

OSTEOARTHRITIS IN SELECTED WILD MAMMALS

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Examination of mammalian skeletons provided evidence that arthritis is widespread among a variety of medium and large-sized mammals, both captive and noncaptive. Many bones are involved; the most extensive exostoses occur around the articular surfaces of the vertebral bodies. Arthritis tends to appear after epiphyseal plates are ossified. Animals of different life styles and diets are afflicted.

INTRODUCTION

Skeletons of various mammals in the collections of the University of Oklahoma Stovall Museum of Science and History and of bears from the collections of the University of Kansas Dyche Museum (Lawrence) and the American Museum of Natural History (New York City) were examined for evidence of osteoarthritis for the purpose of comparing the results with other reports in the literature and extending the knowledge of this disease in wild animals. The disease dates far into antiquity as indicated by its occurrence in fossil remains reported by Moodie (1), Stecher (2), Osborn (3), Brothwell and Sandison (4), and Ruffer (5).

Various reports have been made of arthritis in modern wild mammals, by Stecher (2), and Young and Goldman (6). The most extensive study, by Fox (7), was of wild mammals both from the zoo and taken in the wild.

No reports of arthritis in small wild rodents or bats were found. Fox (7) examined many skeletons of small wild mammals with negative findings. However, Sokoloff (8) reported arthritis as common in small laboratory rodents (some strains of rats, mice, and guinea pigs). There are numerous reports, especially in the veterinary literature, of arthritis in domestic animals.

Examination of skeletal material housed in the University of Oklahoma Stovall Museum of Science and History revealed degenerative arthritis (osteoarthritis) in a variety of mammals. Our findings are summarized below and include only mature animals with ossified epiphyseal plates, unless otherwise stated. All animals examined with unossified epiphyseal plates were free of arthritis except for slight degenerative changes in one large bear which still retained a few bones with incompletely fused epiphyses. All of the animals described were captive unless otherwise stated. Reference catalogue numbers relate to specimens in the Stovall Museum collection unless otherwise stated. Because of difficulty in precise measurement of the arthritic growths, the subjective designations of mild or slight, moderate, and severe or marked will be used.

Of four black bears examined, one (2288) had marked arthritic changes, including fused vertebrae (see Figure 1). The bony abnormalities of this specimen included ossification of the ventral longitudinal ligament with marked hypertrophy in some areas and bony growth around articular facets. The long bones, including metatarsals and metacarpals, also displayed marked arthritic changes. A third specimen (1869) showed mild changes on all vertebrae except the cervical and there was mild involvement of the bones of the extremities including the feet. A fourth specimen (2292) showed only mild arthritic changes. Although it was the largest specimen of the three, it seemed to be the youngest because of the presence of some incompletely fused epiphyses.

Two specimens of sun bear (*Helarctos malayanus*, 9271, 10923) revealed only slight changes on some vertebrae. One specimen of sloth bear (*Melursus ursinus*, 3748) displayed fusion of one proximal tibio-fibular joint and possible early arthritic changes on other bones.

Of the four specimens of captive black bear examined at the University of Kansas Dyche Museum, one (KU 8415) demon-

