

Evaluating Nature's 2009 “15 Evolutionary Gems” Darwin-Evangelism Kit

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I. Introduction

In 2009, during the bicentennial anniversary of Darwin's birth, *Nature* released a free online packet titled “15 Evolutionary Gems.”² Its subtitle was “A resource from *Nature* for those wishing to spread awareness of evidence for evolution by natural selection.” It might have been better subtitled ‘An evangelism packet for those wishing to spread the good news about Darwinism.’ After all, when *Nature* announced the packet, they said they were heeding a prior call which “urged scientists and their institutions to ‘spread the word’” about evolution and “highlight reasons why scientists can treat evolution by natural selection as, in effect, an established fact.” The packet is to be used not just in schools, but also in home evangelism or relationship evangelism. At least, that's basically what *Nature* said:

This week we are following our own prescription. Readers will find at www.nature.com/evolutiongems a freely accessible resource for biologists and others who wish to explain to students, friends or loved ones just what is the evidence for evolution by natural selection. ... In a year in which Darwin is being celebrated amid uncertainty and hostility about his ideas among citizens, being aware of the cumulatively incontrovertible evidence for those ideas is all the more important. We trust that this document will help.³

If all that weren't enough, the back page of the packet shows a picture of a smiling young Darwin with animals flocking about him (lizards, birds, monkeys, flowers, turtles, etc.), much like the pictures of Jesus posing with lions and lambs on some cheesy religious tract. You have to see the picture to believe it:



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² Available free online at: <http://www.nature.com/nature/newspdf/evolutiongems.pdf>

³ “Announcement: Evolutionary gems,” *Nature*, Vol. 457 (January 1, 2009).

Should we be surprised that *Nature* -- one of the world's top scientific journals -- is promoting evolution in this fashion? The respected historian of evolution Peter J. Bowler explains that *Nature* itself was originally founded in the late 19th century by T. H. Huxley and others for the express purpose of promoting a “campaign” to support Darwinism:

By exploiting their position in this network, Huxley and his friends ensured that Darwinism had come to stay. (Ruse, 1979a). They controlled the scientific journals -- the journal *Nature* was founded in part to promote the campaign -- and manipulated academic appointments. Hull (1978) has stressed how important these rhetorical and political skills were in creating a scientific revolution. The Darwinists adopted a flexible approach which deflected opposition, minimized infighting among themselves, and made it easy for others to join their campaign. Many, like Huxley himself, were not rigidly committed to the theory of natural selection; they were simply anxious to promote the case for evolution.⁴

The packet is simply an extension of *Nature's* “campaign” for Darwin. But it is quite useful in one important respect: the packet is from the world's top scientific journal and purports to show us “just what is the evidence for evolution by natural selection.” So if the evidence isn't very strong, then that should tell you something.

As we'll see, far from being “incontrovertible,” most of the “evolutionary gems” in the packet do not show any significant amount of evolution and might be best views as “microevolutionary” gems. A couple of the “gems” have little to do with evolution, but an evolutionary interpretation is added in after-the-fact.

Finally, the few “gems” that do deal with large-scale change face serious problems and might be termed ‘lumps of coal.’ For the ‘lumps of coal,’ their strategy is the same: ignore dissent and overhype the evidence.

An Evangelistic Opening

Nature's evolution-evangelism packet opens with one of the most dogmatic statements imaginable in support of evolution. According to the packet, “Most biologists take for granted the idea that all life evolved by natural selection over billions of years ... natural selection is a fact, in the same way that the Earth orbits the Sun is a fact.” Surely, if their claim is true (and not a bluff) then we will find no notable scientific dissent from the view that “all life evolved by natural selection.”

Just a couple years ago science journalist Susan Mazur (*who is no friend of intelligent design*) wrote that “hundreds of other evolutionary scientists (non-Creationists) who contend that natural selection is politics, not science, and that we are in a quagmire because of staggering commercial investment in a Darwinian industry built on an inadequate theory.”⁵ Two of those scientists might be National Academy of Sciences members Philip Skell and Lynn Margulis, staunch critics of the claim that “all life evolved by natural selection”:

“Darwinian evolution – whatever its other virtues -- does not provide a fruitful heuristic in experimental biology. This becomes especially clear when we compare it with a heuristic framework such as the atomic model, which opens up structural chemistry and leads to advances in the synthesis of a multitude of new molecules of practical benefit. None of this demonstrates that Darwinism is false. It does, however, mean that the claim that it is the cornerstone of modern experimental biology will be met with quiet skepticism from a

⁴ Peter J. Bowler, *Evolution: The History of an Idea*, p. 185 (University of California Press, 3rd ed., 2003).

⁵ Susan Mazur, *The Altenberg 16: An Exposé of the Evolution Industry*, p. 55 (Scoop Media Publishing 2009).

growing number of scientists in fields where theories actually do serve as cornerstones for tangible breakthroughs."⁶ -- Philip Skell

*"[The] Darwinian claim to explain all of evolution is a popular half-truth whose lack of explicative power is compensated for only by the religious ferocity of its rhetoric."*⁷ -- Lynn Margulis

And of course there's the 800+ scientists who have courageously signed a statement agreeing that they are skeptical of the creative power of natural selection: "We are skeptical of claims for the ability of random mutation and natural selection to account for the complexity of life. Careful examination of the evidence for Darwinian theory should be encouraged."⁸

But there's a deeper point here. If the claim that "all life evolved by natural selection" is "a fact, in the same way that the Earth orbits the Sun," then shouldn't it be as self-evident as the fact that the Earth orbits the Sun? But no one is making packets to evangelize for heliocentrism -- because in that case the evidence is so overwhelming that no one of any consequence disagrees.

Nature's evolution-evangelism packet seems like a politically motivated attempt to spread the good news about Darwin. And given the power that the journal *Nature* wields within the scientific community, its dogmatic treatment of natural selection serves to stifle academic freedom and dissent from *Nature's* viewpoint. This leads me to suspect that the journal might overstate the evidential case for natural selection. This packet will review just how far these "gems" actually go to support the view that "all life evolved by natural selection" is "a fact, in the same way that the Earth orbits the Sun."

II. Nature's Microevolutionary Gems Part 1: Lizards, Fish, Snakes, and Clams

Early in 2006, the journal *Science* published a long article titled "Evolution in Action"⁹ purporting to give three examples showing the glory of Darwinian evolution. As I discussed at that time, what it really showed was "microevolution in action."¹⁰ *Nature's* evolution-evangelism packet has tried to top *Science*, but much like the *Science* piece, many of the examples in the *Nature* packet entail trivial examples of small-scale evolution. This first installment of *Nature's* "microevolutionary gems" will look at the evidence cited there for evolution among lizards, snakes, clams, and birds.

Size Matters in Stickleback fish and *Anolis* lizards

One of *Nature's* "gems" was said to show "Natural selection in speciation." The study cited found that reproductive isolation between different populations of stickleback fish was established based upon the trait of body size: "Levels of reproductive isolation are well accounted for by differences in a single trait, body size."¹¹ Since body size can be determined by genes or the environment, it wasn't entirely clear whether the selected traits were heritable. In fact, when individuals from different stickleback populations were manipulated in the lab to the "preferred" body size of a different "ecotype" (e.g. a member of the same species from a different habitat), mating occurred even though the sticklebacks had previously been from different reproductively isolated populations.

⁶ Phil Skell, "Why Do We Invoke Darwin?," *The Scientist*, Vol. 19(16):10 (2005).

⁷ Lynn Margulis, Dorion Sagan, *Acquiring Genomes: A Theory of the Origins of the Species*, p. 29 (Basic Books, 2003).

⁸ See <http://www.dissentfromdarwin.com/>

⁹ Elizabeth Culotta and Elizabeth Pennisi, "Evolution in Action," *Science*, Vol. 310 (5756)1878-1879 (December 23, 2005).

¹⁰ For a response to this, see Casey Luskin, "Microevolution In Action," at: http://www.evolutionnews.org/2006/01/microevolution_in_action.html

¹¹ *Gem #6*: Jeffrey S. McKinnon, Seiichi Mori, Benjamin K. Blackman, Lior David, David M. Kingsley, Leia Jamieson, Jennifer Chou & Dolph Schluter, "Evidence for ecology's role in speciation," *Nature*, 429:294-298 (May 20, 2004), at: <http://www.nature.com/nature/journal/v429/n6989/abs/nature02556.html>

While this study is a nice demonstration of how assortative mating can lead to sympatric speciation (so long as we define “speciation” as mere “reproductive isolation” and don't expect significant morphological change), what this shows is that even after untold generations of reproductive isolation, these fish are still reproductively compatible so long as they like the “size” of their partner. And what sort of morphological divergence is observed between the different stickleback populations? A difference of 2-3 centimeters in length. It goes without saying that small changes in the size of stickleback fish are not going to explain the evolution of sticklebacks in the first place. Have we really witnessed differences that show large-scale evolutionary change is possible, or even “speciation”?

Another “gem” claimed to find “Natural selection in lizards.” Well, it wasn't exactly “natural” selection. Somewhat like the way researchers once glued peppered moth on trees to see if they'd be eaten by birds, evolutionary researchers artificially introduced a predatory lizard to small islands in the Caribbean to see if there was any impact upon populations of smaller *Anolis* lizards native to the islands. And they didn't just introduce the lizards to the island. They also artificially released “curly-tailed” predatory lizards right in front of their would-be prey, the lizard species *Anolis sagrei*, to see how *Anolis* lizards would respond. Here's what your taxpayer-funded NSF grant dollars supported:

On four of the experimental islands, we conducted focal animal observations on individual *A. sagrei* to investigate their immediate reaction to the introduction of curly-tailed lizards. Lizards were approached and an experimental object -- either a live curly-tailed lizard (n = 24) or, as a control, an inanimate object of approximately the same size (n = 23) -- was placed 0.5-1.0m from the lizard on the ground and clearly in its visual field.¹²

That the experiment was not entirely “natural” is no great reason to criticize it and in fact it does serve as a nice illustration of what natural selection might be able to do. Confirming prior studies, the *Anolis* lizards were found to undergo selection for both larger body sizes (in females) and longer limb (in males) because this allowed them to better escape the predatory “curly-tailed” lizards. And *Anolis* lizards may be small but they aren't stupid: they also started spending less time on the ground and perched higher up in trees to escape their newfound predators. I'm sure that the slower, smaller *Anolis* lizards didn't appreciate falling prey (literally) to this experiment -- in Darwin's words, such experiments show “Nature red in tooth and claw” at its finest. But we've still seen nothing beyond extremely small-scale changes in lizard sizes. Much like the peppered moth story said nothing about the origin of moths, what does this study tell us about the origin of lizards? Not much.

