CORRELATION AND BODY PROPORTIONS IN MATURE MICE OF THE GENUS PEROMYSCUS*

FRANK H. CLARK

The Edison Institute, Dearborn, Michigan

Received September 27, 1940

IN THE present investigation, three species and several subspecies of mice belonging to the genus *Peromyscus* are compared with respect to the amounts of simple correlation and the size of the ratios between certain body and skeletal measurements. The means, standard deviations, and coefficients of variation are also given for all but one of the measurements. The only exception is ear length, which was added later and appears only in the tables of means and of ratios.

These data, in so far as they have a bearing on the subject, are presented as evidence regarding the relative importance of general, group, and special size factors. Evidence for the existence of these three types of size factors has been convincingly presented by WRIGHT (1932).

SUMNER (1932) and DICE (1932, 1933, 1938, 1939a, 1939b) have made extensive studies on variation in mice of the genus *Peromyscus* and have demonstrated that subspecific characters are inherited, but that there is considerable variation in mice of the same subspecies from different localities.

MATERIALS AND METHODS

Forty-two stocks of mice representing three species and ten subspecies were employed in these statistical analyses. The widespread deer mouse, *Peromyscus maniculatus*, is represented by one or more stocks in each of eight subspecies—namely, *artemisiae*, *bairdii*, *blandus*, *gambelii*, *osgoodi*, *rubidus*, *rufinus*, and *sonoriensis*. The wood mouse, *Peromyscus leucopus*, is presented by eight stocks of the one subspecies, *noveboracensis*. The cactus mouse, *Peromyscus eremicus*, is illustrated by the subspecies *eremicus* from four localities. The classification and range of these mice have been described by OSGOOD (1909).

The funds expended in collecting these mouse stocks were furnished in most part by the CARNEGIE INSTITUTION OF WASHINGTON, the UNIVERSITY OF MICHIGAN Museum of Zoology, and the WILLIAM P. HARRIS, JR., RESEARCH FUND. The stocks were collected by: LEE R. DICE, RUTH and ARTHUR SVIHLA, PAUL A. MOODY, H. J. LERAAS, HOBART M. SMITH, PHILIP F. ALLAN, PAUL HICKIE, G. W. BRADT, F. B. SUMNER, ADOLPH STEBLER, ADOLPH MURIE, O. J. MURIE, B. T. OSTENSON, R. R. HUESTIS, A. J. NICHOLSON, W. L. STRUNK, L. C. STEGEMAN, A. H. HOWELL, and PHILIP BLOSSOM.

* The cost of the tables is borne by the Galton and Mendel Memorial Fund.

The expense of rearing the animals was defrayed by the UNIVERSITY OF MICHIGAN through the Museum of Zoology, Faculty Research Fund, and the Laboratory of Vertebrate Genetics. Additional aid was given by grants from the National Research Council and by assistants furnished by the Federal National Youth Administration and Works Progress Administration.

The methods used in obtaining the body and skull measurements of these mice have been described in detail by DICE (1932). To avoid possible misunderstanding, a brief description of each measurement will be given here. Tail length is the distance from the upper base of the tail to the tip of the tail, not including the hairs; body length is derived by subtracting tail length from the total length, total length being the distance from the tip of the nose to the end of the tail, not including the tail hairs; ear length is the length of the left ear from the notch at the lower end of the ear opening to the tip of the ear; length of femur is the greatest length of the left femur from the condyles to the end of the great trochanter; foot length is length of the left hind foot from the heel to the end of the middle claw; skull length is the distance from the left occipital condyle to the most anterior part of the left premaxilla. The point taken on the premaxilla is slightly below the nasal and is not in the median line of the skull; condyle-zygoma is the distance from the left condyle to the angle at the most anterior part of the zygomatic process of the left maxilla; mandibular length is the greatest length of the left mandible, from condyle to end of incisor; skull width is the width of the skull across the mastoid processes.

The measurements used in this study were all taken from mice of the one year class (36 to 78 weeks of age when killed). There is not enough difference in size between males and females to justify separate treatment of the sexes.

Simple correlations and ratios were calculated for the following pairs of measurements: tail length/body length, skull length/body length, femur length/foot length, mandibular length/skull length, condyle-zygoma/skull length, and skull width/skull length. Ratios alone were calculated for ear length/skull length. The average correlations and ratios for the several subspecies and species are given and these average values will be used more than the individual values in the discussion. The number of individual measurements available for each of the stocks ranged from 44 to 164 and in most stocks was about 70.

It should be emphasized that the mice used in this study were all bred in the laboratory from unselected parents. These laboratory-bred mice were raised under uniform environmental conditions and were all of a nearly similar age when killed. It is believed, therefore, that their measurements and correlations are fully comparable.

The means and standard deviations are not discussed in detail. Values given for these stocks in the publications of DICE may differ slightly from those given in the present paper due to the use of different numbers of mice.

CORRELATIONS BETWEEN MEASUREMENTS

The correlations between certain measurements of *Peromyscus* are given in table 1. The average correlations for the various subspecies and species in table 2 were obtained by transforming the simple correlations in table 1 into z values and securing the weighted averages. In both tables the values of n are included. In table 1, a single $+$ sign after a coefficient means that it equals or is beyond the 5 percent level of significance, while two plus signs ($++$) indicate that it equals or is beyond the 1 percent level of significance. A coefficient with no $+$ sign after it is not statistically significant. All average coefficients in table 2 are significant statistically, so no $+$ signs are used.

After the correlations had been completed, the author's attention was called to the fact that the correlations between some of the pairs of measurements had little significance because one of the variables is a part of the other variable. For example, in the skull length and body length correlations, skull length is a part of body length, for body equals trunk plus head. The same criticism held true for the mandible and skull length correlations as well as for those of condyle-zygoma with skull length. The true correlations in these three sets were obtained by using the following formulae: $\sigma B^2 = \sigma C^2 + \sigma A^2 - 2\sigma A\sigma C r_{AC}$; $\sigma C^2 = \sigma A^2 + \sigma B^2 + 2\sigma A\sigma B r_{AB}$. For example, in the skull length and body length correlations C is a whole (body), A is the skull, and B is the trunk. By means of the first formula, σB^2 and σB are secured. The true value of the correlation is obtained by substituting in the second formula, the equation being solved for r_{AB} .

Slight errors introduced by the fact that the mandible measurement is not taken exactly along the longitudinal axis like the skull length measurement would obviously be less serious than those that would result from using the original spurious correlations.

These three sets of correlations thus become skull length and body length minus skull length; mandible length and skull length minus mandible length; condyle-zygoma and skull length minus condyle-zygoma length. In tables 1 and 2, however, the original headings are used because of their brevity; the reader should bear this fact in mind.

The correlations between the same pairs of measurements in the various stocks differ considerably in magnitude. For example, the simple correlations between tail length and body length vary in the species *maniculatus* from $-.16$ in *P. m. sonoriensis* from Winslow, Arizona, to $+.66$ in *P. m.*

TABLE I
Correlations between certain measurements of *Peromyscus*.

