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Source: Journal of Wildlife Diseases, 28(2) : 268-275

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-28.2.268

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Journal of Wildlife Diseases, 28(2), 1992, pp. 268–275
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TRAUMATIC, DEGENERATIVE, AND DEVELOPMENTAL LESIONS IN WOLVES AND COYOTES FROM SASKATCHEWAN

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ABSTRACT: A retrospective review was done of traumatic and osseous lesions in 241 wolves (*Canis lupus*) and 316 coyotes (*Canis latrans*) necropsied at the University of Saskatchewan between 1971 and 1990. Most lesions were the result of interspecific conflict. The most frequently occurring lesion in wolves was fracture of one or more bones, primarily ribs. Lesions were healed in most cases and appeared to be compatible with injuries caused by prey animals. One wolf, found dead, died as a result of thoracic trauma. Limb and skull fractures were less common. Fractures were uncommon in coyotes. The most frequent injuries in coyotes were related to gunshot wounds. Four coyotes had been killed but not eaten by wolves. One wolf had been killed and another attacked by wolves. Porcupine (*Erethizon dorsatum*) quills contributed to the death of a wolf and two coyotes. Degenerative joint disease, involving the spinal column and limb joints, was found in a few individuals of both species. A coyote had severe anomalies of the spinal column and a wolf had anomalous external genitalia.

Key words: Gray Wolf, coyote, *Canis lupus*, *Canis latrans*, trauma, bone, joint, aggression, anomaly, survey.

INTRODUCTION

The wolf (*Canis lupus*) and the coyote (*Canis latrans*) are the dominant predators in northern and southern Saskatchewan, respectively. Wolves occur from the commercial forest zone north, while coyotes are present throughout the province. Little is known about disease conditions affecting these animals in the province. This study involved the retrospective review of cases examined at the University of Saskatchewan (Saskatoon, Saskatchewan, Canada S7N 0W0) during the past 20 yr.

MATERIALS AND METHODS

Between 1 January 1971 and 31 December 1990, 241 wolves and 316 coyotes, collected in Saskatchewan, were examined in the Department of Veterinary Pathology (Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 0W0). These do not include cases where only portions of an animal were submitted or where only a few tissues were examined, such as in some animals suspected to be rabid in which only the brain was examined. Most specimens were frozen when received and most wolves and many of the coyotes had been skinned prior to submission. Almost all of the animals were submitted for necropsy by conservation officers or biologists of the provincial Department of Parks and Renewable Resources. The reasons for submission were many, including determination of cause of death or of obvious abnormalities, forensic examination to assist with legal cases, and general interest in disease conditions of these species. From 1974 onward, many specimens were submitted because of skin lesions caused by sarcoptic mange. Some coyotes were submitted to assist in a study of the prevalence of the nematode *Oslerus osleri* in this species, and some wolves were submitted because of knowledge of the author's interest in the species. The cause of death or method of collection was not recorded for all cases. Of the cases in which data were available, the proportion of wolves and coyotes, respectively, that were trapped were 57% and 35%, shot 9% and 43%, poisoned 28% and 6%, or died after collision with a vechicle 2% and 6%.

During the 20 yr period, specimens were examined by several pathologists and, because there was no specific protocol for examination of these species, the extent of examination of tissues was variable. The routine necropsy procedure used involved examination of the limb bones and the major joints but the spinal column and distal limb bones were not examined in detail unless there was some obvious abnormality. Lesions associated with terminal trauma will not be discussed here, except for cases in which the animal had been found dead. Many animals had broken and/or missing teeth. These will not be discussed because, in many cases, it was not possible to separate dental lesions that might have occurred as a result of capture in

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TABLE 1. Frequency of occurrence of lesions in wolves and coyotes from Saskatchewan. Some animals had more than one lesion.

