

New Discoveries of Fossil Footprints at Dinosaur National Monument

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Dinosaur National Monument (DINO) is most famous for the spectacular dinosaur bone quarry in the Morrison Formation. Here visitors can see the remains of well known dinosaurs like *Stegosaurus*, "Brontosaurus" (correctly known as *Apatosaurus*), *Camarasaurus* and other extinct animals from the Late Jurassic epoch - or golden age of brontosaurs. As recent discoveries have shown however, it is not just the world famous Morrison beds that reveal evidence of dinosaurs and other Mesozoic vertebrates at DINO. During the last two years the park service has sponsored a fossil footprint research project that has so far resulted in the discovery of about 18 new tracksites.

Historically, dinosaur tracks and other fossil footprints were virtually unknown from DINO and the immediate vicinity. In fact only one fossil track had ever been collected in the large area that makes up the monument. This situation reflected a lack of research activity in the field of Ichology (the study of trace fossils). All this has changed dramatically as the study of tracks and traces has rapidly developed into a mainstream geological science in recent years.

At Dinosaur National Monument there are at least 8 potentially track-bearing Mesozoic formations including 5 that pre-date the bone rich Morrison Formation and 2 that post date it. During the first two years of field work our research team (the U/CO at Denver, Dinosaur Trackers Research Group) has focused attention on pre-Morrison beds. Most of the tracksites so far discovered occur in the Late Triassic Chinle Formation (also referred to as the Popo Agie in this area). A few tracksites also have been discovered in the Glen Canyon sandstone (Late Triassic-Early Jurassic) and tracks have been reported from the Middle Jurassic Carmel Formation very near the monument boundaries.

The Chinle Formation tracksite discoveries are particularly interesting because of the variety of track types and the quality of preservation. Most people are familiar with the Chinle Formation in the type area of northeastern Arizona where it makes up the famous Painted Desert badlands and contains the logs that comprise the well-known Petrified Forest. In this region bones also are abundant but tracks are rare. At Dinosaur National Monument however the reverse is true; bones are very rare but tracks are quite abundant. In fact, as shown below, most well-known Late Triassic tetrapods are represented by their tracks, and it is possible to derive a census of the animal communities of that epoch just from the fossil footprint evidence (Fig.1).

The Late Triassic was the beginning of the Age of Dinosaurs - a time when many non-dinosaurian reptiles were undergoing rapid evolutionary radiation. The track record reflects this epoch of diversification by revealing an interesting menagerie of archosaurian reptiles. In approximate order of relative abundance the Chinle Formation at Dinosaur National Monument has so far yielded the following trackway types (Fig.2).

Agialopus: the three toed tracks of a small, bipedal, turkey sized dinosaur like *Coelophysis* [sim-

