VETERINARSKI ARHIV 71 (4), 187-195, 2001

Height of dental crown used to determine the age of Eneolithic large deer game

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TUŠEK, T., D. MIHELIĆ, K. BABIĆ, T. TRBOJEVIĆ-VUKIČEVIĆ: Height of dental crown used to determine the age of Eneolithic large deer game. Vet. arhiv 71, 187-195, 2001.

ABSTRACT

Abrasion of dental crown and the shape of denture occlusal surface are significant indicators in age determination of domestic mammals. The factors that significantly influence age determination of Eneolithic deer game in conditions of an open wildlife habitat are climatic changes that influenced their survival, as well as specific features of teeth morphological structure. In this paper the age of Eneolithic red deer is determined on the basis of dental crown abrasion of the third and fourth permanent premolars, and the first and third permanent molars. The obtained values for dental crown height of Eneolithic deer were compared with the values for dental crown height of the same tooth material of recent red deer whose age was clearly determined (5-7 years). Dental crown abrasion of Eneolithic deer ("Vučedol deer") is greater than the dental crown abrasion of European deer (*Cervus elaphus L.*), that is to say, the age of "Vučedol deer" is within a range of 7-10 years.

Key words: dental crown, age, "Vučedol deer", red deer

Introduction

The determination of age on the basis of dental crown abrasion and the shape of denture occlusal surface has become a widely accepted method used for domestic mammals, as the conditions of their life have been unchanged and controlled by humans, and is therefore clearly known. The

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ISSN 0372-5480
Printed in Croatia

rate and manner of the tooth abrasion process depends on the teeth (milk or permanent), kind of species, life conditions, nutrition (ELLENBERGER and BAUM, 1977; DUKES, 1975).

The methodology of age determination on the basis of the tooth material of prehistoric animals remains, mainly large deer game, is not well-known due to the specific morphological structure of teeth and seasonal conditions which concern their nutrition that directly influenced abrasion of the dental crown. The teeth of deer consist of dentine and dental cement, as well as of the so-called secondary dentine, which penetrates into the cavity of the tooth pulp and is filled according to the age of an animal. They also consist of secondary cement which forms a thick layer around the root of a tooth (SPINAGE, 1973). The mutual relationship between the thickness of secondary dentine layer and secondary cement is not a constant value, but changes depending on seasonal nutritional habits, namely the abundance of food during certain seasons (DOUGLAS, 1970). This relationship can be seen from the shape of the rings of different thickness and density, interchanging like pairs of light and dark rings, as with growth rings on a tree stump (MORRIS, 1972). By measuring the thickness of these rings, as well as determining their density on the basis of interchange of light and dark rings, the nutritional conditions of a certain season can be determined, as well as the season when the animal died (LIEBERMAN and MEADOW, 1992).

Apart from what was revealed earlier, the rings represent the tooth building material of various degrees of hardness which determine how rapidly a dental crown is worn out, depending on the food source.

We wanted to use that fact to determine the age of deer that lived in the Eneolithic period (a period in the 3rd and 4th millennia B.C.) on the steppes of the right bank of the River Danube near Vučedol, in today's Republic of Croatia.

Materials and methods

The tooth material used in this work originates from prehistoric deer, conditionally called "Vučedol deer", named from the location of its origin, an archaeological site of Vučedol, that lived in the area of today's Eastern Slavonia-Croatia, 5000 years ago, during the Eneolithic period (a period

in the 3rd and 4th millennia B.C.). The age of prehistoric deer is determined by measuring the height of the dental crown (Fig. 1) of the third and fourth permanent premolars (P_3 and P_4 – premolars), and the first and third molars (M_1 and M_3 – molars) of the lower jaw, only on the left or only on the right side, measured from the lingual side (KLEIN et al. 1981). The lower jaw teeth are chosen because they are stronger and less breakable and fragile, and the side is chosen strictly to avoid the diversity of measurements and different heights of dental crown due to a specific manner of dental crown abrasion and the shape of the denture occlusal surface, which is shaped like chisel (GILBERT and STOLT, 1970). Prehistoric dental material has been stored under the mark V-85-V- (1, 3, 5, 6, 7, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27) at the Laboratory for Archaezoology of the Veterinary Faculty, University of Zagreb.

The results of these measurements were compared with the results of similar measurements on tooth material of recent red deer (*Cervus elaphus L.*) of a clearly determined age (5-7 years).

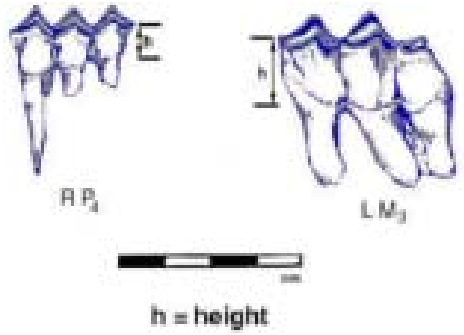

Fig. 1. Determination of dental crown height (h – dimension)

The results of measurements of dental crown height were formulated into mathematical equations to determine the age of an animal on the basis of an individual tooth:

$$Z = a \times (\text{dental crown height} \times 10) + b$$ (KLEIN et al., 1981)

Z represents the age of an animal; constant *a* represents time abrasion of tooth; constant *b* represents the potential age of an animal, given in months.

