

## GIANT HORNED DINOSAURS DID HAVE FULLY ERECT FORELIMBS

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Johnson (1990) presented a new mount of *Torosaurus* with semi-erect forelimbs. This is not in accord with the best available evidence. A Maastrichtian trackway assignable to *Triceratops* or *Torosaurus* shows the hindfeet astride the body midline. Manus prints are somewhat lateral to the pes prints, being separated by one and half manus widths. A similar condition is often observed in other dinosaur trackways, and in some ungulates. A skeletal restoration matched with the trackway shows that the ceratopsid's hands were placed directly beneath the shoulder joints, a fully erect posture. The hands are lateral to the shoulder joint in Johnson's skeletal reconstruction because: a) misarticulation of the anterior ribcage distorts the posture of the arms; and b) the hindfeet are offset too far from the midline, forcing the hands to also be too far apart.

Ceratopsid forelimbs may have been able to assume a secondary semi-erect posture that facilitated head-head intraspecific (but not anti-predator) combat. A comparison of the normal limb movement and vertebral column strength of giant ceratopsids, ungulates and elephants shows that the biomechanics of horned dinosaurs were compatible with a galloping gait.

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## LONG ERECT LEGS AND RAPID GROWTH REQUIRE HIGH MAXIMAL AND MINIMAL METABOLISMS IN DINOSAURS AND ARCHAEOPTERYX

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Vertebrate standard metabolisms are always at least one tenth long term maximal aerobic rates. Walking is energy expensive, and self feeding young must be active to grow rapidly. These energetic constraints force all land vertebrates into four major grades: Grade 1 — most eutherians, protocrocs, all dinosaurs, pterosaurs, all birds: High capacity respiro-circulatory tracts, long, erect striding limbs. Grow and cruise rapidly, can migrate long distances. MAR's and SMR's very high, anaerobic performance modest; Grade 2 — marsupials: Either efficient hopping or awkward limbs. Grow less rapidly. SMR's intermediate; Grade 3 — edentates, monotremes, therapsids: Awkward or less erect limbs, growth rather slowly. SMR's lower; Grade 4 — reptiles and amphibians: Sprawlers, low capacity respiro-circulatory systems, grow and cruise very slowly, do not migrate. Very low MAR's and SMR's, anaerobic performance very high.

All alternative models of dinosaur and protobird physiology (Ruben, 1990) are not compatible with their anatomy, sustained activity and growth rates, and those that combine low SMR's with high aerobic scopes invoke insect-like physiologies!