Taking “Teach the Controversy” Critical Analysis *seriously*:

What does Intelligent Design have to say about the Reptile-Mammal Transition?

James Downard – 16 July 2014

In June 2013 I had occasion to attend a lecture at a Seattle church by several Intelligent Design advocates, including the *Discovery Institute*’s resolute defender Casey Luskin, recounted in Downard (2013) where I handed Luskin a copy of some criticism of Luskin apropos the punctuated equilibrium issue. This was part of a much larger project of mine (*Troubles in Paradise: The Methodology of Creationism and the Dynamics of Misbelief*) but as I would be standing face to face with him and asking some questions I felt I owed it to Luskin to give him a gentlemanly heads-up on the scholarly anvil I proposed to drop on him in due course.

Luskin’s lecture worked off what was evidently a rather rigidly set *PowerPoint* presentation that soon outstripped his allotted time so that he had to rush through his fossil discussion. He briefly tossed off the obligatory Cambrian Explosion talking points (too much too fast to imagine this happening without Intelligent Design), but I did get one question in afterward: that these animals were not like their modern counterparts, but *evolutionary ancestors*, particularly the primitive early chordates and the chelicerates (equally far removed from their horseshoe crab and terrestrial spider and scorpion descendants).

Admitting he had never heard before how paleontologists had expected early chordates to resemble lamprey larvae (which they turned out to do), Luskin engaged in some typical antievolutionary pigeonholing by remarking how a chordate with a “spinal cord” had been found there (as though that could only mean it was too advanced to be otherwise primitive or related to anything before or since). I suspect Luskin was channeling *Haikouella*, a quite basal chordate showing only the first traces of a spinal column connecting some sections in its head, usefully surveyed by Chen (2009) along with the chelicerates and other Cambrian precursors.

Interestingly, Chen’s paper cropped up in Luskin (2013), but only as a source for quote mining apropos how abrupt the Cambrian Explosion was (as though 5 to 10 million years is but a mere bagatelle—it is, after all longer than it took for Lucy the Australopithecine to morph into Ray Comfort).

But Luskin is, if anything, a personable and approachable cuss, and I was able to make up for that Cambrian two-step after the show to ask about something substantially more detailed than the skimpy Cambrian record: the evolution of mammals from their amniotic tetrapod ancestors (henceforth “reptiles,” recognizing that taxonomic purists reserve the term *reptile* only for much more derived models). In my prior draft of *Troubles in Paradise* I had already dismantled the claims made about the transition in the only major antievolutionary treatments: Philip Johnson (1991, 75-78) and Duane Gish (1995, 147-178).

To summarize, both ignored most of the fossils, which Johnson tried to bypass by meaningless concession: admitting the extraordinary evolution of the mammal jaw layout from the reptile one as true but only a “narrow point.” Gish was more disingenuous: sounding like Luskin with *Haikouella*’s “spinal cord,” Gish called attention to a few of the minor reptilian characters the earliest mammals *still retained in some of their bones*, and tried to smoke-and-mirrors this by identifying them as the previous therapsids and *not as the early mammals they actually were*. Alas, his own source citations gave the trick away by identifying them as mammals in the article titles, but Gish may not have anticipated someone like me, more than happy to burrow into every citation in his footnotes that I could get my hands on.

I filtered some of this work into a *Talk Reason* posting, Downard (2003), dissecting a particularly juicy daisy chain: Philip Johnson had read an astonishingly brazen creationist piece on the reptile-mammal transition at *Answers in Genesis*, Woodmorappe (2001), which Johnson in turn recommended to his ID associate David Berlinski, who then offered it as something worthy of legitimate attention in a March 2003 letter to *Commentary* magazine. Neither Johnson nor Berlinski bothered to examine the content of the Woodmorappe article, nor his prickly reputation, including his 1996 Flood Geology tome, *Noah’s Ark: A Feasibility Study*.

Woodmorappe proposed to show that the forensic minutia presented in a very fine technical paper, Luo & Crompton (1994), refuted the reality of the transition from reptile to mammals back in the Permian and Triassic. But the creationist had done no such thing, egregiously misrepresenting the content of the quite meticulous Luo & Crompton, and thereby calling into question Philip Johnson’s ability to tell fresh steak from rotting meat.

Nor has the level of ID thinking improved in the years since. For instance, the two ID books that have appeared to replace the notorious creationist “textbook” *Of Pandas and People* that figured so prominently in the *Kitzmiller v. Dover* case in 2005. One of the contributors to the later editions of *Pandas* was ID stalwart Stephen Meyer, and in 2007 he and some other ID authors penned *Explore Evolution*, followed in 2008 by William Dembski & Jonathan Wells going hardcover with *The Design of Life*.

One thing that can be said about the reptile-mammal transition is that at no point are mammals appearing *poof* out of the middle of nowhere with no antecedents. Quite to the contrary, we have fifty million years worth of fossil data showing the ever-so-gradual acquisition of traits that start out conventionally basal “reptile” on one end, through the therapsids of the Permian (where they represented the dominant land animals) and surviving the mass extinction event ending the Permian, surviving into the Triassic (just as the rival dinosaurs were arriving) to emerge as the first incontrovertible mammals—just the sort of incremental process that ID folk like Wells *et al*. (who obsess on the Cambrian instead of the half-billion years of fossil data piled up from eras since) insist the fossil record *never* shows.

Even worse for the ID picture, the fossil record of mammal evolution tracks those changes in ways that exactly match the mandates of a natural process, where all the evolving pieces have to be functional and reasonable, with no saltational jumps.

The business end of mammal anatomy concerned the skull. Where the post-cranial bone layout of mammals is remarkably conservative when it comes to which bones comprise the package, the mammal jaw differs markedly from their vertebrate cousins. Fish, amphibian, and reptile jaws consist of multiple bones: a frontal dentary containing the teeth, joined to the quadrate and articular bones that hinge off the skull. Mammals by contrast have one enlarged dentary, which itself hinges on a completely different skull bone (the squamosal) while the quadrate and articular bones have exited the jaw completely, tugged up into the inner ear.

While the end products in mammals differ from the other vertebrates in that way, the embryology tells a different story, and this information has been known since the 1830s, long before Darwin came along. Mammal embryos (including you and me and Ann Coulter) start out with a primary cartilaginous jaw joint *in the basic vertebrate manner*. But once the growing dentary and squamosal bones connect to form the secondary jaw we mammals use, the primary disengages and the elements transfer to their new functions in the developing inner ear.

This process is even more apparent among newborn marsupials, where the quadrate and articular only take up their auditory position after the dentary completes its post-natal growth. And it further turns out that the genes that pertain to our inner ear bones are the same ones that operate in reptiles regarding their quadrate and articular bones (still jaw bones for them). See Müller (1996, 129-131), Rowe (1996), Chapman (2011) and Anthwal *et al.* (2013) for some of the technical issues, and works like Carroll (2005) and Shubin (2008) for the bigger Evo-Devo picture.

As far as this endothermic vertebrate, if the putative Designer hadn't wanted me to believe in evolution, he/she/it/they shouldn't have created all those therapsids (and the embryological development and genetic switching that has been ascertained since). At the very least the Designer (or the Designer's various glee clubs and press agents operating today) ought not express shock that scientists have been misled by the Designer's fuddleheaded adherence to an evolutionary cue sheet in matching up those Permian and Triassic critters and the biology of living mammals in ways so flattering to evolutionary expectations.

A particularly revealing historical episode here concerns Robert Broom, later to get involved in the human evolution story involving australopithecines in the 1920s. Looking at the initial fossil forms that had turned up by 1912, though, Broom thought about what natural process could pull off the full transformation to the mammal configuration and threw down a rather detailed gauntlet: there was *only one way* for the shift in jaw layout to occur in mammals, requiring a double-jointed system *unknown in living forms*. This included specific bones positioned in very constrained ways, as well as the muscle attachments in exact spots (which can be discerned on the bones because of the tiny indentations they make) in order for the jaw to remain fully functional even as it shunts from one jaw hinge modality to the other.

Well, thanks to that capricious Designer, in the 1930s paleontologists dug up exactly what Broom had predicted *had to have existed* were evolution the explanation for the first mammals: *Diarthrognathus* (which got its present name in 1958) and a similar cousin, *Probainognathus*.

