TRANSACTIONS OF THE KANSAS ACADEMY OF SCIENCE
Vol. 108, no. 1/2
p. 1-14 (2005)

A review of the dinosaurs from Kansas

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Although Kansas is best known for an abundance of marine fossils from the Late Cretaceous, there may be up to 16 dinosaur records from the state. These are (in order of discovery): 1) the Mudge tracks from the Dakota Formation of Clay County; 2) the hadrosaur, *Claosaurus agilis*, from the Niobrara Chalk of Logan County; 3) the Snow track from the Dakota of Ellsworth County; 4) the "fossil turtle" specimen from the Dakota of Cloud County, which appears to be an ankylosaurid sacrum; 5) a vertebra from the Pierre Shale of Logan County; 6) a partial vertebra from the Kiowa Formation or Cheyenne Sandstone of Clark County; 7) nodosaurid dermal scutes from the Niobrara of Lane County; 8) a partial skeleton of the nodosaurid, "*Hierosaurus sternbergii,*" from the Niobrara of Gove County; 9) a partial skeleton of the nodosaurid, *Niobrarasaurus coleii*, from the Niobrara of Gove County; 10) a large slab containing tracks and trackways from the Dakota of Lincoln County; 11) possible dinosaur gastroliths from the Dakota of Clay County; 12) a partial skeleton of the nodosaurid, *Silvisaurus condrayi*, from the Dakota of Ottawa County; 13) a partial skeleton of a nodosaurid from the Niobrara of Rooks County; 14) a natural mold of a *Silvisaurus*(?) sacrum from the Dakota of Russell County; 15) two associated limb bones of cf. *Niobrarasaurus coleii* from the Niobrara of Lane County; and 16) a dinosaur footprint from the Dakota of Ellsworth County. Of these 16 specimens, five (specimens 1, 3, 4, 6, and 11) are lost. The dinosaur record of Kansas spans the late Albian to the early Campanian, and includes diverse depositional settings that are not otherwise well represented in the dinosaur fossil record.

Keywords: Kansas, Cretaceous, dinosaur, Niobrarasaurus, Silvisaurus, ichnofossil.

INTRODUCTION

Most Mesozoic rocks exposed in Kansas represent marine, marginal marine, and coastal environments, with marine rocks dominating. Therefore, the potential for terrestrial dinosaur fossils is relatively low. Nevertheless, over the years, perhaps as many as 16 dinosaur body and trace fossils have been identified. The last published comprehensive list of known dinosaur specimens from Kansas was given by Lane (1946). For his Masters thesis, Harksen (1963) compiled a bibliography and catalogue of reptilian and avian fossils, which included four dinosaur species. Carpenter, Dilkes and Weishampel (1995) gave a complete review of the dinosaurs from the Niobrara Chalk. Because there has not been a comprehensive review of dinosaurs from Kansas in many years, and several additional dinosaur specimens have come to light, it is appropriate to review them again.

The specimens reviewed are discussed according to the order that they were discovered (Table 1; Fig. 1), and represent both those from past literature reports and two new specimens (14 and 16) not previously published. Five of the specimens (1, 3, 4, 6, and 11) have been lost or are unavailable. It is beyond the scope of this paper to conduct a taxonomic revision; taxonomic assignments by the most recent reviewers are assumed to be correct.

Table 1. Dinosaur specimens from Kansas. The specimens are listed in order of discovery. YPM = Yale Peabody Museum, KUVP = Vertebrate Paleontology collection, University of Kansas, FHSM = Fort Hays State University, Sternberg Museum, KSP = Army Corps of Engineers, Kanopolis State Park.

Specimen	Dinosaur specimen	Year of discovery	Museum
1	Mudge tracks	1866	Lost
2	*Claosaurus agilis*	1872	YPM
3	Snow track	1885	Lost
4	"Fossil turtle," likely an ankylosaurid sacrum	<1899	Lost
5	Pierre Shale vertebra	1900?	KUVP
6	Partial vertebra from Kiowa or Cheyenne	1902	Lost
7	Nodosaurid dermal scutes	1905, collected 1909	YPM
8	*"Hierosaurus sternbergii"*	1905	YPM
9	*Niobrarasaurus coleii*	1930	FHSM
10	Dakota track slab	1933	KUVP & FHSM
11	Gastroliths	<1938	Lost
12	*Silvisaurus condrayi*	1955	KUVP
13	Fragmentary nodosaur	1973	KUVP
14	*Silvisaurus*(?) sacrum	<1988	FHSM
15	cf. *Niobrarasaurus coleii* limb bones	2000	FHSM
16	Kanopolis track	2002	KSP

The following abbreviations are used for institutional collections cited: FHSM VP, Fort Hays State University's Sternberg Museum of Natural History Vertebrate Paleontology collection, Hays, Kansas; KUVP, Vertebrate Paleontology collection at the University of Kansas Museum of Natural History, Lawrence, Kansas; YPM, Yale Peabody Museum, New Haven, Connecticut; and KSP, Army Corps of Engineers office at Kanopolis State Park, Kansas.

