ADDITIONAL STUDIES OF ANOMALIES OF THE SKULL IN DESERT BIGHORN SHEEP

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ABSTRACT:

Data are presented on anomalies of the skull based on examination of 260 skulls of Ovis canadensis nelsoni from the Desert Game Range in southern Nevada. Variations in the dentition are common, especially the absence of second pre-molars in adults. Approximately 7.4 per cent of the rams and 34.3 per cent of the ewes examined had one or more missing second pre-molars. This condition is more common in the lower jaw. A significant deflection of the occipital region from the anterio-posterior axis was found in rams. In addition certain minor anomalies were found. The incidence of dental and other anomalies is believed to be higher than that normally found in other mammalian populations.

Additional studies were made of anomalies of the skull in desert bighorn sheep, Ovis canadensis nelsoni, based on a collection of 260 skulls from the Desert Game Range of southern Nevada on deposit at the Biology Museum, Nevada Southern University. Reports by Hansen (1961), Kiger (1963), Allred and Bradley (1965), and Baker and Bradley (1965) are based on this collection which is especially valuable since it represents the largest sample of skulls from any population of bighorn sheep in North America. The present study is a re-evaluation and continuation of the study made by Allred and Bradley (1965) based on a larger sample with a more adequate representation of age groups, especially of lamb skulls.

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MATERIALS AND METHODS:

The 260 skulls used in this study (147 rams, 102 ewes, and 11 lambs) were picked up by Game Range personnel, hunters and other inter-

ested parties on different areas of the Game Range and therefore may be considered a random sample of the bighorn population. Some of this material is incomplete, broken, or shows excessive weathering and could not be used for this paper. Ninety-six rams, 66 ewes, and 11 lamb skulls were examined for deviations in dental formula, and 48 ram skulls for checking the symmetry of the skull. The bulk of the collection was examined for minor anomalies.

The age of each skull was determined by the horn ring technique employed by Cowan (1940), Murie (1944), and Brandborg (1955).

Deviations in dental formula, and other anomalies were recorded on data sheets. The symmetry of the skull was checked by means of a glass plate with a ruled line which was laid against the ventral surface of the skull with the line covering the platal suture. Lines were drawn from the posterior edge of the palate to the inner border of each occipital condyle. The angles formed by these lines and the line formed by the extension of the palatal suture were measured. Deviations between the angles for left and right condyles were considered as the angle of deflection. Standard measurements from Baker and Bradley (1965) were used in compiling other data.

RESULTS:

Deviations in Dental Formula

Supernumerary canines have been reported in a number of cervids, (Van Gelder and Hoffmeister, 1953; Helminen, 1958; Ryel, 1963; Knowlton and Weigand, 1965; Glaxener, 1965; and others) bovids, (Benson, 1943; Ealquest and Hoffmeister, 1948; Deming, 1952; Child and Riney, 1964; Allred and Bradley, 1965; and others).

Benson (1943) reported upper canines in three bighorn skulls out of a total of 303 examined. Dalquest and Hoffmeister (1948) found six with upper canines in a sample of 37 skulls. Deming (1952) in his study of tooth development in bighorn sheep from the Desert Game Range, reported upper canines in four out of 11 lamb skulls, but found none in 35 skulls of adults. We found three lamb and two adult ram skulls with upper canines. None were evident in our sample of ewe skulls. The higher percentage of upper canines in lambs than in adults would suggest the possibility of bone growing over the vestigial canine or alveolus and concealing its presence in adults. This problem is being investigated further.

Cowan (1940), Dalquest and Hoffmeister (1948), and Deming (1952), all indicate that in bighorn sheep, a complete set of cheek teeth are present by the age of four years. However, Allred and Bradley (1965) found that 17 per cent of the skulls examined of four years of age or over did not contain a full complement of cheek teeth. This study fully supports our previous finding of variations in the accepted dental formula of $I - \frac{0}{3}$, $C - \frac{0}{1}$, $PM - \frac{3}{3}$, $M - \frac{3}{3}$. Allred and Bradley (1965) found 21

adult skulls which had one or more of the second premolars absent. The incidence of absent premolars in adult bighorn is given in Table 1. It is readily evident that missing second premolars are common in both sexes at all locations with the exception of the upper jaw in rams where the full complement of cheek teeth was present in all the skulls examined. The absence of at least one second premolar in 7.4 per cent of the rams and 34.3 per cent of the ewes examined fully substantiates the conclusions al Allred and Bradley (1965). Ewes were also found to be far more variable than rams in standard cranial measurements (Baker and Bradley, 1965).

The absence of second premolars is about equally distributed on the right and left sides of the skull but this condition is far more prevalent in the lower than the upper jaw as is further indicated in Table 2. In ewes 15.6 per cent of the second premolars are absent from the upper jaw and 33.9 per cent from the lower jaw. Rams have 9.4 per cent of the second premolars absent from the lower jaw. Approximately 6.3 per cent of the rams and 27.6 per cent of the ewes have absent second premolars on both sides of the lower jaw in contrast with no rams and 11.1 per cent of the ewes without second premolars on both sides of the upper jaw. No rams and 5.4 per cent of the ewes had three absent second premolars. All skulls examined had at least one second premolar.

