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VARIATION IN A GEOGRAPHIC RACE OF THE DEER-MOUSE, *PEROMYSCUS MANICULATUS BAIRDII*

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IT is the practice of mammalian taxonomists to divide wide-ranging variable species into geographic races, which in nomenclature are called subspecies. As the geographic race or subspecies is the smallest generally recognized taxonomic unit it is highly desirable to know something about the amount of variability within subspecies. Subspecies are presumed by some zoologists to be incipient species, and if this be true we need to know their genetic constitutions, as well as their variability.

There undoubtedly is individual, sex, and age variation in the population of any given species at each locality where it occurs, and there also is probably some geographical variation within the range of each subspecies. Information as to the amount of such variation is essential if critical comparisons are to be made between subspecies.

Extensive studies on variability in *Peromyscus* have been made by F. B. Sumner, who has shown that subspecific characters are inherited and that there is some variation from place to place. The present paper continues the work begun by Dr. Sumner and describes in detail the variability of one geographic race of the deer-mouse, based on breeding stocks taken at three widely separated localities within its range.

The mice here investigated were reared in a laboratory in the University of Michigan Museum of Zoology at Ann Arbor, Michigan, in the cages and with the technique previously described.[1] All were given identical care and were kept in the same laboratory under relatively uniform environmental conditions. The food was a standardized ration and was mixed for all the mice at the same time. The differences found between the stocks must therefore be genetic rather than the result of a difference in the environmental conditions.

All the mice were killed at the same season of the year, in April, May, and June, and therefore the pelage is practically in the same condition in all the specimens. This is important for, in Michigan at least, there are seasonal successions of pelages, and in some races the seasonal differences are quite marked. The late spring was chosen for preparing the specimens as at this season less molt is in progress than at most other times of the year.

In tabulating the measurements and readings for color the mice have been divided into two age classes, the one class including the animals between 35 and 78 weeks of age when killed and the other class those aged 79 weeks and older. The first of these classes includes mice averaging about one year old, with extremes of from a little more than 8 months of age to nearly one and one-half years of age. The older age class mice average somewhat under 2 years old, the youngest in the class being about 17 months old, while the oldest included in the measurements was 2 years and nearly 4 months old. Mice under 35 weeks of age are not included in the tables. The ages of the mice are not known to the exact day for the cages are not examined every day for young. To do so causes a disturbance which may result in the loss of a litter. It is believed that the age of each mouse is known to within about one week.

No positive conclusions can be drawn concerning geographic variability which is based, as this study is, only on three breeding stocks of deer-mice from widely separated localities. It is

[1] L. R. Dice, *Jour. Mammalogy*, 10: 116–124, 1929.

possible that the stocks of animals from the different localities may not well represent the genetic constitution of the population of their region. We know that a population may contain a number of different genetic lines, and it is almost certain that different pairs of wild caught animals used for breeding purposes would produce in the offspring somewhat different average measurements and color readings. Just how much variability there is in genetic constitution among the animals making up a population of deer-mice is unknown, nor do we know much about the local variability of these animals. Studies are now being made in my laboratory of these phases of the investigation. I should have liked to have had a larger number of parent individuals represented, especially in the stocks from Alexander and from Ann Arbor. This would have made the conclusions more dependable. The results obtained, however, are highly indicative; and if used with due caution should not be misleading.

ACKNOWLEDGMENTS

Financial support for this study has mostly been supplied by the Museum of Zoology of the University of Michigan. The Faculty Research Fund of the University has generously assisted by substantial grants in several years. The Graduate School of the University supplied part of the funds for the purchase of a tint photometer. To the Grants-in-Aid Fund of the National Research Council, I am indebted for a grant for employing assistance to clean and measure the specimens and to treat the data statistically. The map was drawn by Grace Eager. The measurements of the skull and skeleton and the tint photometer readings were made by Paul Hickie, Lenore Ward, and Robert M. Bradley.

ORIGIN OF THE BREEDING STOCKS

The prairie deer-mouse, *Peromyscus maniculatus bairdii* (Hoy and Kennicott), occupies a wide geographic range in the central part of North America, extending from Manitoba south to Oklahoma and east to Ohio and Ontario.[2] The sub-

[2] W. H. Osgood, *U. S. Dept. Agric., N. A. Fauna*, no. 28, pl. 1, 1909.

species is at home in the prairies or other open places and it avoids forests. Rocky hillsides are a favorite location for its homes. In the eastern part of its range it is found chiefly in open fields and on lake beaches.

The breeding stocks used in this investigation were taken in the states of Michigan, Iowa, and North Dakota.

