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DINOSAURS OF NEW MEXICO: AN OVERVIEW

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Abstract— New Mexico is in the forefront of dinosaur-collecting grounds. Analysis of the state's dinosaur fossils has been far reaching, touching upon every aspect of dinosaur paleontology, including biogeography, biostratigraphy, functional morphology, paleoecology, phylogeny, taphonomy and taxonomy. This volume brings together studies of New Mexico's dinosaurs in all of these areas of research, as well as up-to-date reviews of New Mexico's dinosaur fossil record and the scientific literature based on it.

INTRODUCTION

Cope (1885) published the first scientific report of dinosaur fossils from New Mexico. In the 115 years that followed, discoveries in Triassic, Jurassic and Cretaceous rocks have placed New Mexico in the forefront of dinosaur-collecting grounds (Fig. 1). Analysis of New Mexico's dinosaur fossils has been far reaching, touching upon every aspect of dinosaur paleontology, including biogeography, biostratigraphy, functional morphology, paleoecology, phylogeny, taphonomy and taxonomy. Indeed, this volume brings together studies of New Mexico's dinosaurs in all of these areas of research, as well as up-to-date reviews of New Mexico's dinosaur fossil record and the scientific literature based on it. To put these articles into broader perspective, we present an overview of scientific research on New Mexico's dinosaurs.

TRIASSIC DINOSAURS

In 1887, Cope proposed the first scientific name for a New Mexican dinosaur, the Triassic theropod now called *Coelophysis bauri*, New Mexico's State Fossil by act of the State Legislature. In 1947, George Whitaker's phenomenal discovery of the Upper Triassic dinosaur quarry at Ghost Ranch revealed a bonebed of hundreds (thousands?) of theropod skeletons, the singlemost extensive fossil assemblage of Triassic theropods known, and probably the largest, by number, accumulation of theropods in the fossil record.

Colbert (1989) monographed these theropods, yet much more research remains to be undertaken on them. Especially needed is a thorough study of their osteological variation to identify features that are of ontogenetic, sexual dimorphic or alphataxonomic significance. Because of this, no consensus has been reached on how many taxa are in the Ghost Ranch quarry (see Downs, this volume).

Until about the time of Colbert's (1989) monograph, virtually nothing was known of New Mexico's Triassic dinosaurs outside of Ghost Ranch. In that year, Hunt (1989) described a new ornithischian dinosaur from isolated teeth found in slightly older strata near Tucumcari, *Revueltosaurus callenderi*. Since then, numerous Triassic dinosaur fossils—mostly isolated bones and teeth, but also partial skeletons—have come from New Mexico (see Heckert et al., this volume). Importantly, this record is stratigraphically superposed and thus particularly significant when studying Triassic dinosaur evolution. For example, the oldest and most fragmentary Triassic dinosaurs from New Mexico are among the oldest known anywhere. Overlying these are more diverse and better preserved dinosaur faunas, including the type of *Eucoelophysis baldwini* Sullivan and Lucas and the Snyder quarry, which yielded the oldest known coelophysoid skull. These are in turn overlain by the Whitaker quarry and its hundreds of preserved *Coelophysis* skeletons. New Mexico's record of Late Triassic dinosaurs has thus emerged as one of the most extensive known, and is significant for several reasons:

- Some of the Upper Triassic dinosaur fossils from New Mexico are among the oldest known dinosaurs and thus are critical to analysis of dinosaur origins.
- Two holotype taxa of Triassic ornithischians and as many as six species overall come from New Mexico and are a significant component of a very scanty record of Triassic ornithischians worldwide.
- The youngest herrerasaurid dinosaurs are from New Mexico.
- Recent discovery of the Snyder quarry near Ghost Ranch, and recognition of *Eucoelophysis* (Sullivan and Lucas, 1999), establishes a stratigraphic (temporal) succession of Late Triassic theropods in the Chama basin, the only such succession known.

Furthermore, New Mexico has a substantial record of Late Triassic dinosaur footprints, including both theropod and prosauropod tracks (see Hunt et al. and Lockley et al., this volume). We anticipate that ongoing collecting efforts will uncover many new and significant dinosaur records from New Mexico's Upper Triassic strata that will continue to improve our nascent understanding of dinosaur origins and early evolution.

