

Notes and Discussion Piece

Conjoined White-Tailed Deer (*Odocoileus virginianus*) Fawns

ABSTRACT.—In May 2016 conjoined white-tailed deer (*Odocoileus virginianus*) fawns were found deceased in southeastern Minnesota. The bodies of the fawns were joined ventrally and laterally with two separate necks and heads. This is the first case described of conjoined two-headed white-tailed deer brought to full-term gestation and delivered.

INTRODUCTION

White-tailed deer (*Odocoileus virginianus*) are the most abundant and widely distributed species of the New World deer (Heffelfinger, 2011). Most female white-tailed deer ≥ 2 y old carry twins (DeYoung, 2011). Conjoined twins are rare in Cervidae but more commonly reported in humans and domestic animals. Kompanje and Hermans (2008) found 19 cases of conjoined twins in nondomestic terrestrial mammals in the literature between 1671 and 2006. These reports included five occurrences in cervids: white-tailed deer, moose (*Alces alces*), and red deer (*Cervus elaphus*). Additionally, Regnault and Regnault (1775) painted and described conjoined twin fawns which were likely red deer. Recently, conjoined twins were reported in bats (*Artibeus phaeotis*, Urban *et al.*, 2015; genus *Artibeus*, Nogueira *et al.*, 2017) and harbor seals (*Phoca vitulina*, Olson *et al.*, 2016). Only two cases of conjoined twins were reported previously in white-tailed deer in the scientific literature. According to criteria presented by Spencer (2003), both cases would be classified as Parapagus dicephalus—a body united ventrally with two separate heads. In Michigan a mid-gestation two-headed white-tailed deer fetus was found during necropsy of an adult doe (Fay, 1960). A similar late-gestation fetus was reported in an adult doe in western South Dakota (Severson *et al.*, 1972). Several cases of parasitic conjoined twins in white-tailed deer have been noted in which supernumerary limbs were attached to an otherwise normal animal (*e.g.*, <https://www.fieldandstream.com/pages/spyder-6-legged-deer-dies-after-surgery>). We present the first known case of conjoined two-headed white-tailed deer fawns that were birthed.

METHODS

In late-May 2016, a mushroom gatherer found a two-headed white-tailed deer fawn near Freeburg, Houston County, Minnesota (43.6111°N, 91.3643°W). The specimen was found on the forest floor and was reported to be clean, dry, and freshly dead. No other deer or signs of parturition were noted in the area. The specimen was submitted to the Minnesota Department of Natural Resources (MNDNR) in excellent condition and was frozen until necropsy. We conducted a detailed necropsy and 3D computed

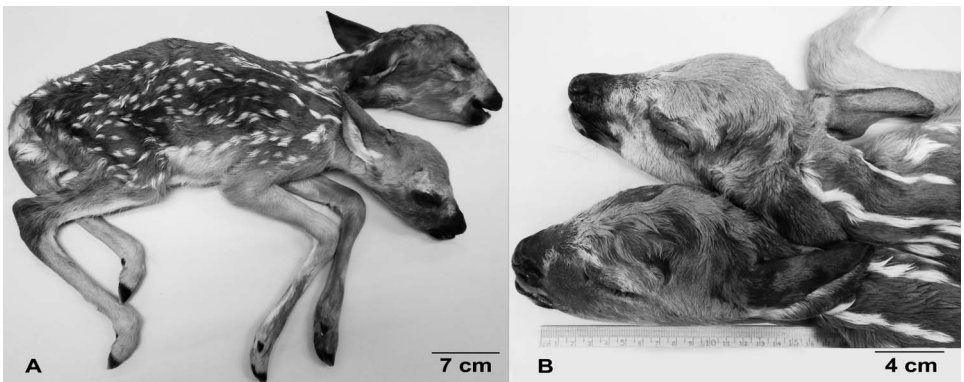


FIG. 1.—Stillborn, conjoined white-tailed deer fawns (*Odocoileus virginianus*) collected in Houston County, Minnesota, during May 2016. A. Lateral view of entire specimen. B. Close-up of head region

