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The Truth About Transitional Fossils

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1. Of Fossils and Creationists

In the United States, the contentious debate about “intelligent design” (ID) has focused on many issues: complexity and its possible explanations; the explanation for biological structures; the naturalistic approach to science; and many other philosophical and biological topics. The books of the “intelligent design” creationists are filled with such examples and discussions, but they pointedly avoid discussing the fossil record or its implications. Behe (1996, p. 27) mentions paleontology only in a few paragraphs in his book-length treatment, and most of the other ID books are similarly silent about the fossil record. Only the ID creationist textbook *Of Pandas and People* (Davis and Kenyon, 2004) discusses fossils at any length, and only in a single chapter of a 170-page book. The ID creationists have been quoted on numerous occasions as conceding that microevolution occurs, and that the earth may be millions of years old. This distinguishes them from the more extreme fundamentalist “Young-Earth Creationists” (YEC), who believe the earth is only 6000 years old and will not admit that microevolution occurs.

The reasons for this lack of interest in fossils are apparent when one scans the contributors and critical reviewers of ID textbooks such as *Of Pandas and People* (Davis and Kenyon, 2004, p. iii). Although the ID creationists include

scientists with backgrounds in biology or chemistry, almost none earned an advanced degree in paleontology or geology from a recognized accredited non-creationist institution (with the possible exception of Kurt Wise, who was a student of Stephen J. Gould at Harvard). To my knowledge, not a single ID creationist has ever published a paper on fossils in the peer-reviewed scientific literature. Reading through the little bit that they write about the fossil record, it is very clear that they have no firsthand experience with collecting or interpreting fossils, because they rehash old myths and misconceptions from the YEC literature. Like the YEC, their “research” on fossils consists of reading popular books about paleontology and pulling quotes out of context. ID creationists may impress the uninformed layperson with their Ph.D.’s in biochemistry, but that background has absolutely no relevance to understanding paleontology and fossils. Without the appropriate background or training, they are no more qualified to make statements about the fossil record than they are to discuss music theory or auto mechanics. Thus, their statements about fossils must always be read with the caveat in mind that they don’t actually work on these fossils, and *have probably never even looked at the actual specimens* (nor do they have the training to tell one bone from another if they did).

In a volume such as this, it is useful to examine these myths and misconceptions about the fossil record, and give a short update about the truth about the fossils. For a longer account, the reader is referred to my book *Evolution: What the Fossils Say and Why it Matters* (2007).

2. Cambrian “Explosion”—or “Slow Fuse”?

This is the myth about the fossil record that the ID creationists mention most frequently, including Behe (1996, p. 27), Davis and Kenyon (2004, p. 94-96), and several others. It even popped up when I debated an ID creationist on a radio talk show, but he quickly got in trouble when his ignorance of the actual Cambrian fossil record was exposed.

Like all their other arguments, this one was recycled from many of the old YEC books, which have long tried to use it to support their cause. Creationists (both ID and YEC) point to the early appearance of most of the living phyla of animals in the Cambrian as some kind of “creation event.” They hijack the commonly used phrase “Cambrian explosion” as if paleontologists were

suggesting that all life arose instantaneously in the Cambrian, and no fossils were known from rocks older than the Cambrian.

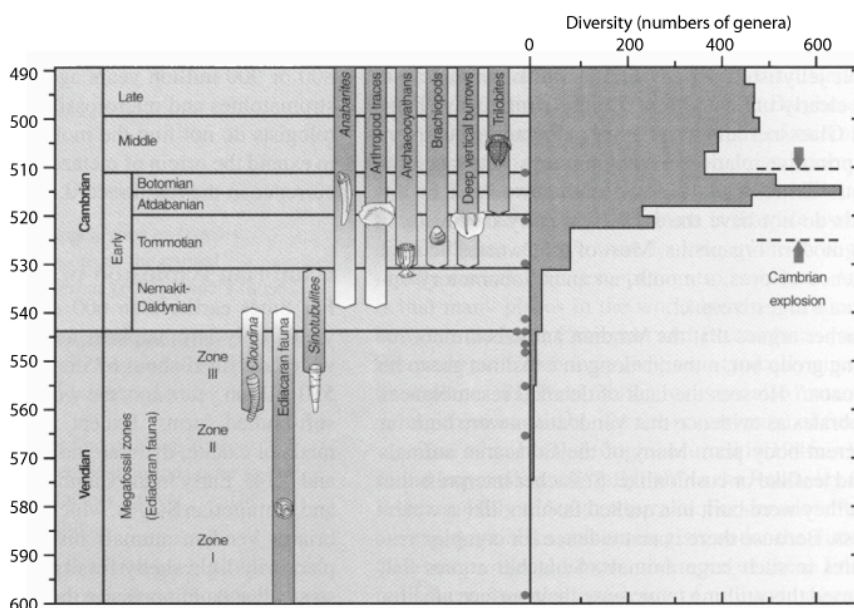


Figure 1: Diagram showing the time ranges of the major fossil groups in the late Precambrian (Vendian) and Cambrian. Generic diversity of these fossils shown on the histogram on the right. (After Prothero and Dott, 2004).

