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TETRAPOD FOOTPRINT ICHNOFAUNA OF THE UPPER TRIASSIC REDONDA FORMATION, CHINLE GROUP, QUAY COUNTY, NEW MEXICO

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Abstract.—The tetrapod footprint ichnofauna from the Upper Triassic Redonda Formation in Quay County, east-central New Mexico, consists of four ichnogenera—*Rhynchosauroides* (rhynchocephalian), *Brachychirotherium* (aetosaur), *Grallator* (theropod) and *Pseudotetrasauropus* (prosauropod). A unique feature of the Redonda tetrapod ichnofauna is the absence of the sauropod track *Tetrasauropus* and the dominance of the prosauropod track *Pseudotetrasauropus*, which may indicate a local, mutual ecological separation of prosauropods and sauropods. This dominance of prosauropod tracks in the Redonda Formation is not mirrored by its body fossil record, which lacks prosauropods and is dominated by semiaquatic taxa. The Redonda tetrapod ichnofauna resembles other Chinle Group tetrapod ichnofaunas of the Apachean Rock Point sequence and well represents a global Late Triassic ichnofauna characterized by *Rhynchosauroides*, *Brachychirotherium*, *Grallator*, *Pseudotetrasauropus* and *Tetrasauropus*.

INTRODUCTION

In 1934, Robert Abercrombie discovered tetrapod footprints in Upper Triassic strata at Mesa Redonda, Quay County, New Mexico (Fig. 1). Gregory (1972) first mentioned this discovery, which was in strata now termed Redonda Formation of the Chinle Group. Gregory (1972) also noted similar track occurrences in the Redonda Formation at Apache Canyon, Quay County (Fig. 1).

Collecting during the 1980s and 1990s revealed both localities in Quay County to be rich sources of tetrapod footprints (Hunt et al., 1989, 1993, 2000; Lockley and Hunt, 1995; Cotton et al., 1996, 1997, 1998; Lockley et al., 2000). Here, we review the tetrapod ichnofauna of the Redonda Formation and discuss its significance. MDM = Mesalands Dinosaur Museum, Tucumcari; NMMNH = New Mexico Museum of Natural History, Albuquerque; UM = University of Michigan, Ann Arbor.

GEOLOGICAL CONTEXT

Redonda tetrapod tracks come from two collecting areas, Mesa Redonda and Apache Canyon in Quay County (Fig. 1). At Mesa Redonda, tracks are found around the entire perimeter of the mesa, though most collections come from limestones and siltstones stratigraphically high in the Redonda Formation in sec. 27, T9N, R31E (Fig. 1).

The Apache Canyon localities are also stratigraphically high in the Redonda Formation, occurring in the sandstone interval Gregory (1972) referred to as the "Redonda ledge" (Fig. 1). The localities are widely distributed along the Llano Estacado edge, and include sites in sec. 9, T8N, R33E (NMMNH localities 445, 446) and in sec. 28, T9N, R33E (NMMNH locality 1471). Redonda Formation deposition took place in and around a large lake (Hester, 1988), and the tetrapod tracks occur in lake-margin facies (Hester, 1988).

TETRAPOD ICHNOTAXA

Redonda tetrapod footprints represent only four ichnogenera (Fig. 2). Here, we briefly review these ichnogenera and the Redonda specimens.

