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HORN GROWTH AND HORN WEAR IN DALL RAMS
AND THEIR RELEVANCE TO MANAGEMENT

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ABSTRACT

Investigations were carried out on captive dall rams as well as on trophies submitted by hunters to determine the annual growth period of horns and the wear rates of the horn tips.

Horns began to grow in lambs during the second week in July, when their age was on the average ten weeks. Growth in the lamb year continued to late December. By the end of January the second horn increment had initiated growth. It is likely, that there is no complete stoppage of growth between the first and second periods, only a slowing down of the growth rate to an immeasurable amount. At the first birthday of the rams, already 20 to 25% of the second increment is completed. In this second year, horn growth continued to the latter half of November. As the rams age, the horn growth period shortened and the dormant period became correspondingly longer. In mature rams, 5 to 6 years of age and older, growth and dormancy are each about six months in duration. At the beginning of the hunting season in the Yukon, August 1, about 75 to 80% of the current years growth is completed, after October 1, no further growth was observed.

There is a gradual wearing down of the horn tips, or the first years' horn increment, with age, which is a process independent of so-called "brooming", in which part of the horn breaks off during fighting. This gradual wear at the horn tip is correlated with age. In the southern Yukon horn growth in the lamb year is about 100 to 120 mm, and by the age of 10 years, only 40 mm and the lamb growth remains. At the age of eight, this horn wear rate at the tips exceeds growth put on at the horn base, and no further increase in horn length can be expected in the average ram.

METHODS AND MATERIALS

All rams kept at the Yukon Game farm at Whitehorse were inspected at about monthly intervals for a four-year period, and subsequently twice a year until the last ram of this initial captive band died at the age of ten in 1979. These periodic inspections included the measurements of the ram's horns to determine growth periods and growth rates in length and circumference and wear rates of the horn tips. This experiment started in 1969, when the rams were caught as day-old lambs in Kluane National Park.

Concurrently the Yukon Wildlife branch began to inspect the horns of hunter killed rams in 1973. During the first few years, submissions of trophies were voluntary, and the measurements taken were those necessary to compute scores according to the Boone and Crocket formula. Since 1976 submissions of trophies is compulsory and the types of measurements taken have become more elaborate, particularly during the past two years. Measurements used in this analysis are of rams from the southwestern Yukon, since inspections for these began in 1973 and a fairly large, representative sample size is available.

In this presentation, we will confine our discussion to two aspects of horn growth dynamics, firstly, the periods of horn growth and secondly, the wear rates of the horn tips, both of which have management implications, particularly in respect to aging accuracy.

