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DESCRIPTION OF A PATHOLOGIC WHITE-TAILED DEER (*Odocoileus virginianus)* MANDIBLE FROM CENTRAL GEORGIA

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ABSTRACT
A pathologic mandible was observed in a male white-tailed deer (*Odocoileus virginianus*) harvested in central Georgia during the 2015 fall hunting season. The deer was approximately four and a half years of age and displayed no outward indication of injury or evidence of irregular tooth attrition at the time of death. Upon soft tissue removal, the mandible displayed signs of premortem trauma. The pathology was consistent with secondary bone deposition associated with bone breakage. The nature of the fracture suggests that it may have been caused by antler impact during male-to-male sparring. A physical examination of 621 white-tailed deer mandibles from the Piedmont National Wildlife Refuge in central Georgia failed to provide additional examples of similar pathology.

Keywords: white-tailed deer, skeletal pathology, fractured mandible

INTRODUCTION
Abnormalities such as bone fractures, tooth loss, and skeletal lesions have been documented in extant and extinct mammals. Identifying signs of previous injuries in animal bones is relatively straightforward because trauma to the skeleton often results in secondary bone deposition or soft tissue inflammation and infection that damages the surrounding bone (Bartosiewicz 2008). Determining the causes of these pathologies provides researchers a greater understanding of the stressors that free-ranging organisms experience. Several comprehensive studies have documented the incidence of healed fractures in a variety of extant vertebrates including mammals (Brandwood et al. 1986; Forsman and Otto 2006; Bartosiewicz 2008). Bone pathologies have also been noted in many extinct mammals such as saber-toothed cats (*Smilodon fatalis*; McCall et al. 2003), Pleistocene badgers (*Meles meles*; Iurino et al. 2015) and bison (*Bison* sp.; Rains et al. 1994; Kierdorf et al. 2012).

For extant small mammalian species, skeletal bone fractures have been described in several taxa including eastern gray squirrels (*Sciurus carolinensis*; Thorington 1972; Bosch et al. 2016), opossums *(Didelphis virginiana*; Mead and Patterson 2009), and northern water voles (*Arvicola terrestris*; Ventura and Gotzens 2005). A number of studies have also documented skeletal pathologies in primate species such as mountain gorillas (*Gorilla gorilla beringei*; Lovell 1990) and mantled howler monkeys (*Alouatta palliata*; DeGusta and Milton 1998). Recent analyses of larger artiodactyl species have documented a variety of limb bone skeletal pathologies in North American taxa (Grandstaff et al. 2015). In addition to bone breakage, degenerative joint diseases have been noted in artiodactyls such as moose (*Alces alces*; Liggett 2004) and white-tailed deer (*Odocoileus virginianus*; Wobeser and Runge 1975).

While healed fractures are more often associated with long bones, facial trauma can also result in bone injuries and subsequent bone pathologies. Mandibular pathologies are the focus of the present study; however, these anomalies are not well-documented in deer. Miller et al. (1975) and Doerr and Dieterich (1979) described mandibular lesions within free-ranging caribou (*Rangifer tarandus*) in Alaska, attributing the deformities to dental abscesses and trauma. Jirava et al. (1967) described a healed jaw fracture in a single deer specimen (species not identified) from Germany. Free et al. (1972) recorded healed mandibular fractures in eight white-tailed deer from the northeast United States. Additionally, Karstad (1967) reported healed mandibular fractures in three young white-tailed deer collected in Canada.

In addition to healed fractures, dental and mandibular anomalies involving nutritional deficiencies and bacterial and parasitic infections have been described in cervids (Couvillion et al. 1986; Fagan et al. 2005). For example, Flueck and Smith-Flueck (2008) analyzed the skeletal remains of 32 predator-killed Patagonian huemuls (*Hippocamelus bisulcus)* and found mandibular lesions attributed to selenium deficiencies present in 63% of the animals. Another well-documented abnormality is mandibular osteomyelitis. Often referred to as *lumpy jaw*, mandibular osteomyelitis is caused by the bacterium *Actinomyces bovis* (Konjević et al. 2011). Deer with this infection often display soft tissue inflammation and pathologic bone remodeling associated with the roots of cheek teeth. Broken or missing teeth and food compaction often lead to bacterial infections, particularly on the mandibular tooth row. An examination of 156 Columbian black-tailed deer (*Odocoileus hemionus columbianus*) revealed that the mandibular tooth row is much more susceptible to infection than the maxillary tooth row (Cowan 1946). In the current study, we examined a pathologic mandible from a male white-tailed deer harvested during the 2015 fall hunting season in central Georgia.

