Tetropod footprints from the lower Permian Yeso Group, Mockingbird Gap, Socorro County, New Mexico

Spencer G. Lucas and Justin A. Spielmann
2009, pp. 305-310. https://doi.org/10.56577/FFC-60.305

in:

Geology of the Chupadera Mesa, Lueth, Virgil; Lucas, Spencer G.; Chamberlin, Richard M.; [eds.], New Mexico Geological Society 60th Annual Fall Field Conference Guidebook, 438 p. https://doi.org/10.56577/FFC-60

This page is intentionally left blank to maintain order of facing pages.

TETRAPOD FOOTPRINTS FROM THE LOWER PERMIAN YESO GROUP, MOCKINGBIRD GAP, SOCORRO COUNTY, NEW MEXICO

SPENCER G. LUCAS AND JUSTIN A. SPIELMANN
New Mexico Museum of Natural History and Science, 1801 Mountain Rd NW, Albuquerque, NM 87104

Abstract—We document an ichnofossil assemblage from the lower part of the Yeso Group (Arroyo de Alamillo Formation) at Mockingbird Gap on the White Sands Missile Range of southern New Mexico. *Dromopus* dominates the assemblage, followed in decreasing order of abundance by *Batrachichnus* and rare *Gilmoreichnus* and aff. *Dimetropus*. This footprint assemblage comes from a tidal flat sandstone lithofacies and closely resembles some older, Abo Formation footprint assemblages from similar lithofacies. The Mockingbird Gap Yeso footprints well represent the *Batrachichnus* ichnofacies and are a characteristic Early Permian red-bed footprint assemblage.

INTRODUCTION

In central and southern New Mexico, strata of the Lower Permian (Wolfcampian-early Leonardian) Abo Formation and correlative strata of part of the Hueco Group yield one of the world's most extensive records of nonmarine Permian red-bed ichnofossils. Particularly significant are the footprints of tetrapods (amphibians and reptiles), which are found at sites in most of the mountain ranges and uplifts that border the Rio Grande rift from Las Cruces to Albuquerque. However, overlying Leonardian strata of the Yeso Group have yielded few footprints in New Mexico despite the fact that some Yeso lithofacies are those that could yield such ichnofossils. Here, we document the second record of Yeso Group tetrapod footprints from New Mexico, from a locality on the White Sands Missile Range at Mockingbird Gap in Socorro County (Fig. 1). In this article, NMMNH refers to the New Mexico Museum of Natural History and Science.

GEOLOGICAL CONTEXT

The Yeso footprint locality at Mockingbird Gap is NMMNH locality 7719 in sec. 13, T09S, R05E. William DiMichele discovered this locality in March 2007, and one of us (SGL) subsequently collected it. The site is approximately 11 m above the base of the Yeso Group (Arroyo de Alamillo Formation of Lucas et al., 2005a) in a 0.8-m-thick bed of finely laminated and ripple-laminated, very fine-grained sandstone/siltstone (Fig. 1). The track-bearing strata lack clay drapes (which probably explains the relatively poor preservation of the tracks) and display mudcracks, indicative of subaerial exposure. Tracks occur throughout this bed, but the preservation of most of the tracks is poor. Of hundreds of slabs with tracks on them, only 22 slabs are cataloged into the NMMNH collection to voucher the track assemblage.

Bachman (1968) mapped the geology of the Mockingbird Gap quadrangle, which encompasses the locality 7719 tracksite. He mapped the strata at the tracksite as Abo Formation overlain by the "Meseta Blanca Member" of the Yeso Formation (Bachman, 1968, pl. 1). However, a careful examination of the stratigraphy in sec. 13, T09S, R05E reveals a fault that repeats the lower part of the Yeso, so that the approximately north-south-oriented ridge marked with an elevation of 5,092 ft on the topographic map is formed by lower Yeso strata, not Abo strata as mapped by Bachman (1968).

The measured section in Figure 1 shows these strata to consist of siltstones, ripple-laminated sandstones, trough bedded (probably of eolian origin) sandstones, and a single bed of dolostone. The sandstones are very fine to fine grained, texturally mature quartzarenites. These lower Yeso strata contrast with underlying Abo mudstones, arkosic sandstones, calcrete beds and intraformational conglomerates.