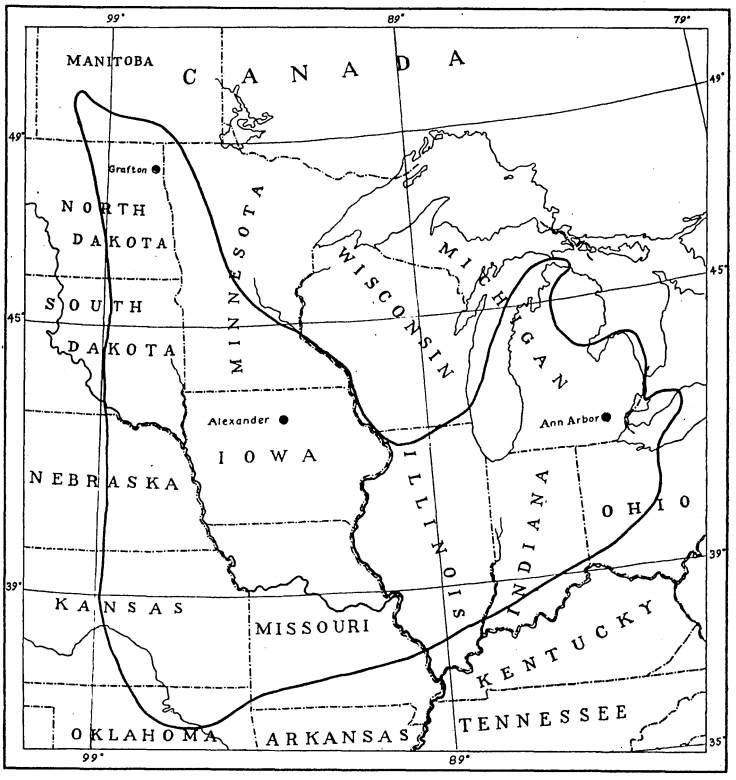

FIG. 1. Geographic range of *Peromyscus maniculatus bairdii* showing localities from which stocks for this study were secured. The map is based largely on that of Osgood.

Alexander, Iowa. The original stock consisted of 1 female and 4 males taken by Paul A. Moody in September, 1926. All of these mice produced fertile offspring, one pair of the original stock being mated, and the odd males being mated

with the daughters of this pair. There was no more inbreeding than was necessary owing to the small number of individuals in the original stock. The offspring available for measurement number 110. The average age of the 1-year age class was 45.7 (37–77) weeks for the females and 48.3 (37–75) weeks for the males, while for the 2-year age class the averages were 98.8 (80–117) weeks for females and 99.9 (80–117) weeks for males. The figures in parenthesis are the extremes of the included ages.

Ann Arbor, Michigan. One female was taken about 3 miles west of the city of Ann Arbor, in 1924, and two males were taken inside the city limits in 1926. All these animals proved to be fertile, but on account of the small number of parents the stock was considerably inbred. Laboratory-bred mice produced number 151. For the 1-year age class the average age of those measured was 44.8 (35–72) weeks for females and 48.2 (35–77) weeks for males. In the 2-year age class the average ages were 95.0 (81–113) weeks for females and 97.6 (86–116) weeks for males.

Grafton, North Dakota. The original stock consisted of 5 females and 7 males taken by H. V. Williams in 1926. All of the females and 5 of the males produced offspring, and only a slight amount of inbreeding took place. There were 107 young reared. The animals of the parent generation were kept in the laboratory before being killed an average of 55.4 (25–87) weeks for the females and 56.3 (25–87) weeks for the males. Of the 1-year age class bred in the laboratory the average age when killed was 48.2 (44–59) weeks for the females and 48.4 (40–60) weeks for the males; while of the 2-year class the average ages were 91.6 (81–116) weeks for the females and 97.5 (88–120) weeks for the males.

Measurements of the Body and Skeleton

In order to have the various measurements strictly comparable they have been taken from carefully standardized points. The body measurements were made immediately after the animal had been killed with ether, and before the onset

of *rigor mortis*. All body measurements were made by myself.

Total length. From the tip of the nose to the end of the tail, not including the tail hairs. Measured on a special rule, the animal being suspended by the tail, which by weight of the body gently extends the animal. The reading is to the nearest millimeter. This measurement is not included in the tables.

Body length. Derived by subtracting tail length from total length.

Tail length. Distance from the upper base of the tail to the tip of the tail, not including the hairs. Measured by allowing the body to hang over the edge of the table, the tail being extended along the measuring rule. Recorded to the nearest millimeter.

Hind foot. Length of the left hind foot, from the heel to the end of the middle claw, the foot being held straight between the thumb and forefinger. Measured by vernier caliper to 0.1 millimeter.

Ear from notch. Length of left ear, from notch at the lower end of the ear opening to the tip of the ear. Measured by special inside-outside vernier caliper reading to 0.1 millimeter.

Weight. Weighed on laboratory balance with sensitivity of about 0.05 gram. Recorded to nearest tenth of a gram. This was more accurate than necessary considering the large daily fluctuation in the weight of the animals, and in my later work I have recorded the weight only to the nearest gram.

Length of femur. Greatest length of left femur from the condyles to the end of the great trochanter. The measurements of the skull and skeleton were made on fully cleaned material with a bench micrometer operated under a low power binocular microscope. The reading of the micrometer was to 0.01 millimeter and the record was usually given to the nearest 0.1 millimeter.

Length of mandible. Greatest length of left mandible, from condyle to end of incisor.

Skull length. From left condyle to most anterior part of left premaxilla. The point on the premaxilla taken is slightly below the nasal and is not in the median line of the skull.

Condylo-zygomatic distance. From left condyle to angle at most anterior part of zygomatic process of the left maxilla.

Mastoid breadth of skull. Width of skull across mastoid processes.

In order to ascertain the difference between right and left bones, the lengths of both right and left humeri, innominate bones, femurs, and mandibles were measured for the 1-year age class from Alexander. The averages for the right and left of all these bones were almost alike, the differences in average lengths of right and left bones in no case being more than slightly greater than once the probable error. It would seem then to make no difference which side is chosen for measurement. The femur seemed to give a less variable and more satisfactory measurement than the humerus or innominate, and as there seemed to be little profit in measuring all of them only the measurements for the femur have been included in the table.

Type of Variability

In order to show the character of variation in these mice there is presented in Table I a comparison of the tail lengths of the mice of the 1-year age class from each of the localities under discussion. Tail length is one of the characters which differs decidedly in the mice of the three stocks, but any other measurable character would have shown a similar type of variability.

