Antler Growth and Shedding in a Captive Group of Fallow Deer (*Dama dama*) in New Zealand.

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Abstract

A twenty year record of observations on velvet and antler shedding in a captive herd of fallow deer is recorded. Evidence is submitted to explain the delay in velvet shedding in mature fallow deer on the basis of differences in the growth patterns existing between mature fallow bucks and males of eight other species. Two complete lifetime sets of antlers were recorded, and attempts made to correlate the changes in yearly growth with varying environmental conditions. The tendency of the right antler to out-produce the left antler is shown to be characteristic not only of the two animals from which lifetime sets were available, but from the local population from which they came

FOR most species of deer, males start the growth of antlers from a pedicel on each frontal bone in late spring or early summer. The velvet, a true skin which supplies the growing antler with nutrient material, is shed in the fall and normally takes only a day or so to peel off. Antlers remain hard until they are cast after the period of the rut, which normally occurs in late fall or early winter

Although records of velvet and antler shedding have been observed and recorded for many species of deer, little attempt has been made to compare patterns of velvet and of antler shedding between several species, and opportunities are extremely rare for measuring lifetime sets of antlers such as are here described.

The following notes include data supplied by Mr. A. H. Caines, who, since 1913, has kept a herd of fallow deer on his station at Upokongaro, near Wanganui, North Island I, fortunately, had opportunity to weigh and measure his sets of collected antlers, and to have access to records which were kept by him between 1928 and 1948.

In this twenty year period, an average of 13 deer were kept in a twelve acre paddock next to the Caines residence Grass in this paddock is rye (*Lolium sp.*), crested dogs' tail (*Cynosurus cristatus*), cocksfoot (*Dactylis glomerata*), Yorkshire fog (*Holcus lanatus*) and paspalum (*Paspalum sp.*). The soil consists of a top layer of dark grey sandy loam about four inches deep with a deep layer of light yellow to white pumice sands and gravels beneath.

Grateful acknowledgment is made not only to Mr Caines but to A. Douglas, C. Taylor and V Stout (Wildlife Division) for assistance with collection of data; to V. Stout and C. Hale (Dominion Museum) for assisting in the preparation of illustrations, and to the Applied Mathematics Laboratory, D.S.I.R., for help with statistical analyses. I am indebted to Professor Richardson and S Watson for critical reading of the manuscript.

ANTLER SHEDDING.

Antlers were shed in October and November; 81% of the 94 antler shedding records were between October 13 and November 6 (see Fig. 1). Over this twenty year period, earliest and latest dates for antler shedding were October 11 (1942) and November 20 (1931), a difference of 41 days. Time between earliest and latest shedding dates for a given season averaged 10 days (min. 0, max. 29).

The individual buck normally shed both antlers on the same day. In thirty (64%) of the 47 recorded observations the antlers were shed together or within a few hours. The remaining seventeen records extend to four days between the times the first and second antler was shed.

In each of the five years for which comparable figures are available, yearlings shed their antlers later than older deer. This characteristic has been described for several kinds of deer. The following species are cited as examples Fallow deer (*Dama dama*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), (Whitehead, 1950); mule deer, *Odocoileus hemionus* (DIXON, 1934); moose, *Alces americana* (Seton, 1927) and Japanese deer, *Cervus nippon* (Mitsui, 1949)

That the heavier antlers should be shed earlier seems understandable by considering what is known of the nature of the shedding process. A short time before the antler is shed, the bone on the outer end of the pedicel becomes softened, the blood supply to this area greatly increases, and granulation tissue begins to be formed which loosens the connection between the dead antler and the pedicel (Hamilton, 1939) The antler then falls off due to its own weight by shaking or accidental contact with a tree or other object

Wislocki (1943) ascribes the cause of antler shedding to normal diminution of the testicular hormone after the rutting season

RELATION BETWEEN AGE AND THE START OF ANTLER GROWTH

According to Mr Caines, old fallow bucks start growing their antlers from two to three weeks sooner than the young males Wislocki and others have observed that for several species of deer the more sexually mature and vigorous the animal, the earlier in a given season the antlers begin to grow (Wislocki, 1943).

