INITIAL INVESTIGATIONS INTO THE REPRODUCTIVE BIOLOGY OF THE DESERT BIGHORN RAM, *OVIS CANADENSIS NELSONI*, *O. C. CREMNOBATES*

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INTRODUCTION

The reproductive phenomenon is incompletely understood for any large wild ungulate species, the bighorn sheep being no exception. Much of what is assumed to be known about the bighorn's reproductive physiology has been surmised from reproductive studies of domestic species. Similar to its domestic relations, the bighorn over most of its North American distribution appears to be cyclic in its breeding ecology, i. e., exhibiting a distinct estrous and anestrous period. However, within some populations lambs appear at virutually any time of the year and courtship displays are observed at intervals not coincident with the normal rut. Such observations suggest at least some populations or segments of these populations are not synchronous or cyclic in their reproductive activity.

Observations on bighorn natality and mortality have been made (and are continuing) for a population of desert bighorn sheep, *Ovis canadensis cremnobates* and *O. c. nelsoni*, in the Santa Rosa Mountains, Riverside County, California. Since 1969, and presumably before but data are lacking, 10 to 35 percent of the annual lamb recruitment has been born out of what is considered to be the normal lambing period.

For bighorn rams, a distinction is made between physiological sexual maturity or puberty and behavioral puberty. Rams to the age of 3 years travel with the ewe herds, after which time they are incorporated into distinct ram herds. Rams within these bachelor bands are generally considered to be mature. Social pressure from the larger mature rams during the rut restrains younger rams from copulating, although they are, perhaps, physiologically capable of doing so. The age of physiological sexual maturation is not known. Mature desert rams generally do not encounter bands of ewes and younger sheep outside of the rut period. The seasonal movement of these two distinct population segments has been considered elsewhere (Geist 1971). The odd season natality suggest precocial sexual development of immature rams within the ewe herds.

The management of any species can be facilitated by an understanding of that species reproductive potentialities. A study has been initiated investigating the reproductive physiology-ecology of the desert bighorn sheep. This study is being conducted through the Department of Zoology

and Physiology, University of Wyoming, Laramie, Wyoming and the P. L. Boyd-Deep Canyon Desert Research Center, University of California, Riverside, California under permits and the cooperation of the California Department of Fish and Game and the assistance of various other state, federal, and private organizations. This paper reports the preliminary investigations of serum testosterone levels and seasonal testicular histology in young desert bighorn rams.

MATERIALS AND METHODS

Eight free-ranging desert bighorn rams were immobilized with Etorphine Hydrochloride or trapped in conjunction with other studies. Ages of the captured animals were determined using dentition criteria and assuming a mean birth date for all bighorn within the range. Similar sampling and sample analysis was performed on two captive rams maintained in pen facilities within the Santa Rosa Mountains. Serum and tissue samples were routinely obtained on a bimonthly schedule.

Blood samples were obtained by venapuncture of the jugular vein. The samples were centrifuged immediately and the serum refrigerated at -18°C until analyzed. Serum levels of testosterone were determined by gas chromatography employing a hydrogen flame ionization detector. The glass column was placed with 3 percent QF-1 on chromosorb 20. Extraction and cleanup essentially followed that described by Whitehead and McEwan (1976).

Testicular biopsies were taken at the time of immobilization and half of the biopsy was fixed in 10 percent buffered formalin and the other half in Bouin's fixative for subsequent histological examination. The tissue samples were dehydrated, embedded in paraffin, sectioned at 8μ and stained with haematoxylin and eosin. The stained sections from each specimen were examined under the light microscope and seasonal changes in histologic appearances were noted and recorded. For the purpose of this study, rams were considered immature if the testis showed no histological signs of spermatogenesis and mature after the initiation of spermatogenesis.

RESULTS AND DISCUSSION

A seasonal variation in the serum concentration of testosterone of mature desert bighorn rams was observed. From mid-December, the pattern of serum testosterone levels in desert rams was less than 1 ng/ml, but showed a decided increase in July. Serum testosterone increased an average of 12 ng/ml (8-15 ng/ml) by September. The testosterone levels remained high until late October when testosterone levels again declinced to less than 1 ng/ml by mid-December.