Toxic Examples of Evolution

It's long been discussed by critics of neo-Darwinian that the evolution of antibiotic resistance entails the evolution of essentially no new functional biological information in the genome. *Nature* calls “Toxin resistance in snakes and clams” an “evolutionary gem,” but what's really going on in the studies cited?

In the case of snakes, a species of garter snakes predate upon certain newts which produce the toxin tetrodotoxin (TTX). The toxin “causes paralysis and death by binding to the outer pore of voltage-gated sodium channels and blocking nerve and muscle fiber activity.”¹³ It turns out that by substituting valine for isoleucine in a gene for a particular protein involved in the sodium ion channel, a small amount of

¹² Gem #7: Jonathan B. Losos, Thomas W. Schoener & David A. Spiller, “Predator-induced behaviour shifts and natural selection in field experimental lizard populations,” *Nature* 432:505-508 (November 25, 2004), at <http://www.nature.com/nature/journal/v432/n7016/full/nature03039.html>

¹³ Gem #14: See Shana L. Geffeney, Esther Fujimoto, Edmund D. Brodie III, Edmund D. Brodie Jr, & Peter C. Ruben, “Evolutionary diversification of TTX-resistant sodium channels in a predator-prey interaction,” *Nature*, Vol. 434:759-763 (April 7, 2005), at: <http://www.nature.com/nature/journal/v434/n7034/abs/nature03444.html>

resistance to TTX is gained. A couple other amino acid substitutions in certain snake species also seem to confer additional resistance. Meanwhile, the sodium ion channels continue to perform their functions. So we see that toxin-resistance requires small-scale genetic changes that entail the origin of no new genes.

As for the clams, the packet reports that "Resistance to the toxin in the exposed populations is correlated with a single mutation in the gene that encodes a sodium channel, at a site already implicated in the binding of saxitoxin."¹⁴

In both cases, we're talking about strong selection pressure causing a couple changes (or even just one change) in the amino acid sequence of structural proteins. No new functions or structures are evolving and all we've seen is the loss of the ability of a toxin to bind to its target -- a protein involved in sodium channels. This is similar to the breaking down of a function -- losing the ability to bind through a mutation. Interesting and important research for sure, but if we're trying to showcase "just what is the evidence" for the grander claims of Darwinian evolution, this will not suffice.

III. Nature's Microevolutionary Gems Part 2: Bird-Sized Evolutionary Change

Two of *Nature's* "evolutionary gems" looked at birds. The first such gem showed "Differential dispersal in wild birds" -- but before we get caught up in the jargon, let's just cut to the main question: *What sort of evolutionary change was observed?* From reading *Nature's* evolution-evangelism packet, one is told that the "findings illustrate the large effect of immigration on the evolution of local adaptations and on genetic population structure" or that "evolutionary differentiation can be rapid and occur over surprisingly small scales." So exactly what was this rapid, large evolutionary change?

In one study it turns out that female members of the bird species *Parus major* (common name: "great tit") bred on the western end of the Dutch island of Vlieland tend to lay 1.15 ± 0.14 eggs per clutch more than females bred in populations on the east end of the islands.¹⁵ *You read that right.* The birds native to the island are still reproductively compatible with "immigrant" birds. The fact that evolutionary biologists consider a difference of 1.15 ± 0.14 eggs per clutch to be a "large effect" on a population shows just how desperate they are to find evidence of biological change in nature.

Another study cited in this "gem" promised to show "marked evolutionary differentiation" at "small spatial and temporal scales." Readers learned that over a span of about 35 years, great tits from the eastern part of the Wytham woodland in southern England saw a decrease in adult body size that amounted to a net average change of about 1 gram (less than 10 percent of total body mass). Fledgling birds likewise saw a small change in body mass. (Birds in the northern part of the wood did not experience such a change.)¹⁶

Recall that *Nature's* introduction to the packet boasts that "all life evolved by natural selection" and claims that this is "a fact, in the same way that the Earth orbits the Sun is a fact." *Nature* claimed the packet would show "just what is the evidence for evolution by natural selection." But if such featured

¹⁴ Gem #14: See V. Monica Bricelj, Laurie Connell, Keiichi Konoki, Scott P. MacQuarrie, Todd Scheuer, William A. Catterall & Vera L. Trainer, "Sodium channel mutation leading to saxitoxin resistance in clams increases risk of PSP," *Nature* 434:736-767 (April 7, 2005), at: <http://www.nature.com/nature/journal/v434/n7034/full/nature03415.html>

¹⁵ Gem #9: See Erik Postma & Arie J. van Noordwijk, "Gene flow maintains a large genetic difference in clutch size at a small spatial scale," *Nature* 433:65-68 (January 6, 2005), at: <http://www.nature.com/nature/journal/v433/n7021/abs/nature03083.html>

¹⁶ Gem #9: See Dany Garant, Loeske E.B. Kruuk, Teddy A. Wilkin, Robin H. McCleery & Ben C. Sheldon, "Evolution driven by differential dispersal within a wild bird population," *Nature* 433:60-65 (January 6, 2005), at: <http://www.nature.com/nature/journal/v433/n7021/abs/nature03051.html>

“evolutionary gems” are among the best that evolutionary scientists have to offer, which is what the packet implies, then that leaves a large gap between the observed data and *Nature’s* grand claims.

Meanwhile, what treatment of microevolutionary changes would be complete without a discussion of Darwin’s Galapagos finches? The packet explains that “When Charles Darwin visited the Galapagos Islands, he recorded the presence of several species of finch that all looked very similar except for their beaks,” further noting that “Darwin speculated that all the finches had a common ancestor that had migrated to the islands.” We’ve all heard this story before -- but is there more to it?

According to the British Natural History Museum, “Mockingbirds from the Galapagos Islands, not finches, gave Charles Darwin his ideas about evolution. ... Darwin's finches are the better-known birds connected with helping Darwin come to his conclusions on evolution. However, it was the little-known mockingbirds that were the key.”¹⁷ Likewise, historian of science Frank Sulloway debunks the finch myth, stating that, “far from being crucial to his evolutionary argument, as the legend would have us believe, the finches were not even mentioned by Darwin in the *Origin of Species*.”¹⁸ Whittaker’s *Island Biogeography* observes that it is “unclear whether [the mockingbird] genus (*Nesomimus*) is sufficiently distinct morphologically to warrant separation from the mainland genus (*Mimus*),”¹⁹ or as *Explore Evolution* explains, the mockingbirds “show only small-scale variations in existing traits.”²⁰

Setting aside *Nature’s* perpetuation of common myths about the Galapagos finches, modern-day field studies of these finch species are commonly cited as examples of evolution. So again we must ask, *How much evolutionary change are we talking about?* Here, the packet is somewhat forthright, acknowledging that we’re in fact only talking about “small differences in the depth, width or length of the beak.” The packet then refers readers to a study that investigated the genetic basis of these small changes in beak morphology. It’s an interesting paper, but as the packet explains, these changes in beak morphology may be caused by mere “differing expression of the gene for calmodulin, a molecule involved in calcium signaling that is vital in many aspects of development and metabolism.”²¹

So what’s at issue here is mere differential expression of a gene (rather than the evolution of an entirely new gene) causing “small differences” in beak morphology. For the Darwin-critic, this is interesting since such differences in beak shape are well-known throughout a variety of bird groups (such as Hawaiian honeycreepers), making it unsurprising that commonly observed forms of biodiversity have a small-scale genetic basis. None of this suggests how large-scale evolutionary change could occur. While the origin of the beaks (and the birds) themselves may remain unexplained, perhaps diverse beak morphologies are designed to evolve.

IV. Nature's Microevolutionary Gems Part 3: Flea and Guppy-Sized Evolutionary Change

While some of the papers cited in *Nature’s* evolution-evangelism packet may attempt to vindicate certain modes of evolutionary change, what they expose is that these mechanisms of evolution have not been shown to yield anything sufficient to justify claims of macroevolution.

¹⁷ <http://www.nhm.ac.uk/about-us/news/2008/november/darwins-mockingbirds-knock-finches-off-perch.html>

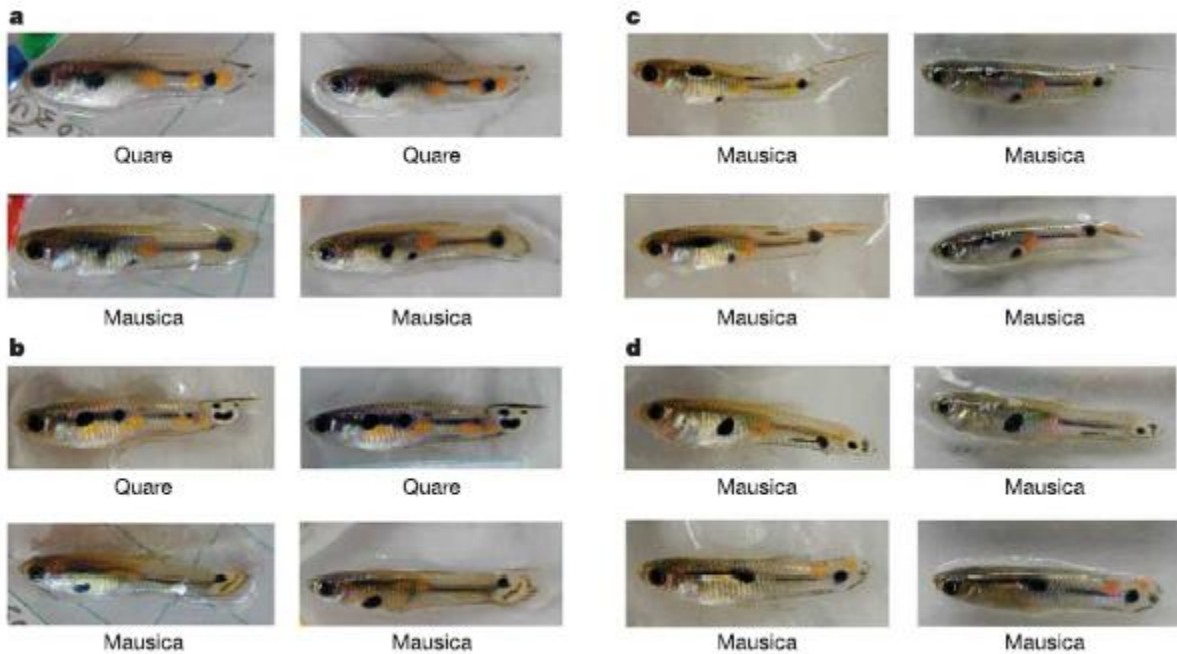
¹⁸ Frank J. Sulloway, “Darwin and His Finches: The Evolution of a Legend,” *Journal of the History of Biology*, Vol. 15(1):1-53 (Spring, 1982).

¹⁹ Robert J. Whittaker, *Island Biogeography: Ecology, Evolution, and Conservation*, p. 96 (Oxford University Press, 1998).

