**PALAIOS, 2009, v. 24, p. 222–238**
**Research Article**
**DOI: 10.2110/palo.2007.p07-070r**

# Laboratory-controlled simulations of dinosaur footprints in sand: A key to understanding vertebrate track formation and preservation

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Keywords: indenter, tridactyl, morphology, moisture, deformation

## ABSTRACT

Dinosaur tracks and trackways yield invaluable information as to the identity, size, and gait of the trackmaker and the conditions of the media (=substrate) it traversed. Correctly interpreting tracks requires consideration oftheir three-dimensional morphology. Laboratory-controlled simulations were conducted to investigate the subsurface track morphology formed from differently shaped feet, as the shape of the footprint deteriorates with depth. A circular, triangular, and a tridactyl dinosaur foot-shaped template, or indenter, were indented vertically into two types of sand, with four moisture contents—dry, 10%, and 20%, , and saturated. The morphology of all three indenters was preserved most accurately in the moist sand. Tracks in dry and saturated sand were distorted by a greater degree of media deformation. Digit imprints of tridactyl tracks were only clearly discernible in near-surface layers and were deformed by shear zones or inward movement of sediment in dry and saturated sand. The long digits of the template produced the greatest degree of outward displacement, and tracks became wider with depth and deepest in the heel region. This was most distinct in dry sand, where extensive shear zones in cross section demonstrated the outward and upward movement of sediment. All tracks in saturated sand were characterized by considerable downward displacement of sediment and features related to the upward pull of sediment as the templates were withdrawn. These diagnostic features allow vertebrate tracks to be differentiated from nonbiogenic, soft-sediment deformation. Fossil tracks studied from the Middle Jurassic succession of the Cleveland Basin, Yorkshire, demonstrate affinities to the experimental tracks formed in saturated sand.