	Wolf (n = 241)	Coyote (n = 316)
Sex ratio (male:female)	49.0:51.0	50.4:49.6
Traumatic lesions		
bone fracture(s)	49	4
bite wounds	2	4
gunshot wounds	1	7
amputation	1	3
embedded foreign body	3	2
intestinal accident	0	1
Degenerative lesions		
arthrosis	4	1
intervertebral disc degeneration	3	1
Developmental anomaly	1	1

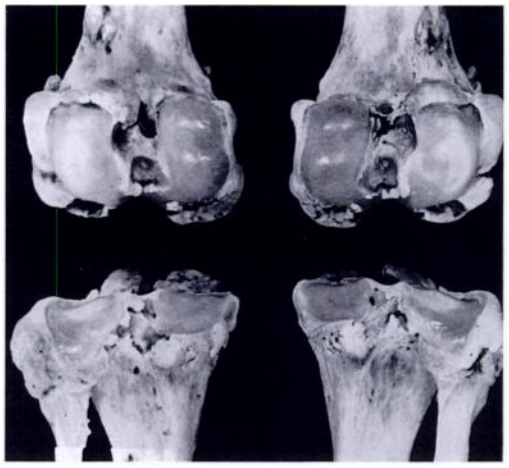


FIGURE 1. Bilateral osteoarthrosis of the stifle joints in a wolf that died as a result of trauma to the thorax. The articular cartilage was eroded from the medial condyles of both femurs with eburnation of the underlying bone. Extensive periarticular osteophytes are present.

traps at the time of death from pre-existing lesions.

RESULTS

The overall distribution of lesions of various types in coyotes and wolves, and the sex distribution of the animals examined are shown in Table 1. The lesions have been divided into those that were traumatic, degenerative and developmental in origin and each group will be discussed separately.

Traumatic lesions

Bone fractures were the most frequently observed lesion in wolves and also occurred among coyotes (Table 1). The bones most commonly involved were the ribs (Table 2). In all but one animal, the fractured ribs were partially or completely healed, although there was often malalignment or enlargement at the fracture site. There was fibrous thickening of the parietal pleura over the affected rib(s). In two wolves, the visceral pleura was adherent to the fracture site. In affected wolves, the average number of ribs involved was 2.6 (range 1 to 8) and 70% of fractures involved ribs 6 through 11. There were more fractures on the left than on the right side of the body (63 versus 52) but the difference was not significant. The sex ratio of wolves with fractured ribs was 65% male: 35% female, which was significantly different from that of all wolves examined (χ^2 = 10.24, 1 df). Wolves with fractured ribs were heavier on average than those of the same sex without rib fractures but the difference was significant only in females (Table 3). One wolf had recent rib fractures and appeared to have died as a result of the injuries. This was an aged male with severely worn teeth found dead on the shore of Weyakawin Lake (54°30′N, 106°00′W) by a trapper during December. It was in good general body condition but had massive subcutaneous edema and hemorrhage over the right thoracic wall. Ribs 2, 3, and 4 were fractured near the costo-chondral junction. Both the parietal pleura overlying the site and the visceral pleura of the adjacent lung were torn. There was unilateral pneumothorax and extensive intrapulmonary hemorrhage. This animal also had healed fractures of three ribs on the left, degenerate intervertebral discs at six sites in the thoracic spine with a ventral osteophyte causing

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TABLE 2. Frequency of occurrence of traumatic osseous lesions in wolves and coyotes.

	Wolf (n = 241)	Coyote (n = 316)
Fracture		
rib(s)	45	3
limb	4	1
skull	2	0
Amputation		
digits	1	0
limb	0	3

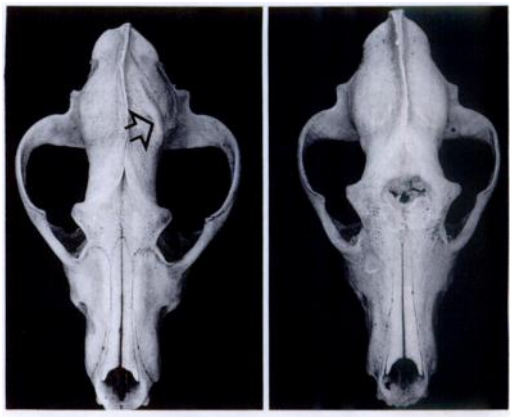


FIGURE 2. Wolf skulls with healed fractures. The skull on the left had a linear fracture with partial overlapping of the fragments in the parietal region (arrow); the skull on the right had a compression fracture on the frontal bone.

ankylosis between thoracic vertebrae 5 and 6, and severe, bilateral, degenerative joint disease of the stifles (Fig. 1). Three coyotes, two males and a female, had healed rib fractures. In each, only a single rib was involved.

