Chapter 4. Creationism Lite

Are there really any such things as vampires? In a sociological sense, yes. There appears to be a certain subculture of jaded urban youth who affect a nocturnal lifestyle, dress in black outfits, don pasty-faced makeup, and go so far as to sup blood for a hobby when they can manage it. But are they *vampires*? Well, those with a firm grip on the naturalistic assumption would reply with a flat, "no." The contemporary "vampire" will not be able to turn into a bat, nor seep through keyholes in the form of a supernatural fog. And should you slap a mirror in front of their heavily decorated face, they *will* cast a reflection. Our present understanding of optics absolutely precludes the idea that an object visible to the eye (reflecting light into our retina) can *fail* to produce an image in a mirror.

This is not to say that someone wedded to scientific naturalism wouldn't be open to new evidence. Should the spiritual descendant of Dr. Van Helsing burst into the room, alleged vampire in tow, and demonstrate by active experiment that the "creature of the night" really doesn't have a reflection, that would be data to sink your teeth into (so to speak). Anyone with a modern scientific sensibility would be genuinely flabbergasted by such a discovery, of course, and may be distracted for a time trying to decide whether first to alert the local health authorities or notify the nearest tabloid newspaper.

So, from our present understanding of things, science is extremely certain that "vampires" as they are traditionally conceived don't exist—in fact, that they *never* existed. Such a broader conclusion comes from rigorously applying present conceptions to an irretrievable historical circumstance. But would such a line of reasoning be all that permissible in the new regime of Theistic Realism? Our Van Helsing Mirror Test cannot in principle be performed retroactively. There is no way then to really "prove" that there weren't objective vampires in the past, from the days of Vlad "the Impaler" Tepes in 15th century Wallachia all the way down to suspicious Transylvanian tourists in Victorian London. It is purely the application of contemporary scientific experience that allows the naturalistic thinker to be so smug here. Nor is this attitude one without substantive repercussion. To deal with modern vampirism, the naturalistic recommendation would be to call in the psychotherapist or counselor—it would never cross the rationalist mind to order garlic or sharpen wooden stakes.[1]

Ideas have consequences, remember?

The larger philosophical concept here is that it is possible to reach a sufficient understanding of a phenomenon to rule out *as a practical matter* a supernatural explanation. As noted, this most certainly does *not* mean you wouldn't be willing to look at evidence for a non-naturalistic alternative. But you would need *some* evidence, tangible observations you could grab onto within the context of your honed contemporary view. Historic tales of vampires wouldn't cut it on their own—it would help to see some successful Van Helsing Mirror Tests before the "vampire hypothesis" could be taken seriously. These days such supernatural options are not considered viable research topics from the start because of this combination of theoretical comprehension and practical experience. It is the difference between "ontological naturalism" (where non-natural causation is rejected on principle) and the workaday "methodological naturalism" practiced by scientists.[2]

But that rather basic distinction is precisely what Intelligent Design philosophy is out to rid science of. In the course of laying out "What Every Theologian Should Know about Creation, Evolution, and Design," mathematician William Dembski declared that the two versions of naturalism were "functionally equivalent." That questionable conclusion jumped, Intelligent Design was now free to pry both concepts loose with the same draconian crowbar: "*The ground rules of science have to be changed*." Into *what*, Dembski didn't specify. But not to worry, though, since this happy state of affairs "happens once we realize that it was not empirical evidence but the power of a metaphysical world view that was all along urging us to adopt methodological naturalism in the first place. Yes, the heavens still declare the glory of God, and yes, God's invisible attributes are clearly seen from God's creation. But to hear what the heavens declare and to see what the creation makes manifest, we need to get rid of our metaphysical blinders."[3]

And what about those methodological purists who object to being hijacked along with their more rigid ontological cousins? It is the reluctance of rationalist scientists to toss off their "metaphysical blinders" and join in the triumphant creation chorus without some fairly solid supporting reasons that Phillip Johnson or William Dembski are ultimately objecting to when they castigate "methodological naturalism." That Intelligent Design hasn't gone on to apply this extraordinary principle to vampires is only an accident of their theology—not any fundamental feature of the underlying creationist logic.[4]

Frankly, vampires are the easy game. If they really existed they themselves would constitute a supernatural phenomenon, but what Intelligent Design creationists are envisaging is something far more subtle, and consequently more difficult to pin down. It is the inference of a supernatural agency within the confines of an otherwise natural world. Consider the parting of the waters for Moses during the Exodus. It might have been a truly miraculous event—or a natural occurrence mistaken for a divine act. For the more conservative, a resonant tidal wave from the eruption of Thera has its defenders, while the cataclysmic passage of Velikovsky's cometary Venus might be more up the non-Biblical alleys of Vine Deloria or Richard Milton. But that is assuming that the historical Exodus even took place as advertised—as well as begging the antecedent geological question of how the Sea of Crossing came about before it had a chance to be crossed.

You can see that moving from a direct supernatural phenomenon like vampires to the activities of a supernatural force complicates the problem of verifying that action in a historical or scientific sense. But design theorists think they have a surefire way out when it comes to at least some elements of the divine handiwork. The escape hatch here is about as far from the exciting world of vampire lore as you can get, and concerns the humdrum essence of pocket watches.

Back in 1802 theologian and naturalist William Paley set down one of the most enticing and influential creationist design arguments with his famed Watchmaker analogy. Supposing you found a pocket watch lying on the ground, it would never occur to you that the timepiece was a sport of nature. Its very existence would suggest a *watchmaker*. And since living "watches" are no less intricate a piece of work, reasoned Paley, the divine craftsman may be inferred in exactly the same way … QED.

Now Paley recognized that living things differed from watches in one fundamental respect: they *reproduce*. But as far as he was concerned that only helped his case. Just think how much more challenging it would be to create a self-replicating watch—certainly animal reproduction even more clearly illustrated the Watchmaker's sublime craftsmanship![5]

What Paley didn't stop to consider was how this exultant little step brings with it some thoroughly "awkward" logical packaging. For at that moment the watch on the heath itself ceases to be the artifact of design, but only the continuing product of a presumed original prototypical created watch. In that case, unless the copying process were *absolutely perfect*, the watch would be potentially liable to natural modification, varying to some degree from the purported ideal source. Once you allowed for that, you'd have to answer some basic questions. First, how much can natural watches vary? How does one define watch "models," and can one "model" transform into another entirely on its own? If it can, then how do you identify what the *original* watch models were? Once you've accepted the possibility of watch modification, any and every watch you encounter would carry around it a host of possible variants—and watch taxonomy would consist of trying to work out where natural lineages leave off and basal created watches began.

That is, if there *were* any basal created watches.

Independent of whether "creation" or "evolution" was responsible for some or all of its salient features, a sound comprehension of the historical record of "watch" production would seem in order. But we've already seen that is not a comfortable habitat for creationists. As documented in the last two chapters, the record of fossil "watch" turnover is exactly the topic they have the most trouble with. Kenneth Miller put this in stark terms when he criticized the Creation Science version, but his remarks are no less applicable to Intelligent Design, since Young Earth Flood Geology is not robust enough to rescue either of them:

> Accepting the premise of divine creation and the impossibility of evolution, we would have to suggest that a creator formed the first jawless fish vertebrates some 600 million years ago by an act of special creation, so that these animals appeared suddenly and without ancestors. Nearly all these jawless fish forms died out shortly after being created, and those that do survive are quite different. Some in fact survive by parasitizing species of fish that did not appear until some 200 million years after the jawless fishes were specially created, a curious fact indeed. Then, nearly 100 million years later the creator made bony fishes, somewhat like the kinds which now occupy the oceans. Later he specially created primitive amphibians, stepping in again and again over the next 50 million years to create the many amphibian groups which appear and then disappear in the fossil record. Still later, he formed primitive birds and primitive mammals, intervening again and again to carry out a series of special creation events so closely graded that the scientists of the present would misinterpret these progressive appearances and disappearances as the result of evolutionary change and extinction.[6]

The more you know about the observed fossil turnover rate—which "watches" appeared on the scene and in what order—the paleontological pattern looked increasingly less like the sort of static ideal Paley had in mind. And the key to unraveling the mystery was in the very reproduction that Paley thought to award God as another medal of merit.

Remember what Darwinian "common descent" involves. Take any two organisms (fossil or living) and there shall have been a *physical lineage* linking them via a common ancestor. We're talking about nothing except begetting here, in the nice old-fashioned way. No abrupt saltations—and no miracles. But deciding how much it would take to change some A into another B would depend on which "A" and "B" we were talking about wouldn't it? The gap separating Phillip Johnson from a bacterium is wide indeed, but most of what is spotted taking place in paleontological history doesn't involve nearly so intimidating a stretch. That would be especially evident through the Mesozoic dinosaurs, where you get a lot of things along the general prosauropod-to-sauropod pattern. The modifications required to get from one of those to the other are comparatively modest: their bones grew bigger and hollow, their teeth modified a bit, and a few specializations turned up as they adapted to increasing size (such as bony rods to stiffen their long neck).

If this class of modification sounds a bit familiar, it ought to. All of this is variation on a Galápagos "finch beak" scale—taking inherited body parts and tweaking them a bit. The vast majority of "evolution" going on in earth's history has been of exactly that character. Going from a tiny proto-horse to a full-blown horse didn't involve "macroevolution" in the sense that it is seen at the class level in the diversification of amniotes into mammals and birds. There were no new organs appearing, no wings to fly with, nor any fancy adaptations for an aquatic environment. Apart from a dietary shift from a browser with low-crowned teeth to a high-crowned grazer, the "big" item for horses was a loss of side toes. And as we've seen, paleontologists have actually caught an ancestral horse group where that shift was still taking place—a developmental change furthermore recapitulated in the embryos of all extant horses.[7]

Given that most creationists supposedly accept speciation, the horse example would seem more than just a perfectly safe concession for them to make. This would be an *obvious* and *necessary* application of microevolutionary speciation, if anything were. Yet, apart from Michael Denton's wishy-washy exception, creationists do not seem in a hurry to concede even that the proposed members of the horse sequence are actually related.[8] Why? Because the horse series is simply a stand-in for most of what has been going on in evolutionary history. To allow the finch beak case to spill over to horses releases the inductive floodgates. Going from *Hyracotherium* to

Equus is conceptually identical to transforming *Plateosaurus* to *Diplodocus*—and so on all through the fossil record. Those finch beaks knock over the first domino in a very long line.

So it's no coincidence that creationists cannot come to grips with the implications of the Galápagos finches. In fact, Phillip Johnson and Richard Milton in their own inimitable fashion have gone to some extraordinary lengths to downplay their significance. The lightning rod for them both was Jonathan Weiner's 1994 Pulitzer Prize-winning book *The Beak of the Finch*. Johnson first hit on it in *Reason in the Balance*:

> The May 8, 1994, issue of *The New York Times Sunday Magazine* carried a short article by Jonathan Weiner, titled "The Handy-Dandy Evolution Prover." Weiner began by telling stories about fundamentalist Christians he had met who did not believe in evolution and insisted that the earth was less than ten thousand years old. He thought it extremely odd that such people still existed, since he himself had seen evolution actually in progress. Weiner had written a book about his time in the Galápagos Archipelago with Peter and Rosemary Grant, two Princeton scientists who study finches. The distinctive characteristics of "Darwin's finches" on these islands have long been an important example of what Julian Huxley called "evolution in action," although Charles Darwin himself did not seem to perceive their significance when he visited the islands on his famous voyage. The Grants observe, measure and record the characteristics of the finch populations, especially their beaks, and note variations that appear from time to time due to environmental changes.
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> The most spectacular example of evolution that the Grants witnessed involved a finch species that was greatly reduced in numbers during the terrible drought year of 1977 on Daphne Island. The beaks of the next generation following the drought were on average 4 to 5 percent larger, and better shaped for opening the last tough seeds that remained on the island. Then in 1983 spectacular floods came, many finches died, and the island turned rapidly from desert to jungle. The first postflood generation of finches again had smaller beaks, which fitted them to enjoy the multitude of tiny seeds that became available. Beak size thus went through a cycle, caused by environmental changes, from smaller to larger and then back to smaller.
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> A laudatory review of Weiner's book (*The Beak of the Finch: A Story of Evolution in Our Time*) appeared in the *Times* book-review section a week later. Like Weiner's essay, it began by commenting on the astonishing persistence of biblical creationism among persons who appear to be otherwise perfectly reasonable. The reviewer attributed this to a lack of knowledge of the overwhelming proof of evolution which scientists have discovered. "Although there is abundant hard proof of natural selection and the origin of species in the form of fossils embedded in the rock of ages," said the reviewer, "the evidence is far more subtle among living creatures." The reviewer praised Weiner for demonstrating that evolution is not just a theory about changes that happened in the remote past but a process that we can watch, because it goes on all around us all the time. As Weiner himself wrote, after one has seen evolution actually happening, "debating the reality of the process seems as absurd as debating the existence of gravity."[9]
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> [*At this point a note explained:*]
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> Readers who are at all familiar with the literature of evolution will have noticed that the case of the finch beak is a variation of the most famous textbook example of "evolution in action": a phenomenon called "industrial melanism" in the peppered moth. In a population containing both light and dark moths, the light moths were predominant while the background trees were light in color, but the dark moths tended to predominate when the trees became darkened due to industrial smoke. The example does not illustrate moths in the process of

> changing to something else, or even changing in color. It illustrates an essentially stable population that can vary cyclically to adjust to conditions.[10]
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> [*The text continued under the heading* **A Caricatured Debate***:*]
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> The Weiner article and book review illustrate what I would call the "official caricature" of the creation-evolution debate, a distortion that is either explicit or implicit in nearly all media and textbook treatments of the subject. According to the caricature, "evolution" is a simple, unitary process that one can see in operation today and that is also supported unequivocally by all the fossil evidence. Everyone accepts the truth of evolution except a disturbingly large group of biblical fundamentalists, who insist that the earth is no more than ten thousand years old and the fossil beds were laid down in Noah's flood. These baffling persons either are uninformed about the evidence or perhaps choose to disregard it as a temptation placed before us by God to test out faith in Genesis. There is no conceivable intellectual basis for their dissent, because the evidence for evolution is absolutely conclusive.
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> According to the official caricature, the finch-beak variation that the Grants observed on Daphne Island is fundamentally the same process that brought birds into existence in the first place. Essentially the same process, extended over immense stretches of geological time, produced complex plants and animals from single-celled microbes. Biological evolution at all levels is thus fundamentally a single process, which one either accepts or (irrationally) rejects.
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> This scientific understanding of evolution, according to the caricature, does not threaten theistic religion. As the *New York Times* book reviewer put it, "The secret of life is that it can change with [environmental changes] and continue to thrive, and if I were searching for signs of an infinitely wise creator, I might find them here."
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> Of course the official caricature utterly misrepresents the scope of the controversy. Creationists are not necessarily Genesis literalists or believers in a young earth, nor do they necessarily reject "evolution" in all senses of that highly manipulable term. A creationist is simply a person who believes that God *creates*—meaning that the living world is the product of an intelligent and purposeful Creator rather than merely a combination of chance events and impersonal natural laws. Critics of evolutionary theory are well aware of the standard examples of microevolution, including dog breeding and the cyclical variations that have been seen in things like finch beaks and moth populations.[11]
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> [*Another note explained:*]
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> The Daphne Island finch-beak example is discussed on page 25 of my book *Darwin on Trial* as a typical example of cyclical variation.[12]
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> [*The main body of the text concluded:*]
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> The difference is that we interpret these observations as examples of the capacity of dogs and finches to vary within limits, not of a process capable of creating dogs and finches, much less the main groups of plants and animals, in the first place.[13]

As with his ventures into Cambrian phyletic affinities and the reptile-mammal transition, Johnson threaded his way through this landscape of "cyclical variations" with great care. Although his argument slammed directly into the sociology and methodology of Biblical creationism, Johnson devoted no attention whatsoever to exploring that prickly affair. He simply assumed again that there was something objectively peripheral or idiosyncratic about how Young Earth creationists have arrived at their special conclusions, as though their reasoning were not functionally indistinguishable from that of antievolutionists in general (including Johnson). Through that narrow keyhole, what other reason could there have been for Jonathan Weiner to have devoted space to remarking on these inconsequential eccentrics, other than as another gauche manifestation of the "official caricature" of creationism?[14]

Johnson was correct about one thing: there is a "unitary" aspect to evolutionary reasoning. But that is only because it follows the standard operating practice of scientific inference, where you're *supposed* to follow through on the theory to its logical and reasonable conclusions. The "big picture" evolutionary view Johnson objects to rests on a substantial chain of reasoning, only the first step of which concerns the inheritance of naturally selected variation such as seen with the Galápagos finches. One of the more fascinating aspects of Weiner's book was that evolutionists had only assumed (though not without some biological and paleontological justification) that such processes actually took place in nature as Darwin posited. What made the work of Grant *et al.* on the Galápagos so important and exciting was its quantitative confirmation that the theory not only worked—but that it could even be seen to work *quickly*.[15]

But that's where Johnson's creationist argument short-circuited. Once you understood that natural selection could indeed vary the physical parameters of an organism, the next stage would be to move on and apply it somewhere … to horses, sauropods, or whatever. Otherwise the insight was meaningless. And that's exactly how Johnson means to keep it.[16]

So Johnson spoke sagely of "finches" varying within their limits—but which "finches" did he have in mind to set those limits? The ones that looked so much like blackbirds, warblers, or wrens, that Darwin initially mistook them for blackbirds, warblers, and wrens? That's why "Darwin himself did not seem to perceive their significance when he visited the islands." It was only when he returned home with his specimens that the ornithologist (and devout creationist) John Gould ironically set the evolutionary embers alight by marveling at how many *finches* Darwin had brought back. Darwin hadn't paid much attention to them at the time because he hadn't realized they *were* all "finches"—their highly variable beaks had thrown him off. Once that recognition came, the next jump was obvious. Remember biogeography: so many finches out in the middle of nowhere on the Galápagos only made sense if they had varied from a common finch-like ancestor (most probably one of the mainland varieties).[17]

Richard Milton thought to nip that sort of thinking in the bud by denying Darwin's finches were separate species in the first place. This taxonomical sleight-of-hand was accomplished through something Weiner reported on in *The Beak of the Finch*.[18] Recalling what Francisco Ayala had to say about the "prezygotic isolation mechanisms" of fruit flies, the genetic and behavioral barriers to speciation don't swing abruptly shut like a garden gate. There has been sufficient time on the Galápagos for much of that differentiation to take place, making natural interbreeding among the finches a rarity. But a few species had not entirely reached that "point of no return" when the disruption of the 1977 El Niño temporarily changed the environmental rules. In the altered "adaptive landscape" (where advantageous "peaks" had become "valleys" of disadvantage and vice versa) interbreeding among those finches markedly picked up, with their offspring proving to be successful under the new selection pressure in a way that earlier chance encounters had not. Milton extracted this information as though it applied to *all* the finches. But a degree of contingent drift among *some* related species is exactly what would have had to occur in nature for speciation to have operated as an unguided process. So it was quite daring of Milton to try turning the tables and wield Darwin's famous finches as a wedge to dispose of natural speciation as a primary evolutionary concept.[19]

This Gordian Knot approach is certainly faster than the evasive maneuvers Duane Gish used with the Madagascar tenrecs, which may be why Phillip Johnson has adopted it in his latest book. "The most frequently cited example of evolutionary speciation is the thirteen or so species of finches on the various islands of the Galapagos chain. In this case the question is not whether the finches all descended from a single ancestral type but whether they are truly separate species—since they can interbreed when given the opportunity."[20] Whether Johnson realizes how wide he has just stretched the species boundary remains unclear. It requires that the warbler-like finch *Certhidea olivacea* be conspecific not only with the main *Geospiza* ground finches, but also to the several genera of tree finches that inhabit the Galápagos, both vegetarian and insectivorous. We await Johnson's monograph on this fascinating ornithological theme.

But scratching out the generic label on the Galápagos finches only begs the issue Johnson decided "the question is not." For if the island forms can vary so widely, why not include the South American finch stock? And where then does Johnson propose to apply the brakes? However

Johnson wants to clump the taxa, his "acceptance" of natural variation inevitably cascades all the way back through the entire lineage of birds. (And since all of them would have been "birds," the question of how wings or feathers originated would be entirely irrelevant.) The creationist failure to conceptualize the practical implications of species *overlap* represents a blind spot as massive as Zeno's inability to conceive of *speed*. The work on the Galápagos of the Grants and others suggest "finch" is only a transitory label for a collection of variable attributes. Yet for Johnson, "it is only Darwinists who think that what evolutionary theory needs to explain is primarily *speciation*."[21]

Much like Duane Gish's repeated stabs at caging *Protoavis*, Johnson hasn't let well enough alone when it came to *The Beak of the Finch*. Weiner was also nicked in *Defeating Darwinism*. The occasion was a flap over young Danny Phillips, a Denver high school student who had challenged the awful evolutionary propaganda contained in a PBS *NOVA* program called "The Miracle of Life" that was being included in the school science curriculum. This time Johnson's natural tendency to pole vault over any intervening data lead him to pompously decry the faults of evolutionary pedagogy:

> The uproar so upset science educators that they brought out a really big gun to squelch the high-school student. Bruce Alberts, president of the National Academy of Sciences, personally responded to Danny in an editorial published in the *Denver Post*. The NAS is the most prestigious organization of scientists in the United States, and so its president is effectively the official voice of the scientific establishment. Danny should have felt very honored to be engaged by so powerful an adversary.
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> Unfortunately, Alberts replied with the stock arguments that evolutionary naturalists use to silence discussion on this topic. He identified dissent from evolutionary naturalism with "religion" and hence with untestable speculation that science must disregard. As a clincher, he recommended that "those interested in understanding how science works may wish to read a recent book, *The Beak of the Finch*, by Jonathan Weiner, which describes new studies on the Galápagos Islands that confirm and elaborate on Darwin's original work. Evolution happens all around us."
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> Alberts was referring to studies which show that the average size of finch beaks on a particular island varies from year to year in response to environmental changes. (I discuss the Weiner book in chapter four of *Reason in the Balance*.) Anyone who has even the slightest acquaintance with the evolution-creation controversy would know that such minor variation is readily accepted by even the strictest Biblical creationists. The evolution-creation controversy is not about minor variations but about how things like birds come into existence in the first place.
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> One of the truly bizarre things about our current cultural situation is that the leading figures of the scientific establishment seem genuinely amazed that the citizens do not accept finch-beak variation as proof of the claim that humans, like all animals and plants, are accidental products of a purposeless universe in which only material processes have operated from the beginning.
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> It's an absurd situation, isn't it? Educators aren't allowed to address the issues about which their students, and the general public, are most concerned, When teachers challenge students to think about how their worldviews affect the understanding of the creation-evolution controversy, so-called civil liberties lawyers censor the teaching by threatening to bring a lawsuit that the school district can't afford to defend. The president of the National Academy of Sciences writes an essay so simplistic that it insults the intelligence of a well-informed high-school student. He urges a bright high-school student not to think for himself but to trust the findings of a research community that thinks it can settle the question of our origins by defining finch-beak variation as "evolution."

> How did the scientists get themselves into such a mess? It has to do with the way Darwinists think, and how they define *science*.[22]

One would have thought Alberts was doing quite the opposite of urging Danny "not to think for himself"—unless it was no longer an appropriate educational suggestion to advise someone to acquaint themselves with more of the salient information first. But that nit-pick aside, the thrust of Johnson's argument was to further escalate the debate. The question of *finch* origins was now supplanted by "how things like birds come into existence in the first place."

OK, since he brought the subject up … only, which origin of "birds" was it to be this time? Johnson couldn't have been talking about the Jurassic, could he? That would be our old reptilian friend *Archaeopteryx*. If you may recall, that was the specimen *Darwin on Trial* described as "on the whole a point for the Darwinists." Either Johnson had decided to take the "point" back in the meantime, or he was thinking of some later birds—ones that evidently weren't "a point for the Darwinists." Perhaps he had in mind the newer Cretaceous bird fossils—the slightly less reptilian ones that had appeared during the intervening six years while Johnson wasn't paying attention to any of them in print. Then again, maybe he meant the more familiar Cenozoic aviary we all know and appreciate (especially as luncheon snacks). But with them we're well past the origin of birds—and in the thick of the question Johnson will not consider. However birds came into being initially (by natural speciation from feathered theropods or by gratuitous creation) could *most* subsequent bird differentiation be reasonably accounted for through the natural processes observed on the Galápagos?

Waiting for Phillip Johnson to light on so narrow a perch long enough for him to evaluate any of its scientific implications is not unlike trying to nail Jell-O to a wall. It reminds me of an arch exchange from the film version of *Inherit the Wind* during the dramatic cross-examination of creationist "Matthew Harrison Brady" (Frederic March) by evolutionist "Henry Drummond" (Spencer Tracy).[23] The point of contention being how long were the "days" of creation:

BRADY: "The Bible says it was a *day*."
DRUMMOND: "Well, was it a normal day, a literal day, a 24-hour day?"
BRADY: "I don't know."
DRUMMOND: "What do you think?"
BRADY (following a long pause): "I do not think about things I do not think about."
DRUMMOND: "Do you ever think about things that you *do* think about?"

Not to intimate that Phillip Johnson doesn't have a lot to think about (or that the days of Biblical creation would likely be one of them). On this occasion his ballistic trajectory was aimed for no lower than the philosophical stratosphere, with the launch pad neatly staked out in the research notes for the Danny Phillips passage:

> The essay by National Academy of Sciences President Bruce Alberts, "Evolution Versus Creationism: Don't Pit Science Against Religion," was published in *The Denver Post*, September 10, 1996, p. B9. The essay is a compendium of the usual spin-doctor arguments that official science organizations rely on to stop any serious questioning of evolution or materialism before it can get started. I recommend that teachers look for essays of this kind and use them for critical-thinking exercises after students have read chapters three, four and five of this book. One thing to notice right away is the title: the debate is set up as pitting creation*ism* (that is, an ideology) against evolution (no *ism*, therefore a fact). No matter what the evidence may be, an ideology (especially a *religious* ideology) can never beat a "fact" in a debate conducted under scientific rules. Scientific materialists actually see the issue that way, and so they naturally frame the debate in those terms. I always insist that an *ism* be put on both words or neither. Let the debate be between the competing facts (creation and evolution) or the competing ideologies (creationism and

> evolutionism). Better still, let it be between theism and materialism. What was present and active in the beginning, God or matter? That frames the question correctly and levels the playing field.[24]

Oh yes, that does "level" the playing field, doesn't it? In rather the same way as the Bomb leveled Hiroshima.[25]

So a technical issue of whether natural finch variation can properly be taken as an exemplar for broader generic branching, and thence interpolated up the phylogenetic ladder is, in Johnson's capable legal hands, quickly spun off into the metaphysics of whether you accept "theism" or "materialism." But do such things as the observation of prosauropod vertebrae, and their plausible relationship to the variations observed in sauropods tens of millions of years later, really require the paleontologist to take a stand right now on whether they favor "God or matter"? That Johnson landed so readily on that square only served to ironically reinforce what he had just insisted was part of Alberts' faulty "stock arguments." Unless "God" isn't to be regarded as a religious concept, it would seem "dissent from evolutionary naturalism" *does* translate into "religion" after all, since that was exactly how Johnson chose to play it.

While one must grant how this approach effectively upstages the Gablers' modest "equal time" hopes for education reform, there are a few niggling details still to flesh out. Although Johnson proposed that "the competing facts" of creation and evolution be investigated, it is difficult to tell from his own writings what those "creation" facts are supposed to be, as we just saw in the case of speciation. Acknowledging that God truly *creates* would involve more than some abstract Platonic bird archetype. If "creation" means anything in a nonevolutionary sense, God would have to be introducing *tangible* birds into time and space, creatures with definable qualities.

