Kevin Padian on *Of Pandas and People*: A Summary of the Testimony in *Kitzmiller v. Dover*

Of Pandas and People claims to provide a number of examples of where evolution fails as an adequate explanation: specifically, how the fossil record fails to show evidence of transitions from one form to another or fails to explain how complex structures such as the mammalian ear appear suddenly. These are common creationist arguments. In his testimony during the *Kitzmiller v. Dover* trial, Kevin Padian, a paleontologist at the University of California Berkeley, addressed a number of the antievolution claims made in the *Pandas* text.

Below is a summary of his testimony as it relates to three specific claims.

On the Cambrian Explosion

The Cambrian Explosion refers to the sudden appearance of organisms that are shelled marine organisms within a geologically rapid time, with 10 to 30 million years as the smallest possible increment.

Of Pandas and People claims that the fossil record provides no evidence of any earlier fossils of these multicellular marine organisms. Instead, these organisms appear fully formed. The authors of *Pandas* claim that only an intelligent designer could organize the creation of such complex life forms at a single point in time.

Padian addresses two aspects of the claims made in *Pandas*.

First, Padian shows that the argument itself is faulty. The authors of *Pandas* state that the sudden appearance of multicellular animals, with no intermediates, is a problem for evolution. Later, however, the authors inform their readers that these groups (phyla) are a human construct. Padian asks how the authors can treat phyla as real entities that you cannot bridge, but then also claim that these categories are largely artificial.

Second, Padian addresses the scientific evidence that *Pandas* neglects to discuss. *Pandas* includes a figure showing numerous lines beginning at a particular point that correspond to the beginning of the Cambrian and extending various lengths. The figure provides no additional information—no reference to what the lines represent (species, families, or phyla), no indication of where particular fossils occur, no reference to life before the Cambrian, and no further breakdown of time. Some lineages actually extend from the Precambrian/Cambrian boundary to the present.

Padian acknowledges that the fossil record is incomplete, but references a peer-reviewed article appearing in *Paleobiology* (Peterson et al., 2005) that provides evidence of when the major groups of animals evolved, the presence of Precambrian fossils, and the fact that even using a narrow definition based on the appearance of clear bilaterian fossils, the "explosion" took at least 30 million years. The figure on the next page (Fig. 1) (Peterson et al., 2005) also shows that fossil diversity did increase relatively rapidly, but not all at once, and that a number of lineages do date to before the Cambrian.

