ANTLER GROWTH IN DEER 168

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Antlers are bony outgrowths from the skull and are found in most members of the deer family, the Cervidae. They are not to be confused with horns; horns consist mainly of keratin filaments surrounding a bony core and do not regrow if amputated. In contrast, antlers are formed as a living tissue, regrow if amputated, are normally replaced annually and except for reindeer and caribou they are carried only by males. The antler is formed as an appendage of the pedicle, the pedicle being a bony projection of the frontal bone. The pedicle normally develops during the stag's first year of life and thereafter is permanent in contrast to the antler which is cast and replaced.

There have been a number of enquiries about the effect of pedicle removal on subsequent antler growth and for this reason, an Appendix covering this topic has been added to this paper. Those readers requiring a more detailed knowledge of antlers are referred to the paper by Chapman (1975).

The Antler Cycle

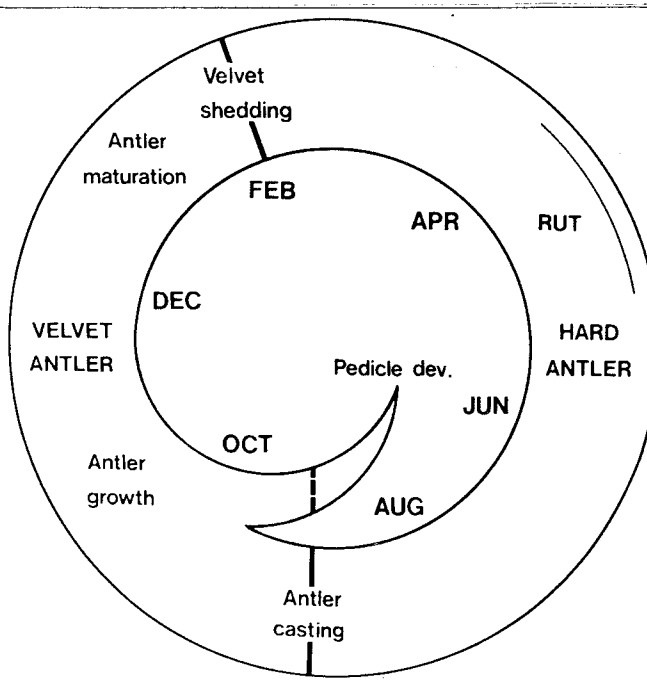

Figure 1: Outline of the antler cycle in red deer.

The growth cycle of the antler is shown in Figure 1. Usually the pedicle first becomes prominent at about 6-10 months of age. The growth of the pedicle and the first (spike) antler is essentially a continuous process except in those deer in which the pedicle is initiated in the autumn (i.e. at 3-5 months of age). After attaining full size, the antler undergoes internal maturation and is converted to bone. After the antler hardens, the blood supply to the velvet dries up, and the velvet is shed in about February so that the stag is in the hard antler for the rut. In the following spring, the tissue around the pedicle swells, the old antlers are cast and the pedicle heals over initiating the new antler growth.

The antler cycle is associated with the sexual cycle of the stag. Velvet stripping occurs as the testosterone concentration rises and the casting of the antler in the spring is generally associated with a low concentration of testosterone. Much of the understanding of the antler cycle has come from studies of the effects of castration and the administration of high rates of testosterone which are outlined below.

Castration of stags:

before puberty	-	prevents pedicle development and subsequent antler growth;
in velvet antler	-	antler remains in velvet and continues growth;
in hard antler	-	antlers are cast - new antlers grow and remain in velvet.

High rates of testosterone given to entire stags:

in velvet antler	-	inhibit antler growth and promote velvet shedding;
in hard antler	-	inhibit casting of the old antlers;
after antler casting	-	inhibit pedicle healing and regrowth of the antlers.

However, the control of antler growth is not simply affected by the sex hormones. Rather it seems as though the sex hormones exert a permissive effect on the cycle, e.g. high levels of circulating testosterone or oestradiol will inhibit antler casting. Clearly local factors are also important. For example, in work with 11 month old stags in November we amputated one antler above the coronet after the antlers had stopped or almost stopped growing. Following this amputation the antler healed over and a branched antler regrew. The important point in terms of the understanding of the cycle is that all of the new antler growth took place after the growth of the spike antler had stopped.