SPECIES	SUBSPECIES	LOCALITY	TAIL		SKULL LENGTH		FEMUR		MANDIBLE		CONDYLE-ZYGOMA		SKULL WIDTH	
			n	r	n	r	n	r	n	r	n	r	n	r
<i>maniculatus</i>	<i>artemisiae</i>	Godman Springs, Wash. Palouse Falls, Wash. Troy, Idaho	66 86 74	+.45 +.28 +.09	67 76 54	+.50 +.53 +.28	60 85 63	+.36 +.47 +.40	63 83 57	+.71 +.71 +.49	63 84 58	+.10 +.24 +.28	66 83 59	+.11 +.50 +.71
"	<i>bairdii</i>	Ann Arbor, Mich. Alexander, Iowa Barrett, Minn. Onaga, Kansas Sand Point, Mich. Lake Village, Ind.	106 97 88 85 82 78	+.66 +.51 +.67 +.37 +.47 +.45	82 63 79 80 77 70	+.55 +.66 +.40 +.47 +.38 +.51	94 74 85 80 78 74	+.59 +.41 +.08 +.11 +.32 +.34	80 62 78 80 73 70	+.78 +.83 +.75 +.71 +.65 +.71	83 93 80 86 77 70	+.26 +.31 +.29 +.26 +.06 +.22	80 58 77 80 73 69	+.55 +.73 +.60 +.53 +.04 +.71
"	"	Alamogordo, N. Mex. White Sands, N. Mex.	107 99	+.28 +.10	88 59	+.64 +.55	86 61	+.57 +.53	85 57	+.73 +.60	88 59	+.55 +.05	85 58	+.65 +.53
"	<i>gambelii</i>	La Jolla, Calif.	164	+.09	149	+.47	159	+.34	148	+.72	149	+.14	149	+.48
"	<i>osgondi</i>	Cottonwood Basin, S. Dak. Mandan, N. Dak. Otis, S. Dak. Jackson, Wyo.	49 96 95 114	+.19 +.05 +.22 +.30	49 93 96 70	+.62 +.50 +.51 +.52	52 95 94 68	+.39 +.39 +.24 +.02	52 95 96 70	+.87 +.77 +.74 +.80	52 95 96 70	+.29 +.44 +.58 +.41	52 95 96 69	+.64 +.70 +.40 +.03
"	"	Logan Canyon, Utah Taylor, N. Dak. Gregory, S. Dak.	63 82 94	+.34 +.36 +.10	63 81 89	+.13 +.59 +.53	61 80 92	+.51 +.32 +.40	64 81 92	+.52 +.79 +.78	63 81 93	+.53 +.15 +.38	63 78 93	+.71 +.50 +.61
"	<i>rubidus</i>	Eugene, Oregon	73	+.59	92	+.59	93	+.53	92	+.78	97	+.31	92	+.63
"	<i>ru/inus</i>	La Veta, Colo. Deadman Flat, Ariz. Little Spring, Ariz. Ice Caves, Ariz.	78 75 115 57	+.38 +.66 +.34 +.39	59 84 109 64	+.68 +.68 +.64 +.59	70 82 108 55	+.35 +.31 +.26 +.33	60 86 104 59	+.81 +.87 +.69 +.85	60 78 103 66	+.41 +.53 +.38 +.29	59 79 97 58	+.61 +.70 +.81 +.05
"	"	Bonito Canyon, N. Mex. Cloudcroft, N. Mex.	52 110	+.22 +.56	83 83	+.22 +.62	105 105	+.36 +.32	70 94	+.73 +.71	63 101	+.37 +.50	54 91	+.63 +.49
"	<i>sonoriensis</i>	Miller Canyon, Ariz. Winslow, Ariz. San Felipe, Calif. Victorville, Calif.	74 59 78 61	+.56 +.16 +.31 +.18	73 57 78 60	+.68 +.50 +.60 +.35	67 56 90 59	+.40 +.41 +.31 +.13	77 57 88 57	+.75 +.72 +.81 +.87	74 56 90 60	+.43 +.21 +.50 +.26	71 54 83 57	+.68 +.51 +.50 +.43
<i>leucopus</i>	<i>noveboracensis</i>	Ann Arbor (W), Mich. Ann Arbor (St), Mich. Ann Arbor (D), Mich. Cedarvale, N. Y. Decker, Ind. Greenland, N. H. Canebrake, Ind. Asheville, N. C.	99 47 56 85 71 85 62 66	+.33 +.08 +.26 +.40 +.40 +.38 +.42 +.37	94 51 52 83 80 69 62 59	+.53 +.48 +.38 +.61 +.39 +.48 +.62 +.40	95 48 52 83 84 81 68 61	+.27 +.04 +.51 +.38 +.61 +.19 +.34 +.49	94 48 50 66 71 71 74 59	+.79 +.78 +.91 +.75 +.88 +.63 +.80 +.72	95 44 53 84 71 72 74 60	+.14 +.18 +.20 +.18 +.41 +.54 +.19 -.17	93 53 51 84 75 68 68 62	+.53 +.43 +.04 +.56 +.53 +.48 +.50 +.48
<i>eremicus</i>	<i>eremicus</i>	Tumamoc Hill, Ariz. Tortolito Mts., Ariz. Pima Canyon, Ariz. 1000-Palm Canyon, Calif.	98 105 84 73	+.28 +.24 +.19 +.15	122 93 83 99	+.29 +.45 +.61 +.57	124 96 91 99	+.52 +.36 +.57 +.54	119 94 84 100	+.62 +.72 +.73 +.73	122 95 83 100	+.40 +.22 +.35 +.37	120 94 84 99	+.45 +.61 +.57 +.61

+ 5% level of significance.

+ + 1% level of significance.

bairdii from Ann Arbor, Michigan. The remainder of these correlations fall between these extremes, and although they are small, most of them are statistically significant. By referring to the average correlations in table 2, we find that within the species *maniculatus*, the average coefficient varies from +.09 in the subspecies *P. m. gambelii* to +.59 in the subspecies *P. m. rubidus*. Since each of the subspecies is represented by only one stock, the coefficients in this case are not averages but are included in the table for comparison. In subspecies which are represented by three or more stocks, the correlations range from +.26 to +.47 in the species *P. maniculatus*. In the three species *P. maniculatus*, *P. leucopus*, and *P. eremicus* the average correlations are +.34, +.35, and +.22, respectively, the grand average being +.33. Since body length is a good measure of general body size, the small magnitude of these correlations indicates that tail length is determined largely by factors other than those that determine general body size—in other words, by special size factors.

The correlations between skull length and body length (minus skull length) in tables 1 and 2 represent the true correlations. The correlations are somewhat larger than those found between tail and body. In table 1, these correlation coefficients vary from +.13 in *P. m. osgoodi* from Logan Canyon, Utah, to +.68 in two stocks of *P. m. rufinus* and one stock of *P. m. sonoriensis*. In table 2, the average coefficients of the subspecies fluctuate from +.46 in *P. m. artemisiae* to +.61 in *P. m. blandus* and *P. m. rufinus*. The average species correlations for the three species *P. maniculatus*, *P. leucopus*, and *P. eremicus* are +.54, +.50 and +.47, respectively, the grand average being +.52. These data indicate that only approximately 27 percent (r^2) of the variation in skull length and body (trunk) length is due to common genetic or environmental causes.

The correlations between femur length and foot length are, in general, small but statistically significant. Referring to table 1, we find that the coefficients for the individual stocks range from +.08 in *P. m. bairdii* from Barrett, Minnesota, to +.64 in *P. l. noveborascensis* from Ann Arbor (St), Michigan. The species averages for *P. maniculatus*, *P. leucopus*, and *P. eremicus* are +.37, +.42, and +.50, the grand average being +.40 (table 2). These results show that foot length, for the most part, varies independently of femur length.

The correlations between mandible length and skull length (minus mandible length) proved to be the largest of any of those studied and ranged from +.49 in *P. m. artemisiae* from Troy, Idaho, to +.91 in *P. l. noveborascensis* from Ann Arbor (D), Michigan (table 1). The average correlations of the ten subspecies (table 2) vary from +.66 to +.79. The species's averages are +.75, +.79, and +.70, respectively, for the three species *P. maniculatus*, *P. leucopus*, and *P. eremicus*, the grand average being +.75.

TABLE 2
Average correlations between certain measurements of several species and subspecies of *Peromyscus*.

SPECIES	SUBSPECIES	NO. OF STOCKS AVERAGED	TAIL		SKULL LENGTH		FEMUR		MANDIBLE*		CONDYLE-ZYGOMA		SKULL WIDTH	
			n	r	n	r	n	r	n	r	n	r	n	r
<i>maniculatus</i>	<i>artemisiae</i>	3	226	+ .27	197	+ .46	123	+ .42	203	+ .66	205	+ .21	208	+ .47
	<i>bardii</i>	6	536	+ .47	452	+ .50	485	+ .43	443	+ .74	453	+ .23	437	+ .57
	<i>blandus</i>	2	206	+ .20	147	+ .61	147	+ .55	142	+ .68	147	+ .37	143	+ .60
	<i>gambelii</i>	1	164	+ .09	149	+ .47	159	+ .34	148	+ .72	149	+ .14	149	+ .48
	<i>osgoodi</i>	7	593	+ .22	541	+ .50	542	+ .40	550	+ .76	550	+ .40	549	+ .61
	<i>rubidus</i>	1	73	+ .59	92	+ .59	93	+ .53	92	+ .78	97	+ .31	92	+ .62
	<i>rufinus</i>	6	500	+ .46	451	+ .61	474	+ .31	473	+ .78	371	+ .42	438	+ .60
	<i>sonoriensis</i>	4	272	+ .26	268	+ .56	272	+ .32	279	+ .79	280	+ .40	265	+ .57
	Species average			+ .34		+ .54		+ .37		+ .75		+ .34		+ .58
<i>leucopus</i>	<i>novborascensis</i>	8	571	+ .35	557	+ .50	572	+ .42	540	+ .79	553	+ .22	554	+ .54
	<i>eremicus</i>	4	360	+ .22	397	+ .47	410	+ .50	397	+ .70	400	+ .34	397	+ .56
	Genus average			+ .33		+ .52		+ .40		+ .75		+ .32		+ .57

* See text of article for explanation of these correlations.