Age $P_3 = -1.04 \times (\text{dental crown height} \times 10) + 232.80$

Age $P_4 = -0.84 \times (\text{dental crown height} \times 10) + 216.28$

Age $M_1 = -0.65 \times (\text{dental crown height} \times 10) + 136.72$ and

Age $M_3 = -0.62 \times (\text{dental crown height} \times 10) + 177.63$

Results

The obtained values and mutual relationships between the dental crown of "Vučedol deer" and European red deer (*Cervus elaphus L.*) are given in Fig. 2.

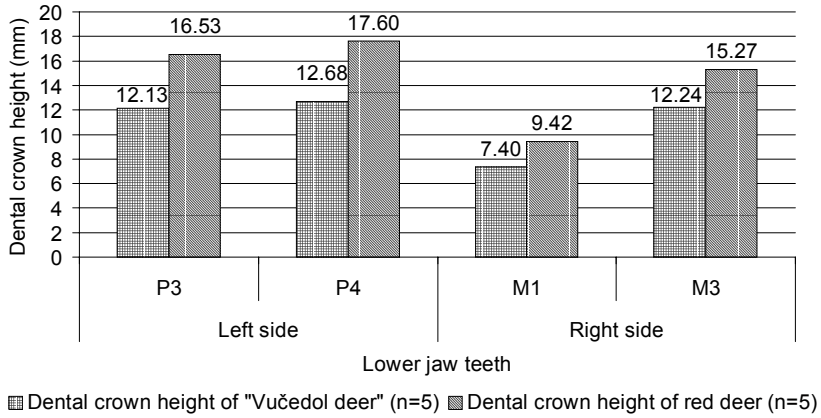

Fig. 2. Relationship of dental crown height used to determine age of deer

On the basis of the values obtained by measuring dental crown, the approximate age structure was calculated for the red deer found on the Vučedol location from the Eneolithic period (a period in the 3rd and 4th millennia B.C.).

The results obtained by measuring the height for dental crown P_3 indicate an average age value of 107 months, while the average value of dental crown P_4 indicates an average age value of 110 months. The average value of height for dental crown M_1 indicates an average age value of 89 months, while the average value of height for dental crown M_3 resembles an average age value of 102 months (Fig. 3).

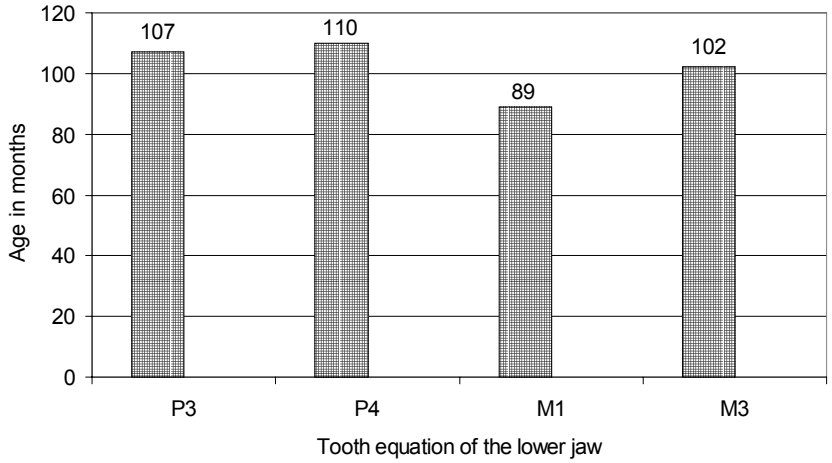

Fig. 3. Age categories of "Vučedol deer" calculated on the basis of dental crown height
P_3 – third premolar, P_4 – fourth premolar, M_1 – first molar, M_3 – third molar

The obtained average values for dental crown height for premolars and molars were compared with the dental crown height of recent European red deer (*Cervus elaphus L.*) of a known age. On the basis of the obtained measurements of heights for dental crown of premolars (P_3 and P_4) and molars (M_1 and M_3) the age structure was determined within a range of 89 and 110 months, namely an age from 7 to 10 years (Fig. 3).

Discussion

According to nutritional habits, PUTMAN (1988) put the Euroasian red deer (of the New World) within an intermediary group of red deer with

selective adaptability to sources of food. This selective adaptability to the food sources of a red deer can be seen from the abrasion of teeth and the shape of denture occlusal surfaces, in particular the molars of the lower and upper jaws. Therefore, DUKES (1975) emphasises that extensive chewing is needed for hard, solid fodder, and this is the reason for movement of the lower jaw left and right, in order to grind food between the molars. The specific structure of the upper jaw, which is wider than the lower in herbivores, is the reason for food chewing on one side only. As a result the denture occlusal surface of the molars has the appearance of a chisel, with the sharp edge of the molars situated on the lingual side, and of upper molars on the facial side of the tooth. The specific structure of the teeth contributes to the shape of the denture occlusal surface. The denture occlusal surface consists of the materials of various degrees of solidity, so grinding efficiency is increased due to the uneven abrasion of tooth material (O'BRIEN, 1994).

