external and cranial measurements tested for both sexes showed significant differences among young, subadults, and adults. Results of SS-STP in the samples of both females and males revealed three nonoverlapping subsets for all characters except length of tail and length of hind foot. Length of tail in both sexes formed two nonoverlapping subsets, one consisting of adults and subadults and a second of young. Length of hind foot in both sexes formed two over-

TABLE 1
*Age variation in selected external and cranial measurements of
Pappogeomys castanops from Lubbock Co., Texas.*

Sex and age classes	N	Mean	2 SE	Range	CV	Fs/F
Total Length						
Females						
Adult	37	267.8	4.32	243.0–290.0	4.91	31.85
Subadult	20	255.4	8.41	190.0–278.0	7.37	(3.15)
Young	14	224.6	12.59	185.0–260.0	10.49	
Males						
Adult	18	299.0	8.58	262.0–340.0	6.09	70.27
Subadult	21	276.2	6.04	252.0–305.0	5.01	(3.15)
Young	17	236.8	7.22	211.0–263.0	6.28	
Condylobasal length						
Females						
Adult	37	51.3	0.60	47.2–55.2	3.55	81.26
Subadult	20	47.6	0.65	44.3–50.3	3.06	(3.15)
Young	14	42.3	2.04	35.2–46.9	9.03	
Males						
Adult	18	58.1	1.34	52.7–63.0	4.91	177.67
Subadult	21	50.8	0.53	49.0–53.6	2.39	(3.15)
Young	17	44.3	1.09	40.2–46.7	5.07	
Zygomatic breadth						
Females						
Adult	37	33.3	0.44	30.4–36.1	3.98	93.10
Subadult	20	30.2	0.56	27.4–32.1	4.11	(3.15)
Young	14	26.7	1.29	22.6–30.2	9.05	
Males						
Adult	18	39.9	1.44	34.4–44.0	7.64	147.24
Subadult	21	32.8	0.60	30.5–35.4	4.22	(3.15)
Young	17	27.5	0.83	24.3–29.5	6.20	
Palatofrontal depth						
Females						
Adult	37	20.1	0.29	18.3–21.9	4.35	54.87
Subadult	19	18.7	0.22	17.6–19.4	2.62	(3.15)
Young	15	17.4	0.65	15.0–18.9	6.97	

TABLE 1 Continued

Sex and age classes	N	Mean	2 SE	Range	CV	Fs/F
Males						
Adult	18	22.8	0.67	20.2–25.0	6.20	95.82
Subadult	21	20.0	0.35	18.3–21.8	4.06	(3.15)
Young	17	17.9	0.43	16.3–19.3	4.95	
Length of rostrum						
Females						
Adult	34	22.9	0.39	20.8–25.2	4.95	71.71
Subadult	19	20.8	0.37	19.2–22.0	3.85	(3.15)
Young	14	18.3	0.96	15.4–21.0	9.76	
Males						
Adult	18	26.5	0.78	23.6–29.1	6.26	143.46
Subadult	21	22.7	0.38	21.3–24.3	3.85	(3.15)
Young	17	19.3	0.59	17.0–21.1	6.33	

lapping subsets, one consisting of adults and subadults and a second of subadults and young.

Secondary sexual variation.—The sample of adult males and females (selected measurements given in Table 1) from Lubbock County was tested to determine if significant secondary sexual dimorphism was present. Male *P. castanops* were found to be significantly larger than females in all 13 measurements. This agrees with findings by Russell (1968) for the subgenus *Cratogeomys*. Based on these data, all analyses of geographic variation were conducted separately by sex.

Individual variation.—Coefficients of variation (see Table 1) for the sample of female *P. castanops* from Lubbock Co., Texas, ranged from 3.20 (squamosal breadth) to 7.65 (length of tail). In addition to length of tail, one other external measurement (length of hind foot) and one cranial measurement (length of nasals) had coefficients of variation greater than 5.

Coefficients of variation for males from Lubbock County ranged from 4.25 (breadth of braincase) to 8.49 (length of tail). Only three (condylobasal length, breadth of braincase, and alveolar length of maxillary toothrow) of 13 measurements had coefficients of variation of less than 5. For both sexes, coefficients of variation for all char-

acters except one (length of tail in males) fell between 2 and 8, the range of variation suggested by Long (1968) as typical for mammals in general. Coefficients of variation did, however, average higher than those given for *Geomys bursarius* (Hendricksen 1973) and coefficients of variation determined for condylobasal length in females (3.55) and males (4.91) in this study were somewhat higher than those for the same measurement in female (2.35) and male (3.41) *Pappogeomys merriami* (Russell 1968).

Coefficients of variation for male *P. castanops* were higher than those for females in all 13 measurements. Greater variability in males previously has been documented for *Pappogeomys* (Russell 1968) and *Geomys* (Hendricksen 1973). Because of greater variability in males, we have placed emphasis on data for females in our interpretation of subspecific relationships, although data on males are shown for comparison.

GEOGRAPHIC VARIATION. Specimens of *Pappogeomys castanops* were grouped into 12 samples for analysis of geographic variation. Samples were collected from localities approximating four west-to-east and three north-to-south transects (see Figs. 1, 2, and 3). Populations of *P. castanops* could not, however, be located in northern Curry Co., New Mexico (in the northwestern portion of the Llano Estacado), or from Ector Co., Texas (in the southernmost portion). Standard statistics for measurements of specimens from all samples are given in Table 2.

UNIVARIATE ANALYSIS. *External measurements.*—Means for total length in female *P. castanops* were arranged in three overlapping subsets as follows: the first, samples 1, 2, 4, 7, 8, 10, and 11; second, all samples except the largest (10) and smallest (12); third, all samples except 10 and 11. Total length in males was less variable, with means falling out in only two nonsignificant subsets, each containing all samples but the extremes—3 and 10. Means for length of tail showed no significant differences in males, but fell into three overlapping subsets for females as follows: first, all samples but 2, 7, and 12; second, lacking only 7, 10, and 12; third, all but the two largest, 8 and 10. Sample 12 was again among the smallest means for length of tail. Length of hind foot was the most variable of external measurements with means for males falling into three subsets and those for females falling into five. Subsets for both males and females were broadly overlapping. Means for females from areas

TABLE 2

Standard statistics for adult females and males from 12 samples of Pappogeomys castanops on the Llano Estacado of Texas and New Mexico. See Fig. 1 for key to samples.