Velvet Antler Production

There are three possible approaches to increasing velvet antler growth and yields:

a. To increase the length of the growth season and so to increase the likelihood of a good second cut, although the value of second cut velvet, which is usually very calcified, is in doubt;

b. To increase the daily rate of antler growth between casting and the appropriate time of harvest;

c. By genetic means, selecting for velvet antler yield, assuming that the heritability is high enough to render selection effective.

The absolute limits of the antler growth season are set by the dates of hard antler casting and velvet shedding. It seems unlikely that the date of velvet shedding can be influenced except by lighting or hormonal manipulation (including castration) although the date of casting may be more easily manipulated (e.g. by nutrition). There is clearly an association between casting date and velvet antler yield in that older stags cast their old antlers earlier and produce higher yields of A grade velvet antler at the first cut. There is also some evidence that within an age group, stags which cast their old antlers earlier tend to produce higher yields of velvet antler. They also tend to be the heavier stags within the group while the time from casting to harvest also tends to be slightly longer.

The apparent relationship between casting date and velvet antler yield resulted in trials on four farms in 1979. On each farm, three groups, each of about 15 stags, were fed either - hay only, hay and ad libitum nuts, hay and ½ ad libitum nuts, in late winter (starting in late June - early July). A summary of the results is given in Table 1.

Table 1: Means for casting date, velvet antler yield and days from casting to harvest.[1]

Farm	Treatment[2]	Casting Date	Velvet Antler (kg)	Days to Harvest
A	Hay	8 Oct.	1.22	51
	Hay, ½ nuts	29 Sep.	1.38	54
	H, nuts	25 Sep.	1.46	54
B	Hay	29 Sep.	1.37	54
	H, ½ nuts	21 Sep.	1.61	57
	H, nuts	16 Sep.	1.73	56
C	Hay	17 Sep.	1.77	68
	H, ½ nuts	9 Sep.	1.94	64
	H, nuts	9 Sep.	1.77	66
D	Hay	20 Sep.	2.28	70
	H, ½ nuts	21 Sep.	2.17	70
	H, nuts	15 Sep.	2.30	69

[1] Trial conducted by Invermay and Animal Science Department, Lincoln College.
[2] The deer nuts contained 46% barley, 35% lucerne meal, 15% linseed meal plus 4% minerals and vitamins. The average ad libitum intakes of nuts ranged from 2.1 to 2.9 kg/head/day.

The mean yield over the four properties ranged from 1.36 to 2.25 kg of velvet antler. This variation could be a function of many factors, including body size, age, nutrition during the period of antler growth, the level of culling within the herd and genetic factors. The period of velvet antler growth (casting to harvest) also differed between properties. This probably means

that the antlers were being harvested at different morphological stages on different properties and highlights the need for some means of objective definition of the stage of antler growth at harvest. There were differences between properties in both casting date and velvet antler yield. The level of nutrition had a significant effect on casting date but not on velvet antler yield. In both cases the interactions failed to attain significance although there was some suggestion that the level of nutrition may have had some effect on the yield of velvet antler on the two properties on which the mean yield for the hay only group was low. On these properties the advancement in the date of casting was associated with an increased yield of velvet antler. In summary, it would appear that the relationship between casting date and velvet antler yield is not causative but rather that the level of late winter nutrition may influence casting date independent of its effect on velvet antler yield.

At this stage very little is known of the effects of nutrition during the antler growth period on velvet antler yield. During the last season, there have been trials investigating the feeding of high protein diets to two year old stags but the treatments were without effect on velvet antler yield. The desirability of the early casting induced by good winter nutrition is frequently questioned. At the time of casting in early spring often pasture supply is limited and the stag's voluntary intake is only just starting to increase so that it is possible that the supply of nutrients available for antler growth is limited. However, at this stage no information is available on this very important question.

The heritability of velvet antler yield or even antler size is not known. However, some strains of red deer are known to have larger antlers than others. Generally within an unculled group of stags of the same age, the heavier stags will tend to have larger antlers. At the present time many farmers are selecting their breeding stags on the basis of velvet antler yield, body size and temperament; on the basis of available information, this is a sound approach.

An understanding of the pattern of growth of the antler should enable harvesting at the appropriate stage to maximise yields of A grade velvet antler. The timing of events for a group of three year old stags at Invermay is shown below (note: this pattern may not apply to two year olds since many stags in this group do not develop full heads). The values are means:

Pedicle swelling	Day - 7
Casting	0
Brow bud	16
Bez bud	30
Trez bud	44
Harvest ("maximum" bulbing)	66

Information collected from farmers has revealed that some are mistaking the trez bud for bulbing of the royals and so harvesting the antler at much below its potential. This observed pattern has important implications for the management of velvetting stags. Stags can be sorted into groups based on casting date and left for about seven weeks without the necessity of having to run them through yards, thus reducing the opportunity for velvet damage.