²⁰ See: http://www2.exploreevolution.com/exploreEvolutionFurtherDebate/2010/01/the_ncses_biogeographic_conund.php

²¹ *Gem #12*: Arhat Abzhanov, Winston P. Kuo, Christine Hartmann, B. Rosemary Grant, Peter R. Grant, and Clifford J. Tabin, “The calmodulin pathway and evolution of elongated beak morphology in Darwin's finches,” *Nature*, Vol. 442:563-567 (August 3, 2006), at: <http://www.nature.com/nature/journal/v442/n7102/abs/nature04843.html>

The paper cited for this “gem” opens by saying that “The maintenance of genetic variation in traits under natural selection is a long-standing paradox in evolutionary biology.” Before getting into the “paradox” and its implications, we must assess the degree of evolutionary change observed. Turns out we’re talking about small changes in the coloration spots on male guppies. The picture below tells the entire story of these small-scale differences:



Adapted by permission from Macmillan Publishers Ltd: *Nature*, Figure 1, Robert Olendorf, F. Helen Rodd, David Punzalan, Anne E. Houde, Carla Hurt, David N. Reznick, & Kimberly A. Hughes, "Frequency-dependent survival in natural guppy populations," Vol. 441:633-636 (June 1, 2006).²² Copyright 2006.

Keep in mind that it's nearly identical fish like these that *Nature* boasted would show us "just what is the evidence for evolution by natural selection."

While this is undoubtedly *exciting* stuff, I found more color variation in the goldfish I caught at the local school carnival back in the third grade. (Those were hardy goldfish -- they lived for years and grew quite large, for a goldfish, until a neighbor fed them tap water during a family vacation and killed them. Two lessons learned: Leave good instructions for petsitters and don't drink unfiltered tap water.)

One of the interesting findings in this paper was that "rare phenotypes had a highly significant survival advantage compared to common phenotypes." If they confer such a strong survival advantage, why are they rare? The evidence suggests that the fitness a trait is not determining its frequency, but rather the frequency of a trait is determining its fitness. If fitness is not the causative agent, then what is causing natural selection? Just as the standout in the crowd often gets noticed, it seems that sexual selection is driving male coloration patterns, as "females have a mating preference for rare or novel males." That's all fine and good, but how is the evolution of small-scale changes in coloration patterns in male-guppies going to explain large-scale evolutionary change?

Flea-Sized Evolution

Another innovative study awakened dormant parasites (bacteria) and their hosts (water fleas) from layers of lake sediment to show that they have undergone an evolutionary "arms races." The article speculated, "It is likely that different genes contributed to different parasite fitness components and thus

²² Available at: <http://www.nature.com/nature/journal/v441/n7093/abs/nature04646.html>

follow different evolutionary dynamics," and thus the genetic basis for increased parasite infectivity or host resistance was not determined.²³ As a result, it's difficult to assess whether any significant biological changes took place. All the researchers know was that a game of cat-and-mouse occurred between parasite and host. From the beginning to the end of the race, the bacteria remained bacteria and the water fleas remained water fleas. While this does show that the red queen hypothesis is viable, it also shows that the queen tends to send species running down evolutionary dead ends.

V. Nature's "Gems": Microevolution Meets Macroevolution

One of the "evolutionary gems" in *Nature's* evolution-evangelism packet was titled "Microevolution meets macroevolution," implying that it would show how small-scale evolutionary change could lead to large-scale changes. The packet explains, observing a difference between "microevolution" and "macroevolution":

Darwin conceived of evolutionary change as happening in infinitesimally small steps. He called these "insensible gradations," which, if extrapolated over long periods of time, would result in wholesale changes of form and function. There is a mountain of evidence for such small changes, called microevolution -- the evolution of drug resistance, for instance, is just one of many documented examples.

We can infer from the fossil record that larger species-to-species changes, or macroevolution, also occur, but they are naturally harder to observe in action. That said, the mechanisms of macroevolution can be seen in the here-and-now, in the architecture of genes. Sometimes genes involved in the day-to-day lives of organisms are connected to, or are even the same as, those that govern major features of animal shape and development. So every day evolution can have large effects.

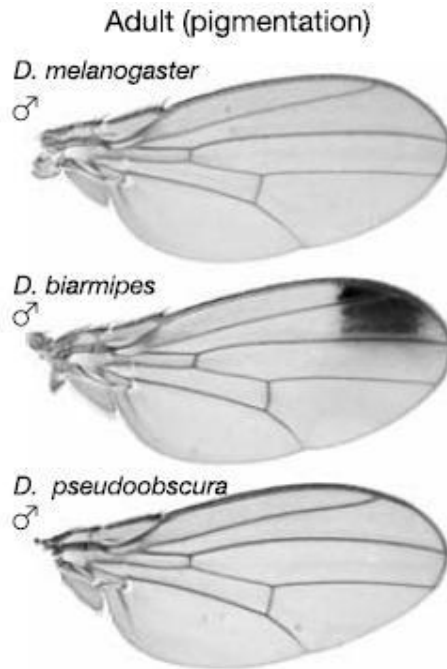
With high hopes finding a genetic change that shows "large effects" on an organism, the reader is then directed to a paper co-authored by Sean Carroll. The paper discussed changes in fruit flies thought to result from mutations in *cis*-regulatory elements of a gene controlling wing pigmentation. And what was the "large effect" that shows "macroevolution"? The article states:

Here we identify one of the molecular mechanisms that contributes to the evolutionary gain of a male-specific wing pigmentation spot in *Drosophila biarmipes*, a species closely related to *Drosophila melanogaster*. We show that the evolution of this spot involved modifications of an ancestral *cis*-regulatory element of the yellow pigmentation gene.²⁴

That's right: All this hype about "large" evolutionary effects and "microevolution meets macroevolution," yet all they've attempted to explain is the origin of small-scale coloration changes in spots on fruit fly wings. If you want to understand the underwhelming nature of these spots, just look at the dark spot on the end of the wing of *Drosophila biarmipes* in the diagram below:

²³ See Ellen Decaestecker, Sabrina Gaba, Joost A. M. Raeymaekers, Robby Stoks, Liesbeth Van Kerckhoven, Dieter Ebert, & Luc De Meester, "Host-parasite 'Red Queen' dynamics archived in pond sediment," *Nature*, Vol. 450:870-873 (December 6, 2007), at: <http://www.nature.com/nature/journal/v450/n7171/abs/nature06291.html>

²⁴ *Gem #13*: Nicolas Gompel, Benjamin Prud'homme, Patricia J. Wittkopp, Victoria A. Kassner & Sean B. Carroll, "Chance caught on the wing: *cis*-regulatory evolution and the origin of pigment patterns in *Drosophila*," *Nature*, Vol. 433:481-487 (February 3, 2005), at: <http://www.nature.com/nature/journal/v433/n7025/abs/nature03235.html>



Adapted by permission from Macmillan Publishers Ltd: *Nature*, Figure 1, Nicolas Gompel, Benjamin Prud'homme, Patricia J. Wittkopp, Victoria A. Kassner & Sean B. Carroll, "Chance caught on the wing: *cis*-regulatory evolution and the origin of pigment patterns in *Drosophila*," *Nature*, Vol. 433:481-487 (February 3, 2005).²⁵ Copyright 2005.

As I remarked discussed above regarding small-scale coloration changes in guppies, again bear in mind that it is minor coloration variations like these which *Nature* claimed would show "just what is the evidence for evolution by natural selection." Does this show "macroevolution"?

Apart from the obvious fact that this paper has *not* shown that changes in *cis*-regulatory regions of genes are capable of explaining large-scale evolutionary change, it's worth noting that some leading evolutionary biologists have been highly critical of those who seek to explain evolution by appealing to such regulatory mutations.

Two years after this *Nature* gem was published, Hopi E. Hoekstra and Jerry Coyne wrote a review article in the journal *Evolution* offering a potent rebuttal to arguments from "evo-devo" based upon changes in *cis*-regulatory elements:

An important tenet of evolutionary developmental biology ("evo devo") is that adaptive mutations affecting morphology are more likely to occur in the *cis*-regulatory regions than in the protein-coding regions of genes. This argument rests on two claims: (1) the modular nature of *cis*-regulatory elements largely frees them from deleterious pleiotropic effects, and (2) a growing body of empirical evidence appears to support the predominant role of gene regulatory change in adaptation, especially morphological adaptation. Here we discuss and critique these assertions. We first show that there is no theoretical or empirical basis for the evo devo contention that adaptations involving morphology evolve by genetic mechanisms different from those involving physiology and other traits. ... Genomic studies lend little support to the *cis*-regulatory theory...²⁶

²⁵ At: <http://www.nature.com/nature/journal/v433/n7025/abs/nature03235.html>

²⁶ Hopi E. Hoekstra and Jerry A. Coyne, "The Locus of Evolution: Evo Devo and the Genetics of Adaptation," *Evolution*, Vol. 61-5: 995-1016 (2007), at: <http://www3.interscience.wiley.com/journal/117958848/abstract?CRETRY=1&SRETRY=0>

Significantly, the authors argue that “evo devo’s enthusiasm for *cis*-regulatory changes is unfounded and premature. There is no evidence at present that *cis*-regulatory changes play a major role -- much less a pre-eminent one -- in adaptive evolution.” In fact, Hoekstra and Coyne argue that in this very “gem” cited by *Nature*, the evidence linking phenotypic change to *cis*-regulatory elements has not been fully established:

Although in this case the promoter region clearly contains regulatory modules controlling the spatial expression of *yellow*, the direct link between genotype and phenotype is not complete. This is because changes the *cis*-regulatory elements of *yellow* alone are not sufficient to produce the phenotype of interest -- the pigmented wing spot (Gompel et al. 2005). Additional loci must therefore be involved. Although it is not surprising that different *cis*-regulatory elements in the *yellow* promoter affect *yellow* expression, a critical piece of evidence is still missing: the demonstration that species-specific *cis*-regulatory elements produce the species-specific difference in the wing spot.²⁷

Given that *Nature*’s evolutionary gem admits “the shape of the wings and the pattern of venation have not changed much over 60-80 Myr of evolution,” perhaps *Nature*’s efforts would be better spent trying to explain why species *don’t* change rather than making stretched arguments that small changes in the color of wings are “large effects” that actually do show how “microevolution meets macroevolution.”

In fact, the 15th gem in *Nature*’s packet tries to explain “Variation versus stability” and account for the fact that “Species can remain mostly unchanged for millions of years, long enough for us to pick up their traces in the fossil record. But they change, too, and often very suddenly.” The implication, of course, is that the evolutionary change does not last “long enough for us to pick up their traces in the fossil record” -- i.e., we don’t find transitional fossils. Can this “gem” cited by *Nature* explain how rapid evolutionary change takes place?