Sex and statistics	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
TOTAL LENGTH												
Females												
N	10	10	9	9	10	6	11	37	7	10	19	10
Mean	261.5	266.2	261.1	270.7	260.8	258.0	263.5	267.8	256.9	282.9	272.9	256.8
Minimum	255.0	254.0	234.0	240.0	240.0	237.0	242.0	243.0	241.0	269.0	235.0	237.0
Maximum	270.0	280.0	293.0	283.0	275.0	286.0	273.0	290.0	280.0	305.0	309.0	280.0
2 SE	2.41	5.08	10.74	9.76	8.04	13.58	5.27	4.32	11.33	7.65	7.37	8.47
Males												
N	6	3	7	2	7	8	10	18	4	7	3	4
Mean	284.7	300.3	279.6	303.5	279.6	282.4	297.2	299.0	284.0	307.6	305.7	287.8
Minimum	265.0	285.0	269.0	302.0	250.0	257.0	284.0	262.0	266.0	283.0	299.0	276.0
Maximum	295.0	326.0	296.0	305.0	291.0	310.0	321.0	340.0	306.0	326.0	310.0	302.0
2 SE	9.40	25.83	6.49	3.0	10.34	14.37	6.41	8.58	19.18	11.19	6.77	10.78
LENGTH OF TAIL												
Females												
N	10	9	9	9	10	6	11	37	7	10	19	9
Mean	74.8	71.2	77.0	71.7	71.3	71.8	69.4	77.1	71.6	79.2	72.9	70.0
Minimum	70.0	62.0	70.0	58.0	63.0	68.0	60.0	61.0	60.0	66.0	60.0	54.0
Maximum	80.0	77.0	89.0	81.0	82.0	85.0	79.0	85.0	82.0	90.0	86.0	85.0
2 SE	2.38	2.74	3.61	4.90	3.40	5.35	3.85	1.94	6.12	3.83	3.64	5.76

TABLE 2 (continued)

Sex and statistics	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
Males												
N	6	3	7	2	7	8	11	18	4	7	3	4
Mean	83.2	86.7	81.1	83.0	80.6	81.3	77.2	86.7	82.0	84.4	86.3	81.0
Minimum	80.0	80.0	76.0	81.0	77.0	69.0	62.0	70.0	75.0	65.0	80.0	75.0
Maximum	86.0	93.0	85.0	85.0	90.0	90.0	93.0	100.0	94.0	94.0	98.0	93.0
2 SE	1.82	7.51	2.41	4.00	3.26	5.01	6.32	3.47	8.29	7.02	11.68	8.29
LENGTH OF HIND FOOT												
Females												
N	10	9	9	9	9	6	11	37	7	10	19	10
Mean	35.2	36.4	34.6	36.6	35.8	34.8	35.7	33.9	32.7	38.9	37.1	33.5
Minimum	31.0	30.0	30.0	34.0	33.0	31.0	32.0	30.0	30.0	37.0	30.0	30.0
Maximum	38.0	42.0	38.0	38.0	37.0	38.0	38.0	39.0	35.0	40.0	45.0	36.0
2 SE	1.11	2.26	1.70	0.95	0.93	1.96	1.11	0.58	1.36	0.70	1.73	1.37
Males												
N	6	3	7	2	7	8	11	18	4	7	3	4
Mean	38.3	41.0	36.6	40.0	35.9	37.4	38.5	36.2	35.5	40.3	40.3	37.5
Minimum	37.0	40.0	35.0	39.0	25.0	35.0	34.0	34.0	33.0	37.0	39.0	36.0
Maximum	40.0	43.0	38.0	41.0	40.0	39.0	42.0	42.0	40.0	45.0	41.0	39.0
2 SE	0.84	2.00	1.06	2.00	3.84	1.13	1.65	0.99	3.11	1.99	1.33	1.29
CONDYLOBASAL LENGTH												
Females												
N	10	11	9	9	11	6	11	37	7	10	19	10
Mean	49.5	51.1	49.9	51.3	49.8	48.4	51.5	51.3	49.2	51.7	51.3	48.3
Minimum	48.0	48.8	45.0	49.2	46.4	46.5	49.4	47.2	48.2	49.1	48.9	45.8
Maximum	50.3	53.5	56.2	53.5	55.0	50.2	52.4	55.2	50.7	55.9	54.3	50.0
2 SE	0.50	0.89	1.97	0.83	1.29	1.26	0.50	0.60	0.63	1.29	0.73	0.88

Males												
N	6	4	7	2	8	8	11	18	4	7	3	4
Mean	54.1	57.3	54.1	56.3	54.4	54.7	58.0	58.1	53.6	57.7	59.4	56.1
Minimum	51.6	51.2	52.6	56.1	51.6	50.2	51.0	52.7	49.1	53.1	56.9	54.8
Maximum	56.4	61.3	56.1	56.5	57.9	57.3	61.0	63.0	57.8	63.5	61.4	57.1
2 SE	1.65	4.33	0.91	0.40	1.29	1.71	1.71	1.34	4.49	3.06	2.65	0.98

ZYGOMATIC BREADTH

Females												
N	10	11	9	9	11	6	11	37	7	10	19	10
Mean	31.8	32.9	32.0	33.5	32.2	31.2	32.9	33.3	31.4	33.1	32.9	30.6
Minimum	30.7	31.2	28.5	29.9	28.0	29.8	32.0	30.4	29.8	30.2	30.1	28.5
Maximum	32.7	34.5	37.0	35.2	36.2	32.9	33.7	36.1	32.5	36.6	34.8	32.2
2 SE	0.37	0.67	1.46	1.16	1.20	0.93	0.35	0.44	0.65	1.16	0.57	0.73