As it turns out, Johnson was no more likely to run that idea through the "little gray cells" than he was the percept of species overlap. He touched on a concrete example of how Intelligent Design might be manifest in a living package exactly once, back in *Darwin on Trial*. Fortunately for our analytical purpose, the victim he chose was a bird:

> One important subsidiary concept—sexual selection—illustrates the skill of Darwinists at incorporating recalcitrant examples into their theory. Sexual selection is a relatively minor component in Darwinist theory today, but to Darwin it was almost as important as natural selection itself. (Darwin's second classic, *The Descent of Man,* is mainly a treatise on sexual selection.) The most famous example of sexual selection is the peacock's gaudy fan, which is obviously an encumbrance when a peacock wants to escape a predator. The fan is stimulating to peahens, however; and so its possession increases the peacock's prospects for producing progeny even though it decreases his life expectancy.
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> The explanation so far is reasonable, even delightful, but what I find intriguing is that Darwinists are not troubled by the unfitness of the peahen's sexual taste. Why would natural selection, which supposedly formed all birds from lowly predecessors, produce a species whose females lust for males with life-threatening decorations? The peahen ought to have developed a preference for males with sharp talons and mighty wings. Perhaps the taste for fans is associated genetically with some absolutely vital trait like strong egg shells, but then why and how did natural selection encourage such an absurd genetic linkage? Nevertheless, Douglas Futuyma boldly proclaims the peacock as a problem not for Darwinists but for creationists:
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>> Do the creation scientists really suppose their Creator saw fit to create a bird that couldn't reproduce without six feet of bulky feathers that make it easy prey for leopards?
>
> I don't know what creation-scientists may suppose, but it seems to me that the peacock and peahen are just the kind of creatures a whimsical Creator might favor; but that an "uncaring mechanical process" like natural selection would never permit to develop.[26]

This passage beautifully illustrates why Phillip Johnson is never going to cut it as a naturalist, any more than Duane Gish did when disporting on the camouflage characteristics of polar bears.[27] The glaring flaw in Johnson's argument turns on his casually slipping in the word "ought" to describe peacock desire. Here he once more followed the curvaceous path of B. F. Skinner, by employing terminology in a thoroughly inappropriate context. Who says what peacocks "ought" to want? Certainly not evolutionists enamored of "methodological naturalism," as Douglas Futuyma took pains to point out in the sentence immediately before the one Johnson quoted. "The peacock's train of feathers is a perfectly natural result of a process in which genes that affect his plumage either succeed or not, depending on the whim of the female's sexual preference—a process that doesn't in any way enhance the peacock's adaptation to anything except the act of reproduction."[28]

The peahen's "taste for fans" doesn't need to be "associated genetically with some absolutely vital trait" *to be preserved*. That's the whole point of naturalistic evolution: such accidental associations can (and are) retained entirely through sexual selection, independent of its ultimate "unfitness" in a design sense. For Johnson to castigate evolutionists who do not believe in design because they refuse to be "troubled" by an example like the peacock that doesn't favor a design argument is surreal thinking indeed.[29]

Part of Johnson's difficulty stemmed from his dated views on the role of sexual selection in contemporary evolutionary thought. Stephen Jay Gould pointed that out in his *Scientific American* review: "sexual selection is perhaps the hottest Darwinian topic of the past decade, subject of at least a dozen books (which Johnson has neither noted nor read—a sure sign of his unfamiliarity with current thinking in evolutionary theory)."[30] Johnson's reply in the 1993 Epilogue to *Darwin on Trial* was another exercise in surgical precision, carefully lopping off Gould's criticism of his reading habits:

> Johnson writes that "sexual selection is a relatively minor component in Darwinist theory today," but sexual selection "is perhaps the hottest Darwinian topic of the past decade." [The point was not whether sexual selection is a fashionable topic but whether contemporary evolutionary biologists would accord it an explanatory scope as broad as that asserted by Darwin in *The Descent of Man*.][31]

To answer Johnson's rhetorical question, we may return to *The Beak of the Finch*. Weiner noted how Darwin's "sexual selection theory went into a long eclipse after his death. It began to reemerge only after *The Descent of Man* was reprinted in a centennial edition in 1971."[32] He then went on to describe how sexual selection has come to permeate the thinking of modern field researchers, from those following Darwin's finches on the Galápagos to John Endler methodically investigating the guppies of Trinidad. Endler studied the guppy in both its natural environment and through active experimentation, mixing and matching variables (guppy, predators, and background). The results were compelling:

> Everywhere in those streams, daily and hourly, natural selection in the form of cichlids and prawns is not just metaphorically but literally scrutinizing the male guppies. The result of enemy predations on each generation keeps pushing the males to blend in with the stream bottom. At the same time, daily and hourly, sexual selection in the form of female guppies is scrutinizing those same males. The result of their choices is that generation after generation of males is pushed to stand out.[33]

What best arouses a female Trinidad guppy is a male bearing gaudy blue spots on its body. Unfortunately, that also is like painting on a target. But when the guppies had only prawns as predators, they developed large red spots instead. Why? Because prawns have poor vision on the red end of the spectrum—the guppies could get away with a big red splotch in a way that doesn't work so well with blue. When other predators were present, though, the game turned out differently, with smaller spots more suited to making the guppy less visible against a dappled background. But not *invisible*, lest it be unable to attract a female when the need arose.[34]

Now I think Phillip Johnson would agree that John Endler is not "God." But Endler does "matter," for he was able to "play God"—at least insofar as he was able to replicate the various combinations of guppy skin decoration simply by permuting the predators and backgrounds. Why then should we suppose any different when it comes to the origin of peacock tails? This is not a question of where "organs" or "birds" come from—only what can happen to naturally occurring surface plumage once the peahen sexual preference starts fixating on *long* and *blue*.

Such a process is "absurd" only to sentient beings like ourselves who have a sense of pathos and irony. Both of which you would need to overcome to swallow Johnson's explanation for peacock tails. For imagine the furore that would ensue were a human genetic engineer to create such an animal today. We are talking about the peacock as a *decorative object*, something to prance around outside the bay window. The ASPCA would have a fit, and rightly so. The idea of tinkering with an animal's intimate sexual nature merely to supply an amusing entertainment would be disreputable enough—but to do so at the potential risk of the creature's own life borders on "cruelty to animals." Is Johnson prepared to declare such manipulation a "whimsical" activity? Where does that fall on the "pulling wings off butterflies" index? If it would be unethical for a mortal to engage in such sport, what makes a divinity different?[35]

So we're back at that "*Titanic* versus iceberg" question. Ethical judgments that are truly meaningless in a purely natural context are *obligatory* in a world of design.

It's not as though a natural system could not be contrived to reduce such moral obstacles. The leopard could be designed in such a way as not to consider the peacock food, and the peahen's sexual thermostat could be set to minimize population growth without requiring predation at all. Or the designer might have skipped the sexual folderol to begin with and simply had the peacock traipse around with its splendid finery without this being related to mating—thus allowing it to keep both eyes peeled for prowling leopards during its scenic perambulations. Either of those situations would be highly inconsistent with "Darwinism." But that's not what we see. Instead, we have the same sexually driven motivations as traced in the naturalistic pattern of guppy spots.

What is most revealing about Johnson and the peacock is how the "whimsical Creator" was left only the most happy and innocuous of assignments, the pretty display tails—as though nature were one of those upbeat Walt Disney color featurettes from the 1950s. The creationist is less likely to consider the unpleasant side of things, the seamy underworld where nematode worms live in places you don't really want to know about, and parasitic wasps inject their young into a paralyzed living host.[36] Or where dumb luck seems to rule, where the difference between life and death turns on whether *adenine* is replaced by *thymine* at just one spot in human DNA. While Phillip Johnson had occasion to mention that little number in *Darwin on Trial*, it doesn't come off as either a theoretical problem—or even much of a human tragedy:

> The allele (genetic state) responsible for sickle-cell anemia in African populations is also associated with a trait that confers resistance to malaria. Individuals who are totally free of the sickle-cell allele suffer high mortality from malaria, and individuals who inherit the sickle-cell allele from both parents tend to die early from anemia. Chances for survival are greatest when the individual inherits the sickle-cell allele from one parent but not the other, and so the trait is not bred out of the population. Futuyma comments that the example shows not only that natural selection is effective, but also that it is "an uncaring mechanical process."[37]

Johnson concluded that the sickle-cell case "merely shows that in special circumstances an apparently disadvantageous trait may not be eliminated from the population."[38] And Johnson is by no means alone in this insouciance. Gary Parker classified the sickle-cell mutation as one of those odd "mischievous results" that can happen in nature, while Wendell Bird decided it was too "minor" to help evolutionists in their quest for macroevolutionary processes.[39]

As with the bombardier beetle, it helps to know a few more details. First, the single nucleic substitution found in the sickle-cell allele results in the amino acid valine being produced rather than glutamic acid at one position along the chain of 600 amino acids that make up human hemoglobin. That's all it takes. The altered protein sequence fails to fold and function properly. Bad thing—except that it trips up the malaria parasite (the protozoan *Plasmodium falciparum*) —good thing. So a mutation can be *simultaneously* harmful and helpful. But there's more. The larger implication concerns the critical role of dynamic context when trying to make sense of living things. Sickle-cell demonstrates how a "defective" product may be preserved because its malfunctioning component has a beneficial application *somewhere else*. The malaria parasite requires potassium in the blood cells for its own survival—but sickled cells leak the potassium away. It is that peripheral happenstance that explains why the otherwise dangerous point mutation has remained in the genetic game.[40]

Secondly, the natural circumstances that can lead to that sort of combination aren't nearly so "special" as Johnson thought. Many genetic disorders are based on quite small mutations along specific genes.[41] Once biologists recognized what was going on in the malaria case they began to reevaluate other examples that function as a "scorched earth" defense against unrelated diseases. A string of mutations that began some 50,000 years ago have resulted in the cystic fibrosis gene that kills one of 2500 *dual* carriers—but if only *one* copy is present it appears to decrease the infection risk from typhoid fever (which once had a 15 percent mortality rate). This may be accomplished through another of those biological flukes: the gene coding for the defective lung-cell protein that causes trouble in cystic fibrosis also codes for a faulty intestinal protein that helps prevent *Salmonella typhi* from attacking the lining. Nor is sickle-cell the only half-baked option nature has deployed against malaria. Greeks and Italians are among the 400 million people worldwide who carry the G6PD allele that can induce life-threatening anemia following the consumption of certain foods—broad beans, for instance (which would explain why the classical Greek mathematician Pythagoras recommended people not eat them). The upside of the G6PD gene is that it cuts the susceptibility to malaria roughly in half.[42]

Of a piece with Duane Gish and the tenrecs, the interesting feature of how Johnson, Parker, and Bird addressed sickle-cell anemia is that none stopped to ponder what its existence might signify from their own *creationist* point of view. This was a particularly protruding oversight for Phillip Johnson given how much philosophical hay he has baled castigating "methodological naturalism" for bypassing just such speculation. A golden opportunity was missed to show off the explanatory superiority of "theistic realism" by describing the genuine *meaning* and *purpose* behind such diseases and their role in the grand scheme of things. Unless, of course, all "theistic realism" means in practice is "the absence of methodological naturalism." If applied only to peacock plumage, the *Theistic Realism Guide to Nature* is going to be a singularly light read.

But recall the reason why there is a persistent sickle-cell allele at all: malaria. The question presents itself whether *Plasmodium falciparum* was intentionally created with that human disease as its purpose. It would seem either it was or it wasn't. If it was, then are we gumming up the divine plan by combating its "whimsical" features through our studied medical intervention? In fact, is interfering with "God's nature" at any level fundamentally an act of blasphemy, no less than erecting brick ziggurats higher than the divine zoning regulation? Mary Baker Eddy's Christian Science has taken its own adamant stance on this topic, as have some radical environmentalists and animal rights advocates from their broader ecological ideologies. Theistic Realism is free to put an oar into this turbulent water whenever it likes.[43]

Now supposing as objective a nuisance as the malaria parasite *wasn't* deliberately designed, on what basis could medical science conclude any diseases were? Might not all of them have been the result of similarly undirected natural processes? This is most definitely not an academic question of abstract Baconian induction, not so long as the likes of Jerry Falwell or Pat Robertson are out there grumbling about AIDS being God's judgment on homosexuality. How far a creationist epidemiology may go would be more interesting to watch if real peoples' lives weren't dependent on the outcome—but in the meantime, Theistic Realism might start by working out whether malaria or sickle-cell are no less a product of "blind nature" than mountain ranges or thunderstorms.[44]

The AIDS parallel is relevant in another way. Like the HIV virus, the malaria protozoan cannot easily invade the human blood stream unassisted. It requires a *delivery mechanism*—in this instance, a quite particular species of mosquito. So, was that mosquito engineered for this purpose too, as a sort of sloppy self-loading winged syringe, or was its acquisition of the bacterium again purely an accident of nature? What started out as a single point mutation in human DNA has ballooned into a whole ecological complex: a protozoan-mosquito-genetic conspiracy of far greater moment than whether the Air Force is squirreling away wrecked UFOs and dead aliens in the mythic Area 51.

If the idea were to resolve the "malaria problem" the easiest way would be for the creator to change (or better still, *uncreate*) the protozoan that causes the disease in the first place, but that clearly hasn't been done. Viewed purely as a design option, sickle-cell is a clumsy and cruel one at best—and all the more so when you stop to consider what it means for the sickle-cell gene to leave its original malarial environment. For millions of Americans of African descent that migration was not even remotely voluntary. Once settled in America, though, any biological utility for the sickle-cell gene vanished, leaving only the downside of anemia for dual carriers. With the selection pressure for sickle-cell removed, the frequency of the allele has been dropping. But there has been no wholesale switching of the nucleotides back to adenine, even though this plaguing "unto the seventh generation" dictates suffering for those whose only fault was to be descended from people who managed to survive malaria by drawing that particular hand. This suggests that the "whimsical Creator" was unable or unwilling to interfere with the natural play of a genetic game clearly left to run on autopilot.[45]

The philosophical quandary of how to draw the line between where natural "iceberg" processes leave off and "*Titanic*" design weighs in has a venerable pedigree. Stephen J. Gould observed how Reverend Thomas Burnet (whose 17th century explanations for the Flood presaging Brown's "hydroplate" theory were noted last chapter) tried his best to avoid overt miracles when accounting for what was then known of geological history. That his resulting speculations were both fanciful and wrong shouldn't obscure the fact that "Burnet's God, like the deity of Newton and Boyle, was a clock-winder, not a bungler who continually perturbed his own system with later corrections."[46]

But a proliferation of self-winding clocks is what 20th century creationism has a problem dealing with, as Phillip Johnson illustrated with his ingenuous selection of those "famous" trilobite eyes and "whimsical" peacock tails. But unless TR intends to be a wholly owned subsidiary of conservative western Christianity, on what scientific grounds are they to distinguish between one "theistic" explanation and another? None of the watches on Paley's heath carry designer labels, and so how is a rational science to decide that the clever Watchmaker was not Vishnu rather than the God of Abraham? Just looking at "nature" square in the face would suggest larger organisms like people might just have reasonably been created as a habitat (or even *playground*) for parasitical organisms like *Plasmodium falciparum*, rather than the other way around. While orthodox Hindus might raise a benign smile at such drollery and broaden their caste categories a few notches accordingly, this is not a position likely to be favored by those featherless bipedal vertebrates of a Christian persuasion who lack a suitably "bacteriocentric" view of the world. But on purely empirical grounds there would seem no way for TR to exclude such non-naturalistic discourse from the *scientific* debate.

At the root of discerning "meaning" and "purpose" in the natural world is a serious technical ambiguity that creationists are slow to warm to. Nothing about a Paley watch would tell you whether its "purpose" was to time genial footraces or to measure the rate at which human victims needed to have their hearts ripped out to keep the sun shining. This is the same intractable merry-go-round that governs arguments over the Second Amendment: "Guns don't kill people, people kill people" versus "Guns have as their only function killing things." For any object of design, its "meaning" and "purpose" is a mixture of its internal operation and its external context. Only who is to supply the context? And why stop with the watches of life? There are pantheistic cultures that invest personality and import into things contemporary science would regard as exclusively inanimate: selected mineral formations, the motion of atmospheric molecules, or the fluid state of water. Johnson's Theistic Realism isn't likely to address those points only because his particular theology has come not to recognize them as viable questions. Which means how TR is to play out in a social context translates into a purely *political* football. My religion is more popular than yours is—therefore rocks cannot be spiritual beings, and highway engineers do not require prayer and moral guidance before excavating hillsides.

That creationists do not actively mull over the philosophical implications of their own position is among the understatements of the century. Following the sickle-cell lesson to its conclusion reveals yet more about the inadequacies of the creationist mindset as applied to natural science.

Time for a thought experiment. What if you didn't know about the existence of malaria? In that case the peculiar survival of the sickle-cell allele would seem mysterious indeed. Although that deleterious point mutation would still have had a perfectly natural explanation, without awareness of that isolated external factor (the potassium affinity of *Plasmodium falciparum*) you'd have no obvious way to spot that connection empirically. And if such processes are at work today why shouldn't we expect that sort of thing to have been going on all through the history of life? Only that means making sense of a lot of internal biochemistry would be *a priori* impossible because the antecedent details of the larger environment are unavailable for inspection by contemporary researchers. There's simply no way to know what analogs of malaria were knocking about hundreds of millions (if not billions) of years ago when many biological innovations were occurring. But pretending as if such serendipitous factors didn't exist or would have had no effect would be a serious logical mistake.

Now take another step. If "wrong" genes like the sickle-cell allele can survive by being comparatively useful somewhere else, what about "right" ones—small mutations generating benign variant proteins that may not be valuable at the original site, but are actively handy elsewhere? These variants would have been brought on the scene to serve their own initially unrelated functions, and only later kick back into use at the original location *as a new partnership* with other components that came about through exactly the same mix-and-match process. There is a quite complicated biological dance implied by the existence of interacting complexes like the protozoan-mosquito-genome trine of sickle-cell anemia. And the failure to recognize the possibility of such interactions in general evolution would be one very fast track to not understanding what has been going on with life over the last few billion years.

The World of Michael Behe: minus Populations and Gene Duplications

Which brings us to the "irreducible complexity" defense put forward by Michael Behe in *Darwin's Black Box*. Behe's primary contention is that "The scientific disciplines that were part of the evolutionary synthesis are all nonmolecular. Yet for the Darwinian theory of evolution to be true, it has to account for the molecular structure of life. It is the purpose of this book to show that it does not."[47]

According to Behe there exist biological structures whose components interconnect exactly like a mousetrap: the platform, spring and hammer all need to be on hand as working pieces before successful mouse catching can take place. Remove any part of such an "irreducibly complex" system and what you have left is a functionless collection of leftover pieces, not a more rudimentary operation that does anything. Insofar as Darwinists have failed to explain such systems at the molecular level, reasoned Behe, that is a signal that they are in principle incapable of doing so. Irreducibly complex systems reveal by their very existence the hand of an intelligent designer. And you can guess which Intelligent Designer Behe has in mind.

Darwin's Black Box offered five examples of such momentous biochemical mousetraps. The whip-like cilium many cells use to move about requires connectors to link the microtubules that are wiggled by biological motors. There is even a variety of bacterial flagellum that employs a *rotary* system (something otherwise unknown in nature) consisting of a paddle, rotor, and motor. Behe's third example was the blood-clotting cascade, a veritable funhouse of interlocking chemistry where enzymes activate and deactivate one another in a highly interactive way. Then there is the intracellular transport mechanism that selectively shunts proteins around to wherever cellular chamber they are needed—this features what amounts to a scanner that checks a molecular tag before allowing the protein through a restrictive gate. Finally, Behe proposed that the vertebrate immune system was irreducibly complex, noting particularly the relationship between the messenger molecule used to detect the presence of membrane-cloaked antibodies and its triggering of the production of the modified antibodies actually used as warriors in the anti-infection campaign.[48]

We've seen just how popular Behe's work has become among the latest crop of antievolutionists, with authors ranging from Robert Bork to the disparate contributors to *Three Views on Creation and Evolution* latching onto it as the ultimate "Silver Bullet" to dispose of the Darwinian monster.[49] Given the sweeping confidence of *Darwin's Black Box*, this positive attitude on the part of creationists is not difficult to understand. Just look at how Behe painted the results of the last few decades of cellular biology:

> The result of these cumulative efforts to investigate the cell—to investigate life at the molecular level—is a loud, clear, piercing cry of "*design!*" The result is so unambiguous and so significant that it must be ranked as one of the greatest achievements in the history of science. The discovery rivals those of Newton and Einstein, Lavoisier and Schrödinger, Pasteur, and Darwin. The observation of the intelligent design of life is as momentous as the observation that the earth goes around the sun or that disease is caused by bacteria or that radiation is emitted by quanta. The magnitude of the victory, gained at such great cost through sustained effort over the course of decades, would be expected to send champagne corks flying in labs around the world. This triumph of science should evoke cries of "Eureka!" from ten thousand throats, should occasion much hand-slapping and high-living, and perhaps even be an excuse to take a day off.
>
> But no bottles have been uncorked, no hands slapped. Instead, a curious, embarrassed silence surrounds the stark complexity of the cell. When the subject comes up in public, feet start to shuffle, and breathing gets a bit labored. In private people are a bit more relaxed; many explicitly admit the obvious but then stare at the ground, shake their heads. And let it go at that.
>
> Why does the scientific community not greedily embrace its startling discovery? Why is the observation of design handled with intellectual gloves? The dilemma is that while one side of the elephant is labeled intelligent design, the other side might be labeled God.[50]

Or maybe there has been less congratulatory back slapping in the scientific community about all this than Behe's effusive prose might suggest because there are serious methodological problems undermining the rigor of the very "irreducible complexity" that Behe contends reveals that designing hand.

First and foremost is the standard by which one establishes the "irreducible complexity" of a suite of biological components in the first place. As far as Behe is concerned, "in order to find out how a thing works, you have to take it apart and reassemble it, stopping at many points to see if function has yet been restored."[51] That's all well and good as a first step, but discovering whether evolutionary processes might lie behind them would mean going beyond plugging the existing pieces in and out. You would have to actively experiment with *replacement parts*, ones theoretically antecedent through natural mutation or gene recombination, to test out how possible precursor systems might have developed. Behe did not do that. Indeed, it did not evidently occur to him that he needed to. But without having performed that critical variation, how could Behe be so certain that the parts presently used were the only ones that would work in some useful way? Unless and until he supplied that missing piece, Behe hasn't *proved* irreducible complexity—only identified possible instances of it.

Which brings us to the same problem previously encountered with Phillip Johnson's "famous" trilobite eyes. It's the methodological question of deciding at what point hypothesis formation can safely graduate to the experimental exploration of a theory—and what a healthy natural science is supposed to do in the meantime until it is able to take that step. Reading *Darwin's Black Box* it was all too easy to forget that biological engineering has by no means advanced to where investigators (evolutionary or otherwise) can cobble up on demand specific proteins to play around with. Nor did Behe go out of his way to point that out.

While giving only the most perfunctory consideration to how scientists might formulate a strict "step-by-step" point mutation explanation for complex biological systems, Behe never thought to investigate the far more serious challenge of how those scientists might go about *testing* it. It was that considerable philosophical omission that flipped Behe's overall argument from the "God of the gaps" category ("evolution hasn't explained gap X") to a refined example of the Bermuda Triangle defense (failure to look into why there might be a gap in the first place).

This is no lame excuse. What we're looking at here is the same technical hitch that keeps much of medical science tethered to the tactic of throwing a battery of plant extracts at diseases and watching to see if something salutary happens. If there were some Star Trek-class medical scanner capable of synthesizing hypos full of targeted serum on the spot, that technology would be just the thing to help work out the fiddly bits of biochemical evolution. It would even help if computer simulations were able to usefully model the function of hypothetical changes in a protein code. But alas, as Wen-Hsiung Li noted in his recent book on molecular evolution, "our knowledge of protein folding is not yet good enough to predict accurately the secondary and tertiary structures of a protein from its primary structure. This is a challenging problem in protein chemistry today."[52]

Not that this limitation precluded Behe from proceeding as though evolutionists were in a position to answer these questions in the substantive manner demanded of them. "One might also expect that, although perhaps some details would be harder to explain than others, on the whole science should have a good grasp of how the cilium evolved."[53] Or apropos the rotary flagellum: "Even though we are told that all biology must be seen through the lens of evolution, no scientist has *ever* published a model to account for the gradual evolution of this extraordinary molecular machine."[54]

Behe did address the technical challenges of evolutionary analysis in one instance, the case recounted by Richard Dawkins in *The Blind Watchmaker* of the bombardier beetle and its toxic spray. But Behe was barely more charitable toward Dawkins' evolutionary conclusions than Duane Gish had been:

> All we can conclude at this point is that Darwinian evolution *might* have occured [*sic*]. If we could analyze the structural details of the beetle down to the last protein and enzyme, and if we could account for all these details with a Darwinian explanation, then we could agree with Dawkins. For now, though, we cannot tell whether the step-by-step accretions of our hypothetical evolutionary stream are single-mutation "hops" or helicopter rides between distant buttes.[55]

Along with Michael Denton and Phillip Johnson, Behe thus took an all-or-nothing stance when it came to evolutionary evidence, requiring the complete package deal of point mutations to be nailed down *before* a naturalistic evolutionary model might be adopted as the probable working explanation.[56] This was one high analytical hurdle that Behe expressed no doubt about: "Science, however, cannot ultimately ignore relevant details, and at the molecular level all the 'details' become critical."[57]

Most commendable … but how well did Behe play that game himself? It was revealing to follow through on this complexity idea, especially how Behe used it to preclude making substantive judgments about major evolutionary processes:

> Thus, to go back to the bombardier beetle and the human eye, the question is whether the numerous anatomical changes can be accounted for by many small mutations. The frustrating answer is that *we can't tell*. Both the bombardier beetle's defensive apparatus and the vertebrate eye contain so many molecular components (on the order of tens of thousands of different types of molecules) that listing them—and speculating on the mutations that might have produced them—is currently impossible. Too many of the nuts and bolts (and screws, motor parts, handlebars, and so on) are unaccounted for. For us to debate whether Darwinian evolution could produce such large structures is like

> nineteenth century scientists debating whether cells could arise spontaneously. Such debates are fruitless because not all the components are known.
>
> We should not, however, lose our perspective over this; other ages have been unable to answer many questions that interested them. Furthermore, because we can't yet evaluate the question of eye evolution or beetle evolution does not mean we can't evaluate Darwinism's claims for any biological structure. When we descend from the level of a whole animal (such as a beetle) or whole organ (such as an eye) to the molecular level, then in many cases we *can* make a judgment on evolution because all of the parts of many discrete molecular systems *are* known. In the next five chapters we will meet a number of such systems—and render our judgment.[58]

Here were planted the seeds of a sizable double standard, where Behe set up evolutionists to play by a stricter set of rules than he applied to his own case. For not long after announcing that "all of the parts … *are* known" concerning his irreducibly complex quintet, Behe puts things a little differently. "In the past several decades modern biochemistry has elucidated all or most of the components of a number of biochemical systems. In the next five chapters I will discuss a few of them."[59]

So "all" the details had become "all or most." And along that gentle gradient Behe kept the reader rolling ever lower, reminding me finally of a scene from Charlie Chaplin's classic satire *The Great Dictator*. Forced by the rules of diplomacy to dance with the portly wife of visiting thug Benzino Napaloni, tyrant Adenoid Hynkel summarily goose-stepped her around the floor, then paid her this studiously deescalating compliment: "Madame, your dancing was superb … excellent … very good … good." Likewise, *Darwin's Black Box* turned out to have glided rather farther from the "all" side of the detail equation than originally advertised.[60]

Consider the blood-clotting cascade:

> Potentially, then, there are two possible ways to trigger clotting. The relative importance of the two pathways in living organisms is still rather murky. Many experiments on blood clotting are hard to do; some of the proteins—especially the ones involved in the early stages of the pathway—are found in only minute amounts in blood. For example, one hundred gallons of blood contain only about 1 one-thousandth of an ounce of antihemophilic factor. Furthermore, because the initial stages of clotting feed back to generate more of the initial activating proteins, it's often quite difficult to sort out just who is activating whom.[61]

Yet evolutionists are supposed to account for it anyway.

Regarding that extraordinary rotary motor, Behe declared how "A number of models for the motor have been suggested; none of them are simple. (One such model is shown in Figure 3-3 just to give the reader a taste of the motor's expected complexity.)"[62] Oh! There are competing *models* for the motor—not an agreed on mechanism, pinned down to the last schematic DNA nucleotide. Now apparently having only a "model" for a physical process is all right so long as it isn't an explicitly Darwinian one. But nonetheless, if biochemists only have a proposal for how the rotary flagellum motor operates, doesn't that make it a tad harder for evolutionists to describe its precise development *at the molecular level*? And since there are only models to be had for the motor as of the mid-1990s, how reasonable was it for Behe to decry how "no scientist has *ever* published a model" for the whole evolutionary genesis of the rotary flagellum? Must Darwinian theorizing strike on a hair-trigger in order to satisfy the Intelligent Design specifications?[63]

By insisting that the answers be given before the questions were properly defined, Behe has positioned himself as odds-on favorite to understudy Henry Morris as the Queen of Hearts ("sentence first—verdict afterwards"). Yet all the while Behe made abundantly clear that he was not about to apply this "have to know all the details" stuff to his own argument:

> Above I noted that the cilium contains tubulin, dynein, nexin, and several other connector proteins. If you take these and inject them into a cell that lacks a cilium, however, they do not assemble to give a functioning cilium. Much more is required to obtain a cilium in a cell. A thorough biochemical analysis shows that a cilium contains over *two hundred different kinds of proteins*; the actual complexity of the cilium is enormously greater than what we have considered. All of the reasons for such complexity are not yet clear and await further experimental investigation. Other tasks for which the proteins might be required, however, include attachment of the cilium to a base structure inside the cell; modification of the elasticity of the cilium; control of the timing of the beating; and strengthening of the ciliary membrane.
>
> The bacterial flagellum, in addition to the proteins already discussed, requires about forty other proteins for function. Again, the exact roles of most of the proteins are not known, but they include signals to turn the motor on and off; "bushing" proteins to allow the flagellum to penetrate through the cell membrane and cell wall; proteins to assist in the assembly of the structure; and proteins to regulate the production of the proteins that make up the flagellum.
>
> In summary, as biochemists have begun to examine apparently simple structures like cilia and flagella, they have discovered staggering complexity, with dozens or even hundreds of precisely tailored parts. It is very likely that many of the parts we have not considered here are required for any cilium to function in a cell. As the number of required parts increases, the difficulty of gradually putting the system together skyrockets, and the likelihood of indirect scenarios plummets. Darwin looks more and more forlorn. New research on the roles of the auxiliary proteins cannot simplify the irreducibly complex system. The intransigence of the problem cannot be alleviated; it will only get worse. Darwinian theory has given no explanation for the cilium or flagellum. The overwhelming complexity of the swimming systems push us to think it may never give an explanation.[64]

The attitude Behe adopted towards complexity suggests how he can remain so aloof from an evolutionary perspective. Biological complexity was not approached as an exceedingly difficult technical problem to tease apart into any mutational constituents, but rather as more barriers to preclude explaining the "irreducible complexity" of the isolated components Behe was so sure of. But the lesson of sickle-cell casts doubt on the inherent applicability of that approach, where comprehending the natural character of the outcome depended on not merely recognizing the variety of the internal biological picture—but also the presence of a particular *external* factor, the relevant microbial parasite.

When it comes to natural complexity one might think Behe had the microscope turned the wrong way around. With a tendency to frame the issue with only the antievolutionary target in mind, he kept skirting past the epistemological implications of relevant information, as when he criticized evolutionary journals for fielding papers of insufficient detail to satisfy his criteria. Behe blithely remarked that "In fact, evolutionary explanations even of systems that do not appear to be irreducibly complex, such as specific metabolic pathways, are missing from the literature. The reason for this appears to be similar to the reason for the failure to explain the origin of life: a choking complexity strangles all such attempts."[65]

But comparable "choking complexity" prevails in many systems having nothing to do with the origin of life or even biology. Any physical system runs the risk of being hard to figure out with the available tools, from superconductivity to the Lewis Overthrust. But this is even so for thunderclouds, which consist of about the simplest constituents imaginable (water vapor jostling around in the atmosphere) and so presumably have no "design" quality about them whatsoever. Nonetheless, there are so many interacting electron exchanges that meteorologists are still at the "somehow discharge takes place" stage of thunderstorm modeling, and one continues to read general sentiments like: "For reasons that scientists still do not completely understand, storm clouds separate charges into positive and negative clusters."[66]

That such perils play havoc at so basic a physical level ought to have made Behe considerably more circumspect about criticizing Darwinists for failing to resolve biochemical problems of far more daunting intricacy. Instead, Behe complained of the "fuzzy word-pictures typical of evolutionary biology. The lack of quantitative details—a calculation or informed estimation based on a proposed intermediate structure of how much any particular change would have improved the active swimming ability of the organism—makes such a story utterly useless for understanding how a cilium truly might have evolved."[67]

But even within rigorous mathematics (where 1+1=2—and don't you forget it, buster!) there are disagreeable limitations to the tricks you can pull off, and how long it may take to do them, as the Olympian saga of Fermat's Last Theorem attests.