Specimens 1-16

Specimen 1—Mudge tracks

Specimen Number/Description: Lost
Locality: Northwestern Clay County

Mudge (1866a) described four tracks from a slab of sandstone from along the Republican River. Mudge described the locality as being "…in T. 6, R. 1, east of the sixth principal meridian" (Mudge 1866b, p. 11) and being "on

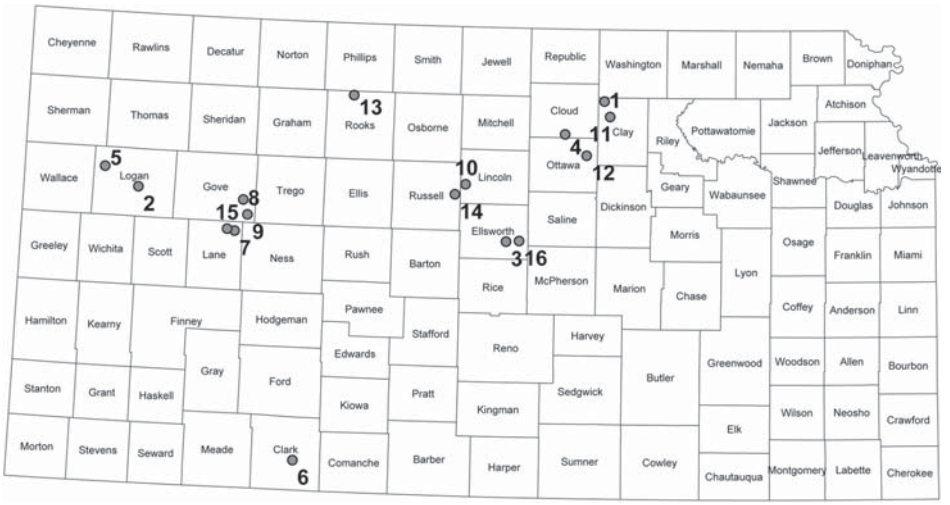

Figure 1. Localities of dinosaur fossils in Kansas. Specimen numbers are the same as in the text and table.

the south-westerly bank of the Republican river [sic], about fifty miles from its mouth" and the slab was found "near the highest point of the bluff, on a projection within one hundred yards of the river" (Mudge 1866a, p. 174). A review of the geology and topography of the specified township shows that the specimen most likely came from the southern half of section 9 of the specified township, being in extreme northwestern Clay County, from the Dakota Formation.

Mudge thought that there were at least two varieties of ichnofossils among the four impressions preserved. He provided measurements for the tracks. Both ichnotaxa were tridactyl. The first had the following measurements: toe lengths, from medial to lateral, of 9.5, 13.0, and 9.5 cm; and total print length, from anterior to posterior, of 14.0 cm. The second had the following measurements: toe lengths, from medial to lateral, of 6.6, 8.9, and 7.9 cm; and total print length, from anterior to posterior, of 9.5 cm. (Mudge gave measurements in inches and they have been converted to metric units here). Mudge (1866a, p. 176) wrote that the slab was unfortunately lost when his wagon overturned in a swollen stream.

Mudge thought that the track-maker(s) were birds (1866a), and noted the similarity of the Kansas tracks to those found in Triassic rocks in Connecticut (1866b). The Connecticut tracks are now widely recognized as being dinosaur ichnofossils (Lull 1953). Currie (1981) summarized past work and added his own observations on distinguishing bird and dinosaur foot prints. In general, the divarication angle between digits II and IV in dinosaurs tended to be less than 90 degrees, and tends to be higher in birds, particularly shorebirds. There seems to be a trend also in the width-to-length ratio of the prints, with dinosaurs tending to have a ratio of less than 1.0, and birds tending to have a ratio higher than 1.0, although there is considerable overlap in the ratio and divarication values. Currie interpreted the divarication angle in the two Kansas track types described by Mudge as being 65 degrees, and he concluded that these tracks were made by dinosaurs (1981).