Males												
N	6	4	7	2	8	8	10	18	4	7	3	4
Mean	37.0	38.7	36.4	37.8	37.5	37.0	39.5	39.9	35.5	38.9	40.7	38.8
Minimum	32.7	33.6	35.3	37.4	34.2	32.6	32.7	34.4	30.8	33.8	36.4	37.8
Maximum	40.7	41.3	38.4	38.1	40.3	40.6	43.0	44.0	38.8	44.2	44.5	40.2
2 SE	2.41	3.48	0.79	0.70	1.55	1.78	1.97	1.44	3.92	3.39	4.70	1.16

PALATOFRONTAL DEPTH

Females												
N	10	11	9	9	11	6	11	37	7	10	19	10
Mean	19.6	20.3	19.9	20.2	19.5	19.1	20.1	20.1	19.5	20.7	20.2	19.0
Minimum	18.8	19.3	17.5	19.5	18.3	18.4	19.3	18.3	19.0	19.6	19.0	17.9
Maximum	20.3	21.2	22.1	20.9	21.3	19.6	21.2	21.9	20.0	22.5	21.1	19.4
2 SE	0.28	0.43	0.84	0.37	0.44	0.42	0.32	0.29	0.27	0.56	0.24	0.33

TABLE 2 (continued)

Sex and statistics	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
Males												
N	6	4	7	2	8	8	11	18	4	7	3	4
Mean	21.3	22.6	21.0	21.6	21.2	21.2	23.1	22.8	21.1	22.7	23.2	22.2
Minimum	20.3	20.7	20.3	21.5	20.7	19.3	19.7	20.2	19.4	21.1	21.3	21.9
Maximum	22.4	23.8	21.8	21.6	22.4	22.2	25.2	25.0	22.6	24.1	24.2	22.7
2 SE	0.59	1.36	0.34	0.10	0.38	0.67	0.89	0.67	1.66	0.95	1.90	0.36
LENGTH OF PALATE												
Females												
N	10	11	9	9	11	6	11	37	7	10	19	10
Mean	35.1	36.0	34.7	35.8	34.8	33.5	35.8	35.8	34.2	36.5	35.8	33.2
Minimum	33.5	33.5	31.1	34.6	32.3	32.3	34.0	32.7	33.1	34.3	33.9	31.4
Maximum	36.2	38.1	39.4	37.0	38.2	35.0	36.7	39.5	35.2	40.2	37.7	34.3
2 SE	0.50	0.86	1.49	0.53	0.85	0.92	0.41	0.52	0.58	1.09	0.51	0.68
Males												
N	6	4	7	2	8	8	11	18	4	7	3	4
Mean	38.7	41.1	38.3	39.4	38.7	37.0	41.0	41.1	38.2	40.9	42.6	39.2
Minimum	36.1	35.6	37.1	39.3	36.3	28.5	35.6	37.3	34.5	36.7	40.5	37.7
Maximum	40.4	44.2	39.9	39.5	41.2	40.9	43.7	45.3	41.7	44.9	44.2	40.3
2 SE	1.48	3.79	0.70	0.20	0.99	2.83	1.44	10.8	3.91	2.44	2.19	1.09
LENGTH OF NASALS												
Females												
N	10	10	9	9	11	6	11	35	7	10	19	9
Mean	17.9	19.1	18.0	19.0	18.2	17.3	18.5	19.3	17.9	19.1	18.4	16.9
Minimum	16.6	16.5	15.6	17.5	16.1	16.8	17.2	17.0	16.7	17.0	16.6	15.6
Maximum	18.7	21.0	20.8	20.5	20.4	17.9	19.0	21.1	18.8	21.5	20.0	17.7
2 SE	0.41	0.82	1.01	0.66	0.75	0.38	0.29	0.35	0.51	0.78	0.37	0.51

Males

N	6	4	7	2	8	8	11	18	4	7	3	4
Mean	19.9	21.4	19.9	20.8	20.6	20.3	21.8	22.7	19.6	21.8	22.3	21.1
Minimum	18.8	18.8	19.3	20.5	18.6	17.8	18.6	19.7	17.3	19.7	20.4	19.9
Maximum	20.4	22.6	21.0	21.0	22.4	21.7	23.5	25.2	21.5	23.7	23.4	22.1
2 SE	0.48	1.73	0.41	0.50	0.99	0.90	0.85	0.77	2.16	1.23	1.94	0.92

BREADTH OF BRAINCASE

Females

N	10	11	9	9	10	6	11	37	7	10	19	10
Mean	21.4	21.3	21.3	21.7	21.6	21.1	22.0	22.3	21.2	22.4	22.3	21.0
Minimum	20.6	20.5	20.2	20.0	19.3	20.2	21.2	20.4	20.6	20.9	20.4	19.7
Maximum	22.4	22.0	22.4	22.8	23.8	22.2	22.6	23.6	22.1	23.2	23.8	22.1
2 SE	0.33	0.30	0.45	0.56	0.71	0.59	0.29	0.25	0.39	0.44	0.35	0.54

Males

N	6	4	7	2	8	8	11	18	4	7	3	4
Mean	22.9	23.2	22.4	23.2	22.8	23.2	23.9	24.4	22.6	24.2	25.2	24.0
Minimum	22.1	22.3	21.7	22.5	21.8	21.2	21.1	22.7	21.5	21.9	23.2	22.7
Maximum	23.7	24.2	23.0	23.8	24.2	24.5	26.0	26.0	24.0	26.6	26.7	25.3
2 SE	0.43	0.86	0.38	1.30	0.59	0.85	0.81	0.49	1.27	1.32	2.07	1.08

SQUAMOSAL BREADTH

Females

N	10	11	9	9	11	6	11	37	7	10	19	10
Mean	28.1	28.0	28.2	28.9	28.7	27.9	29.5	29.0	27.7	29.4	29.4	28.0
Minimum	27.3	21.7	24.6	27.0	26.0	26.7	28.0	27.2	26.2	27.9	28.0	26.6
Maximum	29.0	30.0	32.3	29.8	31.5	29.9	31.4	30.6	28.6	31.1	31.6	29.2
2 SE	0.37	1.34	1.31	0.61	0.78	0.94	0.55	0.30	0.62	0.54	0.44	0.55

TABLE 2 (continued)