According to the paper *Nature* cites, some genes serve as “evolutionary capacitors” which inhibit “variation under normal conditions, thereby promoting the accumulation of hidden polymorphism.”²⁸ When these genes are “knocked-out,” the authors speculate this allows hidden genetic variation to lead to phenotypic change. They spell out exactly what they are hypothesizing: “most, and perhaps all, genes reveal phenotypic variation when functionally compromised” and “the availability of loss-of-function mutations accelerates adaptation to a new optimum phenotype.”

The aforementioned article by Hoekstra and Coyne might be instructive here. They argued that the case for evolution by changes in *cis*-regulatory elements is weak because “Supporting the evo devo claim that *cis*-regulatory changes are responsible for morphological innovations requires showing that promoters are important in the evolution of *new* traits, not just the losses of old ones.” This criticism seems applicable to the final *Nature* gem as well: If phenotypic evolution occurs during “loss-of-function mutations” where genes are “functionally compromised” or “knocked out,” then how do we explain the evolution of new genes in the first place? At some point evolution cannot proceed simply by “loss-of-function mutations.”

Nature’s evolution-evangelism packet isn’t forthcoming about the fact that this paper has made the ultimately impotent proposal that evolution proceeds by “loss-of-function mutations.” The packet claims that Bergman and Siegal “showed that most, and perhaps all, genes hold variation in reserve that is released only when they are functionally compromised. In other words, it looks as if evolutionary capacitance might go wider and deeper than Hsp90.” But the paper does not support these grand claims.

²⁷ *Id.*

²⁸ Gem #15: Aviv Bergman & Mark L. Siegal, “Evolutionary capacitance as a general feature of complex gene networks,” *Nature*, Vol. 424:549-552 (July 31, 2003), at: <http://www.nature.com/nature/journal/v424/n6948/full/nature01765.html>

First, it admits that the gene that was knocked out -- Hsp90 -- might be a severe case since it serves as a chaperone protein, and most other potential evolutionary capacitors "might have more subtle effects than Hsp90 has."

Second, Bergman and Siegal's study used a computer simulation to "ask how an arbitrary null ('knockout') mutation affects the expression of other genes." But without using real experiments knocking out real genes in real organisms, they have not actually tested whether knocking out genes might have deadly or deleterious effects. They recognize this is important, writing, "At this point one might ask whether there is any corroborating experimental evidence that knockout mutations tend to increase variation in the expression of other genes."

The paper answers "there is," but the authors don't tell the reader about the numerous deleterious effects that occurred in experiments that knocked out Hsp90 in fruit flies. Likewise, *Nature's* evolution-evangelism packet says that when Hsp90 is compromised, "the proteins it normally regulates are left to run free, producing a welter of otherwise hidden variation." However, the original research found that various "developmental defects" occurred in fruit flies where Hsp90 was knocked out, including deformed eyes, deformed legs, malformed tergites, and various other abnormalities that would never lead to viable variation in the wild.²⁹ If such deleterious deformities are the types of "variation" observed, then it would seem that this mechanism is not going to foster viable evolutionary novelty in the wild.

In fact, a commentary on this "gem" noted that "the authors looked only at gene expression (the 'transcriptome'), rather than at anything approaching the complexity of whole-organism phenotype" -- so the all-important question of what organism-wide effects would be produced by knocking out these genes has not been investigated. As the critique explains, the effects of knocking out these genes might be deleterious:

[V]ariation released in the transcriptome could also produce changes in reproduction and mortality rates, which determine the strength of natural selection. If increased genetic variation were accompanied by reduced variation in reproductive success, or by reductions in the correlation between variation in traits and variation in reproductive success, the rate of evolution would not necessarily change. In fact, if the effects were strong enough, the rate of evolution might even decrease.³⁰

While the study by Bergman and Siegal might show that gene expression changes when a gene is knocked out, this doesn't account for the effects on the organism stemming from (1) the loss of a gene, and (2) differential expression of other genes. To repeat the basic question here: "*Does evolutionary capacitance explain the periods of stasis and rapid change that are seen in experimental studies of evolution -- or perhaps even in the fossil record?*," Stearns's critique of this paper makes it clear that the question has not yet been answered in the affirmative. Perhaps, the deleterious effects observed in organisms that have lost such "capacitor" genes suggest that the question has indeed been answered -- *and that the answer is no.*

VI. Evolutionary "Gems" or "Narrative Gloss"?

In the previous four sections responding to *Nature's* evolution-evangelism packet, we saw that at least 9 of their 15 "evolutionary gems" showed mere small-scale examples evolutionary change. Despite promises of explaining how "microevolution meets macroevolution" and suggestions that it's "a fact, in

²⁹ See Suzanne L. Rutherford & Susan Lindquist, "Hsp90 as a capacitor for morphological evolution," *Nature*, Vol. 396:336-342 (November 26, 1998), at: <http://www.nature.com/nature/journal/v396/n6709/full/396336a0.html>

³⁰ Stephen C. Stearns, "Safeguards and spurs," *Nature*, Vol. 424:501-504 (July 31, 2003), at: <http://www.nature.com/nature/journal/v424/n6948/full/424501a.html>

the same way that the Earth orbits the Sun is a fact” that “all life evolved by natural selection,” instead we were treated to discussions of how small coloration spots change in guppies and fruit flies, or how lizards, birds, and fish undergo small-scale changes in body size. While these are undoubtedly legitimate examples of evolution, such slight modifications cannot, as the packet put it, be “extrapolated over long periods of time[to] result in wholesale changes of form and function.” But with some of the “gems” cited by *Nature*, it’s arguable that they don’t even have anything to do with evolution at all.

In 2005, U.S. National Academy of Sciences member Phil Skell wrote in *The Scientist* that in his experience, most research -- even in biology -- does not require evolution. According to Skell, evolution rarely formed the basis of research:

I also examined the outstanding biodiscoveries of the past century: the discovery of the double helix; the characterization of the ribosome; the mapping of genomes; research on medications and drug reactions; improvements in food production and sanitation; the development of new surgeries; and others. I even queried biologists working in areas where one would expect the Darwinian paradigm to have most benefited research, such as the emergence of resistance to antibiotics and pesticides. Here, as elsewhere, **I found that Darwin's theory had provided no discernible guidance, but was brought in, after the breakthroughs, as an interesting narrative gloss.**³¹

This seems to be the case for at least two of the evolutionary “gems” in *Nature’s* evolution-evangelism packet. As Skell says, evolution is added in later as a “narrative gloss.”

In Praise of Teeth

One “gem from the fossil record” cited by *Nature* was “The evolutionary history of teeth.”³² *Nature* offered only two short paragraphs on this study:

One motivation in the study of development is the discovery of mechanisms that guide evolutionary change. Kathryn Kavanagh at the University of Helsinki and her colleagues investigated just this by looking at the mechanisms behind the relative size and number of molar teeth in mice. The research, published in 2007, uncovered the pattern of gene expression that governs the development of teeth -- molars emerge from the front backwards, with each tooth smaller than the last.

The beauty of the study lies in its application. Their model predicts the dentition patterns found in mouse-like rodent species with various diets, providing an example of ecologically driven evolution along a developmentally favored trajectory. In general, the work shows how the pattern of gene expression can be modified during evolution to produce adaptive changes in natural systems.

This is indeed a fascinating study about the mechanisms controlling molar development in mice, but what does it have to do with natural selection? The authors compared relative molar sizes in 29 species of murine rodents and found that the relative sizes fit the patterns predicted by the developmental mechanisms they uncovered in their research. Here's where the evolutionary interpretation comes in: what's really a mere comparison of relative tooth sizes in existing murine rodent species is now termed

³¹ Phil Skell, “Why Do We Invoke Darwin?,” *The Scientist*, Vol. 19(16):10 (2005) (emphasis added).

³² Gem #4: See Kathryn D. Kavanagh, Alistair R. Evans, & Jukka Jernvall, “Predicting evolutionary patterns of mammalian teeth from development,” *Nature*, Vol. 449:427-433 (September 27, 2007), at: <http://www.nature.com/nature/journal/v449/n7161/abs/nature06153.html>

“macroevolutionary data.” At base, they’ve found that all murine rodents follow similar developmental patterns. They term it “macroevolution.”

Perhaps evolution did do all of this. But is this “macroevolutionary data” or is it a study of mere comparative tooth morphology? All this really does is identify molecular mechanisms that explain tooth development in a variety of rodent species.

And if evolution did cause these changes, all we’re talking about is small-scale changes in tooth-sizes within highly similar species of rodents. But no one doubts that mammalian teeth are readily susceptible to evolutionary change. In fact, tooth morphology is so plastic in mammals that many evolutionary systematists find teeth to be nearly useless when studying evolutionary history and constructing supposed phylogenetic trees. As one study in *PNAS* wrote, “tooth morphology is prone to homoplasy and is therefore a poor guide to low-level phylogenetic relationships.”³³ Likewise another paper reported: “Given the robustness of the molecular phylogenies, these results indicate that little confidence can be placed in phylogenies generated solely from higher primate craniodental evidence.”³⁴

In any case, what this paper terms “macroevolutionary data” is merely small-scale differences in tooth morphology observed by comparing various rodent species. The idea that this provides “macroevolutionary data” is just an interpretative gloss added after the fact.

Double-Jawed Moray Eels: Very Cool Structures, but What's Evolution Got to Do With It?

In another gem, *Nature's* evolution-evangelism packet highlights a fascinating feature of certain moray eels which allows its pharyngeal jaws to “move forwards into the mouth cavity, trapping the prey and dragging it backwards” into the gut where digestion can begin. The packet calls this “evolution's breathtaking solution” to allow moray eels to feed. But the paper is little more than a description of the fascinating feature, with a note that it has striking convergent similarities to the mechanisms that allow snakes to swallow large prey: “The independent evolution of ratcheting mechanisms enables both morays and snakes to maintain a constant grip on their prey.” The last paragraph of the paper states:

The evolution of the newly discovered function and design of this widespread jaw system adds to our general understanding of how innovations arise and how they correlate with a particular body plan. Our discovery demonstrates that striking functional novelties can arise with only subtle modifications in existing systems, and offers new insights into the functional morphology of a successful radiation of predatory fish, the moray eels.³⁵

The short 3 sentences in the quotes above, which are crammed at the very end of this paper, entail literally *everything* that this paper says about “evolution.” Apart the fact that moray eel jaws would require much more than mere “subtle modifications” in existing systems to generate this “striking functional novelt[y],” this paper's bland and vague reference to “evolution” at the end does not offer anything close to an evolutionary explanation. Evolution has been added in only as a narrative gloss.

Where's the Evolution?

³³ Sally Gibbs, Mark Collard, and Bernard Wood, “Soft-tissue characters in higher primate phylogenetics,” *Proceedings of the U.S. National Academy of Sciences*, Vol. 97:11130-11132 (September 26, 2000).

