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PEDAL BIOMECHANICS FROM DIGITIGRAD TO SUBUNGULIGRAD

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The parallel evolution of subunguligrady from a digitigrade posture had occurred in several opportunities in terrestrial tetrapods. Mammals like rhinocerotids and proboscideans as well as dinosaurs like stegosaurs, ceratopsians, and sauropods, followed similar patterns of modification in the phalangeal anatomy: flattening of the phalanges, attenuation of its tendon processes, reduction of the sagittal ridge and unguals were transformed from claw to hoof. Also, soft tissue changed its primary function as an energy absorber, to became part of the columnar support. These changes demonstrate to be somewhat related to the increment in body size. As seen in mammals, limb posture becomes progressively more upright, and limb motion is restricted to a predominantly parasagittal plane, being a response to a reduction of the mass-specific amount of force required to counteract moments about the joints. Therefore, it is reasonable to hypothesize that such changes are valid for quadrupedal dinosaurs as well, although this has not been studied in depth yet.

To assess the different loading conditions in the acquisition of subunguligradism, and with special focus in the evolution of Ornithopoda, I modeled diverse phalangeal morphologies and pes in different stance degrees, in 2 and 3 dimensions, using finite element analysis and comparing results with CT scanned images of different feet. The result showed that the stress distribution and internal structure, such as the arrangement of the compact and cancellous bone, as well as the presence of a medullar cavity, are direct consequences of the external anatomy. Moreover, the physics behind the anatomical features of the subunguligrade pes suggest a remarkable capability of supporting high compressive loads in comparison with digitigrades.