In the 17th century Pierre de Fermat asserted there were no whole number solutions greater than n=2 for the equation $a^n+b^n=c^n$. Which led to the most vexing marginal scribble in the history of mathematical scholarship: "I have a truly marvelous demonstration of this proposition, which this margin is too narrow to contain." Over the next three hundred years the greatest minds in mathematics took a stab at either proving or disproving it, including Leonard Euler in the 18th century and Bertrand Russell in the 20th. Their persistent and collective failure led some to suspect Fermat might have been having them on. Finally, after ten years of effort, the comparatively unknown Andrew Wiles cracked the proof in the 1990s—or rather, *a* proof, since Wiles used a great deal of mathematics completely unknown to Fermat. Thus we still don't know whether Fermat actually had a proof in mind, or that it was valid if he did. Rest assured there shall be further mathematical head scratching on that one.[68]

Now the Fermat episode took place entirely in the abstruse environment of absolute logic, where all you needed was paper and a sharp pencil (wielded by an even sharper brain, of course). There would be no physical experimentation, no call to ponder Darwinian principles of inheritance or mutation. And yet it took *three centuries* to resolve the Fermat problem, and several whole new branches of mathematics to do it. With so many unanswered questions remaining in developmental biology (such as the exact principles under which genes are expressed or suppressed—something that would seem likely to play a preeminent role in naturalistic evolution) why should we expect Darwinists to have an easier go of it?[69]

But what is supposed to happen should evolutionary biologists arrive at an epiphany and come to believe they grasp enough of the essential problem to start the "hypothesis formation" ball rolling? Well, if detailed research is to be undertaken to affirm or confute a proposition, you do have to start with a proposition—something specific enough for an experimenter to get a grip on. Unfortunately, the history of science suggests the first off the mark with an explanatory model for some hitherto intractable phenomenon may well have the major idea right, but will likely slip on many of the finer points. However ugly the process may be, that's how science (and not just the Darwinian sort) has stumbled its merry way through the last half millennium. Back at the turn of the 20th century, for example, the adamant Herr Wegener had almost everything wrong about continental drift except for the basic idea that continents drifted. Only after much later research (including a few serendipitous findings about seafloor spreading in the 1960s) did the tectonic dust settle. Human technology also follows that haphazard track, where the Wright Brothers started off with gliders and only later added an engine that allowed them to fly farther than the length of a modern airliner fuselage. They did not bound straight from aerodynamic theory to constructing swing-wing supersonics—and it would have been a hard-nosed critic indeed who would have seriously expected otherwise.

So how did Behe tackle the unsightly "hypothesis formation" stage of evolutionary thinking? In 1993 Russell Doolittle proposed a fairly detailed "yin and yang" dance to account for the blood-clotting cascade, relying primarily on gene duplication to supply the various interacting components.[70] It offered plenty of provocative questions to explore—if and when structural biology progressed to the point where they might be answered experimentally. But since Behe appears to countenance only the publication of final absolute conclusions from Darwinists, disallowing them any intervening toe-stubbing investigative phase, *Darwin's Black Box* gave Doolittle's argument failing marks:

> Now let's take a little time to give Professor Doolittle's scenario a critical look. The first thing to notice is that no causative factors are cited. Thus tissue factor "appears," fibrogen "is born," antiplasmin "arises," TPA "springs forth," a cross-linking protein "is unleashed," and so forth. What exactly, we might ask, is causing all this springing and unleashing? Doolittle appears to have in mind a step-by-step Darwinian scenario involving the undirected, random duplication and recombination of gene pieces. But consider the enormous amount of luck needed to get the right gene pieces to the right places. Eukaryotic organisms have quite a few gene pieces, and apparently the process that switches them is random. So making a new blood-coagulation protein by shuffling is like picking a dozen sentences randomly from an encyclopedia in the hope of making a coherent paragraph. Professor Doolittle does not go to the trouble of calculating how many incorrect, inactive, useless "variously shuffled domains" would have to be discarded before obtaining a protein with, say, TPA-like activity.
>
> To illustrate the problem, let's do our own quick calculation. Consider that animals with blood-clotting cascades have roughly 10,000 genes, each of which is divided into an average of three pieces. This gives a total of about 30,000 gene pieces. TPA has four different types of domains. By "variously shuffling," the odds of getting those four domains together is 30,000 to the fourth power, which is approximately one-tenth to the eighteenth power. Now, if the Irish Sweepstakes had odds of winning of one-tenth to the eighteenth power, and if a million people played the lottery each year, it would take an average of about a thousand billion years before *anyone* (not just a particular person) won the lottery. A thousand billion years is roughly a hundred times the current estimate of the age of the universe. Doolittle's casual language ("spring forth," etc.) conceals enormous difficulties. The same problem of ultra-slim odds would trouble the appearance of prothrombin ("the result of a … protease gene duplication and … shuffling"), fibrinogen ("a bastard protein derived from …"), plasminogen, proaccelerin, and each of the several proposed rearrangements of prothrombin. Doolittle apparently needs to shuffle and deal himself a number of perfect bridge hands to win the game. Unfortunately, the universe doesn't have enough time to wait.
>
> The second question to consider is the implicit assumption that a protein made from a duplicated gene would immediately have the new, necessary properties. Thus we are told that "tissue factor appears as the result of the duplication of a gene for [another protein]." But tissue factor would certainly not appear as the result of the duplication—the other protein would. If a factory for making bicycles were duplicated, it would make bicycles, not motorcycles; that's what is meant by the word *duplication*. A gene for a protein might be duplicated by a random mutation, but it does not just "happen" to also have sophisticated new properties. Since a duplicated gene is simply a copy of the old gene, an explanation for the appearance of the tissue factor must include the putative route it took to acquire a new function. This problem is discreetly avoided. Doolittle's scheme runs into the same problem in the production of prothrombin, a thrombin receptor, antithrombin, plasminogen, antiplasmin, proaccelerin, Stuart factor, proconvertin, Christmas factor, antihemophiliac factor, and protein C—virtually every protein in the system!
>
> The third problem in the blood-coagulation scenario is that it avoids the crucial issues of how much, how fast, when, and where. Nothing is said about the amount of clotting material initially available, the strength of the clot that would be formed by a primitive system, the length of time the clot would take to

> form once a cut occurred, what fluid pressure the clot could resist, how detrimental the formation of inappropriate clots would be, or a hundred other such questions. The absolute and relative values of these factors and others could make any particular hypothetical system either possible or (much more likely) wildly wrong. For example, if only a small amount of fibrinogen were available it would not cover a wound; if a primitive fibrin formed a random blob instead of a meshwork, it would be unlikely to stop blood flow. If the initial action of antithrombin were too fast, the initial action of thrombin too slow, or the original Stuart factor or Christmas factor or antihemophiliac factor bound too loosely or too tightly (or if they bound to the inactive forms of their targets as well as the active forms), then the whole system would crash. At no step—not even one—does Doolittle give a model that includes numbers or quantities; without numbers, there is no science. When a merely verbal picture is painted of the development of such a complex system, there is absolutely no way to know if it would actually work. When such crucial questions are ignored we leave science and enter the world of Calvin and Hobbes.
>
> Yet the objections raised so far are not the most serious. The most serious, and perhaps the most obvious, concerns irreducible complexity. I emphasize that natural selection, the engine of Darwinian evolution, only works if there is something to select—something that is useful *right now*, not in the future. Even if we accept his scenario for purposes of discussion, however, by Doolittle's own account no blood clotting factor appears at least until the third step. The formation of tissue factor at the first step is unexplained, since it would then be sitting around with nothing to do. In the next step (prothrombin popping up already endowed with the ability to bind tissue factor, which somehow activates it) the poor proto-prothrombin would also be twiddling its thumbs with nothing to do until, at last, a hypothetical thrombin receptor appears at the third step and fibrinogen falls from heaven at step four. Plasminogen appears in one step, but its activator (TPA) doesn't appear until two steps later, Stuart factor is introduced in one step, but whiles away its time doing nothing until its activator (proconvertin) appears in the next step and somehow tissue factor decides that this is the complex it wants to bind. Virtually every step of the suggested pathway faces similar problems.
>
> Simple words like "the activator doesn't appear until two steps later" may not seem impressive until you ponder the implications. Since two proteins—the proenzyme and its activator—are both required for one step in the pathway, then the odds of getting both the proteins together are roughly the square of the odds of getting one protein. We calculated the odds of getting TPA alone to be one-tenth to the eighteenth power; the odds of getting TPA and its activator together would be about one-tenth to the thirty-sixth power! That is a horrendously large number. Such an event would not be expected to happen even if the universe's ten-billion year life were compressed into a single second and relived every second for ten billion years. But the situation is actually much worse: if a protein appeared in one step with nothing to do, then mutation and natural selection would *tend to eliminate it*. Since it is doing nothing critical, its loss would not be detrimental, and production of the gene and protein would cost energy that other animals aren't spending. So producing the useless protein would, at least to some marginal degree, be detrimental. Darwin's mechanism of natural selection would actually hinder the formation of irreducibly complex systems such as the clotting cascade.[71]

Hammering these particular nails into Doolittle's "yin and yang" coffin would have been considerably more persuasive had Behe not forgotten to put the lid on first. For what Behe did not do in setting out to impeach Doolittle's hypothetical sequence was to get anywhere near taking the empirical high ground, where rigorous experimentation would settle the matter. As philosopher Robert Pennock observed:

> The most that Behe has done here is to point to a number of interesting research problems. One wonders why he, as a biochemist, does not begin the research himself. He is correct that these remain explanatory gaps for science, but he has failed to demonstrate the single point upon which his whole case rests, namely, that irreducibly complex systems, assuming that this is what these are, could not in principle have arisen by Darwinian (or by any other natural) means.[72]

That was an understatement.

When I first read the criticism of Doolittle in *Darwin's Black Box*, I thought a particularly good place for a critic to begin would have been to tackle the final step in Doolittle's proposal directly. Demonstrating that no gene modification could actually switch the binding domain of prothrombin from EGF to fibrin would have neatly prevented the rest of Doolittle's parade from connecting up with the present clotting system. Unfortunately, to pull off that trick would require Behe to employ the very techniques presently missing from the structural biology kit. This situation would also explain why Behe stressed "how much, how fast, when, and where" without offering any calculations or experiments himself to establish that blobs of fibrin "would be unlikely to stop blood flow" or where the threshold lies for how much fibrinogen really is required to be effective.

Behe took a similar tack concerning another of his irreducibly complex candidates, the intracellular transport system, claiming that the relevant components could not have developed from viable precursors. "An exhaustive consideration of all possible roles for a particular component can't be done," Behe noted with unintended irony. "We can, however, consider a few likely roles for some of the components of the transport system." But all his "likely" examples turned out to be hypothetical ones—and circumstantially defined with properties exactly opposite of the specifications wanted for the molecules they were supposed to evolve into. (Shades of Duane Gish laying out the explosive antecedents for the bombardier beetle!) Behe did not start at the source and work backwards from gene sequences to establish that neither point mutations nor gene duplication could have resulted in useful players, let alone offer experimentation to show that such forerunner molecules would indeed have upset the system in the way he asserted.[73]

It could be that an animal with a clumsy intermediate clotting system or a bungling transport mechanism wouldn't be better off than one without any activity there at all, or that intermediate operations in those instances really are impossible. But it would be premature to decide that question before research had progressed to the point where that level of the irreducible complexity argument could be tackled procedurally. Instead of acknowledging that serious limitation, Behe invariably assumed that which was to be proven.[74]

And he assumed something else: that he could invoke the example of modern biochemistry as though the ancestral bloodstream or transport environment would be essentially unchanged. The problem is that anything from fluid viscosity to the charge properties of tissue membranes might throw off retroactive analysis as assuredly as trying to calculate bumblebee aerodynamics before the effects of standing vortexes were isolated. That Behe offered no reflection of these possibilities didn't impede his own "numbers or quantities" in these areas because he didn't offer any. Thus honoring analytical propriety in the breach, Behe ambled down a path just as procedurally diaphanous as the evolutionary scenarios he was hot to criticize.

Sticking out most conspicuously was that withering probability calculation cradling Behe's argument against Doolittle. It rested on the premise that the components of molecules like TPA had to have been plugged together in one go—or, at least, act that way in a mathematical sense. For it was only under such a strict proviso that Behe could permute the 30,000-card genetic deck so as to obtain those monumentally intimidating odds against being dealt one specific four-card hand. That Behe was not about to let go of those appealing figures was affirmed by his endnotes:

> The odds are not decreased if the domains are hooked together at different times—with domains 1 and 2 coming together in one event, then later on domain

> 3 joining them, and so on. Think of the odds of picking four black balls from a barrel containing black balls and white balls. If you take out four at once, or take two at the first grab and one apiece on the next two grabs, the odds of ending up with four black balls are the same.
>
> The calculation is exceedingly generous. It only assumes that the four types of domains would have to be in the correct linear order. In order to work, however, the combination would have to be located in an active area of the genome, the correct signals for splicing together the parts would have to be in place, the amino acid sequences of the four domains would have to be compatible with each other, and other considerations would affect the outcome. These further considerations only make the event much more improbable.
>
> It is good to keep in mind that a 'step' could well be thousands of generations. A mutation must start in a single animal and then spread through the population. In order to do that, the descendants of the mutant animal must displace the descendants of all other animals.[75]

Only that's where the logical complication hit: what *does* it mean for a mutation to spread through a population over generations? If a duplicated gene should happen to plug a new element onto a protein, and that is in turn passed onto progeny, the offspring are *inheriting* the mutation. For them it's no longer an independently random choice; as far as they're concerned the "odds" for that particular step would be 100%.

The evolutionary version of Bridge thus operates under very different rules than those implied by Behe's analogy. For a natural population a busy tournament is going on, with many thousands of tables in play *simultaneously*. The consequence for those individuals dealt really crappy hands is not a re-deal, but having their tables summarily yanked from the game. As for those players receiving more fortunate hands, they don't move on to be dealt a new hand either. Those who stick it out long enough become the *dealers* for the next round, only now the deck to be shuffled has been *modified*. The effect of these specialized rules is not just to pass on the attributes of the previous hand to subsequent players at that table—it is to filter to them the conserved features of *all* prior deals involving that lineage.

Precisely like Richard Milton with sedimentary erosion, the evolutionary properties of populations remained for Behe purely an abstraction, as Robert Pennock spotted when Behe repeated the mistake in another analogy meant to illustrate the difficulties faced by gradual Darwinian transformation. Behe supposed that an amorous Mr. Groundhog setting out across a vast traffic-clogged expressway in quest of an intended Mrs. Groundhog would surely end up as "road kill" long before reaching the other side.[76] But this highway analogy was fundamentally wrong, missing the essence of Darwinian analysis completely. Pennock explained:

> We cannot think that Behe's groundhog is supposed to stand in the analogy for a population, for in the story we see others from his population, his sweetie waiting on the other side, and the carcasses of his dead rivals that litter the first few lanes of the 2,000 lane highway he must cross to meet her. One might forgive Behe this minor infidelity, but he compounds it by inexplicably leaving out of his analogy all of the very elements that do the explanatory work for Darwinian gradualism. Keeping in mind that it is a population that evolves, recall how the Darwinian processes operate: on the average those individuals in the population who are even slightly more fit to their environment will have a better chance than others to survive, reproduce, and thus pass on those fit characteristics to their offspring, and so on. So how should Behe have told the story to make it a fair analogy?
>
> Instead of having our groundhog prayerfully inching out where angels fear to tread, toward his sweetie, and past the dead bodies of his unsuccessful rivals strewn about the first few lanes of the superhighway, to represent the Darwinian picture correctly Behe should have had Mr. and Mrs. Groundhog and the whole

> great population of groundhogs striking out *en masse*. Behe is right that most would not survive even the first lane and if they continued straight on then fewer and fewer would be left after each lane. But wait … gradualistic evolution does not claim that a population just heads across a gap in this way. Rather it observes that Mr. and Mrs. Groundhog and those of their fellows who have successfully made it past the first lane (perhaps because they stepped just a little quicker than those who failed to make it) stop to have a bunch of kids. With the population now more or less returned to its former numbers, Ma and Pa then retire and leave the second generation to tackle lane two. The casualties still will be legion, but this time the whole group starts off being on average a bit fleeter of foot than the previous. Again, those whose slightly fitter characteristics allow them to survive the second lane and reproduce yield the race across lane three to the third generation. With each generation, new variations arise, and though in many cases these will hinder rather than help in the race, those few with useful new traits (not just increases swiftness but perhaps also sneakiness, better hearing, larger litters, and so on) will likely carry them forward to their offspring and in this way each generation—naturally selected by the traffic—will turn out to be better adapted to their dangerous environment. Mr. and Mrs. Groundhog never themselves cross the entire superhighway; it is their distant descendants, now quite modified, who will be found on the other side.[77]

That Behe had founded his argument on an invalid conception of what "Darwinism" was supposed to be about was no casual foible. Redefining the evidential and philosophical turf turned out to be Behe's primary tactical defense, and by following all his logical perambulations it was possible to discover why Intelligent Design isn't likely to go anywhere in a scientifically productive sense.

To start with, there was no "implicit assumption" among evolutionists that duplicated genes would "immediately" result in a new protein. To the contrary, it is because of the gene duplication that the power of natural selection would be able to get around otherwise dangerous variations. So long as there is only a single gene encoding a particular protein there prevails an obvious downside to that gene mutating—especially if the protein's function is so vital to some critical system that it's absence proves fatal to any individual luckless enough to undergo the modification. That seems plain enough … but once a gene is duplicated that restriction is out the window. With more than one copy available, mutations in either the original or the copy can potentially survive (with the further prospect of eventually wheedling their way into the organism's evolving biology) so long as the original protein continues to be produced in one of them.[78]

Behe's overall failure to conceive of "Darwinism" in population terms promptly ran aground on his idea that natural selection would "*tend to eliminate*" such novel proteins because cells couldn't afford wasting precious energy on their aimless production. The problem with this logic is that selection works on individuals within a population, not their building blocks *per se* deep at the molecular level. By peering so intently through his narrow biochemical keyhole Behe evidently forgot that either the whole organism muddles along (aberrant metabolism and all) or it doesn't. Unless an alteration actively rendered the complete package less competitive at either general survival or successful breeding there would be nothing discernable for Darwinian selection to select.[79]

Moreover, underlying Behe's reasoning was the curiously parochial assumption that only that one individual would be engaged in this "detrimental" foray into genetic novelty. This is the voice of the design advocate in full throat: proceeding as though the default condition in the natural world was a collection of "lean and mean" organisms running at optimal efficiency, against which any blundering natural experiment would be unfavorably selected out of existence. But if the cellular machinery of *most* organisms undergoes some degree of molecular experimentation (and the ubiquitous presence of variant alleles suggests exactly that) no particular individual would be at a comparative disadvantage on that basis alone.

Think sickle-cell again: how could selection possibly distinguish between organism A hampered by a proliferation of botched hemoglobin molecules and rival organism B, where a component was churning out a superfluous extra protein? At no point in the selective gauntlet do the contenders compare itemized notes on their energy budgets, like shopping for a new refrigerator, where the one with the lowest rating wins. That each carried a different burden wouldn't necessarily matter at all when it came to which one would do better in eking out a living in the wild. Because examples like sickle-cell objectively occur in the real world, clearly the natural biological environment is capable of tolerating a competitive overhead of inefficiency not permitted in Behe's theoretical designer version.[80]

Trying to work out all the ramifications of evolutionary processes at the molecular level hits not only the technical snag of limitations on experimental skills, but also runs up against the constraints of economics and medical ethics. Under the "squeaky wheel gets the oil" rule, alleles that lead to disease have been more likely to be discovered, and for darned good reason. Benign or even favorable alleles would be comparatively invisible, since the only way to detect them would be through the concerted genetic analysis of a population of chromosomes where nothing bad seemed to be going on. Medical research has been understandably disinterested in devoting as much priority to that endeavor as to the identification of genetically driven illness, though this doesn't mean relevant examples haven't cropped up anyway. Such as this "well-known" contender from the very bloodstream through which Behe's irreducibly complex clotting system is supposed to work:

> By contrast, duplication of a structural domain is less likely to be problematic. Indeed, such a duplication can sometimes even enhance the function of the protein produced, for example, by increasing the number of active sites. A well-known example is the haptoglobin α2 allele in humans, which was formed by a nonhomologous crossing-over within different introns of two α1 genes, probably a slow and a fast electrophoretic variant (α1S and α1F). The internal duplication nearly doubled the length of the polypeptide (changing from 84 to 143 amino acids) and it seems to increase the stability of the haptoglobin-hemoglobin complex and the efficiency in rendering the heme group of hemoglobin susceptible to degradation (Black and Dixon 1968). The α2 gene is probably of recent origin, at least more recent than the human-chimpanzee split, but it has a fairly high frequency (30-70%) in Europe and parts of Asia (Mourant et al. 1976). It is likely that the α2 allele will replace the α1 alleles.[81]

The differential presence of these haptoglobin alleles returns us to the philosophical issues posed by the schizochroal trilobite eyes. Except this time, the much simpler living analog can be pinned down to an exact set of genes, and so firm up the analytical boundaries. Supposing gene duplication was not responsible for the improved haptoglobin, what was? If the α2 allele was indeed an act of intentional design, why then is the unimproved α1 version still paddling about in the human gene pool? Could a "theistic science" legitimately infer that there might have been more than one creator running amok? While antievolutionists like Behe are excessively timorous about addressing such issues, there is one factor here that is far too salient to ignore. If gene duplication *is* responsible for the α2 allele, we then have a concrete example not only of both the original version of a gene and its modified copy working within the system—we have the duplication generating a positively objective improvement. So how realistic was it for Behe to proceed as though protein tinkering in theory could not possibly avoid tripping over the functionality speed bump at every step?

And speaking of functionality, what about the conjecture that a protein could be useful somewhere far removed from the final system, kicking into its new role when additional molecular partners came along? Behe was well aware of the objection, and almost answered it concerning the intracellular transport mechanism. But all his remarks ended up directed at a subtly different question: the extent to which *ancestral* forms of the transport components might have contributed properties to the final operation. Those were the "likely" examples mentioned above—the ones all carefully tailored to the opposite purpose. By so switching the subject, Behe conflated what may have well been a composite process ... the "yin and yang" Doolittle was getting at.

There was another potential factor that Behe noted in passing: "In cells, although some components make some materials for themselves, the great majority of proteins are centrally made and shipped to other compartments."[82] That means effectively a common parts bin, where the automated handling equipment swoops in to take whatever trips its signal cues. But rather than relating this to whether the cellular machinery might be prone to hijacking any novel proteins that happened along with bonding characteristics suitably flagging their use, Behe tossed it off as prelude to extolling the irreducibly complex wonderment of the transport mechanism that shunted the product proteins about.[83]

At a theoretical level the implication of what would be going on here ought to have been fed back into the idea of an individual living in a population. Most of the time the serendipity of variant proteins having molecular characteristics that trick the machinery into using them would result in the system crashing. Behe would have no quarrel with that outcome. But in a Darwinian sense that activity would inevitably be self-correcting—in extreme cases, we're talking one less Bridge table at the tournament. And if the system didn't "fall down go boom" because the new protein didn't hurt, in exactly the same way that the output of the α2 allele objectively doesn't hurt … what then? To be more specific, would any of the precursor modifications leading to the TPA protein be likely to be either deleterious or useless—either in the clotting cascade itself, or anywhere else in the cellular labyrinth?

We may start with a tiny datum tucked discretely into the endnotes of *Darwin's Black Box*, where we learned that *four* wasn't quite the right number of domains for Behe to have used in his probability calculation: "TPA has a total of five domains. Two domains, however, are of the same type."[84]

Oh, really? If disposing of the applicability of gene duplication was at the heart of Behe's argument, shouldn't the presence of a *duplicate* domain in TPA have been explored in rather more detail? Especially given that TPA was one of the first "mosaic proteins" to be discovered—chains composed entirely of elements shared with a range of other biologically active molecules. Was this just a peculiar coincidence or a basic clue to the mechanism of their origin? Not surprisingly, evolutionists favor the latter view.[85]

The root end of TPA consists of a unit that appears to be a knockoff of the digestive protein trypsin and the trypsin-like serine proteinases (which function as enzymes to chop proteins into their peptide fragments). That same root obtains for three more actors we've already met in the clotting parade: plasminogen, protein C, and prothrombin. And so, too, does a character from a completely different production, urokinase—the "urinary plasminogen activator" that does its specialized thing *outside* the blood clotting sequence. Now if the idea was to suggest that variations on a molecular theme might possibly have multiple biological utility, then we're off to a dandy start.[86]

Attached to the base sequence of TPA are two "kringle" modules (so called for its resemblance to the horseshoe shaped Danish pretzel of that name)—that's the duplicate domain Behe alluded to. Meanwhile, in respectively the same spot, prothrombin also features two kringles, while plasminogen has a long string of five, and urokinase but one. Where the molecules differ most is in what's attached to those varying kringle chains, and it's these add-ons that serve to define their specialized functions. TPA and urokinase both have a "growth factor" module connected to their kringle sections, but urokinase lacks the additional "finger" module that allows TPA to bind to fibrin. Fortunately, there's a whole protein composed of nothing but finger modules (fibronectin, which acts as a cellular anchor), leading molecular evolutionists to suspect that's the source for the caboose that has endowed TPA with its present fibrin-binding affinity. "Moreover, the junctions of these acquired units coincide precisely with the borders between exons and introns, this, lending further credibility to the idea that exons have indeed been transferred from one gene to another."[87]

It is at this juncture that things get really interesting from a methodological point of view. Tiptoeing into the fascinating realm of "exons" and "introns," we may see how evolutionists have taken to using these as tools to trace the process of "descent with modification" … and how antievolutionists like Behe haven't.

If all the DNA of living things had contained nothing but active coding "exons," which were converted smoothly into faithful RNA copies for the ribosomes to translate into the battery of essential protein sequences, Behe would have had a stupendously clear field for his Intelligent Design argument. A code of perfect utility, containing all that is required—and nothing that is not. But that's not even remotely what is found in nature, particularly for complex eukaryotes (up to and including those sentient vertebrates apt to quote *Darwin's Black Box*). Instead of smooth, tidy sequences of exclusively functional code, the exons for a full protein chain don't always come packaged in one piece on a gene. Sometimes they have to be spliced together from completely different locations. But even when encountered *en bloc*, often as not the exons are heavily padded with functionless "introns"—nucleotide sequences that aren't used to code for anything because they sport what amounts to "disregard the following" flags.[88]

Behe referred to one instance of this editing game apropos the immune system: "The answer to the problem of antibody diversity had to await an astonishing discovery: a gene coding for a protein didn't always have to be a continuous segment of DNA—it could be interrupted." To which astonishment an endnote layered on a further aura of enigma: "The cell goes to enormous trouble to splice together gene pieces—employing very complex machinery to align the ends properly and stitch together the pieces. Except in the case of antibody genes, however, the *reason* that 'interrupted genes' exist at all is still a mystery."[89]

And that's the only way Behe was about to look at such things, where the *reason* is a comforting "mystery" that puts the brake on the rest of his thinking. But does the acknowledgement of an underlying puzzle let the investigator off the hook when it comes to working out the implications of the *contents* of the puzzle? Once you've acknowledged that something exists, whether or not you have a clear idea of how it got there, does not the natural scientist still have the obligation to exhaustively consider what that something might be capable of doing?[90]

In the case of introns, there are two huge implications to deal with. First, while some introns may play a structural role in gene expression, most don't code for proteins directly—so they may mutate willy-nilly without gumming up any of the works, floating along in the genome without posing any hazard to the general function of the organism. Add to that the understanding that accidental point mutations would tend to occur at a fairly constant rate (especially if sampled over very long time frames to average out random fluctuations). Put those insights together when you encounter alleles cluttered with modified introns, and you have a rough indication of how many thousands of millennia may have elapsed since their divergence from a common ancestor. That is, provided you believe in common ancestry—which Behe supposedly does.

Now think through what it might mean once you discover genes for different functions that nonetheless have very similar exon coding—*along with the same telltale intron placement*. Wouldn't that be hard not to attribute to gene duplication? That's the second thing about introns that bears on the evolution question, and is the underlying logic against which *Darwin's Black Box* offered no substantive defense.[91] In the meantime, evolutionary biologists have plowed ahead, tracing the intron/exon trail of nucleotide breadcrumbs to work out the successive duplications that have dispersed the large globin superfamily of genes over the last few hundred million years. This includes the extensive α and β hemoglobin families, as well as the oxygen-storing myoglobin proteins found in muscles.[92]

Behe apparently accepts this body of information at face value, as supporting common ancestry.[93] Yet there he invariably gets off the bus, dismissing any further conclusions to be drawn from the circumstantial trout in the milk on the grounds that they don't explain the origin of trout or milk. All through *Darwin's Black Box*, Behe dug in his heels in just this way to keep at bay the invidious evolutionary implications of shared molecular structure:

> The proteins of the blood coagulation cascade are often used as evidence for shuffling. Some regions of cascade proteins coded by separate gene pieces have similarities in their amino acid sequences with other regions of the same protein—that is, they are self-similar. Also, there are similarities between regions of different proteins of the cascade. For example, proconvertin, Christmas

> factor, Stuart factor, and prothrombin all have a roughly similar region of their amino acid sequences. Additionally, in all those proteins the sequence is modified by vitamin K. Furthermore, the regions are similar in sequence to other proteins (not involved with blood coagulation at all) that are also modified by vitamin K.
>
> The sequence similarities are there for all to see and cannot be disputed. By itself, however, the hypothesis of gene duplication and shuffling says nothing about how any particular protein or protein system was first produced—whether slowly or suddenly, or whether by natural selection or some other mechanism. Remember, a mousetrap spring might in some way resemble a clock spring, and a crowbar might resemble a mousetrap hammer, but the similarities say nothing about how a mousetrap is produced. In order to claim that a system developed gradually by a Darwinian mechanism a person must show that the function of the system could "have been formed by numerous successive, slight modifications."[94]

It was quite a leap indeed for Behe to argue that the occurrence of gene duplication "says nothing" about the origin of a system whose components show all the defining characteristics of having originated through gene duplication. But are evolutionary biologists really not allowed to draw these conclusions until they have accounted for the initial generation of kringles or finger modules? This is the same slippery slope that leads some creationists to insist that "evolution" hasn't taken place because Darwinists haven't explained the origin of life. However comforting that approach may be as a philosophical security blanket for antievolutionists, it is a decidedly unproductive dead-end recipe should it be adopted generally in the natural sciences.

