HORN GROWTH IN DALL'S SHEEP: A PRELIMINARY REPORT

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ABSTRACT

Dall's Sheep (Ovis dalli dalli) horn growth was analysed from a sample of 69 rams killed in the Mackenzie Mountains, Northwest Territories by sport hunters. Mean age at full curl was 8.3 years and mean curl diameter was 28.8 cm. Rams with greatest early horn growth experienced lesser annual growth after 3 1/2 years than those with slower early growth. However, the rapid early-growth rams developed longer horns with larger basal diameter than the slow starters. Differences in horn growth characteristics between rams from Mackenzie Mountains and rams from four Alaskan mountain ranges are described.

INTRODUCTION

An arc of cold, dry winters bringing relatively shallow, granular snow cover marks the fringe of Dall's sheep (Ovis dalli dalli) habitat in Alaska and northern Canada. Published records of average winter temperatures and precipitation indicate a similarity in climate in the Brooks Range, Alaska, Richardson Mountains, Yukon and Northwest Territories (NWT), and northern Mackenzie Mountains, (NWT). The temperatures in these regions are cold and snowfall is sparse and relatively dry. The more southerly and westerly Alaska Range and Ogilvie Mountains are warmer, and experience heavier, moister snowfall. In the extreme is the Kenai Peninsula with the warmest temperatures and far greater snowfall and rain.

Researchers have correlated environmental conditions with horn growth (Bunnel 1978; Nievergelt 1966; Heimer and Smith 1975; Geist 1966a, 1971; Shackleton 1973, 1976). Geist (1966a) hypothesized that individual rams which show relatively rapid early growth of horn show relatively slower subsequent growth. Bunnell (1978), using data from Yukon sheep, examined this hypothesis and proposed that rates of horn growth are associated with nutrition. We continue this examination by focussing on incremental horn growth in Dall's sheep from Alaska and the NWT.

Research into the characteristics of the Dall's sheep population in the Mackenzie Mountains began in 1966 (Simmons 1968, 1969), shortly after the area was opened to non-resident sport hunters. The seasonal movements and demography of the sheep have since been described by Simmons (1982) and Simmons etal (1984). During the 1966-73 study period, the population was largely unaffected by humans, and researchers determined that the population level of females and juveniles was stationary. The harsh climate resulted in the highest mortality occurring during the winter in the first year of life.

Feeding and movements were relatively unrestricted by snow (Simmons et al 1984).

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STUDY AREA

The sheep in our sample were collected by sport hunters in the central Mackenzie Mountains. This area is characterized by relatively unstable limestone, dolomite, and shale slopes covered with sparse vegetation. Annual precipitation is 25-30 cm. Rainfall comes mainly in July and August. Most of the range is covered with shallow, lightly-crusted snow (< 50 cm) during winter. There are an average of 70-75 frost-free days a year. During winter, grasses and sedges (Carex, Festuca, Hierochloe, Kobresia, Poa, and Trisetum, among others) are most favoured by sheep and were readily available (W.H. Hoffmann, unpubl. rep., Can. Wildl. Serv., 1973). Winter ranges were most commonly on areas of gentle alpine tundra isolated by spruce (Picea sp.) covered plateaus and lowlands. Winter sheep density was about 1.0 per square kilometer (Simmons 1982), much lower than that reported by Hoefs and Cowan (1979) for the Yukon Territory.

METHODS

Horn measurements reported here were collected from 69 NWT rams (48 full curl) at Alberta taxidermists' shops and in private collections in southern Alberta. The age of each ram was estimated by counting the annual growth segments (Geist 1966b). The length of the longest horn and the lengths of growth segments were measured along the frontal surface of the horn. The first 2 1/2 years of growth was taken as one segment because of indistinct boundaries for the lamb and first-year segments. Horn length for full curl, the point at which horn curl describes a 360° arc when viewed in profile, was measured, and age at full curl was estimated by measuring back from the horn tip. No estimate of horn-tip wear, which can be substantial (Hoefs and Nette 1982), was made. Horn-curl diameter was calculated from horn length at 360°. Basal circumference and tip-to-tip spread were also measured. Measurements were taken using a 1/4 inch flexible steel measuring tape and recorded to the nearest 1/8 inch (3 mm).