Such an idea about the fossil record might have been credible in Darwin's time (and creationists often quote his puzzlement about the lack of Precambrian fossils known in 1859), but it was rendered completely invalid by the discovery of numerous Precambrian fossils since the 1940s. In the past fifty years, the Precambrian fossil record has become enormous, with thousands of localities and tens of thousands of fossils—none of which the creationist literature ever acknowledges. The key difference is that most of these Precambrian fossils were single-celled microscopic organisms for the first 85% of the 3.5 billion years of life's history, so they can only be found with a microscope and the appropriate techniques in the right kinds of rocks. Nonetheless, there are many extraordinarily well-preserved microscopic fossils (see Schopf, 1999; Knoll, 2004; Prothero and Dott, 2004, for further details). After three billion years of nothing but single-celled fossils, the next stage is the famous soft-bodied Ediacaran fauna, which is found worldwide in rocks as old as 600 million years

ago, and vanishes in the early Cambrian (Fig. 1). Following this is the earliest Cambrian, where large shelly invertebrates are rare (and no trilobites occur), but the commonest fossils are tiny forms nicknamed the “small shellies.” These show that the factors that permitted the secretion of mineralized skeletons had finally occurred, but (as would be predicted by evolution) the first skeletons and shells were tiny and simple, not complex invertebrates such as trilobites. It is not until the third stage of the Cambrian (the Atdabanian) that larger more complex invertebrates such as trilobites appear, and the rest of the animal phyla appear even later in the Cambrian. Contrary to the outdated creationist literature, there are several major animal phyla with skeletons (such as the Bryozoa) that do not appear until much later (in the Ordovician).

Thus, the fossil record now shows a gradual series of steps from 3 billion years of single-celled organisms, to the multi-cellular but soft-bodied Ediacarans, to the tiny first shelled invertebrates of the early Cambrian, and only by the late early Cambrian do we see the appearance of more complex forms such as trilobites (and much later still the rest of the animal phyla). This is hardly an “explosion” but much more like a “slow fuse,” with multiple steps spread out over thousands of feet of strata (well documented in the rocks of Russia, Namibia, and Canada). This sequence has now been subjected to numerous of the highest-quality radiometric dates by the top labs in the world, so it is now extremely well calibrated. From the first Ediacarans to the first trilobites (600-520 million years ago) is a span of 80 million years! Even the sequence from the first “small shellies” to the first trilobites (545-520) is still 25 million years in duration. Hardly an “instantaneous explosion”! The misleading term “Cambrian explosion” was coined by geologists decades ago to describe the fact that the majority of animal phyla appear in the Cambrian, and not later or earlier. But it was never intended to suggest that the event was instantaneous or ever rapid by human standards. Geologists and paleontologists are so accustomed to dealing with hundreds of millions to billions of years that anything that is only tens of millions of years in duration (compared to the 540 million years since the event) seems relatively rapid. But “geologically rapid” is still thousands to millions of years in duration, not a rapid “explosion” in the sense of human time scales of hours, days, years, and decades.

Even if one rejects all of the evidence of radiometric dating (which the YEC do, but the ID creationists apparently don't), the clear sequences of more and more complex fossils found in many places around the world (single cells to Ediacarans to “small shellies” to trilobites) completely rules out the use of the

“Cambrian explosion” as some sort of support for an instantaneous creation event as described in the *Bible*. Any time a creationist mentions the “Cambrian explosion” as some sort of geological conundrum possibly supporting their viewpoint, it is clear that they have only read old outdated YEC accounts of the Cambrian, and have not bothered to learn anything about the past 50 years of discoveries which show it was actually a “slow fuse” that fits perfectly with the predictions of evolution.

3. Transitional Forms, “Missing Links”, and the Quality of the Fossil Record

Much of the public (including most creationists) has a mistaken notion of what evolution is. Some will ask, “If humans evolved from apes, why are apes still around?” This misconception goes back to pre-Darwinian seventeenth- and eighteenth-century notions of life as a “great chain of being” or a “ladder of life” (*scala naturae*) up from lowly invertebrates to fish to amphibians to reptiles to mammals to humans to cherubim and seraphim and angels and archangels and ultimately to God at the top. But as Darwin and many other scientists have shown, life is not a “ladder” or “chain” but a branching bush, with many ancestral lineages living alongside their descendants. When humans evolved from apes, they branched out from a lineage that is still around. Apes did not have to become extinct when some of them evolved into the ancestors of humans.