Bachman's (1968) use of the term Meseta Blanca Member for the lower, clastic portion of the Yeso Group at Mockingbird Gap follows earlier use of Wilpolt and Wanek (1951). However, as Lucas et al. (2005a) noted, the Meseta Blanca Member is an unnecessary junior synonym of DeChelly Sandstone (as first suggested by Baars, 1962), and should be abandoned. The DeChelly Sandstone (of the Yeso Group) was thus restricted to the sandstone unit with large scale crossbeds of north-central New Mexico. The homotaxial succession of siltstone, ripple-laminated sandstone, dolomitic limestone and some crossbedded sandstones in central New Mexico was given a new name by Lucas et al. (2005a), the Arroyo de Alamillo Formation. Based on their stratigraphic position and lithology, we assign the track-bearing strata at Mockingbird Gap (Fig. 1) to the Arroyo de Alamillo Formation and thus abandon the term "Meseta Blanca Member" at Mockingbird Gap.

SYSTEMATIC ICHNOLOGY

Ichnogenus *Batrachichnus* Woodworth, 1900
Batrachichnus salamandroides (Geinitz, 1861)
Fig. 2A-B

Referred specimens: Five slabs with multiple tracks from NMMNH locality 7719, all preserved in concave epirelief: NMMNH P-58004 (Fig. 2B), P-58008 (Fig. 2A), P-58010, P-58016.

Description: The tracks from Mockingbird Gap that we assign to *Batrachichnus* are the tracks of a small quadruped in which pes track length is less than 20 mm. The pentadactyl pes

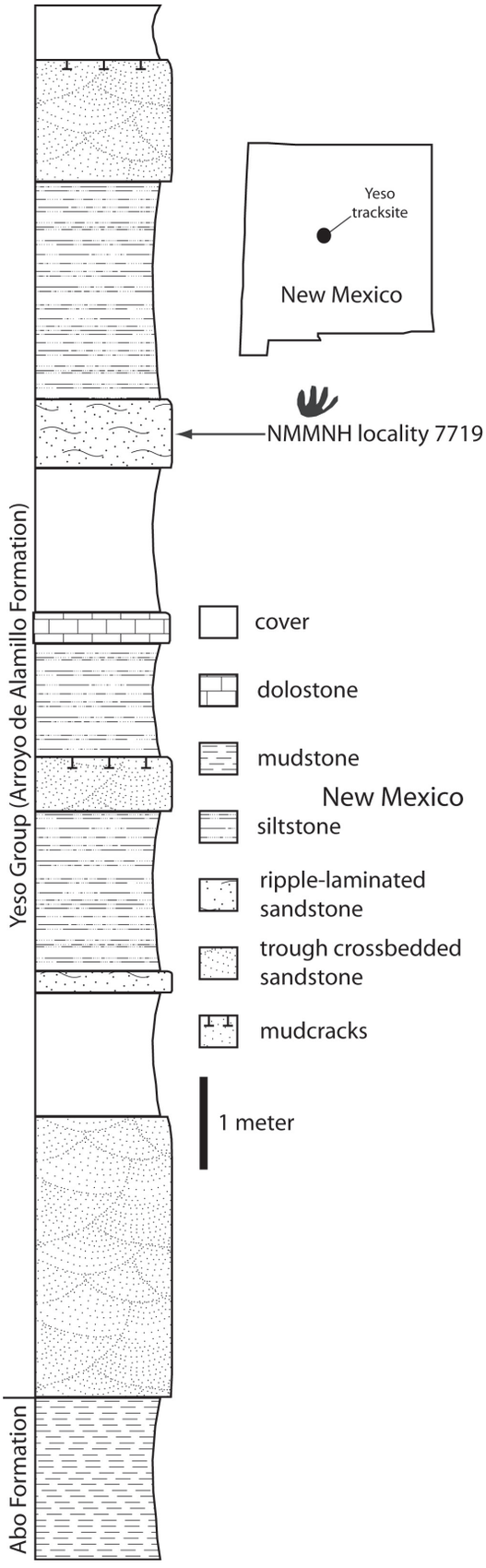

FIGURE 1. Stratigraphic section and index map showing the location and stratigraphic level of NMMNH locality 7719.