It should be noted that Mudge was later led to believe that the marks were the work of Indians (Williston 1898; Gould 1901), although there is no more elaboration as to why he might have come to that conclusion, and it seems most likely that the marks were in fact dinosaur prints.

Specimen 2—*Claosaurus agilis* (Marsh 1872)

Specimen Number/Description: YPM 1190, partial skeleton
Locality: Sec. 28 or 29, T13S, R34W, Logan County

During Marsh's 1872 expedition to the west, the party worked outcrops of the Niobrara Chalk and discovered a partial skeleton of a hadrosaur. Marsh (1872) initially designated the specimen as the holotype of *Hadrosaurus agilis*, but later (Marsh 1890) assigned it to a new genus *Claosaurus*. Only the poorly preserved type specimen has been assigned to this taxon. However, given its geologic age it has taken an important role in the phylogeny of hadrosaurs (Carpenter, Dilkes and Weishampel 1995).

All of the dinosaurs from the Niobrara Chalk (Specimens 2, 7, 8, 9, 13, and 15) are from the Smoky Hill Chalk Member. Carpenter, Dilkes and Weishampel (1995) noted that the Niobrara record of dinosaurs, although sparse, is the best dinosaur assemblage from the late Coniacian to early Campanian.

Specimen 3—Snow track

Specimen Number/Description: Lost
Locality: Near Thompson's Creek, Ellsworth County

Snow (1887) published a report of a track on a slab of Dakota sandstone picked up from a rock pile from a well excavation, estimated to be from about 13 m from the surface. Snow estimated that the slab was from about 60 m above the top of the Dakota, and a similar stratigraphic level, exposed about 2 km from the well along Thompson Creek, produced fossil leaves (Snow 1887). Today, Thompson Creek flows into Kanopolis Lake, so this track was found near the track reported here as Specimen 16.

Snow (1887) identified the track as being from a bird, citing what seems to be the mark of a hallux, or fourth toe, extending posteriorly from the track, as well as its overall small size (Fig. 2). However Currie (1981) wrote that the presumed hallux impression visible in the figure of the track resembles the drag marks left in other dinosaur footprints, and because of the low divarication angle between digits II and IV he determined that the track was made by a small dinosaur. The entire track was reported to be 5 cm long, so the track maker was a small dinosaur, perhaps a juvenile. Unfortunately, since the report of this print, the specimen seems to have been lost.

Specimen 4—"Fossil turtle"

Specimen Number/Description: Lost
Locality: South of Concordia, southern Cloud County

Parmenter (1899) described a specimen from the Dakota Formation that he thought was a turtle. The specimen subsequently has been lost. The figure published by Parmenter, and reproduced here (Fig. 3), suggests that the specimen was a sacrum, perhaps from an

Figure 2. Track identified from the Dakota Formation from Ellsworth County, originally described by Snow (1887) as a bird, but subsequently interpreted as a dinosaur by Currie (1981). It is Specimen Number 3 in text. Figure taken directly from Snow 1887.

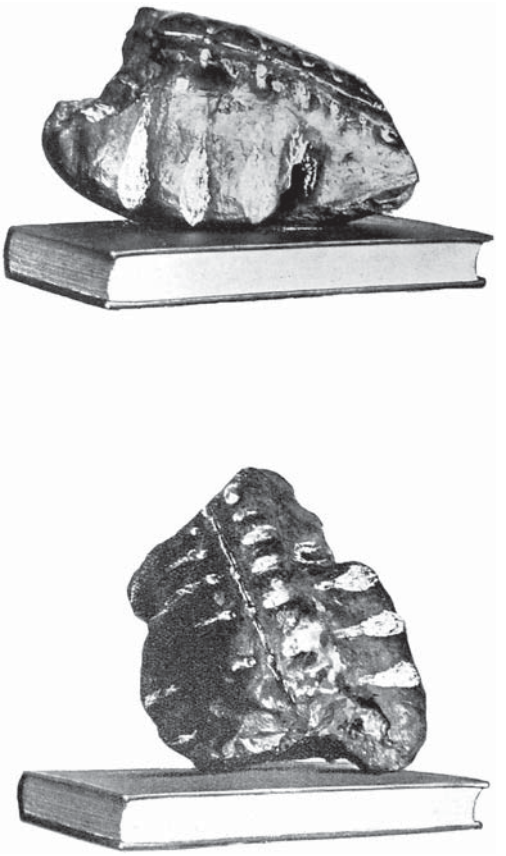

Figure 3. Specimen originally published as a "fossil turtle," but likely a dinosaur sacrum. It is specimen number 4 in text. Figure taken directly from Parmenter 1899.

ankylosaurid. The fused vertebrae of ankylosaur sacra are dorsoventrally compressed, relatively wide, with low, broad neural arches forming a continuous, blade-like ridge (Coombs and Maryanska 1990). It could be that the figure of the Kansas specimen shows such a low ridge down its midline and expanded lateral vertebral processes. The apparent thickness of the specimen seen in the figure could be indicative of sediments filling in the pelvic void, forming the concretionary mass. However, without the specimen itself this line of speculation is not testable.

