Bone. 2007 Jan;40(1):230-5. Epub 2006 Sep 1.

Body weight, early growth and antler size influence antler bone mineral composition of Iberian red deer (Cervus elaphus hispanicus).

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Source

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Abstract

Researchers have devoted little attention to the possibility that the chemical composition of bone might be variable under normal nutrition conditions. This study assessed antler bone composition of 25 one-year old deer (spikes). Antler content of ash, Ca, P, K, Na, Mg, Fe and Zn was assessed in base and tine, and the mean composition or the difference in composition between tine and base was used to explain variability in antler length, weight and perimeter. In turn, mean composition and difference in concentration of each mineral were related to body measures at 1 year of age, weight at birth, weight at 1 year of age and weight gains during lactation, or between weaning and year of age. Chemical composition differed between base and tine in ash, Ca, P, K, Zn and Fe, but not in Na or Mg. Composition explained a mean variability of 77% in antler length and weight. Body weight and size, in turn, influenced mineral composition. The greatest body effect was that of gains during lactation on principal components analysis factor related to Ca, P and other major minerals such as Na, K or Mg. Antler bone composition is variable in normal conditions and such variability may play a role in biomechanical properties of the antler, but it is also likely to show the nutritional status or physiological effort to grow antlers. Assessing bone composition may emerge as a new useful tool to obtain information regarding bone biology and its bearer in other species including ours.

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Bone. 2007 Apr;40(4):1095-102. Epub 2007 Jan 18.

Does chemical composition of antler bone reflect the physiological effort made to grow it?

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Source

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Abstract

In a previous study, antler bone chemical composition was found to differ between base and tip. If such variation is in part due to the physiological effort made to grow the antler, composition trends should differ between antlers from deer population differing in mineral or food availability, or body reserves. To assess this, we examined cortical thickness and bone composition along the antler shaft, and compared trends between antlers from two populations: captive, well-fed, health-managed deer (n=15), and free-ranging deer with lower food quality and no health treatment (n=10). Significant and clear divergent trends supporting greater physiological exhaustion in free-ranging deer and high or moderate predictive models were found for cortical thickness (R(2)=61.8%), content of Na (R(2)=68.6%), Mg (R(2)=56.3%), K (R(2)=40.0%), and Zn (34.6%); lower predictive power was found for protein (R(2)=25.6%) and ash content (R(2)=19.5%); and poor predictive power was found for Ca (R(2)=4.3%), Fe (R(2)=11.1%), and Si (R(2)=4.7%). A second part of the study assessed similar antler structures grown at the beginning (brow tine) and end (top tine) of antler growth within captive deer. Greater cortical thickness and ash content was found for brow tine, as well as a smaller protein, K and Mg content. In contrast, no difference was found for Ca, Na, Zn, Fe or Si. The results suggest that thickness and mineral composition reflect the physiological effort made to build antler bone.

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Bone. 2007 Nov;41(5):794-803. Epub 2007 Jul 25.

Influence of physiological effort of growth and chemical composition on antler bone mechanical properties.

Landete-Castillejos T, Currey JD, Estevez JA, Gaspar-López E, Garcia A, Gallego L.

Source

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Abstract

Antler is a good model to study bone biology both because it is accessible and because it grows and is shed every year. Previous studies have shown that chemical composition changes as the antler is grown, implying constraints in mineral availability and the physiological effort made to grow it. This study aimed at examining antler mechanical properties to assess whether they reflect physiological effort and whether they are associated with precise mineral bone composition rather than just ash content, which is usually the main factor affecting mechanical properties. We examined Young's modulus of elasticity (E), strength, and work to maximum load, as well as bone mineral composition, along the antler shaft. Then we compared trends between antlers from two populations: captive, well-fed, health-managed deer (n=15), and free-ranging deer with lower food quality and no health treatment (n=10). Greater E, strength and work were found for better fed and health managed deer. In addition, antler chemical composition of both populations differed in Na, Mg, K, Fe and Si, and marginally in Zn, but not in ash or Ca content. Significant and clear divergent trends in mechanical properties supporting greater physiological exhaustion in free-ranging deer were found for all mechanical variables. Detailed models showed that, in addition to ash content, independent factors extracted from principal component analyses on composition affected E and strength, but not work to maximum load. The results suggest that there is an association between bone chemical composition and mechanical properties independently of ash content.

PMID: 17822969 [PubMed - indexed for MEDLINE]

Bone. 2010 Oct;47(4):815-25. doi: 10.1016/j.bone.2010.07.021. Epub 2010 Jul 27.