track is plantigrade to semiplantigrade, digit imprints I-III are closely grouped, and they increase in length from I to IV. Digit imprint IV is longest, and digit imprint V is posterior to the other digit imprints. The manus track is tetradactyl, semiplantigrade and smaller than the pes track. The digit imprints on the manus increase in length from I to III, and digit imprint IV diverges outward. No body or tail drags are evident. Preservation is almost exclusively digitgrade undertracks, most with long and thin digit imprints.

Comments: The size and morphology of these tracks (e.g., tetradactyl manus, less than 20 mm long) supports their identification as *Batrachichnus salamandroides* (cf. Haubold et al., 1995; Melchor and Sarjeant, 2004; Voigt, 2004; Lucas, 2005; Lucas et al., 2005c, d). *Batrachichnus* is widely considered the trackway of a small temnospondyl amphibian.

Ichnogenus *Dromopus* Marsh, 1894
Dromopus lacertoides (Geinitz, 1861)
Fig. 2C-E

Referred specimens: Thirteen slabs with multiple tracks in concave epirelief from NMMNH locality 7719: NMMNH P-58005, P-58006 (Fig. 2C), P-58007 (Fig. 2D), P-58011, P-58013, P-58014, P-58017 (three slabs), P-58018 (two slabs), P-58019, P-58020. Two slabs with multiple tracks in convex hyporelief from NMMNH locality 7719: NMMNH P-58009 (Fig. 2E) and P-58015.

Description: Pes tracks are 10-30 mm long, pentadactyl and are plantigrade but lack a "heel" imprint. Pes digit imprints are curved and increase in length greatly from I to IV. Digit imprint V is laterally or postero-laterally directed. The manus track is smaller than the pes track but similar.

Comments: These tracks are readily assigned to *Dromopus lacertoides* based on size and morphology—note the elongate, curved digit imprints, large divarication of digit V and the great increase in length from digits I through IV (cf. Haubold et al., 1995; Hunt et al., 1995; Voigt, 2004; Lucas et al., 2005c). *Dromopus* is widely considered to be the footprint of an araeoscelid reptile.

Ichnogenus *Gilmoreichnus* Haubold, 1971
Gilmoreichnus hermitanus (Gilmore, 1927)
Fig. 2F

Referred specimens: One slab with two footprints in concave epirelief: NMMNH P-58003 (Fig. 2F).

Description: These tracks are pentadactyl and semiplantigrade to plantigrade with little heel impression. The digit imprints are thin, pointed and increase in length from I to IV, with II and V subequal in length. Pes track length is approximately 40 mm, and width is approximately 25 mm.

Comments: These tracks closely resemble specimens assigned to *Gilmoreichnus hermitanus* by Haubold et al., (1995) and Hunt et al. (1995). Thus, note their pentadactyly, thin and pointed digits and relative digit sizes, which are characteristic of *Gilmoreich-*