Whatever are we to make of this? Had the Designer taken a liking to Robert Broom and (despite how this might look from an evolutionary perspective) decided back in the Triassic to plunk down those perfectly matching examples to gratuitously fulfill his oh-so-specific prediction? Or is there a less byzantine explanation: that Broom was showing what no antievolutionist is willing to concede—that there actually is a natural evolutionary process at work and, by honest understanding of it, scientists can successfully interpolate and even *predict* the existence and character of hitherto unknown extinct life. As Richard Aulie (1974a-b; 1975) put it in his series on the topic in the *American Biology Teacher*, such a prediction "can be expected in evolutionary theory but not in the doctrine of special creation."

So how has Intelligent Design tackled all these data?

Let's start with those pesky migrating jaw and ear bones. In his massive classic anticreationist *Science and Earth History*, Strahler (1987, 416) succinctly illustrated the process, where the auditory stapes (a bone of long standing in vertebrates, originating in fish) shifted back and forth in its skull positioning until in the mammal-like reptiles it became attached to the shrinking articular and quadrate jawbones, which eventually end up in the middle ear.

In **Figure 1** below, I have arranged the illustration from Strahler on top (showing from left to right the *fish*, *amphibian*, *therapsid* and *mammal* layouts, with my own color coding added to highlight which bones were which to better follow their evolutionary migration), followed by the relevant image from the 1993 version of the Intelligent Design textbook-wannabe *Of Pandas and People*, and the new-and not-so-improved *Design of Life* counterpart occupying (rather appropriately) the bottom.

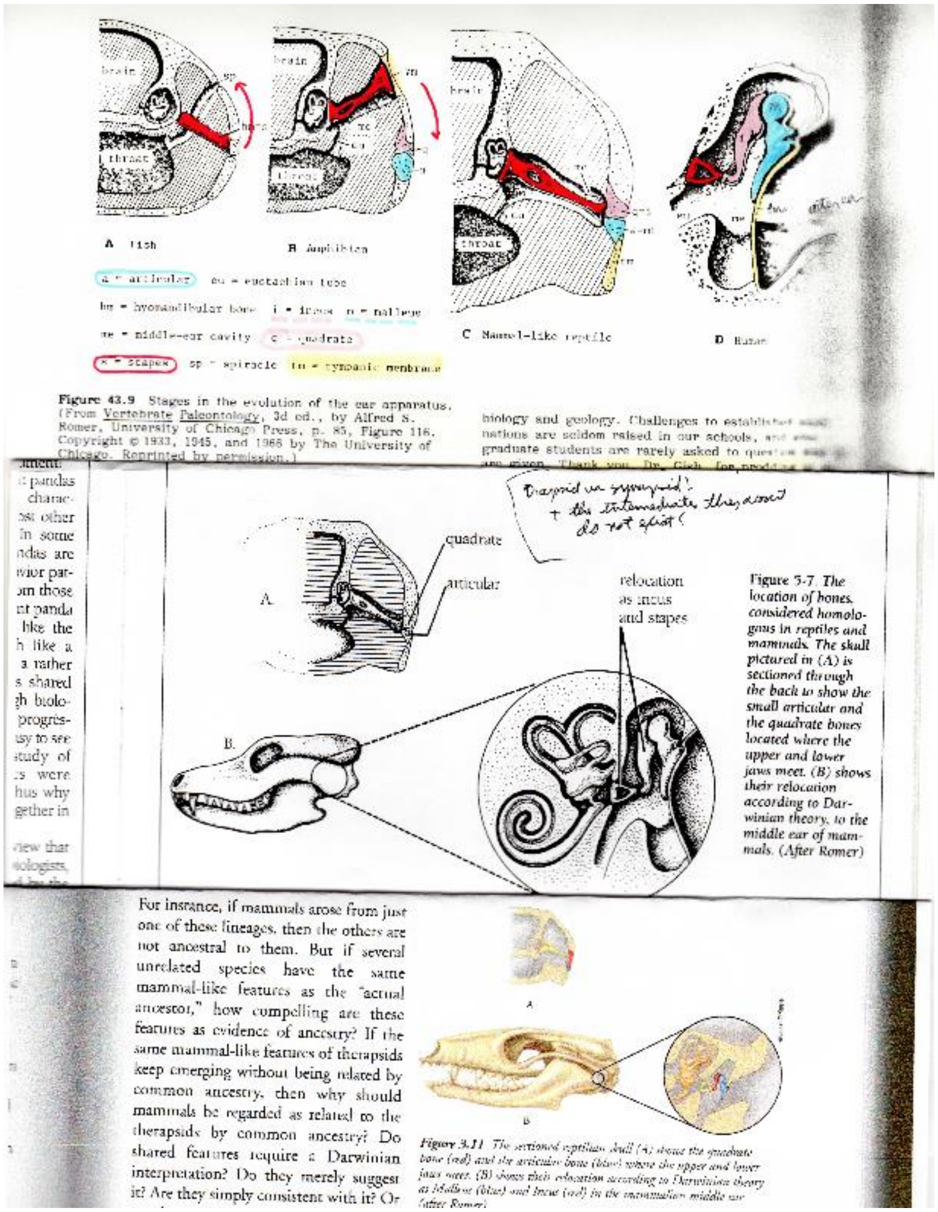


Figure 43.9 Stages in the evolution of the ear apparatus. (From Vertebrate Paleontology, 3d ed., by Alfred S. Romer, University of Chicago Press, p. 85, Figure 116. Copyright © 1933, 1945, and 1966 by The University of Chicago. Reprinted by permission.)

biology and geology. Challenges to establish... nations are seldom raised in our schools, and ... graduate students are rarely asked to ques... are given. Thank you, Dr. Gish, for provid...

Diapsid vs synapsid!
+ the intermediates they assert do not exist!

Figure 5-7. The location of bones considered homologous in reptiles and mammals. The skull pictured in (A) is sectioned through the back to show the small articular and the quadrate bones located where the upper and lower jaws meet. (B) shows their relocation according to Darwinian theory, to the middle ear of mammals. (After Romer)

For instance, if mammals arose from just one of these lineages, then the others are not ancestral to them. But if several unrelated species have the same mammal-like features as the "actual ancestor," how compelling are these features as evidence of ancestry? If the same mammal-like features of therapsids keep emerging without being related by common ancestry, then why should mammals be regarded as related to the therapsids by common ancestry? Do shared features require a Darwinian interpretation? Do they merely suggest it? Are they simply consistent with it? Or

Figure 3.11 The sectioned reptilian skull (A) shows the quadrate bone (red) and the articular bone (blue) where the upper and lower jaws meet. (B) shows their relocation according to Darwinian theory as Malleus (blue) and Incus (red) in the mammalian middle ear (after Romer)

Figure 1. *Top*: Strahler (1987, 416); *Middle*: Davis & Kenyon (1993, 121); *Bottom*: Dembski & Wells (2008, 83).

Pandas had screwed up rather royally in its brief section on the mammal jaw issue. Not only did they avoid mentioning the varied characters in this evolutionary parade (and remember big blocks of the data were known half a century before *Pandas* sprang from the bowels of the *Foundation for Thought and Ethics* in Texas), Davis & Kenyon bungled what they did allude to by mistakenly illustrating as the *reptile* bone layout the *intermediate mammal-like reptile* configuration they were so firmly intimating didn't exist.

The replacement volume of Dembski & Wells showed their attention to fine detail by making exactly the same mistake, compounded because it wasn't a direct crib of the *Pandas* picture, but instead showed a different mammal skull (meaning they had to have compiled the new graphic without ever stumbling on the fact that they were getting their initial depiction wrong). The section on the mammal transition in Meyer *et al.* (2007) avoided this goof by the expedient of not showing any pictures of the inner bone layouts at all, thus saving their readers a disorienting episode of cognitive dissonance.

Dembski & Wells' tendency to copy but not improve was further illustrated by the main body of their argument, which drew on an excellent treatment of the reptile-mammal transition by someone who actually did the work, mammal paleontologist James Hopson (1987). Dembski & Wells (2008, 82) argued that the taxa supposedly weren't really in a chronological sequence, particularly that "the final therapsid is more recent than the mammal (Morganucodon) that is supposed to be its descendant."