Therefore, approximately 56 percent (r^2) of the size variations in mandible length and skull length (minus mandible length) may be attributed to general or group size factors. Apparently, special size factors also play an important part in determining the size of these parts.

The true or net correlation coefficients between condyle-zygoma and skull length (minus condyle-zygoma length) are listed in the fifth columns of tables 1 and 2. These coefficients are small, being of about the same magnitude as those for tail with body, and they vary from $+.05$ in *P. m. blandus* from White Sands, New Mexico, to $+.58$ in *P. m. osgoodi* from Otis, S. Dakota (table 1). The average coefficients (table 2) for the three species *P. maniculatus*, *P. leucopus*, and *P. eremicus* are $+.34$, $+.22$, and $+.34$, respectively. The grand average is $+.32$.

The correlations between skull width and skull length are only moderate in size, most of them being statistically significant. The average values (table 2) for the three species *P. maniculatus*, *P. leucopus*, and *P. eremicus* are $+.58$, $+.54$, and $+.56$, respectively; the grand average is $+.57$. Obviously some of the size factors affecting skull length also have an effect upon skull width. Such factors may be either general or group factors. Only 32 percent of the variation in these two variables is caused by such factors. The remainder may be attributed to special genetic or environmental factors.

RATIOS BETWEEN MEASUREMENTS

Ratios were calculated between some of the body and skeletal measurements for the purpose of comparing the relative proportion between these parts in different stocks. For example, the tail length/body length ratio was computed by dividing mean tail length by mean body length. It is true that the ratio of two means may differ from the mean of individual ratios especially if the coefficients of variability are large. With several stocks, a ratio was obtained in both ways, and since they checked to three or four decimal places, the easier method was used. For calculating the standard errors of the ratios, the following formula was used:

$$\text{S.E. } B/A = \frac{B/A \sqrt{V_A^2 + V_B^2 - 2V_A V_B r_{AB}}}{\sqrt{n}}$$

where B/A = the ratio, V/A = coefficient of variability of $A/100$, and r_{AB} = correlation coefficient between A and B .

The ratios of the individual stocks are shown in table 3. There are so many significant differences between these ratios, however, that a discussion of them is somewhat confusing. To simplify matters, the ratios of the individual stocks were averaged to obtain the average ratio for each subspecies, each species, and for all the stocks. Since the collections of mice

TABLE 3
Ratios and their standard errors between certain measurements of Peromyscus.

SPECIES	SUBSPECIES	LOCALITY	TAIL		SKULL LENGTH		FEMUR		EAR		MANDIBLE		CONDYLE-ZYGOMA		SKULL WIDTH	
			BODY		BODY		FOOT		SKULL LENGTH		SKULL LENGTH		SKULL LENGTH		SKULL LENGTH	
<i>maniculatus</i>	<i>arlemistae</i>	Godman Springs	.8783 ± .0063		.2683 ± .0014		.7819 ± .0051		.7312 ± .0039		.6460 ± .0014		.7091 ± .0027		.4382 ± .0016	
	"	Palouse Falls	.7346 ± .0051		.2554 ± .0010		.8035 ± .0032		.7204 ± .0036		.6137 ± .0013		.7086 ± .0021		.4378 ± .0010	
	"	Troy	.8506 ± .0063		.2609 ± .0012		.7946 ± .0036		.7200 ± .0038		.6513 ± .0020		.7202 ± .0024		.4344 ± .0008	
	<i>bairdii</i>	Ann Arbor	.7063 ± .0035		.2725 ± .0013		.7878 ± .0033		.6182 ± .0033		.6015 ± .0017		.7316 ± .0027		.4576 ± .0014	
	"	Alexander	.7295 ± .0037		.2768 ± .0013		.8135 ± .0042		.6273 ± .0038		.6743 ± .0015		.7274 ± .0034		.4402 ± .0014	
"	"	Barrett	.6345 ± .0030		.2524 ± .0012		.8220 ± .0039		.6418 ± .0032		.6740 ± .0012		.7209 ± .0022		.4530 ± .0012	
	"	Onaga	.6281 ± .0042		.2599 ± .0009		.7908 ± .0050		.6466 ± .0028		.6661 ± .0013		.7205 ± .0023		.4606 ± .0011	
	"	Sandpoint	.6127 ± .0050		.2551 ± .0009		.8119 ± .0036		.6500 ± .0024		.6641 ± .0014		.7317 ± .0021		.4583 ± .0014	
	"	Lake Village	.6540 ± .0039		.2580 ± .0010		.7840 ± .0039		.6351 ± .0034		.6867 ± .0015		.7315 ± .0026		.4486 ± .0010	
"	<i>blandus</i>	Alamogordo	.7524 ± .0064		.2593 ± .0016		.8051 ± .0053		.7452 ± .0040		.6573 ± .0016		.7145 ± .0021		.4303 ± .0011	
	"	White Sands	.7416 ± .0063		.2582 ± .0015		.7906 ± .0054		.7016 ± .0035		.6628 ± .0020		.7177 ± .0030		.4345 ± .0012	
"	<i>gambelii</i>	La Jolla	.7941 ± .0054		.2538 ± .0008		.8040 ± .0026		.7553 ± .0026		.6559 ± .0008		.7140 ± .0015		.4420 ± .0008	
	<i>osgoodi</i>	Cottonwood Basin	.7001 ± .0071		.2560 ± .0012		.7737 ± .0044		.6617 ± .0043		.6679 ± .0013		.7231 ± .0026		.4447 ± .0013	
"	"	Mandan	.6632 ± .0053		.2505 ± .0009		.8109 ± .0032		.6660 ± .0033		.6610 ± .0013		.7200 ± .0035		.4570 ± .0009	
	"	Otis	.6707 ± .0037		.2510 ± .0010		.7871 ± .0032		.7137 ± .0036		.6672 ± .0012		.7159 ± .0016		.4508 ± .0012	
	"	Jackson	.8012 ± .0062		.2776 ± .0016		.8047 ± .0036		.7168 ± .0040		.6620 ± .0014		.7197 ± .0028		.4508 ± .0013	
	"	Logan Canyon	.7572 ± .0063		.2580 ± .0015		.7926 ± .0037		.7349 ± .0041		.6557 ± .0021		.7061 ± .0021		.4460 ± .0013	
	"	Taylor	.6270 ± .0045		.2525 ± .0009		.8365 ± .0048		.6576 ± .0020		.6631 ± .0012		.7235 ± .0024		.4460 ± .0011	
"	"	Gregory	.6406 ± .0032		.2538 ± .0011		.8390 ± .0038		.6493 ± .0044		.6716 ± .0015		.7293 ± .0024		.4372 ± .0013	
	<i>rubidus</i>	Eugene	.9606 ± .0068		.2607 ± .0011		.7612 ± .0030		.7185 ± .0039		.6485 ± .0013		.7161 ± .0026		.4386 ± .0011	
"	<i>rufinus</i>	La Veta	.8301 ± .0068		.2775 ± .0013		.7831 ± .0039		.7450 ± .0051		.6603 ± .0018		.7140 ± .0035		.4441 ± .0011	
	"	Deadman Flat	.6523 ± .0050		.2580 ± .0011		.8013 ± .0042		.7840 ± .0043		.6553 ± .0012		.7196 ± .0044		.4445 ± .0013	
	"	Little Spring	.6521 ± .0037		.2564 ± .0008		.7953 ± .0035		.7569 ± .0032		.6537 ± .0012		.7153 ± .0022		.4452 ± .0009	
	"	Ice Caves	.6751 ± .0058		.2520 ± .0009		.8357 ± .0052		.7704 ± .0045		.6537 ± .0015		.7148 ± .0027		.4454 ± .0011	
	"	Benito Canyon	.7176 ± .0038		.2628 ± .0017		.7894 ± .0047		.7424 ± .0044		.6807 ± .0014		.7122 ± .0027		.4439 ± .0013	
"	"	Cloudercroft	.8133 ± .0047		.2803 ± .0012		.7776 ± .0037		.7553 ± .0038		.6809 ± .0015		.7084 ± .0019		.4347 ± .0012	
	"	Miller Canyon	.6498 ± .0038		.2523 ± .0015		.8128 ± .0039		.6958 ± .0040		.6411 ± .0016		.7242 ± .0025		.4428 ± .0012	
	"	Winslow	.8542 ± .0051		.2597 ± .0009		.7998 ± .0042		.7436 ± .0050		.6539 ± .0018		.7169 ± .0028		.4458 ± .0015	
	"	San Felipe	.7831 ± .0067		.2612 ± .0011		.7939 ± .0040		.7432 ± .0040		.6461 ± .0013		.7225 ± .0021		.4138 ± .0012	
	"	Victorville	.8203 ± .0061		.2820 ± .0013		.8125 ± .0047		.6061 ± .0035		.6477 ± .0013		.7249 ± .0030		.4504 ± .0010	
<i>leucopus</i>	<i>noveboracensis</i>	Ann Arbor (W)	.8441 ± .0051		.2585 ± .0012		.8146 ± .0034		.6810 ± .0027		.6608 ± .0011		.7146 ± .0023		.4360 ± .0015	
	"	Ann Arbor (St)	.8071 ± .0100		.2647 ± .0018		.7950 ± .0060		.6824 ± .0033		.6608 ± .0010		.7254 ± .0029		.4450 ± .0013	
	"	Ann Arbor (D)	.8072 ± .0086		.2606 ± .0018		.8079 ± .0059		.7008 ± .0043		.6603 ± .0011		.7269 ± .0035		.4452 ± .0015	
	"	Cedarvale	.8085 ± .0045		.2639 ± .0008		.8348 ± .0047		.6662 ± .0029		.6642 ± .0012		.7185 ± .0023		.4337 ± .0009	
	"	Decker	.7804 ± .0060		.2519 ± .0012		.8008 ± .0032		.6582 ± .0030		.6780 ± .0012		.7264 ± .0023		.4459 ± .0011	
"	"	Greenland	.7977 ± .0032		.2490 ± .0009		.8061 ± .0037		.6976 ± .0040		.6087 ± .0015		.7236 ± .0017		.4403 ± .0010	
	"	Canebrake	.8568 ± .0005		.2550 ± .0012		.8151 ± .0041		.6722 ± .0041		.6740 ± .0014		.7261 ± .0025		.4368 ± .0012	
	"	Asheville	.8435 ± .0070		.2507 ± .0014		.8053 ± .0053		.6029 ± .0040		.6053 ± .0015		.7202 ± .0032		.4414 ± .0013	
<i>eremicus</i>	"	Tumamoc Hill	1.0694 ± .0062		.2540 ± .0009		.8101 ± .0022		.8182 ± .0024		.6459 ± .0011		.7318 ± .0015		.4634 ± .0008	
	"	Tortolito Mts.	1.0347 ± .0035		.2488 ± .0008		.8091 ± .0029		.8062 ± .0030		.6483 ± .0011		.7290 ± .0018		.4619 ± .0008	
	"	Pima Canyon	1.0037 ± .0003		.2507 ± .0009		.8223 ± .0026		.8223 ± .0030		.6455 ± .0012		.7291 ± .0019		.4601 ± .0009	
	"	1000-Palm Canyon	1.0710 ± .0083		.2526 ± .0009		.7996 ± .0024		.8345 ± .0037		.6533 ± .0009		.7395 ± .0028		.4614 ± .0007	

