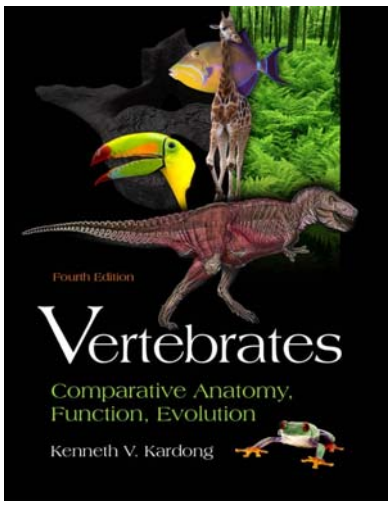


Archaeopteryx:
"reptile" and "bird"

Follow up in Textbook: Chapter 3; Figures 8.31, 8.42, 9.53

A. Objective:

Examine a fossil cast of *Archaeopteryx* to see if it is most like a modern bird or a modern reptile.

B. Textbook Reference:

No textbooks are to be used during this exercise. Work in small groups. As you do, carefully observe and discuss the cast of *Archaeopteryx* available in the laboratory, paying particular attention to features that may relate it to reptiles and/or to birds.

C. Introduction:

Seven skeletal specimens of *Archaeopteryx* are currently known. The cast available in the lab is of the "Berlin Specimen", found in 1877 near Blumenberg, Germany. Like the other specimens, it was found in smooth, fine grained limestone formed on the bottom of a hypersaline lagoon in the Late Jurassic, about 150 million years ago.

D. Preparation & Procedures:

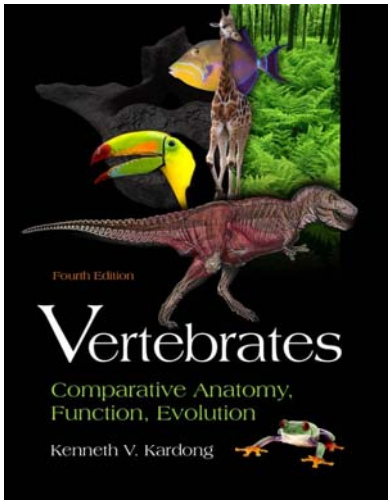
Many evolutionary biologists find in *Archaeopteryx* characteristics linking it with basal reptiles and characteristics it shares with derived birds. It is an example of mosaic evolution, a mixture of primitive and derived features. Examine the fossil specimen of *Archaeopteryx* to identify "reptilian" and "avian" traits. As points of comparison, use the anatomical features of alligators (or turtles) as representative of basal "reptiles" and the anatomic features of a modern bird (e.g. pigeon, chicken) as an example of a derived "bird". Where is *Archaeopteryx* placed compared to these two groups?

E. Synthesis:

Based upon what you can observe in the *Archaeopteryx* cast:

1. List and compare the features of this specimen that represent reptilian and avian features.

2. Critique the view, "*Archaeopteryx* is an evolutionary mosaic, wherein some reptilian features have changed little and others have undergone significant modification to represent avian features."



Instructor's Guide

Archaeopteryx: "reptile" and "bird"

Follow up in Textbook: Chapter 3; Figures 8.31, 8.42, 9.53

A. Background:

Chapter 9 of the Textbook addresses the structure and evolution of the appendicular skeleton. This exercise is best implemented after this material has been introduced, especially if students have had the chance to follow up with laboratory exercises first. Of particularly importance are textbook Figures 5.44, 9.19, 9.25, 9.42 - 9.45.

B. Materials Preparation:

Good reproductions of the Berlin specimen are available from many sites on the Internet. One popular source, Wards Natural Science (www.wardsci.com) carries a replica for about $100.00.

C. Facilitating Tips:

The opportunity to compare the fossil *Archaeopteryx* to mounted skeletons of birds (such as a chicken or pigeon) and reptiles (such as an Alligator) will greatly facilitate your students' work.

D. Assessment - Advice for Evaluating Responses:

The lists of reptilian and avian traits found in *Archaeopteryx* can be long and some features remain difficult to see in a commercial cast of the original. The following examples are discussed in some detail at:
http://www.talkorigins.org/faqs/archaeopteryx/info.html

Reptilian characteristics

- Premaxilla and maxilla are not covered with a beak
- Little skeletal fusion - trunk vertebra note fused
- Neck attaches to skull from the rear as in dinosaurs not from below as in modern birds.
- Amphicoelous centra versus heterocoelous in birds.
- Long bony tail with no pygostyle

- Premaxilla and maxilla with teeth
- Simple ribs
- Six sacral vertebra (archosaurian) versus the 11-23 seen in modern birds.
- Metacarpals are generally free versus fused into the carpometacarpus in birds.
- Nasal opening far forward, separated from the eye by a large preorbital fenestra (hole).

Avian traits

- Feathers
- Furcula
- Opposable hallux
- Pubis elongate and directed caudally
- Wings

E. Phylogenetic Issues:

1. Strictly speaking, birds are reptiles (Figure 3.28). In particular, birds evolved within the monophyletic group that includes Saurischia, and hence birds are "Dinosaurs" (Figure 3.28). Some dissent from this view, arguing that birds evolved from non-dinosaur reptiles. A less radical dissent is that birds are so different from dinosaurs that they should be recognized as a separate, distinct taxonomic group apart from the quite different dinosaurs.

Although important in its own right, the whole point of this exercise can be lost if it is reduced to a strictly taxonomic issue in isolation. The importance of *Archaeopteryx* is that it is a dated fossil with the morphological features that place it between more derived birds on the one hand and more basal groups of reptiles on the other. Students can actually see some of these features for themselves in the cast. Further, because most students have examples of more basal reptiles before them (turtles, alligators), they can draw on their own knowledge to critically evaluate *Archaeopteryx*, and in turn reinforce their anatomical knowledge directly. We see this exercise serving several metacognitive instructional goals:

a. This exercise encourages students to be critical observers of an informative fossil.

b. This exercise answers a complaint of special creationists about "gaps" in the fossil record and/or absence of "intermediates" between "kinds" of animals, by providing a look at just such an intermediate organism.

c. More constructively, this fossil illustrates the mosaic nature of evolution (e.g. Chapter 18).

d. This exercise is an effective setup and transition into a specific phylogenetic analysis of reptile radiation in general, and dinosaur evolution in particular.

2. For instructors with a taxonomic interest, phylogenetic schemes can be used as a follow up to examine the specific hypotheses of evolution within the Dinosauria and the specific character state changes. In turn, a discussion of phylogenetics follows nicely as students by now have a firsthand knowledge of comparative morphological characters within reptiles.