MATERIALS AND METHODS

A mandible was obtained from a four and a half year old male white-tailed deer harvested in Monroe County, Georgia, during the 2015 fall hunting season. Age was determined based on eruption and wear of cheek teeth as described by Thompson (1958). Soft tissue removal was accomplished using dermestid beetles. The cleaned mandible was examined with the naked eye and under a dissecting microscope. Dental and whole bone x-rays were taken to reveal internal damage. For comparison, 356 white-tailed deer mandibles collected in 2001 from the Piedmont National Wildlife Refuge (NWR) in central Georgia were examined for signs of bone pathology (Morris and Mead 2016). An additional 265 deer were physically examined (manual palpation) for mandibular pathology at the Piedmont NWR hunter check station during the fall of 2016. One side of each of these mandibles was subsequently cleaned and visually examined for evidence of bone pathology. The pathologic mandible and all additional comparative materials are housed in the Georgia College recent mammal collection (GCM).

RESULTS

During the cleaning of the Monroe County skull, the soft tissue associated with the mandible (GCM 3146) showed no evidence of swelling or wound discharge that would indicate that an infection was present. Examination of the cleaned mandible revealed the presence of secondary bone deposition (Figure 1A). Bony callus was present along the lateral surface of the left mandible between the anterior mental foramen and the superior mental foramen (Figure 1B). On the medial side of the mandible, the bony callus was thicker and extended posteriorly to the anterior root of the third premolar (Figure 1C). The greater proliferation of bony callus on the medial surface was more evident in dorsal view (Figure 1D). No visible evidence of bone fracture or bone misalignment due to breakage was seen with the naked eye.