Closely related to this false notion is another metaphor, where each organism on the “chain of being” is like a “link” in the chain. From this kind of thinking comes the notion of “missing links” which tie together two organisms in the chain. Biologists and paleontologists seldom use the term “missing link” because of its erroneous connotations that life is a chain of being, but the public is still confused about this. In reality, there are hundreds of fossils (and a few living forms) that could be called “missing links” or “transitional forms” between major lineages and species. Yet creationists cannot admit the existence of these forms because that would be tantamount to admitting that evolution occurs. So they go through all sorts of rhetorical tricks to deny an obvious reality. In some cases, they blatantly deny the truth that is easily demonstrated. When provided with a picture of a transitional fossil in a debate, they will ask the evolutionist debater to provide even more transitional forms between that fossil and the fossils that came before and after it! No proof of no-longer-

missing links is ever enough! No matter what evidence they are given, their denial mechanisms are so strong that they cannot see what is right before them.

Unfortunately, the ID creationists have borrowed one of the worst habits of the YEC authors: quoting scientists out of context to support their arguments. Quoting anyone out of context to indicate the opposite of what they meant is clearly dishonest, a political and rhetorical trick that reflects badly on whomever does it. Usually, when the true context of the quote is revealed, it shows that the person who quoted out of context either couldn't or didn't understand what the quote really means—or that they were intentionally trying to mislead the reader. Davis and Kenyon (2004, p. 96) in their ID creationist book for high school readers provide a particularly egregious example (borrowed directly from YEC books). They quote distinguished paleontologists such as Stephen Jay Gould and David Raup to say that the gradual transitions between fossil groups are rare, and that most fossil species are static and unchanged through millions of years. This is from the “punctuated equilibrium” debate that began with the famous Eldredge and Gould (1972) paper. Anyone who bothers to read this subject carefully, or read the full context of the quotations will realize that what these paleontologists are saying is that transitional forms are indeed rare, *but they are not unknown*. Contrary to the gradualistic evolutionary expectations that were widely held prior to 1972, we now know that there are good biological reasons for most species to stay stable and unchanging for millions of years once they have evolved, *but nevertheless there are good transitions between many of these species within transforming lineages*. More importantly, we can view each step in a transforming lineage as a transitional form, even though each individual species is relatively unchanging during its time on earth.

When ID creationists write about the quality of the fossil record and the supposed lack of transitional forms, they show most clearly that they have borrowed from the old YEC literature without reading anything more up-to-date. For example, Davis and Kenyon (2004, p. 95-98) repeat the old YEC myth that the fossil record must be nearly complete, and that the apparent absence of transitional forms therefore is proof that evolution did not occur. Ironically, what the past 40 years of paleontological research has shown is that the fossil record is much less complete than most people believe. At this moment, biologists have described and named about 1.5 million species on earth (mostly insects), and some estimates say that the earth harbors at least 4 or 5 million species in total. Yet there are at best only about 250,000 known species of fossil animals and plants, or about 5% of the species living today. But today is only one time slice

among millions in the past 600 million years that multicellular life has existed. If we total up all those time slices as well, then the total number of species that are represented in the fossil record is a tiny fraction of 1%.

Consequently, the fossil record of some groups that are entirely soft-bodied without hard skeletons or shells (especially insects, worms, jellyfish, and the like) is so poor that most paleontologists do not study them, and do not attempt to say much about their evolution. In certain groups with hard skeletons, however, the potential for preservation is much higher. If we focus just on groups with excellent skeletons and a good chance for preservation (including microfossils, sponges, corals, mollusks, sea stars and sea urchins and their relatives, trilobites, the “lamp shells” or brachiopods, and “moss animals” or bryozoans), the fossil record is not nearly so incomplete. These groups have about 150,000 living species, but over 180,000 fossil species. Depending upon how you do the calculation, between 2% and 13% of all the species that have ever lived in these groups may be fossilized (Prothero, 2004). That’s still not great, but much better than the fraction of 1% estimate we just discussed. In some places, the record of fossil shells is very dense and continuous, and these are places where paleontologists focus their attention to study things like evolution. They know that not every species is preserved, of course, but they have enough data to see how evolution occurs in the groups that do fossilize.

In such groups, paleontologists have found abundant evidence of transitional forms between major groups. Here is where the ID creationists are the most in denial of reality. For example, Davis and Kenyon (2004, pp. 95-96) write that “we cannot form a smooth, unambiguous transitional series linking, let’s say, the first small horse to today’s horse, land-dwelling mammals to today’s whales, fishes to amphibians, or reptiles to mammals.” This is a terrible deception to put in a high-school textbook. They could not have asked for better-documented cases than the evolution of horses, whales, early mammals or amphibians. Let us look at each of these examples in turn.

