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A NEW *OTOZOUM*-DOMINATED TRACKSITE IN THE GLEN CANYON GROUP (JURASSIC) OF EASTERN UTAH

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Abstract—A newly-reported dinosaur tracksite in the upper part of the Kayenta Formation, (Lower Jurassic), Glen Canyon Group, near Moab, Utah, yields *Otozoum* from multiple track-bearing levels. The tracksite appears to yield only *Otozoum*. The mode of preservation of natural impressions and naturals casts is quite distinct, resulting in apparently different morphotypes.

INTRODUCTION

Numerous tracksites have been reported from the three formations (Wingate, Kayenta and Navajo) that comprise the Glen Canyon Group in eastern Utah (Lockley and Hunt, 1995; Lockley et al., 1998; Lockley and Gierlinski, 2006). These yield typical Lower Jurassic ichnofaunas in which the most common ichnogenera are *Grallator, Eubrontes, Anomoepus* and *Otozoum*. This typical assemblage was labeled the Early Jurassic footprint biochron by Lucas (2007).

As noted elsewhere in this volume, tracksites appear to be particularly abundant in the upper part of the Kayenta Formation or in the Kayenta-Navajo transition zone. Here we report a newly-discovered tracksite at this level, which appears to be dominated almost exclusively by *Otozoum*.

THE TRACKSITE LOCATION

The Poison Spider Mesa tracksite is located just west of Moab (Fig. 1), on public lands administered by the Bureau of Land Management. The location was reported to the authors by Jeff Pillus and visited in April 2013. The site is at a remote location, which for all practical purposes is accessible only with small, specialized off road vehicles. Thus, transportation logistics make it difficult to camp at the site or bring in much survey or replication equipment.

METHODS AND MATERIALS

In order to make a preliminary documentation of the site, in April 2013, in the short time available for our visit, we used the following methods. We photographed the most diagnostic trackways, without chalk outlines, then with outlines. We combined these photographs, using Kolor Autopano Giga 2.6 software, in order to make trackway photo-maps. We also made tracings of representative tracks using clear acetate film. The local stratigraphic section was measured in order to determine how many track-bearing levels occur at the site. In addition, we collected 11 loose natural casts reposited in the University of Colorado Museum of Natural History collections as specimens UCM 180.59-69.

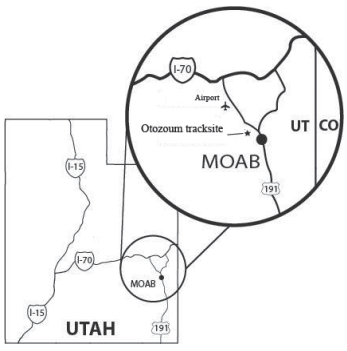


FIGURE 1. Location of the Poison Spider Mesa *Otozoum* tracksite.