Four wolves had fractured limb bones. One female had old fractures involving the anconeal process of the right ulna and the acetabulum of the right os coxae. The right femoral head appeared to have been driven medially into the acetabulum resulting in considerable deformation of both the femoral head and pelvis. There was extensive osteophyte proliferation about the margin of both the elbow and hip joints. The animal was in moderate body condition. A male wolf had healed fractures of two proximal phalanges of one foot. Numerous metal fragments were visible on a radiograph of the area indicating that it was the result of a gunshot wound. Two other wolves had fractures that were not healed. A female wolf shot by a trapper had a mid-shaft fracture of the femur. The fragments were overlapping and encased in dense connective tissue but there was still considerable mobility at the site. The other wolf was an emaciated female with severe sarcoptic mange that had a compound fracture of the distal tibia with purulent arthritis of the stifle joint.

The coyote found to have a fractured limb had been shot by a farmer because it acted abnormally tame. It was an adult female, in poor body condition, with draining tracts from both the elbow and hip joints on the right. There were comminuted fractures and suppurative arthritis involving both joints.

Three wolves had skull injuries. In two, there were healed fractures (Fig. 2). The other had a localized area of new bone formation on the surface of the frontal bone suggestive of subperiosteal bone formation in response to injury or hemorrhage.

Two wolves and four coyotes had fatal bite wound injuries. Based on the geographical location where the animals were found and the type of injury, wolves were responsible in all instances. The spacing between puncture wounds made by the canine teeth of the predator was from 4.5 to 5.5 cm in all instances, which is appro-

TABLE 3. Comparison of weight of wolves (skinned) with and without fractured ribs.

	Weight[a]			
	Fractures present		Number of fracture	
	Weight	n	Weight	n
Male	35.5 (5.6)	21	33.1 (4.9)	49
Female	33.2 (5.2[b])	13	27.6 (4.8[b])	67

[a] Expressed as mean (SD) kg.
[b] Significantly different, $P < 0.05$, (unpaired t-test, $t = 4.03$, 78 df).

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FIGURE 3. Right shoulder region of a coyote with an old gunshot injury. There is severe atrophy of the supraspinatus and infraspinatus muscles. A mass in the region of the proximal humerus (arrow) was a large callus containing lead fragments.

priate for a wolf and larger than that caused by a coyote. An adult female wolf in excellent body condition was found dead on a sand bar in the frozen Saskatchewan River, near Cumberland House (53°58′N, 102°16′W), during March. Lesions were restricted to the head and neck. There was massive subcutaneous and intramuscular hemorrhage dorsally and ventrally with many puncture wounds in the skin. The neck muscles were severely lacerated and the larynx was crushed. The second wolf was an adult male that died after collision with an automobile, near the Beaver River (55°26′N, 107°20′W), in February. It had extensive skin lesions caused by sarcoptic mange as well as several puncture wounds in the throat region with localized suppurative cellulitis of the underlying tissues. Two of the coyotes were adult males in good body condition found dead on the ice of lakes. One was found on Leaf Lake (53°01′N, 102°08′W) during March, the other was on Kingsmere Lake (54°05′N, 106°27′W) in February. Both had multiple bite wounds over the hips, back, and thorax with many fractured ribs and massive hemothorax and hemoperitoneum. The first animal had a large volume of canine hair and the foot pads and claws of a wolf in its stomach, suggesting it may have been scavenging on a dead wolf. The other two coyotes were females found dead, close together, along a trail near La Ronge (55°06′N, 105°17′W) during February. Both were in good body condition with numerous puncture wounds and associated hemorrhages and muscle lacerations similar to those in the males.