A sub-sample of horns was selected which showed no brooming, were full curl or more, and were at least 9 years old. The longest horns from 18 heads met these criteria, and were ranked, longest to shortest, according to the length of the 0-2.5 year increment and split into two sub-samples of nine each. Differences in age and horn growth characteristics between the two sub-samples were examined using one-tailed t-tests.

Mean age and mean horn length at full curl for rams from Alaska Range East, Brooks Range, Chugach Range, and the Kenai Mountains were taken from Heimer and Smith (1975, Tables 1, 7 and 13). Horn-curl diameters were calculated from horn length at full curl. Mean length of growth segments for rams from these four Alaskan ranges were taken from Erickson (1970).

Differences in mean age, mean curl diameter, and mean length of growth increments for the Alaskan and Mackenzie Mountains rams were examined using chi-square analysis.

RESULTS

Mean annual horn growth increments for 69 Dall's rams are shown in Table 1. The growth increment formed during the year of death has not been included. Few rams in the sample were more than 10 years old.

The mean age at full curl was 8.3 years (Table 2), earlier than rams from Alaska Range East (8.7 yrs.) and Brooks Range (9.6 yrs.), but later than rams from the Kenai Mountains (8.0 yrs.) and the Chugach Range (8.1 yrs.) (Table 4). The mean curl diameter (28.8 cm) is similar to the calculated mean curl diameter for Chugach Range rams (28.5 cm), but is smaller than those calculated for the Kenai Mountains (29.0 cm), Brooks Range (29.8 cm) and Alaska Range East (29.2 cm) (Table 4). However, no significant differences among mean ages at full curl and among mean curl diameters were found.

The measurements for the 2 sub-samples of full curl rams of at least 9 years of age (Table 3) show some important differences. Horns with rapid early horn growth show significantly larger mean measurements for length of longest horn ($P<0.025$), 0-2.5 year increment ($P<0.0005$), tip-to-tip spread $P<0.025$), and horn base circumference ($P<0.05$). The mean total length of the 3.5-8.5 year increments for horns with rapid early horn growth was significantly shorter ($P<0.01$) than for horns with slow early horn growth. These results support the hypothesis that rapid early horn growth will be followed by slower growth (Bunnell 1978, Geist 1966a). Moreover, the mean length of each increment from 3.5 to 8.5 years for horns with slow early growth is as large or larger than the respective increments for horns with rapid early growth (Figure 1).

Variation among the mean lengths of 0-2.5 year growth segments for Mackenzie Mountains rams and rams from 4 Alaskan mountain ranges (Table 4) is significant ($P<0.005$). However, the variations among the mean lengths of the 3.5-9.5 year increment and among the mean lengths at 9.5 years are not significant. Plotting the mean lengths of 0-2.5 year growth segments shows an upward trend in mean length beginning with rams from the cold, dry Brooks Range and ending with the warm, wet Kenai Mountains (Figure 2). The mean lengths at 9.5 years show a similar trend for all mountain ranges except for the Kenai Mountains. Age at maximum mean horn length appears to decline as climatic conditions become warmer and wetter (Table 4).

DISCUSSION

Analysis of our small sample of rams from the Mackenzie Mountains indicates characteristics of ram horn growth that warrant further investigation with a larger sample. The future use of horn volume as a size measurement will reduce the variables operating on our linear measurements. Furthermore, horn volume is the best measure of trophy quality and may be a better indicator of social ranking than horn curl.

Table 1. Mean length of horn growth increments for a sample of 69 Dall's Rams from Mackenzie Mountains, N.W.T.

Horn Growth Increment (yrs.)	Number in Sample	Increment Length	
		Mean (cm)	Standard Deviation (cm)
0 - 2.5	69	39.00	7.11
2.5 - 3.5	69	14.36	2.42
3.5 - 4.5	67	12.10	1.83
4.5 - 5.5	65	9.40	1.80
5.5 - 6.5	56	7.08	1.44
6.5 - 7.5	50	5.19	1.27
7.5 - 8.5	37	3.94	0.78
8.5 - 9.5	25	2.93	0.77
9.5 - 10.5	14	2.43	0.75
10.5 - 11.5	3	2.01	0.48
11.5 - 12.5	2	1.91	0.90
12.5 - 13.5	2	1.59	0.90
13.5 - 14.5	1	1.59	-

Table 2. Summary of horn measurements for a sample of 69 Dall's rams from Mackenzie Mountains, NWT.

