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SOME HISTOLOGICAL CHARACTERISTICS OF THE FAT DORMICE INCISORS IN THE GORSKI KOTAR AREA (CROATIA)

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The fat dormouse (*Glis glis*) is an indigenous game species of Croatia, especially in the area called Gorski Kotar. Morphological and histological characteristics of teeth are determined by both genetic and functional factors but investigations of dormice teeth are extremely rare in the recent literature. Thirty dormice, collected from May to the end of October 2001, in the areas known as Mrkopalj and Delnice, both in the Gorski Kotar, were used to examine some physical and histological characteristics of the incisors. Jaws were separated from the skull, marked and stored in formalin, and then embedded in methylmetachrylat. We then made thin slices on which we measured histological characteristics of the enamel and dentine. The enamel of the incisors is built up in two layers. The basis of the enamel structure is enamel prisms, which differ in their course, direction and inclination, thus giving a striped appearance (diazone and parazone). Our results indicate that the enamel is thicker in the lower than in the upper incisors of these dormice. In the upper incisors the enamel is thickest in the medial layer of the crown, while in the lower incisors it is thickest in the cervical portion of the crown. The results of this study point to some statistically important values in comparison to statements in the literature.

Key words: fat dormouse, incisors, enamel

INTRODUCTION

Fat dormouse (*Glis glis*) is a member of rodent group (*Rodentia*), and member of the Dormouse family Muscardinidae (ANDRAŠIĆ 1979, FORENBACHER 2002). According to the shape of the skull, to the morphology of the masticator muscles and the histological structure of their teeth we divide rodents into three subgroups (*Sciuromorpha*, *Myomorpha* and *Hystricomorpha*), of which the *Myomorpha* includes the dormice (HILLSON 1986). The masticatory system which plays an important role in the process of feeding and other activities in the life of dormice has been inadequately studied, which inspired us to investigate some structural characteristics of the dormice's teeth and to compare the results with data in the literature. The main feature of the masticatory system of each species is that the order of the teeth is determined by genetic factors, as is whether they belong to a specific

group, but the details are also undoubtedly the consequence of adjustment to life style, especially to their nutrition. On rodent incisors enamel is located only on the outer surface of the teeth (HILLSON 1986). The enamel is of different thickness on particular parts of the crown, and on particular categories of teeth, but there are also some individual differences or, to be precise, some differences between particular species (KORVEKONTIO 1934). The enamel gradually becomes thinner towards the neck of the tooth, and the density decreases to the enamel-dentine junction. The enamel is built out of millions of enamel prisms, which are bounded by the prism's integument/membrane (OSBORN 1973) and its colour depends on its thickness, density and the level of mineralization. Under the light-microscope it can be seen that the enamel is built of many thin strings bounded by the prism membranes and separated by inter-prism areas, which spread from the enamel-dentine junction to the surface of the enamel. Intermittent dark and light zones (dia and parazone) are formed in the enamel caused by the course of the enamel prisms, but also because of various enamel sections. Dentine in the dry specimens of teeth, under the light-microscope, shows many tubules which spread from the periphery of the pulp to the junction with the enamel and in living teeth consists of odontoblastical extensiors. With this study we tried to establish some physical and histological features of the teeth of the fat dormice, which live in our geographical area.

METHODS

The sample consisted of 30 fat dormice (20 females and 10 males) caught in the area of Gorski Kotar (localities: Mrkopalj, Delnice, Gerovo and Crni Lug) from the beginning of May until August 2001, especially for this investigation. As soon as they were caught the dormice were weighed and measured; these parameters were then written on labels and the specimens were frozen. The areas of forest from which the dormice were collected are mostly of natural composition; just a small area containing planted trees. The lower jaws were separated from the skulls with a cut through the jaw-joint. The incisors of the upper jaw and attached alveolar bone were separated from the rest by cutting the upper jaws just in front of the pre-molar teeth with a diamond drill of the Kavo estetic 1024 turbo machine, at 1500 revolutions per second. All samples were labelled and stored in 5% formalin. While preparing the samples for the light-microscope they were embedded into methacrylat using Varidur 10 powder (dibenzoilperoxid) and Varidur liquid (tetrahyrofurfuryl-2 methacrylat). Some 15 minutes after embedding the samples were ready for cutting and the cuts were made with an Isomet 1000 (Buehler), cutting machine at 175–200 revolutions per second. The slices we obtained were 0.7 mm thick, and they were examined, measured and recorded under a light-microscope, Olympus BH-2 at magnifications of 40, 100 and 200 times. The samples were measured with objectives of 10× and 40× magnification. The enamel thickness was measured in the cervical, medial and incisal parts of the tooth crown. In the dentine we measured the dentine thickness in the incisal third, that is above the roof of the pulp chamber. After that we measured the dentine thickness in the middle