Measurements of the teeth adjacent to the missing premolars did not reveal any increase in tooth size to fill in the missing portion of the dental arcade. Miller et al. (1964) found no compensation in tooth size in dogs having incomplete portions of the dental arch.

SYMMETRY OF THE SKULL:

Dalquest and Hoffmeister (1948) reported on a five year old ram which exhibited about 3 degrees deflection to the left of the basioccipital region from the plane of the rostrum. Allred and Bradley (1965) noted several rams with occipital condyles which were deflected from the anterio-posterior axis. Approximately 90 per cent of the 48 ram skulls examined show some degree of deflection of the occipital condyles from the anterio-posterior axis of the skull structure (Table 3). Of those skulls exhibiting deflection approximately 66 per cent are deflected to the left. Approximately 46 per cent exhibited deflection, are deflected 3 or more degrees. Ewe skulls have not as yet been checked for this condition.

Allred and Bradley (1965) have suggested that this deflection is a compensation for unequal horn weight. Such factors as differences in horn lengths, including brooming and differences in spread between the left and right horns may result in significant differences in horn weight in relation to balancing the head. It is plausible that compensation in the anterio-posterior axis of the skull and associated head and neck muscles would occur. There appears to be little relationship between measurements of the basal circumference of the horn and the degree or direction of deflection. However, unequal spread, especially near the terminal tip of the horn, and unequal horn length does appear to be a

Table 1. The incidence of absent second premolars in Ovis canadensis nelsoni, of four years of age or over, from the Desert Game Range, Nevada

	Right Side				Left Side			
	Upper Jaw		Lower Jaw		Upper Jaw		Lower Jaw	
	♂	♀	♂	♀	♂	♀	♂	♀
Number Examined	95	65	95	59	95	63	96	59
Number with absent premolars	0	11	10	19	0	9	8	21
Per cent with absent premolars	0	17.1	10.5	32.2	0	14,4	8.3	35.6

Table 2. The number and per cent of absent second premolars in Ovis canadensis nelsoni, of four years of age or over, from the Desert Game Range, Nevada.

	Upper Jaw			Lower Jaw		
	♂	♀	combined	♂	♀	combined
No. of premolars expected (using a standard dental formula)	190	128	318	191	118	309
No. of absent premolars	0	20	20	18	40	58
Per cent of absent premolars	0	15.6	6.3	9.4	33.9	18.8

Table 3. Incidence and degree of deflection of the occipital condyles from the axis of the palatal suture.

Number of skulls examined	Degree of Deflection 0-1°	1-1.5°	2-2.5°	3-3.5°	4-4.5°	over 5°
48	5	9	14	10	6	4

factor affecting degree and direction of deflection in rams under 10 years of age.

There appears to be less of a relationship in older rams. Cowan (1940) suggested that ossification of sutures of the dorsal portions of the skull occurs between 5 and 10 years of age. We found nearly complete ossification of the sutures in the occipital region by 9 and 10 years and complete ossification by 11 or 12 years of age. This would suggest that compensation for balance as evidenced by deflection of the occipital region occurs primarily in younger animals before ossification of sutures has been completed.

MINOR ANOMALIES

As noted previously by Allred and Bradley (1965), splitting of the nasal bones occurred in four ram skulls but not in the ewes examined. We found five rams and no ewes with split nasals in the present study. The absence of this condition in ewes, which otherwise exhibit more variability and a higher incidence of anamolies, would suggest that it may be due to damages sustained during the rut.

Dalquest and Hoffmeister (1948) and Allred and Bradley (1965) both noted a thickening of the nasal bone, producing a humped appearance. We found eight ram and two ewe skull with these areas of calcified bone occuring on the frontal region. These areas are located on the nasal, frontal, maxillary and premaxillary bones, and are raised as high as 1.04 cm. from the surface of the bone, and extend in length up to 8.43 cm. One nine year old ram had large calcified deposits on the tip of the premaxillary bone, and the rostrum had been broken, and healed. These areas which are more common in rams are probably sites of old injuries sustained during the rut.

DISCUSSION:

The present study clearly indicates that anomalies are both variable and extremely prevalent in the population of desert bighorn sheep on the Desert Game Range. The population on the Desert Game Range appears to have a higher incidence of anomalies than other ungulate populations which have been studied. Dalquest and Hoffmeister (1948) conclude that cranial aberrations are rather common in bighorn sheep but the percentage of abnormalities that they and Cowan (1940) report are far exceeded in the present study.

Some of these abnormalities, especially those which are more common in rams, are probably usually related to injuries. Also asymmetry of the skull may be directly related to brooming, injuries to the horns, and other factors which are largely related with individual behavior. However, the deviations in dental formula are so intimately related to the gross embryological patterns of the individual that they must have a

genetic basis. The extreme variability in the second premolar is undoubtedly genetic, and should be studied from that viewpoint. To our knowledge this condition is rare, if it does occur in other bighorn populations.

One of the major difficulties encountered in a comparison of variation of anomalies between populations is the paucity of bighorn skulls in museums. Therefore adequate data on these conditions are not available. Usually when series of skulls have been available, investigators have been content to utilize this material for taxonomic purposes only. The present study based on an adequate sample from a single population indicates the kind and incidence of anomalies which may be present in such a population.

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