Measurement	Sample Size	Mean	Standard Deviation
Length of longest horn (cm)	69	90.1	8.80
Length of horn at full curl (cm)	48	90.4	5.71
Estimated age at full curl (yrs.)	48	8.3	1.36
Diameter of horn curl (cm)[a]	48	28.8	1.82
Circumference of horn base (cm)	69	31.7	1.83
Tip-to-tip spread (cm)	67	58.3	8.22

[a] Calculated from horn length at 360°.

Table 3. Horn measurements for Mackenzie Mountains Dall's rams with slow and rapid horn growth during first 2.5 years of life.

Measurement	Slow Early Growth			Rapid Early Growth		
	Sample Size	Mean	Standard Deviation	Sample Size	Mean	Standard Deviation
Estimated age (yrs.)	9	10.3[a]	0.87	9	10.6[a]	1.58
Estimated age at full curl (yrs.)	9	8.8[b]	1.09	9	8.2[b]	1.86
Length of longest horn (cm)	9	93.7[c]	7.08	9	99.7[c]	4.17
Horn length at full curl (cm)	9	89.5[d]	4.96	9	93.5[d]	4.88
Horn curl diameter (cm)	9	28.5	1.58	9	29.7	1.55
0 - 2.5 year increment (cm)	9	34.6[e]	6.11	9	45.0[e]	4.11
3.5 - 8.5 year increment (cm)	9	55.0[f]	4.28	9	50.0[f]	3.71
Tip-to-tip spread (cm)	8	60.6[g]	7.28	9	67.6[g]	5.17
Circumference of horn base (cm)	9	31.3[h]	1.84	9	32.8[h]	1.80

[a] $t = 0.50$, P 0.10

[b] $t = 0.83$, P 0.10

[c] $t = 2.19$, P 0.025

[d] $t = 1.72$, P 0.05

[e] $t = 4.24$, P 0.0005

[f] $t = 2.65$, P 0.01

[g] $t = 2.31$, P 0.025

[h] $t = 1.75$, P 0.05

Table 4. Mean horn measurements for Dall's rams from Mackenzie Mountains, N.W.T. and four mountain regions in Alaska.

Measurement	Geographical Region				
	Mackenzie Mountains	Brooks Range	Alaska Range(E)	Chugach Range	Kenai Mountains
0-2.5 yr increment (mm)[a]	346	336	390	398	438
(n)	(69)	(32-42)[b]	(72-82)	(67-73)	(47)
3.5-9.5 yr increment (mm)[a]	550	535	532	553	507
(n)	(69-25)	(42-17)	(84-24)	(73-18)	(46-5)
Mean length at 9.5 years (mm)[a]	896	871	922	951	945
(n)	(25)	(17)	(24)	(18)	(5)
Maximum mean horn length (mm)[a]	1099[c]	918	958	951	945
(n)	(1)	(5)	(11)	(18)	(5)
Age at maximum mean length (yrs.)[a]	14.5[c]	11.5	11.5	9.5	9.5
Horn length at full curl (mm)[d]	904	937	918	895	910
(n)	(48)	(68)	(118)	(48)	(23)
Diameter of horn curl (cm)	28.8	29.8	29.2	28.5	29.0
Estimated age at full curl (yrs.)[d]	8.3	9.6	8.7	8.1	8.0
(n)	(48)	(68)	(118)	(48)	(23)

[a] Erickson (1970).

[b] Range of n used in calculations.

[c] Mean horn length and mean age for the 3 oldest rams in the sample are 917 mm and 14.2 years, respectively.

[d] Heimer and Smith (1975).