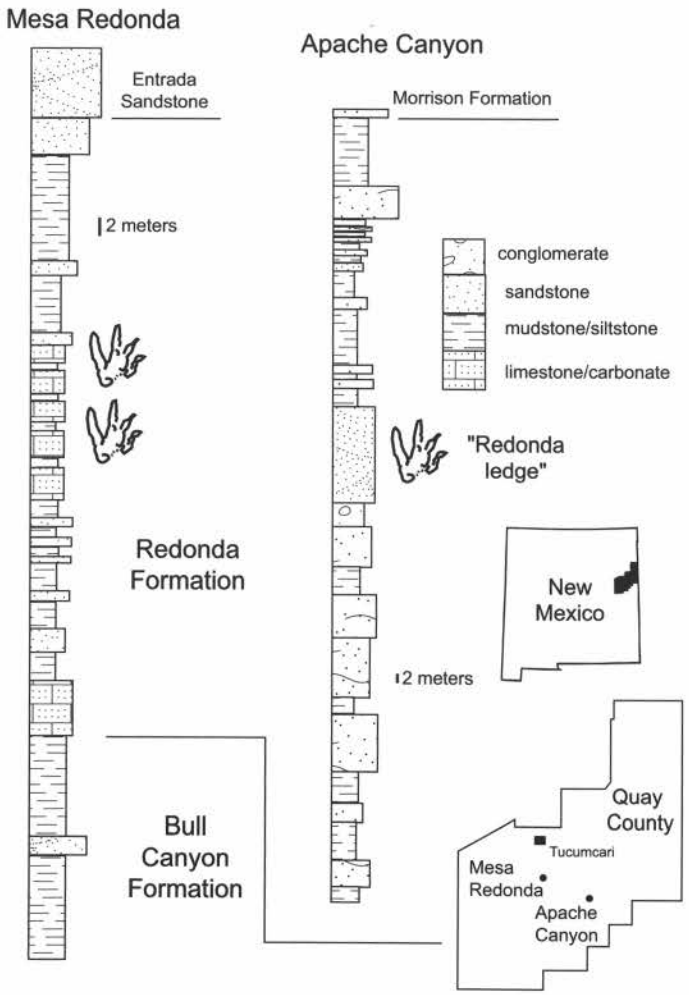

FIGURE 1. Location map and stratigraphic sections of Redonda Formation tetrapod footprint localities in Quay County, New Mexico.

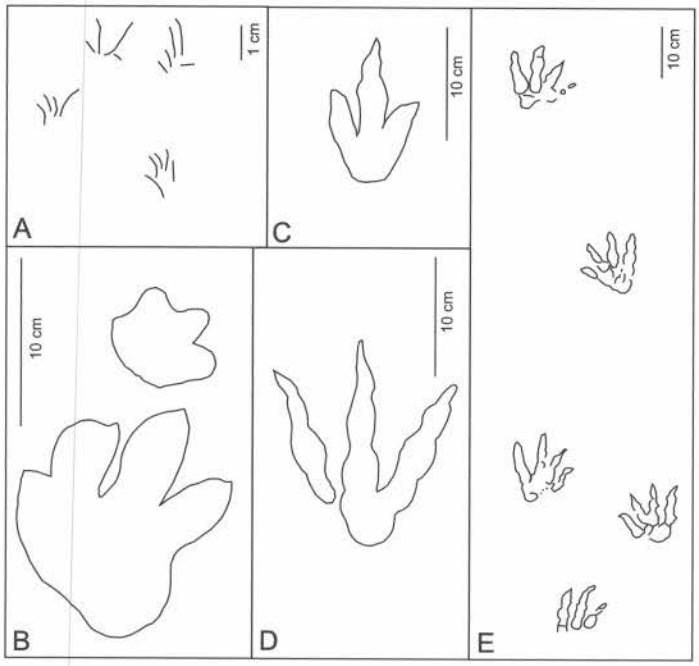

FIGURE 2. Outline drawings of the four Redonda tetrapod ichnotaxa. A, *Rhynchosauroides*. B, *Brachychirotherium*. C, *Grallator*. D, *Pseudotetrasauropus* (tridactyl extramorphological variant) E., trackway of *Pseudotetrasauropus*.

Rhynchosauroides

Most *Rhynchosauroides* tracks from the Redonda Formation are relatively small (pes up to 2 cm long) tracks of a quadruped in which the pentadactyl manus is much smaller than the pentadactyl pes. Both manus and pes are longer than wide, and have long, thin digits that taper to clawed tips. The digits are straight or slightly curved, and length increases from digit I to digit IV, with digit V being as small or smaller than digit I. The animal usually walked in a digitigrade posture as heel (palm) impressions are rare. A large number of ichnospecies of *Rhynchosauroides* have been proposed (Baird, 1964; Haubold, 1971, p. 46), but we make no attempt to assign the Redonda specimens to an ichnospecies.