4. Of Horses and Whales

Davis and Kenyon (2004, p. 96) deny the existence of the evolutionary sequence of horses, yet make no further mention of it anywhere else in their book. The evolution of horses was one of the first transitional series documented after Darwin’s book was published. It began with studies published by Thomas Henry

Huxley and O.C. Marsh in the 1870s and 1880s, and still stands today as one the best transitions we have. As early as 1870, we had fossils of early Eocene (55 million years old) horses such as *Protorohippus* (once called “*Eohippus*” or “*Hyracotherium*”) which were the size of small dogs, had four fingers on their hands and three toes on their feet, and primitive low-crowned teeth. As nearly every textbook in evolution and biology shows, from these simple primitive ancestors, horses went through an amazing sequence of changes: their side toes were reduced until modern horses run only on the middle digit; their legs got longer for fast running; their teeth became more and more high crowned for eating gritty grasses; their body and brain size increased, snout became elongated, and overall skull and body proportions changed dramatically until they resembled horses that we know today. All of those transitional horse fossils are real and well documented. I have personally published research on the *Mesohippus-Miohippus* part of the sequence (Prothero and Shubin, 1989; Prothero, 1994), and I have collected, identified, and studied horse fossils from many parts of the sequence.

Some parts of this story have been changed and modified as more fossils are discovered. For example, many of the early renditions of horse evolution were necessarily oversimplifications that showed a simple linear trend in these anatomical changes through time. But we have known for over a century that horse evolution, like that of nearly every other family of organisms on earth, is bushy and branching, with multiple lineages overlapping in time. Not only do we have this well-documented transformation within the horse lineage, but in recent years we have discovered their primitive ancestors, including a fossil from Mongolian rocks 58 million years old known as *Radinskya*, which links horses and their close relatives, the tapirs and rhinos, to all the other lineages of hoofed mammals. I have spent much time working with early Eocene horses such as *Protorohippus* and its close relative, the earliest tapir relative *Homogalax*. In most features, their teeth and skeletons are nearly indistinguishable, yet there are subtle differences in the cusps and crests of teeth that show that one of them was ancestral to horses, and the other to tapirs and rhinos.

The ID creationist websites follow the YEC model when faced with this reality: quote out of context. Usually they cite very outdated references about specific details of horse evolution, and leave out just enough information to give the complete opposite impression about what the quote means—and deliberately deceive their reader. Most of these quotations concern the replacement of the old

oversimplified straight-line evolution model with our more modern “bushy” branching model. None of those quotations deny that horse evolution occurs, only that it is more complex than originally thought. None of ID creationists bothers to read the more recent literature or deal with new transitional fossils such as *Radinskya*. Better still, they could stop deceptively mining old papers for quotes out of context and go study the fossils themselves!

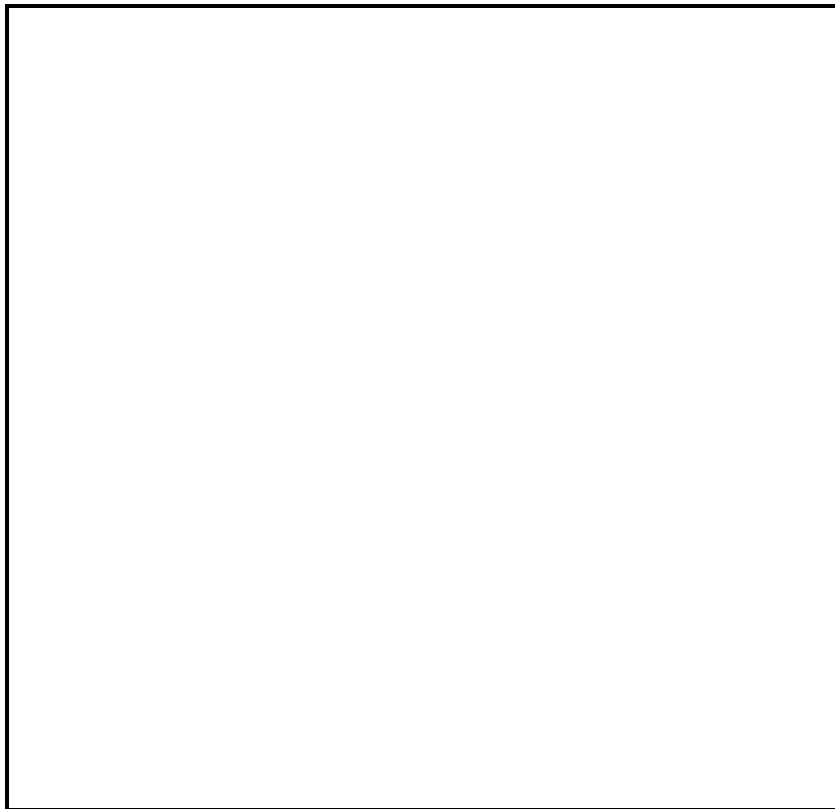


Figure 2: Evolutionary history of whales (from Prothero, 1994).

Even more spectacular is the origin of whales. Davis and Kenyon (2004, p. 101-102) claim “there are no transitional fossils linking land mammals to whales.” *They could not be more wrong*. This false statement is carried over from their 1989 edition into their 2004 edition, yet the 1980s and 1990s yielded an amazing array of transitional whale fossils that clearly link terrestrial land mammals to full-fledged aquatic whales (Fig. 2). These fossils have been well

documented in many television shows, in popular books such as Carl Zimmer's (1998) *At the Water's Edge*, and published in high-profile scientific journals such as *Science* and *Nature*, so there is no excuse for creationist ignorance or denial of these fossils. Davis and Kenyon (2004, Fig. 4-5, p. 101) illustrate two extremes of the whale evolutionary sequence (the terrestrial mesonychids and the aquatic archaeocetes) but falsely state that there are no transitional forms between them.

