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MANDIBULAR LESIONS IN THE WESTERN ARCTIC CARIBOU HERD OF ALASKA

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Abstract: Lesions were noted in 7.0 and 4.4% of mandible pairs collected from the Western Arctic caribou herd of northwestern Alaska in 1959-61 and 1975-77, respectively. The prevalence of mandibular lesions in the 1959-61 collection is believed to be the highest reported in wild caribou herds of North America. The frequency of occurrence of mandibular lesions was highest in caribou 7 years of age and older, and there was a higher prevalence in adult males than in adult females.

Trauma, dental abscesses, and periodontal disease were the probable cause of most lesions. Pathogenic bacteria were not isolated from mandibular lesions from an 11 year-old female. Thirty-three of 98 (33.7%) mandibles with lesions were missing one tooth, while ten (10.2%) were missing more than one tooth. The first molar (M₁) was the most common tooth lost in association with lesions, although the loss of two or more teeth was more common among premolars than among molars.

INTRODUCTION

Confusion exists in the literature concerning the cause and importance of osseous mandibular lesions in free-ranging caribou (*Rangifer tarandus*) in North America. Banfield² felt that necrosis of the alveoli and exostoses on the mandibles of barren-ground caribou in Canada were of actinomycotic origin and of widespread occurrence in the population. Skoog²² suggested that necrosis of the mandibles caused by *Fusobacterium necrophorum* (*Sphaerophorus necrophorus*) was, together with brucellosis, one of the two most important diseases of caribou in Alaska. Miller *et al.*¹¹ found only five instances of lesions among 1,226 barren-ground caribou mandibles examined. They concluded, on the basis of radiology, that four lesions were the result of dental abscesses and one was the result of trauma. They felt actinomycosis was of rare occurrence in barren-ground

caribou. Unfortunately, bacteriology was not done in any of these studies.

This paper describes the occurrence and nature of lesions in mandibles collected from the Western Arctic caribou herd and discusses possible relationships between the lesions and the general welfare of the herd.

MATERIALS AND METHODS

The Western Arctic Herd occupies a range of approximately 362,700 km² in the extreme northwestern portion of Alaska.⁷ Prior to a drastic decline in the 1970's, this was the largest caribou herd in North America with an estimated fall population of 300,000 to 400,000 animals (Doerr, unpubl.).

Two collections of caribou mandibles from the herd were examined. One collection, consisting of 776 mandible pairs, 372 right mandibles and 363 left man-

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dibles, was obtained during an intensive ecological study of the Cape Thompson region of northwestern Alaska in 1959-61.²³ The second, consisting of 68 mandible pairs, seven right mandibles and 10 left mandibles was gathered during an aging study conducted jointly by the Alaska Cooperative Wildlife Research Unit and the Alaska Department of Fish and Game (ADFG) from 1975-77. The 1959-61 collection was from caribou killed by hunters from the villages of Anaktuvuk Pass, Kivalina, Point Hope, and Noatak, as well as caribou collected by P.C. Lent and others. The mandibles from this collection had been stored dry in the University of Alaska Museum, Fairbanks, Alaska, for 14 to 16 years before being examined. The mandibles from the 1975-77 collection were obtained while collecting incisiform teeth for aging purposes from caribou killed by hunters from the villages of Bettles, Kivalina, Selawik, Barrow, Point Hope, Umiat and Kotzebue, as well as in the Kiana Hills. Mandibles from ten caribou dying of natural causes (wolf predation, starvation) in the Norutak Lake area, west of Bettles were collected by J.L. Davis, ADFG, in March, 1977.

Mandibles were cleaned of soft tissue prior to examination. Slight swellings of the lingual surface of the mandible were considered normal when radiographic examination of several of these mandibles revealed that the enlargements were the result of an expansion of the bone surface rather than the result of excessive bone deposition. Mandibles missing teeth but lacking necrosis or exostoses also were considered normal. Lesions and the absence of teeth were assumed to be associated if the alveoli had begun to fill with cancellous bone or if the crown of the tooth had completely eroded away at the site of the lesion. A Kaminuriak herd study¹¹ was included with this study when evaluating the occurrence and distribution of missing molariform teeth in mandibles with lesions.