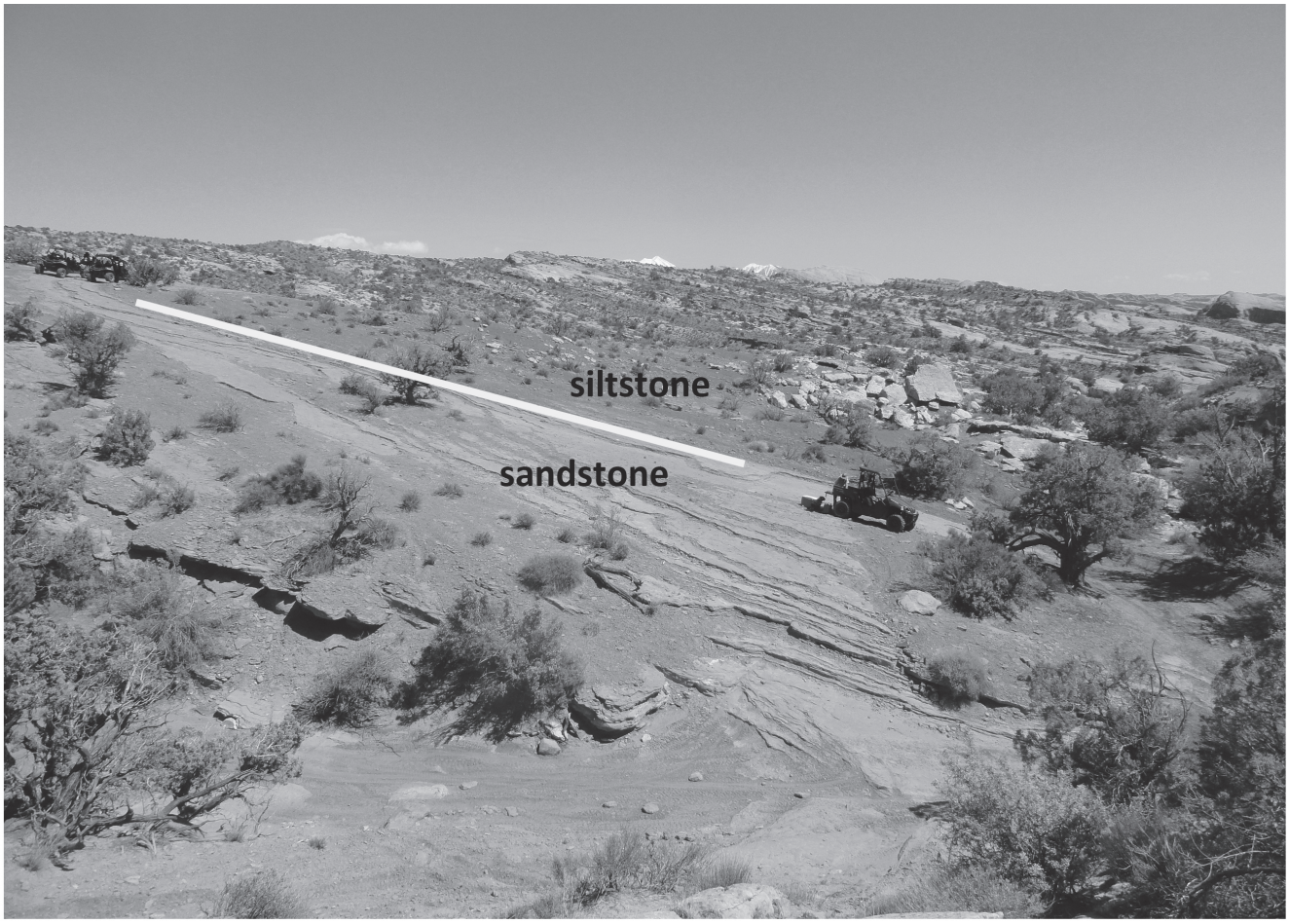
As indicated in the following sections, we used the photographs, photo maps and tracings to obtain standard measurements of tracks and trackway configurations, including track length and width, step, stride pace angulation and trackway width. It is acknowledged that other recording methods, e.g., photogrammetry, could have been used to obtain digital images, and that these are potentially more accurate for the obtaining of measurements if correctly analyzed (Richard McCrea, written communication, 2013).

LOCAL GEOGRAPHIC AND GEOLOGIC SETTING

The Poison Spider Mesa site is situated about 13 km (8 miles) from the Poison Spider trailhead, which is situated by another dinosaur tracksite along the Potash Road on Highway 279, 7 miles south of the junction with Highway 191. This Potash Road dinosaur tracksite is significant for several reasons. First, it is locally well-known and very accessible, in contrast to the site described here. Second, it is the type locality for *Anomoepus moabensis* (Lockley and Gierlinski, 2006), formerly referred to *Trisauropodiscus moabensis* (Lockley et al., 1992). Third, as discussed below, it is associated with the same Kayenta-Navajo transition zone from which the Poison Spider Mesa tracksite has been identified.

The site cannot be reached by normal two or four-wheel drive vehicles. However, it is on a BLM designated off road trail only suitable for off road vehicles (ATV, SxS, Rhinos, etc.). The site can also be accessed by off road motor bikes and mountain bikes. The site could also be reached on horseback or on foot, although the distance is sufficient to make the latter option difficult and impractical, especially in adverse weather conditions.