Despite the cheery optimism of some abstract physicists who anticipate the imminent formulation of a "theory of everything," the historical record of scientific investigation strongly suggests that beneath any level of understanding there may only lie more mystery. Parents have been grappling with that phenomenon when trying to answer an incessantly inquisitive child. *Why is the sky blue?* "Because light is scattered by lots of nitrogen gas in the atmosphere." *Why is the nitrogen there?* "Because of the way planets get formed." *No, why is there nitrogen anywhere?* "Because big old stars made it long ago." *Why are there stars*? "Because gravity compresses hydrogen gas until stars form." *Why?* "Because the universe is structured that way." *Why?* "Because … go play hopscotch."

Had the child wondered instead why light scatters as it does, there would have been a chain of questions leading to another brick wall: why matter is organized so that it gives off quanta at all. Physicists exploring the billiard ball atoms of the early 20th century discovered them to be composed of "fundamental" particles like protons and neutrons that were themselves made of "even more fundamental" quarks that may really be manifestations of "even more fundamental yet" strings of vibrating probability states. No one has the foggiest idea of where this regress will end, if at all.

Unlike that inquiring child, Behe was using his questions as a way to expedite getting to the hopscotch, posing the conundrum of irreducible complexity not in order to thoroughly explore that level of biological reality so much as to circumvent pondering the implications of the previous levels. And thus did *Darwin's Black Box* assiduously follow the rote creationist practice of closing research doors rather than opening them. An endnote observed:

> Indeed, some proteins we have discussed in this book have sequences or shapes similar to other proteins. For example, antibodies are shaped similarly to a protein called superoxide dismutase, which helps protect the cell against damage by oxygen. And rhodopsin, which is used in vision, is similar to a protein found in bacteria, called bactreiorhodopsin, which is involved in the production of energy. Nonetheless, the similarities tell us nothing about how vision or the immune system could develop step-by-step.[95]

Behe may well obtain a record for the number of "nothings" he has chalked up on the track board of molecular evolution. But if gene duplication is capable of proliferating batches of similar molecules prone to inveigling their way into the developing metabolic system, Behe seems less than innately curious enough to be the one to find out.

Much as Phillip Johnson had with finch beaks and birds, Behe tended to nudge the issue farther away from the focused topic of gene duplication as he went along. For him, the bottomless wastebasket was a nebulous reference to *descent*:

> Although useful for determining possible lines of descent, which is an interesting question in its own right, comparing sequences cannot show how a complex biochemical system achieved its function—the question that most concerns us in this book. By way of analogy, the instruction manuals for two different models of computer put out by the same company might have many identical words, sentences, and even paragraphs, suggesting a common ancestry (perhaps the same author wrote both manuals), but comparing the sequences of letters in the instruction manuals will never tell us if a computer can be produced step-by-step starting from a typewriter.[96]

Here was another of Behe's misfired analogies, but this time it had attached a most revealing conceptual fuse.

Superficially, the analogy was simply inappropriate: the DNA found in living things isn't very much like the user's guide included in the little plastic wrapper taped to a new CPU. Any terminology chosen for computer manuals could reflect the stylistic considerations of their author and might therefore be related for that reason. But the connections at that level would be purely arbitrary. A foreign mistranslation of "keystroke" as "breaststroke" wouldn't really change anything in the computer. But that's exactly *not* what happens with mutations to DNA, as biochemist Behe must assuredly know. The biological gizmo and its DNA code are far more intimately associated than that, making DNA like the machine code for the operating system, not the instruction manual. Admitting to changes in DNA involves significantly more than the recognition of rhetorical similarity—it is an implicit acknowledgement of tangible transformations taking place somewhere within the physical mechanism.

That is why Behe's references to "descent" are so perplexing. You are *descended* from your grandparents because of a causal natural process, not because of the sequential intervention of stork deliveries. Supposing that a lizard can never naturally reproduce anything except another lizard within its "type," giving birth to a shrew one day would be just as miraculous as if the shrew had materialized from thin air. The shrew would not be "descended" from the lizard any more than the Biblical Eve was "descended" from Adam's rib, and the investigation of the biology of lizards and shrews would be no more productive than a study of male rib anatomy concerning the origin of women.

But we already have some paleontological clue about the lizard-to-shrew process, don't we? So let's broaden the cast to consider a therapsid and a bacterium, or a sea urchin and a parakeet. Remarking on their "common ancestry" is to subsume even their most blatant macroevolutionary distinctions under the umbrella of physical lineage. However disparate they may be today, in order for a therapsid and a parakeet to share "common ancestry" their sundry DNA variations must somehow have come about through the same natural process that governs reproduction and speciation. That's what "common descent" would signify to a paleontologist, for example—but apparently not to Behe. By proposing one or more miraculous interventions of design Behe has interposed a yawning biological discontinuity that makes his use of the term "common ancestry" extremely suspect. If what Behe believes about irreducibly complex systems were true, the bacterium and the sea urchin (failing as they do to share an antibody-based immune system) would not have come to their present condition along a conventional natural line of descent that would include vertebrates. At some point their origins would be just as transcendently "unnatural" as Jesus' purported virgin birth, someone not quite a "son of Joseph" in the genetic sense that our present understanding of procreation would have it.[97]

Parked squarely at his molecular keyhole, the only thing for Behe to accept about the "common ancestry" of the collective genome are those similarities in DNA coding which might be attributed to common authorship in the same way as wandering plot lines and unbelievable coincidences characterize a serialized Dickens novel. That would explain the soothing mantra of abject irrelevance Behe assigns to the findings of molecular comparison, for the "descent" he has agreed to as its only allowed interpretation turns out to be merely another way Behe has elected to conceptualize design.

In this respect *Darwin's Black Box* may have ascended to new heights when it comes to the creationist cottage industry of Zeno-slicing. This time the antievolutionary Tortoise triumphantly crosses the finish line without a strain because Achilles is never let on the field to compete. Playing the role of referee in this exercise, Behe whistled whole disciplines onto the sideline:

> Thus biochemistry offers a Lilliputian challenge to Darwin. Anatomy is, quite simply, irrelevant to the question of whether evolution could take place on the molecular level. So is the fossil record. It no longer matters whether there are huge gaps in the fossil record or whether the record is as continuous as that of U.S. presidents. And if there are gaps, it does not matter whether they can be explained plausibly. The fossil record has nothing to tell us about whether the interaction of 11-*cis*-retinal with rhodopsin, transducin, and phosphodiesterase could have developed step-by-step. Neither do the patterns of biogeography matter, nor those of population biology, nor the traditional explanations of evolutionary theory for rudimentary organs or species abundance. This is not to say that random mutation is a myth, or that Darwinism fails to explain anything (it explains microevolution very nicely), or that large-scale phenomena like population genetics don't matter. They do. Until recently, however, evolutionary biologists could be unconcerned with the molecular details of life because so little was known about them. Now the black box of the cell has been opened, and the infinitesmal [*sic*] world that stands revealed must be explained.[98]

As indeed it must … and to the extent that the available technical skills permit, evolutionists have been hot at it. But Behe's restricted Lilliputian equation cuts both ways, especially when applied to the realm of paleontology. Complex organisms like the first horses or sauropods would have acquired their eyes from their immediate ancestors as a done deal. It therefore wouldn't matter to the issue of their particular evolution what processes governed the first appearance of eyes hundreds of millions of years earlier. Even if there proved to be a truly insoluble mystery about how "the interaction of 11-*cis*-retinal with rhodopsin, transducin, and phosphodiesterase" came to be initially, the vast bulk of observed "evolution" would remain just as reasonably inferable from the fossil evidence, up to and including the macroevolutionary reptile-mammal transition.

Behe did charitably allow that "those who labor in the fields of paleontology, comparative anatomy, population genetics, and biogeography should not invoke design until the molecular sciences show that design has an effect at those higher levels."[99] But that was his keyhole perspective showing again, for Behe did not explain just what that was supposed to mean. Did "higher levels" refer to the complexity of a mammal's adaptations, or the role of developmental genes like *homeobox* (the hot topic of 1990s evolutionary biology that never came up in *Darwin's Black Box*), or what? The fact was that Behe showed no reciprocal *noblesse oblige* by accepting any significant Darwinian utterances tossed down the conclusion chute from those aforesaid disciplines (as the whale episode shall shortly illustrate for paleontology). Nor was the reader given any indication of where on Behe's Intelligent Design landscape the boundaries of "microevolution" might be drawn (with finches … horses … sauropods … therapsids?) or in what respect population genetics *did* matter.[100]

No less than with his Byzantine acceptance of common descent, Behe all too readily acknowledged evolutionary terminology without giving a clue to what that meant for his own practical understanding. Certainly none of these surface caveats filtered up through the creationist food chain. Just as no design advocate cited *Evolution: A Theory in Crisis* in order to expound on Michael Denton's potentially corrosive admission of Darwinian speciation (allowing horses in the microevolutionary parade, for example), those invoking *Darwin's Black Box* did not have common descent or biogeography on their minds.

For creationists, irreducible complexity has the ring of special authority about it both because of Behe's academic credentials and the elegant simplicity of the claim. Here were biochemical mousetraps thumbing their designer noses at the secular humanists in much the same way as Robert Gentry's polonium halos. The problem was that Behe had not in fact got around to solidly establishing the irreducible complexity of *any* of his examples … a not inconsiderable methodological lapse that none of the creationist writers extolling *Darwin's Black Box* happened to notice. Which suggests that in everyday usage Intelligent Design is unlikely to stimulate the antievolutionary imagination sufficiently to overcome its historical reluctance to look gift horses in the mouth.[101]

Behind the molecular veneer of prothrombin and 11-*cis*-retinal lies a broader philosophical minefield that returns us to the quintessential creationist oversight: the failure to follow through on the logic of their own position. With the exception of eccentrics like Richard Milton, antievolutionists are out to confirm the reality of *creation*, where the "designer" is none other than *the* Designer. But divine personages of that character customarily have attached a considerable theology, often with embarrassingly detailed chronicles of the deity's alleged actions and goals. We have already seen how the God of Abraham is claimed to have repented of making mankind at one point, and of having caused the physical obliteration of the earth's surface via the Flood to correct that oversight. Relating the designed natural system to that transcendental data set would seem the most essential thing in the world for a *theistic* science founded on a Biblical worldview to think about.

But what about the other side of the equation: what does it mean to be a theistic *science*? In a scientific discipline meaningful hypotheses are in principle refutable, and those that have successfully run the gauntlet of test and criticism long enough to graduate may be considered a solid theory, as have gravitation and (gasp!) evolution. But do the advocates (and nominal practitioners) of theistic science show themselves open to submitting their conclusions and assumptions to that same uncompromising wringer? Can the comparison of evidence ever compel them to decide, "well, that certainly doesn't fit the idea of God I had in mind"—and on that basis conclude that their conception of how God interacts with the physical world might be *wrong*?

This is definitely not the sort of thing creationists are primed to think about. Which ironically plops them down slightly to one side of conventional Darwinists when it comes to evaluating the evidence of the natural world. Evolutionists don't have to worry about finding teleological "meaning" or "purpose" in their research, because methodological naturalism doesn't consider those issues part of the science game. This isn't to say that thinkers of the Richard Dawkins stripe haven't enthusiastically weighed in on the burning questions of "God" and "matter" that so rile Phillip Johnson. But the actual focus of an evolutionist's work will be to poke around a natural "iceberg" with an eye to amassing enough useful observation at one level to make grinding the "hypothesis formation" mill at the next deeper level worthwhile.

Now creationists enter this picture as far from disinterested bystanders … but not usually to be found examining the machine itself so much as peeking over the shoulders of those who do. Advancing to the cutting edge of explanation where the tangle of unanswered questions is thickest, the creationists dutifully winnow out what they can and *leave the rest alone*. But even with what information they have commandeered to their apologetic purpose, creationists do not press on to seriously consider to what extent they have tumbled onto a purposeful "*Titanic*" that may not be at all congenial to their denominational concerns.

This is what tags along with Behe's irreducibly complex immune system. *Darwin's Black Box* never slowed down long enough in the monotonous refrain of "this can tell us nothing" to consider what implications the pattern and character of that system being a *designed object* might hold for his own metaphysic. Following that trail proves as indicative of the utility of Intelligent Design philosophy for theistic science as tracking down Duane Gish's lapses on Triassic geology did to denote the scholarly scruples of Scientific Creationism.

The first clue concerns the *diversity* of the immune system, which differs among vertebrates and invertebrates in ways distinct from the comparative uniformity of the clotting cascade. That is helpful because stepping back a notch and comparing variations can often be the key to resolving complex scientific problems. Especially when you can't play around with the components experimentally, it's instructive to see whether nature may have gone ahead and done some of the more interesting lab work on its own. Taking the example of meteorology again, observing dust storms on Mars may actually help the understanding of earth's more unpredictable weather. Why? Because Mars has no *oceans*, thus removing a hugely complicating set of variables that make terrestrial climate analysis such a pain—and even controversy, as when the topic is global warming.

With biological variation being the stuff of evolution, the field of comparative immunology has naturally become a frontline player in the quest to make sense of the emerging pattern visible once the metabolism is viewed across phylogenetic lines. But off at the Intelligent Design ranch that busy discipline's recent findings were summarily corralled: "A search of the immunological literature shows ongoing work in comparative immunology (the study of the immune systems from various species). But that work, valuable though it is, does not address in molecular detail the question of how immune systems originated."[102]

Once more Behe was calling attention to the absence of a "step-by-step" Darwinian origin theory concerning a body of work consisting of the more plodding "step-by-step" accumulation of the root data and preliminary speculation whereby questions of origin might eventually be answered.[103] This mantra of molecular reductionism appears to play the same narcotic role for Behe as "fully formed" does for Duane Gish and the dinosaurs. Just as Gish thought he could make sweeping pronouncements about the fossil record without offering any of the relevant geological context, Behe left all the "valuable" lessons of comparative immunology outside the Intelligent Design debating hall. Just what such information might entail was coincidentally shown right about the time *Darwin's Black Box* came out, by a 1996 article in *Scientific American* summarizing what had been discovered so far about the immune system.[104]

The innate immune response to cellular intruders is the "engulf and devour" approach. But whereas vertebrates have ended up using white blood cell macrophages for that task, the invertebrates have split off in a different direction, employing specialized coelomocyte cells to the same end. The macrophages are assisted by thirty-odd blood proteins called *complement* that help identify and destroy nonself invaders, but here too a commonality is to be found hiding among the differences:

> In place of complement, several phyla of invertebrates, including insects, crabs and worms, exhibit a similar response, called the prophenoloxidase (proPO) system. Like the complement system, proPO is activated by a series of enzymes. A cascade of reactions ends with the conversion of proPO to the fully active enzyme phenoloxidase, which plays a role in encapsulating foreign objects. Kenneth Söderhäll of the University of Uppsala in Sweden and Valerie J. Smith of Gatty Marine Laboratory in Scotland have shown that the system serves other purposes as well, including blood coagulation and the killing of microbes.
>
> Invertebrates lack lymphocytes and an antibody-based humoral immune system. Nevertheless, they do have mechanisms that seem to be precursors of those aspects of vertebrate immunity. For example, lymphocytelike cells have been found in earthworms—which probably appeared 500 million years ago. Perhaps more significantly, all invertebrates have molecules that appear to function much like antibodies and may be their forerunners. These molecules, a group of proteins called lectins, can bind to sugar molecules on cells, thereby making the cells sticky and causing them to clump. Lectins must have evolved quite early because they are ubiquitous; they are found in plants, bacteria and vertebrates, in addition to invertebrates.
>
> The role of lectins in immune responses is not known exactly; they appear to play a part in tagging invading organisms, which are probably covered with different sugar molecules. Lectins isolated from earthworms, snails, clams and virtually every other invertebrate animal participate in the coating of foreign particles, thus enhancing phagocytosis. Numerous lectins with different sugar

> specificities can be found in each animal phylum. Lectins isolated from the flesh fly, *Sarcophaga peregrina*, and from the sea urchin are related to a family of vertebrate proteins called collectins. In humans, collectins serve important roles in innate immunity by coating microbes so they can be more easily identified by phagocytes and by activating immune cells or complement.
>
> And although antibodies are not found in invertebrates, molecules that are structurally and even functionally similar to them are. Antibodies (also known as immunoglobulins) belong to a very large, very old family of molecules—the immunoglobulin superfamily. Molecules of this group all have a characteristic structure called the Ig fold. They serve diverse functions but in general are involved with recognizing nonself as well as other types of molecules.[105]

Whether there exists a substrate of genetic switches that long ago flipped one way for chordates and another in the invertebrate line will eventually be tested by meticulously examining the immune system code itself. Should a future experimental biology be capable of playing artificial designer, it could also be investigated whether there are other natural ways for an "immune system" to operate besides the examples encountered in extant forms. At that point it would even be possible for Intelligent Design to take a second swing at the irreducible complexity argument—assuming, of course, by then Behe's original examples were still resting on the "unexplained" tray.

And while evolutionists plod their way toward specifying their grubby step-by-step Darwinian explanations with the tools at hand … what are the odds that Behe will only find more to fault with them? After all, there would still be lectins and collectins to account for—and if worse comes to worst, there's always the existence of matter to explain.

Intelligent Design Teleology: *Titanic* or Iceberg?

But this debate over which provides a better provisional explanation for the immune system (unguided natural gene duplication versus interventionist design) begs another of those absurdly obvious questions, like those previously seen concerning the existence of Cambrian shells or avian bipedality. Supposing the immune system was designed, *what was it designed for?*

Methodological naturalists don't have to bother about this question because they don't believe features like the immune system were deliberately "designed" for anything to begin with. But the "awkward" philosophical significance of taking the immune system as an artifact comes into sharper focus when it is contrasted with the function of another of Behe's irreducibly complex quintet: the blood clotting cascade. If an animal exists, and if the physical properties of matter are not tweaked, then unless it were armor plated there would always be the possibility of accidentally bumping into things in such a way as to cause the animal to bleed to death. The existence of a blood clotting apparatus would therefore be as necessary for a designed ecosystem as for a chance-driven one, the common response to the "thousand natural shocks that flesh is heir to."

But why ever would living things need an *immune system*?

The immune system is not a response to "accidents" of the sort the clotting cascade confronts. Killer *T* cells are set on their deadly mission as a means of repelling overt invaders, from bacteria whose natural metabolism threatens the system to viruses that aren't really "alive" on their own, but function like subroutines that reprogram the cellular machinery to manufacture copies of themselves. To attribute the core of the immune system to design is therefore to say at least a few things about those agents of harm. Was the designer trying to come up with an automated mechanism that could respond to a cast of intruders over which the designer otherwise had no control? In that case the observed immune system would be a fairly exemplary design solution—though by no means an infallible one. Just as blood clotting is normally carried off quite effectively (except in hemophilia) the immune system is likewise a fabulous wonder, unless a mutation tricks it into deciding "self" is "nonself" and lymphocytes start devouring your insides.

This version of the designer is not quite that one perfect Designer conservative Christian creationists so fervently believe in. Their proposed creator is a supremely omnipotent agent, who must therefore evidently suffer bacteria to exist for some other reason than "circumstances beyond our control." Now it could be that dangerous bacteria come with the turf—that no possible functional ecosystem can exist without there being forms that can interfere with one another. But this brings us back to the idea that there are physical constraints to God's creative power. This is not a Bible-friendly concept (and would take the wind out of the assorted anthropic defenses for God's existence to be discussed later). Furthermore, that same reasoning can be promptly turned on its head to propose that God couldn't have avoided creating a material universe in which living things are capable of *evolving*.

Of course, the traditional Biblical view may pertain: that nasty things like deadly protozoa exist as a part of the judgment on mankind occasioned by original sin. But even if that were true, there would still be the need for theistic science to think through the implications of why the system works as it does, and not in some other way. If bacteria were the wages of the Fall, why not have designer plagues targeting iniquity or heretics directly, in the way the God of Abraham was reported to have selectively exterminated Egypt's firstborn in Exodus? Why go to all the trouble of constructing an intricate defense force whose only job is to see to it that the wages of sin are deferred to a later date?

Independent then of *why* dangerous organisms are on the scene (by divine fiat or natural process) there are observations to be made by a rational intelligence concerning the structure and suitability of the mechanism designed to deal with them. When it comes to the immune system, the way it is set up suggests an operation where there is no obvious connection between the activity of the invading threat and the survival of the assailed host other than the luck of the draw … the immune system as *lottery*.

Now the logic of a naturalistic Darwinian operation *also* leads to an immune system that functions like a lottery. And here is where the philosophical going gets rough for Intelligent Design no less than Creation Science. For if everything evolved naturally from common ancestors, their metabolic parts kit would inevitably overlap and disease effects would be unavoidable. Naturally any organism incapable of blunting an attack won't survive, so the most imperative selection pressure of all would be to develop a good biological defense. Which means that God would have deliberately designed an immune system that coincidentally looked like the one that would have arisen in a purely naturalistic context. But isn't that what we've been seeing all along? The Permian and Triassic were littered with synapsids that exactly resembled what you'd expect if those reptiles were evolving into mammals. Feathered dinosaurs have dropped in as though on cue to make Darwinian paleontologists happy. Even the embryology of horses recapitulates their imagined ancestry as manifestly as do the repressed genes of hen's teeth.

This is the "awkward" question of *pattern* that creationists resolutely will not think about, and it's not difficult to understand why. It is creationism's Scylla and Charybdis—twin monsters that grow ever fiercer with each new evolutionary discovery. Either the designer was too much of a dunce not to realize how all this was going to look to recalcitrant vertebrate skeptics a few hundred million years later … or the creator indulged in all this with the purposeful intent of beguiling naturalists into believing in Darwinian evolution. Neither option appears particularly attractive from a scriptural point of view.

Given how contemporary creationist philosophy objects to the idea of a relentlessly chancy universe, there is something decidedly fishy (beyond the trout in the milk) about the readiness of Behe to attribute glaring examples of it like the immune system to design. And there is further irony to the circumstance that while creationists are not liable to speculate on such purposeful matters, evolutionists are nowhere near so shy.

Consider Behe's apparent assent to Lynn Margulis' influential (and still somewhat controversial) ideas about endosymbiosis. This is the view that eukaryotic organelles are actually formerly free-living organisms that invaded long ago—only to stay and set up housekeeping. Mitochondria resemble primitive purple bacteria more than they do the nucleated cells in which they now reside, as well as retaining their own proprietary DNA. Along with plant chloroplasts (once cyanobacteria), their endosymbiotic origin has won over even its staunchest critics. But Behe kept all this at arm's length: "Symbiosis theory may have important points to make about the development of life on earth, but it cannot explain the ultimate origin of complex systems."[106]

Behe might have explained a bit more (or even *anything*) about what he thought of those "important points" the symbiosis theory might have made concerning that uneventful two-billion-or-so years life has spent lollygagging about since the proposed mitochondrial hijacking.[107] Even better had Behe stooped to relate any of those insights to his own Intelligent Design conceptions, so we might better understand what those were. One intriguing example concerns the oxidative phosphorylation pathway in the ATP energy cycle (which generates about 120 watts for a typical human). It turns out many proteins used here are coded jointly by the host's nuclear DNA and the mitochondrial DNA (mtDNA). Here are more of those "interrupted genes" Behe chanced to remark on above … only in spades. For by so contributing critical exons to the system, mtDNA is keeping as tight a grip on its host cells (which include us) as certain fungi do the cyanobacteria used to generate food in the symbiotic lichens.[108]

Evolutionist John Avise found this mitochondrial ATP parasitism especially relevant to the design question:

> Why in the world would an omnipotent biochemical engineer jury-rig such a molecular patchwork to perform the most indispensable of metabolic functions? Why should genes of bacterial origin (mitochondria) be utilized at all to govern critical energy production in the cells of higher animals, humans included? Perhaps there is some (meta)physical necessity for this state of affairs that we don't yet understand, but if so, why wouldn't a creator at least have the good sense to demand that these mitochondria efficiently complete the task of oxidative phosphorylation without the inefficient and cumbersome complications of nuclear gene involvement? How can our metabolic fates be left in such a precarious position? Evolution provides the best explanation.[109]

Creationists are well aware of this category of "argument from imperfection" because when evolutionists are challenged on the issue of design they have a habit of bringing it up—in my own case it's what I've dubbed the *Titanic*-iceberg problem. Such reasoning plays an important role in the philosophical battle over where natural systems fall on the spectrum between Paley's divine Watchmaker and Dawkins' blind Darwinian one. But there is more to this than simply a squabble over detecting "purpose" in nature. There is a quite real and fundamental divide between creationists and evolutionists over how they approach such topics, and what they do with them once they get there.

Ironically enough, the hallmark of real "methodological naturalism" is that it invariably wants to know *why* something is so—conceptually, at least, that's the basement end of "meaning." And nowhere in science is this more evident than in evolutionary analysis, which affirms in no uncertain terms that there must be natural reasons for even the dumbest anatomical arrangement. One of the most common illustrations is the reversed structure of the vertebrate eye, resulting in a blind spot where the wiring has to poke through the retina to link up with the photoreceptor cells (which themselves point *away* from the light). The example turned up most recently in an essay on the new field of "Darwinian medicine" for *Scientific American* by Randolph Nesse and George Williams.[110]

Since the authors weren't penning a targeted criticism of creationism, their version neatly illustrates why there is more to the "imperfection" argument than just a talking point in the creation-evolution debate. The quest for evolutionary understanding necessarily spans the ages and can't help connecting up with other things:

> Because evolution can take place only in the direction of time's arrow, an organism's design is constrained by structures already in place. As noted, the vertebrate eye is arranged backward. The squid eye, in contrast, is free from this defect, with vessels and nerves running on the outside, penetrating where necessary and pinning down the retina so it cannot detach. The human eye's flaw results from simple bad luck; hundreds of millions of years ago, the layer of cells that happened to become sensitive to light in our ancestors was positioned

> differently from the corresponding layer in ancestors of squids. The two designs evolved along separate tracks, and there is no going back.
>
> Such path dependence also explains why the simple act of swallowing can be life-threatening. Our respiratory and food passages intersect because in an early lungfish ancestor the air opening for breathing at the surface was understandably located at the top of the snout and led into a common space shared by the food passageway. Because natural selection cannot start from scratch, humans are stuck with the possibility that food will clog the opening to our lungs.
>
> The path of natural selection can even lead to a potentially fatal cul-de-sac, as in the case of the appendix, that vestige of a cavity that our ancestors employed in digestion. Because it no longer performs that function, and as it can kill when infected, the expectation might be that natural selection would have eliminated it. The reality is more complex. Appendicitis results when inflammation causes swelling, which compresses the artery supplying blood to the appendix. Blood flow protects against bacterial growth, so any reduction aids infection, which creates more swelling. If the blood supply is cut off completely, bacteria have free rein until the appendix bursts. A slender appendix is especially susceptible to this chain of events, so appendicitis may, paradoxically, apply the selective pressure that maintains a large appendix. Far from arguing that everything in the body is perfect, an evolutionary analysis reveals that we live with some very unfortunate legacies and that some vulnerabilities may even be actively maintained by the force of natural selection.[111]

Michael Behe discussed the retinal wiring problem solely as it related to the "argument from imperfection." Drawing on an account in *Technology Review* by Kenneth Miller, Behe concluded that the evolutionist's argument was "based on psychology and emotion, instead of hard science."[112] How Behe went about showing that, and what didn't get explored in the process, couldn't have been more different from the way Nesse and Williams tackled the matter:

> Miller elegantly expresses a basic confusion; the key to intelligent-design theory is *not* whether a "basic structural plan is the obvious product of design." The conclusion of intelligent design for physically interacting systems rests on the observation of highly specific, irreducible complexity—the ordering of separate, well-fitted components to achieve a function that is beyond any of the components themselves. Although I emphasize that one has to examine molecular systems for evidence of design, let's use Miller's essay as a springboard to examine other problems with the argument from imperfection.
>
> The most basic problem is that the argument demands perfection at all. Clearly, designers who have the ability to make better designs do not necessarily do so. For example, in manufacturing, "built-in obsolescence" is not uncommon—a product is intentionally made so it will not last as long as it might, for reasons that supercede the simple goal of engineering excellence. Another example is a personal one: I do not give my children the best, fanciest toys because I do not want to spoil them, and because I want them to learn the value of a dollar. The argument from imperfection overlooks the possibility that the designer might have multiple motives, with engineering excellence oftentimes relegated to a secondary role. Most people throughout history have thought that life was designed despite sickness, death, and other obvious imperfections.
>
> Another problem with the argument from imperfection is that it critically depends on the psychoanalysis of the unidentified designer. Yet the reasons that a designer would or would not do anything are virtually impossible to know unless the designer tells you specifically what those reasons are. One only has to go into a modern art gallery to come across designed objects for which the purposes are completely obscure (to me at least). Features that strike us as odd

> in a design might have been placed there by the designer for a reason—for artistic reasons, for variety, to show off, for some as-yet-undetected practical purpose, or for some unguessable reason—or they might not. Odd they may be, but they may still be designed by an intelligence. The point of scientific interest is not the internal mental state of the designer but whether one can detect design.[113]

Ah … but is not the issue also whether it is possible to detect *bad* design? On that matter Behe has edged himself out onto some very thin ice, dragging the philosophical pretensions of Intelligent Design along with him. By arguing in principle that it was unjustified to render *any* meaningful technical conclusions about designed objects—or at least, those being attributed to transcendent craftsmanship—*Darwin's Black Box* has effectively applied moral relativism to practical engineering. Now, no matter how cumbersome, stupid, or reckless a biological *Titanic* might appear in our eyes, none of this may reflect back unfavorably on the designer. Being that we mere mortals are not privy to the divine game plan, a theistic science is evidently not supposed to notice such anomalies solely on the grounds that there might be a higher context in which they would make perfect sense.

Which means there is an element of "perfection" to the Intelligent Design conception after all. Otherwise, why not simply concede examples of fallibility and be done with it? ("Of course God uses sloppy engineering—does it all the time … no problem for us there!") Behe's failure to indulge in that particular admission quietly affirmed the logic underlying Miller's "basic confusion": that there is indeed something intellectually unpalatable about "awkward" design showing up in the direct handiwork of a deity. Though no more awkward, perhaps, than the misshapen analogies Behe offered to let theistic science off the judgmental hook here. Prone as I am to sarcasm, this veritable cavalcade of "misplaced concreteness" was too hard to resist.