If you look at the fully aquatic dolphins, orcas, and blue whales, you would have a hard time imagining them walking on land. Yet scientists have long known that whales are related to hoofed mammals, and even living whales retain tiny vestiges of their hips and thighbones deeply buried in the muscles along their spines. In 1983, specimens of *Pakicetus* were discovered in Pakistan from early Eocene beds about 52 million years old. Although its body was primarily terrestrial, it had the skull and teeth of the archaic archaeocete whales that swam the world oceans in the middle Eocene. Then in 1994, another specimen was found in Pakistan. Dubbed *Ambulocetus natans* (literally, "walking swimming whale"), it was the size of a large sea lion, with broad webbed feet on both front and hind limbs so it could both walk and swim—yet it still had tiny hooves on its toes, and also had the primitive skull and teeth of the archaeocetes. *Ambulocetus* apparently swam much like an otter with an up-and-down motion of the spine, precursor to the vertical motion of the flukes of a whale's tail. Then *Dalanistes* was discovered, with its shorter legs with webbed feet and longer tail, but with a much larger and more whale-like skull. Today, there are over a dozen excellent transitional whale fossils, making this one of the best insensibly graded series that could be expected for such rarely fossilized animals. Their DNA suggests that whales are most closely related to the artiodactyls (even-toed hoofed mammals) and the hippopotamus in particular. This was dramatically confirmed by the 2001 discovery of the characteristic artiodactyl "double-pulley" ankle bone in two types of primitive whales. By the late Eocene, we see the first members of the modern toothed whales (sperm whales and dolphins) and the baleen whales (filter-feeding whales like the blue, right, humpback, and gray whales). There are excellent transitional forms of some of the extremely primitive baleen whales that are not yet toothless (like all modern baleen whale species), but still retain teeth while also developing their baleen filters. As the years go by, more and more transitional whales are being discovered, so that by now the amazing transformation from terrestrial mesonychid to whale is one of the best examples of evolutionary transitions in the fossil record (Fig. 2). This may not make creationists happy, but the fossils cannot be denied.

Whales are not the only aquatic mammals with terrestrial ancestors. Modern sirenians (manatees and dugongs) are huge, docile aquatic plant eaters with no external hind limbs, and front limbs modified into flippers. Their detailed anatomy and molecular biology, however, show that they are closely related to the ancestors of elephants. In 2001, Daryl Domning described a remarkable complete skeleton of *Pezosiren portelli* from Jamaican deposits about 50 million years old. This fossil had the typical skull and teeth of a sirenian, and even the thick sirenian ribs made of dense bone (for ballast)—yet *Pezosiren* had four legs with feet, not flippers. The origin of seals and sea lions from bear-like ancestors is also well documented. *Enaliarctos mealsi* from beds about 20 million years old in California is a perfect transitional form. Although it retained many primitive features of bears, it has some specializations seen in seals and sea lions, such as enlarged eyes, an enlarged nasal cavity for regulating the temperature of the blood as it swims, and larger openings for the muscles that control lips and whiskers. More importantly, its hands and feet are developed into very crude flippers, so superficially it looks like a modern seal.

The origin of mammals is also very well documented. The lineage that led to mammals is known as the Synapsida (once known as “mammal-like reptiles,” although they are a separate and parallel branch that had nothing to do with true reptiles). The earliest synapsids include the finback *Dimetrodon* (familiar from kids’ toy dinosaur kits, even though it was not a dinosaur), which was the largest predator on earth about 280 million years ago. Even though it was a very primitive form, it already had large stabbing canine teeth and some of the specialized skull features of mammals. Over the next 80 million years, synapsids evolved into a variety of wolf-like and bear-like predators, as well as a variety of bizarre pig-like herbivores. Through their evolution, they show progressively more and more mammalian features: expansion of the area for jaw muscles, with additional jaw muscles for complex chewing motions; a secondary palate covering the old reptilian palate and nasal region, so they could breathe and eat at the same time; specialized multi-cusped molars for chewing, rather than gulping, food; enlarged brains; more upright (rather than sprawling) posture; a muscular diaphragm in the rib cage for efficient breathing; and even evidence that they had that characteristic mammalian feature, hair.

