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TRANSFERRIN POLYMORPHISM IN BIGHORN SHEEP, *OVIS CANADENSIS*, IN COLORADO

Patrick W. Roberts¹, Donald J. Nash¹, and Robert E. Keiss²

ABSTRACT.— Serum transferrins were analyzed by polyacrylamide gel electrophoresis in four populations of Colorado bighorn sheep, *Ovis canadensis canadensis*. Transferrin was found to be polymorphic, with two alleles, Tf D and Tf E, being represented in each of the four populations. Within herds the phenotypic ratios conformed to values predicted by the Hardy-Weinberg equilibrium. Among populations, significant differences were seen with respect to phenotypic frequencies.

Transferrin polymorphisms have been described in a number of breeds of domestic sheep and in different species of wild sheep including *Ovis canadensis*, *O. dalli*, and *O. mouflon* (Nadler et al. 1971). They reported three transferrin alleles, Tf B⁺, Tf D, and Tf E, in two subspecies of bighorn sheep, *O. c. canadensis* and *O. c. mexicana*. In 14 specimens of *O. c. canadensis* from Montana, 13 had the Tf DE phenotype and one sheep was B⁺D. Two specimens of *O. c. mexicana* from Arizona were of the EE phenotype.

In Colorado, bighorn sheep historically ranged over much of the central and western parts of the state, but the distribution has been fragmented in recent times (Armstrong 1972), and there are now more than 30 disjunct bands occurring in the less accessible parts of the higher mountains. A study was undertaken to characterize electrophoretically demonstrable genetic variation in several serum proteins and in hemoglobin of several disjunct herds to determine the degree of genetic similarity or dissimilarity among and within the bands sampled. The present study is a report of transferrins observed in several herds.

Blood samples were collected from four different herds in Colorado. The designation of the herds and their centers of distribution are as follows: (1) Poudre—north slope of Poudre Canyon, Larimer Co., (2) Tarryall—Tarryall and Kenosha Mts., Park Co., (3)

Chalk Creek—Chafee Co., and (4) Gunnison—Gunnison Co.

Transferrins were analyzed by polyacrylamide disc gel electrophoresis using the techniques described by Smith (1968). Gels were prepared at 7 percent (w/v) concentration. Serum samples were prepared by making serum with 50 percent sucrose containing 0.25 percent brom phenol blue as a tracking dye. Electrophoresis was carried out in tris-glycine buffer at pH 9.5. Twelve serum samples were electrophoresed for 26 minutes at 3 milliamps per gel at 10 C.

Samples of domestic sheep blood of known transferrin type were obtained from the Serology Laboratory of Dr. Stormont of the University of California at Davis and were used as reference sera.

All populations were polymorphic for transferrin phenotypes (Table 1). Two herds, Chalk Creek and Poudre, had three phenotypes and two herds, Tarryall and Gunnison, each had two phenotypes. The phenotypes

TABLE 1. Transferrin phenotypic frequencies of bighorn sheep, *Ovis canadensis canadensis*, in Colorado (numbers of observations in parentheses).

Herd	Tf DD	Tf DE	Tf EE
Gunnison (7)	0.000	0.557	0.143
Chalk Creek (16)	0.313	0.374	0.313
Tarryall (26)	0.577	0.423	0.000
Poudre (15)	0.316	0.526	0.155

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were determined to correspond to those produced by two alleles, Tf D and Tf E. Allelic frequencies ranged from 0.43 to 0.79 for Tf D and from 0.21 to 0.57 for Tf E. Significant differences among herds were observed for the distribution of phenotypes. Within herds the transferrin frequencies followed a Hardy-Weinberg distribution. The proportion of heterozygotes was high in all populations, with the lowest value of 0.375 being observed in the Tarryall herd.

Although surveys of isozymes in natural populations of small mammals have indicated considerable genetic variability, relatively few biochemical studies have been done on large mammals. Bonnell and Selander (1974) found no polymorphisms in 24 presumptive loci in northern elephant seals. Heterozygosity of 0.04 have been reported for elk (Cameron and Vyse 1978), 0.04 for moose (Ryman et al. 1977), and 0.32 for white-tailed deer (Manlove et al. 1976). These species were monomorphic at the transferrin locus except for white-tailed deer, which had 23 percent heterozygosity.

It is of interest that the bands of bighorn sheep in Colorado retain such a high degree of polymorphism, at least at the transferrin locus, although the populations have been relatively isolated and have had relatively small population numbers. Some recent estimates of population size include Poudre,

65-75, Tarryall, 100, and Chalk Creek, 90-100. Results at the transferrin locus indicate that inbreeding within the herds may not be a major problem, although surveys of additional genetic loci should be undertaken.

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