Does Behe seriously want to intimate that the divine author's motives might be like that grasping "short-term profit at the expense of safety" attitude distinctive of Detroit's planned obsolescence before the advent of St. Ralph Nader? Or was it that the designer really liked squid best, accounting for the streamlined wiring having been lavished on them instead of the vertebrates? Then again, cephalopods don't really need to appreciate the value of a dollar, do they? (Certainly not when it comes to paying the ophthalmology bills of higher primates.) But the spectacle of the vertebrate blind spot as artistic statement was the most sublime. Applied to a notorious human example, would a decision to have painted the Tacoma Narrows Bridge *magenta* back in 1940 really have meant you weren't supposed to draw the appropriate engineering conclusions when it fell apart in the first stiff breeze?

Behe's analogies were so far from apt that they revealed more about his own mindset than they illuminated the scientific issue of retinal wiring. All his examples were framed in the most benign (if not banal) terms. But living biology features more than the equivalent of an annual sheet metal makeover to spur sales—on occasion the wonderful automatic transmission can drop out or even explode in flames. And while a parent who does not spoil their children with extravagant playthings may be practicing the virtue of thrift, the real life situation is tragically more like a skinflint failing to buy a safer more expensive toy. All too many natural diversions have hidden sharp edges—and should one of the little tykes slice off a finger or get tetanus, the Intelligent Designer has left the kids to work out that little matter on their own.

By sticking close to the keyhole and insisting that such questions were intrinsically illegitimate, Behe thought to invoke design at the Lilliputian level without dragging along any of the Brobdingnagian philosophical baggage. Which seemed an especially wimpy course to take given Phillip Johnson's moralizing how the new Theistic Realism manifested its superiority to Methodological Naturalism precisely because it would undertake that imperative quest for "meaning" and "purpose." When the opportunity arose for that speculation, Michael Behe seemed less disposed to such fancies than the evolutionists Avise and Miller. Is there not something highly incongruous about that?[114]

The closest Behe got to this subject was the vaulting naïveté of his throwaway observation that "Most people throughout history have thought that life was designed despite sickness, death, and other obvious imperfections." So obvious, in fact, that any religion with an eye out not to appear totally irrelevant had better have *something* to say about them. Fortunately, the many pantheons of vengeful or indifferent deities known through the ages have usually been as amenable to rationalizing disease and misfortune as medieval Christianity was chalking it all off to original sin. Only Aristotle and Leviticus knew not of *Archaeopteryx*—and until microscopes came along to reveal all the myriad of bacteria, viruses, nematode worms, and those tiny mites inhabiting our eyelashes, there was a lot less about the natural "design" to accommodate. What a surprise then: people who believed in gods that were supposed to create things came to the conclusion that the things they saw around them were "designed." And this quite independent of whether they actually were designed. Or had "common ancestry" Behe forgotten how animal "kinds" were thought to be the direct handiwork of God, unchanging and unchangeable?

Of course there are ways to account for the existence of natural imperfection without grinding the mental gears too painfully. There's even a rather nifty avenue to follow that involves neither original sin nor ostensible cruelty, but instead hitches a ride on the logic of free will and morality: in a world free of *defect*, of what meaning is *compassion*? This idea tags around the edges of folklore because it strikes a profoundly resonant chord. To be useful, ethical information must be tendered without distortion. So to observe the realm as it really is, the king must escape the insular world of obsequious courtiers and venture out in the guise of a commoner. The Beast may only be restored to a handsome prince when Beauty's kiss is bestowed free of coercion. And when some hotheaded hero blunders onto an infirm peasant, the kindness shown to no reciprocal benefit turns out to have been an important test passed—the peasant actually being a powerful spirit or wizard in disguise.[115]

Not that this insight helps the Christian creationist's theological case much. For human beings could just as easily have been put on earth as moral lab rats, where the individual response of sentient beings to random travail would be the object of a clinical exercise—not as a path either to salvation or Nirvana. Perhaps on some distant planet there is an annoyingly smug and healthy humanoid control group whose environment includes mosquitoes specifically engineered to spit out *Plasmodium falciparum* at the first sign of trouble.

While the idea of God operating in B. F. Skinner mode is arguably a most ghastly oxymoron, that weird possibility only indicates the depth of the perplexing mystery of life that *Darwin's Black Box* seemed only willing to apply to molecules like interrupted genes. Religion and philosophy remain the perennially contentious and intractable subjects they are because humanity's assorted conceptions of God and transcendence have trouble resolving their own absolute differences—let alone keeping up with the scientifically described physical reality, where last millennium's theology may not apply so well to this century's biotechnology. But rather than delving honestly into the nature of their own belief system, including both its promises and drawbacks, it is far easier for the creationist to dig their trenches on the frontier of evolutionary discovery and hope the barbed wire holds.

How scientifically restricting this Maginot Line approach to antievolutionism can get was clinched by what Behe discussed next in his attempt to dispose of the imperfection argument. It was especially interesting because it was the only spot in *Darwin's Black Box* where the subject of *pseudogenes* came up, a genetic feature that carries the intron/exon issue onto yet another level of what might be called "reducible complexity."

Just as genes can be duplicated, so too may they be shut off, and if the gene is performing a critical function … well, exit one Bridge table. But because gene duplications by definition expand the number of players, it is possible for those to be disconnected without the organism being any the wiser. And therein lies the evolutionary fun, for the genetic mechanism of eukaryotes really has no way to tidy things up later to rid themselves of these superfluous pseudogenes. Consequently, genes that get turned off simply sit there—randomly mutating, of course, but otherwise being carried over and piling up in the general process of replication generation after generation … species after genus after family.[116]

Dangling like charms from the great chain of life, pseudogenes have a story to tell about the epic of descent with modification. Here's Behe's version:

> There is a subcategory of the no-designer-would-have-done-it-in-this-way argument that requires a different response. Instead of saying that a useful

structure contains flaws that should not have been allowed, the writer points to some feature that has no apparent use at all. Often the feature resembles something that is actually used in other species, and so appears to be something that was in fact used at one time but then lost its function. Vestigial organs play a prominent role in this argument. For example, evolutionary biologist Douglas Futuyma cites the "rudimentary eyes of cave animals; the tiny, useless legs of many snakelike lizards; [and] the vestiges of the pelvis in pythons" as evidence that evolution has occurred. Since I'm a biochemist, I prefer molecular versions of this argument. Ken Miller talks about the several genes that produce different forms of hemoglobin in humans:

> Are the five genes of this complex the elegant products of design, or a series of mistakes of which evolution took advantage? The cluster itself, or more specifically a sixth β-globin gene in the cluster, provides the answer. This gene is … nearly identical to that of the other five genes. Oddly, however, this gene … plays no role in producing hemoglobin. Biologists call such regions "pseudogenes," reflecting the fact that however much they may resemble working genes, in fact they are not.

Miller tells the readers that the pseudogene lacks the proper signals to inform the rest of the cell's machinery to make a protein from it. He then concludes as follows:

> The theory of intelligent design cannot explain the presence of nonfunctional pseudogenes unless it is willing to allow that the designer made serious errors, wasting millions of bases of DNA on a blueprint full of junk and scribbles. Evolution, in contrast, can easily explain them as nothing more than failed experiments in a random process of gene duplication that persist in the genome as evolutionary remnants.

This argument is unconvincing for three reasons. First, because we have not yet discovered a use for a structure does not mean that no use exists. The tonsils were once considered to be useless organs, but an important function in immunity has been discovered for them. A python pelvis might be doing something useful for which we are ignorant. This point also applies on the molecular scale; hemoglobin pseudogenes and other pseudogenes, although they are not used to make proteins, may be used for other things that we don't know about. A couple of potential uses that spring to mind as I sit here at my desk include bonding to active hemoglobin genes during DNA replication in order to stabilize the DNA; guiding DNA recombination events; and aligning protein factors relative to the active genes. Whether any of these are actual duties of the pseudogene for hemoglobin does not matter. The point here is that Miller's assertion rests on assumptions only.

The second reason why Miller's argument fails to persuade is that even if pseudogenes have no function, evolution has "explained" nothing about how pseudogenes arose. In order to make even a pseudocopy of a gene, a dozen sophisticated proteins are required: to pry apart the two DNA strands, to align the copying machinery at the right place, to stitch the nucleotides together into a string, to insert the pseudocopy back into the DNA, and much more. In his article Miller has not told us how any of these functions might have arisen in a Darwinian step-by-step process, nor has he pointed to articles in the scientific literature where we can find the information. He can't do that, because the information is nowhere to be found.

Folks such as Douglas Futuyma, who cite vestigial organs as evidence of evolution, have the same problem. Futuyma never explains how a real pelvis or eye developed in the first place, so as to be able to give rise to a vestigial organ later on, yet both the functioning organ and the vestigial organ require explanation. I do not purport to understand everything about design or evolution—far from it; I just cannot ignore the evidence for design. If I insert a letter into a photocopier, for instance, and it makes a dozen good copies and one copy that has a couple of large smears on it, I would be wrong to use the smeared copy as evidence that the photocopier arose by chance.

Arguments based on perceived faults or vestigial genes and organs run the danger of the argument of Diogenes that the progression of seasons show intelligent design. It is scientifically unsound to make any assumptions of the way things ought to be.

The third reason why Miller's argument misses the mark is actually quite understandable. It arises from the confusion of two separate ideas—the theory that life was intelligently designed and the theory that the earth is young. Because religious groups who strongly advocate both ideas have been in the headlines over the past several decades, much of the public thinks that the two ideas are necessarily linked. Implicit in Ken Miller's argument about pseudogenes, and absolutely required for his conclusions, is the idea that the designer had to have made life recently. *That is not a part of intelligent-design theory*. The conclusion that some features of life were designed can be made in the absence of knowledge about when the designing took place. A child who looks at the faces on Mt. Rushmore immediately knows that they were designed but might have no idea of their history; for all she knows, the faces might have been designed the day before she got there, or might have been there since the beginning of time. An art museum might display a statue of a bronze cat purportedly made in Egypt thousands of years ago—until the statue is examined by technologically advanced methods and shown to be a modern forgery. In either case, though, the bronze cat was certainly designed by an intelligent agent.

The irreducibly complex biochemical systems that I have discussed in this book did not have to be produced recently. It is entirely possible, based simply on an examination of the systems themselves, that they were designed billions of years ago and that they have been passed down to the present by the normal process of cellular reproduction. Perhaps a speculative scenario will illustrate the point. Suppose that nearly four billion years ago the designer made the first cell, already containing all of the irreducibly complex biochemical systems discussed here and many others. (One can postulate that the designs for systems that were to be used later, such as blood-clotting, were present but not "turned on." In present-day organisms plenty of genes are turned off for a while, sometimes for generations, to be turned on at a later time.) Additionally, suppose the designer placed into the cell some other systems for which we cannot adduce enough evidence to conclude design. The cell containing the designed systems then was left on autopilot to reproduce, mutate, eat and be eaten, bump against rocks, and suffer all the vagaries of life on earth. During this process, *pace* Ken Miller, pseudogenes might occasionally arise and a complex organ might become nonfunctional. These chance events do not mean that the initial biochemical systems were not designed. The cellular warts and wrinkles that Miller takes as evidence of evolution may simply be evidence of age.

Simple ideas can take a surprising amount of time to be properly developed. One way in which a simple idea can be sidetracked is through conflation with an extraneous idea. When it is considered by itself—apart from logically unrelated ideas—the theory of intelligent design is seen to be quite robust, easily answering the argument from imperfection.[117]

But just how "easily" has Behe done this? First we were told that vestigial features might be neither vestigial nor functionless. Next, that even if evolutionists were right that these characters didn't do anything, their ultimate origin would have to be explained before scientists would be free to put forward meaningful observations about them. And besides, it was all evolutionists' fault anyway for confusing Intelligent Design with belief in a Young Earth. If this palaver is a typical example of how Behe's "robust" philosophy proposes to deal with the potentially recalcitrant problems of evolutionary life, Intelligent Design is headed for a lot of trouble.

Behe's recipe was to hack off any "extraneous" or "unrelated" meat until the eviscerated remains could be identified as an intelligently designed carcass. Of course, to arrive at his conclusions it was necessary to pay no attention whatsoever to the explanatory context of what *creation* is supposed to mean. The root of modern creationism is the Biblical tradition that separate "kinds" had been created pretty much as they are at some point in the past, undergoing only the most trivial (and tactically undefined) of "microevolution" since. So the matter of vestigial organs related directly to the notion of special creation: was it more likely that God had made cave animals with useless remnant eyes or that these forms had derived via some natural process from ancestors with functioning eyes?

Labeling this sort of thing "simply the evidence of age" evaded that basic question in a highly ingenuous way. For if vestigial eyes constituted one of the "warts and wrinkles" of life, then they would be no less natural a feature than warts or wrinkles, wouldn't they? Which would mean God presumably didn't *directly* create animals with functionless eyes after all. But pulling things off God's overt creation list in this sense does not appear to be something Behe enjoys doing. So instead he framed the matter in such a way that God might persistently hover in the background, responsible yet not responsible, designing yet not designing, in a way exactly as amorphous as the "creation" definition employed by Behe's Intelligent Design compatriot Phillip Johnson.[118]

The problem with this attitude as applied to the natural sciences is that there is far more to the world than what Intelligent Design can spy through the molecular keyhole. Futuyma called attention to several examples in a paragraph some eighty pages farther back from the short phrase Behe plucked out:

> Look at the structure and physiology of species and you will find many instances in which species are not yet optimally adapted to their way of life, and other cases in which they are adapted to a former way of life that they no longer practice. The marine iguana of the Galápagos Islands spends much of its life diving beneath the waves for seaweed, but it has virtually no physiological or structural adaptations for life in the water: it is essentially a terrestrial lizard, distinguished from the Galápagos land iguana merely by its slightly flattened tail. It can't hold its breath under water any longer than the land iguana can. Conversely, look at a common dandelion and you will see a species adapted to its past. Most of the species of dandelions reproduce sexually, and have nectar and bright yellow petals that attract insects for cross-pollination. But the particular species of dandelion that grows in everyone's lawn is an anachronism: it reproduces entirely asexually, and does not need to be pollinated. Yet it still has nectar and yellow petals to which insects come, though they serve no function. They are useless characteristics, left over from the dandelion's sexual past.[119]

Both the Galápagos marine iguanas and the common dandelion remind us of the boundaries of adaptation. Time is one of them. The oldest of the Galápagos chain is only about three million years, with the youngest volcanic peaks a few hundred thousand. That's long enough for the comparatively slight size and beak variations in the finch population to come about, but insufficient for the iguana to pull off a measurable improvement in its breath holding. As a derived diapsid reptile, it may not even presently possess the genetic capacity for such modification—the iguana may be as stuck in its ways as the dandelion, carting along its superfluous genetic baggage because there's little serious downside to retaining them. Future geneticists may well plumb the depths of the iguana genome to investigate their available options, and compare them with the human adaptation to the oxygen-poor high Andes—or to our more ancient mammalian cousins, the whales, and their splendid marine diving skills honed over a much longer time frame. In any case, the evolutionary perspective inevitably opens up a vast body of potentially interconnecting research that the creationist by philosophy (and temperament?) seems ill disposed to commence on their own.[120]

But across the fence in Intelligent Design, for Behe to acknowledge that anything really is incompletely adapted to its living conditions would reflect back on the skill and thoroughness of the designer. That would account for why he quickly launched into a reprise of his argument on bad design, proposing that features like vestigial pelvises or pseudogenes might somehow possess some secret functionality. In this exercise, for perhaps the only time in *Darwin's Black Box*, Behe approached a technical problem as a methodological naturalist would. He put on his thinking cap and considered how a string of DNA code might perform some ancillary activity unrelated to the actual gene sequence. Which may qualify as one of the cheekier ironies in the modern creationist literature, for had an evolutionist offered such a proposition Behe would have instantly swatted it down as another baseless "just so" story. Evidently Intelligent Design need not be so scrupulous.

The Behe wing of Intelligent Design creationism also appears to have its own unique lexicon of terminology, wherein Miller's remarks on the hemoglobin pseudogene somehow turned out to have "rested on assumptions only." Since Behe offered not a shred of physical evidence (with or without "numbers or quantities") that the sixth β-globin gene really does do anything, Miller's assertion would more commonly be called an *observation*. At least until positive information comes along to the contrary, there would be no "assumption" about it—any more than there would be were one to remark that the vertebrate copies of *homeobox* do not generate antennae on our frontal segment in the manner of fruit flies.[121]

But then, Behe wasn't submitting these hypothetical pseudogene functions as a spur to serious investigation, was he? These bonbons served solely as diversionary maneuvers: "Whether any of these are actual duties of the pseudogene for hemoglobin does not matter." The object was to get off to the hopscotch, which Behe directly did in his second reason why Futuyma and Miller's evolutionary argument "fails to persuade."

Where eyes and pelvises and the mechanism for making pseudogenes came from are legitimate scientific questions. And had Behe wanted to explore them in more depth, he was free to do so. But working out how eyes originated is a very tricky developmental question indeed, whose difficulties were already encountered concerning the trilobites. Living animals do show a variety of photoreceptive systems, which Darwinists consider plausible intermediate stages when it comes to imagining how the full panoply of vertebrate or cephalopod eyes developed—and we also know how Behe finds such Darwinian inferences unconvincing.[122] But with pelvises he was starting to wear the paleontological welcome mat thin. The "origin" of pelvic bones spans hundreds of millions of years, but which part of that extended process Behe had a problem with remained artfully unstated. Was he concerned about how diapsids got their specialized pelvises … or how that anatomy evolved from the primitive pelvic fins of crossopterygian fish … or why vertebrates have bones at all?[123]

By not backing up his objections with even a perfunctory analysis, Behe proved as free with superficial rhetorical flourish as Phillip Johnson was in dismissing *The Beak of the Finch* for not explaining how "birds come into existence." Though Behe at least obligingly dropped another of his pithy analogies on the reader to indicate where his particular reasoning had gone awry. A beautifully designed photocopier long past the expiration of its service contract might well start delivering smudged copies during its decrepit last days—but that's not what is happening with vestigial features. It is not the output of the copier *but it's very design* that is the evidence being adduced in favor of its evolutionary heritage. We are talking about models that possess most of the workings for an imaging system (paper feeds and so on), just like the copiers that actually do make copies—only there is no functioning light sensor or wiring to allow the thing to work. While a bulky over-engineered box might adequately serve as a doorstop (or an exceedingly large paperweight), a customer delivered of such an instrument would have every right to wonder why any designer in his right mind would have made something that wasn't a copier look so much *like* a copier. Did the designer have a collection of spare parts that needed to be cleared out for new models, and so ended up dumping them in the doorstop (or paperweight) catalog for want of any better option? Or aren't we supposed to think about that?[124]

As with his arbitrary exclusion of the impact of population genetics, Behe's fusion of *mechanism* with *product* was another opportunity for Intelligent Design to bog down. The ambiguity hit bottom with pseudogenes, for wasn't the means of their production the process of gene duplication? Behe didn't make much of that when it came to the clotting cascade, where it was unclear whether he thought genes got duplicated or not. Now Behe seemed to acknowledge the existence of the mechanism, only to knock it over as another obstacle to slow the pursuing evolutionary hounds. A nice try, but just because the *origin* of gene duplication is not fully understood doesn't justify Behe's trying to sideline Miller's general point about what has happened with the pseudogenes objectively produced by that process playing out over time.[125]

And speaking of *time* … with his third criticism of the vestigial argument it was Behe who "misses the mark," barging so rapidly through the open front door that he propelled himself straight through the house and out the back. For there was *nothing* about Futuyma and Miller's critique in which the Young Earth doctrine was either "implicit" or "absolutely necessary." The idea of God designing organisms with vestigial features doesn't look any less strained or peculiar when the creating is believed to have taken place six million (or even a few billion) years ago instead of six thousand. That Behe thought to claim that it did was a surprisingly rickety straw man … unless the intent of dipping this construction in the unsavory goo of Creation Science was to firm it up as a "tar baby" to keep evolutionary critics otherwise occupied.

Then again, Behe has his own rather sticky concoction to contend with in this department, his "speculative scenario" of that extraordinary primeval mega-cell. As he put it a bit later in *Darwin's Black Box*: "the simplest possible design scenario posits a single cell—formed billions of years ago—that already contained all information to produce descendant organisms."[126]

All information … is that really what Behe meant to say? Would that include the developmental coding for feathers, sauropod vertebrae, mammary glands, echolocation (not only for bats and cetaceans, but even the form the Venezuelan oil bird uses to locate its cave roost), wasp parasitism, and the ability of some brains to do differential calculus and compose piano quartets? From the biochemical keyhole it evidently slipped Behe's mind that bird wings and such require genes just as much as flagella and blood clotting. Wherever did all this come from? Isn't that the question he was constantly asking of Darwinists?

With breathtaking ease Behe dropped one of the great show-stopping chimeras of modern creationism on the scene, and promptly thought no more about it. To suggest that the first created cell "was left on autopilot to reproduce, mutate, eat and be eaten, bump against rocks, and suffer all the vagaries of life on earth" was a verbose but coy way of not answering a quite fundamental question. If all life is descended from this original source, with the genes in place to be turned on by some (natural?) process, why don't we find the coding for things like the mammalian immune system in yeast, invertebrates, or sharks? Tripping over the physical evidence at the chocks, Behe's mega-cell is a spectacular non-starter—tumbling beside poor Achilles, forced to cool his heels at the gate while the rival Tortoise slogs its solitary way on to the finishing line.

But in what way is Behe's position all that different from traditional creationism? The literal Genesis account defines a single unique creation period, followed by an absolutely non-Darwinian stasis. Degeneracy and decay are allowed, but no true genetic novelty is permitted to emerge apart from that contained in the originally designed perfection—no Darwinian synergy by which natural experiments build off reams of rough drafts and dead ends generated by the random fluctuations of the reproductive apparatus. As far as creationists are concerned, the chance augmentation of A+A can only mean a redundancy of A, never a change in the rules whereby the genetic whole comes to exceed the sum of its parts.

This taxonomy is as true of Behe's Intelligent Design as it is of Gary Parker's Scientific Creationism. All *Darwin's Black Box* has done is pack in a few extra zeros to push Creation back to the Precambrian, where the primordial mega-cell performs the role of a one-man band, a sort of created macro-"type." But getting from there to the existing diversity, along a hopscotch fossil path of pseudo-Darwinian mimicry, without even once stepping on the forbidden crack of macroevolution requires squeezing more mileage from the mega-cell than the physical evidence warrants. In view of what is known about random genetic mutation and drift, Behe's notion of "preformed" genes lying dormant for up to several billion years constitutes, as Kenneth Miller charitably put it, "an absolutely hopeless genetic fantasy."[127]

And then there's Behe's revealing remark that "pseudogenes might occasionally arise" during this stately Intelligent Design pageant, intruding like the blurred output of a copier in need of a fresh cartridge. Now there was an interesting proposition … reminding me of the nineteenth century American railroads trying to lure European immigrants to the prairies of Kansas with the promise that it hardly ever snowed there. Just how "occasionally" do pseudogenes occur?

In his book on molecular evolution Li observed that "pseudogenes have been found in almost every gene family that has been examined in detail."[128] A ripe example concerns the *Alu* part of the eukaryote signal recognition particle (SRP). *Alu* consists of variations on a string of 282 base pairs, which would translate into a good-sized protein chain of 94 amino acids if it weren't a pseudogene. Copies of *Alu* are particularly abundant among the primates, a group evolutionists argue has undergone some mighty interesting natural experiments over the last few million years. They possess *five hundred thousand* copies of it, accounting for 10% of their genome. Three hundred thousand of these occur in the human haploid genome, representing over 5% of our DNA (and a full 16.8% of the short chromosome 22, the first to be fully sequenced).[129]

Indeed, *Alu* is so prolific the evolutionary suspicion is the seminal form may have been a *transposon*. This is a little number where the edited RNA used for protein coding carries a gene for "transposase," enabling it to copy itself back into the DNA molecule—and not always anywhere near the original place. They are particularly detectable in complex eukaryotes because of how they originate: an RNA template has all the introns edited out, so their DNA transposition is going to be a stretch of suspiciously intron-free coding. Fortunately transposons are fairly rare, since they pose a real risk of tripping up the operating system if they interrupt the normal genetic reading frame.[130] Pseudogenes transposed this way have the luxury of being able to sit there in the DNA, ticking away as a molecular clock (or time bomb) until the luck of the mutational draw switches them back on. That is what appears to have happened with a few of the *Alu* copies, as John Avise noted concerning "two human globin genes (α and ε) that utilize truncated sequences of the formerly mobile *Alu* elements to regulate the expression in a tissue-specific manner."[131]

The wearying thing about Behe's mega-cell scenario is that it is about the closest one can get to a testable creationist hypothesis, where the default condition is to criticize evolutionary models without pressing too far with what they themselves think happened. In Behe's case, to get a grip on what manner of divine intervention we might be dealing with, and how important it was to the subsequent development of life, it would have been relevant for Behe to have explained what sort of systems he thought *weren't* designed, and why. But on that front an impenetrable fog settled in. The reader was left with no idea what biological systems failed the irreducible complexity test, let alone what scientific or philosophical conclusions Behe would draw from that negative condition. If a host of biological cycles weren't designed, wouldn't evolution be the only viable alternative for their existence? Or are those examples of complexity that do not *seem* to have been designed only potential candidates for the "Not yet proven to be designed" bin, pending further Intelligent Design research? We don't know the answer to these questions because Behe never extended his analysis to alternatives for the reader to judge.[132]

But the most important unresolved methodological issue here concerns one of general scientific philosophy. It is an extension of the "vampire" problem posed at the beginning of the chapter. Should a plausible natural explanation be established for a particular instance of a class of information, doesn't Baconian induction allow science as a practical matter to presume its general operation throughout that class? Taking our thundercloud again: lightning objectively being a form of electricity, can't we infer that somehow electric charges are differentiated, even though this phenomenon cannot yet be explicitly "proven" either in fact or theory?

In the case of evolution, suppose one of these days Doolittle did pin down the clotting sequence to the point mutation level, what would Intelligent Design do about that? Would Behe elect to simply remove that particular example from his list … and quietly move on to recruit another provisionally "unexplained" understudy to take its place? Or would ID have to reconsider the logic of the whole idea? In his 1997 reply to H. Allen Orr in the *Boston Review*, Behe agreed that if "a bacterial flagellum, or any other comparably complex system, could arise by natural selection," he "would conclude that neither flagella nor any system of similar or lesser complexity had to have been designed." The problem was that "similar" part, as nine months later in the "Firing Line" debate, Ken Miller tried unsuccessfully to get Behe to clarify his position on what didn't constitute an irreducibly complex system.[133]

A Whale of a Tale: Michael Behe & Phillip Johnson in the *Firing Line*

That Behe might be willing to lay down a gauntlet only if he thought he might never have to pick it up again is suggested by his reaction to the verification of something else he had concluded shouldn't exist. It was an installment of an extended marine melodrama with a cast of characters including Michael Denton and Phillip Johnson, a logical gymnastic interlude by Percival Davis and Dean Kenyon, and (playing the thankless roles of Rosenkrantz and Guildenstern) Duane Gish and Hugh Ross.

If one may pardon a most egregious pun, this is one "whale of a tale."

The prologue commenced six decades ago with British creationist Douglas Dewar. Possessed of a skilled wit, Dewar painted the picture of a "shrew" trying to become a whale through an unwieldy chain of intermediate stages. Such as requiring the hind limbs to remain tucked up incongruously beside the tail for much of the process, as its streamlined body grew up around them. There would also be the matter of underwater birth to contend with, along with the modification of the nipples for an airtight fit for suckling. As for breathing, somehow the nostrils would have to migrate up to the top of the head to form the blowhole. For creationists, such a concatenation of biophysical events is plainly impossible.[134]

Michael Denton duly quoted Dewar on this subject as a "leading anti-evolutionist" in *Evolution: A Theory in Crisis*. Phillip Johnson subsequently found the account such "an amusing description" of the difficulties of whale evolution that he extracted the Dewar quote almost at full length secondarily from Denton.[135] That the Intelligent Design argument on whales grounded on the opinions of an oddball creationist writing half a century earlier didn't bother either Denton or Johnson in the least. It certainly didn't inspire them to cautiously analyze Dewar's reasoning to see whether there were any serious flaws in it. Instead, Intelligent Design only embroidered that view, amplifying what they took to be the condition of the fossil and biological evidence as though not much had changed since Dewar wrote in the 1930s.[136]

Such was the mood as Michael Denton methodically enumerated the hurdles facing Darwinists, and ended up sounding a lot like Duane Gish on the quantity of fossil intermediates:

> Considering how trivial the differences in morphology usually are between well-defined species today, such as rat-mouse, fox-dog, and taking into account all the modifications necessary to convert a land mammal into a whale—forelimb modifications, the evolution of tail flukes, the streamlining, reduction of hindlimbs, modifications of skull to bring nostrils to the top of the head, modification of trachea, modifications of behaviour patterns, specialized nipples so that the young could feed underwater (a complete list would be enormous)—one is inclined to think in terms of possibly hundreds, even thousands, of transitional species on the most direct path between a hypothetical land ancestor and the common ancestor of modern whales.[137]

Phillip Johnson perambulated the creationist high wire here with even more daring in *Darwin on Trial*, as he pinned the whole case on the purported lack of relevant fossil evidence:

> Nobody is proposing than at ancestral rodent (or whatever) became a whale or a bat in a single episode of speciation, with or without the aid of a mutation in its regulatory genes. Many intermediate species would have had to exist, some of which ought to have been numerous and long-lived. None of these appear in the fossil record. Of course the intermediates could have been very shortlived if they

> were not well fitted for survival, as would probably be the case with a creature midway in the process of changing legs to fins or wings. Raising this issue, however, adds nothing to the plausibility of the Darwinist scenario.
>
> No doubt a certain amount of evolution could have occurred in such a way that it left no trace in the fossil record, but at some point we need more than ingenious excuses to fill the gaps. The discontinuities between the major groups—phyla, classes, orders—are not only pervasive, but in many cases immense. Was there never anything but invisible peripheral isolates in between?[138]

If you stopped to think about it (which neither Denton nor Johnson did) you would realize that what was going on here was a full-press invocation of the Bermuda Triangle defense. Whales live in the sea, after all, which means that only the earliest stages of their proposed evolution would have been taking place anywhere near the shore. Depending on where and when this transformation occurred, the relevant geological deposits might be abundant—or they might not. Some of the changes (such as echolocation or an improved suckling of the young in the water) might have transpired well along in their marine evolution. In which case, their putative fossilized remains would stand a good chance of being at the bottom of the ocean. But unless tectonic happenstance has exposed such sediments on the surface, how exactly are paleontologists supposed to dig them up?