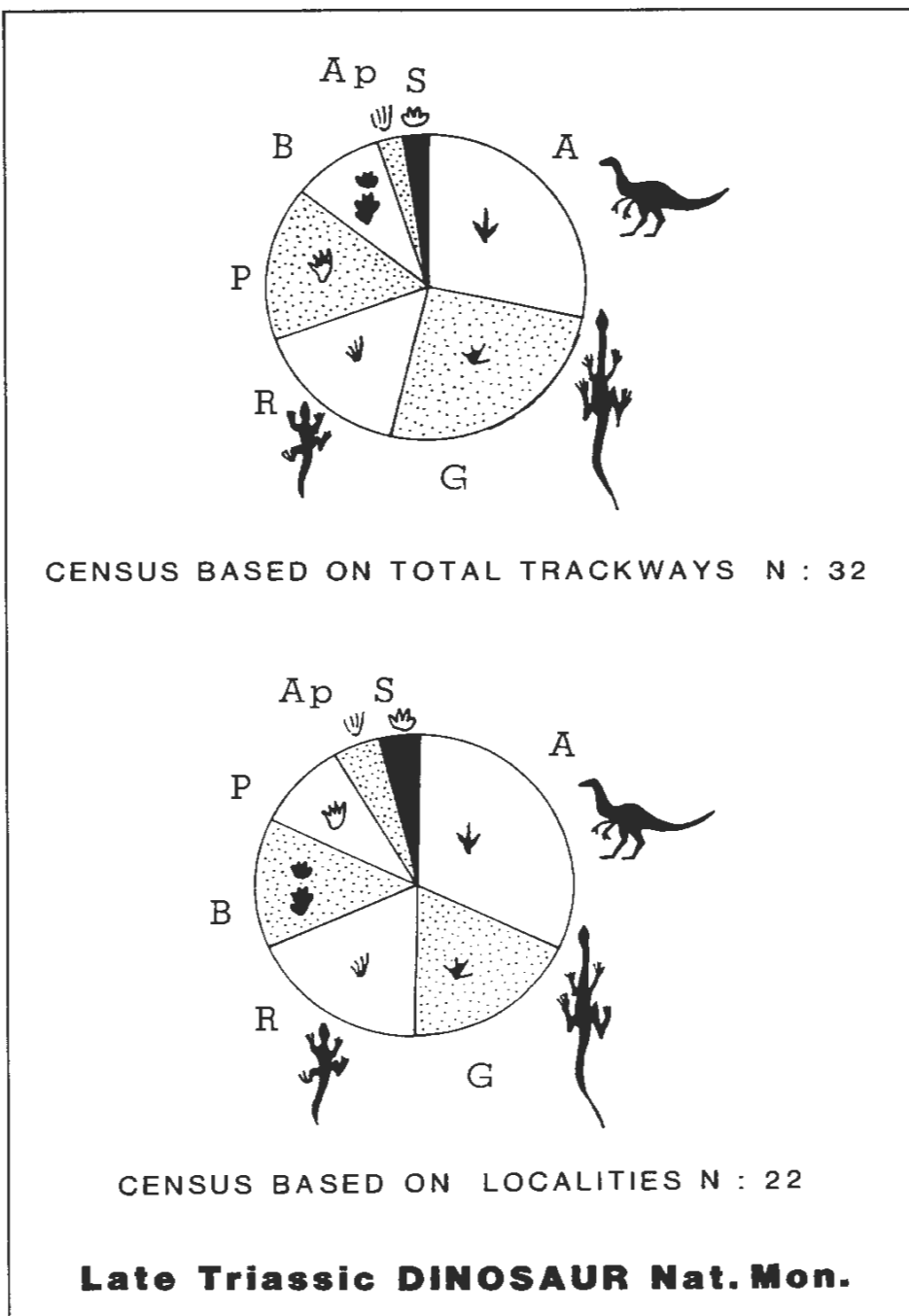


Figure 1. Pie diagrams showing the proportion of different Late Triassic track types found at Dinosaur National Monument. Top diagram based on total number of trackways; bottom based on number of localities revealing various track types.

ilar bird-like tracks are also referred to as *Grallator*].

Gwyneddinium: the four toed tracks of a relatively rare aquatic reptile known as a tanystropheid [possibly genus *Tonyrachelos*].

Rhychosauroides: the five toed tracks of a lizard, or lizard-like animal related to the modern "Tuatara" (genus *Sphenodon*) from New Zealand.

Brachychirotherium: the five toed tracks (hind feet) and four toed front footprints of a quadrupedal

archosaur, probably an armored herbivorous aetosaur.

"*Chirotherium*": the five toed tracks (hind feet) of a quadrupedal archosaur, probably an aquatic, crocodile-like form known as a phytosaur.

Mammal-like reptile tracks: five toed footprints made by the only non-archosaurian vertebrate represented in this list.