As indicated above, the remote location of the site described here precluded prolonged study of the local stratigraphy. However, it was possible to measure about 2 meters of section and identify multiple track-bearing levels (Fig. 2). The section consists of thin, tabular beds of well-sorted fine sandstone with ripple marks, grading up into a friable red siltstone containing many isolated sandstone casts. Due to the



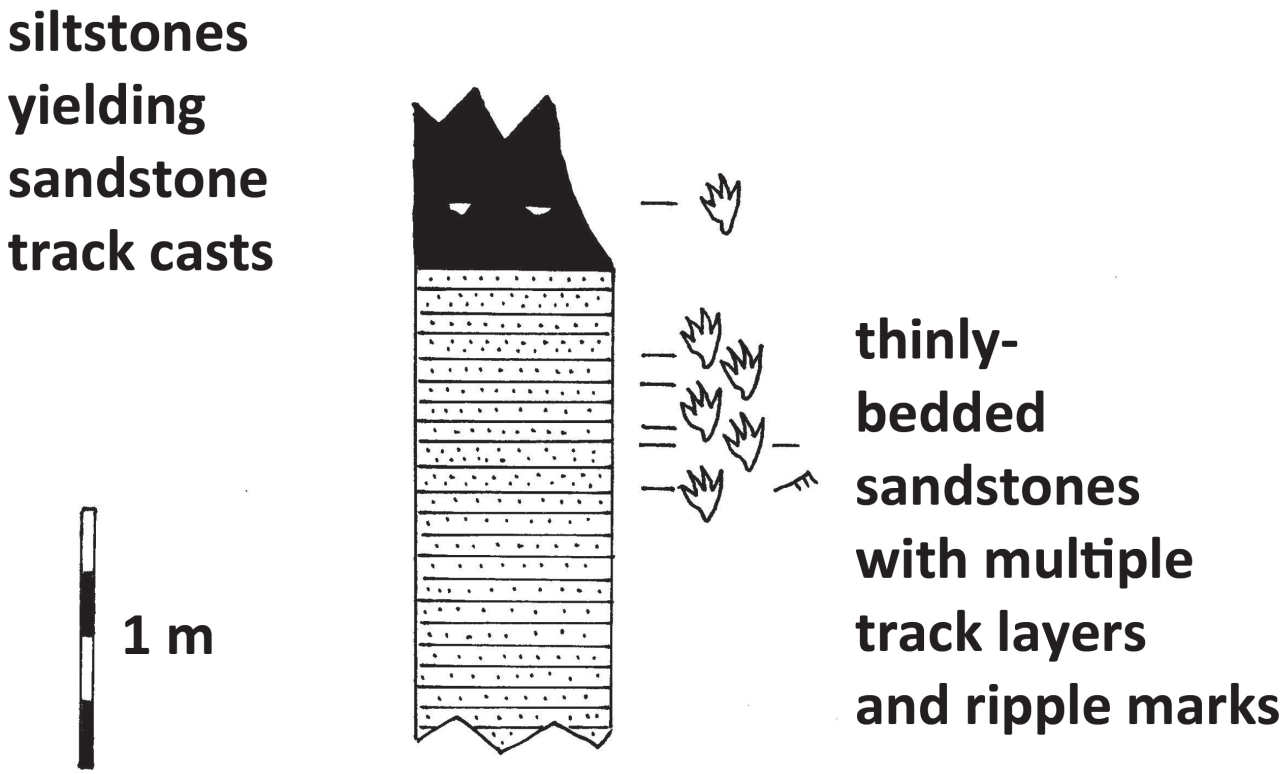


FIGURE 2. Photograph (above) and simplified section (below) showing the local stratigraphy of the multiple track-bearing beds with thinly bedded sandstone overlain by red siltstones.

