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Why ornithopod feet rotate inward

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Abstract:

Inward rotation of hindfoot axis (orientation of digit III relative to the trackway midline) is commonly observed in both bipedal and quadrupedal trackways of ornithopods, suggesting in-toed gait of the trackmakers. The origin of quadrupedalism of ornithopods has been often discussed in previous research, but the cause of in-toed orientation of the pes is largely unknown.

We investigated 14 ornithopod trackways, all showing inward rotation of the hindfoot. The average pace angulation of 14 trackways based on the measurement connecting the center of the footprints is 158°. In contrast, the value based on the measurement connecting the tip of digit III is 166°. The latter value is close to that of the average pace angulation of theropods.

The observation of shorebirds has proven that birds with long legs and high-positioned acetabular joints do not have inward rotated feet. In contrast, birds with short legs and low positioned acetabular joints have inward rotated feet.

Based on these data, we interpret this as follows. The inward rotation of the hindfoot axis: 1) increases the stability of the body against the lateral overturning moment; 2) compensates for the short distance between knee and ground, and resolves the disadvantage of short legs when placing the foot closer to the trackway midline (center of mass) for maintaining body balance.

Keywords: dinosaur, footprint, trackway, in-toed, pronation