Right at the start, and before any specifics got discussed, this was the background context that neither Denton nor Johnson even thought to consider. The origin of whales was believed to have taken place over fifty million years ago, and stretched over tens of millions of years. Yet no chronology of the known fossil evidence appeared in either *Evolution: A Theory in Crisis* or *Darwin on Trial*. It would be like trying to resolve the forensics of a crime scene without a site map or time sequence.[139]

Big surprise: the "map of time" problem has come back to haunt Intelligent Design.

To flesh out the whale picture requires recognizing what may *and may not* be learned from those fossils that paleontologists are able to dig up. Here again Denton and Johnson evinced no appreciation whatsoever for the limitations of fossil information (probably because as armchair antievolutionists they've never got within a hundred miles of an active dig or the subsequent fineries of specimen preparation). Of Denton's eight modifications described above, the shift in forelimbs, hindlimbs, and nostrils could be detected *if the relevant body parts were preserved*. But what would it take to isolate the development of flukes, streamlining, the trachea, or nipples? Now we're talking some very detailed *Lagerstätten*, indeed. Are any of those known for the proper time and place to help settle the question? If not, how methodologically acceptable was it for Denton and Johnson to plow on as though they knew the answers to these things? And as for documenting changes in the "behaviour patterns" of whales … were paleontologists supposed to pull off that little trick by hauling along a video camera when next they explored the Eocene in their Wayback Machine?[140]

But this debate only begs another issue. What about all the fossil evidence that you *can* see—what tale do they tell about the history of whales? Particularly, where does the record stand on those features that *are* naturally amenable to fossil preservation: limb arrangement, blowholes and whatnot? Was it true when Phillip Johnson flatly declared that "none" of these intermediates had appeared in the fossil record when he was opining? Well, he must have been using a Lewis Carroll definition of "none," for later on in *Darwin on Trial* Johnson wrote this:

> The fossils provide much more discouragement than support for Darwinism when they are examined objectively, but objective examination has rarely been the object of Darwinist paleontology. The Darwinist approach has consistently been to find some supporting fossil evidence, claim it is proof for "evolution," and then ignore all the difficulties. The practice is illustrated by the use that has been made of a newly-discovered fossil of a whale-like creature called *Basilosaurus*.

> *Basilosaurus* was a massive serpent-like sea monster that lived during the early age of whales. It was originally thought to be a reptile (the name means "king lizard"), but was soon reclassified as a mammal and a cousin of modern whales. Paleontologists now report that a *Basilosaurus* skeleton recently discovered in Egypt has appendages which appear to be vestigial hind legs and feet. The function these could have served is obscure. They are too small even to have been much assistance in swimming, and could not conceivable [*sic*] have supported the huge body on land. The fossil's discoverers speculate that the appendages may have been used as an aid to copulation.
>
> Accounts of the fossil in the scientific journals and in the newspapers present the find as proof that whales once walked on legs and therefore descended from land mammals. None of these accounts mentions the existence of any unresolved problems in the whale evolution scenario, but the problems are immense. Whales have all sorts of complex equipment to permit deep diving, underwater communication by sound waves, and even to allow the young to suckle without taking in sea water. Step-by-step adaptive development of each one of these features presents the same problems discussed in connection with wings and eyes in Chapter Three. Even the vestigial legs present problems. By what Darwinian process did useful hind limbs wither away to vestigial proportions, and at what stage in the transformation from rodent to sea monster did this occur? Did rodent forelimbs transform themselves by gradual adaptive stages into whale flippers? We hear nothing of the difficulties because to Darwinists unsolvable problems are not important.[141]

I doubt that he realizes it, but as in his other diagnostically revealing forays into technical analysis Johnson has once again managed to pinpoint exactly what ails creationist thinking. This time, we have the privilege of seeing why Intelligent Design can be of no use whatsoever to the practical study of paleontology.

Unlike the doctrinally motivated "Darwinists" he so scorns, Phillip Johnson likes to imagine that he forthrightly investigates all the evidence, never playing fast and loose with the facts or sweeping salient information under the rug. But that isn't even a caricature of his true position. For Johnson the "objective examination" of *Basilosaurus* didn't include even a single remark on the animal's revealing skeleton beyond a glib dismissal of those vestigial legs. One of the most apparent things about early cetaceans like *Basilosaurus* was the location of the nostrils: slightly back of the snout, and nowhere near the top of the head as in modern whales. In fact, like the sauropod nares Gish remarked on only from a safe distance, whales don't manifest the fully differentiated top blowhole until well along in their evolution, millions of years later. One would think this was a curiously ironic condition for a creationist to account for with a straight face, given how they had been intimating that no such variation should be observable in early whales.[142]

In fact, judging by the preserved whale skeletal anatomy, there is quite a case to be made for their natural adaptive evolution, as Douglas Futuyma pointed out in another of those evidential passages Johnson didn't incorporate into his own "objective examination." The key to the evolutionary puzzle is to remember how existing features can be modified by natural selection—think "beak of the finch" here:

> If you ask, "What would I have to do to transform a primitive mammal into a bat or a whale?" the answer is, "Nothing very drastic." Bats didn't evolve wings by inventing new structures: the wings are merely elongated fingers, with the same number of joints as in those of a hedgehog, and with an interdigital webbing grown out to the fingertips. The rest of a bat's skeleton is very similar to a shrew's. Whales are an even more striking case. Most whales, such as porpoises, are rather small. Their muscles and a thickened layer of fat give them a streamlined shape. The hind legs are reduced to vestigial pelvic bones. The front legs are flattened into paddles, with five digits (like primitive mammals); but

> the number of joints per digit is increased. The teeth are partly (in fossils) or entirely (in most modern whales) dedifferentiated, so they all have the same shape; and in modern (but not early fossil) species are increased in number—or else entirely lost, as in the blue whale. The most radical difference from other mammals consists largely of a forward extension of the jawbones out from under the nostrils, which are therefore situated on the top of the head. In species such as the blue whale, the skin on the roof of the mouth is cornified like our calluses, and folded into sheets of baleen ("whalebone") that hang down into the mouth. The *only* characteristics that are not mere modifications of primitive mammalian features are the baleen and the dorsal and tail fins, which are rigid folds of skin and fibrous tissue, like our ears.[143]

On the page following this discussion, Futuyma buttressed his argument by doing another thing Denton and Johnson didn't: actively comparing representative fossils. He illustrated the skulls of a modern dolphin, a pair of Oligocene whales (*Squalodon* and *Archaeodelphis*), our pal *Basilosaurus* and its land-living contemporary, the condylarth *Phenacodus*.[144] Moreover, *Science on Trial* noted something else highly relevant to the origin of the baleen whales that Johnson somehow overlooked in his reading of Futuyma's book: "The embryos of whales and anteaters develop teeth and then absorb them before birth. This makes sense if they carry in their genes the imprint of their history; but could any creationist have predicted these embryonic patterns by the argument from design? Or is the Creator trying to trick us into believing in evolution?"[145]

But creationists aren't in the habit of predicting anything, now are they? Nor are they regularly observed wading though the extensive stack of "Scylla and Charybdis" problems presented by the evolutionary literature.

When it comes to the archaeocetes, the Intelligent Design standard of "objective examination" proves to be as la-di-da as how Morris and the Creation Science camp greeted the prevalence of toothed Cretaceous birds. So when Michael Denton showed the skeleton of "*Zygorhiza kochi"* (an early Eocene cousin of *Basilosaurus*) it was *sans* commentary on its frontal nares, telltale dentition, or rudimentary pelvis.[146] Likewise, Davis & Kenyon's *Of Pandas and People* illustrated *Basilosaurus* and the mesonychid *Mesonyx* together on a previous page, but did not bring them up in order to compare and contrast their skull diagnostics. The dated drawing of *Basilosaurus* even lacked hind limbs, though Davis & Kenyon did mention their recent discovery in the text—but only after subjecting it to a dizzying corkscrew twist, whereby they attempted to flip the history of the find over into an evolutionary disadvantage:

> Recently, small pelvic limbs and foot bones found "in direct association" with a fossil of Basilosaurus in an Egyptian desert. These have been touted as evidence of the land-dwellers-to-whales theory. While this find is interesting, students should be told that portions of the same structures were found with one of the first Basilosaurus finds in the late 19th Century. What is different now, is that enough of these structures have been recovered to suggest that they functioned as guides to mating, and were not vestigial as originally thought. (For the design proponent, who rejects the blind watchmaker hypothesis, function is a great help in explaining the existence of a structure.)[147]

There were three things being clumsily concealed by this magic trick. The first was the sleight-of-hand equation of "vestigial" with *completely useless*. There is no evolutionary reason to suppose that a piece of anatomy of dwindling propulsive importance is going to automatically drop off the animal, any more than did the shrunken (though quite strong) remnant arms of a tyrannosaur. Without knowing its environment, though, figuring out just what they might have been used for during their vestigial swan song is no light pull. Which brings us to the second element of the illusion: it certainly wasn't Intelligent Design comparative anatomists who had come up with the copulation argument—but rather the evolutionary paleontologists who had done the hard work of exposing that fossil evidence in the first place. This was just as parasitical an approach to scientific scholarship as Duane Gish had taken with his juvenile tome on the dinosaurs.[148]

But the really big puff of smoke in *Of Pandas and People* was the same one already wafted by Phillip Johnson: mentioning the legs of *Basilosaurus* as though these were the most natural and expected of created conditions, when the first whales weren't supposed to have legs at all. Add to that another clue from the other side of time and we have an evolutionary vise between which the Intelligent Design model has very little technical wiggle room. In a reprise of hen's teeth (and the tooth buds of baleen whales), on occasion living cetaceans turn up sprouting visibly external aft limbs. The creationist therefore needs to explain why modern whales that don't have hind legs would still have been *designed* with the genes for them?[149]

What has been thoroughly lost in the creationist fog bank is any sense of *Basilosaurus* as a living animal, both in its natural environment and for its place in the sequence of life. Being objectively an extinct marine mammal, it would have been able to swim in the sea and give live birth to air-breathing young that somehow or other got suckled. To this end the female *Basilosaurus* would presumably have had nipples, but how efficient were these compared to those of modern whales? Indeed, while we're about it, how do early whale nipples stack up against those of the condylarth mesonychids considered relatives of the cetacean land ancestor?

It is temptingly easy to ask such questions, but far more difficult to derive scientifically meaningful answers to them—and on that subject Johnson's Intelligent Design abruptly falls down the same epistemological rabbit hole as Duane Gish's Creation Science. The moment you ask such questions, you can spot the technical difficulty. Paleontologists don't know the answers—and have virtually no way of knowing. If you had a suspected whale ancestor to examine, it might be possible to categorically establish that their nipples were incapable of modification into those of *Basilosaurus* or a modern whale or dolphin. But then, it might also turn out that a comparative anatomist would discover mesonychid nipples ideally suited to such an adaptation. Without the living animal to physically inspect, there would be no scientific procedure to tell *one way or the other*. As with trilobite eyes, everything would then depend on the ability of modern developmental biologists to retroactively pull the rabbit out of the hat, and infer the entire mutational chain leading to the observed modern morphology of whale nipples—something presently no more possible than precision tornado prediction. Yet the Intelligent Design of Denton and Johnson proceeded as though the biological history of whale nipples was already known, and comfortably settled in their favor.

What Phillip Johnson has consistently tried to do with fossil evidence is much worse than disputing whether the evolutionary glass is part empty or part full. By invariably focusing on those ongoing puzzles the science cannot yet resolve, he has quite seriously adopted the epistemological position that by waving a finger back and forth in the dry portion of the glass he may declare there is no water sloshing around beneath. Or put another way, the antievolutionary defense in *Darwin on Trial* is trying to forbid, on principle, the arrest of a suspect in spite of incriminating footprints and clothing fragments found at the scene of the crime, along with a stash of stolen goods recovered from the thief's apartment. Instead, summary acquittal is demanded on the basis that no surveillance camera photos were submitted showing the accused braining the night watchman with a baseball bat, or trying to fence the loot later on. An ingenious argument—hampered only by the minor evidential quibble that no cameras were on hand to have taken such ideally conclusive snaps.

If Johnson wants to apply such a distorted exclusion principle to criminal law, he's welcome to it. But it won't wash in any historical science that has to make do with what evidence and methods it can, like paleontology … or archaeology. Which reminds me of someone else whose pompous disregard for the skills of a forensic discipline has infuriated his critics: Erich von Däniken. There is no evidence that Johnson has been consciously angling for the dubious honor of being known as "the Erich von Däniken of modern creationism," but everything about his discourse has been meriting that distinction. Consider these cavils Johnson tossed off in his Research Notes for the whale section of *Darwin on Trial*:

> The *Basilosaurus* reconstruction is described for scientists in the article "Hind Limbs of Eocene *Basilosaurus*: Evidence of Feet in Whales," by Philip D.

> Gingerich, B. Holly Smith, and Elwyn L. Simons, in *Science*, vol. 249, pp. 154-57 (July 15, 1990). The article states that "Limb and foot bones described here were all found in direct association with articulated skeletons of *Basilosaurus isis* and undoubtedly represent this species." Although I accept the authors' description for purposes of this chapter, I confess that expressions like "found in direct association with" and "undoubtedly" whet my curiosity. Is it certain that *Basilosaurus* had shrunken side limbs, or is it only certain that fossil foot bones were found reasonably close to *Basilosaurus* skeletons? The newspaper stories quote discoverer Philip Gingerich as saying that "I feel confident we can go back to any skeleton, measure out the distance from the head—about 40 feet—sweep away the sand, and find more feet." This is an admirably risky prediction, and if Gingerich can make good, all doubts about who owned the feet should be put to rest.[150]

For someone trained in the law, a discipline knee-deep in specialized jargon, it was interesting that it evidently didn't occur to Johnson that paleontology might have a few terminological conventions of its own. To read in a journal paper of bones "found in direct association with" an articulated skeleton means exactly that: they occur just where they ought to had they once been attached to the living body. Specimens do not of course appear in the rocks with neat little metal rods running through them like museum displays … which is where the field skill of the trained paleontologist comes in. Over several years Gingerich's team had examined 243 *in situ* skeletons of *Basilosaurus* before arriving at these tempered conclusions. Not unexpectedly, most of the fossils were partial ensembles, but several were complete enough to establish that the associated hind limbs were no fluke (so to speak). Unfortunately, Johnson's own curiosity was insufficiently whetted to clarifying this matter before pontificating on it, even though this required nothing more demanding than a thorough reading of the paper he had just cited.[151]

The remedy for this condescension might be to tag along on a working paleontological expedition one of these days, though the prospect of Phillip Johnson (even in his chipper heyday) sweating through a search for whale vertebrae seemed remote. Fortunately for Intelligent Design the *Washington Post* can readily substitute for field experience, which is how Michael Behe enters the cetacean picture. Teaching a freshman course on "Popular Arguments on Evolution," Behe drew on a 1990 *Post* report on the Gingerich *Basilosaurus* find, with the most "fascinating" of pedagogical consequences:

> The students themselves, after reading the *Post* article, pointed out that there is no reason to suppose that the ancient whale appeared on earth before the modern whale, since modern whales have vestigial legs that could have developed into the functional legs of the Zeuglodon whale. For the same reason, the students noted, the discovery does not represent the development of a new trait or even the loss of an old one. Finally, most glaringly obvious, if random evolution is true, there must have been a large number of transitional forms between the *Mesonychid* and the ancient whale. Where are they? It seems like quite a coincidence that of all the intermediate species that must have existed between the *Mesonychid* and whale, only species that are very similar to the end species have been found. The students concluded that the fossil whale, although a fascinating discovery for natural science, was no evidence for the *Post's* evolutionary scenario.[152]

If it was Behe's intention to demonstrate that students not unduly burdened by relevant information could draw spurious conclusions from secondary newspaper articles, then he had succeeded admirably. Whether those same freshmen would be able to explain with equal confidence whether Behe had decided intermediate archaeocetes like *Basilosaurus* were (or were not) "very similar" to the end product of contemporary whales is another matter.[153]

But the creamy center here consists of Behe's "glaringly obvious" conditional: "if random evolution is true, there must have been a large number of transitional forms…." Which in the normal parlance of "if-then" logic would appear to oblige Intelligent Design to reconsider its antievolutionary stance on the whales should paleontologists be so inconsiderate as to start digging a few of them up. But this may have seemed a fairly safe bet to place in the later 1980s. Working backwards from the Archaeoceti, the spade work had only turned up the fragmentary skull of *Pakicetus* from the early Eocene to bridge the gap between them and the terrestrial mesonychids (a group of extinct quadrupeds which may be described as "dog-like" or "wolf-like" depending on one's mood). Dating from around 50 million years ago, *Pakicetus* evidently hunted for food in the fish-laden saline lakes and bays of what was left over from the shrinking Tethys Sea as the Indian subcontinent was about to rear-end Asia. But without the rest of *Pakicetus'* body to clinch the case, the indefatigable Duane Gish freely dismissed that contender as merely a peculiar land mammal.[154]

What paleontologists really needed were some early whales with more functional legs attached—the very feature that creationists insisted they couldn't possibly have had. The question was, where and when to look? Back before the tumult of punctuated equilibrium the conventional Darwinian position was that highly diversified organisms (from angiosperms to bats) required oodles of time to get that way. For the whales, that meant a common ancestor may have lived all the way back in the later Cretaceous.[155] But with the new insights of population genetics, revealing that speciation could take place more rapidly than hitherto suspected, it began to dawn on paleontologists that the reason why the earliest whale teeth and *Pakicetus* were showing up in Pakistan was because that's where they had evolved. So at just the time that Behe came along to draw his morphological line in the sand, whale paleontologists like Phillip Gingerich and Hans Thewissen were impelled by their own evolutionary logic to take a closer look at the crumple zone of the Indian plate collision.[156]

The results were, to put it mildly, gratifying to the evolutionary hypothesis.

Living several million years after *Pakicetus* was the semi-aquatic *Ambulocetus*, only this time known from a much more complete skeleton. Although able to flex its spinal column up and down, *Ambulocetus* still got its main kick from some substantial hind legs, swimming much as modern seals do. *Seals?* Recall that it was the contention of antievolutionists like Michael Denton that early whales ought to have exhibited a seal-like stage. So what does it mean for the credibility of their argument that the new *Ambulocetus* was continuing a pattern begun by the ancestral *Pakicetus*, whose preserved skull clearly betrayed the rudiments of seal-like hearing?[157]

Step forward a few more million years and you have the primarily aquatic *Rodhocetus* (again represented by fairly complete remains), with more reduced hind legs that no longer contributed much to its swimming as it was now propelled by power strokes from an undulating (and possibly fluked) tail. Advance a few more million years and *Indocetus* relied even less on its legs, while by the time of *Protocetus* around 45 million years ago the whales were fully acclimated to living in the open ocean, whereupon whale legs could do their vestigial vanishing act. All of these forms, by the way, were in the same size range as the land mesonychids their anatomy traced back to—about eight feet head to tail. Only in the millions of years after this initial radiation did giant specialized archaeocetes come on the scene to hog the fossil picture (*Basilosaurus* in particular ranged from Africa to the Americas, accounting for it being the state fossil of Alabama). And only later still are found the even more specialized familiar whales that contemporary ecotourists pay good money to observe in the open ocean.[158]

Now over in Creation Science land, Duane Gish was evidently in the process of revising his antievolutionary book for reprint as *Evolution: The Fossils STILL Say NO!* when these new whale intermediates washed ashore, and he was Johnny-on-the-spot to dispose of their incriminating carcasses before any evolutionary stink set in:

> More recently, the claim concerning the possible discovery of a link between land mammals and marine mammals was contained in an article published in January 1994, in *Science*. The article served as a basis, once again, for newspaper headlines throughout the U.S. For example, the Cleveland *Plain*

Dealer featured the report in an article published in that paper January 16, 1994, with the bold headline, “Fossil Thought to Belong to Walking Whale—Creature May Be Missing Link.” Since whales don’t walk on land, skeptics would immediately question the basis for designating this creature a whale, whatever it may have been. As a matter of fact, in a commentary published in the same issue of *Science* as the original scientific report, the writer states: “The authors provide some evidence for the seemingly preposterous conclusion that archaic whales were capable of walking on land.” The investigators gave their find the name *Ambulocetus natans*, from ambulare (to walk), cetus (whale), and natans (swimming). They thus believe that this creature both walked on land and swam in the water. In their report, the authors state: “Unlike modern cetaceans, *Ambulocetus* certainly was able to walk on land, probably in a way similar to modern sea lions or fur seals. In water it combined aspects of the locomotion of modern seals, otters, and cetaceans. … As such, *Ambulocetus* represents a critical intermediate between land mammals and marine cetaceans.”

It is reported that Hans Thewissen, an assistant professor of anatomy at Northeastern Ohio Medical School; Tasseer Hussain, professor of anatomy at Harvard University; and M. Arif, a geologist of the Geological Survey of Pakistan, happened upon the fossil during a 1992 dig in hills west of Islamabad, Pakistan. The *Plain Dealer*, along with its article, had a good picture of the fossil. When some of the ICR staff looked at the picture with the knowledge that Thewissen and fellow workers called this creature a whale, they were naturally very skeptical having seen neither an elephant that flies or a whale that walks. In their article, Thewissen and coworkers state that *Ambulocetus* was about the same size of a male sea lion, weighing about 650 lb. And had a robust radius and ulna (the two bones in the upper forearm). They report that the structure of the forearm would have allowed powerful extension by triceps, and that, unlike modern cetaceans, elbow, wrist, and digital joints were flexible, and synovial (lubricated). The hand was long and broad, with five digits. The femur was short and stout, and the feet were enormous. The toes were terminated by a short phalanx carrying a convex hoof. They suggest that unlike modern cetaceans, *Ambulocetus* had a long tail, and that it probably did not possess flukes. One wonders what in the world a whale was doing with hind limbs that terminated in a foot with hooves, or with any kind of powerful forelimbs and hind limbs that were designed to walk on land.

It is reported that the fossil of *Ambulocetus* was found in a silt and mudstone bed which contained impressions of leaves and abundant *Turritella*, a marine gastropod. This would suggest that it lived near the seashore, feeding possibly on land animals and/or plants, and perhaps foraging into shallow seas to feed on gastropods and molluscs. They report that the fossil beds are lower-to-middle Eocene beds, and about 120 meters (approximately 390 feet) higher than those in which *Pakicetus* was found. Berta, in her comments on the paper by Thewissen et al. gives an age of 52 million years for the age of *Pakicetus*, which they refer to as the “oldest cetacean.” *Ambulocetus*, bearing large forelimbs and hoofed hind limbs, was found in strata nearly 400 feet higher than *Pakicetus*. It therefore cannot be older. *Pakicetus* is called the oldest cetacean. Yet it is said that *Ambulocetus* documents transitional modes of locomotion in the evolution of whales. Confused? So are we? It is reported that the teeth resemble those of other archeocetes, which evolutionists believe were either archaic whales or ancestral to whales. The teeth of archeocetes are, however, so similar to mesonychid ungulates, believed to be wolf-like carnivorous mammals, that two of the archaeocetes, *Gandakasia* and *Ichthylestes*, known only from teeth, were originally classified as mesonychids.

G. A. Mchedlidze, a Russian expert on whales, while maintaining that Archeoceti [*sic*] occupy an intermediate position between terrestrial mammals

> and typical Cetacea, states that the problem of the phylogenetic relationship between Archeoceti [*sic*] and modern Cetacea is a highly controversial issue. He reports that a number of authors consider that the Archeoceti [*sic*] is a completely isolated group having nothing in common with typical Cetacea. If this opinion is correct, then the archeocetes, supposedly archaic whales, were not whales at all and did not give rise to whales (cetaceans).
>
> A search of texts on mammals for fossils of creatures resembling *Ambulocetus* failed to produce one closely resembling *Ambulocetus*, although *Allodemus*, an extinct aquatic carnivore believed to have preceded walruses, bears some resemblance.
>
> Perhaps we should not be surprised that Thewissen and coworkers would dare to call *Ambulocetus* a "whale" when we note the fact that Robert Carroll, in his voluminous tome, *Vertebrate Paleontology and Evolution*, made the incredible statement that "Despite the extreme difference in habitus, it is logical from the standpoint of phylogenetic classification to include the mesonychids among the Cetacea." Presto! These wolf-like animals are now whales! Who says evolutionists do not have transitional forms? Anybody who can call a wolf a whale should have no trouble finding "transitional forms."
>
> The final episode in this series (as of this writing) is a report by Gingerich, Raza, Arif, Anwar, and Zhore that they had discovered another fossil between land mammals and whales. They named the creature *Rodhocetus kasrani*. They found the fossil in the southwestern corner of Punjab Province of Pakistan and believe it to be 46-47 million years old. They describe features of this creature which they believe indicate that it could support its weight on land. They believe it also had features which would indicate it was a fairly efficient swimmer, thus constituting a creature intermediate between land mammals and marine mammals.
>
> Were these creatures really intermediates whose evolutionary forebears were wolf-like creatures and whose evolutionary descendants ended up as whales, dolphins, and porpoises? Or were they, as Mchedlidze believes (and others he mentions) an isolated group that had nothing in common with ordinary whales? Here creation scientists and evolutionist Mchedlidze and his evolutionist colleagues find themselves in full agreement—they were creatures that had a mosaic of features, just as do the pinnipeds (seals, sea lions, walruses) and the sirenians (the sea cows, or manatees and dugongs—which appear fully-formed in the fossil record with no trace of transitional forms) and had nothing to do with any supposed ancestors for whales and dolphins.[159]

The most receptive audience for Gish's spin on the new whale fossils would be one suffering from acute historical amnesia. On no account must the reader be reminded how generations of creationists, from Dewar on down, had been hectoring evolutionists to supply whales with legs. Now that legged whales were physically showing up, though, it was even more essential not to describe enough about them to allow the reader to reach an informed opinion concerning how transitional they were. To this apologetic end Gish freely tossed about the ten-dollar anatomical jargon of "robust radius and ulna" or the "synovial (lubricated)" forearm joints so long as it didn't affect his argument.[160] But not a whisper was given where it really mattered: what made a fossil animal identifiable as a cetacean in the first place. On this point the Thewissen paper had been just as explicit as when describing synovial joints. "*Ambulocetus* is clearly a cetacean: it has an inflated ectotympanic that is poorly attached to the skull and bears a sigmoid process, reduced zygomatic arch, long narrow muzzle, broad supraorbital process, and teeth that resemble those of other archaeocetes, the paraphyletic stem group of cetaceans."[161]

For Gish, as with all creationists, intermediate forms are not allowed, so when they annoyingly turn up in the fossil record anyway it is necessary to pigeonhole them on one side or another of an arbitrary typological divide. *Pakicetus* is the earliest whale in the same restricted taxonomical sense that *Archaeopteryx* is the first "bird"—where anatomically modern birds don't show up for another hundred million years, just as later "whales" become progressively more whale-like. This distinction was the source for Gish's professed confusion about whether paleontologists regarded *Pakicetus* or *Ambulocetus* as the oldest cetacean. Only by defining "whale" as a fully oceanic animal with blowholes and directional underwater hearing can the creationist exclude early whales from the category. The irony here was that Gish had been perfectly agreeable to calling *Archaeopteryx* a "bird" in spite of all its apparent reptilian characteristics. Now the same standard had to be stood on its head: a cetacean with legs being creationistically impossible, all its many evident cetacean elements (not shared in any sense by pinnipeds or sirenians) were methodically ignored.

So it could hardly have been a consideration of space that motivated Gish to nip out a single sentence from the Thewissen quote trotted out in the first paragraph about the intermediate character of *Ambulocetus*. Displaced by the ellipsis was the explanation that "Like modern cetaceans it swam by moving its spine up and down, but like seals, the main propulsive surface was provided by its feet."[162] And regarding those feet, Gish saw no need to dispel any common impression that the hooves of *Ambulocetus* were "hooves" in the colloquial barnyard sense of horses or cattle, let alone call attention to how similar those were to the small nail-like toes of its proposed mesonychid ancestors.[163]

As with Phillip Johnson and his recondite use of "none," Gish blazed his own meandering path when he declared how "The mesonychids were wolf-like, hoofed carnivores that, as far as anyone knows, never went near water except to drink."[164] Only on the very next page we read about their possible diet of shoreline *mollusks* … followed two pages later by the ever-so-casual acknowledgement of how similar the teeth of the indisputably aquatic archaeocetes were to those of the purportedly water-shy mesonychids. In this connection, recall those toothed Cretaceous birds and how their specialized dentition was a clue to their diet. As amusing as it is to watch Gish bounding about the facts so gingerly, one does wonder at how the creationist imagination can manage to hit so many evidential dots without ever once connecting any of them up.[165]

Gish did surpass Johnson's whetted curiosity in his more direct disparagement of the observational skills of paleontologists like Thewissen. While the tableau of the ICR sages gathering around the photograph of *Ambulocetus* and muttering of Dumbo ("an elephant that flies") is vivid, it is no fair exchange for a serious discussion of the evidence. But the microscopic hair-splitting of text required to so limit and arrange the facts that the creationist opinion can seem even tactically plausible may be too exhausting for more than a short sprint. That may explain why Gish didn't even bother to describe (let alone challenge) the even more intermediate legs and swimming capabilities of *Rodhocetus*.

Instead Gish quickly advanced to the creationist "Go" with the same logic as Phillip Johnson, continuing on in *Evolution: The Fossils STILL Say NO!* to the matter of contemporary whales and their wonderfully complex adaptations. Gish stressed that modern whales are capable of deep diving, while "None of the so-called intermediate types discussed earlier—*Basilosaurus, Pakicetus, Ambulocetus, Rodhocetus*—were equipped to do that."[166] True enough … but at this point a genuine paleontologist is going to conclude that this adaptation objectively occurred sometime after the heyday of the archaeocetes. That circumstance, in turn, moves their potential fossil record into the realm of largely inaccessible ocean deposits, and the analysis of the evolutionary genesis of deep diving squarely into the plainly unavailable court of retroactive genetics. By never letting on about the nature of the scientific problem, Gish has quietly drifted back into the Bermuda Triangle defense.