RESULTS AND DISCUSSION

A. Horn Growth Periods

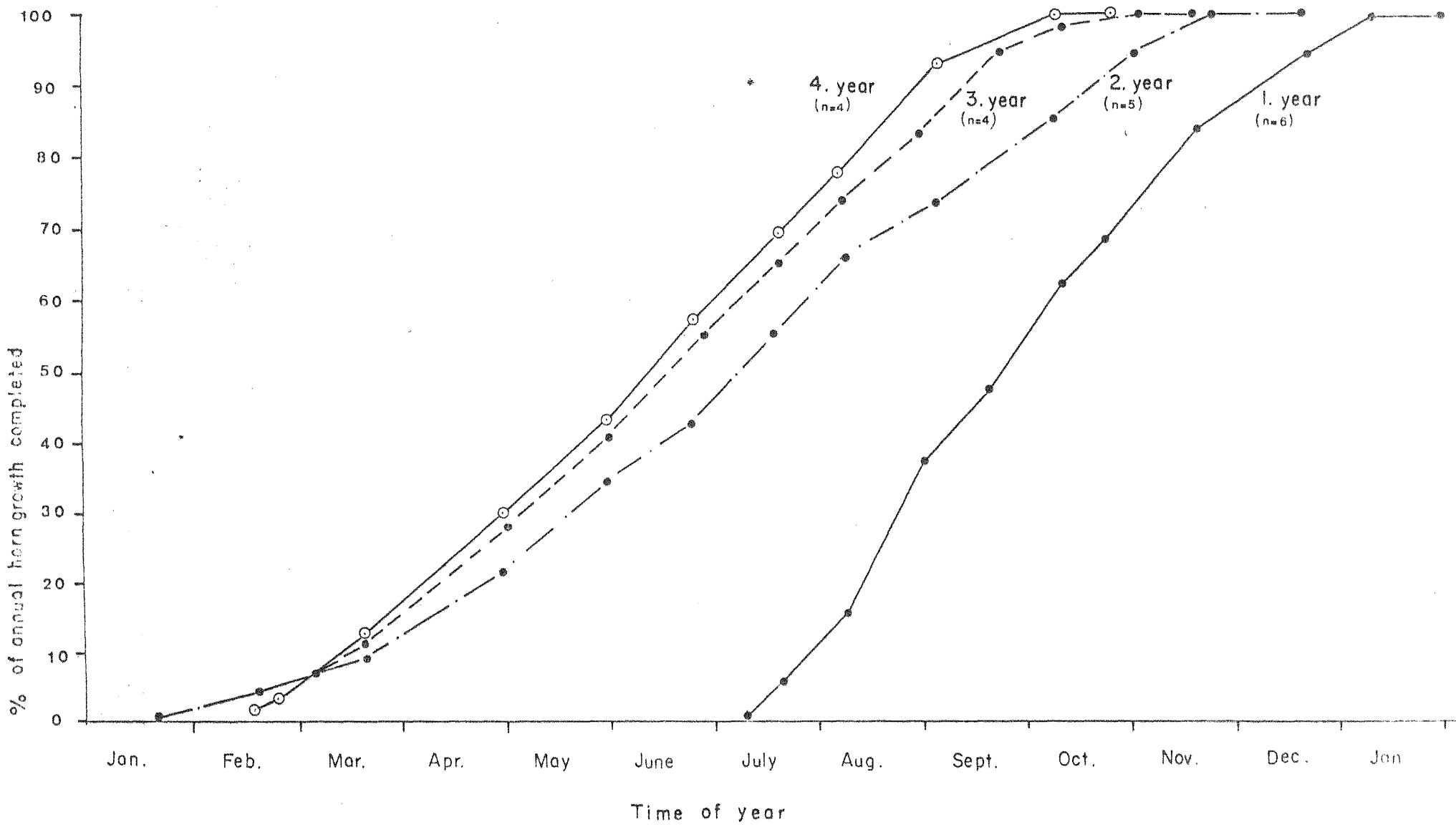
Based on observations of up to six captive rams, the following summary can be made:

Horn growth started in both male and female lambs when they were about 10 weeks old. The mean date of birth of these captive lambs was May 2nd, the first measurable growth was noticed on July 12th, on the average. Growth was slow in the first few weeks, but proceeded rapidly through the months of August to November. In the latter part of November and early December, growth slowed down considerably. The mean growth period during this first year was six months \pm 13 days. Since the lambs could only be captured and inspected every three to four weeks during winter, it was not possible to determine exactly what date growth ceased and new growth for the second increment was initiated. It appeared that there was no measurable growth from late December to late January.

In some short-yearlings, growth was initiated during the last week in January, and by February 20th, the new growth amounted to 5% of the second increment. Growth continued to proceed slowly to late March, but accelerated during April. By May 2nd, when these sheep reached their first birthday, the mean growth accomplished amounted to 22% of the 2nd increment. Growth proceeded at a more or less steady rate to November 1st when 94% of the second increment was completed. After November 25th, no further growth was

Fig.1

Horn growth periods of captive Dall rams



observed. The second growth period is the longest with 10 months \pm 12 days, and the mean rate of horn growth with 34.2 mm/month was the greatest. After the second growth period, there was a cessation of growth for about three months. The third period was initiated in mid February. The growth rate was relatively faster than during the second year, with 28% of the third increment put on by May 1st, when the rams reached their 2nd birthday. By September 22nd, 95% of the annual growth was completed, after November 6th, no further growth was observed. The dormant period increased, being about 4 months after the 3rd growth season. Again, in the latter part of February, horn growth was initiated for the fourth year, and by May 1st, 30% of the fourth increment had been accomplished. By September 5th, 94% of the annual growth was completed, after October 5th, no further growth was observed. The growth rates for these four period are shown in Figure 1; for comparative purposes they are expressed as "Percent of Annual growth completed", rather than in absolute amounts.