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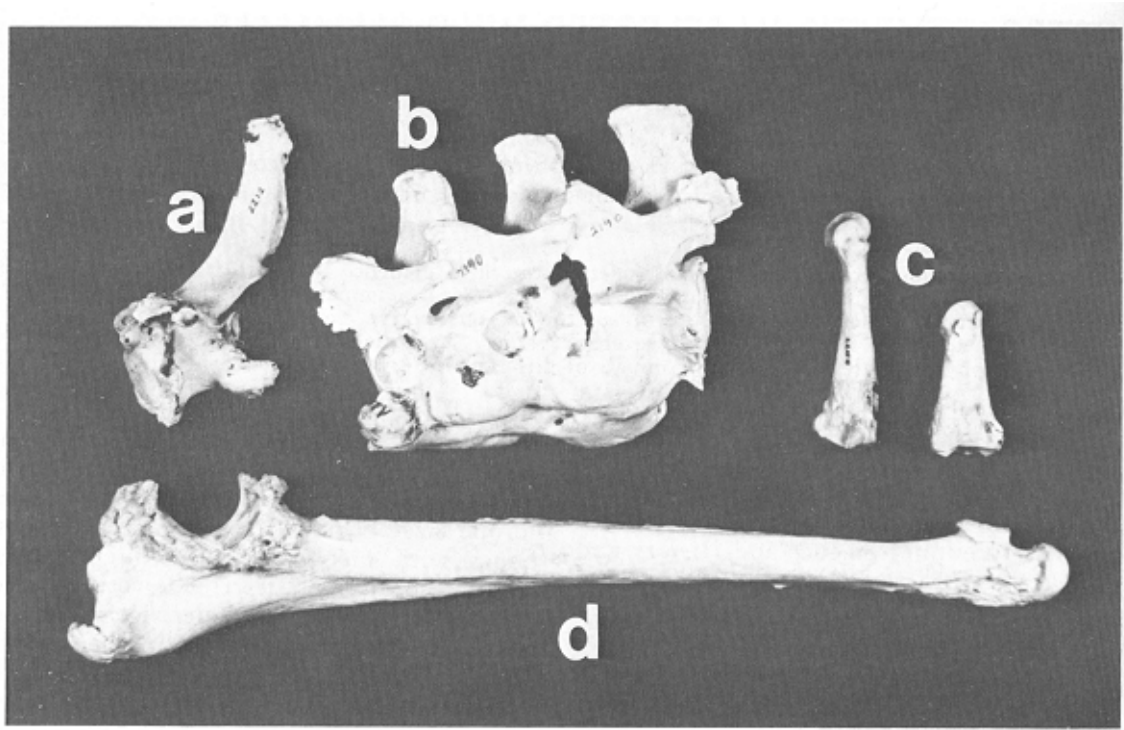


FIGURE 1. Osteoarthritis in several mammalian bones. a. thoracic vertebra of white-tailed deer, b. fused lumbar vertebrae of black bear, c. metatarsal and phalanx of black bear, d. ulna of black bear.

strated marked arthritis throughout the skeleton, one (KU 13268) showed slight arthritis, and two (KU 8414, 2964) were not arthritic. One specimen of sun bear (KU 10653), a captive animal, showed minimal changes on the facet processes of the lumbar vertebrae. One specimen of sun bear (KU uncatalogued) from the Topeka, Kansas Zoo demonstrated marked arthritis of the spine with fusion of three lumbar vertebrae, and of the long bones, especially the distal ends of the ulnas. In addition, in this bear the femora were of unequal length.

Thirty-seven bear skeletons in the American Museum of Natural History (AMNH) were examined. Of these, there were severe changes in one *Tremarctos ornatus* (AMNH 217682), moderate changes in one *Ursus dalli* (AMNH 70330), one *Thalarctos maritimus* (AMNH 215283), one *Euarctos americanus* (AMNH 120843), and one black bear (AMNH 77904). Minor arthritis was found in one *Ursus floridanus* (AMNH 24157), one black bear (AMNH 45149), one *Ursus maritimus* (AMNH 70013), and one Himalayan bear (AMNH 35496). (The species names presented here correspond to the names on the museum labels.)

Specimens examined from the University of Oklahoma Stovall Museum exhibited a variety of arthritic changes and are as follows: of eight specimens of bushbucks (*Tragelaphus* spp.) examined three (2053, 1359, 9539) showed slight signs of arthritis, such as small ridges. One specimen (620) had exostoses on the vertebrae, on the long bones (especially near the articular surfaces), and on the lower border of the mandible, and had marked exostotic growths on the bones of the feet. Another specimen (4922) demonstrated arthritic changes, such as lipping, on all vertebrae, and mild to moderate exostoses on most of the foot bones including marked growths on six phalanges; the first sternebra was markedly hypertrophic and misshapen.

Three specimens of blackbucks (*Antelope* sp.) were examined. One (8928) showed mild lipping on one thoracic body; another (2304) demonstrated mild to marked ossification of the region of the ventral longitudinal ligament in the thoracic spine and mild to moderate bony growths on some metatarsals and phalanges.