As it is obviously impossible to present a table of this kind for each of the characters measured there have been presented in the following tables only the means and their probable errors. The number of individuals used for measurement in each class is also given, although by reason of broken parts and other defects the number of measurements included in some of the means may be slightly less than the number of specimens enumerated. The means for males and females are given separately and also those for the 1-year and for the 2-year age classes.

TABLE I

Variation in tail length

Peromyscus maniculatus bairdii

1-year age class; both sexes together

Number of individuals having each of the stated tail lengths in millimeters

Tail length	Ann Arbor	Alexander	Grafton
44	1		
45			
46			
47			
48	2		
49	1		
50	1		
51	2		
52	3	1	
53	9		
54	7	3	1
55	8		
56	11	3	1
57	9	8	1
58	10	7	1
59	9	11	1
60	14	11	2
61	8	10	1
62	3	6	3
63	4	14	5
64	2	6	12
65		3	13
66		1	5
67		1	6
68	1	1	5
69	1		5
70			1
71			4
72			5
73			2
74			1
75			1
76			1
77			1
Total	106	86	78
Mean	57.20 ± .26 mm.	60.43 ± .22 mm.	66.13 ± .34 mm.

TABLE II

Average body measurements of
Peromyscus maniculatus bairdii

Stock		No.	body length mm.	tail length mm.	hind foot mm.	ear mm.	weight gm.
Alexander, Iowa							
2-year age class	♀	15	87.73 ± .86	63.29 ± .97	18.067 ± .153	14.887 ± .101	17.08 ± .74
	♂	8	87.00 ± 1.46	65.13 ± .78	18.750 ± .266	15.037 ± .176	20.46 ± 1.35
1-year age class	♀	46	81.76 ± .38	59.48 ± .32	17.865 ± .072	14.228 ± .069	15.18 ± .26
	♂	41	84.49 ± .37	61.56 ± .25	18.396 ± .062	14.317 ± .057	19.03 ± .33
Ann Arbor, Michigan							
2-year age class	♀	23	87.78 ± .71	61.00 ± .60	18.030 ± .078	14.191 ± .049	15.97 ± .34
	♂	19	85.53 ± .32	60.17 ± .50	18.100 ± .113	13.889 ± .056	17.88 ± .31
1-year age class	♀	58	81.43 ± .40	56.86 ± .37	17.757 ± .052	13.672 ± .055	14.94 ± .20
	♂	51	81.51 ± .37	57.63 ± .37	17.978 ± .063	13.637 ± .057	16.16 ± .18
Grafton, North Dakota							
2-year age class	♀	15	89.60 ± .75	67.00 ± .74	18.940 ± .110	15.287 ± .109	19.54 ± .63
	♂	13	89.38 ± .57	68.31 ± .60	18.908 ± .096	15.415 ± .111	21.51 ± .54
1-year age class	♀	32	85.87 ± .49	65.45 ± .58	18.772 ± .071	15.097 ± .075	19.40 ± .40
	♂	47	86.68 ± .35	66.57 ± .40	19.070 ± .049	15.000 ± .057	24.27 ± .44
Field caught	♀	5	91.60 ± .82	71.00 ± 1.08	18.360 ± .133	15.060 ± .162	20.48 ± .41
	♂	6	86.50 ± 1.06	66.40 ± 1.46	18.867 ± .177	15.883 ± .207	24.12 ± 1.43

TABLE III

Average measurements of skull and femur

Peromyscus maniculatus bairdii

Stock		No.	femur mm.	mandible mm.	skull length mm.	condyle-zygoma mm.	bullar width mm.
Alexander, Iowa							
2-year age class	♀	13	15.364 ± .139	15.721 ± .118	23.308 ± .160	16.995 ± .131	10.364 ± .059
	♂	7	15.344 ± .133	15.810 ± .127	23.407 ± .287	17.020 ± .214	10.523 ± .027
1-year age class	♀	42	14.641 ± .073	15.263 ± .046	22.619 ± .074	16.386 ± .056	10.178 ± .035
	♂	36	14.860 ± .058	15.486 ± .037	23.009 ± .075	16.764 ± .063	10.333 ± .035
Ann Arbor, Michigan							
2-year age class	♀	23	15.018 ± .100	15.109 ± .065	22.729 ± .069	16.673 ± .056	10.200 ± .032
	♂	16	14.331 ± .089	14.913 ± .062	22.580 ± .079	16.525 ± .063	10.262 ± .035
1-year age class	♀	51	14.025 ± .061	14.688 ± .048	22.098 ± .057	16.191 ± .043	10.093 ± .034
	♂	43	14.128 ± .077	14.591 ± .046	22.053 ± .069	16.200 ± .049	10.157 ± .031
Grafton, North Dakota							
2-year age class	♀	13	15.717 ± .118	15.954 ± .079	23.492 ± .124	17.246 ± .099	10.708 ± .071
	♂	13	15.217 ± .087	15.800 ± .072	23.575 ± .085	17.208 ± .060	10.658 ± .071
1-year age class	♀	32	15.138 ± .110	15.407 ± .060	23.225 ± .087	16.863 ± .061	10.515 ± .053
	♂	43	15.229 ± .061	15.492 ± .042	23.187 ± .068	16.880 ± .046	10.558 ± .040
Field caught	♀	5	15.620 ± .092	15.840 ± .123	23.500 ± .211	17.220 ± .099	10.460 ± .031
	♂	6	15.467 ± .111	15.780 ± .035	23.367 ± .107	17.150 ± .059	10.683 ± .049

Effect of Captivity

Sumner found that there was a considerable amount of stunting in the mice which he raised in his laboratory. The cage-born mice were smaller in all measurements than the mice caught in the wild. In *Peromyscus m. rubidus* the tail length was on the average as much as 11% reduced by captivity.[3]

