

Sprawling *versus* parasagittal stance in multituberculate mammals

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The structure of multituberculate humerus and shoulder and elbow joints is analyzed and compared with those of anurans, lacertilians, monotremes, and fossil and extant therian mammals. The following features are recognized as characteristic of the humeri of tetrapods with a primary sprawling stance: prominent radial and ulnar condyles (trochlea in parasagittal forms), lesser tubercle wider than greater tubercle (narrower in parasagittal forms), wide intertubercular groove (narrow in parasagittal forms). Torsion of the humerus occurs in terrestrial tetrapods with abducted forelimbs, which use symmetrical diagonal gaits, but not in anurans which have abducted forelimbs but use asymmetrical jumps, and not in fossorial therians with sprawling or semi-sprawling stance (except Chrysochloridae). Lack of torsion is not indicative of parasagittalism. Condylar structure of the elbow joint, characteristic of multituberculates, occurs in all tetrapods with primary abducted forelimbs. Fossorial therians that secondarily acquired half-sprawling or sprawling stance, differ from tetrapods with primary sprawling stance in having a trochlea and radial condyle, but no ulnar condyle, and in having a narrow intertubercular groove. The hypotheses of Sereno & McKenna on multituberculate parasagittal stance and of Kielan-Jaworowska & Gambaryan on sprawling stance are tested by anatomical comparisons and reconstructions of forelimb movements. It is shown that the range of humeral excursion during flexion-extension at the shoulder joint in multituberculates was much smaller than in *Didelphis*, and that during the swing phase the forelimbs were stretched anteroventrally, as characteristic of mammals before landing. It is concluded that multituberculates were adapted for asymmetrical jumps with abducted forelimbs, rather than that they moved like *Didelphis*. As there is no trace of an incipient trochlea in any known multituberculate, while the trochlea made its appearance in therians possibly during the Late Jurassic, the idea that parasagittalism occurred in mammalian evolution in common ancestors of therians and multituberculates is refuted.

Key words: Multituberculata, Theria, anatomy, digging, sprawling stance, parasagittalism.

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