Rhynchosauroides tracks are well represented in the Redonda Formation, especially at Apache Canyon, and most are extramorphological variants that preserve four or fewer digits (Fig. 2A). Others, however, are much larger (pes length ~5 cm) that have distinct heel impressions (Fig. 3A-B). Probably, the Redonda *Rhynchosauroides* specimens encompass two distinct ichnospecies. *Rhynchosauroides* tracks are generally lizard-like and best match the foot structure of Triassic rhynchocephalians (Baird, 1964), which are also well known from body fossils (especially sphenodont teeth) in the Chinle Group.

Brachychirotherium

Brachychirotherium tracks from the Redonda Formation are relatively large tracks (pes ~18 cm long) of a quadruped with a pentadactyl pes much larger than the pentadactyl manus. The digits are thick, with rounded tips, and the "heel" of the pes is broad and rounded. Actually, this "heel" impression is that of a metatarsal pad, so that there are four digits anterior to it, and occasionally digit V is impressed posteriorly. A large number of ichnospecies of *Brachychirotherium* have been named (Haubold, 1971, p. 56-57), but we make no attempt to assign an ichnospecific name to the Redonda specimens.

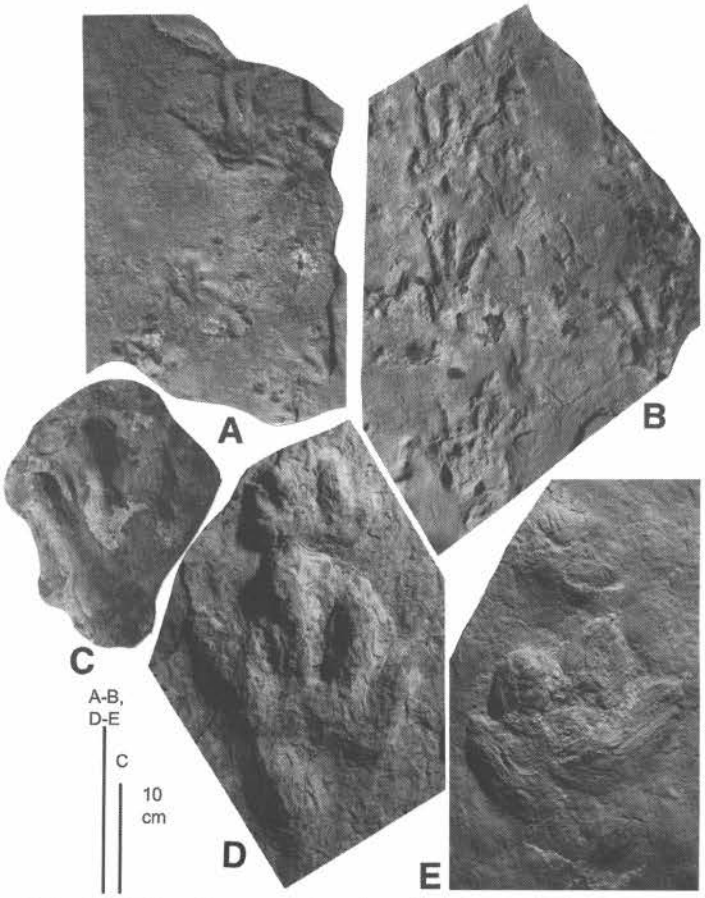

FIGURE 3. Selected tetrapod footprints from the Redonda Formation. A-B, *Rhynchosauroides*, MDM 208 from Apache Canyon 1. C, *Brachychirotherium*, NMMNH P-22426 from NMMNH locality 1477. D, *Brachychirotherium*, MDM 211 from Apache Canyon 2. E, *Brachychirotherium*, UMMP 16160 from Mesa Redonda.