Most remarkable of all is the transformation of the lower jaw. In the reptiles and primitive synapsids, the jaw consists of a number of bones besides the tooth-bearing dentary bone. During synapsid evolution, the dentary bone becomes larger and larger until it takes over the jaw joint and point of jaw muscle

attachment. The other reptilian jaw bones shrink until they vanish. Yet two of these extra jaw bones (the quadrate bone of the skull and articular bone of the lower jaw) do not vanish completely. Instead, these bones are crowded out by the new jaw joint between the dentary and the squamosal bone of the skull. Indeed, one fossil (*Diarthrognathus*, “double jaw joint”) has the old reptilian jaw joint and the new mammalian jaw joint both operating side-by-side on each side of the mouth. Eventually, the mammalian jaw joint (dentary-squamosal) takes over completely, yet the tiny quadrate and articular bones do not vanish, but instead shift to the middle ear, where they become the “anvil” and “hammer” bones with which you hear. This seems surprising until you realize that reptiles hear with their lower jaw, and sound is transmitted from the jaw through the quadrate and articular to the inner ear. Further proof can be seen in embryology: your middle ear bones were in your jaw when you were an early embryo, but shifted to the ear during later development. The story of the synapsids culminates with the evolution of the earliest true mammals (tiny shrew-sized creatures) from beds about 200 million years old in China, Texas, and South Africa.

How do the ID creationists handle this extraordinary transitional series? Davis and Kenyon (2004, p. 100-101) quote a few evolutionists out of context and even concede, “without a doubt, the Therapsids are highly suggestive of a Darwinian lineage.” But then they betray their complete lack of understanding of evolution and try to discredit the entire example by arguing that it is not a single ancestral lineage but many different lineages. That is *exactly* how most evolutionary transitions work in a bushy, branching system—not as “missing links” on a non-existent “chain of being” (the common creationist misunderstanding) but as multiple closely related lineages which each show progressively more mammalian characteristics.

Examples of evolution within the mammals could be enumerated almost endlessly. We have excellent transitional forms that document the evolution of elephants from creatures without tusks or trunks, giraffes from creatures without long necks, rhinoceroses from creatures without horns, camels from creatures without humps, primitive cats and dogs that looked nothing like their living descendants, and hundreds of other beasts familiar from the zoos and circuses. The reader is referred to Prothero (2007) for full details.

5. Of Walking Fishes and Flying Dinosaurs

Another transitional sequence that creationists must deny is the amazing series of fossils that show how some fish evolved into land animals. To some people, it seems amazing that any creature can make the dangerous transition from water to land. However, it turns out to be much easier and more common than you would think. A number of living bony ray-finned fish, including mudskippers, walking catfish, rockfish and sculpins of the intertidal zones, can live out of the water for hours, and many have modified their fin bones into crude devices for crawling across the ground. Thus, when the opportunity presents itself, many different groups of vertebrates have found a way to switch from aquatic to at least a partially terrestrial life.

For decades, the only good transitional fossil between fish and amphibian was *Ichthyostega* from the Late Devonian (about 360 million years ago) of Greenland and Spitzbergen. Although *Ichthyostega* was like many amphibians in having well developed legs, with a complete shoulder girdle, and hips fused to the backbone, it still had the fish-like gill slits, a lateral-line system on its face for detecting underwater currents, and a long fish-like tail fin. More recent discoveries, such as *Acanthostega* from the same beds, show that the picture is much more complicated and interesting. *Acanthostega* had ear bones adapted for underwater hearing, a longer tail fin, and better-developed gills (so it is more primitive and aquatic than *Ichthyostega*), and up to eight fingers and toes on its hands and feet (rather than the standard five of most tetrapods). Apparently, its limbs were primarily adapted for swimming and walking along the bottom than for crawling out on land. Contrary to the popular story that four legs evolved for crawling on land (to escape drying ponds or predators, or chase new food sources, or whatever), it appears that legs evolved for walking underwater (as most salamanders still do today), and only secondarily became useful on land.

The clinching piece of evidence was announced as this chapter was being written. Nicknamed the “Fishapod” but formally named *Tiktaalik*, this Late Devonian fossil from Ellesmere Island in the Canadian Arctic was even more fish-like than *Ichthyostega* or *Acanthostega*, yet its limbs show the perfect transition between fins and feet (Fig. 3). Thanks to this discovery, we now have a beautiful transitional sequence from fully aquatic lobe-finned fish like *Eusthenopteron* to more amphibian-like forms such as *Panderichthys* and *Tiktaalik*, to fully four-legged forms like *Acanthostega* and *Ichthyostega* (which

still retain fish-like gills, tail fins, and lateral line systems on the face). This sequence is now so smoothly gradational that it's hard to tell where the fishes end and the amphibians begin—yet is it clear even to a creationist that *Eusthenopteron* is a fish and *Ichthyostega* is an amphibian.