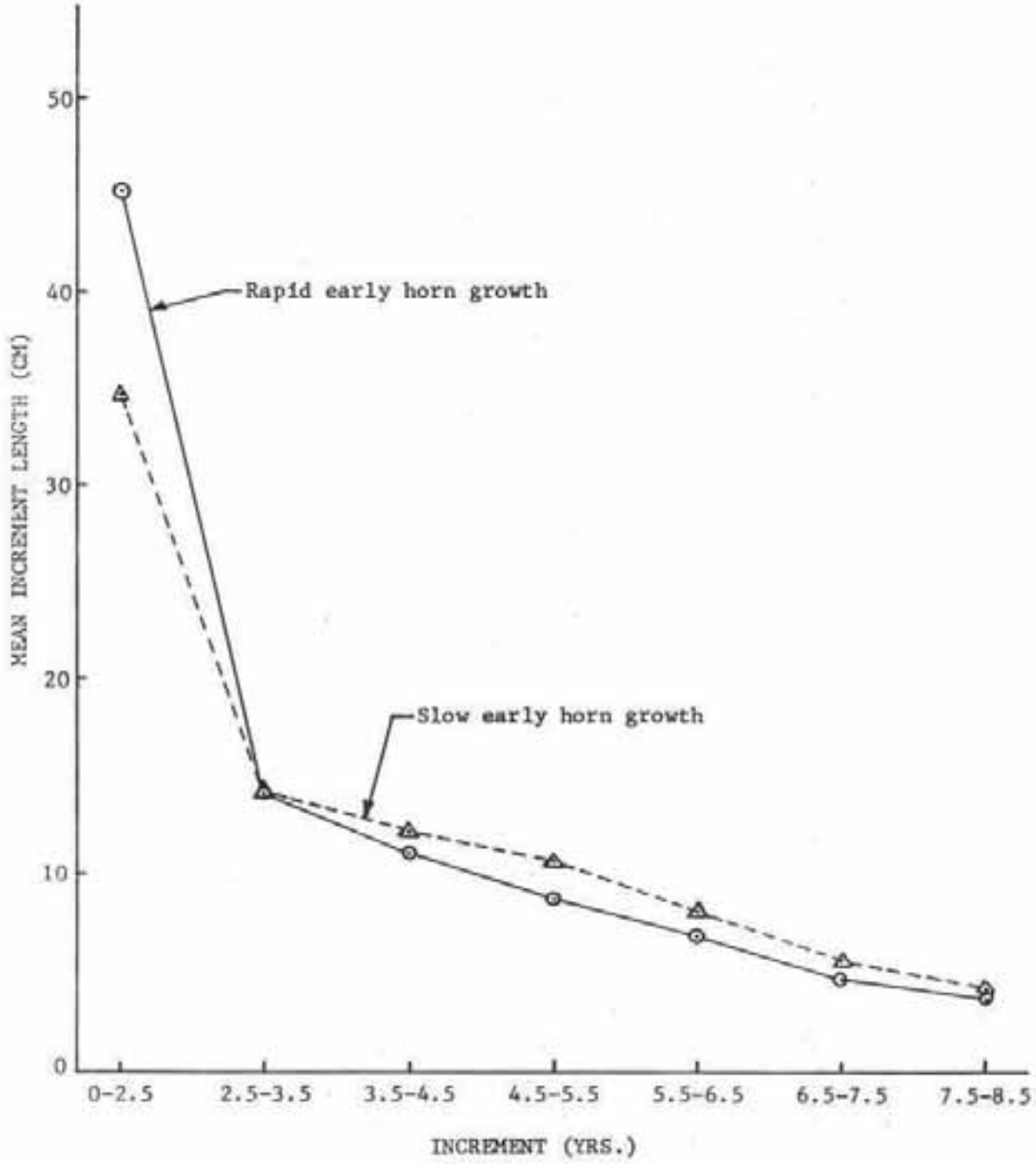

Figure 1. Mean increment lengths for rapid and slow early horn growth in Dall's rams from Mackenzie Mountains, NWT.

