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**DENTAL ANOMALIES IN TWO SPECIES OF CANIDS: RED FOX
(*VULPES VULPES*) AND GRAY FOX (*UROCYON
CINEREOARGENTEUS*)**

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ABSTRACT

Samples of 510 gray fox and 150 red fox from southern Illinois were examined for the presence of congenital dental abnormalities. Anomalies were found in 177 gray fox (34.7%) and 25 red fox (16.6%). The most frequent anomalies were oligodonty in both species. The major case of oligodonty was in m_3 . Anomalies affecting the placement of the tooth (rotations, misalignments) were the next most prominent abnormalities observed. One red fox showed polydonty, and two gray fox showed varying degrees of connation. Other anomalies were seen infrequently. The results from the red fox population are consistent with previous studies; however, the lack of information available on gray fox prevented such a comparison. A significant difference was seen between the proportion of anomalous gray fox and anomalous red fox. The results of this study could not account for this difference. The predominance of m_3 and first premolar anomalies suggested that these teeth lack in importance and are subjected to greater variation.

Dental characteristics such as size, shape, placement, and orientation may show a great deal of variation within a single species. Variations are considered abnormal when they are uncommon and conspicuous. However, the distinction between normal variation and anomalies is very arbitrary (Miles and Grigson 1990). Several factors can cause the presence of dental anomalies, including genetics, physiology, environment, and nutrition. (Miles et al. 1990, Grobler et al. 1999). Dental anomalies have been studied in most orders and families, as compiled by Miles and Grigson (1990).

There are a number of dental anomalies that are considered. The most apparent are the presence of extra teeth in the dental arcade (referred to as polydonty, hyperdontia, or supernumerary dentition) or the congenital loss of teeth from the typical formula (referred to as oligodonty, agenesis, or hypodonty). Vila et al. (1992) recognizes two primary causes for reduction in tooth number, mechanical and a genetic trend toward the reduction of the dental arcade. Mechanical reductions can be distinguished by the presence of porous tissues resulting from alveolar overgrowth. The focus of this study was congenital oligodonty. Tooth morphology, asymmetry (Grobler et al. 1999), and malocclusion (Bouwmeester et al. 1989) have also been considered.

Connation is an unusual anomaly that can occur in dentition. Connate teeth consist of two distinct tooth elements with a single root. The degree of separation in the tooth elements varies from completely fused with a single root to two separate teeth arising from a single pulp cavity (also a form of polydonty). The origin of connation is still under debate. It is possible that some arise from partial splitting or dichotomy while others arise from fusion of tooth germs (Miles and Grigson 1990).

Within the family Canidae, dental anomalies have been studied in red fox (*Vulpes vulpes*) and wolves (*Canis lupus*) (Gingerich et al. 1979, Vila et al. 1992). Tooth morphology of the red fox is highly variable, showing at least 15 morphotypes (Szuma 2002). One of the most variable teeth in the red fox is the last lower molar (m_3). It shows high variability in size, shape, and presence. This suggests that m_3 has little functional significance in the process of capturing and grinding food. While the red fox has been studied extensively, little has been done with the dentition of the gray fox.

The objective of this study is to look at the occurrences of dental anomalies in two species of canids, the gray fox (*Urocyon cinereoargenteus*) and the red fox, determine the prevalence of specific anomalies among foxes from southern Illinois, and determine a relationship between frequencies in anomalous dentition and relative jaw and rostrum length. The occurrences of dental anomalies will be compared between *U. cinereoargenteus* and *V. vulpes*, as well as the presence of any sexual dimorphism in dentition within the two species.

METHODS

The study was based on the examination of the dentition of specimens from southern Illinois housed in the mammal collection of the Department of Zoology at Southern Illinois University. There were 510 gray fox and 150 red fox. Each individual was identified as an adult or juvenile. Juveniles were distinguished from adults on the basis of deciduous teeth, tooth eruption, and incompletely developed cranial sutures. The sex of most specimens was determined and record at the time of collection. Skulls were examined for polydonty, oligodonty, misalignment, rotation, or malocclusion of teeth according to the dental formula of $3/3, 1/1, 4/4, 2/3 = 42$, seen in both *U. cinereoargenteus* and *V. vulpes*. The relationships between the rostrum and mandible

length and the occurrence of anomalies were examined. Lengths were taken as the ratio between the condylobasal length and rostrum or mandible length to standardize measurement.

RESULTS

There were 504 adult and 6 juvenile gray foxes. Of these, 203 were females, 218 were male, and a total of 89 were of unknown sex. There was a total of 140 adult and 10 juvenile red fox. There were 62 females, 80 male, and 8 of unknown sex. Dental anomalies occurred in 177 of the gray fox (34.7%) and 25 red fox (16.6%). In the animals that showed anomalies, 30 of 177 (16.9%) and 4 of 25 red fox (16.0%) showed multiple anomalies.

Oligodonty was the most common anomaly for both species. In the gray fox, 101 individual animals (19.8%) showed oligodonty. The majority of them exhibited a loss of m_3 (72 of 101); 33 were unilateral (17 on the left) while the remainder was bilateral. P^1 was absent in 15 (6 bilateral), and p_1 was lost in 11 (1 bilateral). Two were missing Lm_2 . Two gray fox were missing M^2 unilaterally (right) and one bilaterally. One individual had unilateral oligodonty of the RP^2 and RP^3 and a malformed RP^4 . In the red fox, 13 individuals (8.6%) showed oligodonty. The majority of them exhibited a loss of m_3 (8 of 13); 6 were unilateral (4 on the left) while the remainder was bilateral. RP^1 was absent in 4; p_1 was lost bilaterally in one of these.