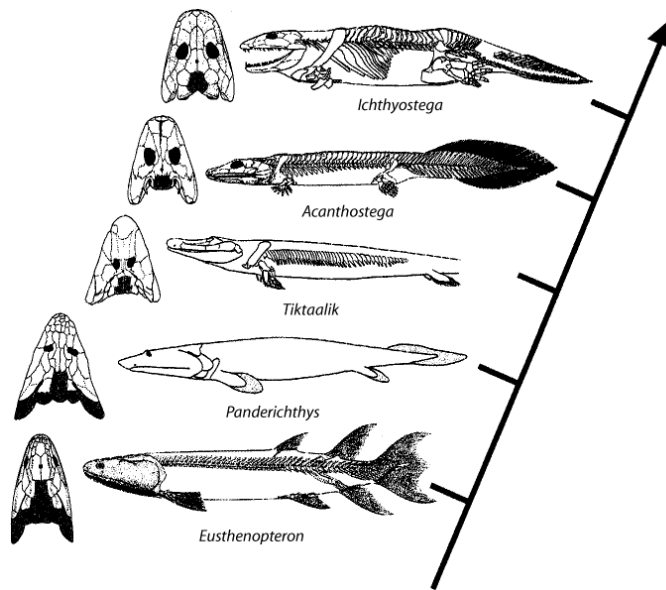


Figure 3: Evolutionary transition from lobe-finned fish such as *Eusthenopteron* through intermediates like *Panderichthys* and *Tiktaalik* to primitive four-legged aquatic amphibians such as *Acanthostega* and *Ichthyostega* (from Ahlberg and Clack, 2006).

How do the ID creationists deal with this extraordinary evidence? They cloud the issue by denying these fossils exist, or by distortion and misstatements. Davis and Kenyon (2004, Fig. 4-8, p. 103) show a fifty-five-year old sketch of *Ichthyostega* and *Eusthenopteron* but make no mention of all the other transitional fossils that were well documented before their book was published in 2004. They show (Fig. 4-9, p. 104) the fin and limb bones of each of these creatures, but ignore all the beautiful transitional fossils that have been documented in the past 50 years. They make a big deal about how dramatic this transition was, yet falsely claim that “we do know that no such transitional species have been recovered.” Thanks to *Panderichthys* and *Acanthostega* and now *Tiktaalik*, that falsehood can be safely laid to rest—but I have no expectation that creationist books will ever acknowledge the existence of these fossils, but simply replay their discredited and outdated arguments.

The creationist blinders about transitional fossils are nowhere better demonstrated than their denial of the classic transitional fossil from reptiles to birds, *Archaeopteryx*. Discovered just two years after Darwin's book was published, paleontologists and biologists could not have wished for a better example of a fossil which bridges the gap between two major classes of vertebrates. Now known from seven specimens (I have studied most of them), they show the classic mixture of bird-like and dinosaurian features. Most of the skeleton is in fact almost indistinguishable from the tiny dinosaur *Compsognathus* (the "compys" of *Jurassic Park* fame), with a long bony tail, long heavy hind limbs, primitive dinosaurian hip bones, well developed clawed fingers, and a dinosaurian skull with teeth—all features found in no modern bird. Yet even the first specimens showed clear bird-like characteristics, including a wishbone and feathers.

Naturally, this fossil has been a thorn in the side of creationists for decades. The usual strategy of the YEC authors (since they can't ignore it or deny its existence, as they have with so many other transitional fossils) is to say it's "just a bird" since it has feathers and a wishbone. Never mind the fact that the entire skeleton is dinosaurian, and no living bird has the long clawed fingers, long bony tail or teeth found in *Archaeopteryx*. The ID creationist authors are even more subtle and misleading. They use a few out-of-context quotations that do not apply, and fall back on the old misconception that evolution must be a smooth gradual "chain of being" within a single lineage. Davis and Kenyon (2004, p. 106) write "it is transitional only if it is part of lineage—one of series of generations in which in-between stages led gradually from one group to another" (illustrated clearly in their Fig. 4-11, p. 106). In one sentence, they have shown their complete misunderstanding of the fundamental concepts of evolution. *Archaeopteryx* does NOT have to be part of single gradually evolving lineage to be a transitional form—those are all misunderstandings about evolution discredited decades ago. It only needs to be one of many species that show transitional features on the bushy, branching tree of life. And in this respect, *Archaeopteryx* could not be a better intermediate transitional form.

But all this creationist focus on discrediting *Archaeopteryx* has been rendered moot by the amazing new Jurassic and Cretaceous bird fossils that have been discovered in the past 15 years, especially from the extraordinary Liaoning beds of China. There are now hundreds of bird fossils that show each step in the evolutionary transition from predatory theropod dinosaurs to full-fledged modern birds. A Late Jurassic bird from China, *Confuciusornis*, had developed

the first toothless bird beak, but still had long fingers with claws. Slightly younger fossils (from the Chinese Lower Cretaceous Liaoning beds about 140 million years in age) have even more birdlike features. *Sinornis* could fold its wings against its body, and had grasping feet with an opposable big toe, and its tailbones were fused into a single element (the pygostyle, or “parson’s nose” of your Thanksgiving turkey). *Iberomesornis* from the Lower Cretaceous rocks of Spain had a large keeled breastbone for powerful flight muscles, yet still had the primitive long backbone of dinosaurs. *Concornis* not only had these advanced features, but also had the upper row of ankle bones fused to the shin bone (which you see in the cap of cartilage on the turkey or chicken drumstick), a characteristic of all modern birds. Thus, *Archaeopteryx* is now one of hundreds of new Mesozoic bird specimens that show the remarkable transformation from dinosaur to bird. Most surprising of all, however, was the recent discovery of numerous non-flying dinosaurs (closely related to *Velociraptor* of *Jurassic Park*) such as *Microraptor* and *Caudipteryx* from the Liaoning beds of China which had well-developed feathers. Apparently, feathers evolved widely in the theropod dinosaurs originally for functions such as insulation, long before they secondarily became useful for flight. Do the ID creationists mention any of these past 15 years of discoveries? Certainly not in their textbook *Of Pandas and People*, which was last revised in 2004, nor do their websites make any mention of them.

