

Relationships between Rutting Behaviour and Non-annual Incisor Dentine Layers of Male Sika Deer — A Hypothesis

ZACHOWANIE RUJOWE A NIECYKLICZNE ODKŁADANIE SIĘ WARSTW DENTYNY
W SIEKACZACH SAMCÓW JELENI SIKA — HIPOTEZA

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In a previous study a comparison was made between methods of age determination in male sika deer. The number of cement layers in the first molar and the number of secondary dentine layers in histological sections of the first incisor were assessed. In only 10.34 per cent were the numbers of layers in the incisor and the molar equal. A hypothesis is put forward that the mentioned differences in the numbers of layers are caused by social activity of the male during rutting season. Presumably the highest ranking males having the lowest number of surplus layers. Some indirect data are presented to support the hypothesis.

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In a previous study a comparison was made between methods of age determination in male sika deer (*Cervus nippon* Temminck, 1938). The number of cement layers in the first molar and the number of secondary dentine layers in histological sections of the first incisor were assessed. In agreement with findings of other authors (Morris, 1972) the values generated by these methods were different in many cases. In only 3 out of 29 instances were the numbers of layers in the incisor and the molar equal. In 14 cases the number of dentine layers in the incisor was double the number of cement layers in the molar, in 10 cases the number of dentine layers was 3 times the number of cement layers and in 2 cases the number of dentine layers was 4 times the number of cement layers (Bartoš *et al.*, 1984). Photographs of these subjects are included in the paper by Bartoš *et al.* (1984).

In several cervid species, authors have reported more cement layers than usual for that age of animal. Additional layers are usually referred to as "surplus" layers and have been recorded in mule deer (*Odocoileus hemionus*) (Low & Cowan, 1963), red deer (*Cervus elaphus*) (Mitchell, 1967), white-tailed deer (*O. virginianus*) (Sauer, 1973 cited by Gasaway *et al.*, 1978; Rice, 1980), and reindeer (*Rangifer tarandus*) (Reimers &

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Nordby, 1968; Leader-Williams, 1979). The origin of these surplus layers has not been fully explained yet. Some authors (eg. Mitchell, 1967; Reimers & Nordby, 1968, etc.) refer to these layers as "rut" layers, suggesting a connection between their production and the sharp annual increase in social activity in deer.

Klevezal (1973) postulated that dentine and/or cement layers are formed in teeth and bones during periods of fasting, reduced food intake or low quality forage intake during adverse climatic conditions which results in a reduction in growth rate.

Active rutting behaviour in a male deer leads usually to physical exhaustion and hence a decrease in physical condition (Gibson & Guinness, 1980). Presumably the more subordinate male sika deer is less likely to actively participate in the rut and therefore remain in better physical condition. However, the annual changes in physical condition in deer which occur during autumn and winter are a complex phenomenon influenced by hormonal and nutritional state (Kay, 1979). This paper aims to explain the formation of surplus dentine layers.

Ashby & Henry (1979) found in roe deer (*Capreolus capreolus*) that the formation of cement layers during winter begins earlier in incisors than in molars. If this is true also for incisor dentine and for other cervid species, one could assume that rutting activity in European sika deer which occur in mid/late autumn (Bartoš & Žirovnický, 1982) would correlate with the beginning of formation of winter dentine layers. A hypothesis is put forward that in sika deer the reduced food intake and/or hormonal changes induced by rutting activity may be manifested by winter dentine layer formation. If rutting is over before winter dentine formation begins, summer dentine growth may continue if sufficient food is available leading to additional growth in incisor teeth. This is in accordance with Reimers & Nordby (1968) who suggested surplus "rut" cement layers in reindeer coming from areas of abundant vegetation but not in reindeer from less suitable areas.

As in red deer (Pollock, 1975) probably also in sika deer the seasonal elevation in testosterone level followed by rutting activity may be accompanied by a lower food intake. High ranking males show a greater increase in testosterone level (Brain, 1980; Bartoš, 1980) which may lead to an even lower food intake (Pollock, 1975). Silberberg & Silberberg (1971) reported high testosterone levels had an inhibitory influence on bone tissue growth in humans and a similar effect was found in white-tailed deer (Brown *et al.*, 1978). Thus presumably the formation of winter dentine layers may be triggered by high testosterone levels and rutting activity in high ranking males and may be maintained until normal restricted winter feeding conditions appears. In subordinate animals winter dentine formation may begin with the onset of rutting too. The reduction of testosterone after social suppression by the more dominant animals, however, may remove the inhibitory effect on bone tissue growth and growth of the previous summer dentine layers may continue. Subordinate stags usually wander between different rutting stands (Yevtushevskiy, 1974) and therefore the level of "social stress" in these animals may fluctuate significantly several times during a short period of time. The consequent hormonal changes may be reflected

in an irregular pattern of dentine formation. Presumably, the most subordinate males may have the highest number of surplus incisor layers while high ranking males should show a reduction in the formation of surplus dentine layers as their rank increases.

