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Oral Cavity Evaluation and Dental Chart Registration of Coati (Nasua nasua) in Captivity

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Summary:
The aims of this study were to develop a dental chart, evaluate any oral cavity disease, develop gypsum models of the dental arches, and to register the occlusions found in coatis (Nasua nasua) in captivity. Formulation of the dental chart was assisted by intraoral radiographs from the head of an adult coati cadaver of the same species with the following dental formula: 1 3/3, C 1/1, P 4/3, M 2/2. Seven live coatis of the Nasua nasua species were evaluated. Five of the seven coatis presented with various dental abnormalities as follows: dental plaque (71.4 %), gingivitis (71.4 %), periodontitis (57.1 %), dental stain (42.9 %), dental abrasion (57.1 %), dental fracture (57.1 %), and supernumerary teeth (14.2 %). J Vet Dent 25 (2); 110 - 117, 2008

Introduction
Functions of the oral cavity and its structures include: introduction of solid food and fluid into the gastrointestinal tract; protection against external forces, such as predators and fights between rivals and injury due to ingestion of deleterious materials; temperature regulation (cooling); sexual stimulation; and, communication.

Oral cavity examination should be made in sequence by evaluating the lips including skin and mucosa, halitosis, palate, tongue and floor of the mouth, oropharynx, tonsils, and the dental organ (tooth and periodontium) using a dental explorer and a periodontal probe. All findings should be registered on a dental chart specific to each species and include patient identification. Charting is essential to record the presence or absence of lesions, a baseline for disease or health status, prognosis, and the results of treatment.

Another important registration of oral cavity structures is the dental gypsum model. When the dental model is made carefully and according to the manufacturer's recommendations, it is possible to obtain a precise copy of the dentition. The dental model allows the demonstration of the normal anatomy, the characterization of several types of diseases, the establishment of modalities of orthodontic treatment, and tooth preparation for cementation of prostheses.

Many animals kept in captivity are at risk of extinction. Maintenance of oral health allows a better quality of life and can influence the well-being and general health of the animal, as well as its reproduction and longevity. Therefore, it is important to conduct studies to provide references for oral anatomy, physiology, and diseases of these animals.

A wild carnivore mammal found commonly in Brazilian zoos is the coati from the Procyonidae family, Procyoninae subfamily, Nasua genus, Nasua nasua species. The geographical distribution of the free, wild coati is limited to South and Central American forests. Due to the limited dental reports pertaining to coati oral anatomy and health, the aim of this study was to develop a representative dental chart, to evaluate any oral cavity disease, to develop gypsum models of the dental arches, and to register the occlusion of coatis kept in captivity.

Materials and Methods
The present study was approved by the Ethical Committee of the School of Veterinary Medicine and Animal Science (149/2006 CEEA), UNESP at Botucatu, Brazil. An adult coati cadaver, without physical abnormalities that could influence the results, was used to accomplish the preparation of the dental chart. Intraoral radiographs of dental arches were made by using intraoral dental parallel and bisecting angle techniques (Fig. 1). The radiographs were taken using a portable dental x-ray unit with technique settings of 70 KVP, 15 map, and 0.8-second exposure time. The images were captured by a digital camera and the dental roots were drawn using the computer software. The final dental chart was based on the modified Triadan system.

Seven (5 females, 2 males) coatis of Nasua nasua species living in the Quinzinho de Barros Municipal Zoo having a body weight from 4 to 6-kg were used in this study. The animals were divided into categories according to age: young (5 to 15 - months, n = 3), adult (24-months to 13-years, n = 3), and old (up 13-years, n = 1), and numbered from 1 to 7. The food was made up of fruits, chicken and cattle meat, commercial dog food, and water ad libitum.

After fasting for 7-hours, coatis were tranquilized with a mixture of xylazine (0.5 mg/Kg/IM) and tiletamine-zolazepam (7.0 mg/kg/IM) by dart administration. An endotracheal tube was placed 15-minutes following tranquilization, and general anesthesia was induced and maintained with isoflurane and oxygen (Fig. 2). Patient heart rate and blood pressure were continuously monitored by means of an electrocardiogram and a Doppler with pressure manometer, respectively. The respiration rate was visually evaluated and the body temperature monitored and maintained by using a warm electric heating pad. Photographic documentation of the oral cavity was performed using a digital camera followed by a specific dentistry examination with the findings registered on the dental chart prepared previously.

The oral cavity was examined by visual inspection of the lips, soft palate, hard palate, tongue, alveolar mucosa, buccal mucosa, and the gingiva. Each tooth was evaluated for the presence/absence of malocclusion, stains, plaque and calculus, mobility, attrition or abrasion, complicated or uncomplicated
Figure 1
Intraoral dental radiographs used to aid in chart development for the adult coati (Nasua nasua).
Figure 2
Photograph of an adult coati (Nasua nasua) being administered general anesthesia during the conduction of this study.