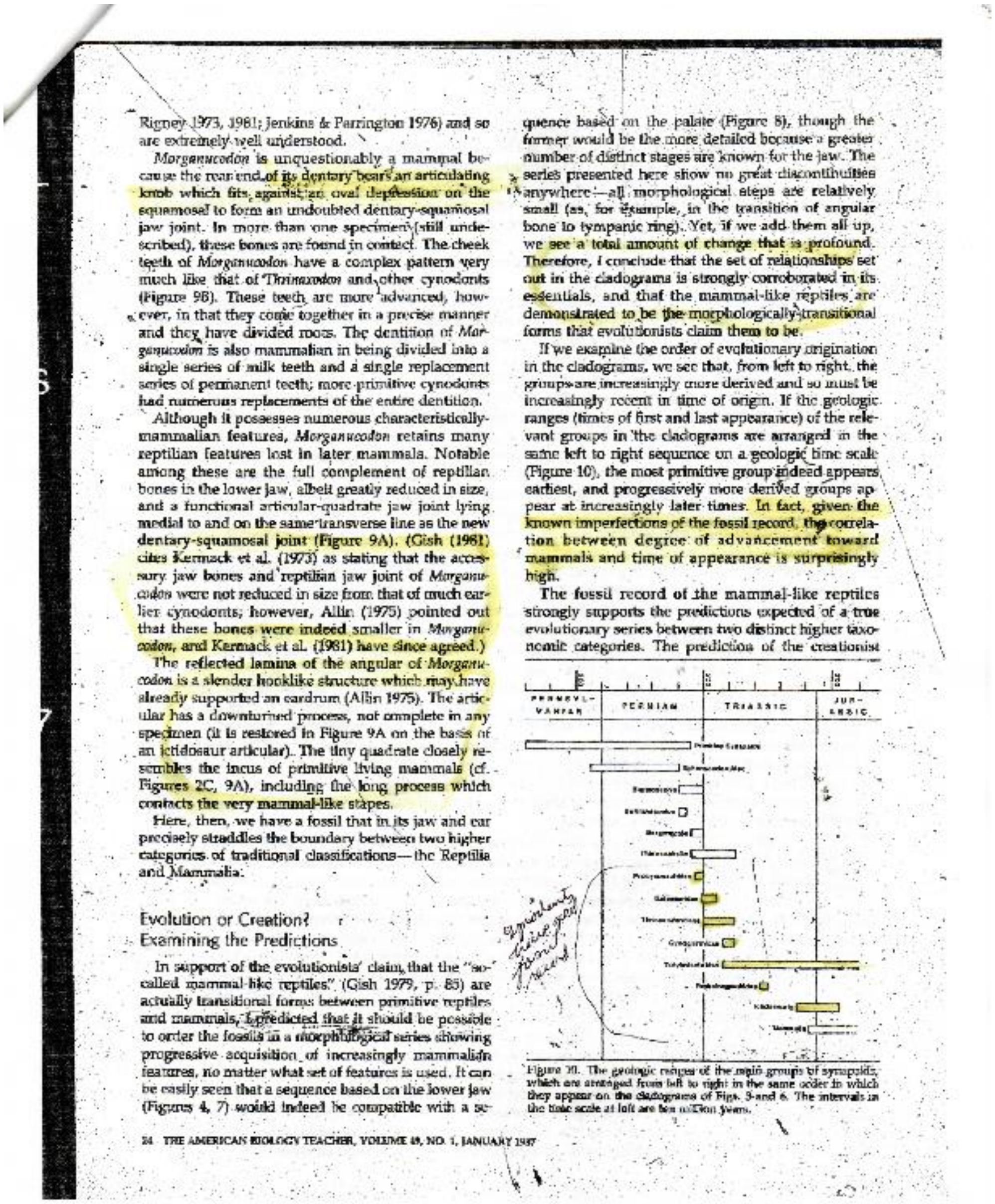
Which happens to be an argument oddly similar to one I had read before: Philip Johnson (1991, 174), likewise citing the Hopson article, and claiming that Hopson ended "the line in a mammal (*Morganucodon*) which is substantially older than the therapsid that precedes it."

The problem with both ID wordings is that neither of them are true. Hopson had indeed covered a variety of taxa, initially in their cladistic order relating their acquisition of key evolutionary features—and yet again with the fossils listed in their evolutionary order but with a chronological frame for when the samples actually existed.

A word on cladism. Cladistic systematics is a powerful analytical tool first proposed by Will Hennig. Because it didn't depend on evolutionary assumptions to process collections of character states (cladistic analysis can be used to categorize furniture or rock formations just as easily as living things) ID supporter Michael Denton (1985) mistook this to mean there was an antievolutionary backlash afoot in taxonomy. Denton (1998) had dropped that topic, by which time it was clear that antievolutionists were not embracing this supposedly non-evolutionary tool—while paleontologists were using it ubiquitously.

The power of cladistic systematics (where the most "parsimonious" arrangement of acquired features naturally reflects their true evolutionary relationships) was particularly evident with the reptile-mammal transition. Indeed, Hopson had gone out of his way to note how the fossil appearances *matched exactly* the independent cladistic view.

Figure 2 below is the relevant page from my copy of the Hopson article (with my annotations and yellow highlighting). As an early mammal, *Morganucodon* falls within the *Mammalia*, the last block down (of thirteen)—and quite obviously making its appearance after the preceding families. Had Johnson decided that *Morganucodon* was "older" because the one above had continued to show fossil representatives after it? If so, that would be like concluding someone couldn't be descended from their own grandmother solely because there came later cousins who outlived them. However Johnson (or the parasitical Dembski & Wells dancing the same tango seventeen years later) came by their misunderstandings, it certainly wasn't from attentively reading their sole cited source, Hopson (1987).



Rigney 1973, 1981; Jenkins & Parrington 1976) and so are extremely well understood.

Morganucodon is unquestionably a mammal because the rear end of its dentary bears an articulating knob which fits against an oval depression on the squamosal to form an undoubted dentary-squamosal jaw joint. In more than one specimen (still undescribed), these bones are found in contact. The cheek teeth of *Morganucodon* have a complex pattern very much like that of *Thrinaxodon* and other cynodonts (Figure 9B). These teeth are more advanced, however, in that they come together in a precise manner and they have divided roots. The dentition of *Morganucodon* is also mammalian in being divided into a single series of milk teeth and a single replacement series of permanent teeth; more primitive cynodonts had numerous replacements of the entire dentition.

Although it possesses numerous characteristically-mammalian features, *Morganucodon* retains many reptilian features lost in later mammals. Notable among these are the full complement of reptilian bones in the lower jaw, albeit greatly reduced in size, and a functional articular-quadrate jaw joint lying medial to and on the same transverse line as the new dentary-squamosal joint (Figure 9A). (Gish (1981) cites Kermack et al. (1973) as stating that the accessory jaw bones and reptilian jaw joint of *Morganucodon* were not reduced in size from that of much earlier cynodonts; however, Allin (1975) pointed out that these bones were indeed smaller in *Morganucodon*, and Kermack et al. (1981) have since agreed.)

The reflected lamina of the angular of *Morganucodon* is a slender hooklike structure which may have already supported an eardrum (Allin 1975). The articular has a downturned process, not complete in any specimen (it is restored in Figure 9A on the basis of an ictidosaur articular). The tiny quadrate closely resembles the incus of primitive living mammals (cf. Figures 2C, 9A), including the long process which contacts the very mammal-like stapes.

Here, then, we have a fossil that in its jaw and ear precisely straddles the boundary between two higher categories of traditional classifications—the Reptilia and Mammalia.

Evolution or Creation? Examining the Predictions

In support of the evolutionists' claim that the "so-called mammal-like reptiles" (Gish 1979, p. 85) are actually transitional forms between primitive reptiles and mammals, I predicted that it should be possible to order the fossils in a morphological series showing progressive acquisition of increasingly mammalian features, no matter what set of features is used. It can be easily seen that a sequence based on the lower jaw (Figures 4, 7) would indeed be compatible with a sequence based on the palate (Figure 8), though the former would be the more detailed because a greater number of distinct stages are known for the jaw. The series presented here show no great discontinuities anywhere—all morphological steps are relatively small (as, for example, in the transition of angular bone to tympanic ring). Yet, if we add them all up, we see a total amount of change that is profound. Therefore, I conclude that the set of relationships set out in the cladograms is strongly corroborated in its essentials, and that the mammal-like reptiles are demonstrated to be the morphologically-transitional forms that evolutionists claim them to be.

If we examine the order of evolutionary origination in the cladograms, we see that, from left to right, the groups are increasingly more derived and so must be increasingly recent in time of origin. If the geologic ranges (times of first and last appearance) of the relevant groups in the cladograms are arranged in the same left to right sequence on a geologic time scale (Figure 10), the most primitive group indeed appears earliest, and progressively more derived groups appear at increasingly later times. In fact, given the known imperfections of the fossil record, the correlation between degree of advancement toward mammals and time of appearance is surprisingly high.