Do drastic weather effects on diet influence changes in chemical composition, mechanical properties and structure in deer antlers?

Landete-Castillejos T, Currey JD, Estevez JA, Fierro Y, Calatayud A, Ceacero F, Garcia AJ, Gallego L.

Source

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Abstract

We attempted to determine why after an exceptionally hard winter deer antlers fractured more often than usual. We assessed mechanical properties, structural variables and mineral composition of deer antlers grown in a game estate (LM) after freezing temperatures (late winter frosts, LWF), which resulted in high incidence of antler fractures despite being grown later in the year, and those grown after a standard winter (SW). Within each year, specimens from broken and intact antlers were assessed. LWF was associated with reduced impact energy (U) and somewhat reduced work to peak force (W), Young's modulus (E) and physical density, as well as cortical thickness. LWF was associated with considerably increased Si and reduced Na. In each year, broken antlers had lower Mn, P and physical density, and they had more Na and B than unbroken antlers. Because no such effect was found in farmed deer fed whole meal, and because freezing in plants usually produces an increase in Si content, which in turn reduces Mn, it is likely that LWF produced a diet rich in Si and low in Mn. Because antlers are grown transferring calcium phosphate from the own skeleton and Ca/P levels were slightly reduced, it seems likely that Mn reduction may have increased antler fractures. A comparison between farm deer and those in another game estate (LI) also shows a link between lower Mn content and lower W. Thus, small changes in minor bone minerals, probably induced by diet, may have marked effects in mechanical properties of bone.

PMID: 20673821 [PubMed - indexed for MEDLINE]

Bone. 2012 Jan;50(1):245-54. doi: 10.1016/j.bone.2011.10.026. Epub 2011 Oct 30.

Does nutrition affect bone porosity and mineral tissue distribution in deer antlers? The relationship between histology, mechanical properties and mineral composition.

Landete-Castillejos T, Currey JD, Ceacero F, García AJ, Gallego L, Gomez S.

Source

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Abstract

It is well known that porosity has an inverse relationship with the mechanical properties of bones. We examined cortical and trabecular porosity of antlers, and mineral composition, thickness and mechanical properties in the cortical wall. Samples belonged to two deer populations: a captive population of an experimental farm having a high quality diet, and a free-ranging population feeding on plants of lower nutritive quality. As shown for minerals and mechanical properties in previous studies by our group, cortical and trabecular porosity increased from the base distally. Cortical porosity was always caused by the presence of incomplete primary osteons. Porosity increased along the length of the antler much more in deer with lower quality diet. Despite cortical porosity being inversely related to mechanical properties and positively with K, Zn and other minerals indicating physiological effort, it was these minerals and not porosity that statistically better explained variability in mechanical properties. Histochemistry showed that the reason for this is that Zn is located around incomplete osteons and also in complete osteons that were still mineralizing, whereas K is located in non-osteonal bone, which constitutes a greater proportion of bone where osteons are incompletely mineralized. This suggests that, K, Zn and other minerals indicate reduction in mechanical performance even with little porosity. If a similar process occurred in internal bones, K, Zn and other minerals in the bone may be an early indicator of decrease in mechanical properties and future osteoporosis. In conclusion, porosity is related to diet and physiological effort in deer.

Front Biosci (Elite Ed). 2012 Jun 1;4:2328-39.

A review of factors affecting antler composition and mechanics.

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Source

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Abstract

Antlers constitute the only mammal model for limb regeneration. A number of factors affect antler regeneration. In this review, we examine such factors and the potential consequences for organ regeneration. As body mineral stores are depleted to grow antlers, physiological exhaustion is shown in the mineral composition, mechanical performance and, according to preliminary studies, porosity of the antler bone material. Nutrition plays an important role in antler characteristics. Thus, antler composition can be used as a diagnostic tool to assess mineral deficiencies in deer. Studies on ecological effects of exceptional weather in plants suggest that minor minerals, particularly Mn, may play disproportionately roles in mechanical performance of bone material. This suggests that Mn (and perhaps other minerals) is essential to incorporate Ca and P from resorbed skeleton material in antlers. Apart from implications for game management, some effects may have applications for medicine.

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J Anim Ecol. 2009 Jan;78(1):42-51. doi: 10.1111/j.1365-2656.2008.01467.x. Epub 2008 Aug 22.

Access to mates in a territorial ungulate is determined by the size of a male's territory, but not by its habitat quality.