Figure 3
Dental chart developed for the adult coati (Nasua nasua).

Results
The coati dental chart consisted of the animal identification, type of diet, clinical examination of the head, oral cavity and adjacent structures; dental formula, and drawings of the dental arches and teeth (Fig. 3). The crown of the incisors showed a similar size and they were denominated as first, second, and third incisors. The canine teeth were the largest teeth of the mouth and had a tri-faced design. Both vestibular and lingual faces of the mandibular canine tooth crowns had a groove extending the length of the crown, which was deeper on the lingual aspect (Fig. 4).

All coatis had two maxillary molar and two mandibular molar teeth, but the number of maxillary premolar teeth varied from three (14.3 %) to four (85.7 %) and number of mandibular premolar teeth varied from three (42.9 %) to four (28.6 %). Two coatis (28.6 %) had three premolar teeth in one mandible and four in the other.

Oral abnormalities found in the coati of this study are listed (Table 1). Malocclusion with incisor level bite was present in 57.1 % of the animals. There was also a left mandibular fourth premolar tooth with vestibular (buccal/facial) displacement in coati #7 (Fig. 5). The index of dental plaque was 1 in coati #7 and 2 for the others (Fig. 6). Gingivitis was detected in five animals: grade 1 (coati 7), grade 2 (coatis 1, 2, 3), and grade 3 (coati 4). Calculus scores were grade 2 or less for all coati except coati 4 (grade 3) (Figs. 6 and 7). Bleeding on probing of the gingival sulcus occurred in coati #3 and #4 with an intensity of 1 and 3, respectively. Periodontal pocketing (4-mm), furcation exposure (F3) and dental mobility (degree 2) were observed in the same coati (#4). Gingival recession, ranging from from 5 to 7-mm, was noted especially on the mesial aspect of the maxillary canine teeth in coatis #1, 2, 3 and 4 (Fig. 8). Coati #4 also had gingival recession in all maxillary premolar teeth, all left mandibular premolar teeth, and at the right mandibular fourth premolar tooth. This coati had generalized severe periodontal disease on the left side of the mouth. Dental staining was more predominant in the
maxillary and mandibular canine teeth (Fig. 9). Except for coati #3, that had severe dental abrasion on all premolar, and maxillary and mandibular molar teeth, the other coatis had more evident dental abrasion on incisor and canine teeth (Fig. 10). Coati #1, 2, 3, 4 had crown fractures usually involving the maxillary and/or mandibular incisor teeth, with pulp exposure occurring in 75% (Fig. 10). Gingival hyperplasia was seen on the distal area of the right maxillary fourth premolar tooth of coati #3 (Fig. 11) and maxillary and mandibular left molar teeth in coati #4. A supernumerary tooth between the maxillary left second and third premolar teeth was detected only in coati #2 (Fig. 12). The maxillary left canine tooth was absent in coati #6, while the other canine teeth were in an eruption process (Fig. 13).

An example of the gypsum models obtained from dental arches of the coatis are shown in Fig. 14. Abnormalities such as gingival recession at maxillary canine teeth and incisor fractures were easily identified on the gypsum models obtained from dental arches of the coatis. The registration of the occlusion in wax was accurate except for the incisor teeth where there was
little evidence of contact due to the long canine teeth.

Discussion
Since coatis are animals with a diversified diet, trituration of the food is a very important function in the digestive system for these animals. Therefore, the maxillary fourth premolar and maxillary molar teeth present an occlusal surface with an anatomic surface favoring a grinding function. Carnivores have sectorial teeth to tear the food, not to grind it. Therefore, the dentition of procionides differs from domestic carnivores in some aspects. In coatis, there are sectorial teeth that interdigitate from the first to the third premolar teeth as in dogs. However, from the fourth premolar tooth caudally, in both the mandible and maxilla, the teeth are bunodonts as in omnivores.
Although several methods for referencing teeth have been utilized, the coati dental chart was developed based on the modified Triadan system that is most used in the veterinary dental nomenclature system. The advantages of this system are to condense information in a small space and give specific identification of the tooth regarding location, anatomic description, and quadrant of the mouth. Also, it is possible to study dental diseases and the effectiveness of any treatment protocol.

The coati dental formula determined in the present study was made up of 3 incisor, 1 canine, three or four premolar and two molar teeth, similar to the dental formula (1 3/3, C 1/1, P 3-4/3-4, M 2/2 = 36 - 40) for coati described by other authors for Nasua nasua species confirming that a varied number of premolar
Figure 13
Photograph showing missing dentition right (104) and left (204) maxillary canine teeth in a young (#6) coati (Nasua nasua).