None of the stocks of *bairdii* studied by me are represented by large numbers in the parent generation. The Grafton stock has the largest numbers, consisting of 5 female and 6 male specimens. In Table IV these have been compared

TABLE IV

Comparison of field-caught and cage-bred animals
Peromyscus maniculatus bairdii from Grafton, North Dakota
Means of field-caught series minus means of cage-bred 2-year age class

	♀	♂
Body length	2.00 ± 1.11 mm.	−2.88 ± 1.20 mm.
Tail length	4.00 ± 1.31 mm.	−1.91 ± 1.58 mm.
Hind foot	−.580 ± .173 mm.	−.041 ± .201 mm.
Ear	−.227 ± .195 mm.	.468 ± .235 mm.
Weight	.94 ± .75 gm.	2.61 ± 1.53 gm.
Femur	−.097 ± .150 mm.	.250 ± .141 mm.
Mandible	−.114 ± .146 mm.	−.020 ± .080 mm.
Skull length	.008 ± .245 mm.	−.208 ± .137 mm.
Condyle-zygoma	−.026 ± .140 mm.	−.058 ± .084 mm.
Bullar width	−.248 ± .077 mm.	.025 ± .086 mm.

with the specimens of the 2-year age class, with which they are probably most comparable in age. Although the numbers of individuals are small and the probable errors therefore high, it is apparent from the table that the means of the laboratory-bred mice are not significantly smaller than those of the wild-caught animals; in fact that seems to be no sigdificant difference of any kind in the measurements. This would seem to indicate that the cage-bred *bairdii* employed

[3] F. B. Sumner, *Amer. Nat.*, 52: 291–293, 1918.

TABLE V

Amount of growth after the first year

Peromyscus maniculatus bairdii

Averages for the 2-year age class minus averages for the 1-year age class

Stock		body length mm.	tail length mm.	hind foot mm.	ear mm.	weight gm.
Alexander, Iowa	♀	5.97 ± .94	3.81 ± 1.02	.202 ± .169	.659 ± .122	1.90 ± .78
	♂	2.51 ± 1.50	3.56 ± .81	.354 ± .273	.721 ± .185	1.43 ± 1.39
Ann Arbor, Michigan ...	♀	6.35 ± .81	4.14 ± .71	.273 ± .094	.519 ± .074	1.02 ± .40
	♂	4.02 ± .49	2.54 ± .62	.122 ± .129	.252 ± .080	1.74 ± .36
Grafton, North Dakota ..	♀	3.73 ± .90	1.55 ± .94	.168 ± .131	.190 ± .132	.14 ± .75
	♂	2.70 ± .67	1.73 ± .72	−.162 ± .108	.415 ± .125	−2.76 ± .70

Stock		femur mm.	mandible mm.	skull length mm.	condyle-zygoma mm.	bullar width mm.
Alexander, Iowa	♀	.723 ± .157	.458 ± .127	.689 ± .176	.609 ± .142	.186 ± .069
	♂	.484 ± .145	.324 ± .132	.398 ± .297	.256 ± .223	.190 ± .044
Ann Arbor, Michigan ...	♀	.993 ± .117	.421 ± .081	.631 ± .089	.482 ± .071	.107 ± .047
	♂	.203 ± .118	.322 ± .077	.527 ± .105	.325 ± .080	.105 ± .047
Grafton, North Dakota ..	♀	.579 ± .161	.547 ± .099	.267 ± .151	.383 ± .116	.193 ± .089
	♂	−.012 ± .106	.308 ± .083	.388 ± .109	.328 ± .076	.100 ± .081

in this study were not stunted. It is possible, of course, that laboratory conditions might affect the wild-caught animals and the cage-bred animals in the same way, but it hardly seems likely that these laboratory influences could greatly alter the dimensions of animals already nearly grown when caught. So far as can be judged from the samples studied the differences between the stocks to be pointed out later are, therefore, probably true differences.

Differences in Measurements Due to Age

There is a significant amount of growth in the prairie deer-mouse after it is one and one-half years old. This is shown clearly in Table V which demonstrates greater size on the average for every part of the body and skeleton in the mice above 78 weeks old, than for the mice of ages between 35 and 78 weeks. This is true of both sexes and of all stocks.

The amount of growth in body length after the first year and one-half is very considerable, the differences between the means of comparable sexes ranging from 2.51 mm. to 6.35 mm., these differences being from 2 to 8 times their probable errors.

The length of the hind foot shows less growth after the first year than the other parts of the body measured, and in one comparison the 1-year old mice average greater in foot length than the 2-year old animals. The difference, in this instance, however, is only $1\frac{1}{2}$ times its probable error and is undoubtedly owing to chance. Mammalogists have long been aware that the foot measurement changes less with age than the other standard body measurements.

The weight comparisons are also somewhat irregular, but weight is one of the most variable characters here studied.

Among the skeletal measurements the fact that the 1-year old males from Grafton average longer in femur length than the older animals seems to have no significance, for in all other comparisons and in all other measurements of the skull and skeleton the 2-year age class averages consistently larger, and in general the amount of growth is considerable.

The demonstration that a considerable amount of growth occurs after the first year of age is quite unexpected as it was presumed that in these tiny mammals there would be little growth, especially in the bones, after the first year of life. Although these mice may be sexually mature at an age of three months or less, and although the adult pelage is acquired at ages well under a year, the mouse continues to grow in size until he is at least somewhat over one and one-half years old.

In studying geographical variation in these mice it is, therefore, extremely important that similar ages be compared. Comparison of series of specimens composed of individuals of different ages might lead to very erroneous conclusions. Series of animals taken in the field cannot be used for statistical comparisons unless some fairly accurate means of determining their ages can be found.