³⁴ Mark Collard and Bernard Wood, “How reliable are human phylogenetic hypotheses?,” *Proceedings of the U.S. National Academy of Sciences*, Vol. 97: 5003–5006 (April 25, 2000).

³⁵ *Gem #11*: See Rita S. Mehta & Peter C. Wainwright, “Raptorial jaws in the throat help moray eels swallow large prey,” *Nature* 449:79-82 (September 6, 2007), at: <http://www.nature.com/nature/journal/v449/n7158/abs/nature06062.html>

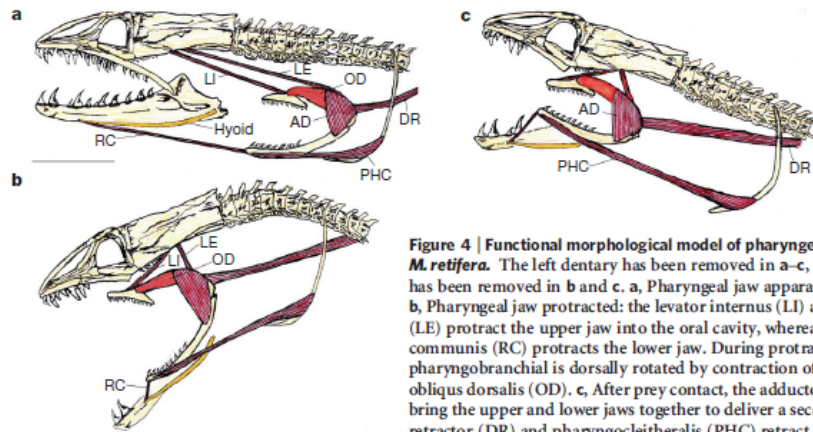


Figure 4 | Functional morphological model of pharyngeal jaw movement in *M. retifera*. The left dentary has been removed in a–c, and the left maxilla has been removed in b and c. a, Pharyngeal jaw apparatus at rest. b, Pharyngeal jaw protracted: the levator internus (LI) and levator externus (LE) protract the upper jaw into the oral cavity, whereas the rectus communis (RC) protracts the lower jaw. During protraction, the upper pharyngobranchial is dorsally rotated by contraction of the LI and the obliquus dorsalis (OD). c, After prey contact, the adductor (AD) contracts to bring the upper and lower jaws together to deliver a second bite. The dorsal retractor (DR) and pharyngocleithralis (PHC) retract the pharyngeal jaws back to their resting position behind the skull. Scale bar, 1 cm.

Adapted by permission from Macmillan Publishers Ltd: *Nature*, Figure 4, Rita S. Mehta & Peter C. Wainwright, "Raptorial jaws in the throat help moray eels swallow large prey," *Nature* 449:79-82 (September 6, 2007). Copyright 2007.

VII. Muscling Past Homology Problems in *Nature's* Vertebrate Skeleton "Evolutionary Gem"

In the prior section, I recounted Phil Skell's observation that for much research, evolution is not foundational but added in after-the-fact as "narrative gloss." One of *Nature's* evolutionary "gems" helped itself to a generous dose of evolutionary gloss. Given the messy picture its evolutionary thinking paints of vertebrate skeletal and muscle development, the authors may wish they'd gone on a gloss-free diet.

Nature's evolution-evangelism packet titles this gem "The origin of the vertebrate skeleton" -- but it's not necessarily the kind of "origin" you'd expect. At best, this research explains not *evolutionary origins* but *developmental origins* -- e.g., it examined the biological mechanisms that control the growth of the bones and muscles in the neck and shoulder region. What is more, those findings regarding developmental origins are applicable, at this point, only to the mouse. Whether their model can be extended generally to all "vertebrates" is another question that hasn't yet been addressed. In any case, *Nature's* evolution-evangelism packet describes the relevant paper, "Neural crest origins of the neck and shoulder," this way:

One key mystery, for example, is how much of the vertebrate skull is contributed by neural-crest cells and how much comes from deeper layers of tissue. New techniques have allowed researchers to label and follow individual cells as embryos develop. They have revealed the boundaries of the bone derived from the neural crest, down to the single-cell level, in the neck and shoulders. Tissue derived from the neural crest anchors the head onto the front lining of the shoulder girdle, whereas the skeleton forming the back of the neck and shoulder grows from a deeper layer of tissue called the mesoderm.

With these new techniques, researchers were able to determine exactly which parts of bones and muscle, "down to the single-cell level" in the neck and shoulder region of mice, are derived from the embryological tissue called the neural crest. They made the surprising discovery that neural crest cells migrate down into the spine of the scapula bone and many other neck and shoulder bones where they serve as attachment points for muscles.

This is absolutely fascinating research and the researchers' methods have huge potential to shed light on developmental processes. Yet one might have undertaken this study of developmental patterns simply by studying comparative development -- without assuming common ancestry. Their data about

development is the same whether one assumes common ancestry or not. In fact, the findings of this research pose severe quandaries for the concept of homology.

The textbook *Explore Evolution* discusses how common ancestry faces a problem when purportedly homologous structures develop via different, non-homologous pathways:

In sharks, for example, the gut develops from cells in the roof of the embryonic cavity. In lampreys, the gut develops from cells on the floor of the cavity. And in frogs, the gut develops from cells from both the roof and the floor of the embryonic cavity. This discovery -- that homologous structures can be produced by different developmental pathways -- contradicts what we would expect to find if all vertebrates share a common ancestor.³⁶

The problem cited in this passage is encountered with the purportedly homologous neck muscles and their attachment points in mice. As the article called a "gem" by *Nature* explains:

[T]he pattern of neck muscles is far more conserved than the ossification modes of the shoulder bones to which these muscles are attached. This poses a serious problem for muscle homologies: in all cranial and trunk regions of the vertebrate body so far examined the embryonic cellular origin of muscle connective tissues and their respective skeletal attachment regions are identical. This implies that if attachment regions change in their cellular origins and ossification type, their coordinated muscle connective tissues also change in their composition. This would force us to reject the homology of all neck musculature in jawed vertebrates, although it has a highly similar and complex connectivity pattern.³⁷

The paper tries to avoid these problems by assuming that the *truly* homologous entity *is not* the neck and shoulders bones but rather the "highly conserved" pattern of neck muscles (and their attachment points) -- what they call the "muscle scaffold." Although the neck and shoulder bones of various vertebrates often have essentially identical locations, shapes, and functions, their developmental pathways can be highly variable, so they can't be homologous. Most would think that muscles grow around bones, but the evolutionary mandate that 'something here must be homologous' leads to the absurd notion that neck and shoulder bones develop as they "'morph' around a highly constrained muscle attachment scaffold," and then on to the following equally absurd claim:

The rather counterintuitive "scaffold model" perceives muscle connectivities as the basic units (because they precisely correspond to cell populations) but considers the bones that everyone can see as mere epiphenomena and subjects of change.³⁸

So if we assume that 'something here must be homologous', then only the muscles are programmed for development, and bones are now mere "epiphenomena" that "morph" their way around the "muscle scaffold." The view that bone structures are an epiphenomenal byproduct of development is called a "counterintuitive" interpretation being forced upon the authors by evolutionary thinking. These are the

³⁶ Stephen C. Meyer, Scott Minnich, Jonathan Moneymaker, Paul Nelson, & Ralph Seelke, *Explore Evolution: The Arguments For and Against Neo-Darwinism*, p. 44 (Hill House, 2007).

³⁷ Toshiyuki Matsuoka, Per E. Ahlberg, Nicoletta Kessarar, Palma Iannarelli, Ulla Dennehy, William D. Richardson, Andrew P. McMahon, & Georgy Koentges, "Neural crest origins of the neck and shoulder," *Nature*, Vol. 436:347-355 (July 21, 2005) (internal figure and citation references omitted), at:

<http://www.nature.com/nature/journal/v436/n7049/abs/nature03837.html>

³⁸ *Id.*

bizarre conclusions forced upon those who are unwilling to question the mandate of universal common ancestry.

And problems still remain. While their “muscle scaffold” model may solve some problems of homology, the model has implications that do not fit neatly under the standard vertebrate phylogeny. *Nature's* evolution-evangelism packet boasts that this research “allows the tracing of ... the location of the major shoulder bone of extinct land vertebrate ancestors, the cleithrum.” That's not quite correct, since the cleithrum isn't known only in “extinct land vertebrate ancestors” – it's also found in living frogs.

Given that frogs have a cleithrum whereas other land-vertebrates do not, the researchers' “muscle scaffold model” of homology forces them to conclude that the lack of a cleithrum is in fact not a primitive trait among extant land-vertebrates, but is the result of convergent evolution. “Thus,” they write, “the cleithrum has been lost at least four times independently: in salamanders, mammals, turtles and diapsids [crocodiles, snakes, lizards, and birds].”

Their “muscle scaffold” model forces them to believe that various similar patterns of bone development -- once thought to be homologous -- in fact evolved convergently:

It remains to illuminate the molecular causes for this unidirectional trend to dismantle the dermal shoulder girdle, replace it by endochondral skeleton or lose it altogether, which seems to continue in mammals and amphibians and also extends to other bones such as the clavicle. In the framework of the highly constrained neck muscle scaffolds we find no evidence for histogenetic reversals; that is, that endochondral bones of ancestors turned into dermal bones of descendants during the course of evolution. We speculate that a common, as yet unknown, genomic *cis*-regulatory architecture governing neck ossifications in tetrapod ancestors might have predisposed different descending tetrapod lineages to similar parallel trends.

You've got to love the last sentence, which is worth repeating: “We speculate that a common, as yet unknown, genomic *cis*-regulatory architecture governing neck ossifications in tetrapod ancestors might have predisposed different descending tetrapod lineages to similar parallel trends.” This is almost starting to sound like teleological evolution--but of course that's not allowed in Darwinian thinking, so it's just by the luck of the draw that all of these taxa independently arrived at the same bone structure.

Moreover, as discussed in Section V, vague appeals to mutations in *cis*-regulatory elements may be a non-starter -- especially when one is trying to explain something as unlikely as genetic and developmental convergent evolution.

As *Explore Evolution* suggests, the problem here is that common ancestry is leading to irreconcilable predictions about homology -- either homologous bones have non-homologous developmental pathways, or the *only* homologous pattern is the “muscle scaffolding” and highly similar bones are mere “epiphenomena” that “morph” around the muscle scaffold.

The research is fascinating but the rather implausible evolutionary speculations are, as Phil Skell observed, mere “narrative gloss.”

VIII. Of Whale and Feather Evolution: *Nature's* Two Macroevolutionary Lumps of Coal

Having now addressed all of the microevolutionary or even non-evolutionary “gems” from *Nature's* evolution-evangelism packet, we turn attention in this series of posts to the few examples that actually led off their packet. Arguably, 12 of the 15 evolutionary gems had nothing to do with “macroevolution.”