One gazelle (*Gasella* sp., 4384) had a spiny projection on the surface of one ilium,

but was negative otherwise. One addax (*Addax nasomaculatus*, 9839) had slight lipping around the facet joints of four vertebrae, small, irregular exostoses on the wings of the ilia, and moderate growths on one calcaneus, one phalanx, and one metatarsal.

The one American bison (*Bison bison*, 7391) examined had mild lipping around the rib articulations of several vertebrae and mild exostoses near the articular surface of the distal end of one metatarsal.

Of the two oryxes (*Oryx gazella*) examined, one (9847) showed mild lipping on some vertebrae and moderate to marked lipping around the rib articulations, mild lipping around the femoral condyles, moderate to marked exostoses on the shaft of one femur, roughened bumpy exostoses on the distal end of one calcaneus, roughened areas under the patellae, and growths on the borders of the ilia and on the vertebral end of one rib.

Of the two sables (*Hippotragus niger*) one (9933) had a flat pointed projection on one ilium.

One specimen of white-tailed deer (*Odocoileus virginianus*, 2212) had marked shelflike lipping on the bodies of the vertebrae in the region of the ventral longitudinal ligament on 15 vertebrae with milder bony growths on the remainder (Figure 1). Mild lipping and ridges were found on the bones of the extremities and rough exostoses were on the sternbrae. Arthritis was not seen on the one specimen of mule deer (*Odocoileus hemionus*, 1576) examined.

Six specimens of red deer and elk (*Cervus* spp.) were examined. One barasingha (*C. davauceilli*, 9926) had mild lipping on some vertebrae, and a marked exostosis on one ilium and lesser growth on the other ilium, and rough areas on most of the bones. Another (9538) had mild, moderate, or marked bony growth on all vertebrae, mostly in the area of the ventral longitudinal ligament; there was mild lipping on some long bones with mild or moderate rough growths on most diaphyses; and some of the irregular bones of the feet and the phalanges showed mild or moderate exostoses. The sternbrae also showed moderate bony growth. A sika (*C. nippon*, 9537) had vertebrae with mild to moderate shelf-like lipping in the region of the ventral longitudinal ligament and flat exostoses on the sternal end of one rib. One wapiti (*C. canadensis*, 2834) had rough exostoses on one metatarsal. Another (1305) had mild lipping on some of the long bones and spiny projections on one innominate. A third wapiti (2834) had bony thickening of the ventral longitudinal ligament on two thoracic and one lumbar vertebrae. The proximal half of one metatarsal was markedly enlarged with bony growths around the proximal articular edges with an exostosis present on one calcaneus, and there was lipping present on the vertebral ends of three ribs. The bones of this animal were rough with many ridges and small projections.

Two specimens of argali (*Ovis ammon*, 4468, 653) were negative for arthritis and one specimen of muntjac (*Muntiacus* sp., 4999) was negative.

One specimen of dromedary (*Camelus dromedarius*, 2216) had marked leaf-like exostoses around the rib articulations of four thoracic vertebrae, and mild, irregular exostoses on the vertebral ends of some ribs.

One specimen of Burchell's zebra (*Equus burchelli*, 10058) showed mild lipping around the rib articulations of one vertebrae.

The one great anteater (*Myrmecophaga tridactyla*, 2258) examined had arthritic growths on all or most vertebrae especially in the region of the ventral ligament. The other bones did not show arthritic changes, but all bones were quite rough.

One aardvark (*Orycteropus afer*, 10927) showed slight arthritis on the vertebrae and on one metatarsal.

One specimen of African lion (*Felis leo*, 2297) had mild exostoses on several thoracic vertebrae, mild lipping around the radial heads, around the trochlear fossae of the ulnas, around the heads of the humeri, and around the glenoid fossae. Bony growths were present in the olecranon fossae. One cheetah (*Acinonyx jubatus*, 3017) had mild lipping around the distal articulations of the femora, tibial plateaus, and one humeral head and fringe-like bony growths around the edges of the patellae. One lynx (*Felis lynx*, 9450) was negative for arthritis. Arthritis was found on three of six specimens examined of gray wolves (*Canis lupus*) taken in Alaska. One (9473) showed indefinite indications of early arthritis on the

long bones. Another (9474) had a spikelike projection on one femur which may have been a non-arthritic anomaly. The third (9472) showed mild lipping at the articular edge of one vertebral body, a small exostosis at the proximal articular edges of the ulna, and other evidence of mild arthritis. The coyote (*Canis latrans*) skeleton examined was negative for arthritis.