The fossil record of the mammal-like reptiles strongly supports the predictions expected of a true evolutionary series between two distinct higher taxonomic categories. The prediction of the creationist

Figure 10. The geologic ranges of the main groups of synapsids, which are arranged from left to right in the same order in which they appear on the cladograms of Figs. 5 and 6. The intervals in the time scale at left are ten million years.

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Figure 2. From top to bottom: *Primitive Synapsida*, *Sphenacodontidae*, *Biarmosuchia*, *Eotitanosuchia*, *Gorgonopsia*, *Therocephalia*; then highlighted in yellow: *Procynosuchidae*, *Galesauridae*, *Thrinaxodontidae*, *Cynognathidae*, *Tritylodontoidea*, *Probainognathidae*, *Ictidosauria*; and finally *Mammalia*, Hopson (1987, 24).

At his Seattle lecture I apprised Casey Luskin of this ID goof, and gave him a full copy of the Hopson article just for good measure, urging him to investigate the issue on his own. (Breath holding was not recommended, especially as a year has passed without any response on it.)

To make matters even worse for the ID mythos, Hopson had alluded to the embryological jaw-ear data, which meant the ever-so-bright-got-into-Harvard-when-he-was-sixteen Philip Johnson had somehow managed to overlook this exceedingly important and relevant info in his faulty redaction of Hopson. Incidentally, Duane Gish *also* had read a source that mentioned this information, McGowan (1984), so he too in principle could have known of it, meaning the only two lengthy accounts of the reptile-mammal transition *in the entire antievolution literature* both successfully failed to discuss that amazing embryological connection. Curious, isn't it?

Naturally the lamentably secondary *Design of Life* and *Explore Evolution* gang never brought the embryological subject up, possibly because they had never dived deep enough into the issue on their own to have independently encountered it (such as actually reading Hopson's article). But since I managed to tumble on it, one has to wonder exactly what mental roadblocks prevented these ID live wires from noticing the same bread crumbs themselves.

All of which omission puts an ironic spin on the confident assertion of Dembski & Wells (2008, 83-84) that "Darwinists describe the reptilian jaw bones as 'migrating' to their new locations in the mammalian ear. Nevertheless there is no fossil record of such an amazing process. Nor is it clear how the neo-Darwinian mechanism of natural selection acting on random genetic changes can cause bones to move and relocate."

It is interesting that Dembski & Wells sounded here remarkably similar to the argument by that noted paleontologist and developmental biologist Ann Coulter (2006, 229) on the same topic, musing how evolutionists supposedly could not explain how migrating jawbones managed to wander to the right spot. It may be only coincidental that Dembski was among Coulter's technical advisors, taking full credit for that honor in Dembski (2006a-b) apropos the criticism I was leveling at Coulter's acumen in Downard (2006a-d).

Unfortunately for Dembski, Wells & Coulter, though, no bones in the transition were wandering anywhere: they remained neatly attached, as bones tend to do in the real biological world ID proponents seem so reluctant to investigate. And, of course, the evolutionary science machine has continued to chug along, nailing down yet more details in the mammal jaw-ear parade for Intelligent Designers to ignore.

For example, a splendidly detailed new Jurassic mammal has been found preserving the intermediate condition where ossified ear cartilage was *still in place* (it breaks down in modern mammals as the bones develop), Ji *et al.* (2009) with commentary by Martin & Ruf (2009). And, evidently unaware how Dembski/Wells/Coulter had so thoroughly fenced off the boundaries of evolutionary discovery for them, Luo *et al.* (2011) have plodded on ahead notwithstanding to work out from fossil and developmental data how the mammalian cochlea has been evolving from its ancestral state.

Back in Seattle I wasn't through with my presentation to Luskin, however. There were still a few oddities about *Explore Evolution* to attend to. Instead of mentioning *Morganucodon* (inaccurately) as Dembski & Wells had done, *Explore Evolution* opted for no discussion at all of any of the actual taxa. Instead Meyer *et al.* (2007, 29) tried to jujitsu the topic by grumping how "some supposed ancestors and descendents were found in widely separated layers of sedimentary rock, representing tens of millions of years of geologic time."

So is this one of the new Robert Broom class of insights emanating from the *Discovery Institute*: that an evolutionary transition of major proportions may be dismissed without investigation, solely because it isn't happening *in the same place and all at the same time*?

Is it any wonder that no antievolutionist is a working paleontologist?

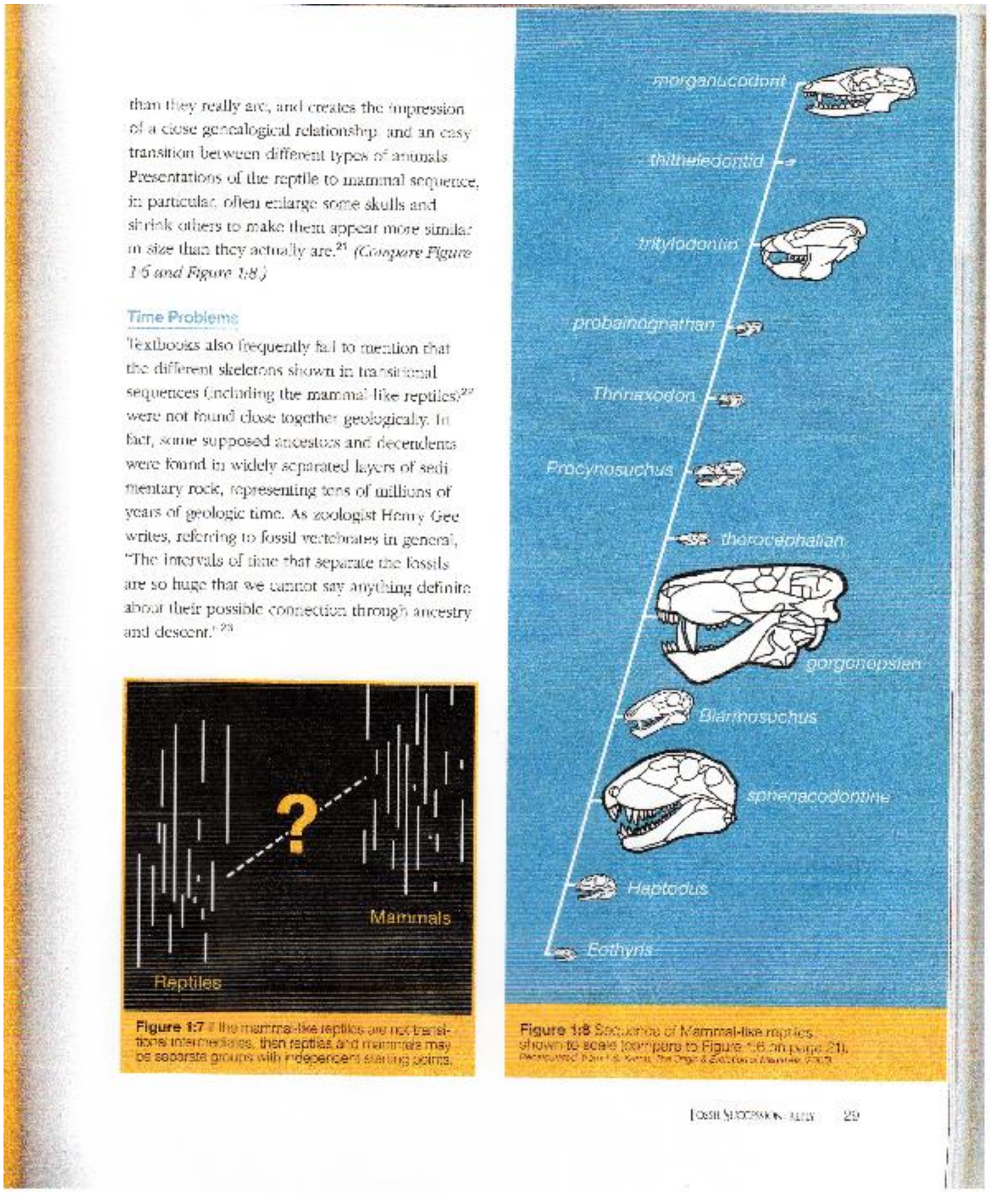
But it gets even better. On that same page there were two most extraordinary illustrations, **Figure 3** below. To the left was *Explore Evolution*'s Figure 1:7, a collection of unidentified vertical lines representing Designer Knows What, and captioned: "If the mammal-like reptiles are not transitional intermediates, then reptiles and mammals may be separate groups with independent starting points."

