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Subspecies Overlap in Mule Deer and Deer Mice in the North Cascades, Washington

Abstract

The North Cascades are a transition zone where floras and faunas characteristic of coastal and inland areas intermix. We obtained data for deer (*Odocoileus hemionus* subspp.) and deer mice (*Peromyscus maniculatus* subspp.) which indicate that phenotype, and presumably genotype, varies significantly even in a small area. This variation appears to be correlated with habitat type.

Interbreeding between subspecies of animals is a common phenomenon (Mayr, 1963). The information presented below, however, is somewhat unusual in that it involves a quantitative measure of the degree of interbreeding in populations of two species from a geographically small, but ecologically diverse, area.

Our study was conducted in the Skagit River drainage, Whatcom County, Washington. More specifically, we collected data in the Ross Lake basin and along the shores of Diablo Lake (Fig. 1). This area is a transition zone where subspecies characteristic of the east slopes of the Cascade Mountains extend westward, probably caused by the rain shadow cast by the Picket Range, into the range of subspecies characteristic of western Washington. We detected interbreeding in several animals, but have quantitative information for only two species—deer (*Odocoileus hemionus* subspp.) and deer mice (*Peromyscus maniculatus* subspp.).

The two subspecies of deer involved are the coastal black-tailed deer (*O. h. columbianus*) and the Rocky Mountain mule deer (*O. h. hemionus*). Because they have different color patterns on the tail and because their rump patches differ in size (Cowan, 1956: 343), these subspecies can be identified at a distance. Thus we were able to acquire a large enough sample to divide into several subsamples.

The subspecies of deer mice involved are *P. m. artemisiae* and *P. m. oreas.* The most useful character for distinguishing between them is tail length (Sheppe, 1961: 423); the eastern *artemisiae* has a tail shorter than its body and the western *oreas* has a tail longer than its body.

Methods

A quantitative measure of gene mixing—i.e., "hybrid" index—was obtained for each deer by classifying tail pattern on a scale of 1 to 5 and by rating rump patch size on a similar 1 to 5 scale (Fig. 2). These two values were then added to give a Rump-Tail (R-T) Index which could theoretically range from 2 to 10. However, we drew

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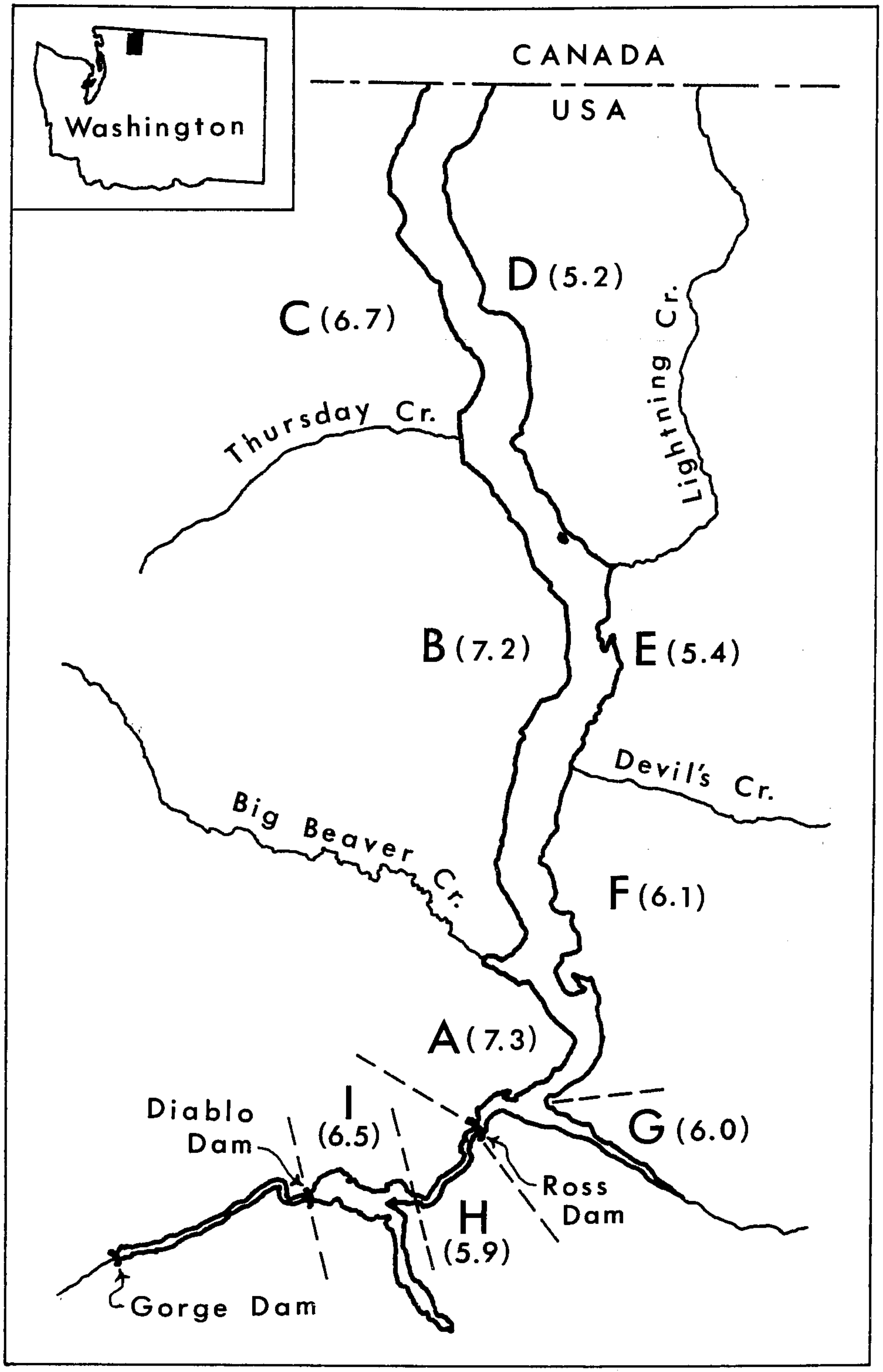