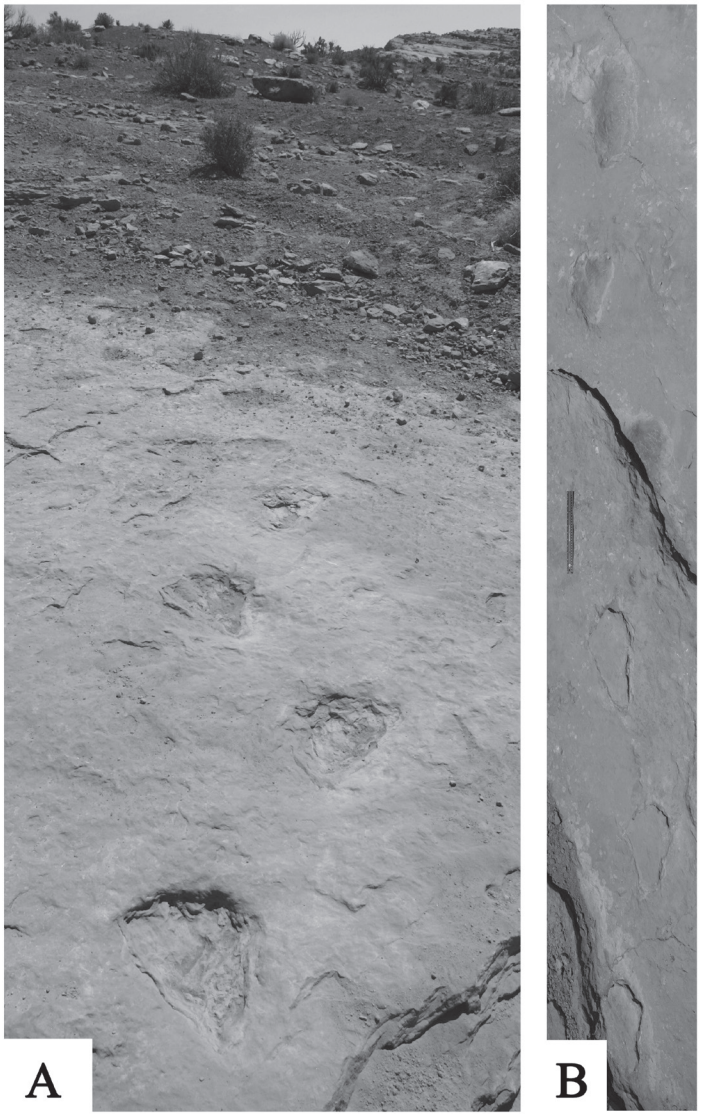


FIGURE 3. Two *Otozoum* trackway segments. A, four consecutive footprints corresponding to line drawing in Fig. 4A. Note the red shales overlying the sandstone bedding planes. B, trackway image corresponding to line drawing in Figure 4B, created by combining a mosaic of photographs using Kolor Autopano Giga 2.6 software.

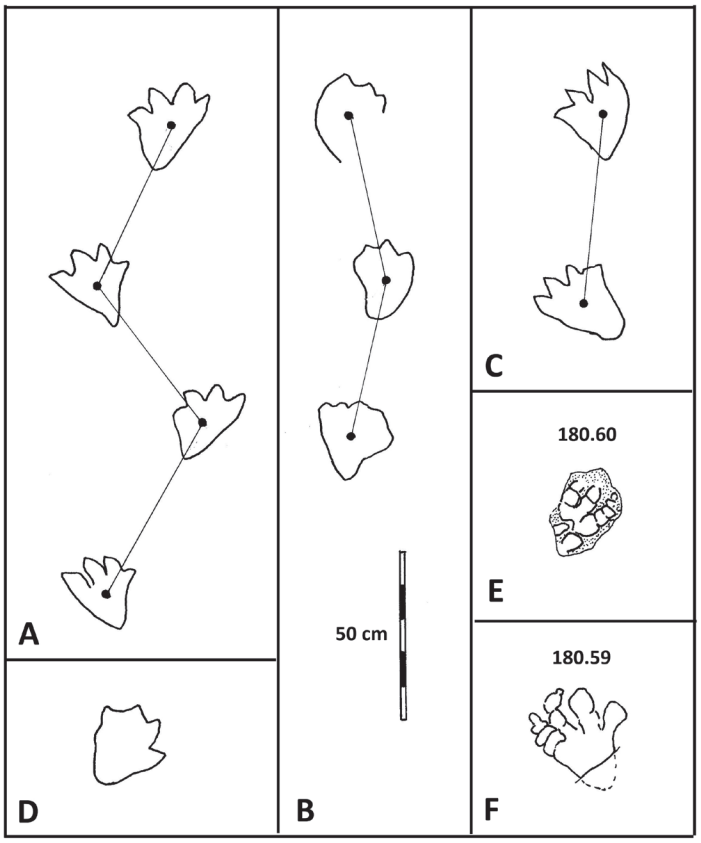


FIGURE 4. *Otozoum* tracks and trackways from the Poison Spider Mesa trail. A, a three step trackway with well defined toe traces and wide pace angulation. B, a two step trackway segment with low pace angulation. C, a trackway segment revealing tracks with well defined toe traces. D, an isolated track with four clear tow races. E, a natural cast (UCM 180.60) with well defined digital pad traces. F, a natural cast (UCM 180.59) with well-defined digital pad traces. See text for details.

thinness of some of the sandstone beds (3-5cm), some surfaces reveal undertracks that correspond to true tracks in overlying layers.