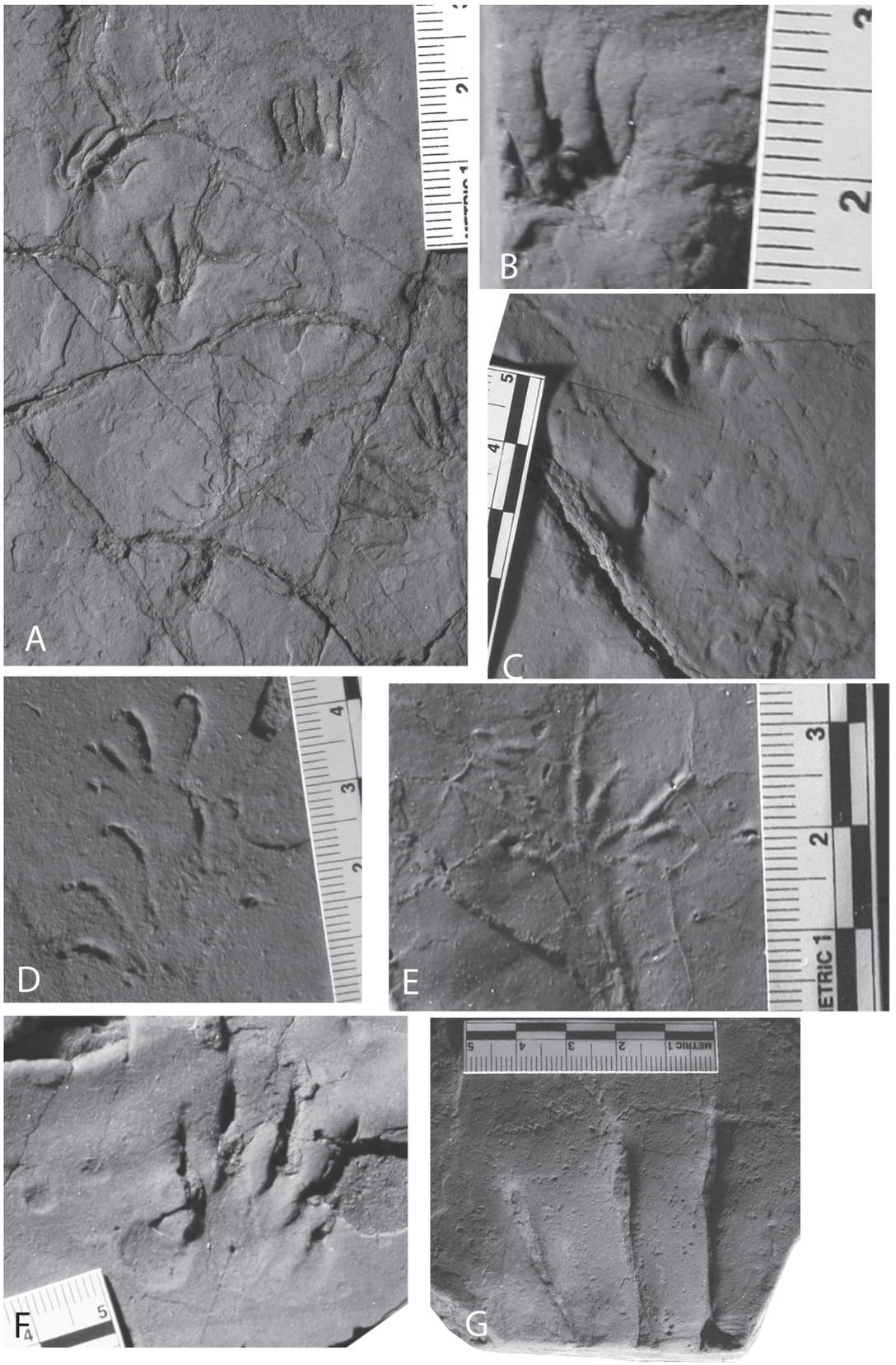

FIGURE 2. Representative ichnofauna from NMMNN locality 7719. **A-B**, *Batrachichnus salamandroides*, **A**, NMMNH P-58008, numerous tracks in concave epirelief; **B**, NMMNH P-58004, manus track in concave epirelief. **C-E**, *Dromopus lacertoides*, **C**, NMMNH P-58006, track in concave epirelief; **D**, NMMNH P-58007, tracks with digit tips in concave epirelief; **E**, NMMNH P-58009, track in convex hyporelief. **F**, *Gilmoreichnus hermitanus*, NMMNH P-58003, two tracks in concave epirelief. **G**, aff. *Dimetropus*, NMMNH P-58002, incomplete track in concave epirelief.

nus. *Gilmoreichnus* is considered to be the track of a small pelycosaur.

Ichnogenus *Dimetropus* Romer and Price, 1940
aff. *Dimetropus* sp.
Fig. 2G

Referred specimen: NMMNH P-58002, part of a footprint preserved in concave epirelief (Fig. 2G).