used were not random samples of the same homogeneous population, weighted averages of the ratios, means, and coefficients of variation were not used. The unweighted averages were calculated by using the following formula:

$$\frac{\Sigma A}{n} \pm \sqrt{\frac{\Sigma A^2 - (\Sigma A)^2/n}{n(n-1)}}$$

in which A represents the values to be averaged.

The average ratios are shown in table 4, and the discussion of ratios will be largely confined to the data in this table. The average means of the various body measurements in table 6 also aid in the interpretations of the ratios.

The tail/body ratios of the different species and subspecies differ greatly. Within the species *P. maniculatus*, the subspecies *P. m. artemisiae*, *P. m. gambelii*, and *P. m. rubidus* have significantly higher ratios than the other mice in this species (table 4). This is due mostly to their longer tails, all three being at times tree-inhabiting forms, while the other five subspecies are mostly nonarboreal. The body lengths of these three subspecies differ very little from those of the nonarboreal forms (table 6). The average tail/body ratios of the three species *P. maniculatus*, *P. leucopus*, and *P. eremicus* are respectively $.7677 \pm .033$, $.8329 \pm .014$, and $1.0597 \pm .008$. The ratio of *P. eremicus* is significantly higher than those of the other two species, whose ratios are hardly significantly different from one another. It should be pointed out, however, that the tail/body ratio of *P. leucopus noveborascensis* is similar to that of the subspecies *P. maniculatus artemisiae*. *P. eremicus eremicus* has a very high ratio due to the fact that it has an extremely long tail with only a slightly longer body than the other species (table 6). It should be emphasized that the average ratios of these species should not be taken as typical of the whole species. In *P. maniculatus*, for example, if fewer subspecies of the nonarboreal type had been included, the ratio would be higher. *P. leucopus* is semiarboreal, and *P. eremicus* is saxicolous in habit. Each is represented here by only one subspecies.

The average skull length/body length ratios are much less variable than the tail/body ratios, although significant differences do occur. Here there is very little correlation between habit and size of ratio. For example, the semiarboreal subspecies *P. m. artemisiae* has about the same ratio (table 4) as the prairie subspecies *P. m. bairdii*. On the other hand, the saxicolous form *P. eremicus eremicus*, although it has a tail length out of all proportion to its body length, also has a shorter skull in relation to body length than any of the other species and subspecies.

In the species *P. maniculatus*, the semiarboreal subspecies *P. m. rubidus*

TABLE 4
Average ratios and their standard errors between certain measurements of several species and subspecies of *Peromyscus*.

SPECIES	SUBSPECIES	NO. OF STOCKS AVERAGED	TAIL		SKULL LENGTH		FEMUR		EAR		MANDIBLE		CONDYLE-ZYGOMA		SKULL WIDTH	
			BODY		BODY		FOOT		SKULL LENGTH		SKULL LENGTH		SKULL LENGTH		SKULL LENGTH	
<i>maniculatus</i>	<i>artemisiae</i>	3	.8212 ± .044		.2615 ± .001		.7933 ± .006		.7268 ± .003		.6499 ± .003		.7126 ± .004		.4368 ± .001	
"	<i>bairdii</i>	6	.6608 ± .043		.2624 ± .002		.8030 ± .019		.6365 ± .006		.6711 ± .002		.7301 ± .000		.4545 ± .002	
"	<i>blandus</i>	2	.7470 ± .005		.2588 ± .001		.8023 ± .003		.7234 ± .022		.6601 ± .003		.7161 ± .000		.4369 ± .002	
"	<i>gambelii</i>	1	.7941 ± .005		.2538 ± .001		.8040 ± .003		.7553 ± .003		.6550 ± .001		.7140 ± .002		.4420 ± .001	
"	<i>osgoodi</i>	7	.7073 ± .035		.2572 ± .004		.8049 ± .008		.6914 ± .016		.6644 ± .002		.7171 ± .003		.4471 ± .002	
"	<i>rubidus</i>	1	.9606 ± .007		.2607 ± .001		.7612 ± .003		.7185 ± .004		.6485 ± .001		.7161 ± .003		.4386 ± .001	
"	<i>rufinus</i>	6	.7249 ± .034		.2648 ± .005		.7935 ± .005		.7593 ± .006		.6573 ± .001		.7129 ± .001		.4427 ± .002	
"	<i>sonoriensis</i>	4	.7258 ± .046		.2609 ± .007		.8052 ± .004		.7121 ± .019		.6508 ± .002		.7221 ± .002		.3382 ± .008	
	Species average		.7677 ± .033		.2600 ± .001		.7959 ± .005		.7154 ± .014		.6571 ± .003		.7176 ± .002		.4296 ± .013	
<i>leucopus</i>	<i>noveboracensis</i>	8	.8329 ± .014		.2594 ± .002		.8045 ± .004		.6781 ± .005		.6657 ± .002		.7230 ± .002		.4406 ± .002	
<i>eremicus</i>	<i>eremicus</i>	4	1.0507 ± .008		.2516 ± .001		.8134 ± .008		.8203 ± .001		.6481 ± .002		.7318 ± .002		.4617 ± .001	
	Genus average		.8034 ± .039		.2591 ± .001		.7985 ± .005		.7222 ± .016		.6571 ± .002		.7196 ± .002		.4239 ± .012	

tends to have a shorter femur in relation to foot length than most of the nonarboreal forms. This is shown by its small ratio (table 4). However, another semiarboreal form, *P. m. gambelii*, has a ratio almost identical with those of the nonarboreal subspecies *P. m. bairdii*, *P. m. blandus*, *P. m. osgoodi*, and *P. m. sonoriensis*. The saxicolous species *P. eremicus eremicus* tends to have a longer femur in relation to foot length than any of the other species or subspecies, although the difference is not significant in every case.

In table 4, it may readily be seen that mice of the species *P. e. eremicus* have a strikingly higher ear/skull length ratio ($.8203 \pm .001$) than any of the other forms here compared. The *eremicus* mice have exceptionally long ears. On the other hand, mice of the form *P. m. bairdii* have a smaller ratio ($.6365 \pm .006$) than mice of the other species or subspecies, due to their extremely short ears.