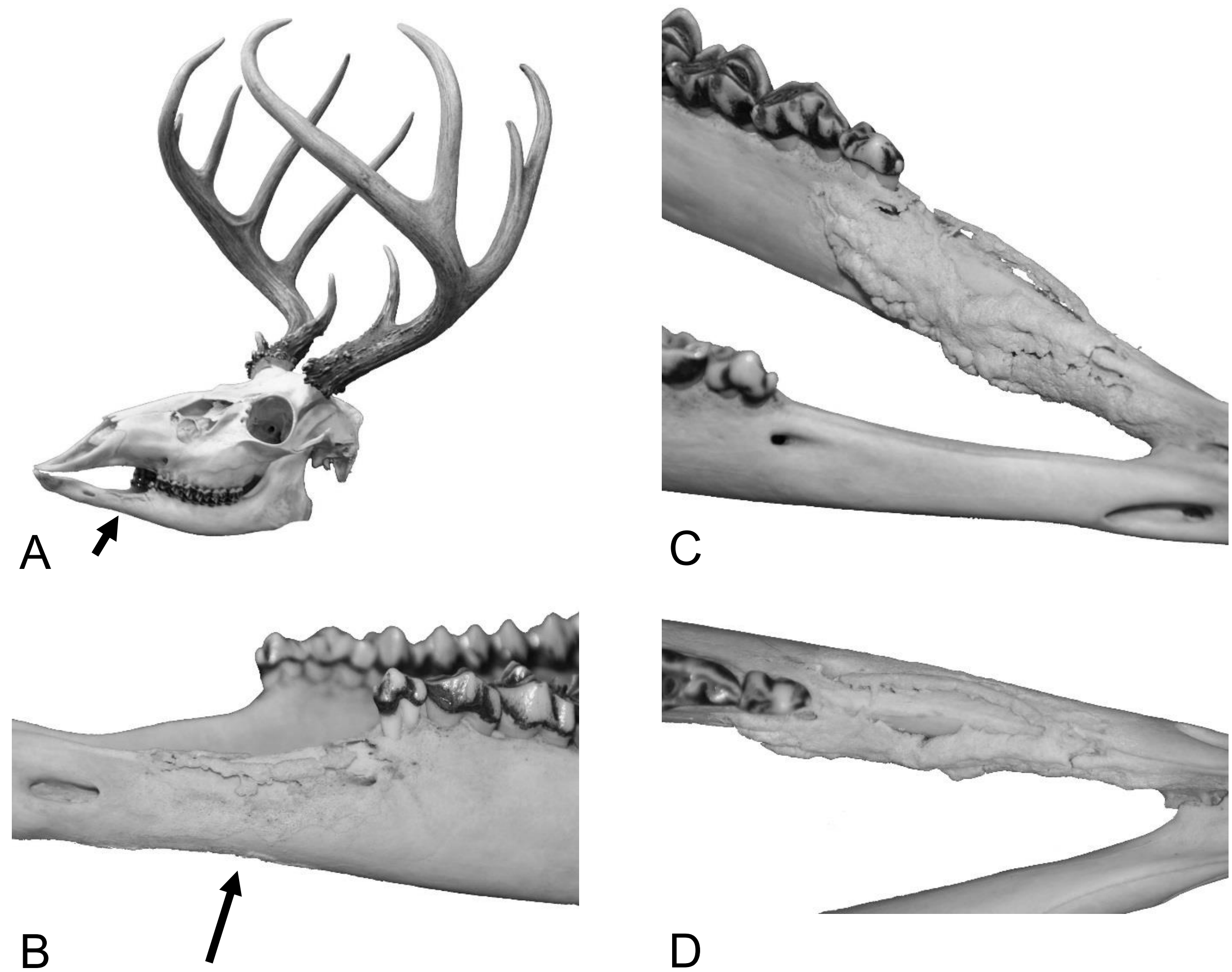

Figure 1. Skull of a white-tailed deer (*Odocoileus virginianus*) from Monroe County, Georgia exhibiting signs of bone pathology along the left mandibular (GCM 3146) diastema (A). Bridging fracture callus evident in lateral (B), medial (C) and dorsal (D) views.

Preliminary dental x-rays suggested the presence of a longitudinal fracture, but the coverage area was too small for a thorough analysis. Whole bone x-rays revealed a longitudinal fracture extending from the anterior root of the second premolar to approximately three-fourths the distance to the anterior mental foramen (Figure 2A). The fracture did not extend through the superior mental foramen, but was situated just above it. The dorsal whole bone x-ray displayed evidence of bone proliferation within the mandibular canal between the anterior and the superior mental foramina (Figure 2B). None of the additional comparative material (N = 621) from 2001 or 2016 showed evidence of similar bone pathology.