Vanpé C, Morellet N, Kjellander P, Goulard M, Liberg O, Hewison AJ.

Source

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Abstract

1. Territoriality is commonly associated with resource defence polygyny, where males are expected to gain access to females by anticipating how resources will influence female distribution and competing for resource-rich sites to establish their zone of dominance. 2. We tested this hypothesis in European roe deer (Capreolus capreolus) by simultaneously assessing the influence of resources on female distribution and the influence of female distribution on male distribution and breeding success using paternity analyses. 3. Females did not fully distribute themselves among male territories in relation to resources. As a result, relative female abundance in a male's territory depended on territory size, but not on its habitat quality. In turn, relative female abundance in a male's territory determined, at least partially, his breeding success. 4. Interestingly, male territory size, and hence access to females, was partly determined by male body mass (all males) and by residual antler size (subadults only). The latter result suggests that large antlers may be important to young males for establishing their first territory, which is then usually retained for all subsequent reproductive seasons. 5. To conclude, although territoriality of male roe deer has certainly evolved as a tactic for ensuring access to mates, our results suggest that it does not really conform to a conventional resource defence polygyny strategy, as males seem to gain no obvious benefit from defending a territory in an area of high habitat quality in terms of enhanced access to mates. 6. This may explain the stability of male territories between years, suggesting that male territoriality conforms to an 'always stay' and 'low risk-low gain' mating strategy in roe deer.

PMID: 18752539 [PubMed - indexed for MEDLINE]

Biol Trace Elem Res. 2011 Feb;139(2):168-76. doi: 10.1007/s12011-010-8655-8. Epub 2010 Mar 2.

Iodine distribution in the environment as a limiting factor for roe deer antler development.

Lehoczki R, Erdélyi K, Sonkoly K, Szemethy L, Csányi S.

Source

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Abstract

The iodine-containing hormones produced by the thyroid gland play a role in the complex neuro-hormonal regulation of antler development. The proper function of the thyroid depends on the adequate iodine supply of the organism, which is directly related to the iodine content of food and drinking water. The purpose of this study was to explore the connection between the iodine content of the water base, which has a strong correlation with the iodine concentration of environmental components available to animals, and the antler weight of roe deer (Capreolus capreolus) shot in Hungarian hunting areas. Using a general linear model, controlling for the collective effects of other environmental factors (deer population density, harvest rate, land use, and soil fertility information), the iodine content of the water base explained 51.4% of the total variance of antler weights. The results suggest that antler weights increase with increasing iodine concentration regardless of other factors; thus, the environmental iodine distribution can be a limiting factor suppressing roe deer performance assessed here as antler weight. Further experimental studies of controlled iodine uptake are needed to define the exact physiological iodine requirements of roe deer bucks.

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Ann Acad Med Stetin. 2012;58(1):71-7.

The influence of lipid compounds on the content of fluorides in antlers and cranial bones of roe deer (Capreoluscapreolus L.).

[Article in English, Polish]

Sobota S.

Source

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Abstract

INTRODUCTION:

Fluorine is a lipophilic element and for this reason lipids play a significant role in the accumulation and metabolism of fluorides in organs and bodily fluids. One of the places where interactions between fluorides and lipids can be observed are bones and antlers of deer. Even though the overall content of fluorides and lipid compounds in bones has repeatedly been analysed, we still know little about their interactions inantlers which are shed every year. The aim of this study was to determine the relation between the total content of total lipids and five most important fatty acids, linoleic acid (C 18:2 delta 9.12), oleic acid (C 18:1 delta 9), palmitic acid (C 16:0), stearic acid (C 18:0), and eicosadienoic acid (C 20:2 delta 11.14), and the content of fluorides in cranial bones and antlers of roe deer (Capreolus capreolus L.).

MATERIAL AND METHODS:

The content of fluorides in antlers and cranial bones of roe deer was measured with an ion-selective electrode, total lipids were determined with a spectrophotometric method, and fatty acids were identified with gas chromatography and an internal standard (heptadecanoic acid C 17:0).

RESULTS AND CONCLUSIONS:

The mean amount of fluorides in antlers and cranial bones was 0.0004 mg/g (SD: 0.10718) and 0.0004 mg/g (SD: 0.14988), respectively. The mean content of lipids in antlers and cranial bones was 64.63736 mg/g (SD: 17.62648) and 73.03208 mg/g (SD: 22.69000), respectively. In older animals, a tendency for fluorides to accumulate in antlers and frontal bones may be the reason why antlers appear less impressive, i.e. undergo involution.

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