Sex and statistics	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12
Males												
N	6	4	7	2	8	8	11	18	4	7	3	4
Mean	31.1	32.3	31.3	32.5	31.4	31.5	33.5	32.9	30.4	33.3	34.4	33.2
Minimum	29.3	29.8	30.6	32.4	30.2	29.0	28.3	29.5	27.9	30.6	32.4	32.2
Maximum	32.1	34.6	33.2	32.5	32.7	33.5	35.9	34.8	32.9	36.5	35.6	34.0
2 SE	0.94	2.02	0.71	0.10	0.65	1.27	1.28	0.78	2.64	1.81	2.04	0.78
BREADTH OF ROSTRUM												
Females												
N	10	11	9	9	11	6	11	37	7	10	19	10
Mean	10.6	11.1	10.6	11.1	10.9	10.6	11.5	11.3	10.5	11.6	11.2	10.3
Minimum	9.9	10.1	9.8	10.5	9.8	10.2	11.0	10.2	10.0	10.5	10.4	9.5
Maximum	11.1	11.8	12.1	11.8	12.3	10.9	12.1	12.1	10.8	13.8	12.0	10.9
2 SE	0.22	0.33	0.43	0.29	0.38	0.27	0.25	0.16	0.22	0.55	0.26	0.28
Males												
N	6	4	7	2	8	8	11	18	4	7	3	4
Mean	12.1	13.0	12.0	12.7	12.4	12.4	13.2	13.4	12.0	13.5	13.5	13.0
Minimum	11.1	11.0	11.6	12.6	11.3	10.3	11.0	11.2	10.8	11.7	12.1	12.6
Maximum	13.0	13.9	12.6	12.7	13.0	13.2	14.7	15.3	13.2	15.6	14.4	13.8
2 SE	0.61	1.34	0.29	0.10	0.41	0.67	0.68	0.52	1.08	1.14	1.42	0.57
LENGTH OF ROSTRUM												
Females												
N	10	10	9	9	11	6	11	34	7	10	18	9
Mean	21.8	23.2	21.7	22.9	22.3	20.9	22.7	22.9	21.3	23.0	22.4	21.0
Minimum	20.4	21.2	18.9	21.4	20.2	19.9	20.9	20.8	20.1	21.1	20.8	19.6
Maximum	23.1	24.8	25.7	24.0	25.4	21.8	23.4	25.2	22.1	24.7	24.5	22.0
2 SE	0.46	0.67	1.28	0.63	0.75	0.67	0.41	0.39	0.54	0.65	0.45	0.50

Males												
N	6	4	7	2	8	8	11	18	4	7	3	4
Mean	24.2	26.1	24.0	24.6	24.3	24.2	26.4	26.5	23.5	26.2	26.8	25.1
Minimum	22.8	23.6	22.5	24.3	22.8	21.4	23.1	23.6	20.9	23.8	25.3	24.6
Maximum	25.4	27.9	25.0	24.8	25.8	25.6	28.8	29.1	25.9	28.6	27.7	25.9
2 SE	0.83	1.81	0.63	0.50	0.69	0.96	0.96	0.78	2.59	1.63	1.48	0.61

ALVEOLAR LENGTH OF MAXILLARY TOOTHROW

Females												
N	10	11	9	9	11	6	11	37	7	10	19	10
Mean	9.8	9.9	10.2	10.4	10.1	10.0	10.3	10.1	10.2	10.3	10.2	9.6
Minimum	9.3	9.1	9.4	9.7	9.0	9.6	9.9	9.5	9.9	9.0	9.4	8.9
Maximum	10.6	10.6	11.6	11.0	10.7	10.2	11.1	11.0	10.5	11.3	11.0	10.0
2 SE	0.28	0.23	0.45	0.33	0.27	0.22	0.19	0.12	0.15	0.45	0.21	0.21

Males												
N	6	4	7	2	8	8	11	18	4	7	3	4
Mean	10.7	10.6	10.5	10.6	10.5	10.5	11.0	10.9	10.8	10.8	11.1	10.1
Minimum	10.3	10.0	10.1	10.3	10.1	9.8	10.0	9.7	10.0	10.2	10.7	9.8
Maximum	11.3	11.3	10.9	10.8	11.3	11.1	11.5	11.6	11.7	11.7	11.4	10.3
2 SE	0.33	0.57	0.26	0.50	0.27	0.29	0.26	0.22	0.74	0.46	0.44	0.22

10 and 11 were largest, and those from areas 9 and 12 were smallest (see Table 2).

Cranial measurements.—Variation in condylobasal length in females is shown in Figs. 1 and 2. A general increase in size from north to south is apparent in Fig. 1B-C except that sample 12 is unusually small. There is a step in the cline between the northernmost samples, 1 and 2, and the adjacent samples, 4 and 5. How-

Fig. 1. Variation in condylobasal length (A, B, C) and squamosal breadth (D, E, F) in samples of female *Pappogeomys castanops* for north-south transects. Lines perpendicular to the scale represent means, those parallel to the scale, ranges; open rectangles represent one standard deviation, closed rectangles, two standard errors of the mean. Numbers to the left refer to sample numbers (see Fig. 3).

Fig. 2. Variation in condylobasal length (A, B, C) and squamosal breadth (D, E, F) in samples of female *Pappogeomys castanops* for west-east transects. For explanation of symbols, see Fig. 1; for key to samples, see Fig. 3.

ever, sample 1 is smaller than the adjacent sample (4), whereas sample 2 averages larger than sample 5. West-east variation (Fig. 3A-C) shows a step in the cline between western (3, 6, 9) and central samples (4, 7, 10), which are slightly larger in size. Two of the eastern samples (5, 11) are smaller in size than their respective central samples, but sample 8 averages 0.1 mm larger than sample 7 to the west. The SS-STP for females yielded four overlapping subsets. Means for males were arranged in three subsets.

Means for zygomatic breadth in females were arranged in three overlapping nonsignificant subsets. The first subset contained all samples but the three smallest (9, 6, and 12); the second, all but the two largest (4 and 8) and the smallest (12); the third, only the five smallest means. No significant differences were found between samples for zygomatic breadth in males. The four western samples (1, 3, 6, and 9) were among the smallest in zygomatic breadth for both sexes.

