

# Categorizing various classes of morphological variation, and the importance of this to vertebrate paleontology

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## Abstract

For paleontologists, as well as other anatomists, the concept of morphological variation is crucial and lays the foundation on which almost all of our scientific work rests. It is useful to subdivide and categorize different types of morphological variation to more fully understand the concept.

Morphological variation is a complex mix of interspecific and intraspecific variation. One way we can subdivide the concept of morphological variation is in terms of empirical continuity. *Continuous variation* is something that we sometimes directly observe as a process during ontogeny, but in most cases it is an extrapolation made by connecting ordered discrete components. *Discontinuous variation* is recognized by empirical gaps in morphological continuity. It is discontinuous variation that enables us to recognize different species morphologically, which in turn allows us to recognize different higher taxa.

Another way we can subdivide the concept of morphological variation is to sort it into three main types: taxonomic, ontogenetic, and individual. *Taxonomic variation* includes the morphological differences between taxa (e.g., proper differential diagnoses). *Ontogenetic variation* comprises the differences between growth stages of an individual organism (usually extrapolated from size correlated differences observed in a population or a species). *Individual variation* occurs within an individual (i.e. between right and left sides or among serially homologous structures), or between different individuals of the same terminal taxon (species or subspecies). In this paper, I will focus on the latter type, which I define as differences between similar sized individuals of the same species (including typical polymorphisms, sexual dimorphism, and anomalies). This paper gives examples of these types of morphological variation and reviews why it is particularly important to remember the distinctions between them.

## Introduction

In this paper, I will look at systematic biological (and paleontological) studies from the perspective of morphological variation. In empirical work regarding phylogeny, systematics, and several other aspects of natural history, the concepts of “change” and “difference” are usually derived from comparative work on variation of form (presence/absence of structures, meristics, or morphometrics) at some level. Morphological variation is at the root of what most vertebrate paleontologists (as well as other organismic biologists) describe and analyze. We apply comparative techniques to variations in form to do a number of things, such as to: (1) diagnose discrete taxa, (2) identify sex type, (3) extrapolate ontogeny, (4) build taxonomic hierarchies; and (5) develop hypotheses concerning structural homology, phylogenetic relationships, and functional morphology.

Morphological variation includes both interspecific and intraspecific variation. I will focus on the most basic aspects of variation relevant to anatomically based phylogenetic studies. I will also focus on the relevance of categorizing variation to paleontologists, in particular, because of this volume’s subject theme (“Mesozoic fishes”). We can subdivide types of morphological variation along at least two different vectors. Through one vector (variation vector 1), we can subdivide it according to empirical continuity (i.e., empirically *continuous* or *discontinuous*). *Continuous variation* is something that is possible to directly observe

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