Thus, it appears that fallow deer are similar to other deer in that mature males start antler growth sooner, and shed their antlers before the younger males.

VELVET SHEDDING

Fallow bucks shed their velvet, in this Wanganui herd, in the latter half of February (83% between February 15 and 28), see Fig. 1. Earliest and latest dates were January 23 (1934) and March 4 (1942) respectively; a maximum year to year variation of forty-one days. Time between first and last velvet shedding records for a single year averaged 5 4 days (min 9, max 32). The date recorded for shedding velvet was the day the buck commenced shedding Mr Caines observed that on nearly every occasion, within 24 hours only small bits of velvet remain, usually close to the base of the antler

In fallow deer, velvet is shed first in the younger deer; later in the older deer, a sequence converse to that occurring in most other deer

In the only three years that four yearlings in the Caines herd could be compared with older deer, velvet was shed first in the younger deer. A complete

record was kept of one deer (buck 2) and Table I shows his antler and velvet shedding dates from 1936 to 1942, when he died. In this buck, while the velvet was being shed later each year, the antlers were shed progressively earlier.

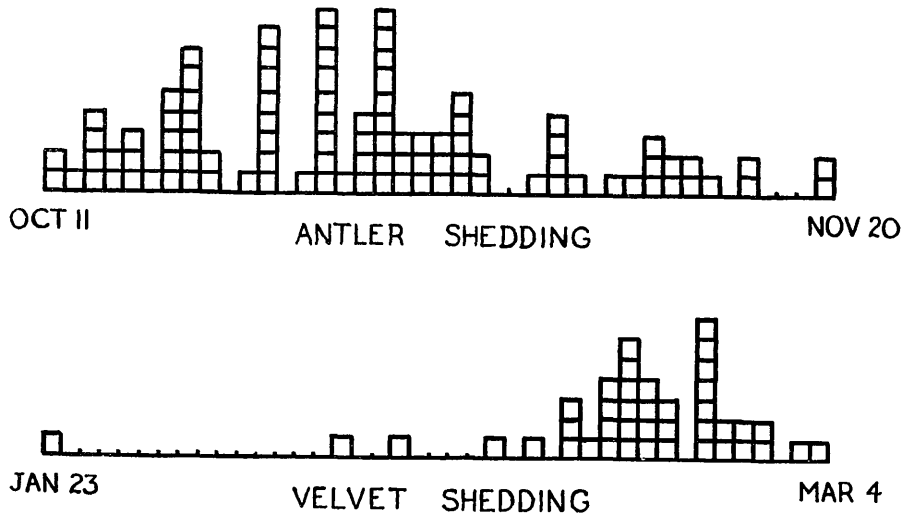

FIGURE 1.—Period of antler shedding and velvet shedding in the Caines Fallow Deer Herd. Each square represents one record.

TABLE I

Velvet and Antler Shedding Dates for Buck No. 2.

Year	Age	Date Velvet Shed	Date Antlers Shed
1936	1	—	Nov. 13
1937	2	Feb. 19	Nov. 11
1938	3	Feb. 21	Nov. 11, Nov. 12
1939	4	Feb. 21	Oct. 22, Oct. 25
1940	5	Feb. 22	Oct. 18, Oct. 22
1941	6	Feb. 26	Oct. 27
1942	7	Feb. 26	Oct. 17, died Dec. 23

The Duke of Bedford has observed of his park fallow deer that not only do yearlings shed their velvet first, but that there is a general tendency for all bucks in a herd to clean in order of youthfulness " two-year-olds, three-year-olds, four-year-olds, and the old bucks last (Whitehead, 1950)."

In most other deer the velvet is shed sooner in the mature deer, a pattern that conforms to the start of the antler growth and the shedding of the antlers. Mature deer shedding velvet earlier than young deer is recorded for Virginia deer by Wislocki (1943), for mule deer by Leopold et al. (1951) and for most English park deer by Whitehead (1950).

Thus fallow deer present a clear exception to the normal pattern of velvet shedding.

For all species of deer velvet is normally dried and shed only after the antlers reach full size, after the tips become completely calcified and after the blood supply to the velvet is gradually closed off. Whitehead (1950) has suggested

that the tendency for velvet to be shed later, as the fallow buck grows older, may simply be due to the fact that it takes a larger antler longer to grow than a smaller one. But this does not explain the difference between fallow deer and other deer.