third of the crown on the vestibulary part of the chamber, and also on the same part of the crown at the oral part. The results were analysed using SPSS for Windows 6.1.

RESULTS

Histological parameters were measured on the upper and lower incisors of the 30 *Glis*, which varied in length from 15.4 (Delnice) to 29.7 cm (Gerovo). The average body length was 18.15 (± 2.61) cm. Body mass varied between 84 g (Crni Lug) and 154 g (Delnice) with an average value of 114.833 (± 16.36) g. Statistical data of the dormice captured (body weight and body length without tale) are given in Table 1 as are the statistical data derived from values of enamel thickness of their upper and lower incisors in 3 different places (neck, middle and incisal part of teeth). The thickness of enamel in the cervical portion of the upper teeth ranged from 36.5 to 40.7 μm, with a mean value of 38.18 (± 1.19) μm but in the lower teeth ranged from 41.4 to 55.41 μm, with a mean of 43.95 (±2.85) μm. The enamel thickness in the medial part of the tooth crown in the upper teeth ranged from 37.0 to 40.8 μm, the mean value being 38.59 (±1.25) μm and in the lower teeth ranged from 41.0 to 51.8 μm; mean 44.48 (±2.51) μm. The thickness of enamel in the incisal edge of the upper teeth ranged from 40.7 to 35.0 μm, with a mean of 38.63 (±2.86), while in the lower teeth the range was from 41.0 to 52.5 μm, with a mean of 45.0 (±2.86) μm. Student-Fischer (t) test showed statistically significant difference between enamel thickness in all three examined areas of teeth among dormice from the localities of Mrkopalj and Delnice, e.g. neck area ($t = 2.06$; $p < 0.05$), midsection ($t = 2.44$; $p < 0.05$) and biting edge ($t = 2.43$; $p < 0.05$).

Table 1. Statistical data derived from parameters about captured fat dormice and enamel thickness. Legend: U = upper incisor, L = lower incisor, Max. = maximal value, Min. = minimal value, Mean = average value, SD = standard deviation

Statistical data	Body length whitout tale (cm)	Body mass (g)	Enamel thickness in the neck area (μm)	Enamel thickness in the midsection (μm)	Enamel thickness in the area of biting edge (μm)
Max.	29.7	154	U 40.70	U 40.80	U 40.70
			L 55.50	L 51.80	L 52.50
Min.	15.4	84	U 36.50	U 37.00	U 35.00
			L 41.10	L 41.00	L 41.00
Mean	18.15	114.83	U 38.18	U 38.59	U 38.63
			L 43.95	L 44.48	L 45.06
SD	2.61	16.36	U 1.19	U 1.25	U 1.32
			L 2.85	L 2.51	L 2.86

Table 2 presents the statistical data derived from the dentine thickness in the incisal third of both the upper and lower incisors, and on the oral and vestibular part of the tooth pulp. Dentine thickness on the incisal third of the upper incisors ranged from 1.545 to 1.750 mm, with a mean of 1.665 (±0.05) mm while in the same region of the lower incisors values ranged from 1.540 to 1.700 mm and the mean was 1.635 (±0.04) mm. Dentine thickness on the vestibular part of the tooth chamber ranged from 0.490 to 0.723 mm on the upper incisors. The mean value was 0.620 (±0.07) mm. Dentine thickness on the same part of the lower incisors ranged from 0.530 to 0.770 mm, with a mean of 0.663 (±0.05) mm. On the oral part of the tooth chamber, dentine thickness ranged from 0.525 to 0.765 mm for the upper incisors. The mean was 0.654 (±0.07) mm. On the same part of the lower incisors the dentine thickness ranged from 0.560 to 0.790 mm, while the mean was 0.666 (±0.05 mm).