The mandible/skull length ratios and condyle-zygoma/skull length ratios reveal few if any differences that would add to the value of this discussion.

The skull width/skull length ratios (table 4) reveal certain interesting differences. The short-eared, short-tailed deer mouse *P. m. bairdii* has a wider skull in relation to skull length than any of the other subspecies of the species *P. maniculatus*, its ratio being $.4545 \pm .002$. This ratio is exceeded only by that of the cactus mouse, *P. eremicus eremicus*, which has a ratio of $.4617 \pm .001$.

MEANS OF THE MEASUREMENTS

The means and their standard errors of the measurements of the individual stocks of *Peromyscus* are listed in table 5. The average means of the species and subspecies were calculated from the data in table 5 and are found in table 6. Differences between these stocks in size of body parts have been reported by DICE (1932, 1933, 1938, 1939a, 1939b). No attempt is made here to analyze these means, since DICE has already done so. He has also discussed the genetic and evolutionary significance of these data (DICE 1940a, 1940b). The data are included so that the other results presented in this paper will be more intelligible, particularly the ratios.

VARIABILITY¹

The coefficients of variation and their standard errors of the individual stocks are shown in table 7, and the averages appear in table 8.

As might be expected, different stocks of mice of the same subspecies often differ significantly from each other in variability. For example, *P. m.*

¹ Tables of standard deviations of all stocks are too extensive to reproduce, but are on file in the Editorial Office of GENETICS and will be supplied on request to persons interested.

TABLE 5
The means and their standard errors of some measurements of *Peromyscus*, in millimeters.

SPECIES	SUBSPECIES	LOCALITY	BODY	TAIL	FOOT	EAR	FEMUR	MANDIBLE	SKULL LENGTH	CONDYLE-ZYGOMA	SKULL WIDTH
<i>maniculatus</i>	<i>artemisiae</i>	Godman Springs	91.14 ± .556	80.05 ± .594	20.16 ± .072	17.87 ± .082	15.77 ± .086	15.75 ± .049	24.44 ± .067	17.31 ± .049	10.71 ± .036
"	"	Palouse Falls	96.64 ± .422	70.99 ± .482	20.12 ± .061	17.09 ± .077	16.17 ± .071	16.14 ± .044	24.07 ± .062	17.51 ± .041	10.81 ± .036
"	"	Troy	93.34 ± .364	79.39 ± .500	20.09 ± .090	17.53 ± .079	15.07 ± .059	15.84 ± .050	24.34 ± .069	17.54 ± .049	10.58 ± .035
"	<i>bairdii</i>	Ann Arbor	81.35 ± .400	77.37 ± .380	17.82 ± .069	13.66 ± .059	14.06 ± .071	14.03 ± .057	22.00 ± .067	16.17 ± .050	10.12 ± .034
"	"	Alexander	82.94 ± .420	66.41 ± .300	18.13 ± .083	14.28 ± .068	14.73 ± .072	15.37 ± .053	22.77 ± .087	16.58 ± .066	10.24 ± .038
"	"	Barrett	92.34 ± .440	58.58 ± .450	18.48 ± .060	15.01 ± .066	15.17 ± .060	15.77 ± .040	23.30 ± .057	17.06 ± .043	10.64 ± .031
"	"	Onaga	88.76 ± .350	55.75 ± .390	19.12 ± .059	14.88 ± .040	15.20 ± .086	15.33 ± .038	23.02 ± .060	16.70 ± .044	10.60 ± .032
"	"	Sand Point	90.18 ± .335	55.26 ± .406	18.03 ± .059	15.18 ± .058	14.62 ± .063	15.30 ± .044	23.01 ± .044	16.84 ± .037	10.53 ± .036
"	"	Lake Village	89.60 ± .386	58.60 ± .396	18.64 ± .063	14.44 ± .067	14.61 ± .072	15.86 ± .050	23.10 ± .063	16.90 ± .049	10.30 ± .033
"	<i>blandus</i>	Alamogordo	94.44 ± .654	71.06 ± .514	20.81 ± .069	18.32 ± .078	16.75 ± .096	16.17 ± .056	24.50 ± .078	17.57 ± .055	10.81 ± .032
"	"	White Sands	94.28 ± .493	69.91 ± .512	21.45 ± .072	17.25 ± .069	17.13 ± .084	16.30 ± .059	24.59 ± .073	17.65 ± .054	10.68 ± .039
"	<i>gambelii</i>	La Jolla	95.12 ± .330	75.44 ± .470	20.46 ± .051	18.28 ± .054	16.45 ± .050	15.84 ± .028	24.20 ± .042	17.20 ± .031	10.69 ± .019
"	<i>osgoodi</i>	Cottonwood Basin	94.66 ± .574	66.28 ± .627	20.64 ± .086	16.28 ± .085	15.07 ± .092	16.15 ± .062	24.23 ± .080	17.51 ± .063	10.77 ± .032
"	"	Mandan	95.38 ± .466	63.25 ± .447	19.59 ± .057	15.80 ± .065	15.88 ± .064	15.83 ± .045	23.86 ± .067	17.26 ± .048	10.70 ± .028
"	"	Oris	94.46 ± .430	63.35 ± .399	20.54 ± .058	16.91 ± .073	16.17 ± .060	16.40 ± .039	23.70 ± .059	17.26 ± .049	10.82 ± .025
"	"	Jackson	85.39 ± .445	76.10 ± .402	19.25 ± .080	17.09 ± .070	15.40 ± .087	15.76 ± .052	23.77 ± .083	16.88 ± .062	10.70 ± .033
"	"	Logan Canyon	93.77 ± .467	71.01 ± .412	20.46 ± .073	17.77 ± .078	16.21 ± .085	15.85 ± .049	24.33 ± .085	17.07 ± .041	10.73 ± .031
"	"	Taylor	96.62 ± .446	66.67 ± .455	19.33 ± .054	16.04 ± .060	16.17 ± .056	16.17 ± .056	24.38 ± .060	17.64 ± .046	10.85 ± .030
"	"	Gregory	94.18 ± .470	66.33 ± .420	19.40 ± .081	15.35 ± .095	16.68 ± .060	16.09 ± .058	23.98 ± .075	17.20 ± .052	10.81 ± .035
"	<i>rubidus</i>	Eugene	92.78 ± .451	83.49 ± .774	20.95 ± .063	17.38 ± .079	15.94 ± .076	15.68 ± .047	24.19 ± .074	17.33 ± .055	10.61 ± .030
"	<i>rufinus</i>	La Veta	87.50 ± .480	73.42 ± .610	20.61 ± .076	18.10 ± .108	16.14 ± .078	16.02 ± .072	24.26 ± .083	17.32 ± .057	10.78 ± .034
"	"	Deadman Flat	93.10 ± .509	61.14 ± .626	19.88 ± .077	18.02 ± .078	15.03 ± .079	15.83 ± .035	24.10 ± .085	17.17 ± .058	10.77 ± .026
"	"	Little Spring	94.57 ± .388	61.66 ± .351	19.71 ± .064	18.16 ± .064	15.68 ± .062	15.90 ± .037	24.25 ± .056	17.32 ± .040	10.70 ± .022
"	"	Ice Caves	96.97 ± .461	65.46 ± .607	20.08 ± .084	18.87 ± .094	16.36 ± .103	16.10 ± .060	24.50 ± .075	17.50 ± .058	10.94 ± .027
"	"	Bonito Canyon	92.39 ± .488	66.30 ± .515	20.30 ± .104	18.03 ± .090	16.02 ± .078	15.96 ± .040	24.20 ± .090	17.31 ± .060	10.80 ± .035
"	"	Cloudercroft	86.48 ± .492	70.34 ± .486	20.21 ± .072	18.38 ± .070	15.71 ± .070	16.68 ± .049	24.33 ± .078	17.20 ± .043	10.70 ± .026
"	<i>sonoriensis</i>	Miller Canyon	96.20 ± .580	61.55 ± .464	20.38 ± .074	16.84 ± .079	16.57 ± .082	15.93 ± .056	24.34 ± .084	17.62 ± .055	10.77 ± .030
"	"	Winslow	93.38 ± .375	61.09 ± .374	19.75 ± .071	17.86 ± .122	15.86 ± .088	15.07 ± .061	23.94 ± .071	17.10 ± .057	10.67 ± .040
"	"	San Felipe	95.02 ± .524	75.11 ± .658	20.61 ± .057	17.92 ± .073	16.45 ± .078	15.54 ± .051	24.12 ± .083	17.40 ± .053	10.70 ± .025
"	"	Victorville	88.81 ± .414	73.38 ± .472	19.29 ± .068	16.09 ± .067	15.08 ± .079	15.15 ± .063	25.05 ± .084	16.90 ± .057	10.54 ± .035
<i>leucopus</i>	<i>noveboracensis</i>	Ann Arbor (W)	95.77 ± .368	80.84 ± .485	20.56 ± .058	16.90 ± .054	16.76 ± .066	16.40 ± .044	24.81 ± .058	17.73 ± .044	10.83 ± .037
"	"	Ann Arbor (S)	92.33 ± .758	83.16 ± .687	20.62 ± .083	16.04 ± .064	16.30 ± .102	16.08 ± .083	24.38 ± .072	17.62 ± .054	10.80 ± .029
"	"	Ann Arbor (D)	92.36 ± .485	80.09 ± .791	20.22 ± .101	16.86 ± .082	16.34 ± .075	15.86 ± .066	23.98 ± .087	17.40 ± .071	10.68 ± .046
"	"	Cedarvale	93.39 ± .376	75.58 ± .443	20.60 ± .072	16.54 ± .061	16.15 ± .056	16.42 ± .045	24.72 ± .059	17.70 ± .046	10.77 ± .024
"	"	Decker	77.41 ± .370	77.41 ± .030	20.91 ± .078	16.30 ± .059	16.87 ± .084	16.04 ± .060	24.86 ± .070	17.92 ± .050	11.00 ± .025
"	"	Greenland	100.02 ± .351	79.78 ± .554	20.84 ± .039	17.44 ± .091	16.86 ± .071	16.73 ± .054	25.00 ± .064	18.15 ± .044	11.00 ± .078
"	"	Canabake	98.08 ± .595	86.50 ± .661	20.63 ± .081	16.81 ± .090	16.81 ± .090	16.01 ± .057	25.01 ± .069	18.21 ± .052	10.97 ± .029
"	"	Asheville	90.26 ± .455	70.14 ± .604	20.13 ± .065	16.16 ± .087	16.21 ± .077	16.23 ± .048	24.31 ± .071	17.58 ± .068	10.78 ± .033
<i>eremicus</i>	<i>eremicus</i>	Tumamoc Hill	93.83 ± .351	100.34 ± .611	20.29 ± .054	19.46 ± .052	16.44 ± .046	15.46 ± .033	23.79 ± .044	17.43 ± .031	11.03 ± .017
"	"	Tortolito Mts.	96.91 ± .389	102.34 ± .486	20.90 ± .059	19.75 ± .062	16.90 ± .056	15.88 ± .038	24.50 ± .052	17.87 ± .033	11.31 ± .022
"	"	Pima Canyon	97.33 ± .375	103.54 ± .552	20.56 ± .069	19.96 ± .066	17.17 ± .056	15.06 ± .041	24.27 ± .057	17.71 ± .038	11.17 ± .022
"	"	tooo-Palm Canyon	95.76 ± .436	103.04 ± .684	20.48 ± .051	20.14 ± .081	16.38 ± .058	15.70 ± .035	23.13 ± .045	17.76 ± .029	11.14 ± .020