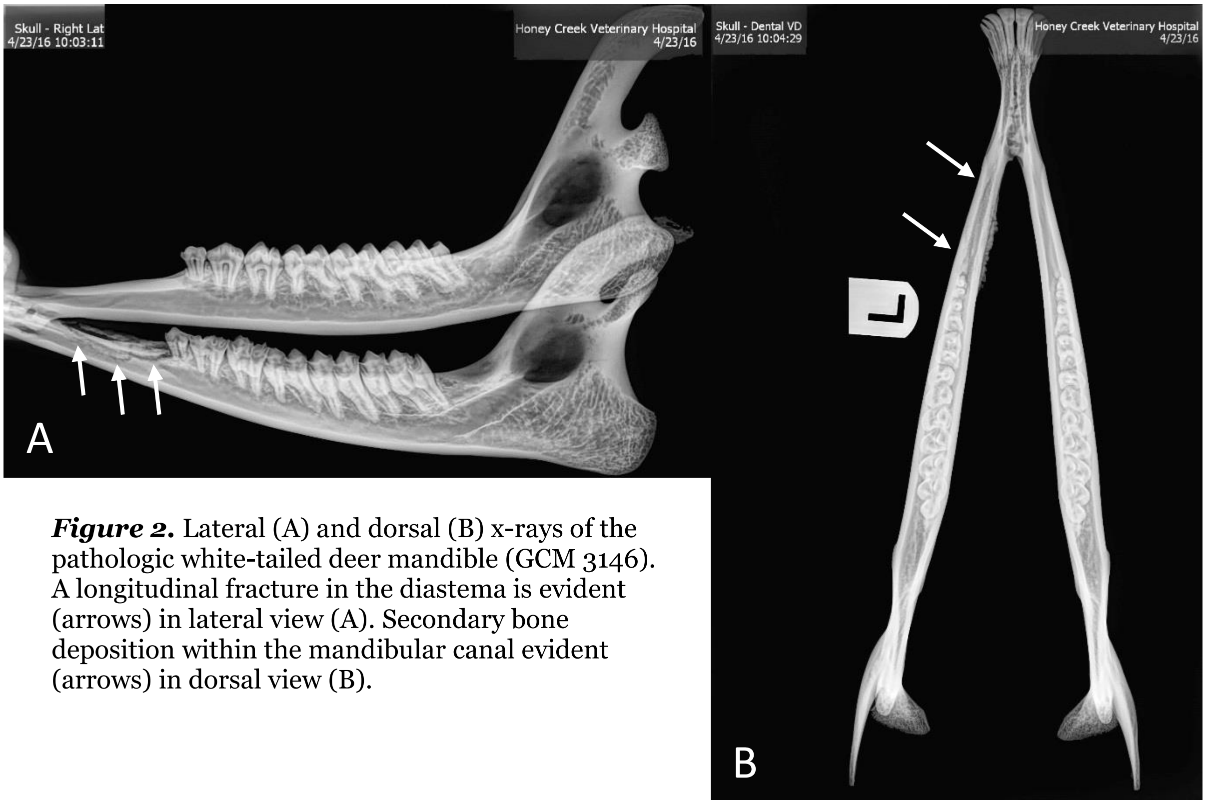

Figure 2. Lateral (A) and dorsal (B) x-rays of the pathologic white-tailed deer mandible (GCM 3146). A longitudinal fracture in the diastema is evident (arrows) in lateral view (A). Secondary bone deposition within the mandibular canal evident (arrows) in dorsal view (B).

DISCUSSION

Reports of mandibular injuries in white-tailed deer are somewhat uncommon. Ryel (1963) summarized physical anomalies present in a sample of approximately 96,500 white-tailed deer and reported no evidence of broken jaws. Mech et al. (1970) described dental anomalies in 36 of 401 white-tailed deer mandibles collected from Minnesota and similarly made no mention of mandibular fractures. As previously indicated, a few cases have been noted involving bacterial and parasitic infections, in addition to physical mandibular trauma (Free et al. 1972). Healed mandibular fractures have been recorded in several other mammalian taxa including wolves (*Canis lupus*; Pasitschniak-Arts et al. 1988), bears (*Ursus americanus*; Dyer 1981), viverrids (Taylor 1971), and foxes (*Vulpes vulpes*; Harris 1978).

Location and severity of a mandibular fracture play a critical role in the healing process. Research suggests that simple fractures are much more likely to heal than compound fractures (Cowan 1946). Constant jaw movements make compound fractures less likely to mend due to improper alignment of the broken region. Mandibular fractures sustained to the tooth row are less likely to heal properly because teeth are often damaged at the time of injury, making infection more likely. Free et al. (1972) concluded that mandibular fractures do not necessarily cause starvation of the injured animal. However, the deer may endure a period of nutritional stress until the wound heals.

Skeletal trauma to white-tailed deer may be caused by stressors such as accidental falls, intraspecific aggression, carnivore attacks, car collisions, and bullet wounds. The mandibular pathology observed in the current study suggests that this animal experienced a medially directed stressor that splintered the superior edge of the left mandibular diastema. The location of the fracture and the lack of complete transverse breakage of the mandible suggest the application of a blunt force to a small area on the jaw. Although potential causes for the observed injury are numerous, it is possible that this deer sustained the observed fracture fighting with a conspecific. It is reasonable to conclude that this fracture was caused by the tip of another male's antler tine striking the mandible during an altercation. The location and minor severity of the wound is the likely reason this individual showed no signs of significant weight loss or irregular tooth attrition.

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