It is here suggested that the difference in pattern of velvet shedding in fallow deer can be explained on the basis of the differences in the growth pattern that exists between mature and young fallow bucks compared with mature and young males of other species.

In any species, the first set of antlers produced tends to consist of two simple spikes with but small hint of the branches and tines that are elaborated from the central beam in later years. If a volumetric measure were taken between the lower and upper half of an individual antler, it would be approximately 1:1 or less than 1 for most species, including the fallow deer. Inspection of the second set of antlers produced by Buck 1 shows that this ratio even in immature fallow deer, is not much change from the original 1:1 or less than 1 ratio (see Fig 2). However, as the male matures the ratio between lower and upper antler halves tends to assume a ratio characteristic for the species concerned.

TABLE II.
Showing Volumetric Ratios Between Lower and Upper Halves of Individual Antlers.

Species	Number of Antlers	Ratio Lower	Ratio Upper
Fallow deer (mature)	3	1	2.00
Mule deer (mature)	1	1	1.30
	2	1	1.00
	1	1	0.75
Virginia deer (mature)	2	1	1.00
Moose (mature)	1	1	1.10
	1	1	1.00
Red deer (mature)	3	1	1 00
Sika deer (immature)	2	1	1.00
(mature)	1	1	0.70
	2	1	0.50
Axis deer (mature)	2	1	0.70
	2	1	0.60
Ceylon sambar (mature)	1	1	1.00
	2	1	0.70
	2	1	0.40
Javan rusa (immature)	2	1	0.60
(mature)	1	1	0 50
	1	1	0.40

To test the differences in volumetric ratios between lower and upper halves of mature antlers of various species, all specimens available in the Dominion Museum (Wellington, New Zealand) were measured by recording water displaced by immersing the antlers in a graduated drum. The halfway point was determined by bisecting the total length. Table II lists ratios between lower and upper halves of individual antlers for the various species.

On a volumetric basis, the upper half of most antlers other than fallow deer was either approximately equal to or less than the volume of the lower half of the antler. The volumes of the upper halves of the three fallow buck antlers measured, on the other hand, were twice as great as the volumes of their corre-