TABLE 6
The average means and their standard errors of several species and subspecies of Peromyscus.

SPECIES	SUBSPECIES	NO. OF STOCKS AVERAGED	BODY	TAIL	FOOT	EAR	FEMUR	MANDIBLE	SKULL LENGTH	CONDYLE-ZYGOMA	SKULL WIDTH
<i>maniculatus</i>	<i>artemisiae</i>	3	93.71 ± 1.60	76.81 ± 2.92	20.12 ± 0.02	17.80 ± 0.19	15.97 ± 0.12	15.91 ± 0.12	24.48 ± 0.10	17.45 ± 0.07	10.70 ± 0.07
"	<i>bairdii</i>	6	87.53 ± 1.78	57.66 ± 0.79	18.37 ± 0.19	14.08 ± 0.23	14.75 ± 0.18	15.28 ± 0.27	22.60 ± 0.18	16.72 ± 0.13	10.41 ± 0.08
"	<i>blandus</i>	2	94.36 ± 0.08	70.48 ± 0.58	21.13 ± 0.32	17.78 ± 0.29	16.94 ± 0.19	16.24 ± 0.06	24.59 ± 0.00	17.61 ± 0.04	10.74 ± 0.06
"	<i>gambelii</i>	1	95.12 ± 0.33	75.44 ± 0.47	20.46 ± 0.05	18.28 ± 0.05	16.45 ± 0.05	15.84 ± 0.03	24.20 ± 0.04	17.29 ± 0.03	10.69 ± 0.02
"	<i>osgoodi</i>	7	93.49 ± 1.40	65.86 ± 2.19	19.80 ± 0.24	16.60 ± 0.37	16.00 ± 0.10	16.04 ± 0.09	24.02 ± 0.10	17.31 ± 0.11	10.79 ± 0.02
"	<i>rubidus</i>	1	92.78 ± 0.45	83.49 ± 0.72	20.95 ± 0.06	17.38 ± 0.08	15.94 ± 0.08	15.68 ± 0.05	24.70 ± 0.07	17.33 ± 0.05	10.61 ± 0.03
"	<i>rufinus</i>	6	91.84 ± 1.67	66.39 ± 1.96	20.13 ± 0.13	18.44 ± 0.15	15.97 ± 0.19	15.98 ± 0.04	24.29 ± 0.05	17.32 ± 0.05	10.80 ± 0.03
"	<i>sonoriensis</i>	4	93.58 ± 1.71	67.78 ± 3.75	20.01 ± 0.30	17.34 ± 0.31	16.12 ± 0.22	15.57 ± 0.16	24.36 ± 0.24	17.28 ± 0.14	10.67 ± 0.05
	Species average		92.80 ± 0.83	70.49 ± 2.82	20.13 ± 0.30	17.29 ± 0.42	16.02 ± 0.22	15.82 ± 0.11	24.13 ± 0.19	17.29 ± 0.09	10.68 ± 0.04
<i>leucopus</i>	<i>noveboracensis</i>	8	95.14 ± 1.26	79.15 ± 0.92	20.56 ± 0.03	16.71 ± 0.14	16.54 ± 0.11	16.41 ± 0.12	24.65 ± 0.13	17.80 ± 0.10	10.86 ± 0.05
<i>eremicus</i>	<i>eremicus</i>	4	96.40 ± 1.09	102.32 ± 0.70	20.57 ± 0.14	19.83 ± 0.15	16.74 ± 0.10	15.67 ± 0.11	24.17 ± 0.15	17.69 ± 0.09	11.16 ± 0.06
	Genus average		93.40 ± 0.77	74.54 ± 3.90	20.22 ± 0.24	17.48 ± 0.43	16.14 ± 0.19	15.86 ± 0.10	24.18 ± 0.16	17.38 ± 0.09	10.74 ± 0.06

TABLE 7
Coefficients of variation and their standard errors for certain measurements of *Peromyscus*.