JURASSIC DINOSAURS

Lucas and Hunt (1985) published the first comprehensive review of New Mexico's Jurassic dinosaurs, bringing together a welter of disparate reports, mostly of isolated bones and teeth from the Brushy Basin Member of the Morrison Formation. Most puzzling to them was the absence of a major Morrison dinosaur quarry in New Mexico, unlike many other western states (Oklahoma, Colorado, Utah, Wyoming) in which one or more mass death assemblages have been found in the Morrison Formation. However, the Peterson quarry near Laguna (see Heckert et al., this volume) is a major dinosaur bonebed in the New Mexican Morrison Formation. First discovered in the 1960s, its significance has only been appreciated during the last few years through the yeoman collecting efforts of dedicated New Mexico Museum of Natural History volunteers directed by Ron and Rod Peterson and Dan D'Andrea. The Peterson quarry is a fluvially-concentrated bonebed, mostly of diplodocid sauropods, but including a very large theropod, in the Brushy Basin Member, as are most of the great Morrison dinosaur quarries.

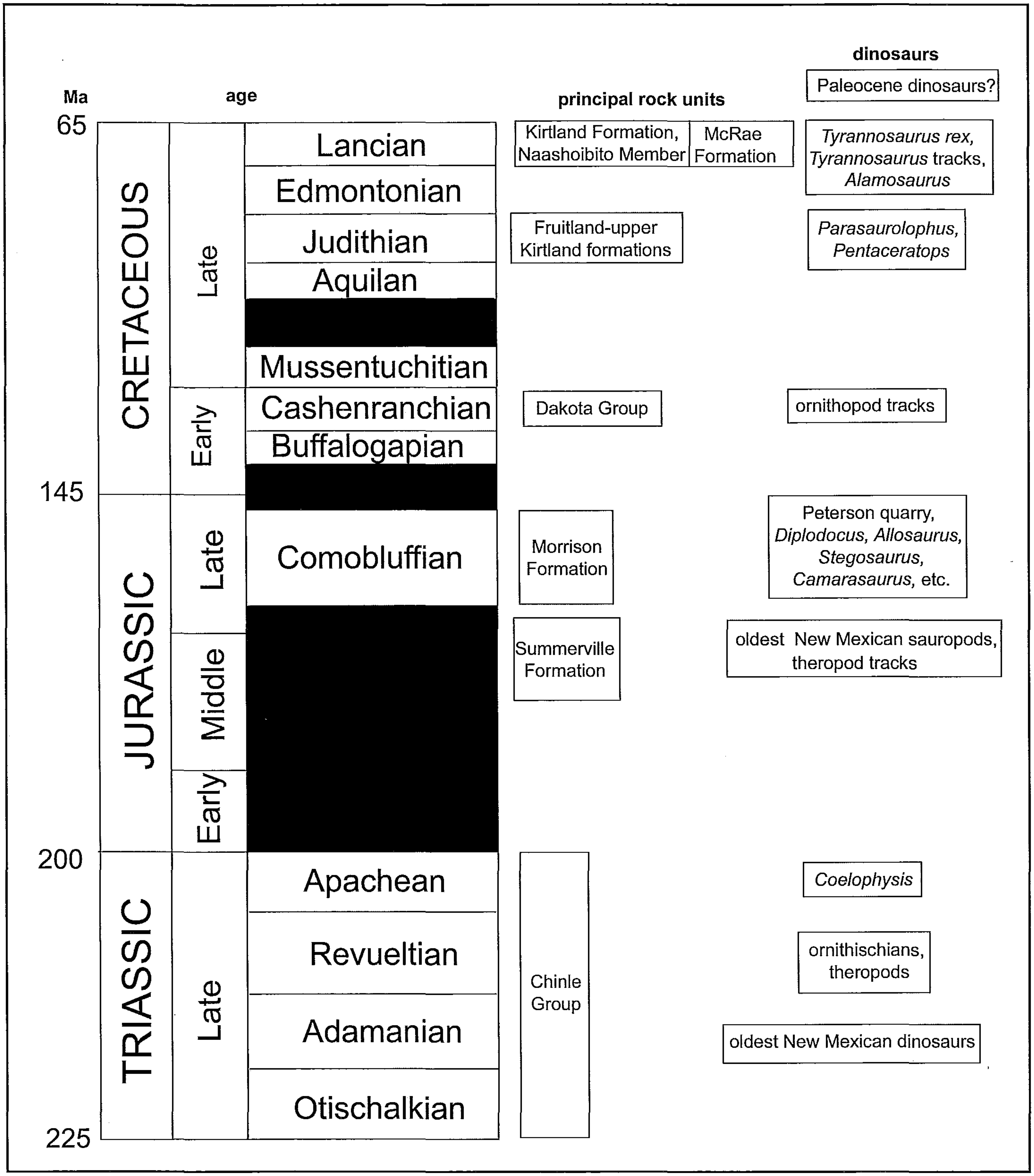

FIGURE 1. Summary of New Mexico's dinosaur record.