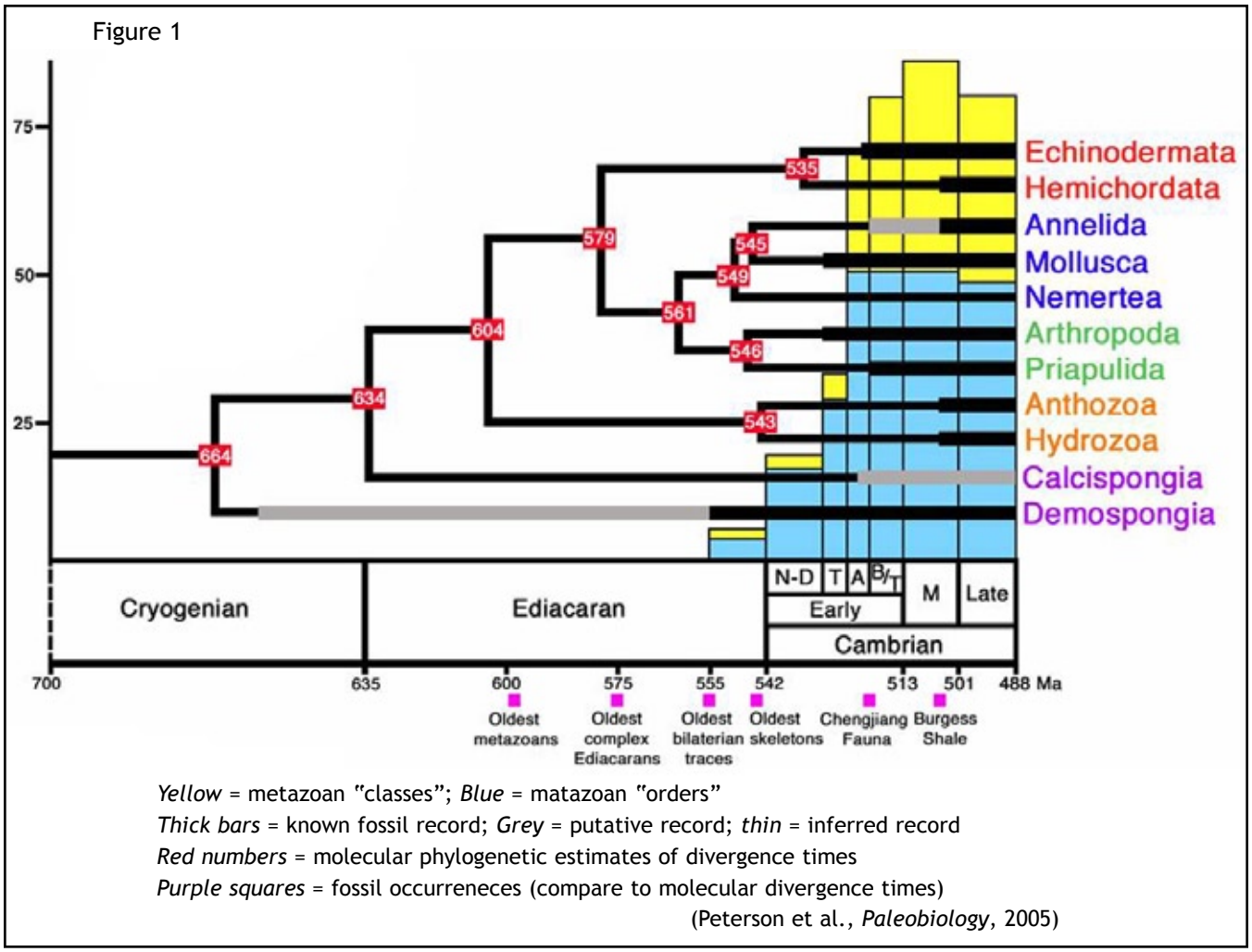


Figure 1. Phylogenetic reconstruction of major animal phyla based on the fossil record (dark bars), with estimates for divergences (red boxes) obtained from molecular data (specifically Hox genes).

Credits:
Diagram from Figure 2, page 4 of: Peterson, Kevin J.; McPeek, Mark A.; and Evans, David A. D. (2005). "Tempo and mode of early animal evolution: inferences from rocks, Hox, and molecular clocks." *Paleobiology* 31(2_Suppl), 36–55. (DOI)

References:
Peterson, K.J., M.A. McPeek, D.A.D. Evans (2005). Tempo and mode of early animal evolution: inferences from rocks, Hox, and molecular clocks. *Paleobiology* 31:36–55.

On How Vertebrates Gained Land

In traditional classification, this is known as the fish-amphibian transition. Specifically, how did lobe-finned fishes, similar to extant lungfish, give rise to tetrapods, such as modern amphibians, reptiles, birds, and mammals?

The textbook *Of Pandas and People* claims that there are no series of fossils showing a gradual transition from fish to amphibians, no creatures that are partly fish and partly something else. The authors place at either end of this transition two species known from the fossil record, *Eustenopteron*, which they label as a fish, and *Ichthyostega*, which they label as the oldest known amphibian, and then claim that there are no fossils showing transitions between these species.

Padian points out that there are a few issues with these claims.

First, the terminology used is problematic. *Eustenopteron* and *Ichthyostega* do not resemble present day fish or amphibians, respectively. Assigning them to these distinct categories draws attention to their differences, not their similarities. Second, given our current application of cladistics, tetrapods are actually a subgroup of fish. Finally, the authors promote the misconception that there are no transitional forms by expecting fish with fins to rapidly transform into amphibians with four limbs.