Figure 1. Study area showing division into subareas at major geographic features.

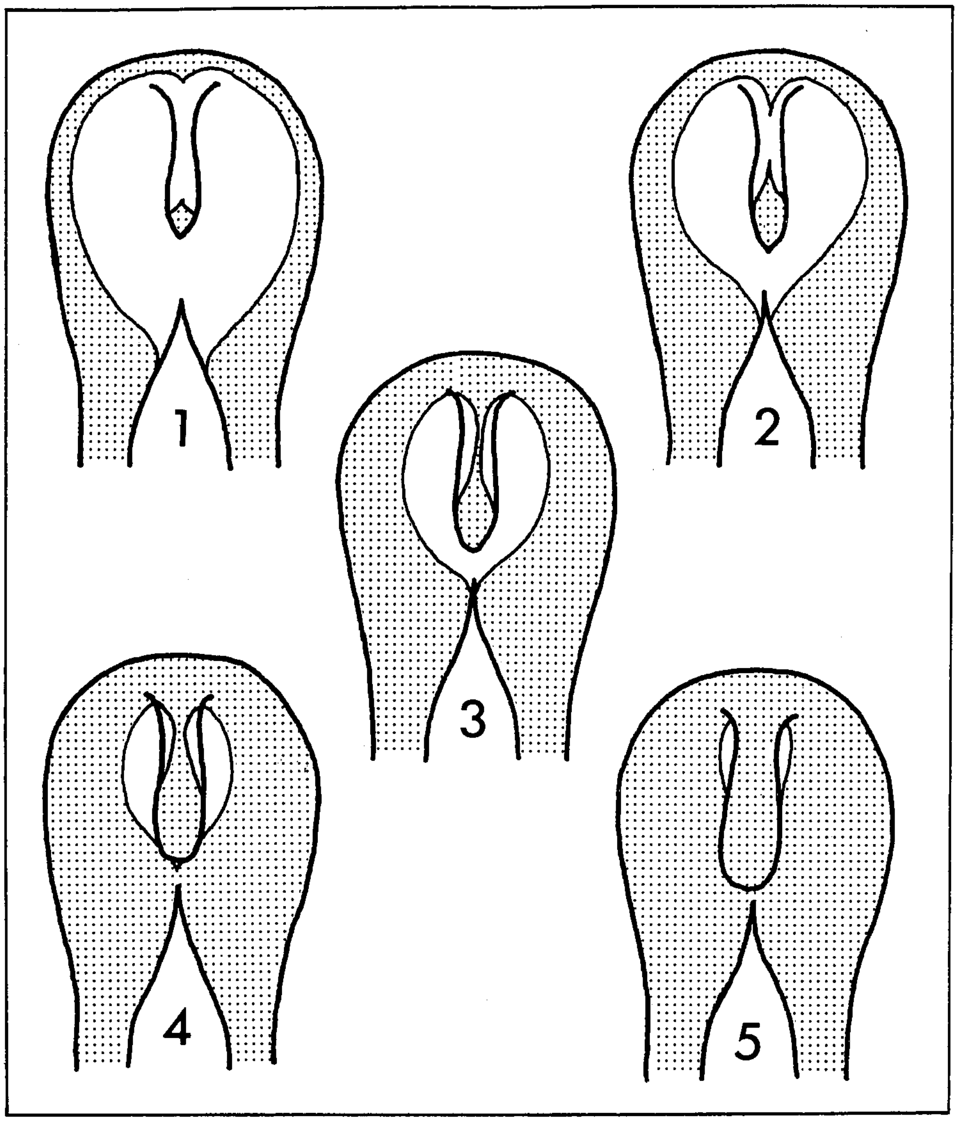

Figure 2. Tail and rump patch classes in Ross Lake deer. Low values indicate mule deer, high values indicate black-tailed deer, and intermediate values indicate intergrades.

the original rump patches slightly too large so that no deer have a rump pattern like No. 1. Thus, the scale actually runs from 1 to 5 for tail, 2 to 5 for rump, and 3 to 10 for R-T. The range that could be expected in R-T Index was verified by observing black-tailed deer on the Cedar River Watershed, King County, all of which had an Index of 10; and by sampling mule deer on the Sinlahekin Wildlife Recreation Area, Okanogan County, all of which had an Index of 3.

The study area was divided, at prominent geographic features, into nine subareas (Fig. 1). Deer were observed in these areas from January to November, 1972. Most observations were made from a boat on deer near the lake shore. An effort was made to obtain an R-T Index for each deer, but some were not in a position or did not remain visible long enough to allow us to make the necessary observations. We avoided counting the same deer twice on any sampling trip but made no effort to avoid duplicate counts of individuals on different days. Thus the counts are not of individual deer but of observations of deer.

The data were arranged in contingency tables and chi-square tests were used to test the null hypothesis that the R-T Index is independent of area. First, all the areas were tested together in an R x C Contingency table and then all possible pairs of areas were tested separately in 2 x C tables. The frequency distributions from certain adjacent areas were combined in order to increase the sample sizes and hence, the validity of the chi-square tests. Also the R-T Index scale was shortened by combining certain neighboring classes so that the expected number in any class was at least five.