Means for palatofrontal depth fell into four and three broadly overlapping nonsignificant subsets in females and males, respectively. Sample 10 had the largest mean in females and sample 12 again had the smallest; however, means for these two samples for males were rather close and both fell into the first nonsignificant subset. Western samples (1, 3, 6, and 9) and one eastern sample (5) were among the smallest in both females and males. Length of palate in females exhibited a pattern of variation similar to that for palatofrontal depth. Little variation was evident for length of palate in males, with means arranged in two broadly overlapping subsets.

Means for length of nasals formed five overlapping, nonsignificant subsets in females, with eastern samples having the largest means and western samples having the smallest. Nasals in females were shortest in individuals from sample 12. Means for length of nasals in males formed three overlapping subsets, the first consisting of all but the western samples (1, 3, 6, and 9), the second having all but the largest (8) and the smallest (9), and the third having all but 8 and 11.

Means for breadth of braincase in females fell into two overlapping subsets with the only samples in common being 1, 4, 5, and 7. Again, west-east division was evident, and sample 12 yielded the smallest mean. Breadth of braincase in males formed three nonsignificant subsets in which means for western samples again were the smallest. Sample 12, with a mean of 23.9, was among the four largest in males.

Variation in squamosal breadth for females is shown in Figs. 1 and 2. The western samples (1, 3, 6, 9) in the north-south transects (Fig. 1D) reveal very little variation. In the other two north-south (Figs. 1E-F) transects, squamosal breadth appears to become broader in southern populations, with the exception of sample 12 in which individuals have unusually narrow squamosal regions. West-east variation (Figs. 2D-F) in squamosal breadth is similar to that shown for condylobasal length, with an increase in size between 3 and 4, 6 and 7, and 9 and 10. However, the step in the cline is not as steep as was shown in condylobasal length. The SS-STP for both females and males yielded three overlapping nonsignificant subsets, though the mean for sample 12 in males was among the four largest, whereas in females it was among the smallest.

Means for breadth of rostrum in females fell into five nonsignificant subsets. Individuals from samples 2, 10, and 8 had the longest

rostra, whereas those from samples 9, 12, and 6 had the shortest. Means for males formed three nonsignificant subsets almost identical to those for length of nasals.

Alveolar length of maxillary toothrow exhibited little geographic variation. Means for both females and males fell into two nonsignificant subsets. The first subset contained all samples but 12 for both sexes. The second subset contained all but samples 4, 7, and 10 for females and all but sample 11 for males.

MULTIVARIATE ANALYSES. Means for three external and 10 cranial measurements were used for multivariate analyses. Distance and correlation phenograms were generated using the NT-SYS program for samples of both male and female *P. castanops*. Samples in the distance phenogram for females are divided into two clusters (one cluster, 1, 3, 5, 6, 8, and 12; the other 2, 4, 7, 8, 10, and 11). The first cluster is further subdivided into one subcluster of samples 1, 3, and 5, and the other the remaining samples. The second major cluster is divided into three subclusters, the first and third consisting only of samples 2 and 10, respectively, and the second with the remainder of the samples.

The distance phenogram for males is also divided into two clusters. The first cluster differs from that in females only in the absence of sample 12. Sample 9 was separated from the other samples in this cluster. The second cluster was subdivided into samples 2, 4, 10, and 12, and samples 7, 8, and 11.

Distance coefficients between adjacent samples are shown in Fig. 3. Those for females ranged from 0.578 between samples 1 and 3 to 2.931 between samples 10 and 12. Distance coefficients greater than 1.00 were found between 11 sets of samples and coefficients greater than 2.00 in three sets of samples (9 and 10, 10 and 12, and 11 and 12). Samples of males had distance coefficients greater than 1.00 in 15 sets of samples and coefficients greater than 2.00 in two sets (7 and 9, and 9 and 10).

Three dimensional projections of the first three principal components for samples of females and males are shown in Fig. 4. The amount of phenetic variation expressed for females and males, respectively, was 75.3 and 76.5 percent for the first eigenvector, 7.7 and 8.1 for the second, and 5.9 and 6.4 for the third. Total variation expressed was 88.9 percent for females and 91.0 percent for males. Table 3 shows the results of factor analysis. The first principal component appears to be influenced greatly by total length and all cra-

Fig. 4. Three-dimensional projections of the first three vectors resulting from principal components analyses of 12 samples of female and male *Pappogeomys castanops*. Vector III is represented by height. See Fig. 3 for key to samples.

TABLE 3

Factor matrix from correlation among the 13 characters studied. Character names referred to below are listed in numerical order in "Methods and Study Area."

Character	Females			Males		
	Component I	Component II	Component III	Component I	Component II	Component III
1	0.898	0.285	-0.107	0.890	-0.304	-0.082
2	0.429	0.867	0.095	0.479	-0.697	-0.001
3	0.763	0.100	-0.178	0.633	-0.464	-0.440
4	0.977	-0.141	0.082	0.993	0.041	-0.004
5	0.955	-0.158	0.146	0.958	0.201	-0.055
6	0.955	0.072	0.168	0.969	0.127	0.037
7	0.966	-0.031	0.189	0.944	-0.104	0.126
8	0.913	-0.067	0.353	0.952	0.160	0.058
9	0.887	0.108	-0.299	0.913	0.187	0.022
10	0.834	-0.109	-0.474	0.929	0.246	-0.185
11	0.948	-0.136	-0.115	0.967	0.138	-0.096
12	0.921	-0.194	0.293	0.977	0.076	0.035
13	0.669	-0.135	-0.290	0.544	-0.222	0.754

of the projection (Fig. 4) and samples consisting of larger individuals are spread across the diagram. Samples 4, 7, 8, and 11 in females and 2, 7, 8, and 10 in males appear to be closely grouped along the first vector, but separated along the second vector. Sample 12 is widely separated from samples 10 and 11, and quite closely associated with samples 6 and 9 in females, whereas in males sample 12 falls between 9 and 6 to the left and 10 and 11 to the right. No distinct groupings of samples are evident.