To the right was their Figure 1:8, a listing of various taxa drawn from a 2005 book by mammal paleontologist T. S. Kemp. As most of the characters were familiar from the Hopson article, at the Seattle ID lecture I asked Luskin to tell me exactly where on Figure 1:7 the quite real taxa of Figure 1:8 on the right fell: reptiles, mammals, or the some other that might legitimately fill that rhetorical question mark?

Although Luskin has spilled much ink defending the scientific legitimacy of *Explore Evolution*, he readily admitted to never having given much thought to the reptile-mammal issue (ah shucks, it's only the crown jewel of macroevolutionary fossil sequences, why should he want to think anything about that?) and blithely declined to taxonomize any of them.

I can well understand why. First, he'd have to know enough about mammal anatomy to be able to distinguish them from reptiles by sight. Not that this is all that difficult: you look for the opening zygomatic arch that forms our own cheekbones, and especially the enlarging dentary bone (grinding molars in the back of the jaw for instance)—all features you can recall without much effort by bringing to mind the typical Halloween human skull image.

The upshot is that the taxa on the bottom of the Kemp graph are as clearly "reptile" as anything that could be put on those vacuous *Explore Evolution* lines, and the taxa on the top are full-blown mammals. It is only as we track step by step up along the chart that we realize how the jaws have morphed ever so gradually from one to the other. I specially noted to Luskin Robert Broom's predicted probainognathids are there (fourth ones down on 1:8).



than they really are, and creates the impression of a close genealogical relationship and an easy transition between different types of animals. Presentations of the reptile to mammal sequence, in particular, often enlarge some skulls and shrink others to make them appear more similar in size than they actually are.[21] *(Compare Figure 1:6 and Figure 1:8.)*

Time Problems

Textbooks also frequently fail to mention that the different skeletons shown in transitional sequences (including the mammal-like reptiles)[22] were not found close together geologically. In fact, some supposed ancestors and decendents were found in widely separated layers of sedimentary rock, representing tens of millions of years of geologic time. As zoologist Henry Gee writes, referring to fossil vertebrates in general, "The intervals of time that separate the fossils are so huge that we cannot say anything definite about their possible connection through ancestry and descent."[23]

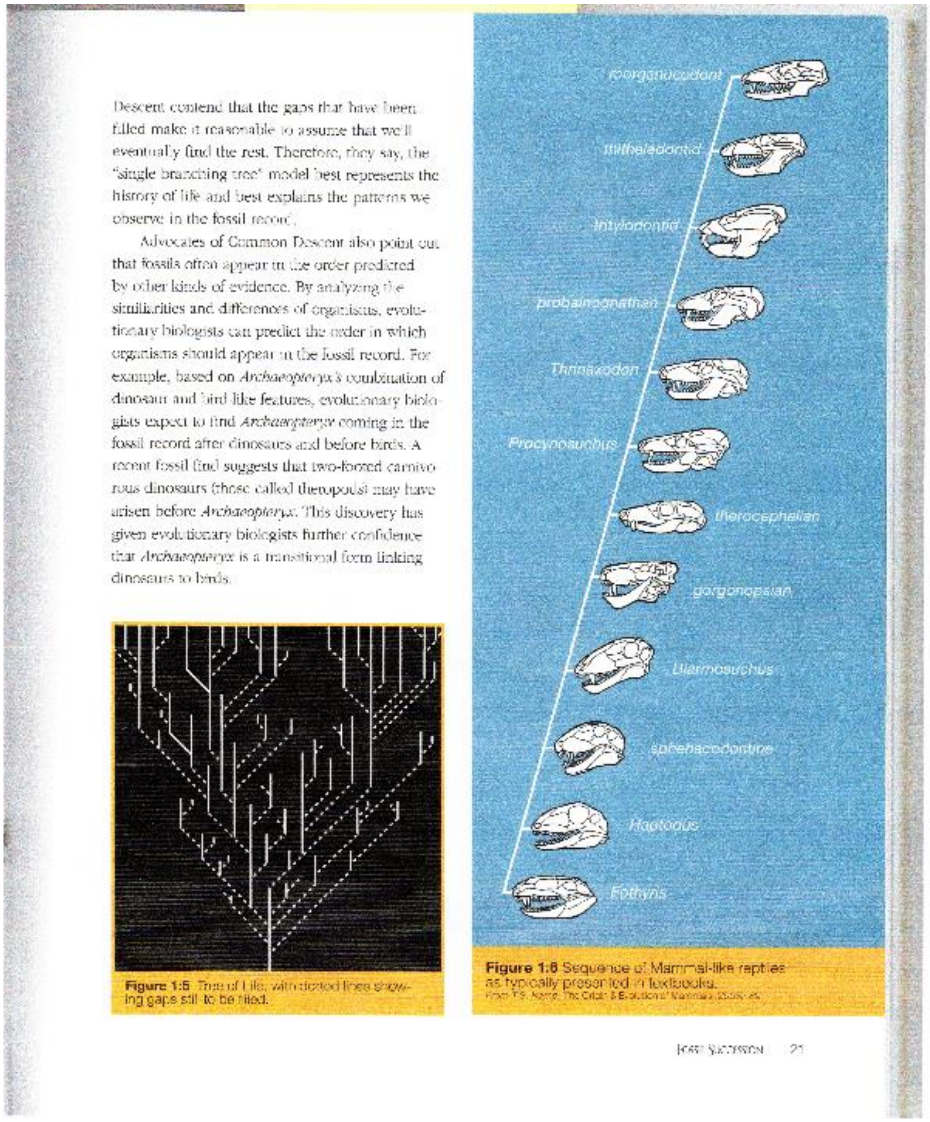
Figure 1:7 If the mammal-like reptiles are not transitional intermediates, then reptiles and mammals may be separate groups with independent starting points.

Figure 1:8 Sequence of Mammal-like reptiles, shown to scale (compare to Figure 1:6 on page 21).

Figure 3. From bottom to top on the Kemp chart: *Eothyris*, *Haptodus*, *sphenacodontine*, *Biarmosuchus*, *gorgonopsian*, *therocephalian*, *Procynosuchus*, *Thrinaxodon*, *probainognathan*, *tritylodontid*, *thitheledontid*, and *morganucodontid*, Meyer *et al.* (2007, 29).

In other words, how could *any* reptile manage to evolve by natural means into mammals without looking exactly like what the actual fossils are known to have done, and which their own Figure 1:8 went out of their way to illustrate? I flatly told Luskin that the “**?**” on the *Explore Evolution* graphic was plainly false, and that if you wanted to see what belonged in that “**?**” you had only to just *glance to the right*.

There was something else curious about the *Explore Evolution* Figure 1:8 that didn’t strike me until later, though. The main text had never mentioned it, just letting it stand there, doing what? And 1:8 was actually the *second* such chart in the book, the caption for it declaring how this one was showing “to scale” the taxa that *Explore Evolution* had trotted out a few pages earlier (**Figure 4**) as Figure 1:6—which again was never mentioned in the main text apart from the passing reference back to it in 1:8.



Descent contend that the gaps that have been filled make it reasonable to assume that we'll eventually find the rest. Therefore, they say, the “single branching tree” model best represents the history of life and best explains the patterns we observe in the fossil record.

Advocates of Common Descent also point out that fossils often appear in the order predicted by other kinds of evidence. By analyzing the similarities and differences of organisms, evolutionary biologists can predict the order in which organisms should appear in the fossil record. For example, based on *Archaeopteryx's* combination of dinosaur and bird like features, evolutionary biologists expect to find *Archaeopteryx* coming in the fossil record after dinosaurs and before birds. A recent fossil find suggests that two-footed carnivorous dinosaurs (those called theropods) may have arisen before *Archaeopteryx*. This discovery has given evolutionary biologists further confidence that *Archaeopteryx* is a transitional form linking dinosaurs to birds.

Figure 1:5 Tree of Life, with dotted lines showing gaps still to be filled.

Figure 1:6 Sequence of Mammal-like reptiles as typically presented in textbooks.
From T.S. Kemp, The Origin & Evolution of Mammals, 2005: 45.

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Figure 4. Taxa in the same order as the 1:8 version, Meyer *et al.* (2007, 21).

Whatever were they up to here? Were Meyer & company trying to suggest by stealth that the various taxa couldn't be legitimately related solely due to the allometric scale changes spooling out over all those millions of years? That natural means could *never* tweak a cousin's anatomy by size, no matter how many millions of years might be available to do it, while otherwise still using the same bones and muscle attachments? Did the *Explore Evolution* authors even realize the dynamically untenable quicksand these dangled illustrations were about to sink into?