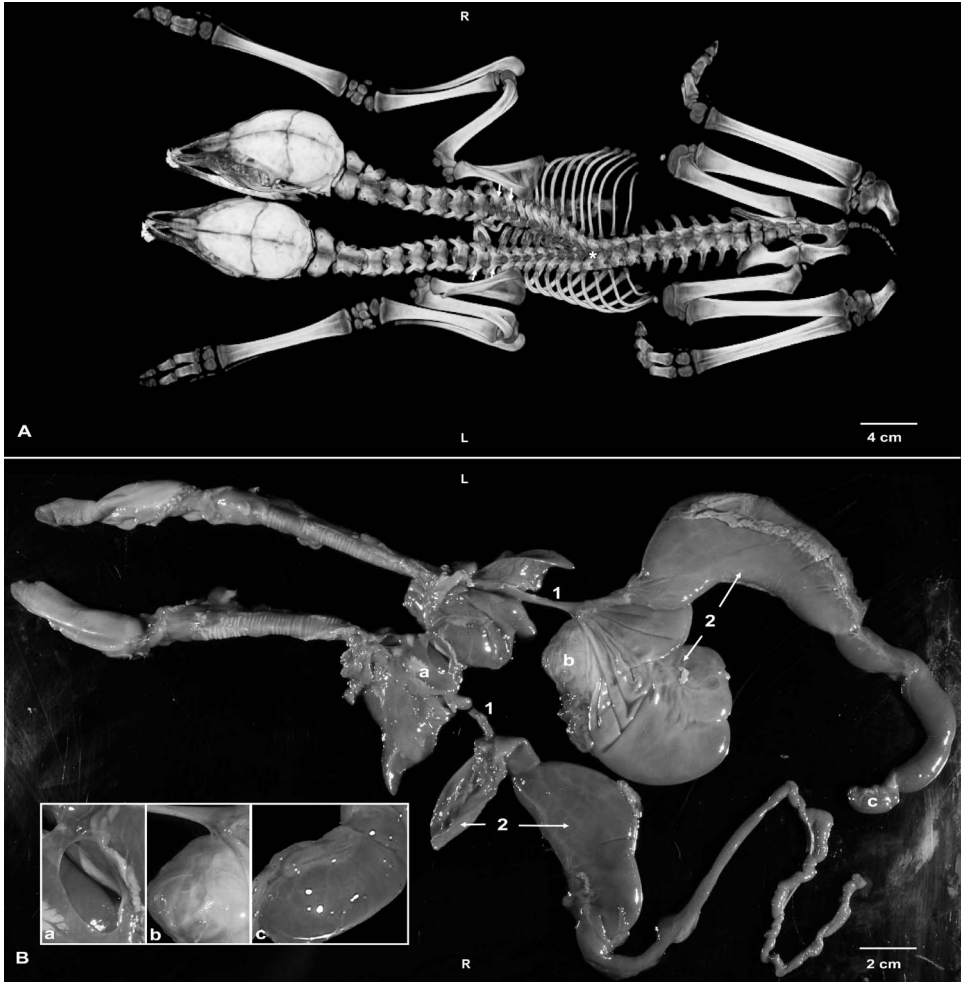


FIG. 2.—A. 3D computed tomography of stillborn, conjoined white-tailed deer fawns (*Odocoileus virginianus*) collected in Houston County, Minnesota, during May 2016. This image documents the grossly visible separate head-neck regions and duplication of most thoracic vertebrae, which then become a single vertebral column at T10-T11 (asterisk). The first two thoracic vertebrae (arrows) each possessed separate ribs, subsequent ribs were only present laterally. B. Viscera removed at necropsy from conjoined white-tailed deer fawns. Two hearts within a shared pericardial sac (a, enlarged inset image a), two esophagi (1) and two forestomachs (2) were present. The left head was connected with the abnormally developed upper visceral tracts, the esophagus ended in a blind sac (b, enlarged inset image b), and the forestomach/upper duodenum was dilated and also ended blindly (c, enlarged inset image c). The lower tract associated with the right head was complete. Note: the incision of the pericardial sac, the small separation seen in the esophagus of the lower tract and the removal of part of the lower gastrointestinal tract was done at necropsy

tomography and magnetic resonance imaging at the Minnesota Veterinary Diagnostic Laboratory at the University of Minnesota.

RESULTS AND DISCUSSION

The specimen presented here demonstrated parapagus dicephalus with ventral fusion along the length of the body (Fig. 1). Whereas the previous cases reported in white-tailed deer had a shared neck and bifurcation in the proximal cervical vertebrae, these fawns had two separate necks and heads. External body parts appeared symmetrical and normal except for bifurcation of the neck. The fawns had a single umbilicus, which was raw and free of umbilical cord. There was one vagina and one anus with fecal pellets present. The pelage was typical of neonatal white-tailed deer with spot patterning, which continued through both necks and heads. The fawns weighed 3.6 kg, which was slightly greater than birth masses reported for neonatal fawns in northeastern Minnesota (Carstensen *et al.*, 2009). Length from base of the tail to bifurcation of the neck was 32 cm and both neck and head lengths were 24 cm. Chest girth was 33 cm. We estimated the age of the fawns to be 0–4 d postpartum based on hoof growth (Sams *et al.*, 1996). Given the timing, morphology, and evidence at the site of collection, we believe the fawns were carried full-term. The lungs sank when placed in water, indicating the fawns were delivered stillborn.

Examination via 3D computed tomography and magnetic resonance imaging indicated duplication of skull, cervical vertebrae, several ribs, most thoracic vertebrae, and the first sternbrae. Caudal to the region of the ninth thoracic vertebra a single vertebral column was evident (Fig. 2A). No other major skeletal anomalies were noted. The gastrointestinal tracts were separate; only the right tract was complete from esophagus to anus (Fig. 2B). The left gastrointestinal tract consisted of two noncontinuous segments, one comprised of a blind-ended esophagus and a second section of gut consisting of a dilated segment of forestomach with duodenum. This latter portion of gut also ended blindly. The liver was malformed and shared. Four segments of splenic tissue were present. Two separate hearts shared a pericardial sac.