SPECIES	SUBSPECIES	LOCALITY	BODY	TAIL	FOOT	FEMUR	MANDIBLE	SKULL LENGTH	CONDYLE-ZYGOMA	SKULL WIDTH
<i>maniculatus</i>	<i>artemisiae</i>	Godman Springs	4.05 ± .431	6.03 ± .525	2.78 ± .254	5.33 ± .486	2.40 ± .222	2.26 ± .105	2.26 ± .201	2.10 ± .183
	"	Paloise Falls	4.95 ± .309	6.30 ± .480	2.80 ± .215	5.03 ± .309	2.51 ± .195	2.21 ± .179	2.15 ± .166	2.18 ± .160
	"	Troy	3.36 ± .276	5.41 ± .445	3.56 ± .317	2.92 ± .260	2.39 ± .224	2.07 ± .199	2.13 ± .198	1.79 ± .165
	<i>bairdii</i>	Ann Arbor	5.02 ± .344	6.74 ± .463	3.76 ± .274	4.87 ± .355	3.63 ± .287	2.72 ± .212	2.84 ± .220	3.02 ± .239
	"	Alexander	4.96 ± .356	4.07 ± .356	3.93 ± .322	4.10 ± .344	2.80 ± .251	3.05 ± .272	3.18 ± .284	3.18 ± .264
	"	Barrett	4.64 ± .350	7.24 ± .445	3.16 ± .242	3.34 ± .256	2.15 ± .175	2.22 ± .175	2.20 ± .181	2.61 ± .210
	"	Onaga	3.60 ± .276	6.40 ± .406	2.75 ± .218	5.04 ± .309	2.31 ± .175	2.35 ± .187	2.33 ± .184	2.74 ± .216
	"	Sand Point	3.37 ± .263	6.66 ± .520	2.88 ± .231	3.81 ± .305	2.35 ± .195	1.67 ± .135	1.93 ± .155	2.74 ± .212
	"	Lake Village	3.71 ± .297	5.80 ± .465	2.89 ± .238	4.24 ± .349	2.61 ± .221	2.26 ± .191	2.44 ± .206	2.62 ± .223
	<i>blanckus</i>	Alamogordo	7.16 ± .490	7.40 ± .510	3.32 ± .253	5.39 ± .495	3.19 ± .245	2.98 ± .220	2.95 ± .222	2.78 ± .213
<i>gambelii</i>	"	White Sands	5.20 ± .370	7.29 ± .518	3.09 ± .280	3.89 ± .346	2.71 ± .254	2.29 ± .211	2.36 ± .217	2.68 ± .193
	"	La Jolla	4.23 ± .334	8.06 ± .445	3.23 ± .181	3.80 ± .213	2.18 ± .127	2.01 ± .116	2.02 ± .117	2.13 ± .123
	<i>osgoodi</i>	Cottonwood Basin	4.24 ± .429	6.62 ± .660	2.90 ± .293	4.15 ± .407	2.75 ± .270	2.58 ± .261	2.58 ± .253	2.17 ± .213
	"	Mandan	4.17 ± .391	6.02 ± .409	2.86 ± .268	3.83 ± .278	2.70 ± .203	2.69 ± .197	2.73 ± .198	2.54 ± .184
	"	Otis	4.44 ± .322	6.13 ± .445	2.74 ± .200	3.57 ± .260	2.33 ± .168	2.42 ± .174	2.25 ± .162	2.25 ± .162
	"	Jackson	5.57 ± .369	6.91 ± .458	3.44 ± .295	4.61 ± .395	2.77 ± .234	2.92 ± .247	3.10 ± .262	2.67 ± .218
	"	Logan Canyon	3.95 ± .356	6.84 ± .615	2.70 ± .253	4.13 ± .373	2.49 ± .220	2.72 ± .245	1.92 ± .173	2.27 ± .204
	"	Taylor	4.18 ± .326	6.70 ± .530	2.50 ± .198	3.10 ± .245	2.60 ± .204	2.20 ± .173	2.35 ± .185	2.51 ± .197
	"	Gregory	4.84 ± .352	6.75 ± .492	4.01 ± .296	4.13 ± .304	3.46 ± .255	2.96 ± .222	2.93 ± .220	3.12 ± .229
	<i>rubidus</i>	Eugene	5.13 ± .425	7.40 ± .613	2.88 ± .211	4.60 ± .338	2.92 ± .215	2.92 ± .215	3.10 ± .222	2.72 ± .200
<i>rufinus</i>	"	La Veta	4.84 ± .388	7.36 ± .580	3.08 ± .260	4.04 ± .342	3.47 ± .317	2.45 ± .226	2.56 ± .234	2.44 ± .224
	"	Deadman Flat (D)	5.23 ± .428	8.36 ± .723	3.52 ± .274	4.48 ± .350	3.25 ± .248	3.24 ± .250	2.06 ± .237	2.14 ± .170
	"	Little Spring	4.40 ± .290	6.11 ± .402	3.38 ± .239	4.13 ± .280	2.38 ± .165	3.38 ± .161	2.35 ± .164	2.02 ± .145
	"	Ice Caves	3.59 ± .376	7.00 ± .655	3.11 ± .296	4.69 ± .445	3.39 ± .304	2.44 ± .216	2.70 ± .235	1.86 ± .173
	"	Bonito Canyon	4.26 ± .374	6.63 ± .582	3.75 ± .361	3.56 ± .343	2.12 ± .179	2.60 ± .264	2.74 ± .244	2.38 ± .220
	"	Cloudcroft	4.88 ± .339	7.24 ± .488	3.64 ± .251	4.57 ± .315	2.93 ± .214	2.93 ± .228	2.51 ± .177	2.27 ± .168
	<i>sonoriensis</i>	Miller Canyon	5.18 ± .426	6.48 ± .532	2.97 ± .256	4.06 ± .350	3.70 ± .247	2.96 ± .245	2.70 ± .222	2.31 ± .194
	"	Winslow	3.00 ± .284	4.70 ± .432	2.60 ± .254	4.16 ± .393	3.93 ± .274	2.23 ± .209	2.47 ± .234	2.78 ± .268
	"	San Felipe	4.81 ± .387	7.50 ± .600	2.63 ± .196	4.51 ± .336	3.06 ± .230	3.03 ± .243	2.87 ± .234	2.11 ± .164
	"	Victorville	3.64 ± .350	5.02 ± .455	2.72 ± .239	3.88 ± .337	3.13 ± .193	2.60 ± .237	2.62 ± .239	2.51 ± .235
<i>leucopus</i>	<i>neochoracensis</i>	Ann Arbor (W)	3.94 ± .250	5.95 ± .423	2.71 ± .197	3.83 ± .286	2.59 ± .189	2.10 ± .153	2.43 ± .176	2.42 ± .178
	"	Ann Arbor (St)	5.66 ± .281	5.66 ± .281	2.78 ± .281	4.33 ± .442	2.73 ± .276	2.12 ± .210	2.03 ± .216	1.96 ± .190
	"	Ann Arbor (D)	7.39 ± .600	7.39 ± .600	3.60 ± .353	3.30 ± .374	2.06 ± .206	2.61 ± .256	2.06 ± .288	3.10 ± .307
	"	Cedarvale	5.41 ± .415	5.41 ± .415	3.18 ± .247	3.16 ± .246	2.51 ± .194	2.17 ± .167	2.38 ± .184	2.07 ± .160
	"	Decker	3.71 ± .285	6.09 ± .570	3.40 ± .262	4.59 ± .354	2.94 ± .256	2.53 ± .200	2.36 ± .168	1.94 ± .158
	"	Greenland	3.23 ± .248	6.49 ± .491	2.57 ± .202	3.80 ± .298	2.27 ± .190	2.14 ± .182	2.07 ± .172	2.23 ± .191
	"	Canebrake	4.78 ± .432	6.46 ± .582	3.24 ± .278	4.42 ± .379	2.79 ± .239	2.20 ± .195	2.43 ± .200	2.16 ± .185
	"	Asheville	4.14 ± .360	7.09 ± .618	2.54 ± .239	3.72 ± .337	2.28 ± .210	2.23 ± .203	2.97 ± .271	2.40 ± .216
	<i>eremicus</i>	Tumamoc Hill	3.70 ± .264	6.02 ± .430	2.97 ± .189	3.13 ± .198	2.35 ± .153	2.04 ± .123	1.98 ± .127	1.70 ± .110
	"	Tortolito Mts.	4.03 ± .278	4.80 ± .331	2.76 ± .190	3.41 ± .246	2.34 ± .171	2.05 ± .150	1.83 ± .133	1.91 ± .139
<i>eremicus</i>	"	Pima Canyon	3.53 ± .272	4.80 ± .378	3.21 ± .238	3.10 ± .230	2.38 ± .184	2.14 ± .166	1.98 ± .154	1.84 ± .142
	"	roco-Palm Canyon	4.36 ± .360	5.97 ± .469	2.47 ± .176	3.51 ± .250	2.01 ± .142	1.85 ± .132	1.64 ± .116	1.75 ± .124

TABLE 8
Average coefficients of variation and their standard errors for certain measurements of *Peromyscus*.