The relevant statistics are given in Table 1, which include annual growth increments, as measured at the end of the respective years, horn growth period, and absolute growth rates expressed as mm/month.

TABLE 1. Statistics on Horn Growth of Dall Rams

Year	<u>n</u>	<u>Increment in mm (\bar{x})</u>	<u>Horn Growth Period</u>	<u>Absolute horn growth rate in mm/month</u>
1.	6	145	6 months \pm 13 days	24.2 mm/month
2.	5	342	10 months \pm 12 days	34.2 mm/month
3.	4	205	9 months \pm 15 days	22.8 mm/month
4.	4	133	8 months \pm 15 days	16.7 mm/month

After the fourth year this experiment could not be continued with the previous regularity; however, periodic assessments, two to three times per year were carried out until the last ram had died at the age of 10.

From these assessments, from inspections of many hundreds of hunter-killed rams, shot in the period of August 1st to October 31st, and from measurements of 117 winter-killed rams in Kluane National Park, we have concluded, that the horn growth periods continue to shorten with increasing age of the rams, and the winter dormancy periods become correspondingly prolonged. However, beyond the age of 5 to 6 years, these changes are not significant anymore. Mature rams initiate horn growth in early April and practically all growth has ceased after October 1st. The growth period and the dormancy period in these older age classes are therefore both about six months in duration.

The trends observed in length of growth period between captive rams and wild ones were comparable, which supports conclusions reached by other investigators (Hansen and Denning, 1980, Bendova, 1979, Türke and Schmincke, 1965, Schmincke, 1958, and Taylor, 1962), that this period is determined by photoperiodicity and sex hormones, and not by quality of forage. Little work has been done on this topic but the following few citations from the literature essentially support our observations:

Hemming (1969), after inspecting 129 skulls of dall sheep, most of

which were shot by Eskimos in the Auaktuvuk Pass area of Alaska's Brook range, writes, "Little, if any, growth was taking place in the horns of animals killed from October through January. In a sample of 18 sheep killed in February, the horns of one had a new annual ring. By May, new growth was evident in all horns. Growth appeared to be most rapid during early summer, and by the end of September, had essentially ceased".

Hansen and Deming (1980) write, "Each year during the rutting period in the fall, horn growth subsides for several months, but resumes again, usually in January".

"Bighorns raised in pens had good feed in front of them all year long. These artificially fed bighorns also formed horn rings and went through the same sequence of growth". "From this evidence and because horns are secondary sexual characteristics, it appears that periods of horn growth are governed by sex hormones". Both Goss (1969) and Cowan (1940) also relate the cessation of horn growth in the fall to the rutting season, and thus to hormone influence. Hormone influence on the horn growth of mouflon rams was shown by Hoefs (1982) in reference to a castrated animal.

The age at which the horns first appear on the lambs differed by as much as 10 days in the same population, and may differ with locality. Hemming (1969) writes, "I found that the horns of Dall sheep begin to develop when lambs are about 4 months old".

Wells and Wells (1961) report the appearance of horns on male lambs of the desert bighorn at three months of age. A male lamb born on Wildhorse Island and placed in captivity is reported to have lost hair from the horn site at one and a half months of age and horn buttons were evident soon afterward (Ogren, 1954).

For mature rams, Taylor (1962) reports: "The appearance of new growth was first evident in a ram from the National Bison Range collected on April 17, 1959. This ram was approximately 57 months old, new growth amounted to 3 inches".

"A ram collected on May 10, 1939, aged at 71 months, had 9 mm of new blue-grey colored horn".

Taylor (1962) reports, that growth had stopped in a 41 month old ram collected October 17th.

Investigations of the European Mufflon essentially show a similar trend (Bendova, 1979; Türcke and Schmincke, 1965; Schmincke, 1958). Türcke and Schmincke state that horn growth in male lambs begins at 3 to 5 months of age, and stops in late December for only one "moonphase". These dormant periods increase with age. Bendova (1979) made similar observations with the Mufflon rams of C.S.S.R. She reports that the period of growth stoppage in 1 and 2 year old rams is 6 to 8 weeks, in mature rams, it may be 4 to 5 months.