Three coyotes that were found dead had been killed by gunshot. Four other coyotes and a wolf had lesions caused by earlier gunshot wounds. The wolf and one of the coyotes were described earlier. Two of the coyotes were killed because of obvious debilitation. One had a fracture of the lumbar spine caused by a rifle bullet and the other had extensive muscle necrosis and fibrosis in the pelvic and lumbar areas in association with embedded shotgun pellets. The third coyote was an emaciated female with severe atrophy of the right supraspinatus and infraspinatus muscles (Fig. 3). A large callus was present about the distal humerus and fragments of lead were embedded in the new bone. The muscle atrophy suggested that the supraspinatus nerve had been injured. The fourth coyote had localized fibrosis of muscles of one shoulder associated with embedded shotgun pellets. The lesion appeared to be of no serious consequence.

A wolf was missing three toes from a forelimb, probably as a result of capture in a leghold trap, and three coyotes had partial limb amputations (at the carpus, mid-radius, and tibio-tarsal joint, respectively). The lesion in the wolf and the first two coyotes were well healed and the animals were in good body condition. The coyote with the amputated hind limb was emaciated and there was purulent osteomyelitis of the distal tibia with draining tracts from the stump. The cause of the amputations in the coyotes was not deter-

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mined. Two coyotes and a wolf that had been killed because of obvious debilitation had wire snares present about their neck.

Three wolves and two coyotes had foreign bodies embedded in their tissues. An adult female wolf, that was in good body condition, had a 15 × 1.5 cm wooden stick embedded in the frenulum of the tongue and extending caudally ventral to the pharynx. The stick was encapsulated in fibrous tissue and there was no evidence of active inflammation. A male wolf had a 5 × 0.8 cm stick embedded within fibrous tissue ventral to the sternum. Both these injuries likely resulted from running onto sticks but neither appeared to have caused serious debilitation. Another wolf had a stick wedged transversely between the carnassial teeth resulting in ulceration of the adjacent palatine mucosa (Fig. 4). This animal was in good body condition.

A severely emaciated female wolf pup was shot in September by a conservation officer because it was acting abnormally and appeared unafraid of vehicles or people. The only lesion found was severe purulent cellulitis in the pharyngeal area in association with numerous embedded porcupine (*Erethizon dorsatum*) quills. An emaciated female coyote pup, that was unable to stand when approached, was found by a farmer during February. It was killed by a conservation officer. Lesions were restricted to the head and oral cavity. There were ulcerations in the palatine mucosa in association with embedded porcupine quills and many quills were embedded in the skin of the head. An emaciated adult coyote (sex not recorded) was found dead in a den during April. It had many porcupine quills embedded in the skin of the hind legs, abdomen, and dorsum of the head but there was little reaction to these. The animal died as a result of intestinal obstruction by a linear foreign body. A 50 × 1.5 cm matted strand of sheep's wool was present from the pylorus to the cecum and the entire small intestine was "accordioned" on this foreign body.



FIGURE 4. Hard palate of a wolf with a stick lodged transversely between the carnassial teeth, resulting in pressure necrosis of the adjacent mucosa.

Degenerative lesions

One female and two male wolves had degenerative changes in intervertebral discs with mineralization of the nucleus pulposus. The most severely affected male was described previously. The female had degenerative discs between cervical vertebrae 6 and 7 and between cervical vertebra 7 and thoracic vertebra 1. The other male had degenerate discs between thoracic vertebrae 7 and 8, and 9 and 10. A male coyote had a single degenerate disc between lumbar vertebrae 3 and 4. Four male wolves had degenerative changes in the stifle joints. The most severe of these was previously described (Fig. 1). The lesions in the other wolves consisted of roughening and wear of the articular cartilage and only one had exostoses about the articular surfaces. An adult male coyote, with severe dental attrition, had degenerative changes in the cartilage of both the shoulder and stifle joints.