Specimen 5—Pierre Shale vertebra

Specimen Number/Description: KUVP 1398, vertebra
Locality: Near McAllaster, Logan County

This single vertebra was collected from the Pierre Shale, likely from the Sharon Springs Shale Member, sometime around the turn of the twentieth century by a party from the University of Kansas (Lane 1946). Although it has been identified as dinosaur, a more specific taxonomic assignment is not possible due to the fragmentary nature of the specimen.

Specimen 6—Partial vertebra

Status/Specimen Number: Lost
Locality: Clark County

Gould collected a vertebral centrum from Cretaceous rocks in Clark County (Williston 1902). Williston thought the specimen was from a carnivorous dinosaur "allied to *Creosaurus* or *Allosaurus*" (Williston 1902, p. 247), and gave its measurements as being 100 mm in length, 87 mm in transverse diameter at the extremities, and 100 mm in height.

As the specimen was collected in Clark County, it must have been from the Lower Cretaceous, either from the Kiowa Shale or Cheyenne Sandstone, as those are the Mesozoic rocks exposed in that county. That fact makes this specimen the oldest dinosaur reported from Kansas. Unfortunately, since Williston first reported the specimen, it cannot be located. Other specimens that Williston (1902) mentioned are in the KUVP collection and are referred to by Schultze et al. (1985), but no mention of this specimen could be found in that report.

Specimen 7—Nodosaurid scutes

Specimen Number/Description: YPM 55419, 2 plates
Locality: Lane County

These two dermal plates were collected by Charles H. and George F. Sternberg during their 1905 expedition in the chalk, and the specimens were described and figured by Wieland (1909). The specimens were re-examined by Carpenter, Dilkes and Weishampel (1995), and they considered them to be from a nodosaur, but were not more specific. The relationship of this specimen with the holotype of "*Hierosaurus sternbergii*," and why it is attributed as being from Lane County, is given below.

Specimen 8—*"Hierosaurus sternbergii"* Wieland 1909

Status/Specimen Number: YPM 1847, partial skeleton
Locality: "five miles south of Castle Rock and three miles south of Hackberry Creek," Gove County

The specimen consists of at least 34 dermal scutes, and skull and rib fragments (Carpenter, Dilkes and Weishampel 1995). Weiland (1909, 1911) described the specimen as the holotype of "*Hierosaurus sternbergii*," although Carpenter, Dilkes and Weishampel (1995) stated that the specimen does not preserve any characters that would justify it as a separate species, and therefore, they considered the taxon to be a *nomen dubium*. However, the specimen is some sort of nodosaurid, and therefore, a true dinosaurian record from the state.

There is some confusion (e.g. Carpenter, Dilkes and Weishampel 1995) about how the holotype of "*Hierosaurus sternbergii*" and the dermal plates (YPM 55419; Specimen 7 here) relate to each other. However, a careful review of the primary literature and museum records suggests a solution. Charles H. Sternberg mentions finding a weathered skeleton in 1905 that he thought was a strange turtle, but "as it was weathered and detached from its matrix I concluded it could not be used and left it there" (Sternberg 1909, p. 257). Sternberg continues his description of the expedition by saying that "Later, my son George brought into camp, a few miles from Hackberry creek [sic], where I had found my specimen, some peculiar plates like the ones I have already mentioned" (p. 257). The plates found by George (specimen 7 here) were sent to Wieland at the Yale Peabody Museum who was studying marine turtles (Sternberg 1909).

Wieland (1909) reported that "amongst turtle material sent to the Yale Museum from the Hackberry Creek region by Mr. Charles H. Sternberg" were "two paired and presumably caudal, or else cervical, dermal elements" (p. 250) which he figured (Wieland 1909, figs. 7 and 7a). C.H. Sternberg visited Wieland at Yale and was told that Wieland thought the plates were from a dinosaur. Sternberg wrote that "Later I secured the skeleton, through the efforts of my son, who found them [additional plates, see below] as I directed (Sternberg 1909, p. 257). The specimen that Sternberg directed his son to find was the first one he mentions as being too weathered to collect when he saw it in 1905, recognizing the similarities between the scutes Wieland identified as dinosaur (YPM 55419; specimen 7 here) and what he saw in the field (YPM 1847; specimen 8 here).