Description: This specimen consists of three relatively long (more than 50 mm long), thin pointed digit imprints. Two of the digit imprints are essentially parallel to each other, and the third is slightly divergent.

Comments: This is the largest footprint in the assemblage and could be part of a *Dimetropus* track (cf. Haubold et al., 1995; Hunt et al., 1995; Voigt, 2004). Given its incompleteness, any identification of the track must be considered tentative.

DISCUSSION

Most trace fossils are facies fossils, and their relationship to specific facies and use in facies interpretation lies at the core of ichnology. In the Abo Formation and equivalent strata of the Hueco Group, tetrapod tracks occur across a range of large-scale facies ranging from inland alluvial plain to coastal tidal flat (e.g., Hunt and Lucas, 2006). Within this framework Abo/Hueco tracksites are almost exclusively preserved in a lithofacies that can be termed "unchannelized sand/silt flat." In the alluvial plain setting these are sheetflood sandstones, whereas they are tidal flat sandstones in the coastal setting.

Some strata of the Yeso Group encompass lithofacies virtually identical to the "unchannelized sand/silt flat" facies of the Abo/Hueco. These are strata of parts of the Arroyo de Amarillo Formation, including the bed that yielded the tracksite documented here. Indeed, in lithology, geometry and ichnofossil content, the Mockingbird Gap track-bearing bed is remarkably similar to some of the track-bearing beds of the Abo/Hueco.

Not surprisingly, the track assemblage from this bed in the Yeso Group is also remarkably similar to an Abo/Hueco footprint assemblage. Thus, it yields the same ichnotaxa found at many Abo/Hueco tracksites, and the dominance of *Dromopus* and *Batrachichnus* mirrors that of Abo/Hueco track sites in the tidal flat setting, such as those in the Robledo Mountains of Doña Ana County. In terms of the ichnofacies concept advocated by Hunt and Lucas (2006, 2007; but see Lockley et al., 1994 for a different ichnofacies concept), the Yeso tracks belong to the *Batrachichnus* ichnofacies in being a moderately diverse assemblage (four ichnogenera) dominated by the tracks of quadrupedal carnivores. This is the same tetrapod ichnofacies represented by the Abo/Hueco track record, and further emphasizes the similarity of the Abo/Hueco and Yeso tracks. In effect, Abo and Yeso strata of the same lithofacies are yielding footprints of the same ichnofacies.

In regional stratigraphy, the Wolfcampian-Leonardian boundary is conventionally placed at the Abo-Yeso contact, though the upper part of the Abo is most likely of early Leonardian age (e.g., Mack and Dinterman, 2002; Lucas et al., 2005a). The one previous report of Yeso footprints from New Mexico was by Lucas et al. (2005b), from the transitional Abo-Yeso strata in the Lucero uplift of central New Mexico. They identified three ichnogenera – *Limnopus*, *Amphisauropus* and *Dimetropus*.

This assemblage also fits into the *Batrachichnus* ichnofacies, further emphasizing the similarity of Abo/Hueco and Yeso footprint assemblages.

Lucas and Hunt (2006) concluded that there is a single biostratigraphic assemblage of footprints from Lower Permian red bed facies, which they termed the pelycosaur assemblage. These are assemblages of the *Batrachichnus* ichnofacies, well documented throughout the Early Permian (Hunt and Lucas, 2006) dominated by the ichnogenera *Amphisauropus*, *Batrachichnus Dimetropus*, *Dromopus*, *Hyloidichnus*, *Ichniotherium*, *Limnopus* and *Varanopus*. The presence of *Batrachichnus*, *Dromopus*, *Gilmoreichnus* and possible *Dimetropus* in the Yeso Group at Mockingbird Gap certainly fits the idea that Early Permian tetrapod ichnogenera have long stratigraphic ranges, as it suggests no change in the footprint ichnofauna in New Mexico from Abo/Hueco (~middle-Wolfcampian-earliest Leonardian) to Yeso (~Leonardian) time.