Figure 14
Photographs of gypsum models showing lateral (A) and rostral (B) views of the dental arches in a coati (Nasua nasua). Models allowed documentation of pathology including (C) gingival recession at the maxillary canine teeth (arrows). Note the absence of incisor tooth impression in the wax (D).

Teeth is probably a natural variation. As mentioned previously, these animals may be considered as heterodonts since the oral examination showed that the height of the canine tooth crown was approximately 3 times the incisor tooth crown length. Additionally, the occlusal surface shows interdigitation from the canine to the third premolar tooth and occlusion from the fourth premolar to second molar teeth. The dentition has anelodont characteristics because teeth have a limited period of growth and brachydont characteristics since radiographic examination showed the height of the roots was greater than the height of the crown. Also, one young coati (#6) presented with dental eruption in group (side-by-side), a characteristic of carnivores.

Dental plaque and gingivitis were observed in 71.4% of the coatis. The index of dental plaque was 1 (n = 1) and 2 (n = 4) and the degree of gingival inflammation was 1 (n = 1), 2 (n = 3), or 3 (n=1). These findings suggest that coatis kept in captivity are predisposed to periodontal disease caused by the accumulation of bacterial plaque. It is likely that firm-textured natural diet made up of fruits, nuts, figs, small birds, rodents, lizards, snails, insects, among others, cause more natural scaling of teeth and less accumulation of plaque.

Although the periodontal disease was generalized, gingival
recession was more evident at the mesial aspect of maxillary canine teeth (n = 4), suggesting that gingival recession may be associated with dental attrition due to the habit of biting structures of the captivity environment or the positioning of mandibular canine teeth that articulate with the mesial aspect of the maxillary canine teeth.

Two coatis had gingival hyperplasia on the fourth premolar and maxillary and mandibular molar teeth where periodontal disease was more severe. Gingival overgrowth towards the crown and around the tooth is commonly found in dogs with periodontal disease forming pseudopockets in many animals.3

Dental calculus occurred in 57.1% of the coatis and most had grade 2 severity. Dental calculus is a mineralized dental plaque, composed primarily of carbonate calcium and calcium phosphate mineral salts deposited between and within remnants of formerly viable microorganisms.1,4 It is known that the alkaline pH that is found in the canine oral cavity, and presence of calcium salts in saliva, stimulates mineralization of plaque.5 Coatis are carnivores, therefore we assume that the pH of their mouth must be alkaline, although no study was found to corroborate this assumption.2 Dental calculus grade 3 and more severe periodontal disease on the left side of the mouth was observed in coati #4. These findings may suggest pain on the left side of the oral cavity. Tooth fracture, pulpitisis or soft tissue injury predispose chewing on the normal side and, consequently, dental calculus accumulation on the affected side.6

Dental staining (darkness) was observed especially on canine teeth (42.9%). Similar staining has been observed in canine, maxillary third premolar, and mandibular molar teeth of the jaguar and puma kept in captivity presumed secondary to pigmented food and dental trauma.7-9 Although the coatis consumed a diet similar to dogs, the presence of dental abrasion and fractures located on the rostral teeth suggested trauma as the primary factor.

Malocclusion indicated by an incisor level bite occurred in 57.1% of the coatis. This probably induced an unequal dental abrasion (57.1%), pulpal exposure (42.9%), and tooth loss (42.9%), due to increased contact between maxillary and mandibular incisor teeth.10-12 Also, the abnormal dental abrasion in wild animals in captivity may be associated with environmental stress that stimulates abnormal habits, such as chewing on metal cage bars.13,14 Only one supernumerary tooth, on the left side of the maxilla, was detected in only one coati. Also, dental calculus accumulation was more intense on the left side as compared to the contralateral side in this animal. The supernumerary tooth is probably a genetic error and dental extraction is indicated if the impact on the adjacent teeth causes development of periodontal disease.15

The gyspum models of the dental arcades and wax registration of the occlusion were made in order to obtain an anatomical evaluation of the oral cavity of the coatis kept in captivity.1,4,12,20 In wild carnivores species, it is sometimes difficult to obtain proper equipment to aid construction of gypsium models from alginate molds.12 Because of the small size and limitation on the vertical dimension of the coati, the veterinary tray was too large for the dental arches and therefore allowed alginate loss through the sides of the tray. To solve this problem and to avoid distortion, the gyspum powder was poured in as soon as the alginate solidified. The preparation of the model was accomplished using gyspum-stone type III because of its excellent resistance and low cost.1,24

From this study it was possible to conclude that coatis in captivity may develop oral diseases that are, in many cases, associated with the environmental stress of captivity and diet.

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