Polydonty occurred in each species once. In the red fox, one male had polydonty, found bilaterally in P^3 . In the gray fox, an unknown had polydonty in the LC^1 ; x-rays of the skull confirmed it had two separate roots. It's RC^1 exhibited connation. Connation was found in one other male gray fox in LI^2 .

Rotation of teeth occurred in 79 (15.5%) gray fox and 9 red fox (6.0%). They varied from slight to 90° and were unilateral or bilateral. P¹ accounted for a majority of the observed rotations: 62 of 79 gray fox, 4 of 9 in red fox. Misalignments were also noted in 14 gray fox and 5 red fox.

In addition, other abnormalities were observed in the gray fox. Two animals showed malformation of P⁴, one had a malformed p₁, and there was one case of an incomplete irruption of P¹. There were four cases where the face was compressed, usually resulting in severe dental abnormalities and occlusion problems.

DISCUSSION

The majority of anomalies found in both species resulted from a loss of dentition, primarily the last lower molar or the first premolar. These results reflect what others have found in studies of red fox dentition. Szuma (1999) reported anomalies in 13.5% of the study population; 7.2% were oligodonty. The absence of m₃ represented the majority of oligodonty cases (Bouwmeester et al. 1989; Szuma 1999). The last lower molar and the first premolars have been greatly reduced in size and importance and have little significance in feeding. They are likely to suffer from weak genetic control during development (Szuma 2002). Similar studies are lacking on the gray fox. The frequency of anomalies seen in the gray fox appears comparatively high, but there is no previous data to compare it to. It is not possible to determine whether this trend is unique to the population in southern Illinois or widespread in gray foxes.

A low frequency of polydonty was expected in both species. The presence of extra teeth in wild canids is generally uncommon since their dental formula almost reaches the full eutherian formula, differing only in the lack of an upper M³. Even though low frequencies of oligodonty were expected in canids, the occurrence of

supernumerary dentition was lower than previous reports. Szuma (1999) reported 2.0% of a population of red fox in Poland had supernumerary dentition and Miles and Grigson (1990) reported 1.6% for red fox.

The percentage of individuals that showed anomalous dentition appeared to be substantially greater in the gray fox population (34.7% in gray to 16.6% in red fox). When tested statistically, a significant difference between the proportion of anomalous gray fox and anomalous red fox ($\chi^2 = 11.5$, $df = 1$, $p = 0.001$). The reason for this difference could not be accounted for with the data collected in this study.

Pengilly (1984) concluded that variations in dentition “probably represent developmental factors that are largely independent of proximate functional considerations.” The findings of this study would tend to contradict this statement. If tooth loss was independent of “proximate functional considerations,” it would be expected that carnassial dentition would be affected in similar proportions as the teeth at the ends of the dental arcade. Instead, the vast majority of observed anomalies affected m_3 or one of the first premolars. Anomalies of carnassial dentition were almost nonexistent. Carnassials, with their complex shearing surfaces and occlusion, should be highly conserved evolutionarily, with variation strongly affecting fitness. Conversely, loss or variation in small, simple molariform dentition, such as m_3 or nonoccluding anterior premolars, may contribute little to individual fitness and exhibit much greater degrees of developmental plasticity.

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METHODS

The study is based on the examination of the dentition of specimens from southern Illinois housed in the mammal collection of the Department of Zoology at Southern Illinois University. Approximately 500 skulls are *U. cinereoargenteus*; about 200 are *V. vulpes*. Each individual will be identified as an adult or juvenile. Juveniles will be distinguished from adults on the basis of deciduous teeth, tooth eruption, and

incompletely developed cranial sutures. The sex of most specimens was determined and record at the time of collection. Skulls will be examined for polydonty, oligodonty, misalignment, rotation, or malocclusion of teeth according to the dental formula of $3/3$ $1/1$ $4/4$ $2/3 = 42$, seen in both *U. cinereoargenteus* and *V. vulpes*. In addition, four measurements will be taken: condylobasal length, mandible length, palate length, and muzzle length.

ANTICIPATED RESULTS

Following with the previously stated hypothesis, a greater percentage of individuals exhibiting oligodonty are expected to be more numerous than occurrences of polydonty. The most likely cases of polydonty would be the presence of a third upper molar. This is the tooth that is absent in both species of foxes, but present in primitive eutherian formula. The most likely case of oligodonty is the loss of M_3 . This tooth has been greatly reduces in size and importance. Since it appears to have little significance in feeding, the tooth is most likely to suffer from weak genetic control during development. P^1 and P_1 are also reduced in size and do not appear to have much significance in feeding. It is likely that these teeth would also show a high frequency in loses. It is further expected that the first premolars will experience the most variation in the type of anomalies observed. It is anticipated that both species show these tends, with the gray fox exhibiting high frequencies of anomalies than the red fox.

The relative jaw and muzzle lengths are expected to influence the presence of dental anomalies. Reduction in the size of one of these two skull features increases the amount of crowding along the dental arcade, and is likely to affect the observed dental characteristics. Since the gray fox is a smaller species than the red fox, it is expected that

relative jaw and muzzle lengths will have more of an affect on their dentition. Muzzle length will be most influential in anomalies related to the first premolar. Reductions in muzzle length will lead to an increase in observed losses and rotational variations in this tooth.

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