To test the hypothesis, indirect data were used as behavioural records were unavailable. Three areas of study were considered (1) It has been recorded in red deer that social rank increases with age in stags (Appleby, 1980; Bartoš & Hyánek, 1982a). One would predict a negative correlation between the proportion of surplus incisor dentine layers and age in male sika deer if the hypothesis is true. (2) In cervids, age and body size are usually correlated with social rank (Clutton-Brock *et al.*, 1979; Suttie, 1980). One would also predict a negative correlation between surplus incisor dentine layers and body weight. (3) In red deer stags, a close relationship has been found between social position during the velvet period and length, weight and number of points on a growing antler (Bartoš & Hyánek, 1982a). A negative correlation between proportion of surplus incisor dentine layers and the length, weight, and number of points on an antler would support this hypothesis. However, since antler weight is not obtainable directly as the trophy includes the skull of the animal, the "antler weight index" (AWI) which showed close correlation with antler weight in red deer (unpublished obs.) was used.

Male sika deer shot between 1 September and 30 December during the period 1976—1980 in the region of West Bohemia, Czechoslovakia, were used for the study. Carcasses were weighted and antlers measured. Analysis involved 29 specimens. The following measurements were taken: a) Length of main beam (from coronet to the farthest tine); b) Number of antler points; c) AWI value was calculated using the formula

$$AWI = \frac{\text{length of main beam} \times (\text{average circumference of beam})^2}{4 \pi}$$

Here the average circumference of the beam was the arithmetic mean of the lower circumference (measured between the brow and the trez tine) and the upper circumference (measured between the trez tine and the terminal fork). In all cases, the value used in the analysis was an average for both antlers.

The age of each subject was estimated by counting the cement layers according to the modified method used by Mitchell (1963; 1967) and described in Bartoš *et al.* (1984). The preparation method for histological sections of incisors are also described in the parallel study (Bartoš *et al.*, 1984). The proportion of surplus incisor dentine layers was calculated using the formula:

$$\text{Proportion of dentine to cement layers (\%)} = \frac{\text{Number of incisor dentine layers}}{\text{Number of molar cement layers}} \times 100$$

1) A significant negative correlation was found between the proportion of incisor dentine layers to molar cement layers and age ($r = -0.67$, $P < 0.001$). 2) A significant negative correlation was found between the proportion of incisor dentine layers to molar cement layers and body weight ($r = -0.37$, $P < 0.05$). 3) A significant negative cor-

relation was found between the proportion of incisor dentine to molar cement layers and the AWI ($r = -0.53$, $P < 0.01$) and antler length ($r = -0.37$, $P < 0.05$). But a non-significant correlation was found between the number of antler points and proportion of incisor dentine layers to molar cement layers ($r = -0.13$, NS).

The results support the hypothesis in four out of five cases. The failure to find a significant correlation between the number of antler points and proportion of surplus dentine to cement layers may be true only in sika deer. The male sika deer develop only 4 points on each antler in both Europe (Bartoš & Žirovnický, 1981) and their native land, Japan (Imaizumi, 1970; Whitehead, 1972) by the age of three or four years. In this study 75.7 per cent of the subjects has 4 points. Hence no relationship would occur between the number of points, rutting activity and number of surplus incisor dentine layers. The results of correlation between antler characteristics and surplus dentine layers may be influenced by the fact that antler size during the rut is only a rough estimate of potential dominance. As in red deer (Bartoš & Hyánek, 1982b) rank success and antler size during the rut in sika deer depend on many ethological and environmental factors.

The results confirm the advanced hypothesis and lead one to conclude that the greater the amount of social activity a male sika deer participates in, the lower the number of surplus incisor dentine layers. The formation of seasonal cement rest lines in cervids of temperate latitude may begin in January or February (Ashby & Henry, 1979; Mitchel, 1963; 1967) after the end of rutting season. The formation of rut cement lines in molar teeth would therefore be less than in dentine of incisors.

The formation of dentine/cement layers is influenced by several factors (e.g. food, climate, etc.), rutting may be only one of many influences which affects the correlation of the number of layers and age. In cases where annual layers are missing (e.g. Lowe, 1967) the rut has probably minimal influence on dentine/cement formation.

This study should be regarded as tentative. Further investigation should involve the study of nutritional, hormonal and social factors and their times of action, in isolation and combined, on formation of annual layers in incisors and molars.

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