Abstract Submitted
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Robotic and mathematical modeling reveal general principles of appendage control and coordination in terrestrial locomotion[1] BENJAMIN MCINROE, UC Berkeley, HENRY ASTLEY, Georgia Tech, CHAOHUI GONG, CMU Robotics Institute, SANDY KAWANO, NIMBioS, PERRIN SCHIEBEL, Georgia Tech, HOWIE CHOSET, CMU Robotics Institute, DANIEL I GOLDMAN, Georgia Tech — The transition from aquatic to terrestrial life presented new challenges to early walkers, necessitating robust locomotion on complex, flowable substrates (e.g. sand, mud). Locomotion on such substrates is sensitive to limb morphology and kinematics. Although early walker morphologies are known, principles of appendage control remain elusive. To reveal limb control strategies that facilitated the invasion of land, we study both robotic and mathematical models. Robot experiments show that an active tail is critical for robust locomotion on granular media, enabling locomotion even with poor foot placement and limited ability to lift the body. Using a granular resistive force theory model, we construct connection vector fields that reveal how appendage coordination and terrain inclination impact locomotor performance. This model replicates experimental results, showing that moving limbs/tail in phase is most effective (suggesting a locomotor template). Varying limb trajectories and contacts, we find gaits for which tail use can be neutral or harmful, suggesting limb-tail coordination to be a nontrivial aspect of locomotion. Our findings show that robot experiments coupled with geometric mechanics provide a general framework to reveal principles of robust terrestrial locomotion.

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Benjamin McInroe
University of California, Berkeley

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