These specimens (Fig. 3C-E) well preserve the thick digits I-IV of the pes, and some specimens (Fig. 3D-E) show a poorly differentiated manus impression immediately anterior to the pes. *Brachychirotherium* tracks are those of a crurotarsan archosaur, and those from the Chinle Group are most reasonably assigned to an aetosaur (Lockley and Hunt, 1995). Aetosaurs are among the most common body fossils of tetrapods from the Chinle Group.

Grallator

Grallator is the name we apply to tridactyl tracks of small theropod dinosaurs found in the Redonda Formation (Fig. 4D-E). These relatively small tracks (pes length ~8-12 cm) have a very long middle toe and long, thin digits with clawed tips, and distinct, well-differentiated digital pads in most examples. Lockley

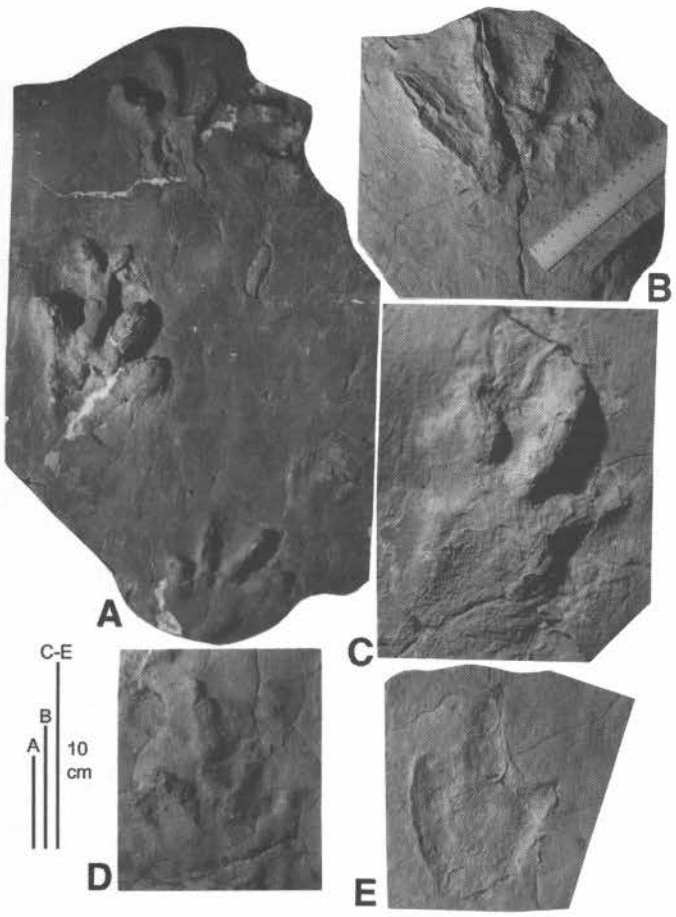

FIGURE 4. Selected tetrapod footprints from the Redonda Formation. A, *Pseudotetrasauropus*, NMMNH P-22416 from NMMNH locality 446. B, *Pseudotetrasauropus*, NMMNH P-22415 from NMMNH locality 445. C, *Pseudotetrasauropus*, NMMNH P-14151 from NMMNH locality 1477. D, *Grallator*, MDM 209 from Apache Canyon 2. E, *Grallator*, UMMP 16161 from Mesa Redonda.

et al. (2000) and Hunt et al. (2000) recently reviewed *Grallator* records from the Redonda Formation, noting that some specimens earlier assigned to this ichnogenus by Hunt and Lucas (1989), Hunt et al. (1989) and Lucas (1993) are actually tridactyl extramorphological variants of *Pseudotetrasauropus* (Fig. 2D, Fig. 4C) Thus, contrary to earlier statements (e.g., Hunt et al., 1989), tracks of *Grallator* are not the most common tracks in the Redonda Formation; instead, tracks of *Pseudotetrasauropus* are most abundant.