In his testimony, Padian presents a series of figures to show the way scientists currently understand the fossil record with respect to the move from aquatic, fish-like critters to the first animals to appear on land. In particular, the figures reference three structural transitions important in the move from water to land: the forelimb, the skull, and the pelvic girdle.

Padian first points out that data used to construct the cladogram (diagram showing evolutionary relationship) was based on dozens and dozens of skeletal characters. Second, ray-finned fishes (trout, salmon, etc.) are a separate lineage and we would not expect these present day species to be directly ancestral to lungfish and the other transitional forms. Third, there are indeed a number of transitional species from the fossil record. Also note that *Tiktaalik*, another fossil from the Devonian, described in the journal *Science* after *Kitzmiller v. Dover*, is one more species assigned to this transition.

Refer to the transcripts from *Kitzmiller v. Dover* for further discussion by Kevin Padian of the evidence for transitional structures.

http://www.talkorigins.org/faqs/dover/kitzmiller_v_dover.html

http://www.sciohost.org/ncse/kvd/Padian/Padian_transcript.html

Figure 2

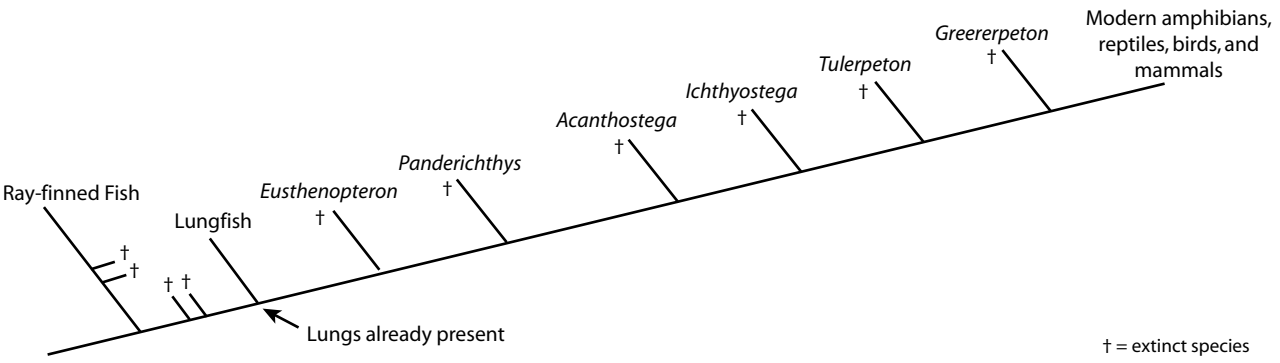


Figure 2. Cladogram showing the placement of *Eusthenopteron*, *Panderichthys*, *Acanthostega*, *Ichthyostega*, *Tulerpeton*, and *Greererpeton*, hypothesized to be important transitional forms. To see images of these forms, check out the Tree of Life Web Project [http://www.tolweb.org/tree/] or the Devonian Times Web site [http://www.devoniantimes.org/].

On the Origin of Birds

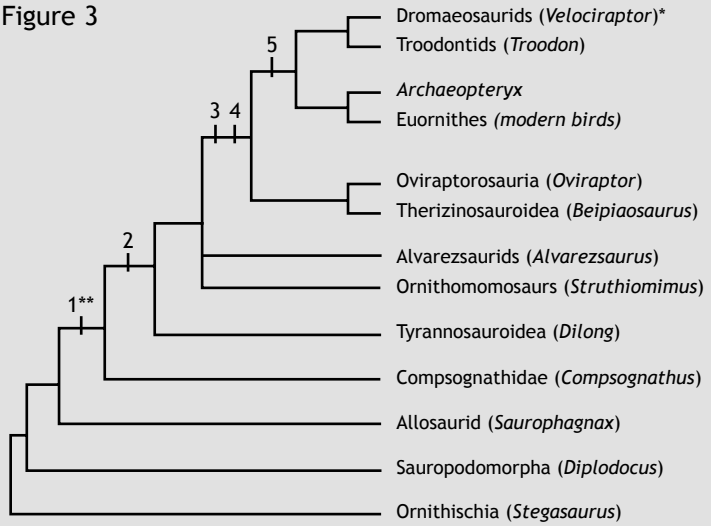
The current understanding among scientists is that birds originated or evolved from carnivorous dinosaurs.