Variation in the adult testicular volume also reflected a seasonal pattern of testicular activity. There was a two-to three-fold increase in testicular volume from June to October and a comparable reduction in volume from October to January.

Coincident with high serum testosterone levels and increased testicular volume was a change in the histological appearance of the tubular and interstitial tissue of the ram testis. During the anerstrous or quiescent phase, there was no evidence of spermatogenic activity. The seminiferous tubules were small and the interstitial tissue volume was minimal and compressed.

Commencing in June, spermatogenic activity was evident, but mature sperm were not observed. Interstitial cell volume was increased, but the Leydig cells were small and compressed. In August, spermatogenic activity had increased appreciably. The seminiferous tubules were large and active. All stages of spermatogenic activity could be demonstrated. The interstitial tissue was 1.5 times greater in volume than in the quiescent phase. Much of this increase was due to the increased volume of the Leydig cells.

Spermatogenic activity could be demonstrated through November, however, much reduced activity. The tubular epithelium was in regression. The interstitial volume was greatly reduced and the Leydig cells again were reduced in size and flattened. In late December and early January the testicular cycle had returned to an anestrous phase.

The lambing period for Santa Rosa Mountain bighorn extends from the middle of April to mid-May. Most (50 percent) lambs are born by the last week of April and the first week of May. There is, however, considerable variation from year to year, presumably due to environmental influences.

Differences in maturation at parturition of the neonatal bighorn ram are apparent from year to year. Generally, the testes have descended at the time of parturition or will descend within the first week postpartum. However, as long as a 5-week postpartum interval has been observed before the descent of the testes.

Descent of the testes is coincident with an increase in serum testosterone levels. During the first 5-10 weeks postpartum, serum testosterone levels approximated 1 ng/ml. However, episodic bursts of testosterone frequently occurred, with levels of testosterone reaching 4-5 ng/ml. During the first 22-24 weeks postpartum there was a slow rise in serum testosterone until about week 26 when serum testosterone levels increased to values comparable to those found in mature rams. This rise in lamb testosterone lags slightly behind the rise of testosterone in mature rams corresponding to the pre-rut season. No post-rut season decline in serum testosterone was observed in the ram lambs. Rather, the pattern of serum levels remained high, 8-12 ng/ml, during the succeeding year and became cyclic only after their second rutting season (21 months postpartum).

The histology of neonatal testicular tissue was difficult to access in relation to testosterone levels due to the insufficient number of samples obtainable and the amount of actual tissue from any given biopsy. Several general trends have emerged, however.

Increased maturation of the testicular tissue closely paralleled the increase in serum testosterone during the first 22-24 weeks postpartum. However, spermatogenesis was not evident until week 20-22. The development of tubular epithelium and interstitial tissues, Leydig cells, approximated the development observed in the testes of mature rams during the pre-rut period. Tubular sperm were not observed until 26-28 weeks postpartum, but were found in quantity until the ram became cyclic at 21 months of age.

In the Santa Rosa Mountains, mature desert bighorn rams undergo a seasonal cycle of spermatogenesis with a distinct estrous and anestrous period. The anestrous period is typified by testicular regression and comparatively low levels of serum testosterone, whereas the estrous period is characterized by testicular hypertrophy and high serum testosterone levels.

Desert ram lambs exhibit a rapid physiological sexual maturation and appear to possess all but physical stature to enter into breeding activity their first rutting season. Undoubtedly social pressure from mature rams also restrains the lambs from copulation with smaller ewes. However, once rutting season has terminated for the mature ram population and this segment has separated from the ewe herds, late estrous ewes could be serviced by the ram lambs within the ewe herds. It is perhaps this segment of the bighorn population in conjunction with late estrous ewes which is responsible for the odd season lambs observed. The odd season lambs allow for population plasticity relative to lamb recruitment and act as a buffer against the loss of a total age class due to drought or other environmental catastrophy during the lambing period.

Literature Cited

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