DESCRIPTION OF TRACKS AND TRACKWAYS

As shown in Figures 3 and 4, various trackway segments are visible on the sandstone bedding planes exposed at the site. Three trackway segments were recorded. All apparently show bipedal progression, unless overprinting of the manus by pes is inferred (see below). The clearest trackway (Figs. 3A and 4A) reveals four consecutive tracks (L-R-L-R) with four clearly defined digit impressions. Diagnostically for *Otozoum*, digit I is the shortest and digit III the longest (III>II=IV>I). Tracks average 25.2 cm long (range 24-27 cm) and 23.2 cm wide (range 22-25 cm). The mean step is 56.3 cm, the mean stride is 90.5 cm and the mean pace angulation is 115°. However, inner trackway width is very low, ~5cm, indicating a narrow gauge trackway. The pes tracks are also strongly rotated outward relative to the trackway mid line (~30° as measured along the axis of digit III). In contrast, a second trackway (Figs. 3B and 4B) of similar size (mean length and width, 23.5 and 20.5 cm, respectively) has a mean step of 49 cm, but a much narrower trackway as indicated by the higher pace angulation of 155° and negative inner trackway width (~ -10°). A third trackway segment (Fig. 4C) shows preservation similar to the longest recorded trackway segment (Fig. 4A).

All the tracks illustrated in Figures 3 and 4A-D were found in situ on exposed sandstone bedding planes. However, numerous additional tracks were found preserved as natural casts in the overlying red shales. Generally, these were poorly preserved, revealing a teardrop-shaped outline, in which the narrow heel expands anteriorly to a transverse expanded region marked by rather blunt, inconspicuous toe traces. This outline seems to be characteristic of an *Otozoum* track cast preservation in certain facies and has been observed elsewhere (e.g., Kayser, 1964; Lockley, 2011, figs. 3, 8 and 9). Among these many poorly preserved casts, two (UCM 180.59 and 180.60) were recovered that preserved diagnostic digital pad traces (Fig 4 E-F). UCM 180.59 is missing a part of the heel but reveals three digital pad traces on digit IV as well as a distal ungual trace, and additional pad traces on digits II and III. Likewise, UCM 180.60 reveals a similar configuration of pad traces on digits II-IV. It appears that pad traces are best preserved on digit IV. This is likely due to slightly greater pressure having been exerted on the

outside of the foot, as it rotated outward during track registration.

DISCUSSION

Otozoum is a distinctive four-toed track of a facultative biped that, in many well-preserved examples, shows very well defined digital pad traces (Fig. 4E-F). Manus tracks are rarely reported (Rainforth, 2003; Lockley et al., 2006), indicating that it was unusual for the trackmaker to adopt a quadrupedal gait. *Otozoum* is usually attributed to a prosauropod (Lull, 1953; Lockley and Hunt, 1995; Lockley et al., 1998; Rainforth, 2003), and, according to Lockley et al. (2006), can be considered part of the *Otozoum-Pseudotetrasauropus-Evazoum-Kalosauripus* or OPEK plexus, within the ichnofamily Otozoidae (Lull, 1904). Based on the reports from the greater Moab area (Lockley and Hunt, 1995) as well as from the Lake Powell area (Lockley et al., 1998, 2014) *Otozoum* is relatively common in what has been referred to as the "Kayenta-Navajo transition zone" (Lockley et al, 1998, p. 195). However, *Otozoum* also occurs below and above this transition zone in the Kayenta and Navajo formations, respectively.

These Kayenta-Navajo transition zone tracksites (Lockley and Hunt, 1995; Lockley et al., 1998) yield typical Lower Jurassic ichnofaunas dominated by *Grallator, Eubrontes, Anomoepus, Otozoum* and *Batrachopus*. The closest, well-documented site to the Poison Spider Mesa site is the aforementioned Potash road site that has yielded *Grallator, Eubrontes* and *Anomoepus* (Lockley and Hunt, 1995), where *Otozoum* has not been reported. Other sites in this interval are known south of Moab, in the vicinity of Canyon Rims, east of Canyonlands (Lockley and Hunt, 1995) as well as the aforementioned Lake Powell sites (Lockley et al., 1998, 2014). The reasons for the concentration of tracksites in this stratigraphic interval are presently unknown, although inferences are briefly discussed elsewhere in this volume (Lockley et al., 2014). To date, *Otozoum* is the only track type identified at the Poison Spider Mesa site. However, insufficient time has been devoted to exploring the track-bearing beds in this area to conclude that this is the only ichnotaxon represented.

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