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Use of morphometric data in taxonomy and functional morphology: a case study of modern and Cretaceous diving birds.

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The Cretaceous Hesperornithiformes and a number of modern avian families (i.e., loons, grebes, cormorants, and some ducks) have convergently derived a foot-propelled diving lifestyle. Differences in the morphology of their skeletons and the underlying morphometrics of these birds may provide insight into their different ecological strategies and differences in the ecological niches they occupy. Studying the details of this evolutionary convergence provides an opportunity to better understand the extinct Hesperornithiformes, particularly in regard to adaptations for foot-propelled diving.

This study presents a morphometric analysis of the hindlimb skeleton of modern and fossil foot-propelled diving birds. Measurements were collected from the tarsometatarsus, tibiotarsus, and femur of 24 species of modern birds and 14 species of hesperornithiforms. In order to explore variation within the data, a number of different combinations of measurements (for example, tarsometatarsus and tibiotarsus, or tibiotarsus and femur) were subjected to principle components analyses (PCA). The primary reason for investigating the data in different subsets was to increase taxonomic inclusion among the fossil specimens, where missing data was the largest impediment to the study. Following the PCA, discriminant function analyses (DFA) were run on each subset of the data to test classification of specimens to assigned species.

Results of this study highlight the differences in the morphometrics of the hindlimbs of modern and extinct foot-propelled diving birds. In most of the PCAs, modern birds cluster in multiple distinct regions of morphospace. In many instances these clusters correspond to higher-order taxonomy, and so may indicate different evolutionary pathways through which these un-related birds (1) arrived at the same locomotor strategy. In general, the hesperornithiforms cluster together in morphospace. The modern taxa that share morphospace with the hesperornithiforms include multiple species of cormorants (*Phalacrocorax*) and diving ducks (*Aythya).* This is interesting because hesperornithiforms are most commonly compared to loons and grebes in terms of hindlimb morphology (2). While in a few analyses certain species of loon (*Gavia*) did overlap in morphospace with hesperornithiforms, species of grebe (*Aechmophorus*, *Podiceps*) rarely or never shared morphospace. This implies that while morphological features of the hindlimb bones of hesperornithiforms may resemble loons or grebes, the morphometrics are more consistent with other diving birds.

This study allows for the quantitative analysis of morphometric variation within convergent modern and fossil taxa. Results highlight differences between morphological features and morphometric data among derived foot-propelled diving birds. Use of these sorts of analyses, in conjunction with detailed morphological work, may enhance our understanding of the evolution of complex ecological strategies or niche partitioning.

References:

[1] Jetz W et al. (2012) Nature 491: 444-448
[2] Zinoviev A (2010) J Syst Paleo 9:65-84