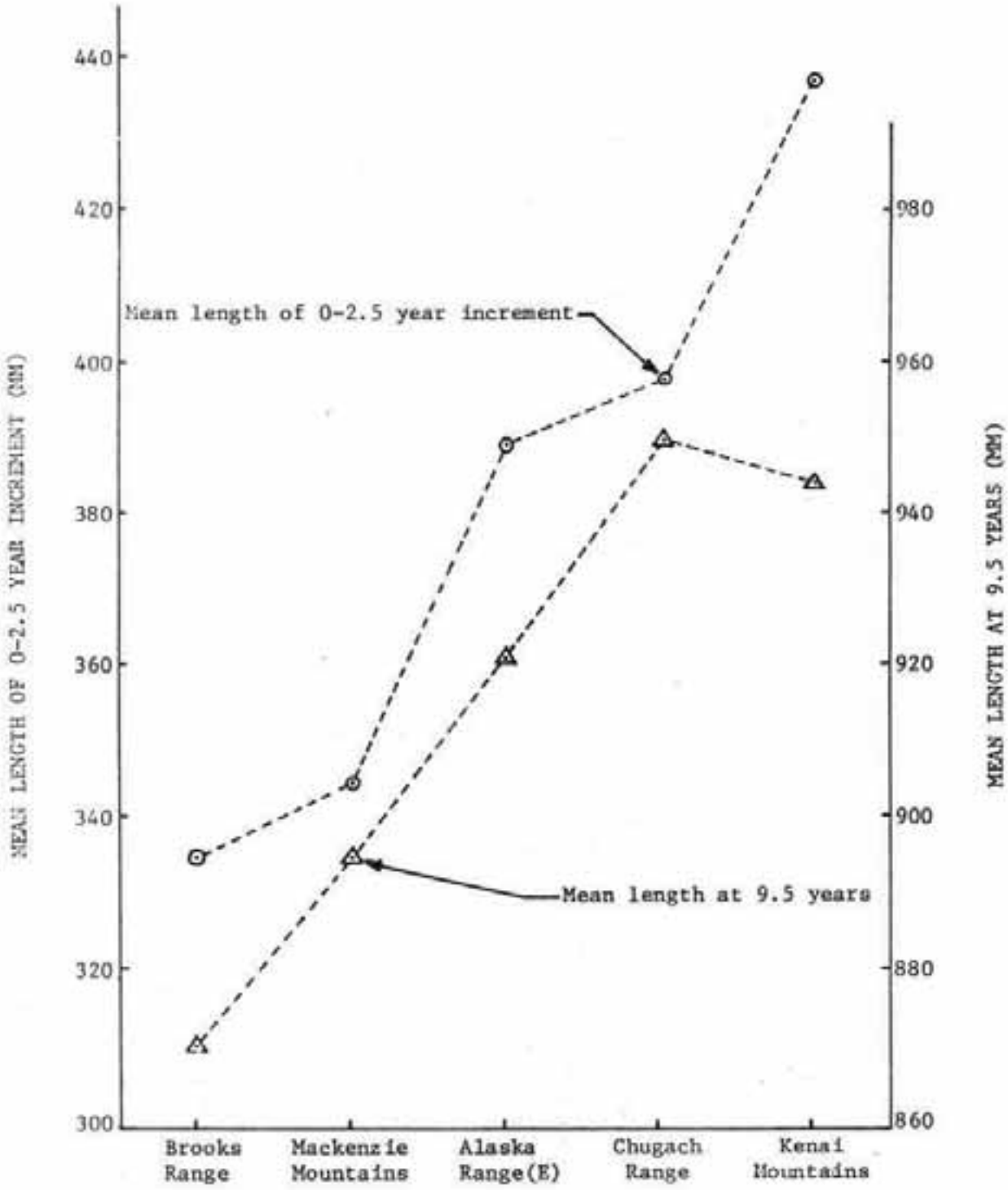

Figure 2. Mean lengths of horn growth increments for Dall's rams from the Mackenzie Mountains and five Alaskan mountain ranges.

Rams from the cold, dry northern ranges exhibit slower early growth than rams from the warmer, wetter ranges to the south. The extreme is the Kenai Peninsula with its high rainfall and lush vegetation. This cline supports the relationship between horn growth and nutrition proposed by Bunnell (1978). Rapid early horn growth also appears to be associated with shorter longevity, and warrants further investigation.

Compensatory horn growth in rams exhibiting slow early growth was also observed in the Brooks Range (W. Heimer, pers. commun., 1984). Mackenzie Mountains rams having rapid early horn growth also exhibit significantly greater basal circumference and tip-to-tip spread. It would be interesting to determine whether Alaskan sheep, particularly Kenai rams, also exhibit this relationship.

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