Nor did Gish leave out his venerable standby: the "no cousins" rule. This made its customary appearance when Gish tried to dispose of the new discoveries because paleontologists didn't think the specialized later archaeocetes were the *direct* ancestors of modern whales. But Gish went further still in trying to invoke the opinion of Mchedlidze from the 1980s to invalidate fossil information uncovered *later on in the 1990s*. This stunt was like sticking with the doubts expressed by that overly skeptical *Scientific American* editorial writer in 1906 concerning whether those cocky Wright Brothers had actually cracked the secret of powered flight. Whenever the science moves on, one's scholarship is supposed to move with it … but not apparently for *Creation*

Science, perpetually mired in its apologetic rut of deploying authority quotes come hell or high water.[167]

Not that Old Earth creationism has done any better in this department, as Hugh Ross demonstrated in one of his rare forays into the minutia of paleontology. In his recent book, *The Genesis Question*, Ross brought up the whales (and horses) in the context of salvaging the reputation of Biblical chronology and the creation story:

> Genesis 1 has been discredited by some paleontologists for placing the introduction of sea mammals (Day Five) before the introduction of land mammals (Day Six). A careful reading of the text, however, removes the basis for their criticism. The fifth creation day mentions the sea mammals generically; however, the sixth creation day narrows in on only three specialized kinds of land mammals. When the other land mammals are introduced we cannot say from the text. Scientific research will have to give us that information. The sixth creation day introduces just three recently created categories of land mammals (before introducing humans).
>
> Recent discoveries reveal that the first sea mammals date much earlier than paleontologists had once thought. Fossils of four extinct species of whales—Pakicetus, Nalacetus, Ambulocetus, and Indocetus—have been dated at 52 million, 52 million, 50 million, and 48 million years ago, respectively. These dates eliminate any credible placement of the first sea mammals on the fifth creation day.
>
> The dates also effectively eliminate a naturalistic explanation for a newly found change in these whales' morphology. Phosphate isotopes in the teeth of these fossilized whales tell of a rapid transition from freshwater ingestion to saltwater ingestion. Geologists and anatomists from the United States and India discovered that Pakicetus and Nalacetus drank only freshwater. Ambulocetus drank freshwater at least through its formative years, probably all its life, and Indocetus drank saltwater only.
>
> In just two to four million years—or less—whales' physiology changed radically. The transition from freshwater ingestion to saltwater ingestion requires completely different internal organs. The number and rapidity of "just right" mutations required to accomplish such a transition defies the limits set by molecular clocks (biomolecules for which mutation rates can be determined relatively easily). Proponents of punctuated equilibria, the increasingly popular alternative to gradualism (traditional Darwinism), suggest that dramatic genetic changes occurred in sudden jumps propelled by severe environmental stress. The period from 48 to 52 million years ago, however, appears to have been remarkably tranquil, far less stressful than such a scenario demands.
>
> For several decades now, evolutionists (those seeking a naturalistic explanation for the changes in life-forms over Earth's history) have pointed to "transitional forms" in the fossil record for proof that their explanation for life's history is correct. The fact that the bone structures of certain large land-dwelling mammals, the mesonychids, ancient freshwater-drinking whales, ancient saltwater-drinking whales, and modern whales exhibit an apparent progression persuades them that modern whales naturally evolved from land-dwelling mammals. Evolutionists often cite this progression as their best demonstration of Darwinian evolution.
>
> Ironically, the evolutionists' "best example" in reality is their worst. No animal is a less efficient evolver than the whales. No animal has a higher probability for extinction than the whales. Many factors severely limit their capacity for natural-process changes and greatly enhance their probability for rapid extinction. The six most significant are:
>
> 1. relatively small population levels.

> 2. long generation spans (the time between birth and the ability to give birth)
> 3. low numbers of progeny produced per adult
> 4. high complexity of morphology and biochemistry
> 5. enormous sizes
> 6. specialized food supplies
>
> These factors limit not only whales' capacity to change through natural selection and mutations but even their ability to adapt to change. Because of these six factors, small environmental changes would tend to drive whales rapidly to extinction.
>
> The same conclusions can be drawn for the so-called descent of horses. The same factors affecting whales also severely restrict horses' capacity to survive internal and external changes. Indeed, ecologists have observed several extinctions of horse and whale species during human history, but never a measurable change within a species, much less the appearance of a new one.
>
> Genesis offers this explanation: God created the first sea mammals on the fifth creation day. As the fossil record documents, sea mammals have persisted on Earth from that epoch until now, though not without interruption. Multiple extinctions of sea mammals imply that God repeatedly replaced extinct species with new ones. (See chapter eight for further discussion of this issue.) In most cases the new species were different from the previous ones because God was changing Earth's geology, biodeposits, and biology, step by step, in preparation for His ultimate creation on Earth—the human race.
>
> The many "transitional" forms of whales and horses suggest that God performed more than just a few creative acts here and there, letting natural evolution fill in the rest. Rather, God was involved and active in creating all the whale and horse species, the first, the last, and the "transitional" forms.[168]

With all the courage of his Biblical convictions, Hugh Ross has forthrightly mandated that the assorted whales (and horses!) known to science were acts of independent special creation. But when it comes to fitting this antievolutionary conception into the available facts of paleontology and population genetics, Ross would be advised to stick to physics.

Ross stumbled right off with his convoluted remarks on the temporal order of mammal appearance—capped by his ingenuous hope that scientific research might someday get around to telling us when land mammals showed up, as though science hadn't already done that. Indeed, one of Ross' own cited sources (Carl Zimmer's *At the Water's Edge* on macroevolution and the whales) had given a quite tidy description of the reptile-mammal transition. And while the new fossils Ross mentioned helped flesh out the origin of whales over about ten million years, that is a drop in the bucket compared to the 150 million years separating them from the first appearance of mammals in the Triassic.[169]

Leaving aside the issue of mammalian genesis Day Five versus Day Six, it was commendably topical of Ross to address the Thewissen paper on cetacean osmoregulation. Unfortunately, his conclusions required skating over a rather important aspect of the *Ambulocetus* case—where the remains were found:

> The δ^{18}O values of *Ambulocetus* are most similar to those of the other Kuldana cetaceans, implying that *Ambulocetus* ingested fresh water. This is surprising, as the taxon is found in unambiguously marine beds high in the Kuldana Formation. Also, *Ambulocetus* has never been found in the freshwater deposits that abound in this part of the Kuldana Formation.
>
> There are two possible explanations. *Ambulocetus*, although it lived in the littoral realm, may have sought out freshwater sources to drink because its osmoregulatory system was unable to handle the excess salt load of its environment. Alternatively, it may have lived in fresh water during the (early)

> part of its life when its teeth were mineralized, then migrated to the sea later on. This explanation lends credence to the idea that the life history of early cetaceans resembled that of modern pinnipeds.[170]

Ross' whale argument had snagged on the other aspect of the "map of time" problem: the failure to consider what it means for fossil forms to have been fully functional animals living in an active environment. With *Ambulocetus* we have a mammal objectively living in the open sea, presumably successfully hunting for food … and yet still dependent (at least in its juvenile stages) on fresh water. That puts the combination squarely in an intermediate category when it comes to positioning *Ambulocetus* on the spectrum from fresh to salt water acclimation of cetaceans. Now what was going on deep in the kidneys of *Ambulocetus* during that crucial period forty-odd million years ago is a problem of the same character as figuring out the development of whale nipples. Were such data available, of course, creationists and evolutionists could haggle over their significance. But in lieu of that, the overall taphonomy nonetheless suggested *Ambulocetus* was a cetacean with some degree of transitional lifestyle.[171]

Having missed that factor, from there on Ross was on a rapid downhill slalom, unimpeded by even the most superficial of citations. Lacking references here, we have no idea what made Ross think small distributions were inherently less liable to evolutionary change than large ones. The evidence of population genetics suggests the opposite is true, where maximum allele stability occurs among larger groups.[172] Nor are most whales of "enormous sizes," but even for those that are Ross did not explain what sheer bulk or a "high complexity of morphology and biochemistry" had to do with restricting their genetic variation (one may note Ross did not allude to baleen teeth or vestigial legs). Finally, the random mutations that fuel evolutionary modification would not be accelerated in the least by methodically exterminating the genome carriers. Expecting new species of whales to have emerged over *only the last century* due to intense human predation was one waterlogged straw man.[173]

Now Hugh Ross has shown himself reasonably capable of steering clear of such athletic logical leaps in his own domain of physics and astronomy. Yet turn the subject to evolution and he abruptly adopted all the worst habits of creationist dilettante scholarship. One might contend that is an inevitable outcome for creationists, since the only way for them to arrive at their antievolutionary conclusions is either by seriously muddling the facts or the methodology used to interpret them. That both Gish and Ross mangled whatever information they presented was no surprise then, but at least the pair did try to grapple with the new whale finds. Step across the creationist hall to the academic cloister of Intelligent Design … and Michael Behe and Phillip Johnson were intently playing out a very different game: "Shoot the messenger."

Behe's earlier focus on how the *Washington Post* had reported the *Basilosaurus* case indicates he was less concerned with examining the actual data than with railing over how such information was disseminated in the media. This approach was continued in *Darwin's Black Box*, where no trace of the new fossil whales was to be found, however closely *Ambulocetus* or *Rodhocetus* fulfilled Behe's own criterion ("if random evolution is true…"). Of course, by then Behe had repositioned himself behind the biochemical keyhole, where all fossil background was conveniently off the line of sight anyway. For *Darwin's Black Box*, only one isolated sperm whale was allowed to swim past as part of a criticism of the evolutionary presumptions of a prominent biochemistry textbook by Albert Lehninger:

> But when we get past origin-of-life chemistry and sequence comparisons (the two references to Lehninger's earlier text), we find that the new edition uses the world *evolution* as a wand to wave over mysteries. For example, one citation is to "evolution, adaptation of sperm whale." When we flip to the indicated page, we learn that sperm whales have several tons of oil in their heads which becomes more dense at colder temperatures. This allows the whale to match the density of the water at the great depths where it often dives and so swim more easily. After describing the whale the textbook remarks, "Thus we see in the sperm whale a remarkable anatomical and biochemical adaptation, perfected by

> evolution." But that single line is all that's said! The whale is stamped "perfected by evolution," and everybody goes home. The authors make no attempt to explain how the sperm whale came to have the structure it has.[174]

Not that Behe paused to explore this fascinating question himself, since to do so would have required him to link up with the very disciplines whose conclusions he was so reluctant to think about: paleontology, comparative anatomy, and so on. While the waxy spermaceti oil of a sperm whale resides chiefly in its "melon," the bulbous frontal portion of the head that gives that species its distinctive *Moby Dick* appearance, similar features are found among many odontocetes (including bottlenose dolphins). The question before the house would be whether the spermaceti had been *designed* to permit sperm whales to dive deeply, or whether those whales found themselves progressively able to dive deeper because of the quite unintentional properties of their melon as it developed synergistically along with something entirely different: echolocation.

As with the immune system, evolutionists interested in whales have been stubbornly unaware that they weren't supposed to investigate fossils and compare anatomy for clues—or have the temerity to draw provisional conclusions from them. Consequently, just as Behe was not discussing the implications of *Ambulocetus* and *Rodhocetus*, paleontologists in the mid-1990s were staking out a few benchmarks for their own subsequent research. Just how far ranging such work has been may be seen in that source Hugh Ross had cited so lightly, Carl Zimmer's *At the Water's Edge*:

> The names biologists have given whales are turning out to be deceptive. Baleen whales apparently arose before there was baleen, and although toothed whales all have teeth, archaeocetes had them as well. To find truly unique defining features of toothed whales, you must look to their melon, monkey lips, and other echolocating organs. The origins of these features is, for all intents and purposes, the origin of toothed whales, but their fossils don't help nearly as much as baleen whales fossils do. The oldest toothed whale fossil, found in Washington State, dates back 34 million years. "It's got everything it takes to be an odontocete," explains Barnes. "It's got the sacs where the air sacs went, it's got the maxillary bone where it needs to be for the squeezing of the melon." The echolocation system starts, at least so far as the fossils can suggest, out of the blue.
>
> By comparing living toothed whales with fossils of archaeocetes, though, some researchers have at least been able to put some boundaries to the possible paths that evolution could have taken. The origin of echolocation probably depended on two of the most common features of macroevolution—exaptations that the ancestors of odonocetes already used for some other function, and the correlated progression of many different parts. The ears of toothed whales, having been partially isolated from their skulls for 10 million years, were already protected from their own clicks and were thus prepared for echolocation. To make the actual cries, odontocetes must have evolved the ability to sing through their noses instead of their voice boxes. Their common heritage with artiodactyls may have helped here: mammalogists have noticed that ibex, chamois, and gazelles all make alarm calls through their noses. Perhaps mesonychids could as well.
>
> Their melon may have already existed as a nose plug. In dissections of baleen whales, John Heyning of the Natural Museum of Los Angeles County and James Mead of the Smithsonian Institution have found small blobs of fat and connective tissue near the blowholes that look like miniature melons. They suggest that melons may have begun as nose plugs for the first archaeocetes to dive deep. These early whales would have needed to clamp their blowholes firmly to keep salt water from getting into their nasal passages. Like living whales, basilosaurids had shelves of bone on the top of their heads, which they

> used for the same purpose—to anchor muscles that slammed the blowhole shut. In order for these muscles to glide smoothly, the whales might have evolved a fatty structure surrounding the blowhole to lubricate the path. In mysticetes we still see this ancestral pad, the argument goes, but in odontocetes it swelled and took on a new function.
>
> Here was raw material that evolution might have used to produce echolocation. It could not have developed any one part of the system to the exclusion of the others—what point would there be in a whale becoming able to hear high-frequency sounds if it couldn't produce them in the first place? But if changes happened in increments all over the heads of toothed whales, each would encourage the other. Perhaps when some whales accidentally made a noise in their nose, they could faintly make out echoes of a neighboring fish, giving them a slight advantage in hunting. Sound might have been inadvertently focused by their nose plugs, and so whales born with oversized ones might have been favored. Meanwhile, the nose was moving up toward the top of the head for what anatomists suspect was an entirely unrelated reason: to make breathing more efficient. But in order for the nose to make its trip, the bones of the upper jaw had to expand back toward the eyes to carry it there. The farther back the upper jaw went, the more stable the whales' skulls became, which helped them in hunting. The same transformation, however, created a reflecting dish on the upper jaw for sound waves coming from the nose, as well as a platform on which the melon could rest. The ears nudged their way up to higher and higher frequencies as they separated even farther from the skull. This possible web of changes carried on for thousands of generations until echolocation, having started as a minor extra clue to the whereabouts of a fish, lit up the ocean.[175]

Creationists may be expected to dismiss this chain of reasoning on the adaptations leading to cetacean echolocation as another evolutionary "just so" story, but that judgment would be at the expense of junking the contribution of paleontology and comparative anatomy as meaningful scientific pursuits. Most of the stages Zimmer described are potentially verifiable, at least to the extent that developmental biology can tell how the melon organizes in the whale embryo or genetic analysis may compare the coding for spermaceti with other constituents of the whale metabolism. Barring researchers in the field self-destructing, therefore, there seems every reason to expect such exploration to continue … meaning that the battle between creationists and evolutionists over the relevance of such information is unlikely to diminish in the years ahead.

This is especially so concerning that transcendent von Däniken density Phillip Johnson has shown when it came to dealing with the new whale discoveries. Unlike Michael Behe, who somehow carelessly mislaid *Ambulocetus* and *Rodhocetus* in *Darwin's Black Box*, Johnson would have no truck with them even when they were thrust under his nose, which occurred late in 1996 when PBS sponsored an e-mail debate between Johnson and Kenneth Miller. Johnson's 1997 tome *Defeating Darwinism* characterized the exchange this way:

> Misleading and dogmatic statements are common in PBS NOVA programs on evolution, the producers apparently being more concerned to promote naturalistic philosophy than to portray the scientific uncertainties accurately. In early 1997 I participated in an Internet debate with Brown University biology professor Kenneth Miller in connection with the PBS NOVA television show *The Ultimate Journey*. This documentary featured photographs by Lennart Nilsson of human embryos developing in the womb. The accompanying narration labored mightily to insinuate the long-discredited doctrine that "ontogeny recapitulates phylogeny"—that is, that the embryo goes through a series of animal stages corresponding to the supposed evolutionary history of the species. Professor Miller did not defend the program but tried to change the subject to talk about hominid fossils and other stock arguments for Darwinism. Our written

> debate may still be available at the PBS/NOVA website http://www.pbs.org/nova.[176]

Here Johnson has obligingly pulled a "Garrett Hardin," confidently pointing the way to the rug underlying his argument and encouraging the reader to yank it out from under him.[177] For one of the "stock arguments" that happened to crop up en route concerned those cetaceans … and the person who had first made a big deal of them in the debate turns out to have been Johnson himself.

The first installment of the special PBS "Odyssey of Life" series had sought to depict the processes of natural evolution using the details of embryology as a backdrop. The topic of the companion online debate was "How Did We Get Here?" and so wasn't *per se* framed as a defense of the scientific merits of the program (though its conclusions were perfectly respectable and justified by the evidence).[178] Kenneth Miller's opening letter started off with a history of the problem, which was that the striking changes uncovered in fossil life "demanded explanation." Miller brought up human fossils briefly at the end of his second riposte (inviting Johnson to comment on some of the latest hominid finds—which the Berkley lawyer didn't). Whales were mentioned earlier in Miller's letter, but only peripherally, as part of a response to Johnson's Pavlovian incantation that the fossil record was "pervasively anti-Darwinian."[179]

Obviously relying on the new fossil intermediates, the NOVA program had illustrated the course of cetacean evolution by showing a computer-animated dog-like carnivore morphing through the now-known transitional stages into true whales. Evidently unaware that 1990s whale paleontology had moved on from *Basilosaurus*, and that the documentary had quite legitimately incorporated this new information in their graphic, Johnson clambered out onto the shakiest of limbs in Letter 4 (November 26, 1996) and then enthusiastically hacked it off:

> Difficulties with the mechanism are swept aside because "evolution" aspires to be both a branch of experimental science and a naturalistic religion. The religious objective predominated Sunday night. The message was "believe that evolution is your true creator, and you will find your proper place in nature." To that end all the propaganda stops were pulled out, including the dog that became a dolphin. (Try detailing the functional intermediate steps.)

Which task Kenneth Miller was most able and happy to accomplish in his reply:

> I noted earlier that evolution consistently explains the interlocking evidence from paleontology, development, and DNA, and challenged you to present an alternative. You have not. Rather than present an alternative (and fail the tests evolution passes), I suspect you'd prefer just to raise objections, hoping to establish reasonable doubt. Good lawyering, weak science.
>
> You made a serious mistake when you called the dog to dolphin sequence "propaganda," asking me to "try detailing the functioning intermediate steps." A perfect example of criticism unrestrained by fact. I don't have to "try" to detail the intermediates … they existed. Beginning with a mesonychid mammal (your "dog") the intermediates are *Pakicetus*, *Ambulocetus*, and *Rodocetus* [*sic*], leading to a true whale, *Basilosaurus*. Even *Basilosaurus* itself is intermediate. It had hindlimbs, a nose in front and teeth like those of its carnivore ancestors, not modern cetaceans.[180]

Now at this stage in the debate Johnson might well have elected to show up Miller's perfidious evolutionary presumptions by describing in detail precisely why *Ambulocetus* and *Rodhocetus* failed to adequately qualify as the very missing intermediates antievolutionists (including Johnson) had been for so long demanding. But of course that would require Johnson to actually pay attention to them … or, to be more precise, to *have paid attention* to them. For why wasn't Johnson aware of them to begin with? As Duane Gish indicated above, these new discoveries were attended by considerable media hoopla—how ever then could Johnson have missed them? In his apparent ignorance on this point Johnson embodied all the diagnostic inadequacies of creationism as a way of looking at the natural world: superficial both in its own "research" and in its thoroughly reactive responses to evolutionary challenges.

What Johnson did have to say in response to Miller's remarks on the whales illustrated something else, perfectly demarcating how Intelligent Design differs from the more Biblically orthodox "scientific" creationists like Gish and Ross. Compared to them, Intelligent Design is nothing more than *Creationism Lite*: "All the ideology … with even less *fact*." Rather than addressing any of the substance of these exciting new whale discoveries, Johnson was all set to hop aboard his latest carousel horse:

> Niles Eldredge has written: "No wonder paleontologists shied away from evolution for so long. It never seems to happen." New things appear suddenly in rocks dated in different ages, but there is no pattern of gradual transformation and no ability to identify specific ancestors of major groups. Although Eldredge admits that the fossil record contradicts the theory of gradual adaptive change, he nonetheless calls himself a "knee-jerk neo-Darwinist," meaning apparently that he believes the theory despite what he knows as a paleontologist.
>
> The non-occurence [*sic*] of Darwinian change is particularly evident where fossils are most plentiful—in marine invertebrates, for example. There it's all variation within the type, with no substantial evolution. Thus Eldredge, a trilobite specialist, tells stories about hominids when he wants to lecture about evolution.
>
> The occasional claims of fossil transitional forms nearly all involve vertebrates, and become "ancestors" only through subjective interpretation. Hominid stories are particularly plentiful because ape and human bones are sufficiently similar that, with a bit of imagination, a variant ape can be seen as on the way to becoming human.
>
> Considering the overall pattern, the claimed transitionals may just be artifacts of the theory. It's commonplace that researchers in any field will find examples to confirm what they already believe, especially if the evidence is scanty and open to interpretation. If you want to test the theory instead of just support it, you have to look at the evidence as a whole without assuming that the theory is true. When we do this, we find that the fossil record remains as it was in 1859: pervasively anti-Darwinian despite unremitting efforts to impose a Darwinian interpretation. (Chapter 4 of *Darwin on Trial* provides details.)
>
> Now let's suppose for argument's sake that *Australopithecus* did become *Homo,* and that wolf-like *Mesonyx* somehow became *Ambulocetus*. Was this by an accumulation of micromutations through natural selection? How did the "dog" improve in fitness while its body was in the early stages of this transformation to aquatic life? What mechanism known to science can produce human mental capacities from an ape brain? What is the source of the vast amount of information required to create these wonders?
>
> The mechanism is all-important because that is what gets the Creator out of the picture. In fact, the mechanism finds its primary support in materialist philosophy, not evidence. If materialism is true, then something roughly like Darwinism is a logical necessity regardless of the evidence. That is why so many believe so fervently despite the fossil disappointments. They were taught that materialist philosophy and science are basically the same thing, and that the most plausible materialist speculation constitutes "scientific knowledge."
>
> I'm not proposing another theory; I'm explaining why I'm not convinced by yours. When the truth is that we don't know, it's best to say so.[181]

We'll take a close look at Eldredge and the invertebrates shortly, but the interesting point for the moment concerns what lay beneath this extraordinary snow job. Miller replied that Johnson "had revealed the real reason for our disagreements, and I hope every reader noticed. You clearly stated what I have suspected all along. Your objections to evolution aren't scientific. They are religious." As a person of faith himself, Miller expressed a willingness to discuss religion with Johnson, "but that would shift our debate into theology."[182]

Something that I noticed was that Johnson was doing exactly what he would do a few years later with my own question on the therapsids at Whitworth College. The grand panjandrum of Theistic Realism was presumptuously declaring why his opponent believed in evolution without bothering to ask Miller about it first. Meanwhile, Miller valiantly tried to haul Johnson back to the technical issues:

> Remember when you challenged me for "intermediate steps" in the evolution of whales? Well, I produced them. But now you say that didn't matter unless I can explain the mechanism of that change. OK. The mechanism was natural selection, acting on developmental mutations and variation, adapting these land-dwellers to new opportunities—shallow tidal inlets loaded with fish. As I explained last time, there are a whole series of well-understood mutational mechanisms that can produce the changes in body structure this would require. So a plausible mechanism is no mystery, no matter how hard you try to pretend that it is.[183]

But by now Johnson was stuck in one very tight circular rut, where Darwinists "avoid or downplay" contrary evidence such as the Cambrian Explosion. "Instead they tell hominid stories, thus relying on the evidence most amenable to subjective evaluation."[184] The problem with this was that Johnson wasn't debating some nebulous "they," but rather Kenneth Miller—someone who hadn't been telling "hominid stories." Miller was trying to discuss the whales, a topic Johnson had thought to pursue only so long as the fossils didn't appear to contradict his expectations.

The capstone for this cetacean farce came a year later with the 1997 "Firing Line" debate, when Behe and Johnson together faced off Kenneth Miller. By now Behe and Johnson should have been primed to discuss the new whales, but when Miller trotted out a chart illustrating the various intermediates, their responses were models of evasion.[185] Behe ostensibly sat there like a log, while Johnson immediately launched into his new medley of the supposedly anti-Darwinian invertebrates—as though evidence of mollusk stability (assuming that to be true) somehow erased the transitional characteristics of the vertebrates *Ambulocetus* and *Rodhocetus*. Johnson then topped his gooey meringue with a hollow sour cherry: "I can quote to you from an article in *Science* says they are not—cannot be placed in an ancestor-descendant sequence." Now there was a trick I should have liked to see Johnson try to pull off … especially since no such article had appeared in that journal from which he proposed to quote.[186]

The "Firing Line" debate switched at that point to a new set of combatants, and Johnson did not bring the subject up later. Nor did it surface in *Objections Sustained* when Johnson mentioned the debate, or when he noted how the NAS science guidelines "claim that whales descended from land-dwelling animals through three intermediate forms."[187] Which made the omission all the more curious. After all, if the "Science" quotation had been as conclusive as Johnson averred, why not call attention to it later as a way to further undermine the evolutionary implication of these new whale fossils? Its absence was therefore suspicious—or at least it would be, if Johnson operated under the general debating principle that you should usually try to "take your best shot."

Since there wasn't actually any "Science" article to cite, though, where had Johnson got the idea that there was one? His unfulfilled attribution could have been an *ad hoc* spurt of one-upmanship, Ken Miller having called attention to Atwell *et al.* (1997) from memory during the debate. Or Johnson might have meant "science" generally and not the journal of that name. Having plowed through volumes of *Science* back issues trying to track down his spurious citation, I had to confess my own curiosity was insufficiently whetted to investigate all the resources Johnson *didn't* cite. Then again, this may have simply been another of those "other example" apparitions that appear from time to time in Johnson's argument when his ideological reach outstrips his scholarly grasp.[188]

Johnson might also have picked up on the controversy over whale phylogeny based on DNA analysis indicating modern whales are more closely related through the artiodactyls to hippos than to anything else living.[189] But a more promising genesis for the whale quote was a short 1994 commentary by Michael Novacek in *Nature*: "*Ambulocetus*, *Rodhocetus*, and other more aquatically specialized archaeocetes cannot be strung in procession from ancestor to descendant in a *scala naturae*. Nonetheless, these fossils are real data on the early evolutionary experiments of whales. They powerfully demonstrate transitions beyond the reach of data, whether molecular or morphological, derived from living organisms alone."[190]

The first sentence at least would appear an enticing start for Johnson's authority quote, but unfortunately Novacek had given the contextual game away by his inclusion of the later archaeocetes. As we've seen, their relationship to modern whales is uncertain, since they had acquired specialized features not found in later cetaceans.[191] But that issue is simply another aspect of the Alphonse/Gaston problem. The odds are plainly stacked against finding *the* ancestor for any specific group conveniently trapped in stone, especially if the genus or family is not particularly diverse. The best you can normally hope for is to unearth a taxon closely enough related to provide morphological benchmarks to go by. That's why finding both *Ambulocetus* and *Rodhocetus* in a fairly constrained paleontological horizon is so important—their very existence significantly improves the likelihood that a lot of legged cousins were paddling about the Tethys Sea that never made it into the fossil mix. Think of living whales here. If all you had were a gray whale and a dolphin as fossils, it would be quite misleading to proceed as though a plethora of close relatives weren't swimming around in the same oceans, from humpbacks to sperm whales—each with their own fascinating behavioral specialties.

Following up on these questions brings us to the fun part, where we embark on a glorious runaround worthy of Kent Hovind or Richard Milton.

In July 2000 I dispatched an e-mail query to Phillip Johnson concerning the provenance of his *Firing Line* "Science" quote. The reply came not from Johnson … but from Michael Behe, who had been forwarded my request because it had been Behe who had provided Johnson with the quotation at the debate. (Behe had not been so log-like after all!) Behe's reference turned out to be that *Nature* bit (or at least the first two lines of it) … but which he still identified as "Michael Novacek, Science 1994." He apologized for not having the exact page number, "but I'm sure from that information you'll be able to find the quote with a trip to the library."

Fat chance there, since I already knew the *Science* attribution was incorrect. But things were even worse than that. Behe had no way of knowing what library resources I might have had at my disposal. While college facilities do tend to retain their journals as bound volumes (meaning one would only have to slog through half a dozen or so to find out that Behe had slipped a cog), public libraries are quite another matter. These days, back issues are likely to be replaced by block microfilm packets, and not always restricted to a particular journal. Completely unrelated titles may be bundled together solely because they were recorded for that week or month. Under those circumstances anyone trying to track down Behe's "Science" quote would hit a brick wall, even had he supplied the proper page numbers—what the librarian would have needed to access the article was the *exact date*.[192]

At this point I decided to perform a bit of an experiment, replying to both Behe and Johnson with these concerns about how to find the source at the library, along with a few further questions. Since the Novacek piece was not a technical article, it could hardly justify on its own the broader conclusion Johnson (or Behe) hoped to jump from it. The scholarly question had thus moved on from mere citation to its *content*—àla Watergate, I wanted to ferret out what Johnson and Behe knew about all this, and when they knew it. Had either seen the original article? If so, how had they come to think it was in *Science*? If Behe had derived it from a secondary source (tertiary, by the time you get to Johnson), from whence the original citation? And so on … and so forth.

Johnson immediately blew a gasket: "Gawd. This sort of thing can go on forever." Yes, ain't scholarship a pain!

Anyway, Johnson now let the cat out of the bag by forwarding to me a revealing e-mail he had received from Eugenie Scott all the way back in late December 1997 (thus right after the "Firing Line" debate). Apparently Behe had shared his "Science" quote with another interested *Firing*

Line viewer, Larry Flammer, who had in turn dispatched his curiosity on to Eugenie Scott, who recruited dinosaur paleontologist Kevin Padian to look into it. Padian quickly determined the correct *Nature* provenance, and questioned the uses to which Johnson and Behe sought to put this "typical example of creationist selective quotation."