One of three specimens of gray fox (*Urocyon cinereoargenteus*, 3815) had bulbous growths on the dorsal surfaces of the lumbar vertebrae; in some cases these formed bridges between vertebral bodies. The heads and proximal ends of the femora and humeri were misshapen.

Six wolverines (*Gulo gulo*) obtained in Alaska were examined. One specimen (2319) exhibited a large exostosis on the edge of one ilium. Another specimen (9448) showed bony growth of the ventral longitudinal ligament region of the thoracic, lumbar, and caudal vertebrae; the humeri showed lipping around the heads, trochleas, and olecranon fossae; there were exostoses on the proximal ends of the radius, fibula, and ulna. Bony growth also was present on the calcaneus.

We examined a number of skeletons of mature mammals in the museum's collection which did not show significant signs of degenerative bone disease, and these are as follows (number of specimens examined follows the scientific binomial): fisher (*Martes pennanti*, 1) marten (*M. americana*, 1), ermine (*Mustela erminea*, 1), weasel (*M. nivalis*, 2), mink (*M. vison*, 1), badger (*Taxidea taxus*, 1), eastern spotted skunk (*Spilogale putorius*, 2), striped skunk (*Mephitis mephitis*, 1), kit fox (*Vulpes macrotis*, 1), cape hunting dog (*Lycaon pictus*, 1), ringtail (*Bassariscus astutus*, 1), raccoon (*Procyon lotor*, 1), spotted hyena