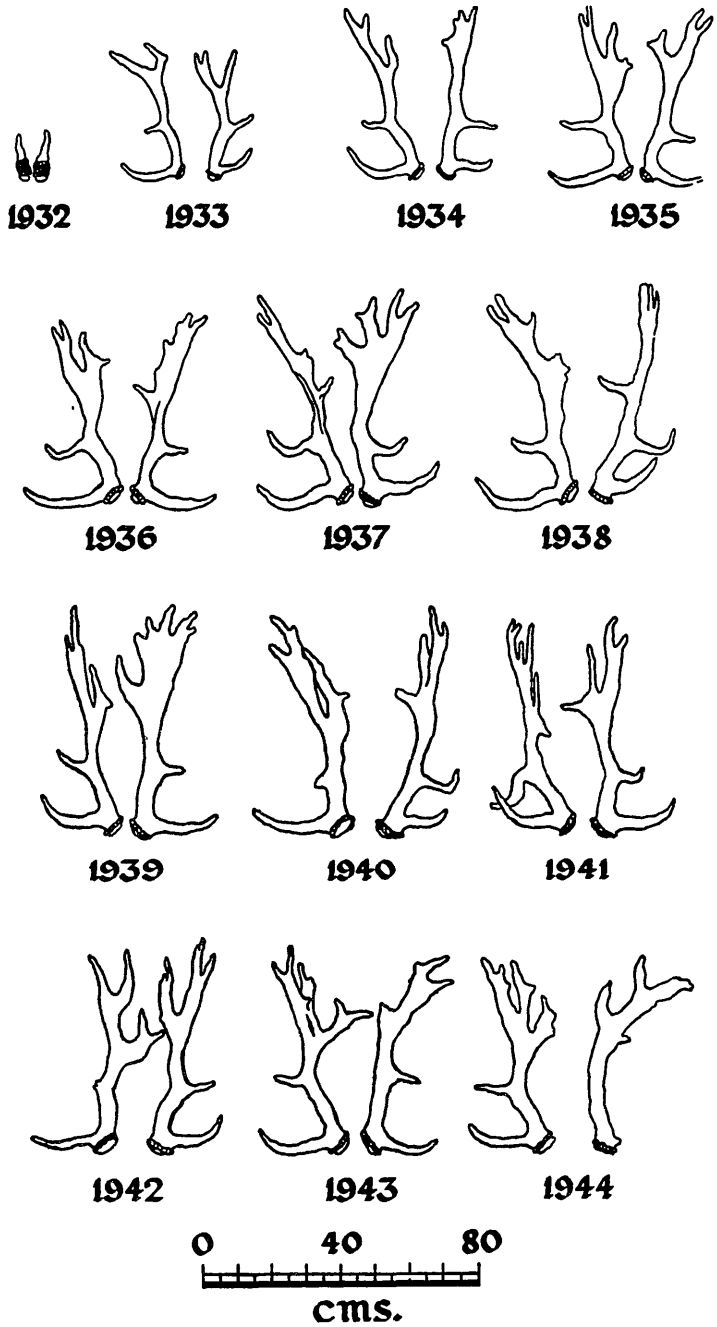

FIGURE 2.—Drawings from photographs, showing all sets of antlers produced by Buck 1.

sponding lower halves. Mature fallow deer antlers are, so to speak, top-heavy when compared with other mature deer measured. This proportionally greater amount of antler produced in the latter part of the growing season may explain the delay in velvet shedding in mature fallow bucks, as compared with velvet shedding in mature males of other species so tested.

ANTLER PRODUCTION.

Values recording yearly changes in antlers were taken as follows: beam diameter, widest diameter one inch above brow tine; antler length, from base of pedicel to tip of antler measured along outside curve; weight in ounces using a small spring scale accurate to the nearest ounce.

Of the measurements taken, the antler weight seems the most unambiguous measure of annual antler production. For Buck 1 a decline in weight and beam diameter started after its ninth year, and in terms of antler length and number of points decline started a year earlier. Greatest number of points (16) were produced in his twelfth year Thus in this adult the size of each of the four characters differed from year to year and variations also occurred between the comparative sizes of the four variables.

Tables III and IV list measurements for two complete antler sets Both deer appeared to be producing mature heads after the sixth or seventh year Buck No. 2 died in its seventh year. Although there was a drop in antler production in its last year, this is thought to be related to a decrease in seasonal forage production. It is assumed that the animal would have exceeded its previous antler production had it continued to live

A drop of 21 and 29 per cent. in total antler weight took place between Bucks 1 and 2 respectively, between 1941 and 1942.

Wislocki (1943) quotes Schumacher, in Switzerland, as suggesting that an increase in the incidence of sunlight be regarded as the most important factor responsible for good development of antlers in roe deer Accordingly, individual antler records for Bucks 1 and 2 were checked against incidence of sunlight in the Wanganui area between October and February, the period when the antlers

TABLE III.

Antler Measurements of Fallow Buck No. 1

Year	Age	Points			Weight (oz)			Length (mm)			Beam diam (mm)		
		Lft.	Rt.	Total	Lft.	Rt.	Total	Lft	Rt	Total	Lft	Rt	Total
1932	1	1	1	2	2	2	4	133	127	260	30	30	60
1933	2	5	4	9	7	8	15	368	368	736	28	20	48
1934	3	6	5	11	15	15	50	470	476	946	33	32	65
1935	4	6	7	13	15	16	31	483	476	959	32	32	64
1936	5	7	6	13	19	19	38	496	515	1011	31	31	62
1937	6	8	6	14	29	25	54	566	586	1152	40	35	75
1938	7	8	7	15	28	30	58	578	604	1182	38	42	80
1939	8	8	7	15	31	31	62	630	630	1260	40	43	83
1940	9	7	7	14	32	34	66	598	624	1222	41	43	84
1941	10	6	8	14	28	35	63	598	598	1196	39	39	78
1942	11	5	6	11	22	23	45	560	591	1151	32	35	67
1943	12	7	9	16	23	28	51	578	534	1112	35	40	75
1944	13	5	8	13	17	25	42	540	540	1080	29	35	64
Total	13	79	81	160	268	291	559	6598	6669	13267	448	457	905