However, in *Of Pandas and People*, the authors state that there is no evidence showing scales developing into feathers and no intermediates showing the transition from reptilian to avian lungs, and hence no evidence for the evolution of birds.

The oldest known fossil bird is *Archaeopteryx*. A photo of the fossil appears in Pandas, showing it to have wings and feathers, and appearing to look very modern. However, *Archaeopteryx* also has a long bony tail and teeth, and many of the bones of its hands and feet are not fused as in the bones of living birds. Since the discovery of *Archaeopteryx*, many more fossils of feathered dinosaurs have been discovered and the evolution of feathers reconstructed in great detail.

In his testimony, Padian specifically addresses the claim that there is no evidence showing scales developing into feathers by describing in detail the reconstruction of the evolution of feathers. Figure 3 below shows the current hypothesis for the reconstruction of feathers based on recently revised phylogenies. The cladogram in Figure 3 shows the evolutionary relationships among various species based on a number of different datasets (Lingham-Soliar et al. 2007, Turner et al. 2007, Xu 2006), with the first occurrence of the structures associated with feather evolution mapped onto the cladogram. Stage 1 in this process shows evidence of hair-like protofeathers, present in fossil compsognathids. Note that the first occurrence of protofeathers is not entirely clear. Recent reexamination of the skin of *Sinosauropteryx* (Lingham-Soliar et al. 2007), a relative of *Compsagnathus*, indicates fossil structures originally thought to be protofeathers are more characteristic of collagen fibers. In Stage 2 the protofeathers become more complex exhibiting some branching structure, as has been found in the fossil of the tyrannosaurid *Dilong*. Stages 3 and 4 include the development of a central vein and barbules linking the barbs together, respectively. In Stage 5, asymmetrical feathers, present in dromaeosaurs like *Microraptor*, develop with aerodynamic properties.

Figure 3



1. Origin of hairlike protofeathers **
2. Origin of more complex feathers exhibiting some branching structure
3. Origin of feathers with a central vein
4. Origin of barbules linking the barbs together
5. Origin of asymmetrical flight feathers

References:

Cladograms represent current hypotheses about evolutionary relationships. Such reconstructions are subject to change should new data be published. This cladogram was constructed from research using the following sources:

Tree of Life Web Project: http://tolweb.org/tree/

Lingham-Soliar, Theagarten, Alan Feduccia, and Xiaolin Wang. 2007. "A new Chinese specimen indicates that 'protofeathers' in the Early Cretaceous theropod dinosaur *Sinosauropteryx* are degraded collagen fibres." Proceedings of the Royal Society B. Vol. 274: 1823-1829.

Turner, Alan H., Diego Pol, Julia A. Clarke, Gregory M. Erickson, and Mark A. Norell. 2007. "A basal dromaeosaurid and size evolution preceding avian flight." *Science*. Vol. 317: 1378-1381.

Xu, X. 2006. "Scales, feathers and dinosaurs." *Nature*. Vol. 440: 287-288.

* Names in italics represent examples of species in the group.

**The placement of #1, the first occurrence of protofeathers, is not entirely clear. Recent reexamination of the skin of *Sinosauropteryx* (Lingham-Soliar et al. 2007), a relative of Compsagnathus, indicates fossil structures originally thought to be protofeathers are more characteristic of collagen fibers.

Figure 3. Phylogeny showing the current hypothesis for the reconstruction feathers.

Refer to the transcripts from *Kitzmiller v. Dover* for further discussion by Kevin Padian of the evidence for the evolution of feathers.

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