To determine if weighting of characters could be used to group samples, canonical analyses were conducted. The projection of the first two canonical vectors showing phenetic position of samples of female *P. castanops* is shown in Fig. 5. The projection for males was similar to that for females and is not figured. The two vectors represent a total percentage of variation for females and males of 56.15 and 59.97, respectively. In neither females nor males does any one sample or group of samples fall out as a distinctly separate group. The least amount of overlap between adjacent samples of females on the projection occurs between samples 9 and 12. Groupings of samples 2, 7, 10, and 11, and 1, 3, 4, 5, 6, and 12 are evident in the

Fig. 5. Projection of sample means for the first two canonical variates in 12 samples of female *Pappogeomys castanops*. Sample numbers represent the mean value for each sample in character space; ellipses represent one standard deviation around the mean. Percentages of variation expressed for vectors I and II are 30.89 and 25.26, respectively. See Fig. 3 for key to samples.

projection for males. Samples 8 and 9 are peripheral with little overlap. Variable coefficients and estimates of percentage influence for each character (Table 4) indicate that, in samples of females, condylobasal length, length of palate, and squamosal breadth contribute the highest influence on both vectors I and II. Highest percentage

TABLE 4

Variable coefficients and estimates of percent influence of each variable on each vector of canonical variates I, II, and III for all samples of Pappogeomys castanops. See "Methods and Study Area" for character names.

Character	Females		Males	
	Variable Coefficient	Percent Influence	Variable Coefficient	Percent Influence
Vector I				
1	-0.0008	1.02	0.0030	5.21
2	0.0068	2.40	0.0019	0.94
3	0.0232	3.91	-0.0238	5.33
4	-0.1358	32.83	0.0166	5.56
5	0.0089	1.38	-0.0712	16.21
6	0.0066	0.85	0.0411	5.40
7	0.1845	31.15	0.0261	6.17
8	0.0159	1.41	0.0539	6.80
9	0.0461	4.80	0.1151	16.14
10	-0.0834	11.45	-0.1059	20.36
11	0.0617	3.26	0.0036	0.27
12	0.0215	2.30	0.0384	5.79
13	-0.0675	3.26	0.0916	5.83
Vector II				
1	0.0021	3.76	0.0007	1.17
2	-0.0113	5.61	-0.0045	2.14
3	0.0152	3.60	0.0286	6.17
4	0.0537	18.24	-0.0449	14.48
5	-0.0357	7.80	-0.0404	8.86
6	-0.0414	5.54	0.0594	7.52
7	-0.0872	20.68	-0.0059	1.34
8	-0.0152	1.89	-0.0672	8.17
9	0.0028	0.41	-0.0519	7.01
10	0.0824	15.89	0.0697	12.91
11	0.1149	8.53	0.0696	5.12
12	0.0410	6.15	0.1370	19.90
13	-0.0281	1.91	-0.0853	5.23

TABLE 4 Continued

Character	Females		Males	
	Variable Coefficient	Percent Influence	Variable Coefficient	Percent Influence
Vector III				
1	0.0006	1.04	-0.0002	0.38
2	-0.0003	0.14	-0.0025	1.35
3	-0.0155	3.56	0.0107	2.63
4	0.0703	23.19	-0.0213	7.82
5	0.0268	5.69	-0.0018	0.45
6	-0.0212	2.76	0.1143	16.48
7	-0.1403	32.33	0.0547	14.19
8	0.0946	11.43	-0.1000	13.85
9	0.0685	9.73	-0.0071	1.09
10	-0.0400	7.49	-0.1097	23.15
11	0.0170	1.23	-0.0079	0.66
12	-0.0033	0.48	0.0346	5.73
13	0.0142	0.94	0.1752	12.23

influence for samples of males was in squamosal breadth, zygomatic breadth, and breadth of braincase in vector I and length of rostrum, condylobasal length, and squamosal breadth in vector II.

TAXONOMIC CONCLUSIONS. In his description of the subspecies *Pappogeomys castanops simulans*, Russell (1968:657) stated that "the name *simulans* is proposed for those populations inhabiting the western limits of the rolling prairie at lower elevations east of the cap-rock escarpment." The name *perplanus* was restricted to those populations of *P. castanops* that occur west of the caprock escarpment on the Llano Estacado. In reviewing Russell's list of specimens examined, all records were from localities above the escarpment on the Llano Estacado proper, with the exception of two specimens collected from Dawson Co. (10 mi E Lamesa). The type specimen of *P. c. simulans* (from Washburn, Armstrong Co.) was not obtained on the rolling plains as stated, but rather was trapped above the escarpment (Blair 1954:246). Thus the caprock escarpment, which might be assumed to serve as a barrier to gene flow between the two subspecies, does not divide the populations in question. The only pocket gopher occurring to the east of the caprock is *Geomys bursarius*.

Samples of *P. castanops* from western and eastern limits of the Llano Estacado have been shown not to differ significantly. Russell (1968:657) stated that specimens assigned to *simulans* measured significantly smaller than *perplanus*. We found, in contrast, that samples from the middle and eastern portions of the Llano Estacado tend to average slightly larger in size than samples from the west. However, males and females from Floyd Co. and Hale Co. (sample 5) and females from Glasscock Co. (sample 12) average as small in most measurements as do samples from western portions of the Llano Estacado. Multivariate analyses also show no meaningful geographic groupings of samples by the characters we utilized; rather variation among samples appears to represent clinal, interdemic variation. Russell (1968:630) noted a lack of clinal variation between subspecies of *Pappogeomys castanops* and suggested that this was due to restricted gene flow between peripheral populations of adjacent subspecies. He also stated that contiguous populations representing subspecies are uniform, and that the transition between them is abrupt. An abrupt transition is not evident between western and eastern samples of *P. castanops* on the Llano Estacado. Therefore, we propose that the name *P. c. simulans* be placed as a junior synonym of *P. c. perplanus*.

Females representing sample 12 are distinctly smaller than those of other samples in a number of measurements and fall out separately in several tests. The males from this sample are smaller than those to the north (7, 8, 10, 11) but are generally larger than those to the west. These gophers may represent intergrades between subspecies recognized in this study (*P. c. perplanus*) and a smaller subspecies, *P. c. angusticeps*, located farther to the south.