But the very first "gem" was whale evolution, where the packet claims there are "numerous fossils from the first ten million years or so of whale evolution." This is odd since Phillip Gingerich has admitted that these are merely "fossils illustrating three or four steps that bridge the precursor of whales to today's mammals."³⁹ The *Nature* packet recites the standard fossils, which are nearly always given as alleged evidence of transitional forms between land mammals and whales. Something very important is missing from their analysis. But we must not miss their comment about "the first ten million years" of whale evolution.

These "ten million years" are mentioned again in the main article cited in the packet, which opens with a retroactive admission of ignorance, stating, "Although the first ten million years of whale evolution are documented by a remarkable series of fossil skeletons, the link to the ancestor of cetaceans has been missing." According to the paper, the land-mammal ancestor of modern whales was very much like:

Indohyus ... a small, stocky artiodactyl, roughly the size of the raccoon *Procyon lotor*. It was not an adept swimmer; instead it waded in shallow water, with its heavy bones providing ballast to keep its feet anchored. *Indohyus* may have fed on land, although a specialized aquatic diet is also possible. The modern artiodactyl morphologically most similar to *Indohyus* is probably the African mousedeer...⁴⁰

The inference of ancestry is made based upon just a few similar features--namely, tooth and ear morphology, limb-bone density, and $\delta^{18}\text{O}$ values (reflective of habitat and diet). On this basis, *Nature's* first gem article suggests that raoellids (an artiodactyl group which includes *Indohyus*) were in fact the "ancestors" of whales: "Our working hypothesis for the origin of whales is that raoellid ancestors, although herbivores or omnivores on land, took to fresh water in times of danger."

Inferring ancestry based upon a couple similar features, like we see here, is kind of like reading tea leaves. Even if there are morphological or behavioral similarities between certain raoellids and whales, ancestry is difficult to unequivocally support. As *Nature* editor Henry Gee commented with regards to studying the much more recent relationships among hominids, "To take a line of fossils and claim that they represent a lineage is not a scientific hypothesis that can be tested, but an assertion that carries the same validity as a bedtime story--amusing, perhaps even instructive, but not scientific."⁴¹ With that in mind, how seriously should we take *Nature's* packet when it confidently asserts that raoellids like *Indohyus* were "the land-living creatures from which whales eventually evolved"?

Even in this case there are questions about which direction the data is pointing. As regards teeth similarities, the authors note that "all of these characters are found in some mammals unrelated to cetaceans." As regards ear morphology, Figure 3 (x-axis) shows that by at least one measurement, other artiodactyls are more similar to whales than *Indohyus*. As regards $\delta^{18}\text{O}$ values, they claim it shows *Indohyus* had a semi-aquatic lifestyle, but $\delta^{13}\text{C}$ values of *Indohyus* "are most similar to the $\delta^{13}\text{C}$ values in enamel for terrestrial mammals from early and middle Eocene deposits in India and Pakistan." Something tells me they really want *Indohyus* to have a semi-aquatic lifestyle, as they make the odd conclusion that "although" *Indohyus* had a semi-aquatic lifestyle "it did not necessarily have an aquatic diet (as suggested by carbon isotopes)." If *Indohyus* does represent the ancestors of cetaceans, the argument is hardly a clean case.

³⁹ See <http://www.actionbioscience.org/evolution/gingerich.html>

⁴⁰ J. G. M. Thewissen, Lisa Noelle Cooper, Mark T. Clementz, Sunil Bajpai & B. N. Tiwari, "Whales originated from aquatic artiodactyls in the Eocene epoch of India," *Nature*, Vol. 450:1190-1194 (December 20/27, 2007).

⁴¹ See Henry Gee, *In Search of Deep Time*, 1999.

But let's return to the comments from *Nature's* evolution-evangelism packet that there are "numerous fossils from the first ten million years or so of whale evolution," also mentioned in the opening line of the paper. Why are the ten million years so important? It's because the fossil record shows that there are less than ten million years available for the transition from a full-fledged land mammal to a fully aquatic whale. So let's grant, for the sake of argument, that these fossils have some characteristics that appear intermediate between the features of land-mammals and whales. Have Darwinian paleontologists made their case?

The fossil record requires that evolution of whales from small land mammals supposedly took place in less than 10 million years. Think about that for a moment. According to this paper, whales, with all of their complex adaptations for aquatic life, supposedly evolved from something like *Indohyus*, a mouse-deer like animal, into a full-fledged whale in less than ten million years. Whales have a long generation time, meaning that there were perhaps only a few million generations at best to allow for the change to add up. If they had a generation time as short as 5 years, Haldane's dilemma predicts that only a few thousand mutations could become fixed into an evolving population during that time period.⁴² In other words, the fossil record permits dramatically insufficient time to convert a land mammal into a whale.

Feathered Dinosaurs or Feathered Birds?

Nature gives only praise for the whale series, showing no appreciation for the mathematical difficulties of evolving a whale in so few generations. But the packet really starts to evangelize for evolution when it gets into the evolution of feathers. Discussing "feathered dinosaurs," the packet states:

The discovery of feathered dinosaurs not only vindicated the idea of transitional forms, but also showed that evolution has a way of coming up with a dazzling variety of solutions when we had no idea that there were even problems. Flight could have been no more than an additional opportunity that presented itself to creatures already clothed in feathers.

The main example given by the packet, *Epidexipteryx*, highlights the problem with many of these claimed "feathered dinosaurs." Unmentioned by *Nature's* packet is the fact that the original paper contains language directly hinting that *Epidexipteryx* could also be "interpreted as secondarily flightless."⁴³ In other words, this fossil could actually be a bird that lost its ability to fly.

Various authorities support such interpretations of these classes of fossils. Bird evolution expert Alan Feduccia believes that "*Caudipteryx* and *Protoarchaeopteryx*, in fact, are replete with features of secondarily flightless Mesozoic sauriurine birds..."⁴⁴ Feduccia further writes:

Given the now substantial evidence that certain taxa once thought to be dinosaurs (e.g. *Caudipteryx*, *Protarchaeopteryx*, and the *Oviraptorosauria*; Maryanska *et al.* 2002) are most likely secondarily flightless birds, and the new hypothesis that certain dinosaurs were secondarily flightless descendants of Mesozoic birds (Paul 2002), we must now carefully consider the possibility that there may have been a number of radiations of secondarily flightless Mesozoic birds that evolved morphologies quite similar to theropod dinosaurs.⁴⁵

Likewise a 2000 *Nature* paper suggested that "*Caudipteryx* was a secondarily flightless, post-*Archaeopteryx*, cursorial bird" because "it [is] a striking coincidence that the only unambiguously

⁴² See Walter ReMine, *The Biotic Message*.

⁴³ See Fucheng Zhang, Zhonghe Zhou, Xing Xu, Xiaolin Wang & Corwin Sullivan, "A bizarre Jurassic maniraptoran from China with elongate ribbon-like feathers," *Nature*, Vol. 455:1105-1108 (October 23, 2008).

⁴⁴ *The Origin and Evolution of Birds*, pg. 396, Yale University Press, 1999.

⁴⁵ See http://findarticles.com/p/articles/mi_qa3793/is_200210/ai_n9143175/pg_10/

feathered theropod was also the only known theropod likely to have utilized locomotory mechanisms identical to those of cursorial birds."⁴⁶

Somehow that 2000 *Nature* paper didn't make it into *Nature's* evolution-evangelism packet. After all, "secondarily flightless" birds are a lot less impressive than "feathered dinosaurs," so there's no mention of this dissenting viewpoint in the *Nature* packet.

IX. **Evolutionary Biologists Are Unaware of Their Own Arguments: Reappraising *Nature's* Prized "Gem," *Tiktaalik***

The final "gem" from *Nature's* evolution-evangelism packet which remains to be assessed in this series deals with the origin of tetrapods, focusing on the alleged transitional form *Tiktaalik roseae*. The packet states: "The discovery and painstaking analysis of *Tiktaalik* illuminates the stage before tetrapods evolved." That was printed in 2009. But how defensible is that statement in 2010? As I discussed in January 2010 at *Tiktaalik* Blown "Out of the Water" by Earlier Tetrapod Fossil Footprints, new evidence of tracks of full tetrapods *before Tiktaalik* refute claims that known specimens of *Tiktaalik* directly document, as the packet implies, "the stage before tetrapods evolved."

To understand the implications of these tracks, here's exactly how *Nature* reported it in January, 2010:

The fish–tetrapod transition was thus seemingly quite well documented. There was a consensus that the divergence between some elpistostegalians (such as *Tiktaalik* or *Panderichthys*) and tetrapods might have occurred during the Givetian, 391–385 Myr ago. Coeval with the earliest fossil tetrapods, trackways dating to the Late Devonian were evidence for their ability to walk or crawl on shores.

Now, however, Niedźwiedzki et al. lob a grenade into that picture. They report the stunning discovery of tetrapod trackways with distinct digit imprints from Zachełmie, Poland, that are unambiguously dated to the lowermost Eifelian (397 Myr ago). This site (an old quarry) has yielded a dozen trackways made by several individuals that ranged from about 0.5 to 2.5 metres in total length, and numerous isolated footprints found on fragments of scree. The tracks predate the oldest tetrapod skeletal remains by 18 Myr and, more surprisingly, the earliest elpistostegalian fishes by about 10 Myr.⁴⁷

Or as a *Nature* news article put it:

The oldest known tracks of a four-limbed land animal could rewrite part of vertebrate evolution.

Some prints, showing individual digits, were found in limestone slabs unearthed in a quarry near Zachełmie, Poland, dated to about 395 million years ago -- more than 18 million years before tetrapods were thought to have evolved.

The tracks suggest that the animals that made them were up to 2.5 metres long and had a footpad up to 26 centimetres wide, although most prints were about 15 centimetres wide, reports a team of Polish and Swedish scientists in *Nature* this week. This would mean that large, land-roaming tetrapods would have coexisted for 10 million years with the

⁴⁶ See Terry D. Jones et al., "Cursoriality in bipedal archosaurs," *Nature*, Vol. 406:716-718 (August 17 2000).

⁴⁷ Philippe Janvier & Gaël Clément, "Muddy tetrapod origins," *Nature* 463:40-41 (January 7, 2010).

elpistostegids -- including *Tiktaalik roseae*, which lived 375 million years ago -- a group thought to mark the transition from fish to land-roaming animals.⁴⁸

Simply put, these tracks suggest that tetrapods predated *Tiktaalik* and thus *Tiktaalik* is not, as *Nature* put it elsewhere, a "direct transitional form" between fish and tetrapods.

What Does It Mean to be "Transitional"?