TABLE IV.
Antler Measurements of Fallow Buck No 2

Year	Age	Points			Weight (oz.)			Length (mm)			Beam diam (mm)		
		Lft	Rt.	Total	Lft.	Rt.	Total	Lft.	Rt.	Total	Lft	Rt	Total
1936	1	1	1	2	1	2	3	120	115	235	16	16	32
1937	2	4	4	8	7	7	14	370	375	745	25	25	50
1938	3	5	6	11	12	13	25	435	455	890	25	25	50
1939	4	5	6	11	17	17	34	495	465	960	27	25	52
1940	5	5	8	13	19	23	42	475	565	1040	27	29	56
1941	6	6	9	15	26	26	52	605	575	1180	30	31	61
1942	7	5	8	13	18	23	41	520	545	1065	29	31	60
Total	7	31	42	73	100	111	211	3020	3095	6115	179	182	361

were growing, and against total annual hours of sunlight. No correlation was apparent between incidence of sunlight and antler development. In fact, for the two years (1941–1942) in which the greatest change in antler production was observed for both bucks, incidence of sunlight was approximately the same. Temperature and rainfall were also considered in the same way as sunlight and again there was no apparent correlation A decrease in antler weight of 29% and 3% was recorded in Buck 1 for the years 1941 and 1942. However, precipitation in these two years increased in 1941 (27%) and decreased in 1942 (29%).

The lack of correlation of antler growth with hours of sunlight, inches of rainfall, or temperature does not necessarily mean these factors are unimportant. Other factors, such as variation in the number of deer in the paddock, or top dressing operations might have such a profound effect on antler production as to mask the effect of the environmental factors tested. Furthermore, weather records may not represent actual conditions in the vicinity of the Caines paddock

Two hand fed bucks kept between 1923 and 1941 in the same Caines paddock differed in the extent to which they were able to produce antlers. One buck went on growing a better pair each year regardless of top dressing and became the " boss of the herd ". Under the same conditions, the other buck kept on growing a poor set with little or no increase in antler weight. Being hand-fed, and in a rather restricted area, this difference in dominance may in itself have accounted for the difference in antler production

It is Mr. Caines' opinion that in markedly drier years, which have resulted in less vigorous pasture growth, the deer produce smaller heads It has long been recognized that certain critical elements of the diet, especially calcium and phosphoric acid (Whitehead, 1950) constitute one important factor in determining the annual amount of antler production in deer However, this factor is usually described in general terms as abundance or scarcity of food (Anthony, 1929, Caton, 1877; Seton, 1909, Wislocki, 1943)

DIFFERENCES BETWEEN RIGHT AND LEFT ANTLER PRODUCTION.

Both of the deer, for whom complete records were kept, grew heavier antlers from their right pedicel than from their left In Buck No. 1, for example, the right pedicel produced a total of 23 (9%) more ounces than did the left pedicel. Total number of points was about the same for each antler, being only two greater in the right than in the left antler,

Twenty-nine other local antler sets were examined to compare right and left antler production in this area. These heads were roughly classified as follows:—

	Number
Right antler clearly larger than left	17
Antlers approximately even	10
Left antler clearly larger than right	2
Total	29

Allocating the ten evenly, between left and right antler groups, the right antler proves to be significantly higher than the left.

The tendency to produce larger right antlers appears to be a definite feature of this particular local population. But the mechanism which results in greater over-all production in the right antlers is still unknown.

For Buck No. 1, with respect to antler beam diameter and weight, this tendency showed up in the seventh year. Total points were consistently more numerous in the right antler only for the last four years of its life. On the other hand, with respect to antler length, the tendency was strongest between its fifth and eleventh years.