SPECIMENS EXAMINED.—A total of 473 specimens of *Pappogeomys castanops* was examined as follows (specimens in The Museum, Texas Tech University, unless otherwise noted):

SAMPLE 1.—TEXAS. Deaf Smith Co.: 1 mi. N, 18 3/10 mi. W Hereford, 15; 1 mi. N, 17 9/10 mi. W Hereford, 4; 1 mi. N, 16 4/10 mi. W Hereford, 4; 1 mi. N, 15 8/10 mi. W Hereford, 1; 1 mi. N, 15 1/2 mi. W Hereford, 1.

SAMPLE 2.—TEXAS. Potter Co.: 3 1/2 mi. W Amarillo, 1; 2 mi. E Amarillo, 2 (TCWC). Randall Co.: 2 6/10 mi. E Canyon, 1; 1 mi. N, 4 8/10 mi. E Canyon, 4; 2/10 mi. N, 6 1/2 mi. E Canyon, 2; 2 mi. E Canyon, 6; 3 mi. E Canyon, 6; 4 8/10 mi. E Canyon, 1; 5 mi. S Canyon, 1.

SAMPLE 3.—NEW MEXICO. DeBaca Co.: 2 7/10 mi. S, 3/10 mi. E Taiban, 2; 3 4/10 mi. S, 3/10 mi. E Taiban, 2; 5 8/10 mi. S, 3/10 mi. E Taiban, 2. Roosevelt Co.: 15 3/10 mi. W Floyd, 3; 13 mi. W Floyd, 2; 12 8/10 mi. W Floyd, 3; 12 3/10 mi. W Floyd, 9; 11 8/10 mi. W Floyd, 2.

SAMPLE 4.—TEXAS. Lamb Co.: 4 8/10 mi. S, 3/10 mi. W Earth, 5; 1 8/10

mi. N Littlefield, 3; $1\frac{1}{2}$ mi. N, $1\frac{1}{2}$ mi. W Littlefield, 4; Littlefield, 1 (TNHC); $\frac{1}{2}$ mi. S, 3 mi. W Littlefield, 5; $1\frac{1}{2}$ mi. S, $1\frac{8}{10}$ mi. E Littlefield, 5.

SAMPLE 5.—TEXAS. Floyd Co.: $4\frac{1}{10}$ mi. N, $1\frac{2}{10}$ mi. W Aiken, 13; $\frac{1}{2}$ mi. N Lockney, 1; $4\frac{1}{10}$ mi. N, $1\frac{8}{10}$ mi. W Lockney, 7; $1\frac{1}{2}$ mi. W Lockney, 1; $1\frac{3}{10}$ mi. W Lockney, 2; 1 mi. W Lockney, 5. Hale Co.: 3 mi. N, 1 mi. E Abernathy, 5 (MHP); Hale Center, 1 (USNM); Hale Co. Airport, 1 (WBC); 9 mi. W Plainview, 1 (WBC); Plainview, 12 (WBC); $1\frac{1}{2}$ mi. E Plainview, 2 (WBC); 1 mi. SW Plainview, 1 (WBC); 1 mi. S, $8\frac{1}{10}$ mi. W Plainview, 1 (WBC); 3 mi. SW Plainview, 4 (WBC); 3 mi. S Plainview, 2; 7 mi. SE Plainview, 1 (WBC).

SAMPLE 6.—NEW MEXICO. Lea Co.: $4\frac{2}{10}$ mi. W Crossroads, 1; $3\frac{1}{2}$ mi. W Crossroads, 7; $3\frac{3}{10}$ mi. W Crossroads, 1; $2\frac{9}{10}$ mi. W Crossroads, 1; $2\frac{7}{10}$ mi. W Crossroads, 1; 1 mi. W Crossroads, 9; $7\frac{1}{10}$ mi. W Crossroads, 1.

SAMPLE 7.—TEXAS. Hockley Co.: 6 mi. SE Anton, 1; 1 mi. N, $4\frac{3}{10}$ mi. W Levelland, 3; $\frac{1}{2}$ mi. N, $3\frac{1}{2}$ mi. W Levelland, 11; $\frac{1}{2}$ mi. N, $3\frac{2}{10}$ mi. W Levelland, 9; $\frac{1}{2}$ mi. N Levelland, 1; 2 mi. S, $3\frac{8}{10}$ mi. W Levelland, 2; 2 mi. S, $2\frac{8}{10}$ mi. W Levelland, 8; 3 mi. SW Levelland, 1; 7 mi. S Levelland, 1.

SAMPLE 8.—TEXAS. Lubbock Co.: Airport, 4; $10\frac{1}{10}$ mi. N Lubbock, 2; 10 mi. N Lubbock, 5; $8\frac{1}{2}$ mi. N Lubbock, 9; 8 mi. N Lubbock, 27; $7\frac{1}{2}$ mi. N Lubbock, 4; $7\frac{4}{10}$ mi. N Lubbock, 2; 7 mi. N Lubbock, 55; $6\frac{3}{10}$ mi. N Lubbock, 3; $5\frac{1}{2}$ mi. N Lubbock, 2; 5 mi. N Lubbock, 3; 5 mi. N, $\frac{1}{2}$ mi. E Lubbock, 1; $4\frac{4}{10}$ mi. N, $2\frac{1}{2}$ mi. E Lubbock, 1; 3 mi. NE Lubbock, 4; 2 mi. NW Lubbock, 2; 1 mi. N Lubbock, 1; $6\frac{1}{2}$ mi. W Lubbock, 1; 6 mi. W Lubbock, 1; $5\frac{1}{2}$ mi. W Lubbock, 6; 5 mi. W. Lubbock, 5; Lubbock, 3; 1 mi. S, 7 mi. W Lubbock, 2.

SAMPLE 9.—NEW MEXICO. Lea Co.: $7\frac{2}{10}$ mi. N, $2\frac{1}{10}$ mi. W Maljamar, 2; $5\frac{8}{10}$ mi. N, $1\frac{1}{2}$ mi. W Maljamar, 1; $3\frac{1}{2}$ mi. N, $\frac{1}{2}$ mi. W Maljamar, 3; 2 mi. N, 3 mi. E Maljamar, 1; $1\frac{4}{10}$ mi. N, $\frac{1}{2}$ mi. E Maljamar, 2; $1\frac{2}{10}$ mi. N, $\frac{1}{2}$ mi. E Maljamar, 1; $6\frac{1}{10}$ mi. N, $6\frac{1}{10}$ mi. E Maljamar, 5; 11 mi. E Maljamar, 2.