Mandibles from calves, yearlings, and some adults were aged on the basis of tooth eruption and wear.²² Some mandibles from caribou older than yearlings were aged by examination of dental cementum annuli.¹⁰

Sixty-one mandibles with lesions were radiographed and examined as described by Miller *et al.*¹¹ One adult female, with lesions in both mandibles, had been frozen in the field since being shot by hunters. The affected portions of mandible were sent to the Alaska State/Federal Laboratory in Palmer, Alaska, for bacteriologic examination. Standard methods were used to attempt isolation of *Actinomyces*.¹ Femur marrow from this caribou was analyzed for fat content.¹⁴

RESULTS

Occurrence of Mandibular Lesions

The occurrence of mandibular lesions in the two collections is shown in Table 1. The lesion was unilateral in 38 of 57 mandible pairs affected, so only mandible pairs were used to estimate the occurrence of lesions. The overall percent of mandibles with lesions in the 1959-61 and 1975-77 collections was 7.0 (n = 776) and 4.4 (n = 68), respectively.

The right mandible had lesions in 40.4% of 57 afflicted mandible pairs compared to 26.3% occurrence in left mandibles only. Fifty-five percent (n = 93) of all mandibles with lesions were right mandibles. Neither of these differences were significant ($\alpha = .25$). The occurrence of lesions in mandible pairs in the 1959-61 collection was not significantly higher in males 2 or more years of age (2+) than in 2+ females ($\chi^2 = 2.40$, $df = 1$, $.25 > P > .10$); however, if all mandibles in the 1959-61 collection were considered, there was a significantly higher occurrence in 2+ males than in 2+ females ($\chi^2 = 6.20$, $df = 1$, $.025 > P > .01$).

Age-specific occurrences of mandibular lesions in the Western Arctic caribou herd in 1959-61 were estimated