DISCUSSION

Histological parameters of the upper and lower incisors, including both dentine and enamel were measured in a sample of 30 fat dormice (*Glis glis*). The configuration of the teeth in these dormice is that on each half of the jaw there is one incisor separated from the premolar and molar teeth by a large diastema. This type of tooth configuration gives a special shape to the jaw and folds of the upper lips in which the soft parts subside into the diastema separating the incisors from the rest of the mouth cavity, and is thought to be a self – protection system for gnawing (HILLSON 1986).

Table 2. Statistical data derived from dentine thickness values of upper (U) and lower (L) incisors (mm). Legend: Max. = maximal value, Min. = minimal value, Mean = average value, SD = standard deviation

Statistical data	Dentine thickness in the incisal third of the incisors	Dentine thickness in the vestibular part of the pulp chamber (midsection)	Dentine thickness in the oral part of the pulp chamber (midsection)
Max.	U 1.750	U 0.723	U 0.765
	L 1.700	L 0.770	L 0.790
Min.	U 1.545	U 0.490	U 0.525
	L 1.540	L 0.530	L 0.560
Mean	U 1.665	U 0.620	U 0.654
	L 1.635	L 0.663	L 0.666
SD	U 0.050	U 0.070	U 0.070
	L0.04	L0.05	L0.05

Continual sharpening and gnawing of the incisors ensures that they have a constant length. In the process, the upper incisors stick to what has been bitten and hold it while the dormouse gnaws with the lower incisors. Because of their position on the lower jaw, which is the only movable bone of the head, the lower incisors, with their constant movement caused by opening and closing the mouth, and moving the lower jaw forward and backward, can chop, that is to gnaw, the food (HILLSON 1986). Based on their different roles, the upper and the lower incisors leave different marks, and that is why the characteristic marks of rodents' teeth are double channels (HILLSON 1986).

There is enamel on the incisors of a fat dormouse only on the vestibular side and up to the biting edge. This is understandable when it is known that enamel is in fact a dead tissue without possibility of renovation, and these incisors are constantly growing. The role of permanent growth and attrition is assumed by the dentine, which forms the biting edge. Average enamel thickness of upper incisors in the fat dormice of the Gorski Kotar area is 38.46 μm, while the greatest average thickness was observed in the biting edge area. These values deviate by +2.46 μm from those given in the literature (KORVEKONTIO 1934). Our results concerning the enamel thickness in dormice shows that it is slightly thicker in the lower than in the upper incisors (55.5 μm vs. 40.8 μm) and this too is in conformity with their functional differences. The fact is, that the animal gnaws with the lower incisors, so that their enamel layer is undergoing constant attrition (therefore needs to be thicker), whereas the upper incisors serve only to hold the bite. The layer of enamel in the upper incisors is thickest in the medial portion of the dental crown and is more or less equally thick in the cervical part and the incisal edge (40.8–37.0 μm vs. 40.7–35.0 μm). In the lower incisors the thickest layer of enamel is found in the cervical portion (55.5–41.4 μm), followed by the incisal edge region (52.5–41.0 μm), and then in the medial part of the dental crown (51.8–41.0 μm). This is commonly considered to be the result of the gnawing function, since constant attrition leads to greater wear on the enamel at the incisal edge and the medial third than in the cervical portion. From all this we could conclude that enamel thickness primarily depends on genetics but some of the differences certainly depend on habitat and feeding conditions. T-test supports this statement, showing statistically significant difference in the enamel thickness between dormice from the localities of Mrkopalj and Delnice.

Dentine thickness on both upper and lower incisors was slightly greater on the oral part of the teeth which suggests a compensatory mechanism (function and dispersion of the odontoblasts on the side protected by the enamel and on the gnawing side) because that dentine layer which is exposed to constant attrition remains at the same thickness as that protected by enamel.

Data about the structural properties of teeth in rodents, dormice in particular, are rather scarce and hence the incentive to undertake our study (KAWAI 1955, WAHLERT 1968, RINSES 1979, VON KOENIGSWALD 1980).

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