Kouphichium: distinctive, complex trace made by

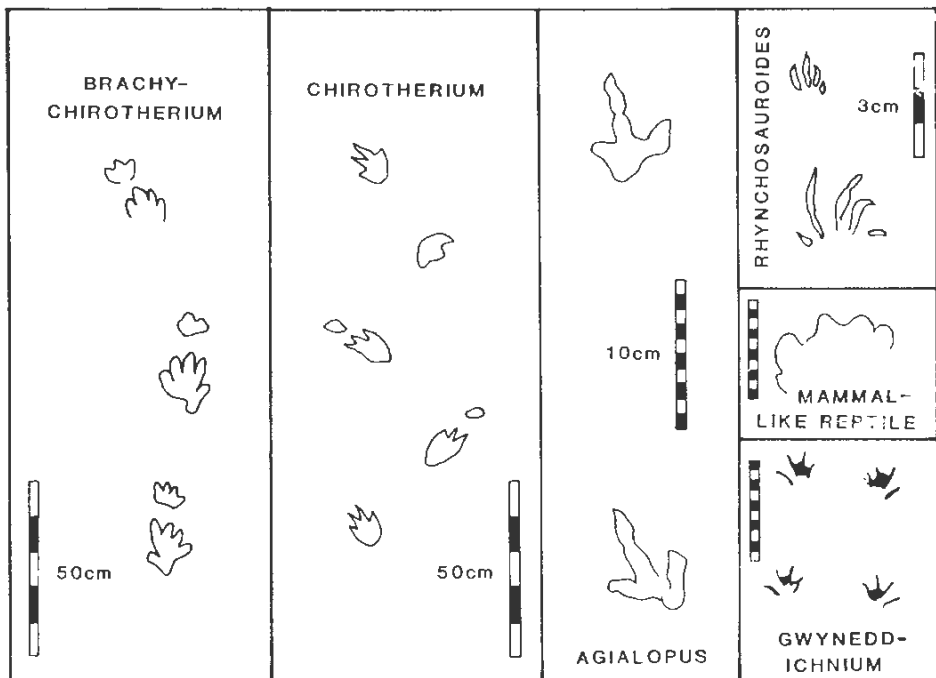


Figure 2. Detail of tracks and trackways of various Late Triassic trackmakers from Dinosaur National Monument

a horseshoe crab, or close relative (cf. modern genus *Limulus*).

Scoyenia and others: trails of various invertebrates including miscellaneous arthropods and worms.

All these vertebrate and invertebrate tracks and traces were found in the upper part of the Chinle Formation in deposits that represent ancient lake and floodplain settings. Recent work suggest that the Late Triassic was generally a wet epoch in the western United States and that intense monsoonal conditions prevailed (the so-called Megamonsoon). Such circumstances would have resulted in high water tables and good conditions for trackmaking as seen in many formations in the western USA at this time.

The presence of at least two mainly aquatic trackmakers (phytosaurs and tanystropheids) also fits this picture. Trackways of the latter animal include examples with pairs of right and left hind foot impressions that reveal distinct web impressions and show that it swam with synchronous strokes of its hind feet (Fig. 3). These trackways are the first "swim tracks" ever reported for this animal and the first evidence that it had webbed hind feet. They are also a very rare example of swim tracks for an animal additionally known from walking tracks, thus allowing us to study two different modes of locomotion.

To date we have done little work on the Jurassic track-bearing beds that overlie the Chinle. However we can report that beds in both the upper part of the Glen Canyon Group (Navajo Formation) and the Carmel Formation are dominated by the three toed tracks of bipedal dinosaurs. This evidence shows that dinosaurs rose to a position of prominence between the Triassic and Jurassic and displaced a significant number of their formerly successfully archosaurian relatives. Ongoing research and the present high rate of discovery fossil footprint sites promises to reveal more trackway evidence at Dinosaur National Monument and elsewhere in the western USA.

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Further Reading

Tracking Dinosaurs by Martin Lockley
Cambridge University Press, 238 p

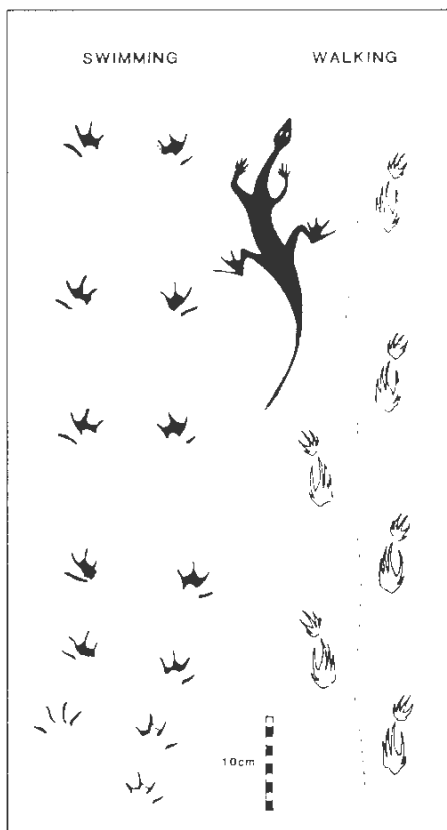


Figure 3. Comparison of trackways of swimming and walking tanystropheids. Note web impressions in swim tracks.