Developmental abnormalities

Two developmental anomalies were detected. One was a juvenile female coyote observed to be small and to "run like a rabbit" prior to being shot by a trapper

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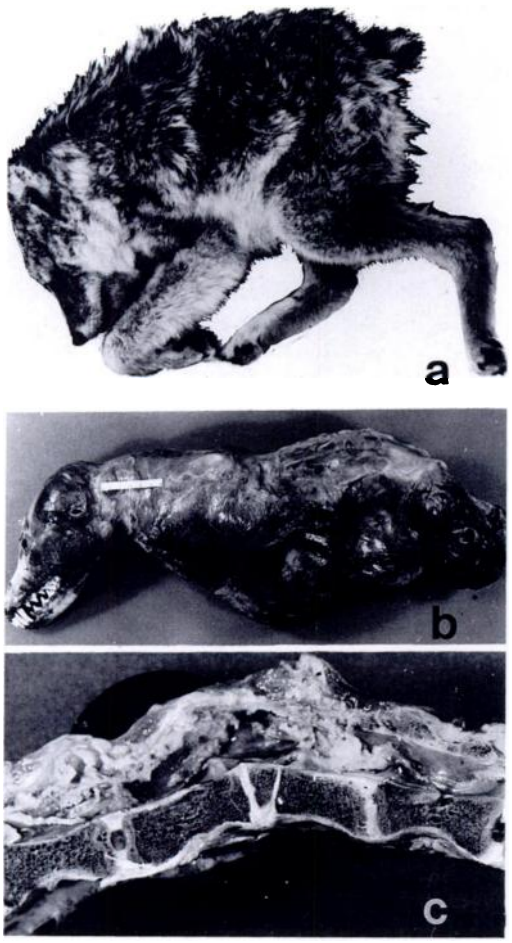


FIGURE 5. Juvenile female coyote with multiple skeletal anomalies. (a) Photograph taken by trapper. The trunk was disproportionately short compared to the legs. The tail was also short. (b) Carcass as received in laboratory. The trunk is shortened compared to the skull. There was lordosis in the thoracic region and kyphoscoliosis of the lumbar area. (c) Wedge-shaped body of lumbar vertebra 3 at the site of maximal kyphoscoliosis.

during January. The head appeared normal but the trunk was shortened, as was the tail (Fig. 5). The skin and legs had been removed before the specimen was submitted to the laboratory. The atlanto-occipital joint was fixed and immobile, there was severe lordosis in the mid-thorax and kyphoscoliosis of the lumbar spine. The atlas was shortened and overrode the base of the skull; the body of cervical vertebra 3 was irregularly shaped and there were only six cervical vertebrae. Five thoracic vertebrae could be identified; the last two appeared normal while the remainder were short and fused. The body of lumbar vertebra 3 was wedge-shaped and that of 7 was shortened. Three ribs on the left and one on the right had healed fractures. The second animal was a large wolf with anomalies of the genital tract. The animal appeared externally to be a female but the vulva was very small with a prominent clitoris containing a 2 cm os clitoridis. The vagina was present but smaller than normal. Dorsal to the vagina was a cylindrical fibrous structure that may have represented a remnant of the Wolffian duct system. Unfortunately, the animal had been partially scavenged and it was not possible to tell if uterus or gonads had been present.

DISCUSSION

This study had many of the problems common to retrospective reviews of records, in that data had not been recorded in a uniform manner and portions of information were absent from some records. It was not possible to assess the significance of the lesions described at the population level and, in some cases, it was difficult to determine the effect of lesions on the individual.

There were differences in the type of lesions that occurred in the two species, but most of the lesions identified appeared to relate to interspecific conflict. Bone fractures, that likely resulted from conflicts with prey, were more common in wolves than in coyotes. This is to be expected as wolves prey on proportionately larger animals, such as moose (*Alces alces*), than do coyotes. Wolves in Saskatchewan may have access to a variety of ungulates, including white-tailed deer (*Odocoileus virginianus*), mule deer (*O. hemionus*), elk (*Cervus elaphus*), and woodland and barren-ground caribou (*Rangifer tarandus*), in addition to moose. There has been no study of food habits of wolves in various