Some of these observations made on horn growth periodicity have

practical relevance. (1) The initiation of horn growth in the lamb year is dictated by the animals age, while termination of growth is determined by the photoperiod. Since there is considerable variation in lambing dates, in the Yukon, this range extends from April 28 to June 10th, lambs born late do not have as much time to grow horns than those born early. The variations observed in horn growth during the lamb year, which is greater than during any other year, will therefore to a large extent be a reflection of different birth dates, and not necessarily one of range productivity or population quality. The growth during the first year should therefore be omitted if comparisons of horn growth quality are made between different populations. (2) The horn growth period is synchronized with the calendar year more so than with the chronological age of the animal. This factor may lead to errors in age determination by the uninformed. As indicated above, new horn growth begins 3 to 4 months before the animal's birthday, and has by this birthday already completed 20 to 30% of the current year's increment. The age of an animal may at that time be overestimated by one year. (3) It is known to be difficult to determine the boundary between the first and second year's horn growth increments, because the distinct growth ring or annulus, which is formed at later ages, does not form here. This factor can lead to an underestimation of a ram's age. While observations on horn growth periodicity will not help to overcome this problem, they do point to an explanation. There is a strong possibility, that horn growth during the lamb's first winter, does not stop completely. It only slows down to a rate not measurable anymore by conventional

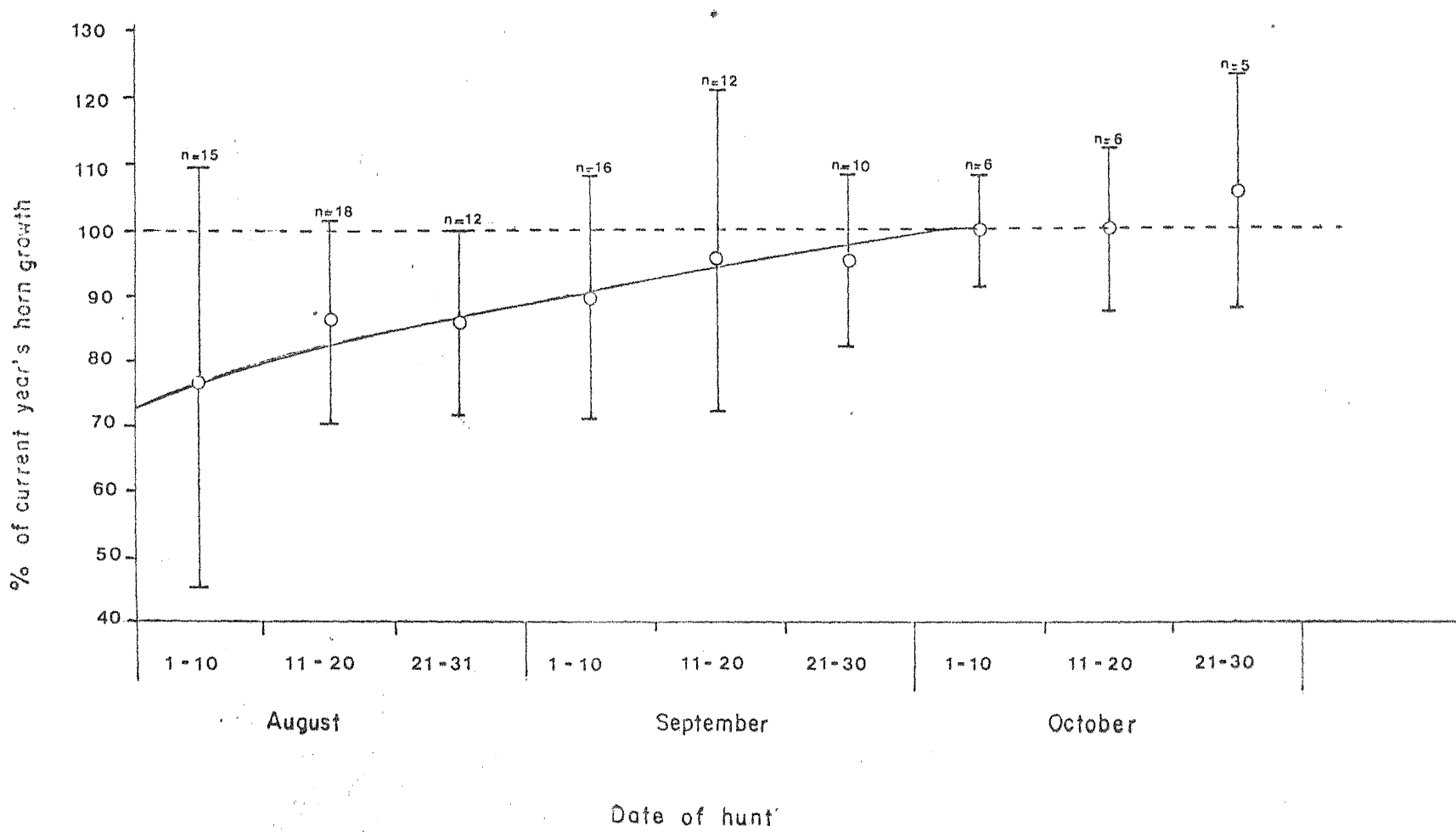
field techniques. For this reasons no typical annulus is formed. This assumption is shared by Bendova (1979), who measured horn growth rates of Mufflon rams.