Wieland stated that "Mr. Sternberg secured, five miles south of Castle Rock and Three [sic] miles south of Hackberry Creek, six dermal scutes of a form quite certainly dinosaurian" (Wieland 1909, p. 250). All these scutes were designated by Wieland as "*Hierosaurus sternbergii*." In a later paper, Wieland described additional skeletal material sent to him by the Sternbergs (Wieland 1911, p. 113) and made it clear that he understood that the specimens sent to him belonged to two separate specimens, with most of the material coming from one site: "They [all the specimens of '*H. sternbergii*'] come from the same locality, and so far as I can determine represent but a single animal, *with the exception of the caudal bands shown in the first description*

[YPM 55419]" [italics added]. This statement, and the statements by Sternberg, strongly suggests that the six scutes and additional skeletal material came from the specimen first determined by Sternberg to be too weathered to collect, and the statement confirms that the first set of scutes sent to Wieland, now YPM 55419 (specimen 7 here), came from a different locality.

Carpenter, Dilkes and Weishampel (1995) present an account of the series of discoveries relating to these two specimens, but admitted to being confused about which specimens came from which locality. Those authors reported that YPM 55419 came from Gove County. This is most likely incorrect.

Accession records at the YPM list specimen YPM 55419 (specimen 7) as being in a lot of material from the Castle Rock area, from both Lane and Gove counties. By matching the descriptions of the specimens contained in the lot to other curated specimens, it is most likely that YPM 55419 was described in the original accession as "'Turtle 1' = Undetermined reptile. Lane Co., Kansas." The holotype of "*Hierosaurus sternbergii*" (YPM 1847) is accessioned separately as coming from Gove County. There is also a third accession record of additional material relating to the type of "*H. sternbergii*," and it is cross referenced to the original accession of the holotype.

Therefore, all the accession records and historic accounts are congruent. The first specimen (YPM 55419; specimen 7 here) was collected in Lane County and sent to Wieland. Sternberg realized he had seen another similar specimen in Gove County (the specimen judged too weathered to collect upon first seeing it), and so that second specimen (YPM 1847) was collected by G.F. Sternberg at C.H. Sternberg's direction, and it too was sent to Wieland, likely in two shipments accounting for the two accessions associated with YPM 1847.

Specimen 9—*Niobrarasaurus coleii* (Mehl 1936)

Specimen Number/Description: FHSM VP-14855, partial skeleton
Locality: Sec 16, T15S, R26W, Gove County (more precise location information is on file at the Sternberg Museum of Natural History)

This specimen was originally sent to the University of Missouri in 1930 by Virgil Cole. It was described by Mehl (1936) as *Hierosaurus coleii*, thinking it was related to, but distinct from "*H. sternbergii*" (see Mehl 1931 for preliminary report). The specimen was reevaluated by Carpenter, Dilkes and Weishampel (1995) and given the new name of *Niobrarasaurus coleii*. This specimen has since been transferred to Fort Hays State University's Sternberg Museum of Natural History (Everhart 2004).

The locality for this specimen, and therefore the type locality for the genus, was re-discovered by Mike Everhart and Tom Caggiano during the spring of 2003, and four additional bones were recovered. The specimen consists of parts of the skull, teeth, cervical vertebrae, dorsal vertebrae, ribs, partial sacrum and ilia, caudal vertebrae, chevrons, partial right scapulocoracoid, complete right humerus, ulna, and radius, fragments of the left ulna and radius, metacarpals, complete right femur, tibia, fibula, and pes, parts of the left femur, tibia, fibula, and pes, and dermal armor.

Specimen 10—Dakota track slab

Specimen Number/Description: KUVP 5914 and FHSM VP-138, sandstone slabs with tracks and trackways
Locality: "A few miles southwest of" Sylvan Grove, Lincoln County

Lane (1946, p. 322-323) wrote: "There is in the University of Kansas Museum of Vertebrate Paleontology at Lawrence a series of over 50

tracks of a large Cretaceous crocodilian, discovered by Mr. C. T. Brandhorst of Sylvan Grove, Lincoln County, Kansas, at a site a few miles southwest of that town. Dr. C. W. Hibbard and the late W. S. Long collected over fifty of these tracks from an area about 7 x 10 feet in extent. They are large sized impressions and may well have been made by an individual of *Dakotasuchus kingi*."