Differences Between Males and Females

It has already been shown by Sumner[4] that in the genus *Peromyscus* the males have on the average somewhat longer feet than the females. This is shown by Table VI to hold for *Peromyscus m. bairdii.* It is also shown by the table that the males average heavier than the females. In tail length and in bullar width of the skull also there seems to be a tendency for the males to exceed the females, but the differences are not very significant. The other measurements show no significant differences between the sexes.

Geographical Variation in Measurements

The mice of the stock of *Peromyscus m. bairdii* from Alexander, Iowa, average somewhat larger (Table VII) in body dimensions than the mice of the Michigan stock. The difference in average tail length is 2.29 mm. or more for both age classes and for both sexes, and the differences are 2 to 8 times their probable errors. The difference in ear length varies in the four age and sex classes from 0.56 to 1.15 mm., and is in each case 6 or more times the probable error of the

[4] F. B. Sumner, *tom. cit.*: 200.

TABLE VI

Sex differences in size

Peromyscus maniculatus bairdii

Averages for females minus averages for males

Stock	Age class	body length mm.	tail length mm.	hind foot mm.	ear mm.	weight gm.
Alexander, Iowa	2-yr.	.73 ± 1.69	−1.84 ± 1.24	−.683 ± .307	−.150 ± .203	−3.38 ± 1.54
	1-yr.	−2.73 ± .53	−2.08 ± .41	−.531 ± .095	−.089 ± .090	−3.85 ± .42
Ann Arbor, Michigan...	2-yr.	2.25 ± .78	.83 ± .78	−.070 ± .137	.302 ± .074	−1.91 ± .46
	1-yr.	− .08 ± .54	− .77 ± .52	−.221 ± .082	.035 ± .079	−1.20 ± .27
Grafton, North Dakota..	2-yr.	.22 ± .94	−1.31 ± .95	.032 ± .146	−.128 ± .156	−1.97 ± .83
	1-yr.	− .81 ± .60	−1.12 ± .70	−.298 ± .086	.097 ± .094	−4.87 ± .59

Stock	Age class	femur mm.	mandible mm.	skull length mm.	condyle-zygoma mm.	bullar width mm.
Alexander, Iowa	2-yr.	.020 ± .192	−.089 ± .173	−.099 ± .329	−.025 ± .251	−.159 ± .065
	1-yr.	−.219 ± .093	−.223 ± .059	−.390 ± .105	−.378 ± .084	−.155 ± .050
Ann Arbor, Michigan...	2-yr.	.687 ± .134	.196 ± .090	.149 ± .105	.148 ± .084	−.062 ± .047
	1-yr.	−.103 ± .098	.097 ± .066	.045 ± .089	−.009 ± .065	−.064 ± .046
Grafton, North Dakota..	2-yr.	.500 ± .147	.154 ± .107	−.083 ± .150	.038 ± .116	.052 ± .100
	1-yr.	−.091 ± .126	−.085 ± .073	.038 ± .110	−.017 ± .076	−.043 ± .066

TABLE VII

Amount of geographical variation in body measurements

Peromyscus maniculatus bairdii

Differences between the means from different localities

Stock		body length mm.	tail length mm.	hind foot mm.	ear mm.	weight gm.
Grafton minus Alexander						
2-year age class	♀	1.87 ± 1.14	3.71 ± 1.22	.873 ± .188	.400 ± .149	2.46 ± .97
	♂	2.38 ± 1.56	3.18 ± .98	.158 ± .282	.378 ± .208	1.05 ± 1.45
1-year age class	♀	4.11 ± .62	5.97 ± .66	.907 ± .101	.869 ± .102	4.22 ± .48
	♂	2.19 ± .51	5.01 ± .47	.674 ± .079	.683 ± .081	5,24 ± .55
Grafton minus Ann Arbor						
2-year age class	♀	1.82 ± 1.03	6.00 ± .95	.910 ± .135	1.096 ± .120	3.57 ± .72
	♂	3.85 ± .65	8.14 ± .78	.808 ± .148	1.526 ± .124	3.63 ± .62
1-year age class	♀	4.44 ± .63	8.59 ± .69	1.015 ± .088	1.425 ± .093	4.46 ± .45
	♂	5.17 ± .51	8.94 ± .54	1.092 ± .080	1.363 ± .081	8.13 ± .48
Alexander minus Ann Arbor						
2-year age class	♀	− .05 ± 1.11	2.29 ± 1.14	.037 ± .172	.696 ± .112	1.11 ± .81
	♂	1.47 ± 1.48	4.96 ± .93	.650 ± .289	1.148 ± .185	2.58 ± 1.39
1-year age class	♀	.33 ± .55	2.62 ± .49	.108 ± .089	.556 ± .088	.24 ± .33
	♂	2.98 ± .52	3.93 ± .45	.418 ± .088	.680 ± .081	2.88 ± .38

difference. The body length, length of hind foot, and weight also tend to be greater in the Iowa series, but although generally consistent, the differences are small, usually not greatly exceeding their probable errors.

The mice from Grafton, North Dakota, are decidedly larger than the mice of the same subspecies from Iowa or from Michigan. As the Iowa mice are somewhat larger than those from Michigan, the differences are greatest between the North Dakota mice and those from Michigan. Every measurement is affected in the same direction, the North Dakota mice averaging larger in every comparison with the other two stocks. The differences are most significant in the stocks of the 1-year age class, for in this age class the number of individuals averaged is larger than in the 2-year age class, and therefore the probable errors are smaller.