The soil stratigraphy and the botanical composition depending on climatic conditions are elements that interweave and geologically indicate the Vučedol site as a loess plateau bordered by fault systems. The Vučedol environment is built of typical (Eolic) loess permeated by relict pedological layers (BOGNAR, 1994). The whole area is included in the sub-boreal layer of the Holocene period, when there was a slight temperature decrease, although the period was still warm and dry. GALOVIĆ and MUTIĆ (1984) point out that the area of Vučedol site in the geological sub-boreal period, which, according to the archaeological classification, comprises the Eneolithic period, denotes as Chernozems forest-steppe soil with an expressed water component. PÉCSI (1993) emphasises that the steppe and humus soils appeared during the interstadial or humid sections of glacial periods. A steppe soil of the Chernozems type appears in arid to semi-arid climatic conditions, and the botanical composition of the grassy steppe (ŠKORIĆ, 1990). ŠPOLJAR (1999) according to the new FAO classification, also includes today's Vučedol environment on the Croatian pedological map in steppe soil of the Chernozems type.

ROBERTS (1994) mentions that the plant association of the Vučedol site in the Eneolithic period consists of grassy steppe. Grasses of these steppes differ from today's grasses on the same site in a higher presence of pulp.

This difference in the pulp content shows the arid and semi-arid climate conditions of the Eneolithic period. Similar differences in pulp content can be found in today's grasses, depending on the vegetation stage, i.e. young grasses have a small amount of pulp, while it increases after blooming (ŠOŠTARIĆ-PISAČIĆ and KOVAČEVIĆ, 1968).

Increased pulp content has no significant influence on the wearing out of "Vučedol deer" teeth, if we take into account the fact that a ruminant soaks a plant mass in the stomach for easier crushing between molar teeth during rumination, and has a micropopulation in the stomach which decomposes pulp for its host. In this way, the vegetable cover of this geographical site requires the same mechanical wearing out of a dental crown during the crushing of food between the molar teeth of Eneolithic deer and of today's allied species.

DURMAN (1988) mentions that in waste pits for the houses of Vučedol inhabitants, the bones of domestic animals were mostly found, and that cattle grazed on the Vučedol site steppe.

"Vučedol deer" grazed in these steppes on the right bank of the River Danube. As Vučedol people were mainly cattle-breeders, their needs for animal proteins were satisfied by the cattle they bred, and to a lesser extent by hunted animals. This explains the greater abrasion of the dental crown of the lower jaw of "Vučedol deer", namely its significant age. The age of "Vučedol deer" on the steppes near the Danube was within a range of seven to ten years. The presence of man, (the Vučedol people) was probably the reason why "Vučedol deer" had no natural enemies on the steppes near the Danube, which further influenced its life expectancy. Abrasion of the dental crown of today's American and European red deer is not so pronounced and it is the result of modern hunting management - the killing of animals for certain reasons, either because they are unsuitable for breeding on hunting grounds, or for obtaining valuable trophies.

Conclusions

The stratigraphy and vegetable cover of the Vučedol site and climatic conditions determined the life conditions and food habits of "the Vučedol deer" in the Eneolithic period.

The more pronounced wearing out of dental crowns on the lower jaw of Eneolithic deer is the result of its habitat and indicates a longer life span, ranging from 7 to 10 years.

The less pronounced wearing out of dental crowns of today's deer indicates a life span of 5-7 years and is the result of human activity, i.e. planned hunting within the hunting economy.

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Received: 19 July 2000
Accepted: 21 August 2001

TUŠEK, T., D. MIHELIĆ, K. BABIĆ, T. TRBOJEVIĆ-VUKIČEVIĆ: Primjena visina zubnih kruna u određivanju životne dobi jelenske divljači eneolitika. Vet. arhiv 71, 187-195, 2001.

SAŽETAK

Istrošenost zubne krune i oblik grizne površine značajni su pokazatelji za utvrđivanje životne dobi domaćih sisavaca. Ti pokazatelji znatno utječu na utvrđivanje životne dobi jelenske divljači koja je živjela u razdoblju eneolitika u uvjetima otvorenog staništa divljine i bila podložna klimatskim promjenama koje su određivale uvjete preživljavanja i specifičnost morfološke građe zubiju. U radu je utvrđena životna dob eneolitičkog jelena običnog na osnovi istrošenosti zubnih kruna trećeg i četvrtog stalnog pretkutnjaka, te stalnog prvog i trećeg kutnjaka. Dobivene vrijednosti visina zubnih kruna eneolitičkog jelena običnog uspoređene su s vrijednostima visina zubnih kruna istog zubnog materijala recentnog jelena običnog točno utvrđene životne dobi (5 do 7 godina). Istrošenost zubnih kruna u eneolitičkog jelena (»vučedolskog jelena«) veća je od istrošenosti zubnih kruna u europskog jelena običnog, odnosno životna dob »vučedolskog jelena« kreće se u rasponu od 7 do 10 godina.

Ključne riječi: zubna kruna, životna dob, »vučedolski jelen«, jelen obični