Structure and Mechanics of Mammalian Prehensile Tail Vertebrae

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Prehensile tails (PTs) – capable of suspending the body weight of the animal – evolved independently as many as 14 times among 40 extant mammalian genera. The structure of the mammalian PT is well studied in New World monkeys, where it evolved twice: once in the atelines (*Ateles*, *Lagothrix*, *Brachyteles*, and *Lagothrix*) and once in the genus *Cebus*. Recently, we have expanded our studies to nonprimate taxa such as carnivoran procyonids (raccoons and relatives) and didelphid marsupials (opossums and relatives). Adult PTs share musculoskeletal features that distinguish them from nonprehensile tails, which are thought to be adaptive to the mechanical demands of suspension and/or prehension incurred with locomotion, posture, and manipulation: 1) craniocaudally expanded sacroiliac joint and more proximal region vertebrae, which increase joint and tail stability; 2) more expansive transverse and hemal processes (proximal and distal attachments for primary tail flexors, respectively); and 3) tail vertebrae that are estimated to be structurally stronger and more rigid.
Yet, our understanding of the broader adaptive significance of the PT has been hampered by two major deficits. First, structural data are largely limited to cortical and trabecular geometric assessments, which only provide estimates of mechanical properties and therefore limit the mechanical conclusions we can draw. Second, our studies have concentrated solely on the features of the adults, even while we know anecdotally that tail-use behavior changes ontogenetically, and it would be expected that these changes would be reflected in the mechanical properties of the tail vertebrae. The present study demonstrates that cortical geometric assessments correlate with structural mechanical properties of tail vertebrae in an ontogenetic series of squirrel monkeys, and both sets of data reveal a trend of increasing structural strength of the vertebrae with increasing body size (i.e, age).

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