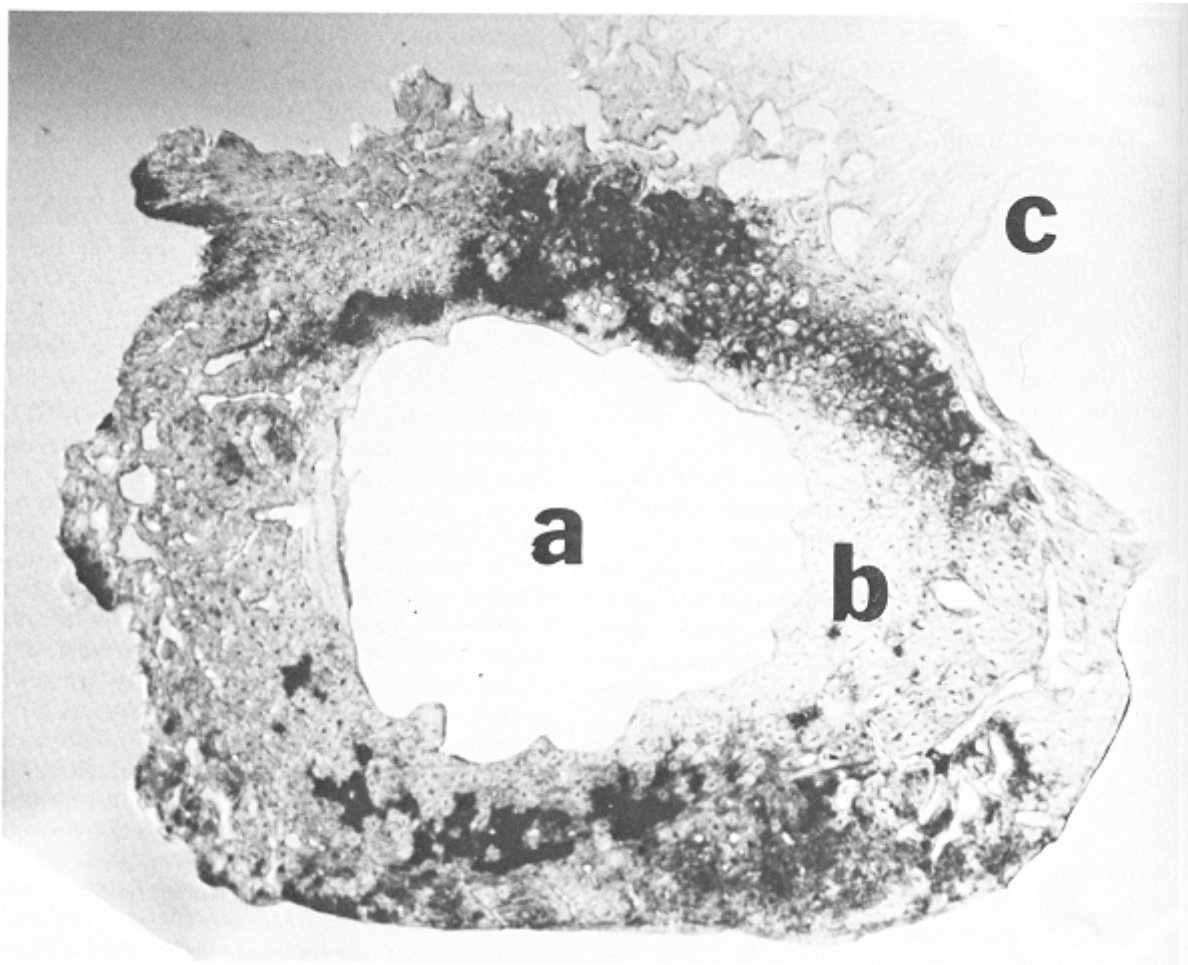


FIGURE 2. Cross section of metatarsal of black bear with osteoarthritis. a. medullary cavity, b. compact bone, c. exostosis.

(*Crocota crocuta*, 1), snow leopard (*Uncia uncia*, 1).

None of the mature primate skeletons showed arthritis. Those examined were: ring-tailed lemur (*Lemur catta*, 1), slow loris (*Nycticebus coucang*, 1), potto (*Perodicticus potto*, 1), night monkey (*Aotus trivirgatus*, 2), howler monkey (*Alouatta seniculus*, 1), squirrel monkey (*Saimiri sciureus*, 2), Geoffroy's marmoset (*Callithrix geoffroyi*, 1), lion-headed marmoset (*Leontideus rosalia*, 1), chimpanzee (*Pan troglodytes*, 1).

None of the small mammals examined showed evidence of arthritis. Those examined were: black-tailed jack rabbit (*Lepus californicus*, 1), ground squirrel (*Spermophilus* spp., 4), plains pocket gopher (*Geomys bursarius*, 1), yellow-faced pocket gopher (*Pappogeomys cumberlandius*, 2), Ord's kangaroo rat (*Dipodomys ordii*, 12), eastern woodrat (*Neotoma floridana*, 8).

DISCUSSION AND CONCLUSIONS

The arthritic changes observed were in various forms - bulbous growths and shelf-like formations (Figure 1), spikes, and flat, plate-like formations. The most common changes observed were the shelf-like outgrowths from the anterior aspects of the vertebral bodies, sometimes resulting in fusion, and lipping around the articular edges of bones forming synovial joints. A microscopic section of a metatarsal of a black bear was examined and showed the exostotic portion to be porous and apparently proliferated from normal, compact bone (Figure 2).

This study supports evidence that degenerative arthritis is widespread among wild mammals, but that life style and diet are not obvious causative agents in its development. Severe arthritis was found in the lumbering bear and the fleet-footed deer; it was found in the termite-eating giant anteater, the carnivorous wolverine, the omnivorous bear, and the herbivorous deer. One factor that appears related is age - arthritis was not found in animals with most epiphyseal plates still unossified (indicative of relatively young mammals). However, since exact age was difficult to determine in the mature animals in this study, we cannot predict what effect age has on arthritic development after animals have reached maturity. If being in captivity has some correlation to development of arthritis it would not be the only correlation. Our study showed arthritis in a variety of the captive animals whereas other studies have shown it in animals captured in the wild. Size of animal seems related since none of the small mammals we examined had arthritis, but the disorder was observed in medium-sized animals such as the wolverine, as well as larger mammals such as the bear.

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