The skull and skeleton of the Michigan mice are, like the body, smaller in every measurement than those of the mice from Iowa and from North Dakota. As shown by Table VIII the differences in measurements between the stocks from Michigan and North Dakota are large and statistically important, ranging from 4 to 14 times their probable errors.

The Iowa mice are intermediate in the average measurements of skull and skeleton between the stocks from Michigan and from North Dakota, but they are nearer the North Dakota series in the size of these parts.

It will be observed that in this subspecies of deer-mouse the North Dakota mice are larger in body size than the mice from Iowa and Michigan. This might be taken to support the law of J. A. Allen[5] that in forms of northern ancestry northern stocks are larger in body size than related southern ones. Possibly the larger size of the North Dakota mice may be correlated with higher latitude, but the generally larger size of the Iowa mice over the Michigan stock can not be owing to the same cause, for both these localities are in nearly the same latitude.

[5] J. A. Allen, *Ann. Rept. Smithsonian Inst.* for 1905: 378, 1906.

TABLE VIII

Amount of geographical variation in size of skull and skeleton

Peromyscus maniculatus bairdii

Differences between the means from different localities

Stock		femur mm.	mandible mm.	skull length mm.	condyle-zygoma mm.	bullar width mm.
Grafton minus Alexander						
2-year age class	♀	.353 ± .182	.233 ± .142	.184 ± .202	.251 ± .164	.344 ± .092
	♂	−.127 ± .164	−.010 ± .145	.168 ± .299	.188 ± .222	.135 ± .076
1-year age class	♀	.497 ± .132	.144 ± .076	.606 ± .114	.477 ± .083	.337 ± .064
	♂	.369 ± .084	.006 ± .056	.178 ± .101	.116 ± .078	.225 ± .053
Grafton minus Ann Arbor						
2-year age class	♀	.699 ± .155	.845 ± .102	.763 ± .142	.573 ± .114	.508 ± .078
	♂	.886 ± .124	.887 ± .095	.995 ± .116	.683 ± .087	.396 ± .079
1-year age class	♀	1.113 ± .126	.719 ± .077	1.127 ± .104	.672 ± .075	.422 ± .063
	♂	1.101 ± .098	.901 ± .062	1.134 ± .097	.680 ± .067	.401 ± .051
Alexander minus Ann Arbor						
2-year age class	♀	.346 ± .171	.612 ± .135	.579 ± .174	.322 ± .142	.164 ± .067
	♂	1.013 ± .160	.897 ± .141	.827 ± .298	.497 ± .223	.261 ± .044
1-year age class	♀	.616 ± .095	.575 ± .066	.521 ± .093	.195 ± .071	.085 ± .049
	♂	.732 ± .096	.895 ± .059	.956 ± .102	.564 ± .080	.176 ± .046

Color of the Pelage

Within a few hours after death the animals were skinned and the skins stretched on a rack similar to that used by Sumner.[6] The flat skins after they were thoroughly dry were cleaned and degreased by a series of baths in cleaners' naphtha.

The color of the pelage has been measured by means of the Ives tint photometer. The instrument was first employed for this purpose by Sumner, and its use has been described by him.[7] My use of the apparatus is modified somewhat from that of Sumner. By inserting a pair of lenses the instrument is focused somewhat sharply on the object to be examined and therefore I am able to determine the color value of quite a small area. The field of view I employ is almost a semicircle with a width a fraction over 8 mm. and a greatest length of about 17 mm. I do not use a glass plate over the pelage, nor hold down in any way the hairs of the area examined. A heavy black brass plate having an opening somewhat larger than the field of view is placed on the skin to hold it firmly in place. The skin is oriented so that the light from the daylight lamp shines on the hairs directly from the rear, the nose of the flat skin being pointed toward the observer.

Determinations of the color have been made for two areas on each specimen. The *dorsal stripe* reading is made on the median line of the back, the center of the area examined being 68 mm. from the tip of the nose. This position on the flat stretched skins of these mice is nearly midway between the nose and the base of the tail. An area on the *side* is read just lateral to the area read for the dorsal stripe. Care is taken to place this side area midway between the edge of the dorsal stripe and the border of the white underparts. As the color of the side varies somewhat from above downward it is difficult to secure uniform readings, and the variability is greater than in the readings for the color of the dorsal stripe.

[6] F. B. Sumner, *Jour. Mammalogy*, 8: 189, pl. 18, 1927.

[7] F. B. Sumner, *tom. cit.*: 194–203.

TABLE IX

Average color of dorsal stripe

Peromyscus maniculatus bairdii

Tint photometer readings

Stock		No.	red	yellow	green	peacock blue	blue-violet
Alexander, Iowa							
2-year age class	♀	13	5.39 ± .29	4.46 ± .22	3.85 ± .23	3.58 ± .18	3.35 ± .16
	♂	6	5.50 ± .22	4.50 ± .06	3.92 ± .17	3.33 ± .13	3.17 ± .13
1-year age class	♀	43	4.70 ± .10	3.95 ± .08	3.42 ± .07	3.06 ± .06	2.85 ± .06
	♂	38	5.39 ± .12	4.47 ± .11	3.86 ± .09	3.61 ± .09	3.20 ± .07
Ann Arbor, Michigan							
2-year age class	♀	24	4.60 ± .15	3.88 ± .12	3.48 ± .10	3.19 ± .07	2.98 ± .07
	♂	17	4.76 ± .11	4.06 ± .10	3.47 ± .06	3.26 ± .06	2.97 ± .04
1-year age class	♀	52	4.74 ± .07	4.03 ± .05	3.48 ± .04	3.13 ± .04	2.92 ± .04
	♂	46	4.97 ± .09	4.22 ± .08	3.61 ± .07	3.36 ± .06	3.03 ± .05
Grafton, North Dakota							
2-year age class	♀	15	5.23 ± .22	4.57 ± .19	3.73 ± .13	3.47 ± .11	3.07 ± .09
	♂	11	4.64 ± .09	4.00 ± .13	3.59 ± .11	3.23 ± .12	3.05 ± .14
1-year age class	♀	30	5.13 ± .11	4.30 ± .10	3.65 ± .08	3.43 ± .08	3.07 ± .07
	♂	45	5.30 ± .08	4.50 ± .07	3.83 ± .07	3.56 ± .06	3.16 ± .05
Field caught.....	♀	5	4.80 ± .20	4.20 ± .15	3.60 ± .11	3.30 ± .07	3.10 ± .11
	♂	6	5.58 ± .19	4.75 ± .13	3.83 ± .13	3.67 ± .10	3.33 ± .10