Horn growth, even in old rams, continues to the latter part of September and this has relevance to the timing of the hunting season. In the Yukon, the sheep hunting season extends from August 1st to October 31st, in the N. W. T., it begins already on July 15th. By July 15th, only 70 to 75% of the current year's horn growth is completed, by August 1st, only 75 to 80%.

We have shown this relationship in Fig. 2 for 100 rams shot in the southwest Yukon during 1980 and 1981. Percentage of growth completed of the current horn increment is plotted against the date at which the ram was shot. These dates show the same trend as observed in captive rams. In early August about 75% of the current horn growth is completed, after October 1st no significant growth was documented.

The practical relevance is, that a delay in the hunt from early August to the latter part of September would in the southwestern Yukon add about 20 mm in horn length to a 6 year old ram, or about 15 mm to an 8 year old. For outfitters in remote areas, with no competition from resident hunters, this may be a factor worthwhile to consider in planning their hunts.

Fig.2 Completion of current year's horn growth in relation to hunting season.

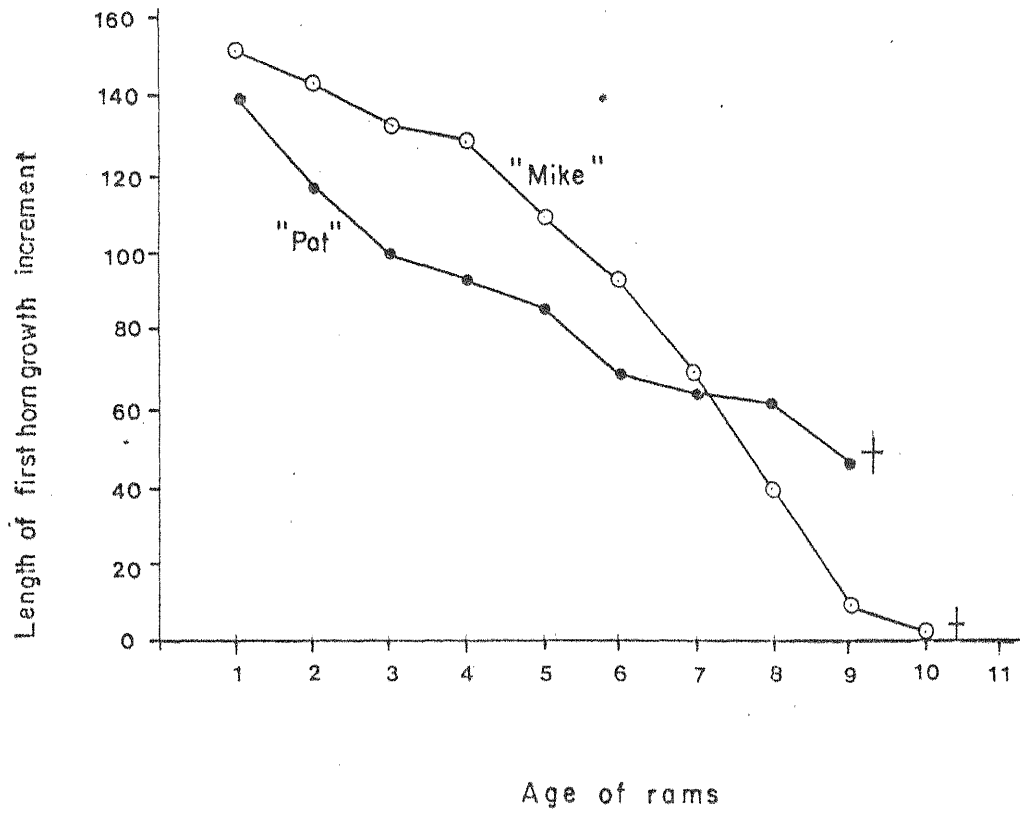


B. WEAR OF THE HORN TIPS

Two factors contribute to a reduction in horn length: (1) the breakage of part of the horn usually as a result of fighting or accidents (Shackleton and Hutton, 1971), leaving behind so-called "broomed" ends, and, (2) the gradual wearing off of the horn tips as a result of a ram rubbing his hide, supporting himself when bedded down, or scraping the horn tips against rocks or vegetation. This gradual wear is observed in all rams, while brooming is much rarer in Dall rams than in Bighorns. Of 319 horns inspected by the Yukon Wildlife Branch, after the 1981 hunting season, only 24% showed brooming, and in only 8% of the skulls submitted, was brooming evident on both sides. Brooming usually effected more than only the first year's horn increment.

Two methods were applied to document this wear rate of the horn tip and its correlation with age. Two of the captive rams already referred to reached ages of 9 and 10 years respectively. Both had one broomed horn, and one, which was not broomed and lend itself to this kind of assessment. The lengths of the first growth increment-the so-called lamb tips - measured at the end of each growing season, are shown in Fig. 3. In December of their first year these rams had horns of 152 mm and 140mm respectively. One ram, "Pat", died at the age of 9, at which time only 48 mm of the lamb growth remained, the other ram "Mike", lived to be 10 years, at which time his lamb growth was hardly noticeable, amounting to about 4 mm. Both lamb tips showed a continuous reduction with years, but

Fig. 3 Wear of lamb horn growth with age in two captive Dall rams



the annual wear rates varied considerably between these two rams.

