

# NEW SPECIMENS OF THE RARE ANKYLOSAURID DINOSAUR *NODOCEPHALOSAURUS KIRTLANDENSIS* (ORNITHISCHIA: ANKYLOSAURIDAE) FROM THE UPPER CRETACEOUS KIRTLAND FORMATION (DE-NA-ZIN MEMBER), SAN JUAN BASIN, NEW MEXICO

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**Abstract**—New material of the rare ankylosaurid dinosaur *Nodocephalosaurus kirtlandensis* Sullivan, 1999 is identified and described. Specimens include cephalic osteoderms, a cervical spine, and two caudal vertebrae. The caudal vertebrae are distinct from other known North American ankylosaurids (such as *Euoplocephalus tutus*), thus reinforcing their taxonomic assignment to *N. kirtlandensis*. Presently, *N. kirtlandensis* is known only from the De-na-zin Member of the Kirtland Formation, San Juan Basin, New Mexico.

## INTRODUCTION

The rare and enigmatic ankylosaurid *Nodocephalosaurus kirtlandensis* was named and described by Sullivan (1999) based on a partial skull (Fig. 1) from the De-na-zin Member, Kirtland Formation, San Juan Basin, New Mexico. Since its initial discovery and description, additional material of *N. kirtlandensis* has been recovered and identified from other sites within the De-na-zin Member and is referable to this species, in part, based on parsimony, as it is the only diagnostic ankylosaurid known from this stratigraphic interval in the San Juan Basin. Here, we document this new material, which provides additional information regarding the morphology of this species. All specimens discussed here are in the collections of the State Museum of Pennsylvania (SMP), Harrisburg.

## NEW MATERIAL

### Dermal Armor

**Cephalic Osteoderms**—Two cephalic (cranial) osteoderms (SMP VP-1957, Fig. 2) were recovered from SMP locality 382 during the 2005 field season. They were found in association and seem to articulate with each other. One is complete, while the other is represented by the greater half. They are sub-conical in form, and their surface is slightly pitted. They compare readily in size and shape to those known from the holotype skull (SMP VP-900).

**Cervical Spine**—A large left cervical spine (SMP VP-1870, Fig. 3) was recovered from SMP locality 361 in the summer or 2004. It measures approximately 153 mm (maximum length) along the left lateral side (Fig 3B). The spine (Fig. 3) is roughly sub-conical, with its base flaring out laterally. It is somewhat laterally compressed near the apex, resulting in a low, keeled edge that runs along the dorsal distal side. In dorsal view, the spine is slightly asymmetrical (Fig. 3C). Ventrally, the spine is broken towards the base and is somewhat flattened toward the apex (Fig. 3A). The thickness of the spine wall varies. It is thickest along the dorsal side, especially towards the apex, and thins laterally, and still thinner ventrally. The internal and external surface texture is granular and pitted.

The location (life position) of the cervical spine was on the first cervical half ring. Based on the half-ring of *Saichania chulsanensis* described and illustrated by Maryańska (1977, pl. 36, 1a,b), we interpret it as having come from the left lateral side, nearest to the midline.

### Postcrania

**Caudal Vertebrae**—Two caudal vertebrae have been recovered (Fig. 4). As in other ankylosaurids they are slightly amphicoelous, bear a distinctive notochordal prominence in the center of the centrum, and have

massive neural spines. The first vertebra (SMP VP-1149, Fig. 4A-C) was collected from SMP locality 309 in the summer of 1998. It has short, laterally-projecting ribs that are low on the lateral sides of the centrum, and have a very broad attachment to the centrum. The prezygapophyses are broken, as are the postzygapophyses and the neural spine. There are also two fragments of the neural spine that have not been rejoined to the vertebra. The second vertebra (SMP VP-1743, Fig. 4D-F) was collected in 2003 at SMP locality 358. It has massive lateral transverse processes (ribs) that extended outward and down. They have a strong contact with the upper part of the centrum and base of the neural arch. Ventrally, the centrum bears two distinctive thumb-sized depressions on each side. Based on comparisons with caudal vertebrae of *Euoplocephalus* and *Ankylosaurus* figured by Coombs (1971) and Carpenter (2004) and the skeletal reconstruction of *Euoplocephalus* (Carpenter, 1982), we believe SMP VP-1149 is the seventh or eighth caudal and SMP VP-1743 is the first.

## DISCUSSION

Gilmore (1919) was the first to report on ankylosaur material from the San Juan Basin, which he referred to “Scelidosauridae genus and species indetermined.” Years later, additional ankylosaur material was discovered from the strata of the San Juan Basin and reviewed by Lucas et al. (1987), who determined that none of the specimens were identifiable to the genus level. Most of this material is from the Naashoibito Member of the Ojo Alamo (formerly part of the Kirtland) Formation. Recently, Ford (2000) named the ankylosaurid species *Glyptodontopelta mimus* and the nodosaurid species *Edmontonia australis*. Both are taxa based solely on osteoderms from the Ojo Alamo (Naashoibito Member). Their taxonomic validity has yet to be fully demonstrated.

