Trackway analysis shows how dinosaurs coped with slippery slopes

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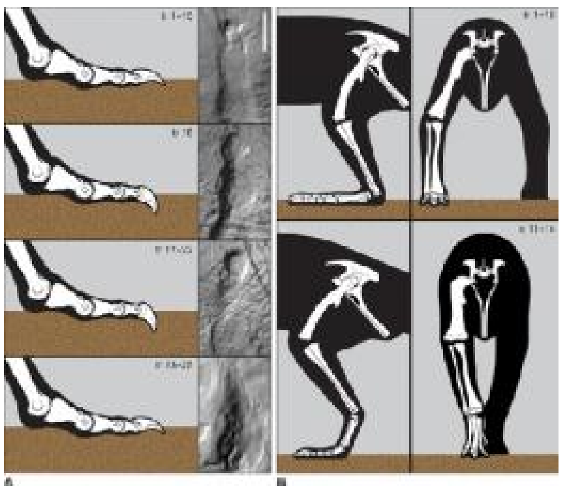

This figure shows how the theropod (left) and ornithischian (right) trackmakers responded to differences in substrate at Moyeni. The theropod reacted to slippery sediments by digging in with its toe claws. In contrast, the ornithischian reacted by shifting between a low, four-footed stance and an upright, two-legged stance, wide and narrow gauge limb support, and plantigrade (i.e., heel down) and digitigrade (elevated heel) foot posture. From Wilson et al. 2009. Dynamic locomotor capabilities revealed by early dinosaur trackmakers from southern Africa. PLoS One. http://dx.plos.org/10.1371/journal.pone.0007331

(PhysOrg.com) -- A new investigation of a fossilized tracksite in southern Africa shows how early dinosaurs made on-the-fly adjustments to their movements to cope with slippery and sloping terrain. Differences in how early dinosaurs made these adjustments provide insight into the later evolution of the group.

The research, conducted by researchers at the University of Michigan, Argentina's Universidad de Buenos Aires, and the Iziko South African Museum in Cape Town, South Africa, will be published online Oct. 6 in the open-access journal PLoS ONE.

The Moyeni tracksite in Lesotho contains more than 250 footprints made by a variety of four-legged animals near the beginning of the Jurassic Period (about 200 million years ago), when the Earth's landmasses were united as Pangea. The site was first discovered and described in the 1960s and 1970s by French paleontologist Paul Ellenberger but has not since been examined in detail. In their re-analysis of the fossil tracksite, the researchers created a high-resolution map of trackway surface using a combination of traditional mapping techniques and a 3D surface scanner, which recorded millimeter-scale detail. The digital record of the site will serve as an archive and will be the source of future research, said U-M's Jeffrey Wilson, an assistant professor in the Department of Geological Sciences and an assistant curator in the Museum of Paleontology.

The researchers' re-interpretation of the geology of the tracksite indicated that the dinosaurs were walking across an ancient point bar that presented the animals with varying surface conditions. Based on the map, scans, and first-hand observations at the site, Wilson and coworkers Claudia Marsicano and Roger Smith interpreted the tracks to understand how dinosaurs adjusted to changes in terrain as they moved between a wet riverbed, a sloping bank, and a flat, upper surface of the point bar.

"Tracks and trackways bring animals to life in a way that their bones cannot, by providing a brief but vibrant record of a living, breathing animal as it moved through its environment," Wilson said. "While fossilized bones can provide a wealth of information about extinct animals' anatomy and physiology, inferences about their locomotion and behavior are necessarily indirect." Tracks, on the other hand, are a direct record of the animal's behavior.

The disadvantage, though, is that tracks preserve the impression of nothing more than the sole of the foot, rendering trackmaker identification an approximation. It is very difficult to identify species with such limited information.

"Suppose you ran down the beach with a group of friends and then tried to identify each person's footprints," Wilson said. "You might use characteristics like foot size and length and even the number of toes, if someone in the group happens to be missing one. We use similar indicators to figure out what we're looking at, and while we can't identify tracks down to the species level, we can distinguish major groups, such as plant-eating ornithischians and meat-eating theropods."

When they analyzed the tracks, the researchers determined that ornithischians changed their way of walking as surface conditions changed. In the river bed, they crouched low, adopted a sprawling four-legged stance, and crept along flat-footed, dragging their feet. On the slope, they narrowed their stance, still walking on all fours, but picking up their feet. Once they reached the flat, stable ground on top, they switched to walking on two legs.

In contrast, the theropod that crossed the surface didn't vary its posture or gait. Remaining upright on two legs, it used claws on its toes to grip slippery surfaces.

"The tracksite is a natural laboratory," said Smith. "We have a record of how different animals reacted to the same set of ground conditions."

The different walking styles also foreshadow evolutionary trends in the two dinosaur lines, Wilson said. Three separate times in their evolutionary history, ornithischians switched from walking mainly on two legs to walking exclusively on all four.

"It was thought that early in their evolutionary history, they had the capacity to do both, but at Moyeni they were caught in the act, and we can analyze how and perhaps why they did it," Marsicano said.

Theropods, on the other hand, never gave up their two-legged stance. But because their lineage is believed to have given rise to birds, the possibility that their gripping claws played a key role is interesting to consider.

"One idea about the origins of flight is that the progenitors of birds learned to fly by flapping their wings while climbing inclined surfaces," Wilson said. "In that scenario, the ability to grip a surface with claws is important."

More information: "Dynamic locomotor capabilities revealed by early dinosaur trackmakers from southern Africa"---dx.plos.org/10.1371/journal.pone.0007331

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