PSEUDOTETRASAUROPUS

Relatively large tracks (pes length ~ 12-16 cm) of a biped from the Redonda Formation are assigned by us to *Pseudotetrasauropus* (Fig. 4A-C). These tracks are tetradactyl, with widely diverging, long slender digits that usually taper to sharp, pointed claws. On one Redonda specimen there is an unusual extramorphological variant — a bifurcation of a digit tip (Fig. 4A), which may simply represent the pentration and extraction phases of the claw (cf. Peabody, 1959). Cotton et al. (1997, 1998) mapped an area at Apache Canyon of ~ 10 m^2 that shows evidence of preferred orientation of seven *Pseudotetrasauropus* trackways, probable evidence of gregarious behavior.

Pseudotetrasauropus is the most common track known from the Redonda Formation (Lockley et al., 2000). It resembles somewhat larger prosauropod tracks termed *Otozoum* (Gand et al., 2000), and well matches the foot structure of a prosauropod dinosaur (Lockley and Hunt, 1995).

DISCUSSION

The significance of the Redonda Formation tetrapod ichnofauna is threefold:

1. A unique feature of the Redonda tetrapod ichnofauna is the absence of the sauropod track *Tetrasauropus*, which is the dominant track at Peacock Canyon in the Upper Triassic Sloan Canyon Formation of northeastern New Mexico and in the Upper Triassic Sheep Pen Sandstone at Furnish Canyon in southeastern Colorado (Lockley et al., this guidebook). This may indicate some sort of mutual ecological separation between prosauropods and sauropods in the Redonda depositional basin, though the two ichnogenera do co-occur elsewhere.

2. The dominance of prosauropod tracks in the Redonda Formation is not mirrored by its body fossil record, which lacks prosauropods and is dominated by semiaquatic phytosaurs and metoposaurs.

3. The Redonda tetrapod ichnofauna resembles other Chinle Group tetrapod ichnofaunas of the Apachean Rock Point sequence. These ichnofaunas are characterized by *Rhynchosauroides*, *Brachychirotherium*, *Grallator* and *Pseudotetrasauropus* or *Tetrasauropus* (e.g., Lockley and Hunt, 1995). Indeed, the Redonda tetrapod ichnofauna well represents a global Late Triassic ichnofauna characterized by *Rhynchosauroides*, *Brachychirotherium*, *Grallator*, *Pseudotetrasauropus* and *Tetrasauropus*. Such ichnofaunas are known from the lower Stormberg Group of southern Africa (Ellenberger, 1970; Olsen and Galton, 1984; Raath et al., 1990; Raath, 1996), the upper Keuper and equivalent strata in western Europe (e.g., Haubold, 1971, 1984; Lockley and Meyer, 2000; Gand et al., 2000) and the Upper Triassic portion of the Newark Supergroup in eastern North America (e.g., Silvestri and Szajna, 1993; Olsen et al., 1998) as well as the Chinle Group in the American Southwest.

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REFERENCES

Baird, D., 1964, Dockum (Late Triassic) reptile footprints from New Mexico: Journal of Paleontology, v. 38, p. 118-125.

Cotton, W. D., Cotton, J. E., and Hunt, A. P., 1997, Social behavior of Cretaceous ornithopod dinosaurs of New Mexico: New Mexico Museum of Natural History and Science, Bulletin 11, p. 45-50.

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, USA: Ichnos, v. 6, p. 141-149.

Cotton, W. D., Hunt, A. P., Cotton, J. E., and Lockley, M. G., 1996, An addition to the vertebrate ichnofauna of the Redonda Formation (Upper Triassic), east-central New Mexico: New Mexico Geology, v. 18, p. 56.

Ellenberger, P., 1970, Les niveaux paléontologiques de première apparition des mammifères primordiaux en Afrique du Sud et leur ichnologie: Etablissement de zones stratigraphiques detaillées dans le Stormberg du Lesotho, (Afrique du Sud) (Triassique supérieur à Jurassique; *in* Haughton, S. H., ed., International Union of Geological Sciences, Second Symposium on Gondwana Stratigraphy and Paleontology. Pretoria, Council for Scientific and Industrial Research, p. 347-370.