Before going further, I must note that the term "transitional form" is generally used in two different ways. The *soft* definition of "transitional" implies that an organism merely needs to bear features that are representative of a potential intermediate--even if the fossil itself could not have been a direct transitional form. Under the *hard* definition of "transitional form," a stronger claim is made that this organism actually was a real-life lineal intermediate between two taxa, a direct transitional form.

As evidence that this *soft/hard* distinction is used, when the early tetrapod tracks were first reported in early 2010, *Nature's Editor's Summary* said that "The finds suggests that the elpistostegids that we know were late-surviving relics rather than **direct transitional forms**, and they highlight just how little we know of the earliest history of land vertebrates."⁴⁹ Usage of the qualified term "direct transitional form" shows that such a *hard* meaning of transitional form exists, and that these tetrapod tracks suggest that *Tiktaalik* does not meet that *hard* definition.

With *Tiktaalik* we don't just see arguments for its transitional nature based upon the *soft* definition of transitional forms. What has made the Darwin's promoters so excited about *Tiktaalik* is the claim that its placement in the fossil record directly before the first known tetrapods, and after certain fish groups allegedly ancestral to tetrapods, makes it a direct transitional form, in the *hard* sense.

Evolutionists have boasted greatly about the purported claim that *Tiktaalik* is an example of a fossil that meets the *hard* definition of a transitional form. Badly needing examples of *hard* transitional forms, many evolutionists have placed great rhetorical weight upon the stratigraphic location of *Tiktaalik* in the fossil record, even claiming it was a "prediction" of neo-Darwinian evolution. Here are some noteworthy examples:

1. *Tiktaalik's* official website (that's right -- it's called "tiktaalik.uchicago.edu") at the University of Chicago claims that *Tiktaalik's* placement in the fossil record was "predicted" by "common sense" leading to "another affirmation of our theory":

[A]ll four groups of lobe-finned fish we looked at first appear in the fossil record around 390-380 million years ago. The first tetrapods appear around 363 million years ago. Common sense tells us that the transitional form between fish and land animals must have arisen between 380 and 363 million years ago. In order to find our transitional fossil, we'll need to find rocks that are between 380 and 363 million years old ... Ultimately, the site produced *Tiktaalik* in 2004! Not only was it exciting to find a new species, but **it was made all the better by the fact that scientists had predicted the existence of a creature like this all along. We only needed to do some detective work to find it. Another affirmation of our theory!**⁵⁰

⁴⁸ Rex Dalton, "Discovery pushes back date of first four-legged animal," *Nature news* (January 6, 2010), at <http://www.nature.com/news/2010/100106/full/news.2010.1.html>

⁴⁹ Editor's Summary, "Four feet in the past: trackways pre-date earliest body fossils," *Nature* (January 7, 2010), at <http://www.nature.com/nature/journal/v463/n7277/edsumm/e100107-01.html> (emphasis added)

⁵⁰ "The Search for *Tiktaalik*," at <http://tiktaalik.uchicago.edu/searching4Tik.html> (emphasis added)

2. In his book *Why Evolution is True*, University of Chicago evolutionary biologist Jerry Coyne hails the discovery of *Tiktaalik* and its placement in the fossil record in similarly triumphant terms. Coyne couldn't have laid out the *hard* "fulfilled prediction of evolutionary biology" any clearer:

One of the greatest fulfilled predictions of evolutionary biology is the discovery, in 2004, of a transitional form between fish and amphibians. This is the fossil species *Tiktaalik roseae*, which tells us a lot about how vertebrates came to live on the land. Its discovery is a stunning vindication of the theory of evolution. ... **This is where the prediction comes in.** If there were lobe-finned fishes but no terrestrial vertebrates 390 million years ago, and clearly terrestrial vertebrates 360 million years ago, where would you expect to find the transitional forms? Somewhere in between. Following this logic, Shubin predicted that if transitional forms existed, their fossils would be found in strata around 375 million years old. ... **equally marvelous is that [*Tiktaalik's*] discovery was not only anticipated, but predicted to occur in rocks of a certain age and in a certain place.**⁵¹

3. During the rhetorical climax of PBS / NOVA's "Judgment Day: Intelligent Design on Trial," *Tiktaalik* co-discoverer Neil Shubin likewise claimed that the stratigraphic placement of *Tiktaalik* fulfilled "specific predictions" of neo-Darwinian theory:

What evolution enables us to do is to make specific predictions about what we should find in the fossil record. The prediction in this case is clear-cut. That is, if we go to rocks of the right age, and the rocks of the right type, we should find transitions between two great forms of life, between fish and amphibian. ... **What we see when we look at the fossil record, at rocks of just the right age,** is a creature like *Tiktaalik*.⁵²

This forceful argument has of course been broadcasted and rebroadcasted on PBS stations around the country.

4. Likewise, the U.S. National Academy of Sciences' (NAS) 2008 booklet *Science, Evolution and Creationism* focused on *Tiktaalik's* placement in the fossil record as one of its primary arguments for evolution:

The team that discovered the new fossil decided to focus on far northern Canada when they noticed in a textbook that the region contained sedimentary rock deposited about 375 million years ago, **just when shallow-water fishes were predicted by evolutionary science to be making the transition to land.** ... **A prediction** from more than a century of findings from evolutionary biology suggests that one of the early species that emerged from the Earth's oceans about 375 million years ago was the ancestor of amphibians, reptiles, dinosaurs, birds, and mammals. The discovery of *Tiktaalik* strongly supports that prediction.⁵³

The NAS feels so strongly that the "just when" of *Tiktaalik* confirmed a "prediction" of "evolutionary science" that it presents this material on the very first pages of its seventy-page booklet promoting evolution. Later, the NAS booklet again reiterates this "confirmed ... prediction" in a section explaining why evolutionary theory is both theory and 'fact':

⁵¹ Jerry Coyne, *Why Evolution is True* (Viking, 2009, pp. 35-38 (emphases added).

⁵² Neil Shubin in "Judgment Day: Intelligent Design on Trial" (emphasis added). For details on "Judgment Day: Intelligent Design on Trial," see www.judgingpbs.com

⁵³ *Science, Evolution, and Creationism*, pp. 1-3, emphasis added.

The evolutionary biologists who discovered *Tiktaalik* (see page 2) **predicted** that they would find fossils intermediate between fish and limbed terrestrial animals in sediments that were about 375 million years old. **Their discovery confirmed the prediction made on the basis of evolutionary theory. In turn, confirmation of a prediction increases confidence in that theory.**⁵⁴

With rhetorical guns blazing, the NAS made *Tiktaalik*'s placement in the fossil record one of its central arguments for evolution. No wonder that *Time Magazine* stated that *Tiktaalik* has become the Darwin lobby's "Exhibit A in their long-running debate with creationists and other antievolutionists,"⁵⁵ or that the *New York Times* quoted paleontologists saying *Tiktaalik* "'might in time become as much an evolutionary icon as the proto-bird *Archaeopteryx*' bridged the gap between reptiles (probably dinosaurs) and today's birds."⁵⁶

But did *Tiktaalik* really "bridge the gap"?

5. Neurologist Steve Novella thinks it did. He got Shubin's message from the PBS / NOVA documentary and recommunicated that message, touting *Tiktaalik*'s location in the fossil record as a confirmed "prediction" of evolutionary biology:

What is especially cool about *Tiktaalik* is that the researchers, Edward B. Daeschler, Neil H. Shubin and Farish A. Jenkins, predicted that they would discover something like *Tiktaalik*. These paleontologists made the prediction that such a transitional form must exist in order to bridge the gap between fish and amphibians. Even more, they predicted that such a species should exist in the late Devonian period, about 375 million years ago.⁵⁷

6. As a final example, in his book on *Tiktaalik*, *Your Inner Fish*, University of Chicago paleontologist and lead *Tiktaalik* researcher Neil Shubin praises its placement in the rock record as having "confirmed a prediction of paleontology":

It took us six years to find [*Tiktaalik*], but this fossil confirmed a prediction of paleontology: not only was the new fish an intermediate between two different kinds of animal, but we had found it also *in the right time period in earth's history and in the right ancient environment*. The answer came from 375-million-year-old rocks, formed in ancient streams.⁵⁸

It appears evident that leading evolutionary scientists have invested heavily in *Tiktaalik*'s stratigraphic and temporal placement in the fossil record as an argument for their cause. They have claimed it fulfills a "specific prediction" of evolution. But if new evidence arises that challenges the view that 375 million years ago is "the right time period in earth's history" to find organisms making the transition from water to land, what should we expect? Should we expect Darwin's loudest defenders to admit their "specific prediction" was wrong? Or will emotions run high and keep us from constructive conversation?

⁵⁴ *Id.* at p. 11 (emphasis added).

⁵⁵ J. Madeleine Nash, "Our Cousin, The Fishapod," *Time* (April 10, 2006), at <http://www.time.com/time/magazine/article/0,9171,1181611,00.html>

⁵⁶ John Noble Wilford, "Fossil Called Missing Link From Sea to Land Animals," *New York Times* (April 6, 2007), at <http://www.nytimes.com/2006/04/06/science/06fossil.html>

⁵⁷ Steve Novella, "The Judgment of *Tiktaalik*" (November 14, 2007), at <http://www.theness.com/neurologicablog/?p=49>

⁵⁸ Neil Shubin, *Your Inner Fish: A Journey into the 3.5-Billion-Year History of the Human Body*, p. 24 (Pantheon, 2008) (all emphases in original)

The Collapse of the "Prediction" of *Tiktaalik's* Stratigraphic Placement

Darwin-critics who follow this debate closely were well-aware of the importance of *Tiktaalik's* stratigraphic placement for the Darwin lobby's public case for evolution. David Tyler at the pro-ID Access Research Network (ARN) wrote an excellent blog post explaining why newly discovered tetrapod tracks from about 395 million years ago refute the prediction of *Tiktaalik's* placement in the fossil record:

Just when everyone thought that a consensus had emerged, a new fossil find is reported -- throwing everything into the melting pot (again!). Trackways of an unknown tetrapod have been recovered from rocks dated 10 million years earlier than *Tiktaalik*. The authors say that the trackways occur in rocks that "can be securely assigned to the lower-middle Eifelian, corresponding to an age of approximately 395 million years." At a stroke, this rules out not only *Tiktaalik* as a tetrapod ancestor, but also all known representatives of the elpistostegids. The arrival of tetrapods is now considered to be 20 million years earlier than previously thought and these tetrapods must now be regarded as coexisting with the elpistostegids. Once again, the fossil record has thrown up a big surprise, but this one is not "entirely compatible with evolutionary thinking." It is a find that was **not** predicted and it does **not** fit at all into the emerging consensus.⁵⁹

A few--though only a few--evolutionists also acknowledged the collapse of this prediction. *Nature* editor Henry Gee acknowledged on his *Nature* blog that the early tetrapod tracks "means that the neatly gift-wrapped correlation between stratigraphy and phylogeny, in which elpistostegids represent a transitional form in the swift evolution of tetrapods in the mid-Frasnian, is a cruel illusion. If -- as the Polish footprints show -- tetrapods already existed in the Eifelian, then an enormous evolutionary void has opened beneath our feet..."⁶⁰

Gee's comments, which were buried in an obscure blog at *Nature*, understood the great rhetorical weight his camp had placed on *Tiktaalik's* stratigraphic placement in the fossil record. He tried to deflect the collapse of the "neatly gift-wrapped correlation between stratigraphy and phylogeny" stating "Note: the first person to find any part of this post quote-mined in support of creationism will receive the highly prestigious and coveted Order of the Unicycling Girrafe."

