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Are Rhinoceros graviportal ? Morphofunctional 3D-analysis of modern Rhinoceros limb long bones

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Many amniote lineages display convergent evolution towards high body mass through time, which strongly impact (among others) the appendicular skeleton. Species displaying adaptations to sustain a high body mass are said to be graviportal, a term defined alternately by the relative length of limb segments, osteological features, body mass, pos- ture or gait. Unlike elephants, rhinoceros do not fulfil all the graviportal criteria and important body mass and body size variations can be observed between the lightest rhinoceros (*Dicerorhinus sumatrensis*) and the heaviest one (*Ceratotherium simum*). Detailed study of long bone shape variation in the five living rhino species could enable to better highlight limb traits potentially linked to body mass increase in the group. Using 3D-geometric morphometrics on the six stylopod and zeugopod bones allows us to clearly discriminate the five species. The fibula displays a particularly strong intraspecific variation which ques- tions its functional adaptive value, among other possible contributing factors. Moreover, morphological traits tend to co-vary because of common developmental origin or similar function, a tendency called integration. We completed our individual bone analysis by exploring this integrative aspect related to high body mass. While the strong dif- ferences between the lightest and the heaviest species tend to indicate an impact of body mass on the bone shape, the influence of body size, body proportions, ecology, and phylogeny are also characterized. This study allows us to propose morphofunctional interpretations of the observed shape variations between the five species and to contribute new elements to the recognition of morphological changes associated with weight bearing adaptations of the limb bones in rhinoceros.