Vaughn (1956) mentioned the tracks when discussing a second specimen of *D. kingi* from the Dakota. Lockley (1986) also speculated that the tracks were attributable to a crocodylomorph. In contrast, McAllister (1989a and 1989b), in his review of the slabs, argued that the track maker was a dinosaur, most likely a hadrosaur or possibly an ankylosaur. However, McAllister (1989a) seems to have made an error in his interpretations of the tracks, even if that error had no deleterious effects upon his conclusions. He noted that the tracks (individual footmarks) and trackways (series of at least three associated tracks) were made in soft mud later covered by sand. The sand filled the tracks and lithified, preserving the tracks on the bottom surface of a massive sandstone. Thus in viewing the track casts in plan view one is looking at the bottom of the tracks. McAllister seems to have failed to account for this, and so he misidentified left and right tracks in the trackways.

McAllister (1989a) justified his interpretation of the track makers as dinosaur rather than crocodylomorph through several observations. The marks McAllister interepreted as being from the manus are pentadactyl, though most commonly preserving marks from only three of the digits. The pes marks are tridactyl. In modern *Alligator mississippiensis*, the digit formula is five for the manus and four for the pes, thus the presumed fossil pes marks show a different digit formula from modern crocodylomorphs. Additionally, the digit marks of the tracks suggested to McAllister that the unguals of the track maker were blunted and hoof-like, not sharp as in crocodylomorphs. He identified several individual trackways in the slabs, indicating that several individuals were involved in the track making, and that the direction of movement was in a more or less uniform pattern. McAllister argued that a uniform direction of movement in several individuals would be less likely with the movements of multiple individual crocodylomorphs each acting alone, but is consistent with group movements proposed for some dinosaurs. Lastly, McAllister cited observations of modern crocodiles moving through water, where they tend to scull through the water with their tails while their limbs are held tightly against the body. The morphological arguments are perhaps most compelling, but all of the arguments by McAllister support an interpretation of these tracks as dinosaur ichnofossils, and so the specimen is included here.

Specimen 11—Gastroliths

Specimen Number/Description: Lost
Locality: Two sites: Sec. 19, T 7 S, R 2 E; and "over 5 miles south and 2.5 miles northwest of that locality," Clay County

Schaffner (1938) reported discovering polished stones, 2.5 to 7.5 cm in diameter, in the Dakota Formation at several localities in northwestern Clay County. He compared the stones to gastroliths from the Morrison Formation, and concluded that the Kansas specimens were gastroliths, as they appeared to be different from other wind- or water-polished stones. However, Schaffner did not state that his specimens were deposited in a collection, and they evidently are lost. These specimens may be from a dinosaur, but this taxonomic assignment is the most uncertain of the specimens reviewed here. It would not be impossible for true dinosaurian gastroliths to occur in the Dakota. Like Schaffner, Whittle and Onorato (2000) also suggested that differences between biologic and natural polish on stones can be seen.

Gastroliths have been found for many taxonomic groups (Whittle and Everhart 2000), including several dinosaur groups. Among these are hadrosaurs and ankylosaurs, the two groups of Kansas dinosaurs known from body fossils. However, even if the stones described by Schaffner were gastroliths, attributing them specifically to dinosaurs is problematic. They are included here only for the sake of completeness of the possible dinosaur record.

Specimen 12—*Silvisaurus condrayi* Eaton 1960

Specimen Number/Description: KUVP 10296, partial skeleton
Locality: SW Sec. 8, T10S, R1W, Ottawa County

A partial skeleton of a nodosaurid dinosaur was found by Warren Condray on his farm in Ottawa County from Dakota Formation rocks. It was collected and donated to the University of Kansas Museum of Natural History in 1955. Eaton (1960) described the specimen and designated it the holotype of *Silvisaurus condrayi*. The specimen consists of the skull, vertebral column, and sacrum, but lacks most limb bones. This specimen is the best preserved example of this taxon.

Specimen 13—Fragmentary nodosaur

Specimen Number/Description: KUVP 25150, partial skeleton
Locality: SE Sec. 12, T6S, R19W, Rooks County

This partial nodosaur was collected in 1973 by J.D. Stewart from the Smoky Hill Chalk and consists of four crushed centra, ribs and rib fragments, proximal and distal ends of the left scapula, a complete left humerus, partial right humerus, proximal ends of the right ulna and radius, partial pubis(?), fragment of the fibula(?), and 12 fragments of dermal armor. After reviewing the specimen, Carpenter, Dilkes and Weishampel (1995) concluded that this specimen was a nodosaur based on the slenderness of the humeral shaft and the position of the acromial process on the scapula, but the specimen was too fragmentary to be assigned to any known genus or species.