SAMPLE 10.—TEXAS. Gaines Co.: $4\frac{4}{10}$ mi. N, $9\frac{3}{10}$ mi. W Seminole, 19; $4\frac{4}{10}$ mi. N, $7\frac{6}{10}$ mi. W Seminole, 1; $4\frac{4}{10}$ mi. N, $6\frac{6}{10}$ mi. W Seminole, 2; $4\frac{4}{10}$ mi. N, $6\frac{2}{10}$ mi. W Seminole, 3; $8\frac{1}{10}$ mi. N, $6\frac{3}{10}$ mi. E Seminole, 1; 3 mi. SW Seminole, 1.

SAMPLE 11.—TEXAS. Dawson Co.: $11\frac{1}{10}$ mi. N, $4\frac{3}{10}$ mi. E Lamesa, 6 (MHP); 10 mi. E Lamesa, 2 (TNHC); $2\frac{2}{10}$ mi. S, $3\frac{1}{10}$ mi. E Lamesa, 2; $2\frac{3}{10}$ mi. S Lamesa, 7; $2\frac{8}{10}$ mi. S, $6\frac{1}{10}$ mi. E Lamesa, 2; $2\frac{9}{10}$ mi. S Lamesa, 4; $3\frac{3}{10}$ mi. S, 4 mi. E Lamesa, 5; $4\frac{6}{10}$ mi. S, $4\frac{3}{10}$ mi. E Lamesa, 1; 5 mi. S, $4\frac{1}{2}$ mi. E Lamesa, 5; $5\frac{2}{10}$ mi. S, 5 mi. E Lamesa, 1; $6\frac{8}{10}$ mi. S, $1\frac{3}{10}$ mi. E Lamesa, 1; 6 mi. S, $5\frac{7}{10}$ mi. E Lamesa, 6; $6\frac{8}{10}$ mi. S, $1\frac{3}{10}$ mi. E Lamesa, 4.

SAMPLE 12.—TEXAS. Glasscock Co.: 6 mi. N Garden City, 2 (ASVRC); 2 mi. N, $13\frac{7}{10}$ mi. W Garden City, 1; 2 mi. N, 13 mi. W Garden City, 1; $1\frac{9}{10}$ mi. N, $12\frac{8}{10}$ mi. W Garden City, 1; $1\frac{8}{10}$ mi. N, $12\frac{7}{10}$ mi. W Garden City, 4; $1\frac{4}{10}$ mi. N, $13\frac{3}{10}$ mi. W Garden City, 1; $\frac{1}{2}$ mi. S, 13 mi. W Garden City, 1; $7\frac{1}{10}$ mi. S, $12\frac{4}{10}$ mi. W Garden City, 2; 1 mi. S, $12\frac{1}{2}$ mi. W Garden City, 1; $1\frac{3}{10}$ mi. S, 12 mi. W Garden City, 2; 2 mi. W Garden City, 2; $2\frac{4}{10}$ mi. S, 12 mi. W Garden City, 2; $2\frac{4}{10}$ mi. S, $11\frac{8}{10}$ mi. W Garden City, 2; $2\frac{6}{10}$ mi. S Jct. Rt. 137 and 158, 1 (ASVRC); 19 mi. S Stanton, 1; 20 mi. S Stanton, 2. Martin Co.: Stanton, 1 (USNM).

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LITERATURE CITED

- BLAIR, W. F. 1954. Mammals of the mesquite plains biotic district in Texas and Oklahoma, and speciation in the central grasslands. *Texas J. Sci.* 6:235-264.
- GABRIEL, K. R. 1964. A procedure for testing the homogeneity of all sets of means in analysis of variance. *Biometrics* 20:459-477.
- HENDRICKSEN, R. L. 1973. Variation in the plains pocket gopher (*Geomys bursarius*) along a transect across Kansas and eastern Colorado. *Trans. Kansas Acad. Sci.* 75:322-368.
- LONG, C. A. 1968. An analysis of patterns of variation in some representative Mammalia. Part I. A review of estimates of variability in selected measurements. *Trans. Kansas Acad. Sci.* 71:201-227.
- NELSON, E. W., and E. A. GOLDMAN. 1934. Revision of the pocket gophers of the genus *Cratogeomys*. *Proc. Biol. Soc. Washington* 47:135-154.
- POWER, D. M. 1970. Geographic variation of red-winged blackbirds in central North America. *Univ. Kansas Publ., Mus. Nat. Hist.* 19:1-83.
- ROHLF, F. J., and J. KISHPAUGH. 1972. Numerical taxonomy system of multivariate statistical programs. State Univ. New York at Stony Brook, Stony Brook, 87 pp.
- RUSSELL, R. J. 1968. Revision of pocket gophers of the genus *Pappogeomys*. *Univ. Kansas Publ., Mus. Nat. Hist.* 16:581-776.
- SCHMIDLY, D. J., and F. S. HENDRICKS. 1976. Systematics of the southern races of Ord's kangaroo rat, *Dipodomys ordii*. *Bull. S. California Acad. Sci.* 75:225-237.
- SERVICE, J. 1972. A users guide to the statistical analysis system. *Instit. Statist., Raleigh Div., North Carolina State Univ.*, 260 pp.
- SOKAL, R. R., and F. J. ROHLF. 1969. *Biometry: the principles and practice of statistics in biological research*. W. H. Freeman and Co., San Francisco, xiii + 776 pp.
- WENDORF, F. 1970. The Lubbock subpluvial. Pp. 23-35, *in* *Pleistocene and Recent environments of the central Great Plains* (W. Dort, Jr., and J. K. Jones, Jr., eds.), Univ. Kansas Press, Lawrence, 433 pp.
- YATES, T. L., and D. J. SCHMIDLY. 1977. Systematics of *Scalopus aquaticus* (Linnaeus) in Texas and adjacent states. *Occas. Pap. Mus., Texas Tech Univ.* 45:1-36.