Although some exceptional stags give very high yields of velvet antler average yields are much lower. An indication of good average yields is given in Table 2. The Invermay data are from stags in a recent trial, while the other data are from two large herds, one in Southland and one in Canterbury. The coefficient of variation of velvet antler yield within an age group within a herd is about 20%. Therefore culling the poorest one-tenth of producers can be expected to increase the average yield by about 4% whereas culling the lowest one-third would increase the average yield by about 10%.

Table 2: Average yields of velvet antler (kg) for deer on three properties.

	Invermay (1980)		Canterbury (1979)	Southland (1979)
2	1.0	(55)[1]	1.2	1.0
3	1.6	(65)	1.5	1.6
4	1.7	(65)	1.9	2.0
5	2.1	(66)	-	2.4
Mature	-	-	-	2.4

[1]Days from casting to harvest

Reference

Chapman, D. I. 1965: Mammal Review 5: 121-172.

APPENDIX

Pedicles and Antler Growth

Pedicles are the developments of the frontal bone of deer. The pedicle appears to be essential for antler growth in that if the pedicle is prevented from developing (as by castration) no antlers are produced.

In most species of deer the pedicles normally develop in the first year of life. From work performed at Invermay it is known that in red deer the time of pedicle initiation is strongly influenced by the level of nutrition. Pedicle initiation appears to be associated with a testosterone surge. In this respect castration*prior to pedicle initiation inhibits pedicle development; oestrogen administration to male deer arrests pedicle development while pedicles can be induced in females of many deer species by testosterone treatment (Goss, 1968, 1969; Jaczewski, 1976; Wislocki et al, 1947).

There has been some work investigating the effects of pedicle removal on subsequent pedicle development and antler growth. Goss et al (1964) working on five white-tailed deer fawns (Odocoileus virginianus) performed two types of surgery using one side of the skull as a control and operating on the other side, namely:

a. excision of the skin from the presumptive pedicle region, and
b. removal of the osseous primordium of the pedicle (i.e. the elevation of the frontal bone) with or without the overlying skin.

With (a) the development of the pedicle and the subsequent antler were slightly retarded compared with the control side, while with (b) the development of the pedicle was completely arrested. However, Jaczewski (1961, 1967) has performed a number of different experiments mainly on red but also on fallow deer. In one set of experiments he chiselled the pedicle from red stag calves: he stated "it may be presumed that the stimulation or the checking of regeneration depends on the extent to which the skull is damage. It is probable that slight damage stimulates growth, greater damage partly checks it, and still greater damage checks it altogether" (Jaczewski, 1961).

The previous paragraph summarises the work on young animals performed before the pedicle has fully developed. However, if the pedicle of moose, red, roe or sika deer is allowed to develop normally but then removed so that nothing but the lamina interna of the frontal bone is left, an antler will still form, although this may not occur until the year following the operation. Regeneration of the pedicle does not appear to take place, although this has not been confirmed histologically (Bubenik & Pavlansky, 1956, 1965; Goss, 1961; Jaczewski, 1954, 1955, 1956, 1958 all cited by Chapman, 1975).

Clearly the effect of surgical removal of the pedicle is not clearcut and could depend on the severity of the surgery performed, the stage of pedicle growth and the species of deer.

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*Castration reduces the rate of liveweight gain and also results in a fatter carcass (Drew et al, 1978).

There have been some studies on the hormonal inhibition of antler growth. The work of Goss using oestrogen on male sika deer has already been cited. Both oestrogen and testosterone administration will inhibit casting of the hard antler (Goss, 1968); so too will the growth promoter, Ralgro, if given at the appropriate time (unpublished Invermay work).

Elastrator rings have been used on the growing antler to constrict blood flow and prevent antler growth (Mautz, 1977; C. T. Robbins, pers com). Robbins (pers comm) injected calcium chloride solution either subcutaneously or periosteally throughout the antlerogenic region of the skull of young Wapiti in attempts to inhibit antler growth. The sizes of the necrotic lesions formed were dependent on the dose rates of calcium chloride; in those cases where the necrosis was very severe it appears that antler growth was prevented, but at lower doses antler growth was stimulated.

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