

The relationship between astragalar size and body mass in land mammals: Estimating body mass of fossil species

TSUBAMOTO, Takehisa^{1*}

¹Hayashibara Biochemical Laboratories, Inc.

Astragalus is a compact and easily handleable bone. Astragalar fossils have been well studied as an indicator of the functional morphology and phyletic relationships of many mammals. However, few studies have investigated the relationship between astragalar size and body mass, even though the body mass of animals strongly correlates with their ecology and physiology and the body mass of fossil taxa has been intensively estimated by several methods.

In this study, I examined the allometric relationship between body mass and astragalar size in extensive extant land mammals (11 orders, 48 species, 80 individuals; body mass ranging from 18 g to 3.4 metric tons) using regression analysis. The results indicate that the best body mass estimator for extensive land mammals is the tibial trochlear size rather than the total size of the astragalus. For example, the body mass is estimated using the width of the tibial trochlea by the following formula ($R^2 = 0.985$; %SEE = 42.0; %PE = 28.8): $\ln(\text{body mass [g]}) = 2.789 \times \ln(\text{width of tibial trochlea [mm]}) + 2.078$.

Then, the body masses of several Paleogene land mammals were estimated using the results of the regression analysis. The estimated body masses are consistent with the results by previous studies. For example, the body mass of the largest terrestrial mammal that ever lived, '*Indricotherium*,' was estimated to be about 10-15 metric tons. Therefore, the regression equations by this study using the astragalus are useful for estimating body masses of fossil land mammals and have the potential to be widely applied to quantitative ecological and physiological studies of fossil mammals.