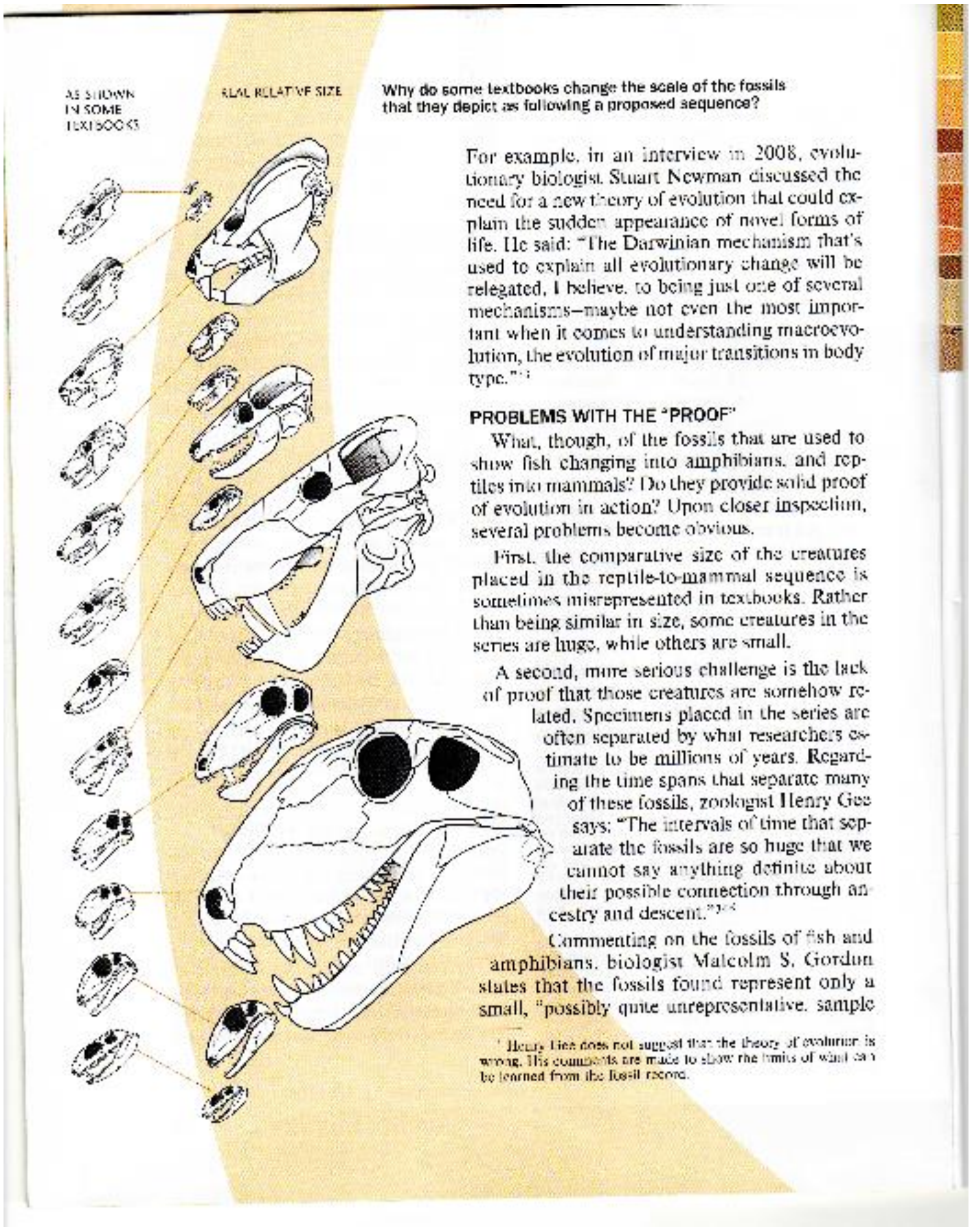
Corroboration that this was exactly what they had in mind was literally dropped in my lap quite serendipitously at the Spokane County Fair a few months after the Seattle ID lecture, courtesy of an ebullient Jehovah's Witness visitor to the booth our *Inland Northwest Freethought Society* and *Spokane Secular Society* (S3) jointly sponsor there.

Parenthetically, we've had increasingly positive reactions over the last three years that we have had a table at the fair, and similarly even in the more politically conservative North Idaho fair that we have been at for the last two years. Our last day at the Spokane fair was especially gratifying, as Spokane native Julia Sweeney flew in to help staff the booth, and Steve Wells, author of *The Skeptic's Annotated Bible*, drove up with his family to meet her. Good times were had all around.

The Jehovah's Witness visitor dropped off two of their pamphlets for me to see, filled with solid scientific evidence in his view, and I returned the favor by giving him a handout our S3 offers at the Darwin Day table we host each February at Riverpark Square mall in downtown Spokane . The Jehovah's Witness booklets were pretty much par for the course: certainly as nice to look at as *Explore Evolution*, but offering the same authority quote heavy treatment of not very much data.

By contrast, our handout (reproduced below as an **Appendix**) drew off recent technical papers on the reptile-mammal transition, endosymbiotic processes, and the chromosome fusion from our primate ancestors (establishing thereby how we can trace our ancestry from reptiles, bacteria, and primates respectively), plus some book recommendations, all readily available online or at our local public library. We aim to be information friendly—though while you can lead some people to information, you can't always make them think.

But one page in the Jehovah's Witness cache did in the catch my eye: their article "Has All Life Descended From a Common Ancestor?" showed the same parade of reptile-mammal taxa as *Explore Evolution*, but with some subtle differences. The orbital (eye) and other skull openings were blacked out and there were no name labels for them (or source provided) but once again there was a second set drawn to scale with a caption: "Why do some textbooks change the scale of the fossils that they depict as following a proposed sequence?" Clearly the pamphlet author thought this was somehow a damning state of affairs (**Figure 5**).



Why do some textbooks change the scale of the fossils that they depict as following a proposed sequence?

For example, in an interview in 2008, evolutionary biologist Stuart Newman discussed the need for a new theory of evolution that could explain the sudden appearance of novel forms of life. He said: "The Darwinian mechanism that's used to explain all evolutionary change will be relegated, I believe, to being just one of several mechanisms—maybe not even the most important when it comes to understanding macroevolution, the evolution of major transitions in body type."[23]

PROBLEMS WITH THE "PROOF"

What, though, of the fossils that are used to show fish changing into amphibians, and reptiles into mammals? Do they provide solid proof of evolution in action? Upon closer inspection, several problems become obvious.

First, the comparative size of the creatures placed in the reptile-to-mammal sequence is sometimes misrepresented in textbooks. Rather than being similar in size, some creatures in the series are huge, while others are small.

A second, more serious challenge is the lack of proof that those creatures are somehow related. Specimens placed in the series are often separated by what researchers estimate to be millions of years. Regarding the time spans that separate many of these fossils, zoologist Henry Gee says: "The intervals of time that separate the fossils are so huge that we cannot say anything definite about their possible connection through ancestry and descent."[24]*

Commenting on the fossils of fish and amphibians, biologist Malcolm S. Gordon states that the fossils found represent only a small, "possibly quite unrepresentative, sample

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* Henry Gee does not suggest that the theory of evolution is wrong. His comments are made to show the limits of what can be learned from the fossil record.

Figure 5. The unlabeled taxa may be compared to the 1:8 **Figure 4** version, *Watch Tower* (2010, 24).

To clinch the deal that they had likely nicked it from *Explore Evolution*, I noticed that the anonymous author couldn't resist cribbing an authority quote that had been used by Meyer *et al.* on the same page, from Henry Gee on how many fossils can't be easily linked up due to the time separating them (true enough in some cases, but certainly not in others, as they could have discovered by diving below general treatments like Gee's to look at the voluminous available technical literature).

In comparing the Jehovah's Witness redaction with the *Explore Evolution* source I noticed one further peculiarity: several of the fossils "to scale" weren't the *same size* as the "to scale" ones in the other. That pesky *Morganucodon* (the top item on both charts), for example, is shown as the tiniest of the lot in JW, but almost as large as the sphenacodont in the EE version (*Dimetrodon* is an example there, the large Permian fin-back predator often included in dinosaur model sets).

Since the real *Morganucodon* was about the size of a mouse—the skull showed to scale in Czerkas & Czerkas (1991, 118) was barely an inch long—it looked like the Jehovah's Witness version had rectified what they had detected as a deficiency in *Explore Evolution*'s graphics—though without stopping to wonder whether the whole exercise was flawed from the start.