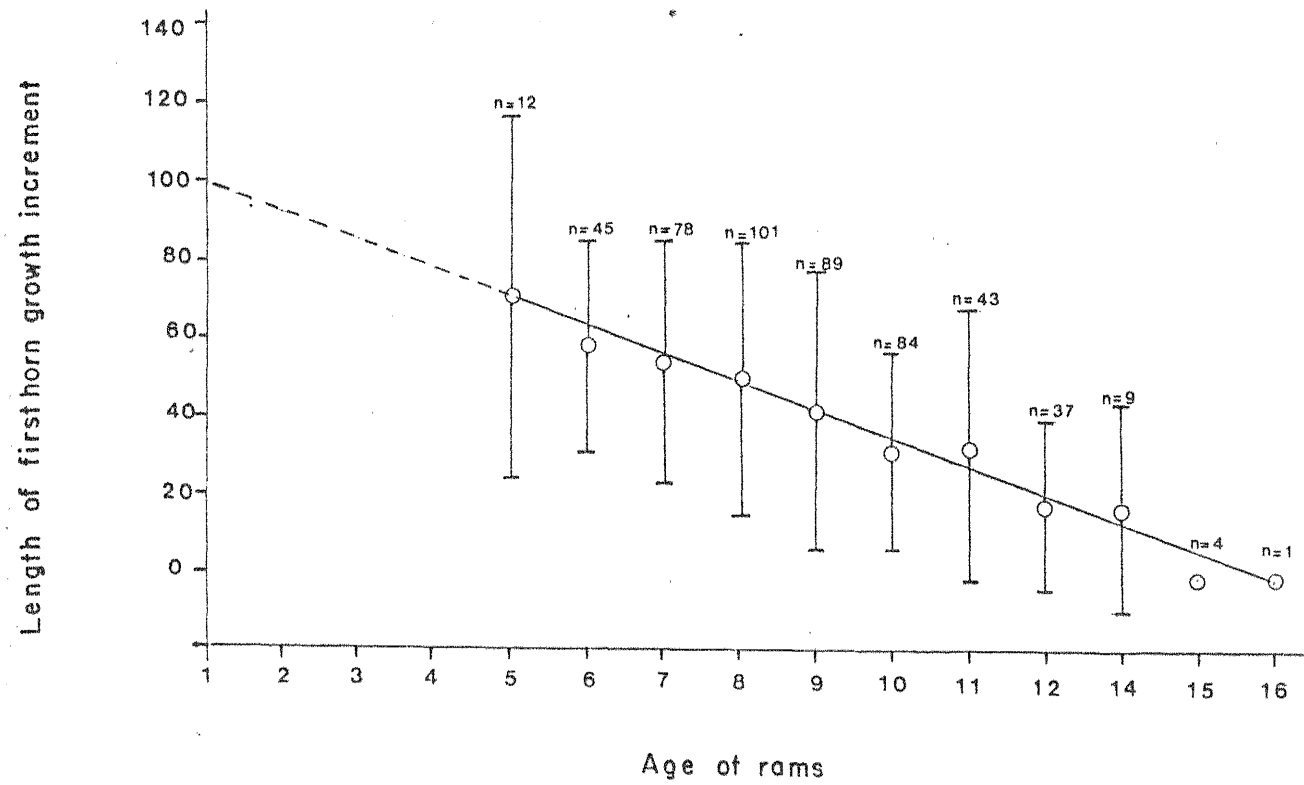
The second method consisted of the inspection of hunter-killed rams. For this analysis, 502 horns of rams taken in the southwestern Yukon since 1973 could be used. In Fig. 4, the lengths of the first horn growth increments, the lamb tips, are plotted against the age of the rams. No rams were available younger than five years, since 3/4 curl horn growth in these populations reached in the 6th growing season. The correlation appears to be linear, and extrapolation to the first year reveals that horn growth in the lamb year will be about 100 mm. Most rams were shot in the 9 to 10 year age class, at which time the remaining lamb tip averages 40 mm in length, 5 rams reaching ages of 14 and 15 years, had no lamb tips left.

Hemming (1969) made similar observations in Alaskan Dall sheep. He writes, "The horn tips of Dall sheep are rarely broomed, but they may show considerable wear on animals more than 5 years old. In some cases, the first year's growth may be almost completely worn away, but the first annual ring was not visible in only 13 of 47 specimens in the 5 to 17 year age classes".

This wearing down of the horn tip has management implications:

1. It may result in an underestimation of the ram's age by one year. Our experience in the Yukon has shown, that this problem is particularly important in old rams, in which very little of