Similarly values tended to be consistently higher in the right antler of Buck No. 2 than in the left one. But the year by year pattern was different, and did not correspond with the development of Buck No. 1 at a comparable age For example, points were consistently higher on the right than on the left antler from the third year on in Buck No. 2, while this tendency did not show up for No. 1 until its ninth year. For both deer, once they became adult, there was a greater tendency for the characteristics of weight, beam diameter, and number

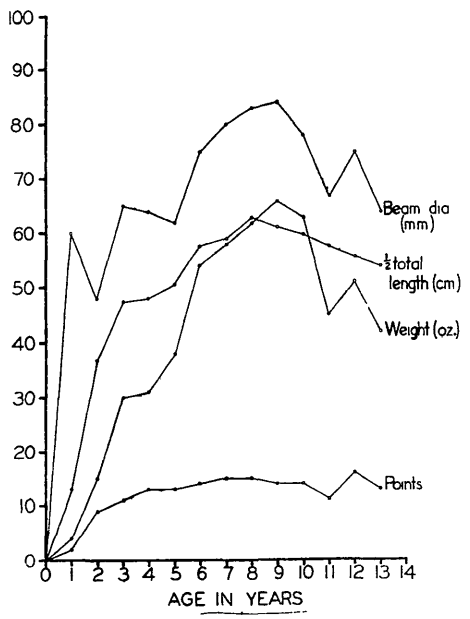

FIGURE 3.—Showing yearly changes in antler characters for Buck 1

of points to be consistently greater in the right antler than was true for the antler length.

From the standpoint of consistency between right and left antler measurements, length was the most erratic character measured in both bucks in their adult years. However, when values for right and left antlers are combined, length seems less subject to annual fluctuation than any of the other measurements taken. See Fig. 3.

Although the length of right and left antlers alternated, one being higher than the other for both bucks, on a year by year basis, the right antler was not always the highest of the two. No correlation is present between the antler sets for both deer of the same age (Fig. 4). When these bucks of different ages were compared, in the same year, differences in length between right and left antlers followed the same pattern for the six years that they could be compared, in spite of the fact that this involved reversals in height between right and left antlers in some years. The correlation coefficient of ·725 is approaching, but under the 5 per cent. significance level.

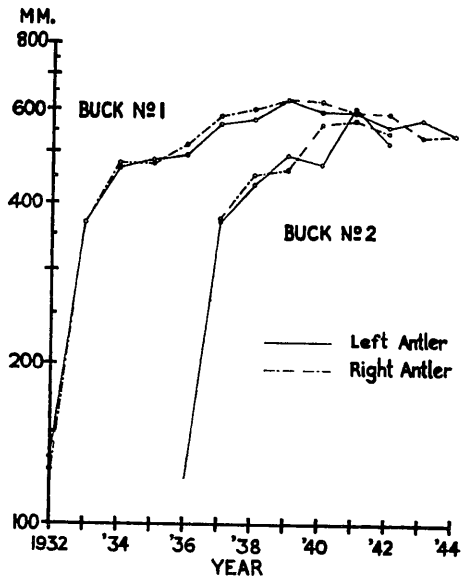

FIGURE 4.—Shows changes in length of right and left antlers for Bucks 1 and 2

SUMMARY

Records on a small captive herd averaging 13 deer for a 20-year period show a maximum variation of over a month between first and last velvet and antler shedding dates.

In fallow deer, velvet is shed first in the younger deer; later in older deer, a sequence converse to that occurring in most other deer. It was suggested that the difference in pattern of velvet shedding in fallow deer, compared with other deer, can be explained on the basis of the differences in growth patterns that exist between young and mature fallow bucks compared with young and mature males of other species. Sets of antlers were measured on a volumetric basis to

obtain ratios between lower and upper halves of antlers and for various species to test the above hypothesis. Ratios of lower to upper halves of antlers in fallow deer measured 1:2 and for eight other species of deer similarly tested, ratios ranged between 1:1·30 and 1:·40.

Yearly changes in antlers were recorded for two bucks for which lifetime sets of antlers were available. Negative results were obtained when attempts were made to correlate antler production with hours of sunlight, temperature or precipitation.

The right antler was shown to develop greater than the left, not only for the two complete antler sets described but for a small series of heads collected in the vicinity of the captive herd. For the two complete antler sets, this tendency showed up at different ages and in varying degrees and for one of the values, antler length, reversals in height were observed between right and left antlers in the same years.

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