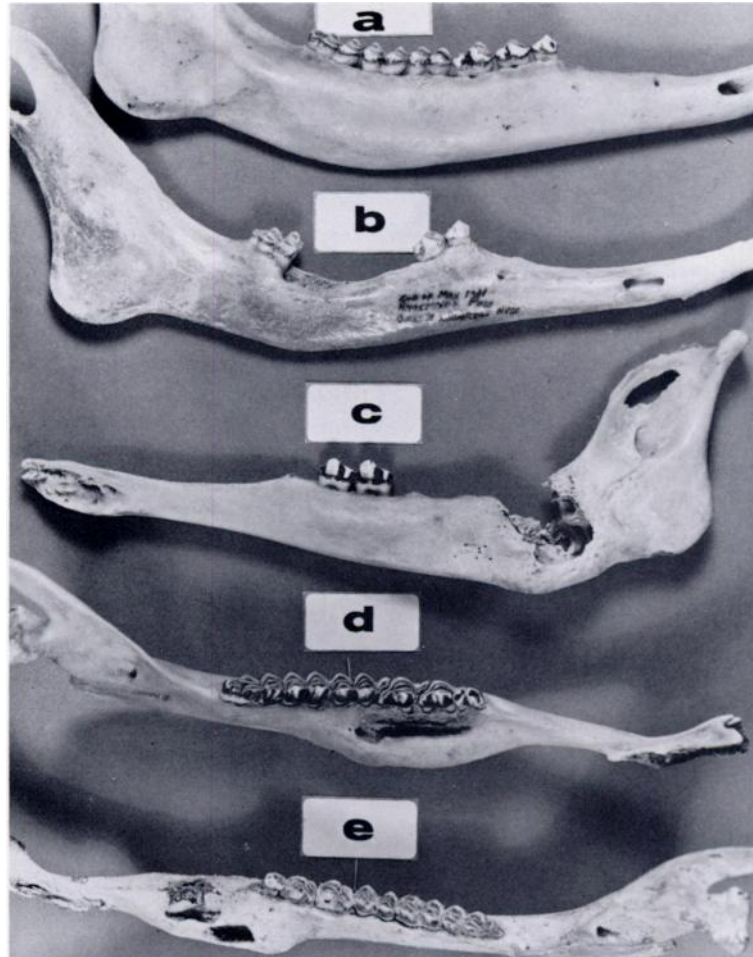


FIGURE 1. Caribou mandibles from the Western Arctic Herd.

- a. Normal mandible.
- b. Mandibular lesion probably resulting from trauma. Note missing first and second molars. The alveoli have been filled with cancellous bone with minimal bone destruction. P_4 has been removed for aging.
- c. Severe bone lysis probably the result of a dental abscess of the third molar. Note increased ventral ossification. P_2 , M_1 , and M_2 teeth were lost in handling and storage.
- d. Lesion in mid-shaft of mandible, probably the result of dental abscess. Note high degree of osteolysis on the lingual and ventral surface of the mandible. Bone erosion is present at the second root of the third molar (radiograph). Disrupted periodontal membrane is present around roots of all three premolar teeth.
- e. Osteolytic lesion in the diastema. There are numerous cavities on dorsal and lingual surfaces of mandible with concurrent bone production on ventral surface.

