

Why tyrannosaurid forelimbs were so short: An integrative hypothesis

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The unusually shortened limbs of giant theropods, including abelisaurids, carcharodontosaurids, and derived tyrannosauroids such as *Tyrannosaurus rex* have long been an object of wonder, speculation, and even derision on the part of both paleontologists and the public. Two questions commonly asked are “Why did the forelimbs become so short?” and “What did the animals use such short forelimbs for, if for anything?” Because basal tyrannosauroids and their outgroups, as well as the outgroups of other giant theropods, had longer forelimbs, the foreshortening of these elements in derived taxa was secondary, and it ostensibly involved a shift in developmental timing of the forelimb elements. Factors proposed to have influenced the evolutionary foreshortening include natural selection, sexual selection, energetic compensation, ontogenetic vagaries, and rudimentation due to disuse. Hypotheses of use have varied from a supporting anchor that allows the hindlimbs a purchase to stand from a reclining position to a pectoral version of pelvic claspers during intercourse to a sort of waving display during sexual or social selection. None of these hypotheses explain selective regimes for reduction; at best, they might argue for maintenance of the limb, but in all cases a larger limb would have suited the function better. It is likely that we have been looking the wrong way through the telescope, and that no specific function of the forelimbs was being selected; instead, another crucial adaptation of the animal profited from forelimb reduction. Here I propose, in the context of phylogenetic, ontogenetic, taphonomic, and social lines of evidence, that the forelimbs became shorter in the context of behavioral ecology: the great skull and jaws provided all the necessary predatory mechanisms, and during group-feeding on carcasses, limb reduction was selected to keep the forelimbs out of the way of the jaws of large conspecific predators, avoiding injury, loss of blood, amputation, infection, and death. A variety of lines of evidence can test this hypothesis.

Key words: Dinosauria, Theropoda, *Tyrannosaurus*, *Abelisaurus*, *Carcharodontosaurus*, predation, limb proportions.

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