Most other New Mexican Jurassic dinosaur occurrences are singleton specimens, mostly of sauropods. Perhaps the most notorious of New Mexico's Jurassic dinosaurs was "*Seismosaurus*," the subject of several articles and a book (e.g., Gillette, 1991, 1994). However, the claims of generic distinctiveness, colossal size and extensive gastroliths of "*Seismosaurus*" have been re-evaluated and shown to lack a sound scientific basis (see Lucas, this volume).

Thus, outside of the Peterson quarry, New Mexico's record of Jurassic dinosaurs remains sparse. The are no Lower Jurassic rocks in New Mexico, and the Middle Jurassic rocks are mostly eolian and therefore unlikely to preserve dinosaur bones, though they may contain an undiscovered dinosaur track record. Nevertheless, a couple of significant points can be derived from New Mexico's Jurassic dinosaur fossils:

- A sauropod record in the Summerville Formation in north-central New Mexico is among the oldest North American sauropods (cf. Gillette, 1996).
- Generically identifiable Morrison Formation dinosaurs from New Mexico are *Camarasaurus, Diplodocus, Apatosaurus, Allosaurus,* and *Stegosaurus,* taxa characteristic of the Morrison Formation dinosaur fauna throughout the Western Interior. This indicates no provincialization or uniqueness of the dinosaurs in the New Mexican portion of the Morrison basin (see Foster, this volume).

Further work with pick and shovel is needed to develop a more significant record of Jurassic dinosaurs in New Mexico.

CRETACEOUS DINOSAURS

Cope's (1885) first report of dinosaur fossils from New Mexico was of teeth and bone fragments found in the Upper Cretaceous Fruitland-Kirtland formations of the San Juan Basin. These are now known to be New Mexico's richest dinosaur-bearing beds, and they have drawn the attention of many dinosaur hunters, most notably the two greatest, Barnum Brown (1873-1963) and Charles Hazelius Sternberg (1850-1943).

Most of the articles (and pages) in this book are devoted to research on the Upper Cretaceous dinosaurs of the San Juan Basin (see Carr and Williamson, Ford, Lucas and Sullivan, Sullivan, Sullivan and Bennett, Sullivan and Lucas, and Williamson, this volume). They well attest to the longstanding and ongoing research in these most productive of New Mexico's dinosaur beds. This record is both significant and in need of more research along the following lines:

- The San Juan Basin Fruitland and Kirtland formations contain one of North America's most significant Campanian dinosaur records, including unique material of *Pentaceratops* and *Parasaurolophus*. Much more can be done with this record in terms of dinosaur microevolution, biogeography and paleoecology.
- Asian elements in the San Juan Basin Campanian faunas (*Nodocephalosaurus, Saurornitholestes, Prenocephale*) indicate biogeographic interchange between North America and Asia, but center(s) of origin and directionality of immigration remain unclear.
- A consensus on the ages of the dinosaur dinosaur fossils close to the Cretaceous-Tertiary boundary in the San Juan Basin has still not been achieved. The possibility of Paleocene dinosaur fossils here remains (Fassett et al., 2000; Fassett and Lucas, this volume).

During the 1980s and 1990s, Cretaceous dinosaur fossils began to be discovered outside of the San Juan Basin, especially in the Moreno Hill Formation in west-central New Mexico (Wolfe and Kirkland, 1998; Wolfe, this volume), in the McRae Formation in south-central New Mexico (Lozinsky et al., 1984) and in the Ringbone Formation in southwestern New Mexico (Lucas et al., 1990). Particularly interesting records from these units include: (1) *Zuniceratops* from the Moreno Hill Formation, the oldest North American ceratopsian with brow horns, raising the possibility of a North American origin of ceratopsids (Wolfe and Kirkland, 1998); (2) a jaw of that rarest of the big meat eaters, *Tyrannosaurus rex*, from the McRae Formation (Gillette et al., 1986); and (3) a superbly preserved hadrosaur skin impression from the Ringbone Formation (Anderson et al., 1998).

Paleontologists also became aware in the 1980s that northeastern New Mexico has an extensive record of Early Cretaceous dinosaur tracks, mostly of ornithopods. These tracks suggest a late Albian extirpation of sauropods in North America. Sauropods did not reappear in North America until the Campanian, after a substantial "sauropod hiatus" (Lucas and Hunt, 1989; Lucas and Sullivan, this volume). Ornithopod tracks from near Mosquero in Harding County also provide some of the best circumstantial evidence of gregarious behavior in dinosaurs (Cotton et al., 1998).