TABLE X

Average color of side

Peromyscus maniculatus bairdii

Tint photometer readings

Stock		No.	red	yellow	green	peacock blue	blue-violet
Alexander, Iowa							
2-year age class	♀	13	12.77 ± .29	11.00 ± .22	9.15 ± .24	8.04 ± .19	7.31 ± .22
	♂	6	14.33 ± .33	12.50 ± .26	10.58 ± .20	9.58 ± .27	8.67 ± .21
1-year age class	♀	43	13.59 ± .15	11.28 ± .13	8.97 ± .11	7.30 ± .10	6.78 ± .11
	♂	38	13.93 ± .20	11.42 ± .15	9.54 ± .14	7.79 ± .12	7.59 ± .15
Ann Arbor, Michigan							
2-year age class	♀	24	14.63 ± .23	12.08 ± .19	10.38 ± .17	8.42 ± .13	8.42 ± .17
	♂	17	14.62 ± .25	12.12 ± .16	10.38 ± .19	8.35 ± .16	8.09 ± .12
1-year age class	♀	52	14.22 ± .12	12.04 ± .11	9.76 ± .11	8.27 ± .08	7.79 ± .09
	♂	46	13.72 ± .13	11.74 ± .12	9.66 ± .10	8.17 ± .10	7.66 ± .10
Grafton, North Dakota							
2-year age class	♀	15	15.73 ± .40	13.40 ± .28	10.60 ± .22	8.93 ± .22	7.93 ± .24
	♂	11	15.91 ± .42	12.91 ± .25	10.82 ± .29	8.73 ± .20	8.09 ± .25
1-year age class	♀	30	16.10 ± .26	13.27 ± .18	10.67 ± .14	8.77 ± .15	7.83 ± .14
	♂	45	16.40 ± .20	13.62 ± .14	10.93 ± .12	9.11 ± .10	8.20 ± .11
Field caught.....	♀	5	15.60 ± .80	14.00 ± .71	10.80 ± .23	9.00 ± .27	7.80 ± .12
	♂	6	16.00 ± .55	14.00 ± .42	10.42 ± .45	10.00 ± .32	8.08 ± .44

Readings of pelage color have been made with five different color screens: red, yellow, green, peacock blue, and blue-violet. The readings are the percentage of light of that color reflected from the specimen as compared with the amount of light of the same color reflected from a white block of magnesium carbonate, which is taken as 100 per cent. A pure white pelage should give readings of approximately 100 per cent for all colors, while a dull black specimen should give zero readings.

There is, however, considerable reflection of white light from any surface, and hair is rather shiny. Readings nearly alike for all colors indicate shades of black and white or gray. The preponderant color of the pelage will be indicated by a higher reading for that color screen than for the others, but most pelages are made up of mixtures of all the colors, and all reflect some white light, so that in every specimen there will be appreciable readings for each color.

So far as can be determined from the tint photometer readings of the skins there is no significant difference in the color of the pelage in *Peromyscus m. bairdii* between males and females, either of the dorsal stripe or of the side. Neither is there any apparent difference in color between the 1-year age class and the 2-year age class. Further, in a comparison of the color of the field-caught animals of the Grafton stock with the mice of the 2-year age class of the same stock born in the laboratory no significant difference can be found. Although the number of individuals involved in this comparison is few the indication is that laboratory conditions have not appreciably affected the color of the animals.

Geographical Variation in Color

In a comparison of the stocks from the three localities no important difference can be found in the averages for the tint photometer readings of the color of the dorsal stripe though there is a slight tendency for the Ann Arbor mice to average darker (smaller readings) than either of the other stocks (Table XI). The differences in readings between the various

TABLE XI

Geographic variation in color of dorsal stripe

Peromyscus maniculatus bairdii

Differences in tint photometer readings

Stock		red	yellow	green	peacock blue	blue-violet
Grafton minus Alexander						
2-year age class	♀	−.16 ± .36	.11 ± .29	−.12 ± .26	−.11 ± .21	−.28 ± .18
	♂	−.86 ± .24	−.50 ± .14	−.33 ± .20	−.11 ± .18	−.12 ± .19
1-year age class	♀	.43 ± .15	.35 ± .13	.23 ± .11	.37 ± .10	.22 ± .09
	♂	−.09 ± .15	−.03 ± .14	−.02 ± .11	−.05 ± .11	−.14 ± .08
Grafton minus Ann Arbor						
2-year age class	♀	.63 ± .27	.70 ± .22	.25 ± .16	.28 ± .13	.09 ± .11
	♂	−.13 ± .14	−.06 ± .16	.12 ± .13	−.04 ± .13	.07 ± .15
1-year age class	♀	.39 ± .13	.27 ± .11	.17 ± .09	.30 ± .09	.15 ± .08
	♂	.33 ± .12	.28 ± .11	.22 ± .10	.20 ± .08	.12 ± .08
Alexander minus Ann Arbor						
2-year age class	♀	.78 ± .33	.59 ± .25	.37 ± .25	.39 ± .20	.37 ± .17
	♂	.74 ± .25	.44 ± .11	.45 ± .18	.07 ± .14	.20 ± .14
1-year age class	♀	−.04 ± .12	−.08 ± .10	−.06 ± .08	−.08 ± .07	−.07 ± .07
	♂	.43 ± .15	.26 ± .14	.25 ± .13	.25 ± .11	.16 ± .08