Deer mice were captured in snap-traps set in standard Calhoun lines (usually 20 stations at 25-foot spacing, 3 traps per station, checked for 3 days). We sampled all major vegetation types adjacent to Ross Lake from 4 June through 10 September 1971, with 44 traplines and an effort of 8,692 trap-nights.

Standard measurements were taken on each mouse and a body:tail (B:T) ratio was subsequently calculated for all animals weighing 17 grams or more. Those mice with a low B:T ratio were identified as *oreas* (western subspecies), those with a high ratio as *artemisiae* (eastern subspecies), and those with an intermediate ratio as hybrids.

Since the B:T data were continuous, a Kruskal-Wallis one way analysis of variance (Siegel, 1956: 184-194) was used to test the null hypothesis that the B:T: ratio is not related to area. Following this analysis the Kruskal-Wallis multiple comparison procedure (Miller, 1966: 165) was used to examine the mean ranks for each area (derived from the Kruskal-Wallis procedures) to see which differences among them appeared to be real.

Results and Discussion

A total of 303 classifications of R-T Index were made on deer (Table 1). Analysis of these data revealed that R-T Index is not independent of area (Table 2). In fact, the frequency distribution of R-T Index in each of the five combined areas differs significantly from all other areas. The frequency distributions themselves show a

TABLE 1. Frequency distribution of R-T Index for deer by areas.