ACKNOWLEDGMENTS

We thank the U.S. Army and Robert G. Myers for permission to work on the White Sands Missile Range. This report has been approved for public release by White Sands Missile Range for unlimited distribution, the WSMR Operational Security review was completed 26 March 2009. Assistance in the field by Dan Chaney, Bill DiMichele and Larry Rinehart proved invaluable. Martin Lockley and Nick Minter provided helpful reviews of the manuscript.

REFERENCES

Baars, D.L., 1962, Permian System of Colorado Plateau: American Association of Petroleum Geologists, Bulletin 46, p. 149-218.

Bachman, G.O., 1968, Geology of the Mockingbird Gap quadrangle, Lincoln and Socorro counties, New Mexico: U.S. Geological Survey, Professional Paper 594-J, 43 p.

Haubold, H., Hunt, A.P., Lucas, S.G. and Lockley, M.G., 1995, Wolfcampian (Early Permian) vertebrate tracks from Arizona and New Mexico: New Mexico Museum of Natural History and Science, Bulletin 6, p. 135-165.

Hunt, A.P. and Lucas, S.G., 2006, Permian tetrapod ichnofacies; *in* Lucas, S.G., Cassinis, G. and Schneider, J.W., eds., Non-marine Permian biostratigraphy and biochronology: Geological Society of London, Special Publication, v. 265, p. 137-156.

Hunt, A.P. and Lucas, S.G., 2007, Tetrapod ichnofacies: a new paradigm: Ichnos, v. 14, p. 59-68.

Hunt, A.P., Lucas, S.G., Haubold, H. and Lockley, M.G., 1995, Early Permian (late Wolfcampian) tetrapod tracks from the Robledo Mountains, south-central New Mexico: New Mexico Museum of Natural History and Science, Bulletin 6, p. 167-180.

Lockley, M.G., Hunt, A.P. and Meyer, C., 1994, Vertebrate tracks and the ichnofacies concept: Implications for paleoecology and palichnostratigraphy; *in* Donovan, S., ed., The paleobiology of trace fossils: Chichester, John Wiley & Sons, p. 241-268.

Lucas, S.G., 2005, Tetrapod ichnofacies and ichnotaxonomy: quo vadis?: Ichnos, v. 12, p. 157-162.

Lucas, S.G., Krainer, K. and Colpitts, R.M., Jr., 2005a, Abo-Yeso (Lower Permian) stratigraphy in central New Mexico: New Mexico Museum of Natural History and Science, Bulletin 31, p. 101-117.

Lucas, S.G., Smith, J.A. and Hunt, A.P., 2005b, Tetrapod tracks from the Lower

Permian Yeso Group, central New Mexico: New Mexico Museum of Natural History and Science, Bulletin 31, p. 121-124.

Lucas, S.G., Minter, N.J., Spielmann, J.A., Hunt, A.P. and Braddy, S.J., 2005c, Early Permian ichnofossil assemblage from the Fra Cristobal Mountains, southern New Mexico: New Mexico Museum of Natural History and Science, Bulletin 31, p. 140-150.

Lucas, S.G., Minter, N.J., Spielmann, J.A., Smith, J.A. and Braddy, S.J., 2005d, Early Permian ichnofossils from the northern Caballo Mountains, Sierra County, New Mexico: New Mexico Museum of Natural History and Science, Bulletin 31, p. 151-162.

Mack, G.H. and Dinterman, P.A., 2002, Depositional environments and paleogeography of the Lower Permian (Leonardian) Yeso and correlative formations in New Mexico: The Mountain Geologist, v. 39, p. 75-88.

Melchor, R.N. and Sarjeant, W.A.S., 2004, Small amphibian and reptile footprints from the Permian Carapacha basin, Argentina: Ichnos, v. 11, p. 57-78.

Voigt, S., 2004, Die tetrapodichnofauna des kontinentalen oberkarbon und Perm im Thüringer Wald-ichnotaxonomie, Paläoökologie and biostratigraphie: Göttigen, Cuvillier Verlag, 179 p.

Wilpolt, R.H. and Wanek, A.A., 1951, Geology of the region from Socorro and San Antonio east to Chupadera Mesa, Socorro County, New Mexico: U.S. Geological Survey, Oil and Gas Investigations Map OM-121.