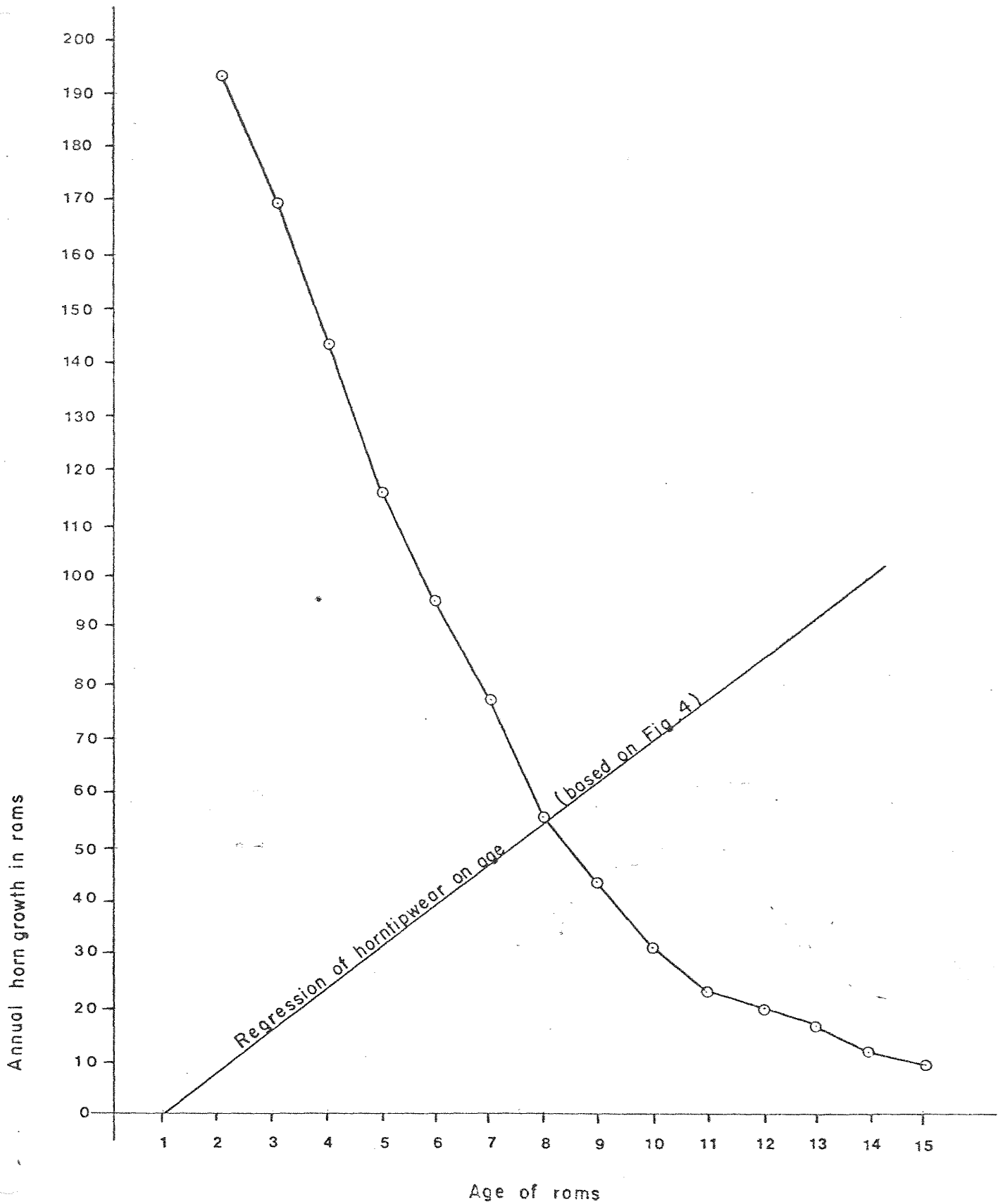
Fig. 4 Wear of lamb horn growth with age of hunter-killed rams



the lamb horn growth remains. Inexperienced trophy evaluators are inclined to demonstrate the existence of a first annulus, and if such is not obvious, the second annulus is mistaken for it, which leads to an underestimation of the ram's age. This horn wear reduced not only the length of the lamb growth, but it also polishes the horn's surface, making it even more difficult to detect the interphase between the first and second growth increments.

2. This horn tip wear effects trophy quality, since horn length is used in computing scores according to Boone and Crocket standards. In Fig. 5, we have shown the mean horn growth rate per year for rams in the southwestern Yukon and we have superimposed on this horn growth curve the regression line of horn tip wear on age, obtained from Fig. 4. This wear rate exceeds new growth put on at the base of the horns after the 8th year. The implications are, that in intensely hunted populations, where all legal rams are removed annually, no improvement of horn length with age should be expected on the average, if rams live longer than 9 years. In many remote Dall sheep populations in the Yukon and the N. W. T., hunting pressure is less severe and only 50 to 70% of the legal rams are removed annually. Under these circumstances hunters can still select the best trophies, those rams with above average horn growth rates and below average horn tip wear, and an increase in horn length with age could still be documented to the 10th and 11th years.

Fig.5 Horn growth rates of Dall rams in S.W. Yukon



Interesting, is the observation that this age of 8, at which horn tip wear begins to exceed new growth, was also observed in the European Mouflon sheep, a species with otherwise different horn morphology and growth dynamics. (Hoefs, 1982, Hromas, 1979).

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