The new material of *Nodocephalosaurus kirtlandensis* comes from a narrow outcrop band of the De-na-zin Member that stretches across a 3-km-long exposure. Because most of the material is not comparable to the holotype skull (SMP VP-900, Fig. 1), reference to the taxon *Nodocephalosaurus kirtlandensis* is based mostly on parsimony. However, differences in the osteology of the caudal vertebrae, noted above, clearly suggest that these elements are not referable to any other North American ankylosaurid taxon (such as *Euoplocephalosaurus tutus*). Ankylosaurid material (osteoderms and vertebrae) has recently been recovered from the lower part of the Kirtland (Hunter Wash Member), but none of this material can be referred to *Nodocephalosaurus kirtlandensis* with any level of confidence due to its incomplete nature.

## ACKNOWLEDGMENTS

We thank field assistant Fred Widmann, who helped to collect one

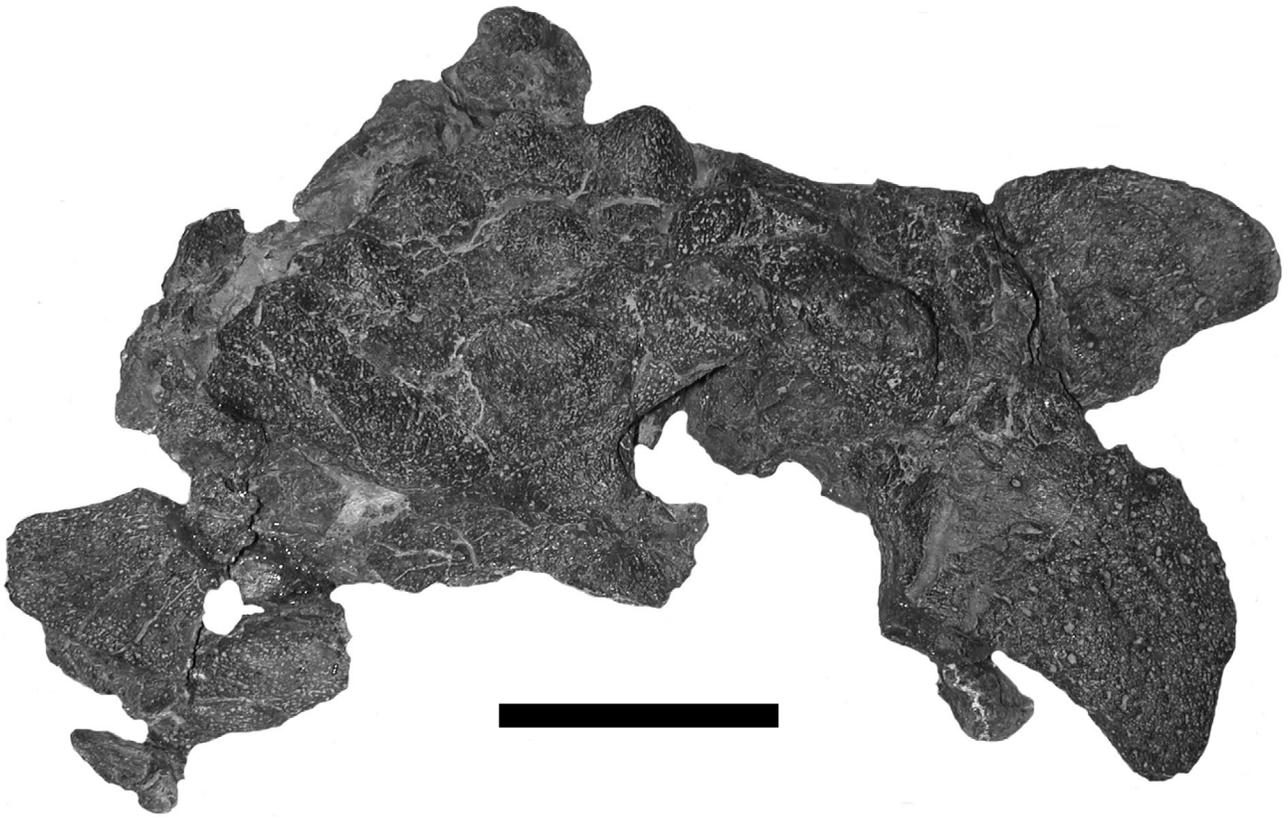


FIGURE 1. SMP VP-900, holotype of *Nodocephalosaurus kirtlandensis* Sullivan, 1999. Left side of skull. Bar scale = 10 cm.