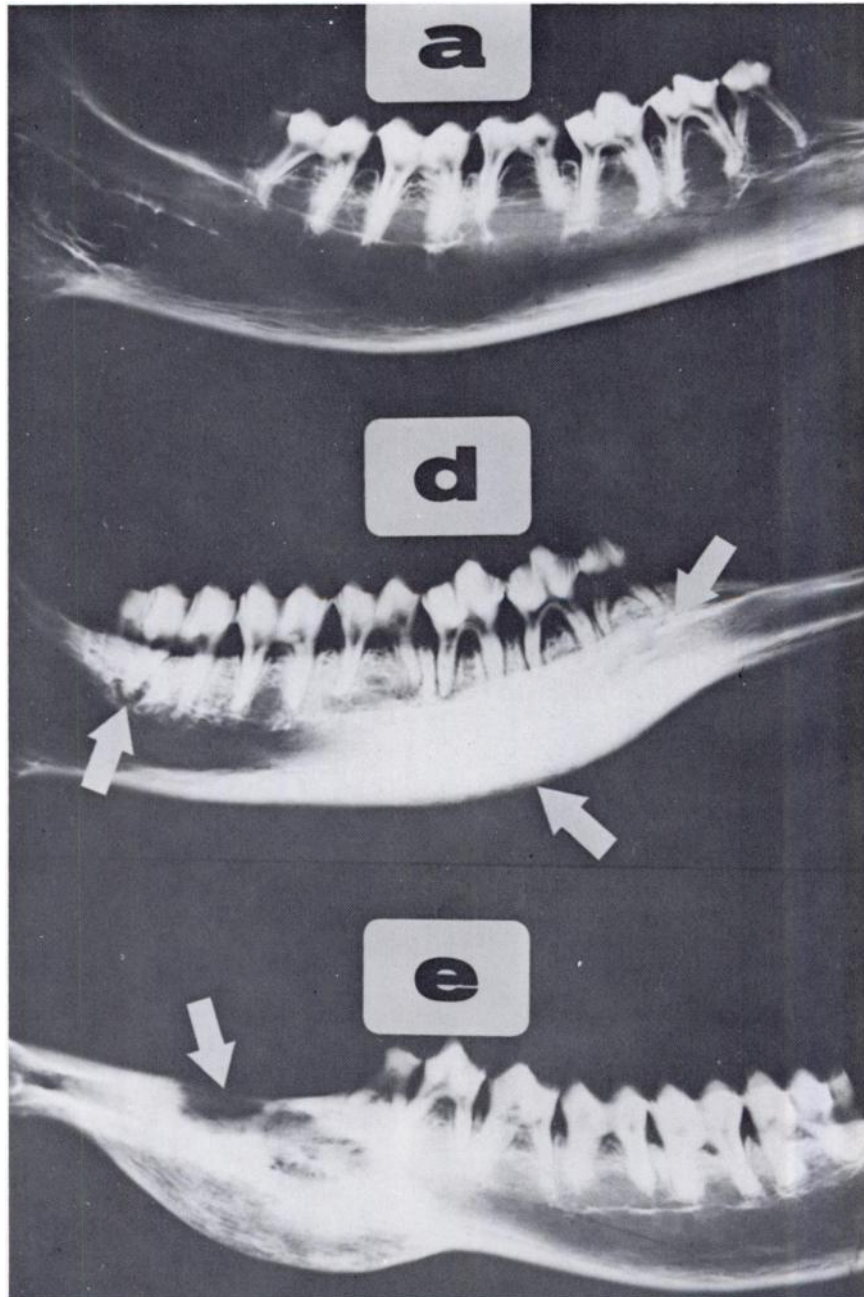


FIGURE 2. Radiographs of some mandibles shown in Figure 1.

TABLE 1. Occurrence of mandibular lesions in Western Arctic Herd caribou by age, sex and collection.

Collection	Mandible(s) with Lesions	Number of Occurrences						Total
		Calves	Yearlings	2+ Male ^a	2+ Female	2+ Sex Unknown		
Paired Mandibles (1959-61)	Both	0	1	6	6	3	16	
	Right only	0	1	9	5	8	23	
	Left only	0	0	5	3	7	15	
Single Mandibles (1959-61)	Total	0(44) ^b	2(68)	20(186)	14(230)	18(248)	54(776)	
	Right	1(50)	0(46)	4(56)	0(92)	4(128)	9(372)	
	Left	1(49)	0(45)	1(54)	0(90)	6(125)	8(363)	
Paired Mandibles (1975-77)	Total	2(99)	0(91)	5(110)	0(182)	10(253)	17(735)	
	Both	0(5)	0(11)	0(4)	1(13)	2(35)	3(68)	
	Right	0(1)	0(2)	0(1)	0(2)	0(1)	0(7)	
Single Mandibles (1975-77)	Left	0(2)	0(2)	—	0(1)	0(5)	0(10)	
	Total	0(3)	0(4)	0(1)	0(3)	0(6)	0(17)	

^a2+ (two or more years of age)^bSample size in parenthesis.

from the equation: $(A \times B_y)/C_y$, where A = proportion of paired mandibles with lesions (Table 1), B_y = proportion of mandibles of age y among all mandibles with lesions, and C_y = proportion of mandibles of age y in the 1959-61 collection. The estimated occurrence of mandibular lesions in caribou 2-3, 4-6, 7-9, and 10+ years of age in the 1959-61 collection are 0.5%, 7.9%, 20.2%, and 15.2%, respectively. The three instances of lesions in the 1975-77 collection were from animals eight, 11 and 13 years old, respectively.

Description of Lesions

Ninety-three mandibles had lesions; of these 61 (65.6%) involved swelling and necrosis in the region of dental alveoli only, four (4.3%) had bony exostoses and cavitation in the region of the diastema and ventral surface of the mandible, and 28 (30.1%) had anomalies affecting both dental alveoli and the ventral aspect of the mandible (Figs. 1, 2). The origin of the lesion appeared to be the mandible itself in five cases; in the other mandibles the lesions originated from the region of dental alveoli. Miller *et al.*¹¹ suggested that *Actinomyces* infections could be determined radiographically by the internal erosion of the bone and the subsequent honeycombed manner in which new bone is deposited. Of the five cases in which the lesions originated from the mandible itself, two had excessive rarefaction that could be the result of actinomycotic invasion prior to bone replacement (Figs. 1, 2e). Internal erosion was not evident in the other three mandibles, and the lesions may have been due to trauma.

