The morphological and structural diversity of aquatic amniote flippers

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Despite the enormous anatomical challenges posed by the return from land to water, several dozen amniote lineages have taken the plunge. These independent transitions resulted in a plurality of ways to swim using locomotor appendages, as arms and legs evolved into flippers. Here, we quantify this diversity in a comparative framework by (i) studying two-dimensional flipper external shape using elliptical Fourier analysis in combination with skeletal organisation; and (ii) testing for relationships between these parameters and body proportions, swimming styles, and phylogenetic distances. Our results show that phylogenetically distant taxa share convergent external flipper shapes due to strong constraints imposed by the aquatic environment. These similarities are, however, counterbalanced by the broad range of swimming styles and varied internal flipper anatomies characterising different amniote lineages. Surprisingly, some species with clearly distinct locomotory styles have comparable flipper morphologies. The functional implications of such similarities across species with distant evolutionary histories and different swimming styles continue to elude our understanding.