Geometric morphometrics out-perform linear-based methods in the taxonomic resolution of a mammalian species complex

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Abstract

Morphology-based taxonomic research frequently applies linear morphometrics (LMM) in skulls to quantify species distinctions. The choice of which measurements to collect generally relies on the expertise of the investigators or a set of standard measurements, but this practice may ignore less obvious or common discriminatory characters. In addition, taxonomic analyses often ignore the potential for subgroups of an otherwise cohesive population to differ in shape purely due to size differences (or allometry). Geometric morphometrics (GMM) is more complicated as an acquisition technique, but can offer a more holistic characterization of shape and provides a rigorous toolkit for accounting for allometry. In this study, we used linear discriminant analysis to assess the discriminatory performance of four published LMM protocols and a 3D GMM dataset for three clades of antechinus known to differ subtly in shape. We assessed discrimination of raw data (which are frequently used by taxonomists); data with isometry removed; and data after allometric correction. We found that group discrimination among raw data was high for LMM, possibly inflated relative to GMM when visualised in PCA plots. However, GMM produced better results in group discrimination after the size and allometry treatments. High measurement redundancy in LMM protocols appears to result in relatively high allometry but low discriminatory performance. These findings suggest that taxonomic measurement protocols might benefit from GMM-based pilot studies, because this offers the option of differentiating allometric and non-allometric shape differences between species, which can then inform on the development of the easier-to-apply LMM protocols.

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