Gand, G., Vianey-Liaud, M., Demathieu, G., and Garric, J., 2000, Deux nouvelles traces de pas de dinosaures du Trias Supérieur de la Bordure Cévenole (La Grand-Combe, sud-est de la France): Geobios, v. 33, p. 599-624.

Gregory, J. T., 1972, Vertebrate faunas of the Dockum Group, Triassic, eastern New Mexico and west Texas: New Mexico Geological Society, 23rd Field Conference, Guidebook 23, p. 120-123.

Haubold, H., 1971, Ichnia amphibiorum et reptilorum fossilum: Encyclopedia of Paleoherpetology, v. 18, 124 p.

Haubold, H., 1984, Saurierfährten. Wittenberg Lutherstadt, A. Ziemsen Verlag, 231 p.

Hester, P. M., 1988, Depositional environments in a Late Triassic lake, east-central New Mexico [M. S. thesis]: Albuquerque, University of New Mexico, 153 p.

Hunt, A.P. and Lucas, S.G., 1989, Late Triassic vertebrate localities in 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. 72-101.

Hunt, A. P., Lucas, S. G., Lockley, M. G., and Heckert, A. B., 2000, Occurrence of the dinosaurian ichnogenus *Grallator* in the Redonda Formation (Upper Triassic: Norian) of eastern New Mexico: New Mexico Museum of Natural History and Science, Bulletin 17, p. 39-41.

Hunt, A. P., Lucas, S. G., and Kietzke, K. K., 1989, Dinosaur footprints from the Redonda Member of the Chinle Formation (Upper Triassic), east-central New Mexico; *in* Gillette, D. D., and Lockley, M. G., eds., Dinosaur tracks and traces: Cambridge, Cambridge University Press, p. 277-280.

Hunt, A. P., Lockley, M. G., and Lucas, S. G., 1993, Vertebrate and invertebrate tracks and trackways from Upper Triassic strata of the Tucumcari basin, east-central New Mexico: New Mexico Museum of Natural History and Science, Bulletin 3, p. 199-201.

Lockley, M. G., and Hunt, A. P., 1995, Dinosaur tracks and other fossil footprints of the western United States. New York, Columbia University Press, 338 p.

Lockley, M. G., and Meyer, C., 2000, Dinosaur tracks and other fossil footprints of Europe. New York, Columbia University Press, 323 p.

Lockley, M. G., Lucas, S. G., and Hunt, A. P., 2000, Dinosaur tracksites in New Mexico: A review: New Mexico Museum of Natural History and Science, Bulletin 17, p. 9-16.

Lucas, S. G., 1993, Dinosaurs of New Mexico. Albuquerque, New Mexico Academy of Science, 130 p.

Olsen, P. E., and Galton, P. M., 1984, A review of the reptile and amphibian assemblages from the Stormberg of South Africa, with special emphasis on the footprints and the age of the Stormberg: Palaeontologia Africana, v. 25, p. 87-110.

Olsen, P. E., Smith, J. B., and McDonald, N. G., 1998, Type material of the species of the classic theropod footprint genera *Eubrontes, Anchisauripus,* and *Grallator* (Early Jurassic, Hartford and Deerfield basins, Connecticut and Massachusetts, U.S.A.): Journal of Vertebrate Paleontology, v. 18, p. 586-601.

Peabody, F., 1959, Trackways of living and fossil salamanders: University of California, Publications in Zoology, v. 63, no. 1, 72 p.

Raath, M. A., 1996, Earliest evidence of dinosaurs from central Godwana: Memoirs of the Queensland Museum, v. 39, p. 703-709.

Raath, M. A., Kitching, J. W., Shone, R. W., and Rossow, G. J., 1990, Dinosaur tracks in Triassic Molteno sediments: The earliest evidence of dinosaurs in South Africa: Palaeontologia Africana, v. 27, p. 89-95.

Silvestri, S. M. and Szajna, M. J., 1993, Biostratigraphy of vertebrate footprints in the Late Triassic section of the Newark Basin, Pennsylvania: Reassessment of stratigraphic ranges: New Mexico Museum of Natural History and Science, Bulletin 3, p. 439-445.