Which leaves us with the following scholarly take-home points: since Johnson (1991) and Gish (1995) the design movement has contributed *nothing* to anyone's understanding of the reptile-mammal transition taxa, not even from their own 'hide the ball" perspective. The two ID attempts to improve on the flimsy *Of Pandas and People* only managed to dig their hole deeper, with *Explore Evolution* apparently impressing the Jehovah's Witnesses in a way they have failed to persuade the folk who dig up the bones for a living, be they Jennifer Clack or Robert Prothero.

At the Seattle ID lecture Luskin was all friendly schmoozing, inviting me to send him information on that reptile-mammal transition I seemed so impressed with. Whereupon on returning home I emailed him the relevant text from a piece I had prepared some years ago (*Three Macroevolutionary Episodes*) that detailed the reptile-mammal transition (including a discussion of the embryological data Johnson & Gish had avoided), along with the Cambrian Explosion (including material on how Jonathan Wells had got even something so rudimentary as his chart of Cambrian Explosion taxa one third wrong) and the evolution of birds (yet another field where the fossil and embryological data has continued to reinforce the evolutionary perspective). I also called attention to the more recent treatments, such as the Carroll and Shubin books, and some of the more recent technical papers I have cited in this piece.

To what extent any of that content will filter into the postings Luskin excretes at *Evolution News & Views* only time will tell, though nothing has shown up in the year since, so I do have my doubts. If he does start addressing the material, at least that might serve to move him off the extremities of a **Tortucan** meter—people with a natural proclivity for not thinking about things they don't think about, per the description I outlined in Downard (2010)—but his behavior to date doesn't suggest that's very likely.

At any rate a gauntlet has been tossed (and emailed) and the experiment is running. Let's see just where Luskin's niche of Intelligent Design (and their full blown creationist counterparts) fall on assessing the data of the reptile-mammal transition (paleontological, embryological, and genetic) five, ten, twenty years from now. Will it be yet another book copying another's book bungling of someday else's data that never ultimately gets assessed?

Bets are open—anyone want to lay odds?

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Appendix. Spokane S3 Darwin Day science handout.

CHARLES DARWIN

A Life and Legacy

On the occasion of Darwin's birthday – Spokane Secular Society

Darwin the Man

Born Shrewsbury, England 1809 – Died 1882, buried in Westminster Abbey, London

The close-knit families of country doctor Robert Darwin and his wife Susannah Wedgwood (of the porcelain making family whose factory is still active today) represented a wealth of Victorian professions and philosophies: from entrepreneurs and physicians to inventors and scientists. In that fertile environment second son Charles was born.

Charles and his elder brother Erasmus (named for their famous paternal grandfather, another doctor but also a prominent author and philosopher) were first set to follow in their father's footsteps and train as physicians. But neither brother much liked that idea, and they were steered to what was during the Victorian era the main career alternative for landed gentry: become a clergyman in the Anglican Church (the official established Church of England).

What really interested young Charles though was natural history and geology. At Cambridge University he found many inspiring professors, and after getting his degree in 1831 he worked with Professor Adam Sedgwick mapping geological formations in Wales. The pivotal event of his life came later that year when he was invited to go on a five-year surveying expedition around the world as their naturalist. While his father disapproved, his grandfather Josiah persuaded Robert that this was far too important an offer to pass up.

During the *HMS Beagle* voyage Darwin cataloged the plants and animals and used his geological skills to relate the extinct fossilized animals preserved in the rocks to the varied living forms. After writing the official scientific report on the expedition, in 1839 Darwin married Emma Wedgwood (a cousin on his mother's side) and settled down to raise a family in the country. At his Down House, with its vegetable gardens and hiking paths, there was ample room for their children to play and grow, as well as instilling in them a deep love for the natural world (Darwin's son Francis became a professional botanist).

The death of their eldest daughter Anne (probably of tuberculosis) in 1851 was a personal tragedy that deeply affected the Darwins during the time he was developing his evolutionary theory (while his wife Emma remained a devout Christian, Darwin couldn't reconcile that loss). Darwin's friend and colleague Thomas Huxley lost a son in much the same way and coined the word "agnostic" to describe his own change in religious views.

Although Darwin became famous worldwide following the publication of *On the Origin of Species* in 1859, he was never drawn into the public scene. He left lecturing to friends like Huxley who enjoyed it, and with his health often failing preferred to spend the rest of his life secluded at Down House to work on his books with his beloved family always close at hand.

Darwin's Contribution to Science

Evolution—The Biggest Idea in Biology

In 1835 the *Beagle* reached the isolated volcanic Galápagos Islands in the Pacific, and these played a great role for the formation of Darwin's theory as they acted like natural laboratories, filled with many animal species found nowhere else. For example, there were tortoises with shells so distinctive the islanders could tell immediately from which island they had come. There were many birds too: from blackbirds and warblers to wrens. Or at least that's what Darwin thought. Only after returning to England did he learn they were actually different species of *finches*, each with beak shapes that had varied so far from the common finch that he had mistaken them for blackbirds, warblers and wrens.

Why should isolated islands have so many specialized animals—ones that resembled those on the far off mainland but yet had varied enough to no longer be considered the *same* species? It was to account for that puzzle that Darwin began to think how variation arises in animals in the first place, and what can happen when they have to compete for survival with others that are themselves slightly different. Darwin's great insight was that there had to be a "**natural selection**" process that governed which variations thrived and which died out—for instance, a bird with a slightly different beak shape might crack open a nut for food more easily than ones that lacked that variation, and its descendants would carry on those variations (at least until conditions changed again and so change the measure of what worked "better").

By the mid-1840s Darwin had worked out the twin pillars of his evolutionary theory (**natural selection** driving **descent with modification** to produce all the observed diversity of life through variation branching away from common ancestors). But Darwin recognized how potentially controversial this new view would be to some, so for many years instead of publishing the idea he accumulated ever more evidence to make the argument as solid as possible, exploring such factors as the "homology" of organs and skeletal parts, where varied animals use the same anatomical features, modified by natural means into specialized forms for use in different ways. For example, all the flying vertebrates (the extinct *pterosaurs*, and the living *birds* and *bats*) all fly using modified forelimbs consisting of the same skeletal structures, with just the bones varying by shape.

Darwin was spurred into action regarding publication of his ideas in 1858 when the young naturalist Alfred Wallace wrote to him with a paper setting out his own ideas about living things. Like Darwin twenty years before, Wallace worked far from a museum office, but primarily in a different part of the world: the island archipelagos of Southeast Asia. Observing the same "biogeographical" patterns of life Darwin had in the Pacific, Wallace independently recognized how the same "natural selection" mechanism could explain it.

Joint papers by Darwin and Wallace were read at the Linnean Society that year, but of greater importance was the "short" version of his larger work that Darwin dashed off to clarify his view of evolution now that Wallace had let the cat out of the bag. Darwin's 1859 book *On the Origin of Species* not only sold out quickly, the ideas in it quickly took hold in the sciences, so that by the 1880s there were very few practicing naturalists who didn't accept the overall premise of descent with modification proposed by Darwin and Wallace.

Part of why evolution came to be accepted in science so quickly relates to what a great reputation Darwin had in his own time as a most careful investigator. Had the *Origin of Species* never been published, Darwin would still be regarded as one of the world's foremost experts on the lowly barnacle, the tiny creature that plasters onto ships (an issue of great concern for an island nation dependent on shipping for commerce and a Navy to protect it), revealing how its internal parts were the evolved modifications of other sea life. So when someone of Darwin's standing proposed this new mechanism for an evolutionary view of life, Darwin's fellow scientists knew it was worthy of full consideration.

But Darwin's impact was far greater: through his work and theories he profoundly revolutionized not only the *content* but also the *practice* of modern science. Darwin brought a sense of history and process to how naturalists investigate the world. Our understanding today of how coral reefs originate and develop began with Darwin's careful observations on the *Beagle* voyage, relating their formation to geological processes of fluctuating sea levels and temperatures. Preserving such habitats today in a time of climate change depends on *correctly understanding their history and adaptability (or lack of it) to changing circumstances*. This way of thinking about nature did not take place before Darwin launched his revolution.

Likewise modern botany (and by connection the entire agricultural system on which we depend for food today) came into being through the new methods pioneered by Darwin. This is illustrated by the work of Asa Gray, the only American made aware of Darwin's theory before its publication, and who early on become a staunch supporter of the new theory. Before *On the Origin of Species* came on the scene, Gray's botany texts were just disconnected lists of plant types. Only when inspired by evolutionary thinking did he start seeing his own field fully, as plant characters came to be recognized as *clues* to both functionality and how those ultimately depended on what their evolutionary relationship were.