Specimen 14—*Silvisaurus*(?) sacrum

Specimen Number/Description: FHSM VP-10441 (original ironstone mold) and FHSM VP-10442 (rubber cast), sacrum
Locality: Wilson Lake, Russell County (more precise location information is on file at the Sternberg Museum of Natural History)

This specimen is an ironstone mold of a sacrum which compares well with the figures of *Silvisaurus* (Eaton 1960). However, a detailed study of the specimen has not yet been conducted. The specimen was reported in a presentation to the Kansas Academy of Sciences by Nelson (1988), and it is figured here for the first time (Fig. 4).

Specimen 15—cf. *Niobrarasaurus coleii* limb bones

Specimen Number/Description: FHSM VP-13985, radius and ulna
Locality: Northeastern Lane County (more precise location information is on file at the Sternberg Museum of Natural History)

In October, 2000, an associated radius and ulna were found in the Smoky Hill Chalk (Hamm and Everhart 2001). Everhart and Hamm (2005, this volume) identified the specimen as a juvenile cf. *Niobrarasaurus coleii*. Tooth marks on the specimen suggest that it was scavenged during its time in the Western Interior Sea.

Specimen 16—Kanopolis track

Status/Specimen Number: KSP specimen, Army Corps of Engineers specimen housed at the

Kanopolis Visitor Center, track
Locality: Kanopolis State Park, Ellsworth County (more precise location information is on file with the Army Corps of Engineers)

In June of 2002, while walking along the lake shore at Kanopolis State Park, Mark Ellis of Wakarusa, Kansas, found a footprint of a dinosaur weathering out of Dakota Formation. Ellis brought the specimen to the attention of the author, who arranged with the Corps of Engineers for its collection. The specimen was collected in a slab of sandstone. The slab, and the area around the collection site, is rich in plant remains. Ripple marks in the sandstone, along with the plant material, attest to a near shore marine or fluvial environment of deposition.

Figure 4. *Silvisaurus*? sacrum, FHSM VP-10441 and specimen number 14 in the text, was discovered at Wilson Lake, Russell County, Kansas.

The single track is preserved as a raised impression and is tridactyl (Fig. 5). The middle toe-mark measures approximately 100 mm from the tip to the somewhat obscure heel-mark. The toe-mark to the left of the middle toe measures 50 mm from the tip to the center of the heel. The toe-mark to the right of the middle toe measures 75 mm from the tip to the center of the heel. The angle between the middle toe-mark and the left toe-mark is 58 degrees, and the angle between the middle toe-mark and the right toe-mark is 40 degrees, thus the total divarication angle between the presumed digits II and IV is 98 degrees. The distance between the outside toe-marks is 80 mm as measured from toe tip to toe tip, giving a width-to-length ratio of 0.80.

Unfortunately, there is only one clear mark preserved in the sandstone. A mark somewhat similar to the middle toe-mark is also evident on the slab, oriented perpendicular and pointing towards the first mark. It is far from clear that the second mark is a poorly preserved track, but that is a possibility. The certainty of the first mark being a track would be greatly enhanced if there were other clear prints like the first forming a trackway. However, given its strong tridactyl appearance and the depositional setting, it is not unlikely that it is an authentic track. While the divarication angle is relatively high, it is not outside the expected range for dinosaur prints, and because the width-to-length ratio is relatively low (see discussion with specimen 1), it is likely that the track was made by a small theropod.

There are many reports of Cretaceous-aged dinosaur tracks and trackways throughout the western plains region, including Texas (Lee 1997), New Mexico (Gillette and Thomas 1985; Lucas, Hunt and Kietzke 1987; Cotton, Cotton and Hunt 1998; and Matsukawa, Matsui and Lockley 2001), Colorado (Lockley 1986, 1987; Matsukawa, Lockley and Hunt 1999; Kurtz, Lockley and Engard 2001; Lockley 2001; and Schumacher 2003), South Dakota (Lockley, Janke and Theisen 2001), and British Columbia (Sternberg 1932).