Dental abscess and trauma (Fig. 1) were believed to be the cause of lesions in 45 and 11, respectively, of the 56 mandibles radiographed in which dental alveoli were believed to be the point of infection. This interpretation follows Miller *et al.*,¹¹ who suggested that bone absorption in the region of dental alveoli and subsequent periosteal bone formation are the result of abscess, while the

absence of periosteal bone formation and limited bone destruction are more indicative of trauma.

Pathogenic bacteria were not isolated from the only specimen examined bacteriologically. This specimen had thickening of the buccal and lingual aspects of the mandibular shafts and absorption of bone from around the roots of the premolars and first molars in both mandibles.

Severity of the Lesions

One index of the affect of lesions on the animal could be absence of teeth. All teeth were present in 56.1% of mandibles with lesions, while in only 10.2% of the cases was more than one tooth missing. The absence of teeth tends to underestimate the effect of mandibular lesions on the mastication process as some teeth were present but aligned improperly. Animals with all teeth present and aligned properly probably are affected minimally by the lesions. For example, an 11 year-old female caribou with lesions in both mandibles, but with all teeth present, was pregnant and had a femur fat content of 86.3% when she was killed by hunters in mid-winter.

No significant difference was found in the loss of teeth between males and females ($\chi^2 = .446$, $df = 1$, $.75 > P > .50$), or in the number of teeth lost in mandibles with unilateral lesions compared to mandibles with bilateral lesions ($\chi^2 = .264$, $df = 1$, $.75 > P > .50$).

Of 33 mandibles in which a single tooth was lost, 19 (57.6%) were M_1 , four were M_2 , one was P_3 , and three each were P_2 , P_4 , and M_3 . In 10 mandibles in which two or more teeth were lost, 14 (63.6%) were premolars and eight were molars. This suggests that lesions in the premolar region were more likely to result in the loss of two or more teeth than were lesions in the molar region. The mean ages of caribou with mandibular lesions and all teeth present, one tooth missing, or two or more teeth missing were approximately the same. This

suggests that the loss of teeth is not a product of the age of the afflicted animal.

The expected frequency of bilateral lesions would be 0.14%, assuming that the occurrence of lesions in one mandible was independent of the occurrence of lesions in the other mandible. The observed frequency of bilateral lesions was 2.3% (n = 844). Thus, the chances of one mandible possessing lesions was 16.4 times greater if the other mandible had lesions than if it was normal. The average age of caribou with lesions on both mandibles was 7.5 years, whereas the average age of caribou with lesions on a single mandible was 5.9 years. We hypothesize that a lesion in one mandible may render the opposite mandible more susceptible. This could be due to the presence of infectious agents or increased masticatory burden placed on the normal mandible. In four cases with bilateral involvement the lesion in one mandible appeared to be the result of trauma with loss of one or more teeth, whereas the lesion in the other mandible appeared to be the result of dental abscesses.

Mandibular lesions were not detected in the 10 caribou found dead of natural causes in 1977.

DISCUSSION

There is disagreement concerning the cause of mandibular lesions in caribou. One popular concept is that alveolar necrosis and exostoses on the mandibles are the result of invasions by *Actinomyces*. *Actinomyces* exist as harmless saprophytes in the oral cavity and may invade the bony tissue of the mandible following deep injuries.⁵ Shanan and Davis²⁰ and Drake⁵ stressed the need for bacteriologic diagnosis to confirm the presence of actinomycosis, but no such diagnoses have been made in wild caribou populations in North America. Murie¹² noted that "actinomycosis" invaded the jaws of Dall sheep (*Ovis dalli*) via the periodontal

areas, and Ritcey and Edwards¹⁷ reported that actinomycotic-like lesions in moose (*Alces alces*) occurred primarily about the teeth, but in neither study was the lesion tested bacteriologically. Cowan⁴ isolated *Actinomyces israeli* from a dentoalveolar abscess in a black-tailed deer (*Odocoileus hemionus columbianus*).