TABLE XII

Geographic variation in color of side

Peromyscus maniculatus bairdii

Differences in tint photometer readings

Stock		red	yellow	green	peacock blue	blue-violet
Grafton minus Alexander						
2-year age class	♀	2.96 ± .49	2.40 ± .36	1.45 ± .33	.89 ± .29	.62 ± .33
	♂	1.58 ± .54	.41 ± .36	.24 ± .35	− .86 ± .33	− .58 ± .33
1-year age class	♀	2.51 ± .30	1.99 ± .22	1.71 ± .18	1.47 ± .18	1.05 ± .18
	♂	2.47 ± .28	2.20 ± .20	.39 ± .19	1.32 ± .16	.61 ± .19
Grafton minus Ann Arbor						
2-year age class	♀	1.11 ± .46	1.32 ± .33	.23 ± .28	.51 ± .26	− .49 ± .29
	♂	1.29 ± .49	.79 ± .30	.44 ± .34	.37 ± .25	.00 ± .28
1-year age class	♀	1.88 ± .29	1.23 ± .21	.91 ± .18	.50 ± .17	.04 ± .17
	♂	2.68 ± .24	1.88 ± .18	1.27 ± .15	.94 ± .14	.54 ± .14
Alexander minus Ann Arbor						
2-year age class	♀	−1.86 ± .37	−1.08 ± .28	−1.22 ± .29	− .38 ± .23	−1.11 ± .28
	♂	− .29 ± .42	.38 ± .31	.20 ± .28	1.23 ± .31	.58 ± .24
1-year age class	♀	− .63 ± .19	− .76 ± .17	− .79 ± .16	− .97 ± .13	−1.01 ± .14
	♂	.22 ± .24	− .32 ± .19	− .12 ± .17	− .38 ± .16	− .07 ± .18

stocks are all less than 1.0 unit; they are not fully consistent in direction; and they are not of great statistical significance.

The color of the side averages brighter (larger readings) for certain colors in the Grafton mice than in those from Alexander or Ann Arbor. This is shown in Table XII. The differences are greatest for red, where the differences range in the two sexes and two age classes from $1.11 \pm .46$ to $2.96 \pm .49$. The readings for yellow and for green also are consistently greater in the Grafton mice; but in the comparisons for peacock blue the differences are not fully consistent. In the readings for blue-violet the differences are not consistent, nor are they in general of statistical significance. It is apparent that the difference in side color between these various stocks of mice lies toward the red end of the spectrum, particularly in the red and yellow, and therefore there is a difference in hue, but only a slight difference in color intensity. The Grafton mice appear to the eye to have sides of a brighter buffy red tone than the other two series, which have sides of a general hue of gray with a slight tinge of buff.

There are no differences of statistical significance between the tint photometer readings for side color between the mice from Ann Arbor and from Alexander.

It is noteworthy to find that *Peromyscus m. bairdii,* which in the stocks from North Dakota, Iowa, and Michigan has such considerable geographic variation in the dimensions of the various parts of the body, has such slight geographic variation in color.

Summary

The amount of variability in the dimensions of the body and skeleton and in tint photometer readings of pelage color are given for the prairie deer-mouse, *Peromyscus maniculatus bairdii,* from three localities within the range of the subspecies: Alexander, Iowa; Ann Arbor, Michigan; and Grafton, North Dakota. The animals were reared under uniform environmental conditions in a laboratory at Ann Arbor, Michigan, and the differences between these stocks are therefore genetic.

Prairie deer-mice averaging two years of age reared in the laboratory are not significantly different in body dimensions or color from those of the same stock caught wild at Grafton and then kept for over a year in the laboratory. It is therefore indicated that the laboratory-bred animals do not differ to any appreciable degree from wild-bred animals.

Prairie deer-mice of an average age of two years average larger in every body and skeleton dimension than animals averaging 1 year of age, demonstrating a considerable amount of growth in size after they are one and one-half years of age. On the other hand, there is apparently no color difference between the 1-year old and 2-year old mice.

Males of these mice have longer hind feet and are heavier than females, and there is an indication that in some other measurements the males may average slightly larger, but there is no detectable color difference between the sexes.

The North Dakota mice are larger in every measurement of the body and skeleton than the mice from Michigan. The Iowa mice are more or less intermediate in size between the other two stocks, averaging somewhat nearer the North Dakota mice in skeletal measurements and nearer the Michigan mice in some of the body dimensions. The tail and ear, however, are both decidedly shorter in the Michigan than in the Iowa mice.

In the color of the pelage there is only slight geographical variation. The three stocks show no significant differences in the tint photometer readings for the color of the dorsal stripe. The color of the side is a brighter buffy red in the North Dakota stock than in either of the others. This is shown by larger tint photometer readings for red and yellow, and to a lesser extent for green, while the readings for blue-violet are not significantly different from those of the Iowa and Michigan stocks.

Within the geographical range of this one subspecies of deer-mouse there are, therefore, indicated to be pronounced geographical differences in the dimensions of several parts of the body and skeleton, while there are only relatively slight geographical differences in the color of the pelage.