In New Mexico, many Upper Cretaceous units, such as the Crevasse Canyon and Menefee formations, have yielded a few dinosaur fossils, but merit much more extensive exploration. These units, and those already well explored, will continue to produce one of the world's most significant fossil records of Late Cretaceous dinosaurs.

REFERENCES

Anderson, B.G., Barrick, R.E., Lucas, S.G., Heckert, A.B., and Basabilvazo, G.T., 1998, Dinosaur skin impressions from the Upper Cretaceous Ringbone Formation, southwestern New Mexico: Journal of Vertebrate Paleontology , v. 18, p. 739-745.

Colbert, E. H., 1989, The Triassic dinosaur *Coelophysis*: Museum of Northern Arizona Bulletin 57, 160 p.

Cope, E. D., 1885, The relations of the Puerco and Laramie deposits: American Naturalist, v. 19, p. 985-986.

Cope, E. D., 1887, The dinosaurian genus *Coelurus*: American Naturalist, v. 21, p. 367-369.

Cotton, W. D., Cotton, J. E. and Hunt, A. P., 1998, Evidence for social behavior in ornithopod dinosaurs from the Dakota Group of northeastern New Mexico, U. S. A.: Ichnos, v. 6, p. 141-149.

Fassett, J.E., Lucas, S. G., Zielinski, R. A. and Budahn, J. R., 2000, Compelling new evidence for Paleocene dinosaurs in the Ojo Alamo Sandstone, San Juan Basin, New Mexico and Colorado, USA; *in* Catastrophic events and mass extinctions: Impacts and beyond: LPI Contribution no. 1053, Lunar and Planetary Institute, Houston, Texas, p. 45-46.

Gillette, D.D., 1991, *Seismosaurus halli*, gen. et. sp. nov., a new sauropod dinosaur from the Morrison Formation (Upper Jurassic/Lower Cretaceous) of New Mexico, USA: Journal of Vertebrate Paleontology, v. 11, p. 417-433.

Gillette, D.D., 1994, *Seismosaurus*, the earth shaker. New York, Columbia University Press, 205 pp.

Gillette, D. D., 1996, Origin and early evolution of the sauropod dinosaurs of North America: The type locality and stratigraphic position of *Dystrophaeus viaemalae* Cope, 1877: Utah Geological Association, Guidebook 25, p. 313-324.

Gillette, D.D., Wolberg, D.L. and Hunt, A.P., 1986, *Tyrannosaurus rex* from the McRae Formation (Lancian, Upper Cretaceous), Elephant Butte Reservoir, Sierra County, New Mexico: New Mexico Geological Society, Guidebook 37, p. 235-238.

Hunt, A. P., 1989, A new ?ornithischian dinosaur from the Bull Canyon Formation (Upper Triassic) of east-central New Mexico; *in* Lucas, S. G. and Hunt, A. P., eds., Dawn of the age of dinosaurs in the American Southwest: Albuquerque, New Mexico Museum of Natural History, p. 355-358.

Lozinsky, R.P., Hunt, A.P., Wolberg, D.L. and Lucas, S.G., 1984, Late Cretaceous (Lancian) dinosaurs from the McRae Formation, Sierra County, New Mexico: New Mexico Geology, v. 6, p. 72-77.

Lucas, S.G. and Hunt, A.P., 1985, Dinosaurs from the Upper Jurassic Morrison Formation in New Mexico: New Mexico Journal of Science, v. 25, p. 1-12.

Lucas, S.G. and Hunt, A.P., 1989, *Alamosaurus* and the sauropod hiatus in the Cretaceous of the North American Western Interior: Geological Society of America, Special Paper 238, p. 75-85.

Lucas, S.G., Basabilvazo, G. and Lawton, T.F., 1990, Late Cretaceous dinosaurs from the Ringbone Formation, southwestern New Mexico: Cretaceous Research, v. 11, p. 343-349.

Sullivan, R. M. and Lucas, S. G., 1999, *Eucoelophysis baldwini*, a new theropod dinosaur from the Upper Triassic of New Mexico, and the status of the original types of *Coelophysis*: Journal of Vertebrate Paleontology, v. 19, p. 81-90

Wolfe, D. G. and Kirkland, J. I., 1998, *Zuniceratops christopheri* n. gen. & n. sp. a ceratopsian dinosaur from the Moreno Hill Formation (Cretaceous, Turonian) of west-central New Mexico: New Mexico Museum of Natural History and Science, Bulletin 14, p. 303-318.