The hypothesis that mandibular lesions in caribou in Alaska are caused by *Fusobacterium necrophorum*²² has not been verified by laboratory studies (K. A. Neiland, *pers. comm.*). Necrobacillosis has been associated with mandibular lesions;^{3,13,18} however, such lesions are not necessarily common, and Zhignov²⁴ did not mention osseous lesions of the mandible in a detailed description of necrobacillosis in domestic reindeer in the Soviet Union. High morbidity and mortality are often associated with outbreaks of necrobacillosis.^{3,13,18,24} Consequently, a high prevalence of lesions resulting from necrobacillosis might not be found in caribou killed by hunters because native hunters of the area are reluctant to shoot caribou which appear sick.

Fracture was not an important cause of lesions in the mandibles examined. Only one healed fracture was found among 2,440 mandibles examined.

The large number of lesions solely in the region of the dental alveoli, the lack of radiographic evidence of actinomycosis, and the failure to isolate the organism from one fresh specimen with lesions suggests that actinomycosis likely occurs infrequently among Western Arctic Herd caribou or is restricted primarily to the periodontal region of the mandible. Trauma, alveolar abscesses, and periodontal disease are more likely causes of mandibular lesions.

Mandibular lesions in Western Arctic Herd caribou were more prevalent among the older age classes as has been reported in moose¹⁷ and black-tailed deer.⁴ In contrast, actinomycosis in domestic animals is most common in

animals from 2 to 5 years of age.⁸ The higher prevalence of lesions in older caribou may be due to a greater susceptibility or to the chronic nature of the disorder. Increasing wear of the teeth may result in a greater chance of food impaction or gum abrasion and may raise the chance of invasion by infectious organisms. Two specimens from the 1975-77 collection had food impacted between the teeth at the site of the lesion.

The large number of mandibles with lesions in the region of M₁ is further evidence of the role of mechanical forces influencing the lesions. M₁ is the first permanent molariform tooth to erupt in caribou and also the most vulnerable to wear. Cowan⁴ found that 9 of 13 dental abscesses in black-tailed deer were in the region of M₁.

The level of occurrence of mandibular lesions in the 1959-61 Western Arctic Herd collection is the highest reported for free-ranging caribou populations in North America (Table 2) and corresponds closely to the level of occurrence for the same herd from 1961-64.²² The occurrence of lesions in mandible collections may not represent the actual occurrence in the population since the mandible collection may be biased toward certain age and sex cohorts. The limited data suggests that Alaskan caribou herds have a higher prevalence of mandibular lesions than do the barren-ground caribou herds of Canada. There also seems to be a tendency for lower prevalences of mandibular disorders to occur at low population levels compared to when the herds are at larger population size. Shalla¹⁹ suggested that the occurrence of periodontal disease in lemmings may be correlated with population density and some studies have indicated a relationship between periodontal disorders and both stress²¹ and diet^{3,11,13,16} so that the prevalence of mandibular lesions in caribou may be a useful index of range quality and herd quality. Further studies are needed to test this hypothesis.

TABLE 2. Reported occurrence of mandibular lesions in North American caribou.

Herd	Years	n	Population Status of Herd	Percent with Lesions	Source
Western Arctic Herd, AK.	1959-61	776	High	7.0	Present study
"	1961-64	538	High	5.9	22
"	1975-77	68	Low following decline from 1970-76	4.4	Present study
Nelchina Herd, AK.	1957-63	3,706	High, increasing to peak 1962-64	2.3	22
Barren-ground Herd, NWT, Canada	1949-53(?)	380	High, declining ⁸	2.1	2
"	1957-58	150	Low, following decline 1940-55 ⁸	0.0	6 cited by 11
Kaminuriak Herd, NWT, Canada	1966-68	1,226	Low, following decline 1940-55 ¹⁵	0.4	11

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