6. Of Integrity and Truth

I could continue to document in much greater detail additional ID creationist falsehoods, distortions, and misstatements, but since space is limited, I welcome the reader to find out the details for themselves in my new book (Prothero, 2007). But the way in which ID creationists approach the issue raises larger questions about intellectual integrity and honesty. The ID creationists have made a great effort to deny in public that their movement is religiously motivated, and claim that the “Intelligent Designer” need not be the Judaeo-Christian God, but in private they admit that their goals are all about pushing their religious viewpoint (documented by many authors, e.g., Shermer, 2006). They are mostly members of right-wing evangelical Christian churches, and their Discovery Institute in Seattle is funded almost entirely by religious organizations and conservative foundations. They have tried to hide their religious motivations to get around the separation of church and state enshrined in the U.S. Constitution, but in 2005 they lost badly in the federal trial of *Kitzmiller et alia vs. Dover*

Pennsylvania School Board. Judge John Jones, a conservative President George W. Bush appointee, ruled against the ID creationists, and pointed out that their ideas were another thinly disguised effort to inject narrow sectarian religious views into the public-school science classroom. He even called their ideas “breathtaking inanity.” Judge Jones was particularly irritated by the hypocrisy of the ID creationists, who attempt to sound secular when the Constitution is involved, but crowed about their religious motives when not in court. “The citizens of the Dover area were poorly served by the members of the board who voted for the intelligent design policy. It is ironic that several of these individuals who so staunchly and proudly touted their religious convictions in public would time and again lie to cover their tracks and disguise the real purpose behind the intelligent design policy.”

ID creationism is not about science, but about political power, and about dictating the agenda for schools and textbooks now, and eventually exerting control over society. They have described their movement as a “Wedge Strategy” to squeeze their religious beliefs (disguised as science) into the public school science classroom. ID creationists play by whatever rules (dishonest if necessary) they need to in order to win. I showed how they ignore, distort or deny the evidence, quote out of context, and do many other unethical things—all in the name of winning their crusade. As someone who was raised in a Presbyterian church, and learned *Bible* verses every Sunday, it appalls me to see how unethically these supposed “Christian” men and women will act in their battle against their perceived foes. It makes you wonder whether they have second thoughts about violating the word and spirit of many parts of the Scripture with their lies and deceptions, all to accomplish their goals at the price of their souls.

How do they reconcile this un-Christian behavior with their Christian beliefs? Apparently, to the ID creationists lying and deception are lesser sins than Darwinism, and they are willing to sacrifice their integrity in their crusade against what they believe to be the source of all evils in the world. Their intellectual blinders are so strong that they see only what they want to see, and read only what they want to read in a quotation, all in the name of their religious beliefs. To ID creationists, pushing their beliefs about the *Bible* is essential to their religious salvation, and everything else (including science) must be sacrificed so their souls can go to heaven.

The ID creationists reveal their true motivations when they speak among themselves (documented by Shermer, 2006). On February 6, 2000, William Dembski told the National Religious Broadcasters:

“Intelligent Design opens the whole possibility of us being created in the image of a benevolent God... . The job of apologetics is to clear the ground, to clear obstacles that prevent people from coming to the knowledge of Christ.... And if there’s anything that I think has blocked the growth of Christ as the free reign of the Spirit and people accepting the Scripture and Jesus Christ, it is the Darwinian naturalistic view.”

At the same conference, Phillip Johnson said:

“Christians in the twentieth century have been playing defense. They’ve been fighting a defensive war to defend what they have, to defend as much of it as they can. It never turns the tide. What we’re trying to do is something entirely different. We’re trying to go into enemy territory, their very center, and blow up the ammunition dump. What is their ammunition dump in this metaphor? It is their version of creation.”

In 1996, Johnson said: “This isn’t really, and never has been, a debate about science... . It’s about religion and philosophy.” One of the ID creationist authors, Jonathan Wells, is a follower of the Reverend Sun-Myung Moon and his Unification Church cult (which is vehemently anti-evolutionary). As Wells wrote: “When Father chose me (along with about a dozen other seminary graduates) to enter a Ph.D. program in 1978, I welcomed the opportunity to prepare myself for battle.”

Perhaps they should go back to their *Bibles*, where Proverbs 12:22 says: *Lying lips are an abomination to the Lord.*

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