SPECIES	SUBSPECIES	NO. OF STOCKS AVERAGED	BODY	TAIL	FOOT	FEMUR	MANDIBLE	SKULL LENGTH	CONDYLE-ZYGOMA	SKULL WIDTH
<i>maniculatus</i>	<i>artemisiae</i>	3	4.12 ± .46	5.91 ± .26	3.05 ± .26	4.09 ± .70	2.46 ± .04	2.18 ± .06	2.18 ± .04	2.02 ± .12
"	<i>bairdii</i>	6	4.22 ± .30	6.31 ± .33	3.23 ± .20	4.25 ± .26	2.62 ± .22	2.38 ± .19	2.50 ± .18	2.65 ± .13
"	<i>blandus</i>	2	6.18 ± .98	7.39 ± .10	3.20 ± .12	4.56 ± .74	2.95 ± .24	2.64 ± .34	2.66 ± .30	2.43 ± .35
"	<i>gambelii</i>	1	4.23 ± .23	8.06 ± .44	3.23 ± .18	3.80 ± .21	2.18 ± .13	2.01 ± .12	2.02 ± .12	2.13 ± .12
"	<i>osgoodi</i>	7	4.48 ± .21	6.71 ± .33	3.05 ± .19	3.93 ± .18	2.74 ± .13	2.64 ± .10	2.55 ± .01	2.49 ± .12
"	<i>rubidus</i>	1	5.13 ± .42	7.40 ± .61	2.88 ± .21	4.60 ± .34	2.92 ± .22	2.92 ± .21	3.10 ± .22	2.72 ± .20
"	<i>rufinus</i>	6	4.54 ± .24	7.20 ± .38	3.41 ± .11	4.24 ± .17	2.91 ± .22	2.69 ± .14	2.64 ± .09	2.18 ± .09
"	<i>sonoriensis</i>	4	4.18 ± .49	5.92 ± .65	2.75 ± .07	4.15 ± .13	3.05 ± .04	2.70 ± .18	2.66 ± .08	2.43 ± .14
	Species average		4.64 ± .25	6.86 ± .28	3.10 ± .08	4.20 ± .10	2.73 ± .10	2.52 ± .11	2.54 ± .12	2.38 ± .09
<i>leucopus</i>	<i>noneborascensis</i>	8	4.19 ± .26	6.41 ± .25	3.00 ± .14	3.89 ± .18	2.63 ± .10	2.27 ± .07	2.45 ± .12	2.28 ± .13
<i>eremicus</i>	<i>eremicus</i>	4	3.90 ± .58	5.34 ± .30	2.85 ± .16	3.28 ± .10	2.27 ± .09	2.02 ± .11	1.86 ± .08	1.80 ± .05
	Genus average		4.52 ± .21	6.66 ± .27	3.06 ± .06	4.08 ± .12	2.67 ± .09	2.44 ± .10	2.46 ± .04	2.31 ± .09

bairdii from Alexander have a coefficient of variation for tail length of $4.97 \pm .356$ percent, while those from Barrett have a variation of $7.24 \pm .545$ v. The difference of 2.27 is 3.47 times its standard error and is, therefore, significant. Other significant differences occur not only in tail length but also in the variation of the other body parts. It does not seem worth while to point out these differences here.

Not only the individual stocks of mice, but the subspecies and species differ in the variation of the body parts (table 8). However, it is of more importance, perhaps, to note which parts of the body are the most variable. We find that tail length is more variable than the other parts, varying from $5.34 \pm .30$ in *P. eremicus eremicus* to $8.06 \pm .44$ in *P. m. gambelii*. *P. m. gambelii* and *P. m. rubidus* are represented by only one stock each, so it is hardly fair to compare them with subspecies having more stocks. The arrangement of the body parts in order of their decreasing percentage of variation is: tail ($6.66 \pm .27$), body ($4.52 \pm .21$), femur ($4.08 \pm .12$), foot ($3.06 \pm .06$), mandible ($2.67 \pm .09$), condyle-zygoma ($2.46 \pm .04$), skull length ($2.44 \pm .10$), and skull width ($2.31 \pm .09$).

A comparison of the variation of the three species *P. maniculatus*, *P. leucopus*, and *P. eremicus* is scarcely permissible, because *P. maniculatus* is represented here by eight subspecies while each of the other two species is represented by only one subspecies. It is interesting to note, however, that *P. eremicus eremicus* is less variable in all the body measurements than is *P. leucopus noveborascensis*, although the differences are not significant in every case.

Differences in the variation of different stocks is not surprising in view of the fact that some stocks originated from the breeding of only two or three pairs of mice while others were the offspring of many pairs. Many of the differences are undoubtedly due to the possession of differing groups of hereditary factors. The greater apparent variation in tail length may be due to the fact that the tail is relatively long, and slight variations in it are more easily measured. On the other hand, a mouse with extreme variation in tail length would conceivably be less handicapped than one with extreme variations in skull or body, parts which house the vital organs. Extreme variations of the latter type might tend to be eliminated because of the handicaps they would impose upon the individuals possessing them.

As a whole, the small size of most of these coefficients of variation indicates that sufficiently large samples of the various mouse populations were studied.

DISCUSSION

The question of whether the great differences in body proportions in mice of the genus *Peromyscus* are due to heterogonic growth or to special

size factors is well worth considering. If body size were due exclusively to general size factors in *Peromyscus*, it would be possible with heterogonic growth to account for the great differences in body proportion found within the genus. However, if general body size were due exclusively to general size factors, we would expect to find perfect correlations between the measurements of the parts. The relatively small size of the correlations between the body measurements demonstrates conclusively that general size factors together with heterogonic growth can account for only a part of the differences in body size between races and species of these mice. Fully half of these differences appear to be due to special size factors (genetic or environmental).

The present analysis, however, cannot be regarded as a critical study of size inheritance. The relative importance of general and special size factors in growth and the question as to whether size factors reside in the chromosomes or in the cytoplasm can be determined with certainty only by appropriate crosses and by a study of growth in all its stages. Those interested in such studies should refer to CASTLE (1929, 1931, 1932, and 1934); CASTLE, GATES, and REED (1936); CASTLE, GATES, REED, and LAW (1936); GREEN (1931, 1933, 1935); GREGORY and CASTLE (1931); SUMNER (1923, 1932), and SVIHLA (1932).

CONCLUSIONS

Ratios between body measurements indicate that the species and subspecies of mice of the genus *Peromyscus* differ greatly in body proportion.

Tail length shows more variation than other measurements of the body.

Body size and proportion in *Peromyscus* cannot be attributed primarily to general size factors and heterogonic growth.

Differences in tail, body, foot, femur, mandible, skull length, condyle-zygoma, and skull width are due primarily to special size factors (genetic and developmental).

LITERATURE CITED

- CASTLE, W. E., 1929 A further study of size inheritance in rabbits, with special reference to the existence of genes for size characters. *J. Exp. Zool.* **53**: 421-454.
1931 Size inheritance in rabbits; the backcross to the large parent race. *J. Exp. Zool.* **60**: 325-338.
1932 Green's studies of linkage in size inheritance. *Amer. Nat.* **66**: 82-87.
1934 Size inheritance in rabbits; further data on the backcross to the small race. *J. Exp. Zool.* **67**: 105-114.
CASTLE, W. E., W. H. GATES, and S. C. REED, 1936 Studies of a size cross in mice. *Genetics* **21**: 66-78.
CASTLE, W. E., W. H. GATES, S. C. REED, and L. W. LAW, 1936 Studies of a size cross in mice. II. *Genetics* **21**: 310-323.

- DICE, L. R., 1932 Variation in a geographic race of the deer mouse, *Peromyscus maniculatus bairdii*. Univ. Mich., Occ. Pap. Mus. Zool., No. 239: 1-26.
- 1933 Variation in *Peromyscus maniculatus rufinus* from Colorado and New Mexico. Univ. Mich., Occ. Pap. Mus. Zool., No. 271: 1-32.
- 1938 Variation in nine stocks of the deer mouse, *Peromyscus maniculatus*, from Arizona. Univ. Mich., Occ. Pap. Mus. Zool. No. 375: 1-19.
- 1939a Variation in the cactus mouse, *Peromyscus eremicus*. Univ. Mich. Contrib. Lab. Vert. Genet. No. 8: 1-27.
- 1939b Variation in the deer mouse (*Peromyscus maniculatus*) in the Columbia Basin of southeastern Washington and adjacent Idaho and Oregon. Univ. Mich., Contrib. Lab. Vert. Genet. No. 12: 1-22.
- 1940a Ecologic and genetic variability within species of *Peromyscus*. Amer. Nat. 74: 212-221.
- 1940b Speciation in *Peromyscus*. Amer. Nat. 74: 289-298.
- GREEN, C. V., 1931 Size inheritance and growth in a mouse species cross. J. Exp. Zool. 59: 213-263.
- 1933 Further evidence of linkage in size inheritance. Amer. Nat. 67: 377-380.
- 1935 Apparent changes with age in crossing over between color and size genes in mice. J. Genet. 30: 101-106.
- GREGORY, P. W., and W. E. CASTLE, 1931 Further studies on the embryological basis of size inheritance in the rabbit. J. Exp. Zool. 59: 199-211.
- OSGOOD, W. H., 1909 Revision of the mice of the American genus *Peromyscus*. Bull. U. S. Dept. Agric. (N. Amer. Fauna) No. 28, 285 pp.
- SUMNER, F. B., 1923 Studies of subspecific hybrids in *Peromyscus*. Proc. Nat. Acad. Sci. 9: 47-52.
- 1932 Genetic, distributional, and evolutionary studies of the subspecies of deer mice (*Peromyscus*). Bibliogr. Genet. 9: 1-106.
- SVIHLA, A., 1932 A comparative life history study of the mice of the genus *Peromyscus*. Univ. Mich. Mus. Zool., Misc. Publ. No. 24: pp. 5-39.
- WRIGHT, S., 1932 General, group and special size factors. Genetics 17: 603-619.