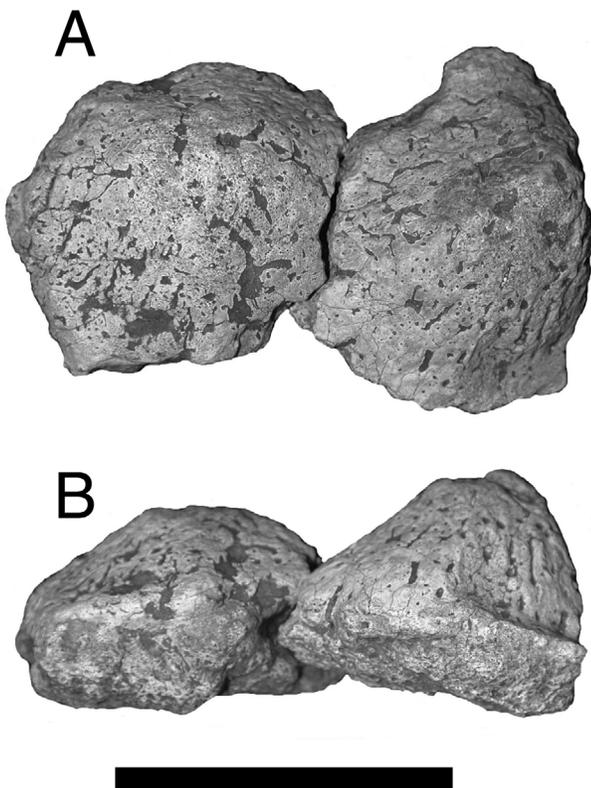


FIGURE 2. *Nodocephalosaurus kirtlandensis* (SMP VP-1957) cephalic (cranial) osteoderms. Bar scale = 5 cm.

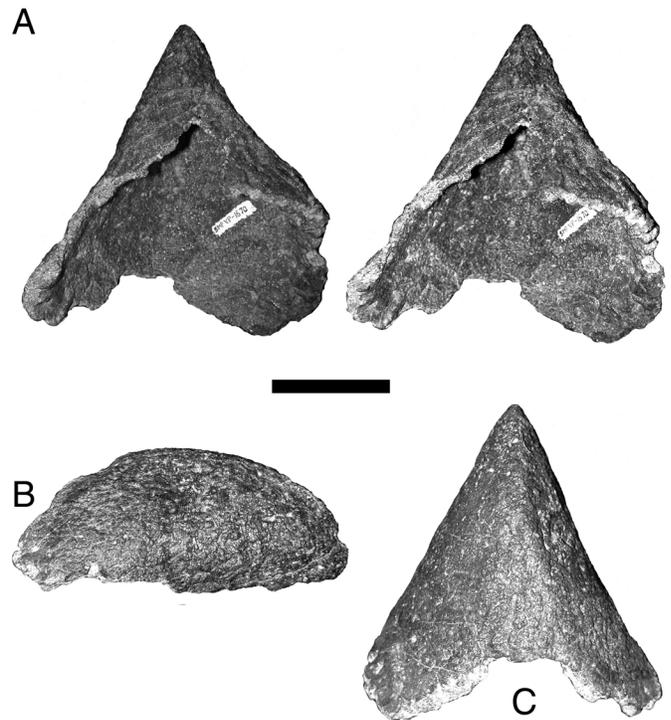


FIGURE 3. *Nodocephalosaurus kirtlandensis* (SMP VP-1870) cervical spine. **A**, posteroventral side (stereo pair); **B**, left lateral side (posterior to right); **C**, anterodorsal view. Bar scale = 5 cm.

of the specimens described above. Thanks are also extended to the Bureau of Land Management regional paleontologist Pat Hester (Albuquerque) and wilderness recreational specialist Rich Simmons (Farmington) for their help and support in field-related matters and permitting. All specimens were collected under Paleontological Resources Use Permits issued to R. M. Sullivan by the BLM, which are gratefully acknowledged.

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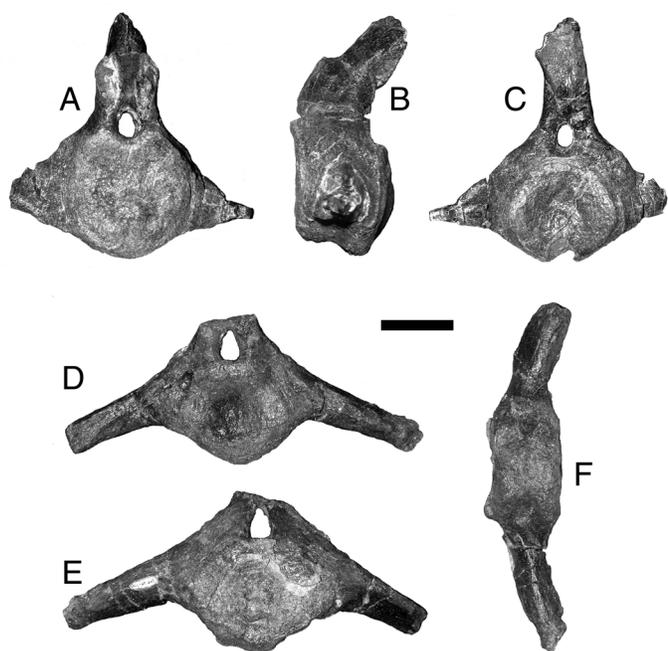


FIGURE 4. *Nodocephalosaurus kirtlandensis*, caudal vertebrae. **A-C**, SMP VP-1149, ?seventh or eighth caudal vertebra; **A**, anterior view; **B**, left lateral view; **C**, posterior view. **D-F**, SMP VP-1743, first caudal vertebra; **D**, posterior view; **E**, anterior view and **F**, ventral view. Bar scale = 5 cm.