Following the Evidence

Discoveries in Evolutionary Science Since Darwin

Trail No. 1: Paleontology … an Earful of Jaw

Well before Charles Darwin's time it had become clear that life had undergone lots of changes. By the early 19th century it was recognized that many animals had gone completely extinct, which was a difficult thing for many to accept when it was thought that all living things had been static through all time (Thomas Jefferson thought herds of mammoths might be alive somewhere out in the new Louisiana Territory, for example).

Darwin's new theory of evolution predicted that intermediate forms ought to have existed showing the transition from one thing to another, and the first striking confirmation popped up right after Darwin made his theory public. Excavators in Germany found a spectacular instance of a fossil crossing a major divide, a feathered reptile linking birds to their ancestry: *Archaeopteryx*. Eventually paleontologists recognized the group from which those early birds developed, another group of animals that were just being discovered in Darwin's day: dinosaurs. Most recently feathered dinosaurs have been found that are clarifying the evolution of birds even more.

Another major group whose evolution has been uncovered from fossil evidence is own mammal class from reptilian ancestors. Long before the dinosaurs appeared there had been a great split in the early *amniotic vertebrates*, where the **Synapsid** and **Diapsid** lines diverged (so named for the skull openings where muscles are attached, where the Synapsids have one opening and the Diapsids a second one). Modern reptiles, dinosaurs and birds stem from that Diapsid line, but the Synapsids in their heyday were just as diverse, being the dominant land animals before the dinosaurs (the well-known finback *Dimetrodon* often included in children's dinosaur sets is an example of a synapsid dating from the Permian Period). One of the branches of synapsids led eventually to the mammals, which appeared right around the time of the earliest dinosaurs (around 225 million years ago).

One of the most amazing transitions in evolutionary history is illustrated by the development of mammals from the later synapsids: the transformation of the reptilian jaw into a completely new configuration where some of the bones have been pulled into a new use inside the mammalian ear. Not only do we have the fossils tracking this remarkable transition, during embryonic development the pieces trace this process by starting out with the jaw arranged in the manner of fish, amphibians, and reptiles. As the bones grow they reconfigure into the mammalian layout, when the other jaw elements shift to their new functions in the developing inner ear. This means every time you hear music or a child's voice you are using fragments of a prehistoric shuffling of the jawbones in our pre-mammalian ancestors.

Trail No. 2: Biology … Deep Bacterial Roots

Although scientists in Darwin's time had begun to notice lots of things about how living things functioned and reproduced it was not until well into the 20th century that biologists began to connect all the many pieces into the overall evolutionary framework. One of the more amazing discoveries was how bacteria could merge in ways that produced novel new systems. Inside all animal cells are subunits called *organelles*. Among the most important of these are the tiny power plants called **mitochondria**, while plant cells have additional vital organelles known as **chloroplasts**.

These are now recognized as originally free-living bacteria that several billion years ago took up residence inside their host cells through a process called **endosymbiosis**. As one of the pioneering scientists in this area (Lynn Margulis) once joked, the more complex cells in plants and animals have come to be the way they are partly because of what amounted to a bad case of bacterial indigestion!

Plant chloroplasts were the easiest to trace back to their bacterial source: they are related to the **cyanobacteria** that were the first major oxygen-producing organisms on Earth, and scientists have discovered cyanobacteria have been wiggling their way into the cellular machinery of many other organisms in much the same way.

The roots of mitochondria have been harder to settle because there are several bacterial groups that share similar features, but one clue is how mitochondria still retain their original internal replication system (which is how this independent "mitochondrial DNA" has come to be used to trace the relationships of organisms, including their use in often controversial court cases).

So all human beings alive today carry around in every cell of their body the tiny biological fossils of an endosymbiotic event that occurred long ago in the bacterial ancestors of complex life.

Trail No. 3: Genetics … Tracks Close to Home

The biggest area scientists of Darwin's era didn't understand was the basic mechanism of inheritance. The word "gene" eventually came into use, but it wasn't until Gregor Mendel's 19th century experiments on plants became better known in the 20th century that the basic rules were worked out. After Francis Crick, James Watson and Rosalind Franklin identified the structure of the long molecule DNA in the 1950s it was recognized that DNA (as well as its related molecule RNA) carried the operating code of life.

DNA consists of strings of four **nucleotides** that serve double duty: some code for the *structural proteins* built from amino acids that make up our cells. Other DNA represent "non-coding" *regulatory genes* that don't get translated into proteins, but instead end up turning the protein making machinery on and off. Yet another set deploys that regulatory toolkit, such as the **homeobox** genes that govern how a growing animal embryo separates into front and back parts, or upper and lower layers.

Up until recently it was thought the many thousands of proteins used by living things each had their own specific coding gene. But it turns out genes can supply parts for lots of different proteins through *alternative splicing* (snipping out code sections and using what's left to make the RNA recipe for that particular protein).

Life has many ways of shuffling genes to generate new features. Whole genes can be *duplicated*, or be borrowed via "horizontal gene transfer" (bacteria are very good at this) and some genetic fragments called *retroposons* can even copy themselves into existing DNA on their own! Often these new stretches of "junk DNA" code don't do anything because they need a "pay attention to me" signal to get activated, but every so often mutations occur to turn them on. This is often trouble (causing diseases) but more rarely such strays can take on new functions too.

Like our mitochondrial endosymbionts, we have another biological fossil in our **chromosomes** (bundles of genes). Our closest primate cousins all have 24 chromosome pairs while we only have 23. But that "missing" set isn't entirely gone: occasionally chromosomes can fuse together, and this is what happened early in our evolution. The result is our overly long 23rd chromosome, with fragments of the end caps and middle of the formerly separate pieces still buried inside.

Blazing New Trails: Paleogenomics

ASR—Reverse Engineering Biology in the Lab

Once scientists discovered the DNA blueprints for biological systems it wasn't long before they had learned enough to start working *backwards* from the current genes of living organisms through *ancestral sequence reconstruction* (ASR) to retrace the steps of their evolution in the laboratory.

Since modern scientists have a wealth of information on how living things are related along evolutionary lines of descent (genetic, developmental and paleontological), they can compare the differences between variant current models and then proceed like genetic archaeologists to peel back the layers of change mutation by mutation to build an earlier form of proteins or receptors that can then be tested physically in the lab to see what their functions have to say about the original forms.

One of the first results of this approach came in the 1990s, as an extinct *retroposon* (see Trail No. 3 above) in mice was resurrected to discover why it had first spread copies of itself and then stopped. Various r*ibonucleases* (used widely from digestion in cattle to antiviral functions in primates) were similarly recovered and tested. By such means it has been learned that the *serine proteases* now used as regulatory proteins started out as much simpler digestive enzymes.

As we advance into the 21st century, ASR paleogenomics has grown more varied, involving science teams from around the world. Some have investigated systems tracking back very early in the development of complex life. One team has reached back 450 million years to rebuild the precursor to the *glucocorticoid* and *mineralocorticoid* receptors used in vertebrates, while others have recovered the ancestral steroid receptor of complex animals, and early versions of the *galectins* (proteins used in many ways, such as helping cells clump together or differentiate) have been resurrected.

Other reconstructions have focused on more specialized areas. How the primate clan has evolved to respond to odors has been illuminated by reverse engineering the OR7D4 receptor. Other researchers have pulled back a few hundred million years to reconstruct visual pigments for the ancient *archosaurs* (the reptile group from which crocodiles, dinosaurs and their kin emerged).

Even beer drinkers can clink a glass to take note of work figuring out how the ancestor of beer yeast got into the alcohol making game!

These techniques have more serious applications too—such as when used to reconstruct the ancestral versions of dangerous bacteria and viruses. To understand how to thwart a disease, it helps to know how it originated (which may have been millions of years ago) as well as how it has responded to varying conditions (not just its current environment). In helping to answer these questions paleogenomic investigations applied to HIV AIDS, for example, is giving medical science one more weapon to defend against this deadly virus.

As more is learned about how regulatory networks (noted in Trail No. 3) guide evolutionary development, it is only a matter of time before scientists advance to the next step of applying their reconstruction techniques to recover the whole genome of extinct organisms. Whether such work can someday advance so far as to rebuild a living mammoth or even a dinosaur remains to be seen, but the future of paleogenomics looks to be very exciting indeed.

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