Small theropod tracks somewhat similar to the Kansas specimen were described by Lockley, Janke and Theisen (2001) from the Lakota Formation of South Dakota. It is of great interest that the KSP specimen closely matches the description given by Mudge (1866a) for one of the tracks that was

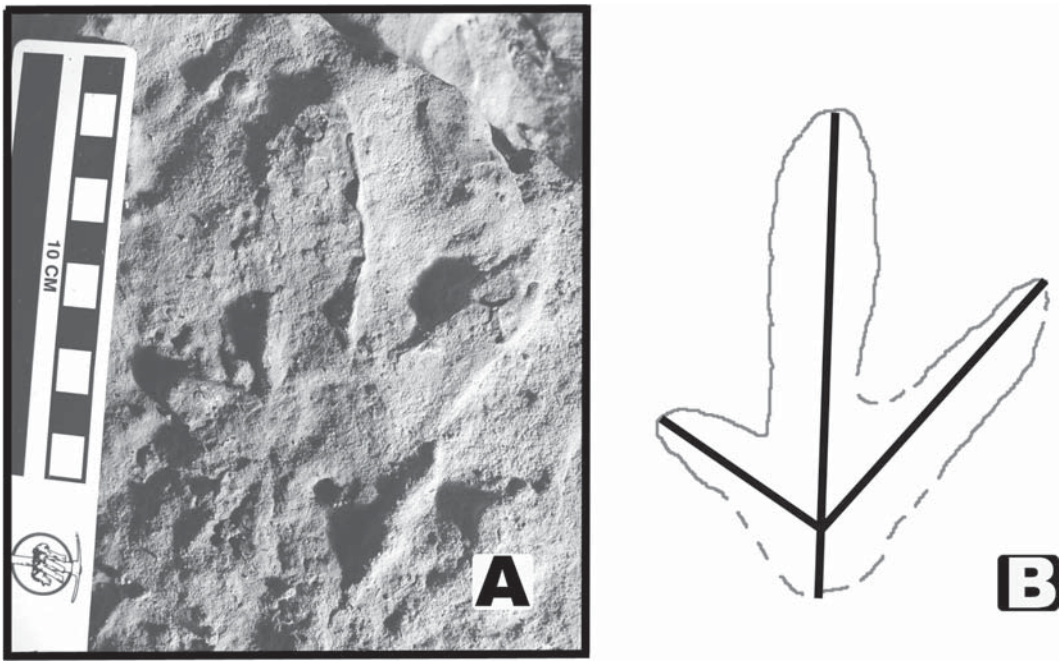

Figure 5. Kanopolis track, specimen number 16 in text. A: photograph of the track; B: tracing of the track with lines showing the midline of the toes.

accidentally lost from the Dakota of Clay County (specimen 1). It could be that this print is the first preserved track of an undescribed taxon of small theropod ichnofossil characteristic of the Dakota Cretaceous in Kansas.

Discussion

Although most of the Mesozoic rocks exposed in the state of Kansas were deposited in a marine setting, a number of dinosaurs have been recovered from the state. Eleven of the 16 reports listed here are specimens held in museums or available for study, including five partial skeletons (specimens 2, 8, 9, 12 and 13). The specimens range in age from the late Albian through the early Campanian, spanning approximately 105-80 Ma, a period not well represented by other dinosaur faunas. In addition, the specimens were recovered from rocks that represent diverse depositional settings, from coastal marine or fluvial rocks of the Dakota Formation (specimens 1, 3, 4, 10, 11, 12, 14, and 16), to more marginal or open marine rocks like those from the Kiowa/Cheyenne, Niobrara, and Pierre (specimens 2, 5, 6, 7, 8, 9, 13, and 15). So although Kansas is not best known for its dinosaurian fauna, the specimens recovered from the state do add significant knowledge to the dinosaurian record.

Acknowledgements

I am grateful to Mary Ann Turner, Yale Peabody Museum, for her help in sorting out the accession records at that institution. Many people were involved with the Kanopolis Dakota track: Mark Ellis discovered it and brought it to my attention; Ken Nelson, Operations Manager, Corps of Engineers, Kanopolis Project Office, and his staff allowed the recovery of the Dakota track; Rick Martin, Park Manager, Wendy Bowles, Conservation Worker, Vicky Packard, Naturalist, and the rest of the staff of Kanopolis State Park were quite helpful with the recovery project; Jim Huenergarde assisted

in the field; and Martin Lockley provided valuable discussions on dinosaur tracks. Mike Nelson shared significant information from his 1988 presentation to the Kansas Academy of Sciences on dinosaurs from Kansas, providing a great head start on the results presented here. Mike Everhart helped give the inspiration for this project, provided valuable references, and helped coordinate its publication with his paper in this same volume. C. Liggett and two anonymous reviewers provided valuable editorial criticism, greatly improving the paper.

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