Spencer (2003) reviewed approximately 1000 cases of conjoined human twins, including 305 parapagus, and postulated that all conjoined twins arise from two separate notochords (*i.e.*, forerunner of vertebral column) on two originally separate embryonic discs. An alternative theory suggests monozygotic conjoined twins occur when splitting of the embryo is incomplete at the primitive streak stage of development (Kaufman, 2004). Although conjoined twins are thought to be most common and well-studied in humans, causes are speculative.

Acknowledgments.—We wish to acknowledge Kevin Serres for collecting and reporting the specimen, and Thomas Hemker and Donald Nelson of the MNDNR for aiding in reporting of the case. Robert Utne and Jessica Brooks of Wild Images In Motion Taxidermy mounted the specimen free of charge. The mount will be on display at the MNDNR headquarters in St. Paul, Minnesota. A skeletal preparation of the specimen will be housed at the University of Minnesota Veterinary Anatomy Museum in St. Paul, Minnesota. This study was funded by MNDNR. We thank Editor H. Hollocher, Associate Editor S. M. Crimmins, and two anonymous reviewers for comments, which improved the quality of the manuscript.

LITERATURE CITED

- CARSTENSEN, M. C., G. D. DELGIUDICE, B. A. SAMPSON, AND D. W. KUEHN. 2009. Survival, birth characteristics, and cause-specific mortality of white-tailed deer neonates. *J. Wildlife Manage.*, **73**:175–183.
- DEYOUNG, C. A. 2011. Population dynamics. p. 147–180. *In*: D. G. Hewitt (ed.). *Biology and management of white-tailed deer*. CRC Press, Boca Raton, Florida.
- FAY, L. D. 1960. A two-headed white-tailed deer fetus. *J. Mammal.*, **41**:411–412.
- HEFFELFINGER, J. R. 2011. Taxonomy, evolutionary history, and distribution. p. 3–39. *In*: D. G. Hewitt (ed.). *Biology and management of white-tailed deer*. CRC Press, Boca Raton, Florida.
- KAUFMAN, M. H. 2004. The embryology of conjoined twins. *Child. Nerv. Syst.*, **20**:508–525.
- KOMPANJE, E. J. O. AND J. J. HERMANS. 2008. Cephalopagus conjoined twins in a leopard cat (*Prionailurus bengalensis*). *J. Wildlife Dis.*, **44**:177–180.

- NOGUEIRA, M. R., A. VENTURA, C. C. P. DA VEIGA, L. R. MONTEIRO, N. L. PINHEIRO, AND A. L. PERACCHI. 2017. Dicephalic parapagus conjoined twins in a large fruit-eating bat, genus *Artibeus* (Chiroptera, Phyllostomidae). *Anatomia Histologia Embryologia*, **46**:319–324.
- OLSON, J. K., J. K. GAYDOS, T. MCKLVEEN, R. POPPENG, K. WICINAS, E. ANDERSON, AND S. RAVERTY. 2016. Conjoined fetal twins in a harbor seal (*Phoca vitulina*). *J. Wildlife Diseases*, **52**:173–176.
- REGNAULT, N. F. AND G. REGNAULT. 1775. *Les ecarts de la nature*. Bibliotheque Nationale de France, Paris, France. 53 p.
- SAMS, M. G., R. L. LOCHMILLER, E. C. HELLGREN, W. D. WARDE, AND L. W. VARNER. 1996. Morphometric predictors of neonatal age for white-tailed deer. *Wildlife Soc. B.*, **24**:53–57.
- SEVERSON, K. E., H. E. MESSNER, AND D. R. DIETZ. 1972. Two-headed white-tailed deer fetus. *Am. Midl. Nat.*, **88**:464–465.
- SPENCER, R. 2003. *Conjoined twins: developmental malformations and clinical implications*. Johns Hopkins University Press, Baltimore, Maryland. 476 p.
- URBAN, D. J., D. W. SORENSEN, J. A. MAIER, M. B. FENTON, N. B. SIMMONS, L. N. COOPER, AND K. E. SEARS. 2015. Conjoined twins in a wild bat: a case report. *Acta Chiropterologica*, **17**:189–192.

GINO J. D'ANGELO¹, Daniel B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens 30602 LOUIS CORNICELLI, Minnesota Department of Natural Resources, St. Paul 55155 CHRISTINA E. CLARKSON, College of Veterinary Medicine, Department of Veterinary and Biomedical Sciences, University of Minnesota, St. Paul 55108, and ARNO WUENSCHMANN, College of Veterinary Medicine, Minnesota Veterinary Diagnostic Laboratory, University of Minnesota, St. Paul 55108. *Submitted 22 August 2017; Accepted 8 January 2018.*

¹ Corresponding author: e-mail: gdangelo@uga.edu

Copyright of American Midland Naturalist is the property of University of Notre Dame / American Midland Naturalist and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.