	Area[1]									
Index	A	B	C	D	E	F	G	H	I	Total
3	0	0	0	1	1	0	0	0	0	2
4	0	0	0	19	7	0	0	5	1	32
5	3	1	1	14	7	3	3	19	6	57
6	2	6	5	15	10	20	2	18	24	102
7	7	6	3	8	2	3	1	14	14	58
8	13	12	3	1	2	2	1	4	12	50
9	1	0	0	0	0	0	0	1	0	2
10	0	0	0	0	0	0	0	0	0	0
Total	26	25	12	58	29	28	7	61	57	303
Mean Index	7.27	7.16	6.67	5.22	5.37	6.14	6.00	5.93	6.53	6.12

[1] See Figure 1 for location of areas.

TABLE 2. Results of chi-square tests of the null hypothesis that the R-T Index is independent of area.

Areas Tested*	X^2 Value	Degrees of Freedom	Probability of A Greater Value
A-C vs. D vs. E+F vs. G+H vs. I	119.75	28	P<0.001
A-C vs. D	49.41	3	P<0.001
A-C vs. E+F	38.57	3	P<0.001
A-C vs. G+H	31.61	3	P<0.001
A-C vs. I	10.51	3	P<0.020
D vs. E+F	11.63	3	P<0.010
D vs. G+H	14.00	3	P<0.005
D vs. I	31.69	4	P<0.001
E+F vs. G+H	11.11	3	P<0.025
E+F vs. I	13.77	3	P<0.005
G+H vs. I	13.30	3	P<0.005

* Frequency distributions from certain areas were combined, as shown, in order to increase the sample sizes and hence the validity of the chi-square tests.

trend with the black-tail influence being strongest on the west side of the lake near Big Beaver Creek (Table 1, Fig. 1). The vegetation in Big Beaver Valley is more characteristic of that of western Washington than is the vegetation of any other area around the lake. Geographic access for black-tails is also from the west whereas for mule deer access is from the east. The area around Lightning Creek is vegetatively more like eastern Washington than are other areas around Ross Lake, and there the mule deer influence is most pronounced.

Trapping yielded 518 deer mice, 237 of which weighed at least 17 grams (Table 3). The resulting H value (90.32), from the Kruskal-Wallis one way analysis of variance of these data, demonstrates that B:T ratio is not independent of area. The mean ranks by area display a definite trend (Table 3). They increase from area A,

TABLE 3. Frequency distribution, and mean ranks derived from Kruskal-Wallis one way analysis of variance, of Body:Tail Ratio of *Peromyscus* by area.

	Area[1]						
B:T Ratio	A	B	C	D	F	G	Total
0.7	0	0	0	0	0	1	1
0.8	13	21	3	0	0	0	37
0.9	7	15	6	2	0	5	35
1.0	4	22	17	4	3	14	64
1.1	2	12	10	6	13	1	44
1.2	0	3	7	11	9	2	32
1.3	0	0	1	7	2	3	13
1.4	0	0	0	3	4	0	7
1.5	0	0	0	0	0	0	0
1.6	0	0	1	1	0	0	2
1.7	0	1	0	0	0	0	1
1.8	0	1	0	0	0	0	1
Total	26	75	45	34	31	26	237
Mean Rank ($\overline{R}$)	53.6	87.5	124.9	180.2	178.3	114.3	—

[1] See Figure 1 for location of areas.

on the west side, in a clockwise and counter-clockwise direction around the lake to area D on the east side. The results from the Kruskal-Wallis multiple comparison procedure indicate that only areas D and F, and areas C and G can be considered the same with respect to their B:T ratios, and that all other areas differ significantly (Table 4). Hence, the B:T data exhibit an apparent trend much like that observed

TABLE 4. Results of the Kruskal-Wallis multiple comparison tests of the null hypothesis that the B:T ratio of *Peromyscus* is the same in both areas concerned.

Areas Tested	Test Statistic
A vs. B	33.90*
A vs. C	71.34*
A vs. D	126.66*
A vs. F	124.73*
A vs. G	60.75*
B vs. C	37.45*
B vs. D	92.76*
B vs. F	90.83*
B vs. G	26.85*
C vs. D	55.31*
C vs. F	53.38*
C vs. G	10.59
D vs. F	1.93
D vs. G	65.91*
F vs. G	63.98*

* Significant difference at the 5% level.

for R:T Index in deer; *artemisiae* predominates on the dryer east side of Ross Lake, and *oreas* is most dominant in Big Beaver Valley.

Acknowledgments

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