The Critical Response

New scientific discoveries are exciting because they force us to revise, rethink, and improve our scientific explanations. In fact, neo-Darwinian evolution is certainly not refuted by these newly discovered tetrapod tracks. However, it's clear that evolutionary thinking led some researchers to make a prediction here. They claimed this prediction was a great confirmation of evolutionary theory. But this prediction is now known to be false. Neo-Darwinism lost an important argument. Thus, I wrote around the same time:

But this week *Tiktaalik's* status as an actual transitional fossil between fish and tetrapods has been called into question by the discovery of unambiguous footprints (with digits) of a full-tetrapod that were made about 20 million years before *Tiktaalik*.⁶¹

⁵⁹ David Tyler, "Lobbing a grenade into the Tetrapod Evolution picture" (January 9, 2010), at http://www.arn.org/blogs/index.php/literature/2010/01/09/lobbing_a_grenade_into_the_tetrapod_evolution (emphases in original)

⁶⁰ Henry Gee, "First Footing," (January 6, 2010), *iEditor: a nature network blog by Henry Gee*, at <http://blogs.nature.com/henrygee/2010/01/06/first-footing>

⁶¹ Casey Luskin, "Tiktaalik Blown 'Out of the Water' by Earlier Tetrapod Fossil Footprints" (January 7, 2010), at http://www.evolutionnews.org/2010/01/tiktaalik_blowed_out_of_the_wat.html

My original post provoked some spirited responses from Darwin-defenders like P.Z. Myers, Darrel Falk, and Josh Rosenau. Their rebuttals made the usual charges of ignorance and incompetence.

Namely, they charged that I don't understand that being a "transitional" fossil doesn't require that the fossil *actually* be found temporally between that fossil's alleged ancestors and descendants. In other words, a transitional form need not be a "direct transitional form." Accompanying this was the charge that I am ignorant of the fact that known fossils may not necessarily mark the actual stratigraphic range of a fossil.

I get it, I really do. If one defines "transitional form" soft enough such that its temporal placement no longer matters, then it becomes very difficult to disprove claims that a fossil was "transitional." And new fossil discoveries are constantly extending the known ranges of taxa. I took plenty of evolutionary biology and earth sciences at one of the top secular science universities in the country and this is basic stuff everyone learns in division courses. This is all old news to me. So what's really going on here?

It is my sense that some Darwin-defenders were unaware of the great rhetorical weight placed by others on *Tiktaalik's* placement in the fossil record. This plausible deniability allowed them to bash Darwin-critics who observed that claimed predictions about *Tiktaalik's* stratigraphic location were wrong. These evolutionary biologists were unaware of their own side's arguments.

The problem for my critics is that other Darwin-defenders were attempting to make a different, much stronger argument for evolution based on *Tiktaalik*. As documented above, they were arguing that *Tiktaalik's* temporal location in the fossil record places it in a position where it could be a direct ancestor of tetrapods, and this was a confirmed "prediction" of evolution. They were making an argument for *Tiktaalik's* transitional nature based upon the *hard* definition.

For example, BioLogos president Darrel Falk confessed to having an intense response to my original post, stating that he "almost hollered in frustration" because he felt I'd misunderstood the science. He promised to show restraint, but then he said my post "is not fair to the Church and it dishonors the discipline," further writing that the ID movement's, "leaders owe it to members of the Church who are not scientists to make sure that this kind of writing ceases for good."⁶²

As for the scientific implications of the track discovery, Falk tried to dismiss any negative repercussions for evolutionary thinking, nonchalantly saying that this new find doesn't change anything since "Finding a new piece that doesn't quite fit into the picture and then revising it accordingly is what brings great joy to being a scientist" and "it will simply involve a revision in the timing of the origin of land vertebrates."

Of course that's right and it's all fine and good. There's nothing wrong with evolutionists revising and improving their ideas in light of new data. That's what science is supposed to do. But what about the fact that so much rhetorical weight was placed on *Tiktaalik's* "predicted" stratigraphic place in the fossil record? Are we supposed to just ignore all of those forceful arguments that Darwin promoters made, and then attack Darwin-critics (like me) who remind the world of those arguments, noting that they were wrong? My sense is that Dr. Falk was not aware of what his fellow neo-Darwinism advocates were arguing.

P.Z. Myers didn't promise to show any restraint, and restraint he didn't show. Calling me the "Baghdad Bob of creationism," he wrote:

⁶² Darrel Falk, "Footprints in the Sand," The Biologos Forum (January 11, 2010), at <http://biologos.org/blog/footprints-in-the-sand/>

Errm, no. Shubin and Daeschler are smart guys who understand what fossils tell us, and they never, ever argued that *Tiktaalik*'s status as a transitional form depended on slotting it in precisely in a specific chronological time period as a "link" between two stages in the evolution of a lineage. A fossil is *representative* of a range of individuals that existed over a window of time; a window that might be quite wide. They would never express the kind of simplistic, naive view of the relationship of a fossil that the DI clowns seem to have.⁶³

P.Z. also makes a good point that scientists shouldn't assume that known fossils necessarily mark the exact stratigraphic range of that species. Except that we've seen that smart guys like Neil Shubin and Jerry Coyne, or groups like the NAS and PBS / NOVA **did in fact** argue that evolution is confirmed by the purported "rocks of just the right age" (Shubin's words) which yielded *Tiktaalik*. This, of course, was all based upon a prediction coming from the supposedly true stratigraphic ranges of tetrapods and lobe-finned fishes. So whether or not P.Z. is right, it seems that P.Z. isn't aware of what his fellow evolutionary biologists have been arguing.

Again, I get it. I really do. In fact I've gotten this point since I studied paleontology, evolutionary biology, and earth sciences in my undergrad and graduate studies; none of this is new to me. Here's my take:

If you use a sufficiently loose, or *soft* definition of "transitional form," then you can better avoid the possibility that future discoveries will overturn your claim that it was "transitional." Under *soft* transitional thinking, the imperfections and ambiguities of the fossil record never require that a "transitional" must be ancestral to its alleged descendants -- it merely needs to bear features that are representative of a potential intermediate, even if the fossil itself is not a direct ancestor. In other words, under the *soft* definition, "transitional" fossils merely serve as proof-of-concept of a transitional form even if they aren't actually fossils from the right place in the fossil record to document that evolutionary transition. As long as it kind of looks like something that could have been a transitional form, then you can say it's a transitional form, even if it was not, as *Nature* put it, a ""direct transitional form." The potential for imperfections in the fossil record can absorb any lingering doubts.

Thus, in a mistitled post "Creationists don't understand fossils," Josh Rosenau does a good job of explaining this *soft* definition:

This doesn't mean that *Tiktaalik* is your great-great-great-...-great-grandparent, but it is a close descendant of that ancestor. Even if that ancestor lived 18 million years earlier than *Tiktaalik*, the transitional state of that ancestor is preserved in its descendants. Casey cites various news articles which mess up this distinction, but never points to the scientific literature where these points are clarified.⁶⁴

The problem for Mr. Rosenau is that it's not "various news articles" that pushed *Tiktaalik* based upon its precise placement in the fossil record, but the scientific literature from top scientists and top scientific groups. These leading Darwin lobbyists have been arguing that *Tiktaalik*, as Coyne put it, was "predicted to occur in rocks of a certain age." Whether or not Shubin or Coyne "mess up" evolutionary thinking is not for me to say; they are leaders in their fields. What is clear is that they are reliable authorities whose credibility is leaps and bounds above "news articles."

⁶³ P.Z. Myers, "Casey Luskin embarrasses himself again," Pharyngula (January 9, 2010), at http://scienceblogs.com/pharyngula/2010/01/casey_luskin_embarrasses_himse.php

⁶⁴ Josh Rosenau, "Creationists don't understand fossils," Thoughts from Kansas (January 8, 2010), at http://scienceblogs.com/tfk/2010/01/creationists_dont_understand_f.php

Thus, when Professor Falk writes, "Science works through constant revision of the individual little hypotheses that make up the entire body of the theory. Luskin and Donald M don't seem to understand this," that's a pretty inaccurate characterization of my views. Of course I understand that scientific hypotheses are constantly revised. That's fine. The problem for Dr. Falk is that he apparently does not realize the immense rhetorical weight placed on *Tiktaalik's* stratigraphic location in the fossil record.

Evolutionists are welcome to revise their theory. But they are not welcome to revise the history of their theory. They should acknowledge that some widely and forcefully promulgated arguments for evolution based upon *Tiktaalik* turned out to be wrong.

In Sum

When a widely touted prediction of evolution falls apart, evolutionists often rewrite history, soften the "prediction," and claim that the harder prediction was never made in the first place. They also attack those who talk about the failure of this prediction as being ignorant of the true claims of evolution. This is known as moving the goalposts.

In this case, my critics cannot escape history. We're left with the following points:

- This post has provided clear documentation that leading evolutionary biologists argued that the known ranges of tetrapods and lobe-finned fishes led them to "predict" that a fossil like *Tiktaalik* would be found in a particular stratigraphic location in the fossil record. When that alleged transitional form was found in that location, they touted it as a confirmed prediction of evolutionary science.
- Some evolutionary scientists apparently didn't realize that many leading Darwin lobbyists had argued that *Tiktaalik* was found in "rocks of just the right age" and thus confirmed a "specific prediction" of neo-Darwinism, that made *Tiktaalik* "direct transitional."
- When a Darwin-critic who realizes the rhetorical importance Darwin-lobbyists have placed on *Tiktaalik's* place in the fossil record points out that this prediction is challenged by new data, Darwin's defenders respond by (1) claiming no one made that prediction in the first place, and (2) levying various amounts of name-calling and allegations of ignorance against the critic.
- The reality is that just like me, evolutionary biologists understand evolutionary theory perfectly well. But they often use slippery definitions of terms to push their theory harder than the evidence allows, and then fall back to weaker arguments when the data contradicts their "prediction." This is a rhetorical strategy. Sadly, those who are willing to call them on it are subjected to ridicule and name-calling.
- My approach is to not respond in kind, to *not* return name-calling with name-calling, and to continue to just talk about the evidence.