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areas of the province, so it was not possible to relate the occurrence of injuries to potential exposure to various prey species. Reports of traumatic injuries in wolves, many of which were anecdotal, have been reviewed by Mech (1970) and Nielsen (1977). The most directly comparable study to the present one is that by Nielsen (1977) who necropsied 112 wolves in Alaska. However, that study was prospective in nature and followed a protocol in which specific bones were examined. Of the 112 wolves examined, 38% had one or more fractures, compared to 20% of the wolves in this study. The distribution of lesions was different in the two studies with 27% of the Alaskan wolves having skull fractures while fractures were found in <1% of the Saskatchewan wolves. The difference may be explained partially by the difference in methodology. Skulls in Alaska were cleaned of flesh prior to examination, so that small lesions were much more likely to be found than at routine necropsy. However, it is unlikely that this can account for the entire difference, as severe skull injuries would have been obvious at necropsy. The prevalence of rib fractures was similar in the two studies (16% in the Alaskan wolves, 19% in the Saskatchewan wolves) and males had fractured ribs more frequently than did females in both studies. One of the wolves in the present study died directly of trauma; this animal also had extensive degenerative changes in the stifle joints and vertebral column that may have hindered his mobility while attacking prey.

Coyotes had more lesions caused by humans than did the wolves, probably reflecting greater contact with people in southern Saskatchewan, where most of the coyotes originated. The intestinal accident found in one coyote was an interesting occurrence but unimportant at the population level. Porcupine quills appeared to have contributed to the death of one wolf and two coyotes.

There was evidence of intraspecific strife among wolves and of antagonism between wolves and coyotes. Mech (1970) reviewed several reports of aggression and intolerance of wolves to others outside their own pack. Peterson (1975) reported that a pack on Isle Royale killed a wolf while trespassing in another pack's territory. Unfortunately, it was impossible to reconstruct events to better understand why the two Saskatchewan wolves were attacked. Mech (1970) stated that "what little is known about the relations between the coyote and the wolf suggests that they are not friendly" and reviewed several reports of coyotes killed by wolves. He also stated that coyotes disappeared from Isle Royale within a few years after the arrival of wolves on the island. Berg and Chesness (1978) indicated that coyotes avoided or were excluded from an area of Minnesota containing a wolf pack and that two coyotes were killed by the wolves during their study. The four coyotes apparently killed by wolves in this study were all in good body condition and had no apparent illness. None had been fed on by the wolves, suggesting that they were not killed for food. Although the four coyotes killed by wolves were a small proportion of the total number examined, they represented two-thirds of the coyotes found dead in areas of the province also occupied by wolves.

The observations of degenerative lesions indicate that such changes occur in wild wolves and coyotes but cannot be used to calculate the prevalence of such lesions in either species. Fritts and Caywood (1980) described degenerative joint disease in a wolf and reviewed several earlier reports of the condition. Mahan and Gipson (1978) reported a case of "osteoarthrosis" in a 14-yr-old coyote × dog hybrid and indicated that coyotes rarely live long enough to develop this type of lesion. The significance of such lesions is unknown but decreased agility must be of considerable consequence to active carnivores.

Despite the presence of multiple skeletal anomalies, the coyote shown in Fig. 5 had survived puppyhood and was not emaciated when killed. The anomalies appeared

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to be confined to the vertebral column; however, the legs were not examined. Vertebral anomalies occur frequently in dogs (Morgan, 1968); the prevalence of such anomalies in coyotes is unknown. Anomalies of the external genitalia, similar to those seen in the wolf, occur in animals with pseudohermaphrodism (Jubb et al., 1985) but the nature of the lesion could not be confirmed.

ACKNOWLEDGMENTS

This study was supported by a grant from Saskatchewan Parks and Renewable Resources for investigation of disease problems of provincial wildlife. The study would not have been possible without the active assistance of biologists B. Stewart and W. Runge and cooperation from many conservation officers. The assistance of many colleagues in the Department of Veterinary Pathology is appreciated greatly.

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Received for publication 16 May 1991.

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