Here's where things get really interesting. First, Johnson could have skipped the folderol in the first place, and replied from square one with something like this: "The article was from *Nature* (28 April 1994), though Mike Behe made a mistake somewhere and thought it was from *Science*. We got a bit of criticism on it from evolutionists, and I haven't relied on it since." But that would have been too straightforward, especially since it would have cut the rug from under his whole point—namely, that he had some "Science" authority to justify his dismissal of the new legged whales. Letting go of Novacek would have left his argument, shall we say, *legless*.

As for Behe, the Scott e-mail (with its Padian inclusion) had evidently been forwarded onto him at that time, back in 1997. Which made it all the more intriguing that he had never revised his own notes to reflect the correct citation. While Behe owned up to that error, he justified it on account of all the mail he receives. Furthermore, since this information was contained in his private files, my concerns about the "logical arguments of scholarly method" didn't apply. Had he gone on to publish anything about it, Behe said he would have rechecked the source.

This took my breath away. Behe had done more with the Novacek quote than simply tuck a mistaken datum into his personal "My Documents" folder. He had slipped Johnson this little number in a nationally televised debate, apropos a subject of not inconsiderable scientific moment—and Johnson would presumably have gone on to actually quote it had not the debating clock intervened. But more interesting was Behe's "separate but unequal" application of scholarly standards: one rule for things that get published … and another (obviously looser one) for his own day-to-day thinking. But if his published logic, such as that contained in *Darwin's Black Box*, doesn't ultimately rest on the precision of his original research, when exactly does it intrude? Sound scholarship should pervade the intellect at all levels—not something you tack on as an afterthought to keep sticklers like me or Mr. Flammer from griping about it.[193]

But all this is "green eye shade" arcana compared to the substantive issue of what the new whale fossils mean—and what Michael Behe proposes that they *not* mean. For Behe had read the original Novacek piece, and was sticking to his guns about invoking the "no cousins" rule: "Since they can't find real ancestors (which Darwinian paleontologists classically did hope to find) the other side wishes to shift the focus to 'morphological' intermediates."

Which naturally raises this question: what would those "real" whale ancestors look like—and in what respect would they differ from either *Ambulocetus* or *Rodhocetus*?

In order to defuse the implication of the new whales, a whole chain of reasoning had to underlie Behe's surface claim about "real" ancestors. First, it was necessary to contend that the particular specializations of *Ambulocetus* and *Rodhocetus* were so different from the ideal that no "real" ancestor could possibly have been related to them through natural speciation. Which in turn would jump the problem back to what the limits of natural speciation really are—and then to apply that understanding clearly to the whale example.

None of which Michael Behe is even remotely disposed to do: "You should understand that I am not a paleontologist and don't give a hoot about whale ancestors or the fossil record. Nor do I care much about common descent." Actually, I had figured that out already … but the problem is that Johnson had relied on Behe as though he were a paleontologist—or at least someone who gave a very big hoot about the nature of fossil evidence. Yet Behe acknowledged that he had "no criteria for distinguishing a direct descendant from a cousin." For him to coyly beg off now justifying his taxonomical assertions on the grounds of extenuating disinterest returns us to the marshy environs of Kent Hovind: *willing neither to defend his position, nor abandon it*.

On one level, how Phillip Johnson and Michael Behe approached the whales in the 1990s was the mirror image of how Creation Scientists had fielded the Glen Rose "man tracks" back in the 1970s. So long as such evidence was perceived as being favorable to their cause it was extolled without qualification. As soon as the data turned against them, though, Behe and Johnson tidied everything up under the rug and moved on, without so much as a nod to evolutionists for having produced exactly what creationists had said shouldn't have existed in the first place.[194]

But the whales represent more than just the "Paluxy River" of Intelligent Design. Squatting behind the creationist attitude is an extraordinary conceit regarding the nature of evidence. The many creationists weighing in on the new whales did not change their position one iota that whales hadn't evolved. But if "*not*-A" (an absence of whales with legs) indicates their evolution hasn't happened … and "A" (discovering that whales with legs actually existed) doesn't support their evolution either … then don't "A" and "*not*-A" (!A) have to mean the same thing? Now in the fuddy-duddy world of analytical logic constructions of the form "A=!A" are frowned upon.[195] But evidently under the liberating new freedom of Theistic Realism that will no longer be an obstacle. Only having maneuvered Intelligent Design into such a position, hovering alongside more orthodox creationists over the evidence without any physical props underneath, what exactly is to keep the Cheshire Cat from drifting all the way into Wonderland?

Going by what Phillip Johnson was doing with Niles Eldredge and the invertebrates, the answer to that question is … *not much*.

Theistic Science: "knee-jerking" Eldredge & the "very atheistic" Weinberg

The timing of Johnson's statements on Eldredge's "knee-jerk" Darwinism coincided with his composition of the next installment in his anti-Darwinian trilogy, *Defeating Darwinism*, where those arguments popped up once again. But there is some difference between abstracting a well-honed position for debating purposes and monotonously recycling the same superficial analysis in a printed volume (where one presumably has both the time and inclination to buttress one's argument with all the best information possible).[196] When you check out the treatment in *Defeating Darwinism*, though, you discover Johnson has "explained" things in no more detail than in the Miller or "Firing Line" debates. He simply repeated his increasingly petrified position, mixing together all his disparate misapprehensions about invertebrate stasis and hominid obsessions into a frenetic muddle, never lighting on one topic long enough to make sense of any of them:

> I've long been fascinated by the conflicting messages Darwinists provide concerning the fossil evidence. On the one hand, they proudly point to a small number of fossil finds that supposedly confirm the theory. These include the venerable bird/reptile *Archaeopteryx*, the "whale with feet" called *Ambulocetus*, the therapsids that supposedly link reptiles to mammals, and especially the hominids or ape-men, like the famous Lucy. These examples, all from vertebrate animals, are pressed very insistently on me in debates as proof of the "fact" of evolution and even of the Darwinian mechanism.
>
> I am not as impressed by such examples as Darwinists think I should be, because I know that the fossil record overall is extremely disappointing to Darwinian expectations. One prime example is the "Cambrian explosion," where the basic animal groups all appear suddenly and without evidence of evolutionary ancestors. What is even more interesting is that the evidence for Darwinian macroevolutionary transformations is most conspicuously absent just where the fossil evidence is most plentiful—among marine invertebrates. (These animals are plentiful as fossils because they are so frequently covered in sediment upon death, whereas land animals are exposed to scavengers and to the elements.) If the theory were true, and if the correct explanation for the difficulty in finding ancestors were the incompleteness of the fossil record, then the evidence for macroevolutionary transitions would be most plentiful where the record is most complete.
>
> Here is how Niles Eldredge, one of the world's leading experts on invertebrate fossils, describes the actual situation:
>
> > No wonder paleontologists shied away from evolution for so long. It never seems to happen. Assiduous collecting up cliff faces yields zigzags, minor oscillations, and the very occasional slight accumulation of change—over millions of years, at a rate

> too slow to account for all the prodigious change that has occurred in evolutionary history. When we do see the introduction of evolutionary novelty, it usually shows up with a bang, and often with no firm evidence that the fossils did not evolve elsewhere! Evolution cannot forever be going on somewhere else. Yet that's how the fossil record has struck many a forlorn paleontologist looking to learn something about evolution.

Eldredge also explains the pressures that could easily lead a forlorn paleontologist to construe a doubtful fossil as an ancestor of evolutionary transitional. Science takes for granted that the ancestors existed, and the transitions occurred, so scientists ought to be finding positive evidence if they expect to have successful careers. According to Eldredge, "the pressure for results, positive results, is enormous." This pressure is particularly great in the area of human evolution, where success in establishing a fossil as a human ancestor can turn an obscure paleontologist into a celebrity. Human evolution is also an area where the evidence is most subject to subjective interpretation, because ape and human bones are relatively similar. If you find an ape or human bone that's a bit unusual, can you construe it as a piece of a prehuman ancestor? If you can, and if the other experts will support you, your future may be a glorious one.[197]

[*A note explained:*]

The ever-changing story of human evolution took a strange new turn late in 1996, when geochronologists announced a study from Java indicating that three human species (*Homo erectus*, Neanderthals and modern humans) apparently coexisted on the earth as recently as thirty thousand years ago. The *New York Times* (December 13, 1996) front-page story reported, "Until a couple of decades ago, scientists conceived of the human lineage as a neat progression of one species to the next and generally thought it impossible that two species could have overlapped in place or time." It also observed, "It is not known how much contact the three species had, or if they could interbreed." If they could interbreed, then it would be more accurate to say that they were all a single species, *Homo sapiens*. Such huge areas of uncertainty support my view that general conclusions about evolution should not be drawn from the human fossil record, where the evidence is scanty and the temptation to subjectivity in interpretation is particularly great. Today's "fact" is likely to be tomorrow's discarded theory.[198]

[*The text continued:*]

In light of these pressures and temptations, how confident should we be that fossils of "human ancestors" are really what they purport to be? Could the wish be father to the thought, as it so often is?

To forestall outraged protests, I should emphasize that there is nothing cynical about asking these questions, nor do they imply that anybody is committing a deliberate fraud. Remember the wise words of Richard Feynman: "The first principle is that you must not fool yourself—and you are the easiest person to fool." Think how easy it would be for ambitious fossil hunters to fool themselves, when the reward for doing so may be a cover story in *National Geographic* and a lifetime of research funding. Think how much pressure the other physical anthropologists are under to develop standards that will allow *some* fossils to be authenticated as human ancestors. A fossil field without fossils is a candidate for extinction.

Keeping all that in mind, why do you think such a high proportion of the fossils used to prove "evolution" come from this one specialty? Why do you think Niles Eldredge, a specialist in marine invertebrates, used hominid examples

> rather than the vast record of fossil invertebrates to argue the case for evolution? If anybody tries to tell you that questions like these are improper (as they probably will), your baloney detector should blow a fuse. A scientist who objects to scientific testing is like a banker who doesn't want the books to be audited by independent accountants. View such people with suspicion.[199]

One might suspect that the fuse on Johnson's personal "baloney detector" blew a long time ago, and in the hubbub of the subsequent antievolutionary crusade has never been replaced. That would at least account for the string of rhetorical accusations Johnson concluded with, and his sublime confidence that the only response opponents might have to them would be to snarl about how "improper" such questions were. But impropriety is the least of Johnson's problems here. For on what objective basis did he decide that "a high proportion" of the fossils being adduced for evolution came from human paleontology anyway? Indeed, going by the examples Johnson rolled out at the start of his own discussion (*Archaeopteryx*, *Ambulocetus*, the therapsids, and Lucy), in his own experience at least three quarters of them *weren't* "hominid examples." So why did Johnson think otherwise?[200]

Indeed, what evidence is there that Niles Eldredge had relied on those supposedly specious "hominid examples" instead of invertebrates when he fielded his particular vision of evolutionary change? Following this meandering trail not only further illuminates the superficiality of Johnson's scholarship and reasoning, but leads us to another of the great blind spots in creationist thought: the utter inability to recognize, let alone explore, the *patterns* to be found in the history of life.

Johnson offered in his Reference Notes exactly one resource apropos the invertebrate claim: Eldredge's 1995 book *Reinventing Darwin*, from which the "never seems to happen" quote was extracted. That work was not trying to "prove" evolution, however, but rather to explain the profound technical differences between the punctuated equilibrium "naturalist" position and the "ultra-Darwinian" reductionism of theorists like Richard Dawkins. Obviously happy to see one more admission of "stasis," Johnson has readily embraced the Eldredge remark with as much tenacious enthusiasm as might Henry Morris or John Ankerberg. What Johnson hasn't bothered with is any consideration of what the book itself might have been about.[201]

The central theme of *Reinventing Darwin* turns on the recognition that Darwinian natural selection operates on both the individual *and the species* level. For Eldredge that is a crucial distinction, with specific consequences for understanding the nature of evolution—a process he considers inherently *historical*, where paleontologists have as much to offer at the "High Table" of debate as population geneticists studying contemporary allele distribution. As for what all this means for the job of junking "Darwinism," Phillip Johnson has been so persistent in mistaking forests for trees here that he manages to perceive neither. Niles Eldredge was quite forthcoming that Darwin had got part of the story wrong (trying to dissolve speciation along a continuous spectrum of gradual change) but had other insights entirely correct. This was especially true for the character of differential reproduction that plays out on the species frontier: "Darwin's original description saw that economic success biases reproductive success, and that such an effect inevitably biases the transmission of heritable features from one generation to the next."[202]

Eldredge was using "economic" here in its strict ecological application, where eating is taken to be an "economic" activity of organisms. And this interplay of genomes and ecological economies plays out very differently to a paleontologist like Eldredge than it does to an Ultra-Darwinian like the zoologist Dawkins. Eldredge explained that "Ultra-Darwinians restrict their list pretty much to genes, organisms, and populations—acknowledging that species, social systems, and ecosystems exist, but not as direct players in the evolutionary arena. In contrast, I see such large-scale systems as absolutely crucial to understanding how the evolutionary process actually works."[203] *Reinventing Darwin* therefore left little doubt about exactly where the "naturalist" position differed from the "ultra-Darwinian" one. But for Johnson the technical issues were entirely irrelevant: "The versions of 'evolution' promulgated by Richard Dawkins and Stephen Jay Gould, for example, have hardly anything in common except their common adherence to philosophical materialism and their mutual dislike for supernatural creation."[204]

The result was that Johnson was getting the point of Eldredge's book *backwards*. Like a seemingly innocuous equation that spawns a host of momentous conclusions once it is applied to specific instances, it was Eldredge's contention that uniting Darwin's concept of natural selection with modern population genetics squares with the pattern of speciation bursts amid stasis found so routinely in the fossil record. So Johnson was trying to invoke Eldredge's idea of fossil stasis to refute the *Darwinian mechanism*, when it was the whole point of *Reinventing Darwin* that the Darwinian mechanism inevitably and neatly explained that fossil stasis! And there, Eldredge's evolutionary logic diverted even farther from Johnson's creationist inversion. For Eldredge the interesting problem was something else altogether: "The fundamental question in evolution is not how adaptive change occurs (it comes through natural selection), but why adaptive evolutionary change occurs when it does."[205]

Those species generated by natural selection appear as historical rarities because the species groupings from which they spring are themselves extremely stable—one of the reasons, in Eldredge's view, why sexual recombination (which leads to species formation) has taken hold among complex organisms in the first place.[206] But the suppressed internal variations don't disappear. They play out in competing venues: local breeding populations ("demes") and those segments of the species ("avatars") that directly participate in a given ecosystem. The *demes* and *avatars* are rarely identical, but instead constitute overlapping subsets that set up a tug-of-war within the species. The internal variety spilling around in the *demes* and *avatars* may (but don't inevitably have to) split off into new species in spurts when triggered by such factors as reproductive isolation.[207]

What happens to those new species is at the heart of Eldredge's conception of evolutionary change, where the fossil pattern of "stasis" illuminates how natural selection unfolds in the living world:

> Speciation, after all, does not necessarily beget evolutionary adaptive change. But *successful* speciation—persistence past infancy, survival long enough to show up in the fossil record—does. That's why adaptive change is so tightly correlated with speciation. Without speciation, little change is possible: stasis is the rule. With speciation, there may be the opportunity for rapid evolution. If not, if little adaptive change occurs at speciation, we get high rates of fledgling species extinction—and no insight about why adaptive change occurs when it does. But if some change does occur, we get a much greater chance for species survival and the production of still more new species down the phylogenetic road. Thus is adaptive change injected into the evolutionary stream.[208]

Where the really big adaptive changes tend to occur is after mass extinctions. "It is the rate, not of speciation per se, but of successful speciation, that goes way up after a major extinction event."[209] Eldredge argued that this was not so much because the environment had changed (though the transition could certainly be bumpy), but that the competitive field has been so cleared of previous rivals that genetic novelties stood the best chance of finding an isolated survival niche. Interestingly, the morphological spiral set off by a mass extinction usually fills up the available adaptive space with roughly the same taxonomical diversity as prevailed before the crash hit. Exit a bevy of aquatic Cretaceous reptiles … enter a proliferation of mammalian whales. That distinctive pattern of ecological replacement is the hallmark of a mass extinction event.[210]

But the post-extinction successors don't arrive *instantaneously*. The mundane process of genetic mutation that fuels their natural selection is apparently *unguided*, remember, so it takes some time for niche-filling macroevolutionary variations to appear. The result is an ecological rebound that consistently stretches over *millions* of years. Whether delayed appearances like that would also be expected for an omnipotent creative intelligence is another matter. Indeed, what Intelligent Designers may think of the necessity of restocking what amounts to a creationist game preserve after so many of the specimens inconsiderately drop dead is hard to tell, given that mass extinctions don't rank very highly on their philosophical agenda. Though it would be interesting to learn what they would make of the *competence* of a designed global zoo periodically falling apart.[211]

Recognizing what *Reinventing Darwin* was really about, that species stasis concealed the pent-up genetic changes that drive evolution, what sort of fossil evidence did Eldredge trot out to illustrate this pivotal concept? Not "hominid examples," to be sure:

> But habitat tracking itself does not preclude adaptive change: a species might survive, but it need not do so completely unchanged. My colleague Bruce Lieberman's study of two species lineages of Devonian fossils sheds some light on the relation between habitat tracking, species survival, and stasis. Lieberman worked on two species of brachiopods, bivalved invertebrates that superficially resemble true clams. In both brachiopod lineages, Lieberman found that after six-million-years, each species ended up pretty much as it began. But Lieberman also found that sometime near the middle of that six million year interval, some significant anatomical deviation occurred in both species—a distinct "dog-leg," the zig of a single zigzag evolutionary history.
>
> So far, Lieberman's brachiopods don't seem to have behaved significantly differently in kind than Sheldon's trilobites, Gingerich's mammals, or most other fossil species. But Lieberman was able to delve further. He compared variation between samples, not only over geologic time, but also between samples of brachiopods that lived at about the same time but in different ecological settings.
>
> Here is the twist to Lieberman's study: Both of his brachiopod species occurred in more than one ecological community. Gradual evolution within each species was most pronounced within populations living in nearly identical environmental settings. Peter Sheldon has made a similar point. Typecast as an ardent gradualist by the splash made by his *Nature* paper and Maynard Smith's commentary, Sheldon actually acknowledges that stasis may indeed predominate in the fossil record. He has suggested that habitats with lots of physical environmental change on geological time scales actually engender stasis, either through habitat tracking, or selection for ecological flexibility (itself a theme explored in depth in later chapters). More stable regimes (themselves harder to find in the fossil record), on the other hand, provide the context for the accumulation of gradual adaptive change. Sheldon's suggestion neatly turns the traditional expectation of evolution tracking environmental change—and of relative evolutionary stability in the face of environmental stability—on its head.
>
> If habitat tracking were absolutely all that there was to stasis, one would not predict that populations living under the most unchanging conditions would be the very ones that express the most change. Something more must underlie the stasis phenomenon, something beyond simple habitat tracking. Something does: Stasis is an outcome of the organization of species in the wild. And our appreciation of that structure and its evolutionary implications comes from the work of a population geneticist: Sewall Wright. The neo-Darwinian failure to grasp the competing notions of Wright's work in the 1930s, plus the competing notions recently espoused by ultra-Darwinians to explain stasis, tell us much about the reductionism of traditional evolutionary biology. And it reveals vividly the lack of importance ultra-Darwinians attach to the organization of living systems in the wild.[212]

It would appear that Phillip Johnson was the one equating "stasis" with "no evolution," and consequently relegated all of Niles Eldredge's coverage of invertebrate variety to the non-Darwinian hinterlands. But if Eldredge wasn't shying away from invertebrate illustrations when it came to his own evolutionary theories, what about all those "hominid examples" Johnson assured us dominated Eldredge's discourse? Here again the reality was that *Reinventing Darwin* had barely even mentioned them. There were only two instances, well down the line of his argument, used in relation to how speciation bursts didn't ineluctably trend in one direction.[213]

Johnson's Pavlovian connection of Eldredge with "hominid stories" appears to owe less to Eldredge's sundry written works than to his one interaction with the paleontologist in a lecture setting, which Eldredge happened to cover in his revised criticism of creationism, *The Triumph of Evolution*. The venue was a Christian college, though Eldredge had some interesting observations to make about his end of the experience:

> The morning after I appeared in a debate with creationist Phillip Johnson at Calvin College in Grand Rapids, Michigan, I attended an informal meeting of science faculty. Though I was the evolutionist, the science faculty at this conservative Christian college (Calvin College is affiliated with the Christian Reformed Church in North America) are extremely professional: not only was I treated cordially, but many faculty members made it plain that, whatever their personal feelings about evolution may be, they know that evolution is a bona fide scientific concept—and they have great respect for science, as they themselves are professional scientists. Rather, it was Johnson with whom they had a bone or two to pick, since Johnson apparently cannot understand why, as a leading Christian conservative intellectual, he is the darling of much of fundamentalist and evangelical circles *except* science faculty at some conservative Christian schools.[214]

Given such an audience of conservative Christians, Eldredge's lecture understandably focused on what has plainly been for that group the most contentious aspect of natural evolution: human origins. Eldredge described the collegiate response:

> In any case, as we were waiting for Johnson to show up, we talked about the program of the preceding night. I'll never forget one faculty member sitting next to me (I believe he was a physicist), who said—in reference to the series of slides of fossil human skulls I had shown—'Boy, you really went for the jugular!' That's really it: if we evolutionary biologists would only stop brandishing the fossil record of human evolution as one of the very best examples of evolutionary change through time, the creationists would be deliriously happy, and all but a few diehards wouldn't give a damn what we said about trilobites, dinosaurs, or horses![215]

And so too Phillip Johnson, who evidently mistook Eldredge's tactical focus on that one occasion as though the paleontologist was congenitally defensive about evolutionary evidence in his own field of invertebrates.

By playing the Eldredge card as he did, confidently repeating claims that were far removed from the content of the only printed work he cited, Johnson has nabbed the "Von Däniken Methods Prize" fair and square. But there is something else going on here besides surreal scholarship. It lies beyond even the juicy irony that Johnson has indulged in the trait most often leveled at doctrinal Creation Scientists: authority quoting out of context. No, it is the *information* in Eldredge's book, not Johnson's sloppy use of it, that should have provoked headaches rather than secondary citation. The patterns in the fossil record that Eldredge's book was about are an unmitigated disaster for the conceptual underpinnings of Intelligent Design taxonomy: creationist "typology" doesn't work.[216]

For the reasons why, step back a notch and consider what Douglas Futuyma had to say about taxonomy in his criticism of creationism:

> Biologists have recognized ever since the dawn of taxonomy that the categories into which animals and plants are classified are arbitrary. Most of the higher categories in the classification of plants and animals are bridged by intermediate forms, so that the limits of each category are almost invariably ill

> defined. For example, the garter snakes and water snakes have been placed in separate genera, but a spectrum of semiaquatic species, differing slightly in almost every possibly respect, connect them. Cobras are put in a separate family, but the fangs and poison glands that distinguish them are developed to varying degrees in certain other snakes. Snakes as a group are distinguished from lizards by their lack of legs and certain features of their teeth and jawbones, but among the lizards there are many species that have diminutive legs or none at all, and others with snakelike jaws. One group of species, the blind snakes, has been classified as lizards by certain taxonomists. Modern reptiles are all easily distinguished from amphibians by their skeletons, but Permian fossils such as *Seymouria* cannot be classified unambiguously as either reptilian or amphibian. So it goes, throughout the whole taxonomic hierarchy. Even the plant and animal kingdoms cannot be distinguished when you examine one-celled organisms that are claimed by the zoologists as protozoa and by the botanists as algae.[217]

But this is not how Michael Denton saw things in his chapter on "The Typological Perception of Nature" in *Evolution: A Theory in Crisis*. His nonevolutionary interpretation of the hierarchical structure of the living world (where finches are birds and cats are mammals, but both are also amniotic vertebrates) was the apotheosis of the "no cousins" rule spooling out from the Bermuda Triangle defense. For Denton, "the order of nature betrays no hint of natural evolutionary sequential arrangements, revealing species to be related as sisters or cousins but *never* as ancestors and descendants as is required by evolution. The form of the tree makes explicit the pre-evolutionary view that it is discontinuity and the absence of sequence which is the most characteristic feature of the order of nature."[218]

Now the "tree" Denton referred to was a radial chart on the next page, where a "vertebrate archetype" branched into the "anamniotic" and "amniotic" archetypes. The anamniotic one in turn diverged into the "amphibian" and "fish" archetypes, while the amniotic side split into the "mammalian" and "avian" archetypes. These categories yielded terminal examples arrayed around a circle: "frog," "toad," and "newt" for the amphibians; "salmon," "lungfish," and "hagfish" for the fish; "dog," "man," and "whale" for the mammals, and "penguin," "duck," and "eagle" for the birds. Denton gave no indication that any of these "archetypes" might once have been physically represented by real organisms, such as some prehistoric "amniotic" creature that was neither mammal nor avian, but ancestral to both. The "archetypes" function as conceptual templates only—the essential blueprints with which an Intelligent Designer might have contrived a particular typological example.[219]

All very prosaic and familiar—but where exactly do the known members of the reptile class fall in this tidy scheme, and how are the fossil diapsids and synapsids to be arranged on it? Their glaring absence served to guide the eye away from the obvious question: what ever is to be done with extinct intermediates like *Archaeopteryx* or the therapsids, which stand both chronologically and morphologically as links attaching two of Denton's immutable types with the antecedent reptiles. Isn't that just the sort of paleontological sequence that he avers "*never*" happened?[220]

Much like Phillip Johnson, chalking off *Archaeopteryx* as a point in evolution's favor only to snatch it back at the first opportunity, Denton allowed that *Archaeopteryx* "hints of a reptilian ancestry" without explaining why a bird with reptilian teeth, tail and clawed wings didn't overflow the "avian archetype." Instead, Denton quickly focused on the feathers and flight anatomy that permitted him to safely tag *Archaeopteryx* as "bird." Nor did Denton pause to relate any Cretaceous birds to the typological *Aves*. A tactically useful oversight there, given that those earliest fliers lacked the fully developed flow-through skeletal and lung system Denton also considered absolutely characteristic of birds, thus further blurring the historical utility of the "avian archetype."[221] Even more audaciously, the mammal-like reptiles were arbitrarily dumped on the "reptile" side of the fence. Only to pull off that trick Denton had to indulge in the same freestyle data selection more traditional creationists like Duane Gish are noted for, when fending off similar assaults on the validity of their "fully formed" Biblical "kinds."[222]

By such wholesale exclusion of fossil taxa Denton cleaned up the natural world until what was left could be crammed into the typological cabinets prepared for them. So the murky dividing line between plants and animals, or unicellular and multicellular organisms, such as Futuyma or Chris McGowan called attention to, never show up on the typological hit parade to cause any problems. Indeed, Denton was willing to allow only three "somewhat anomalous" typological exceptions to exist: lungfish, the monotreme mammals, and the Onychophora (which we met in conjunction with arthropod evolution).[223]

But remember that lungfish appeared on Denton's radial typology chart (along with *whales*), suggesting that these are indeed a "type." The paleontological problem is that the members of the lungfish, considered to be at least an *order* (and maybe even a *subclass*) within the fish, do not arrive all of a piece in fossil history. Most of their derived characters spilled onto the scene over a twenty-million-year period late in the Devonian. If lungfish are a "type," within which microevolution is allowed to run amuck, what about the lungfish order makes them special enough that other orders (like primates?) are not deemed similarly *typical*?[224]

As enamored as Denton was of charts to illustrate his views, it was extremely revealing that he presented no depiction of what was to be expected from the typological framework applied through *time*. That is because, quite literally, chronology plays no more of a role for the typological mindset than speed did for Zeno. Like creationists generally, Michael Denton manifests nothing approaching a working "map of time."[225]

Evolutionists are not comparably restricted, however, and Denton was well aware of what Darwinists expected from the fossil record: a branching tree of extinct life where any temporal slice would produce the same distinctive pattern of clusters of related forms. As even Kurt Wise acknowledged, there has been a persistent turnover from one similar model to the next. The extreme "macroevolutionary" changes are observable mainly when you compare members far removed in time. The reptile-mammal transition is in this respect truly "archetypal"—animals which at one end are garden variety reptiles, but which grade without discernable localized discontinuity over 50 million years until the only thing you can call them at the other end is "mammal."[226]

How Denton thought to circumvent this fossil reality was mind-boggling. He issued an evidential decree utterly unsupported by even his own presentation in the chart of evolutionary expectations:

> There is another stringent condition which must be satisfied if a hierarchic pattern is to result as the end product of an evolutionary process: *no ancestral or transitional forms can be permitted to survive*. This can be seen by examining the tree diagram above on page 135. If any of the ancestors X, Y and Z, or if any of the hypothetical transitional connecting species stationed on the main branches of the tree, had survived and had therefore to be included in the classification scheme, the distinctness of the divisions would be blurred by intermediate or partially inclusive classes and what remained of the hierarchic pattern would be highly disordered.[227]

Except the intermediates *did* survive—often for millions of years, long enough to land in the fossil record as the therapsids assuredly did. If Denton was thinking that transitional forms have to also hang on *to the present day*, that is a further requirement nature (whether designed or not) has failed to heed with a vengeance: 99% of described families are thoroughly extinct.[228] By arbitrarily saddling paleontology with this "survival" condition, Denton has tried to slip typology off the hook when it comes to dealing with the unruly intermediates that insisted on living in the past in spite of their typological incongruity. There are no living therapsids to put under the microscope, but Denton showed the stuff of typological curiosity by paying no further attention to the rest of their preserved physical anatomy.[229]

Part of the reason for this sanguine disinterest may be because many creationists have become convinced that the tide of scientific classification has already turned in their favor—a revolution accomplished through the popularity of cladistic analysis. For instance, Gary Parker burbled in

1987 that “one of the most brilliantly and perceptively developed themes” in Denton’s *Evolution: A Theory in Crisis* concerned “how leaders in the science of classification—after a century of trying vainly to accommodate evolution—are returning to, and fleshing out, the creationist typological concepts of the pre-Darwinian era.”[230] But if cladistics were so obviously anti-Darwinian, why then have so many unapologetic evolutionists (paleontologists in particular) avidly embraced it? That question should have raised a few red flags, but antievolutionists from Denton to Gish haven’t ventured that far. All they’ve noticed is that contemporary systematics goes its merry way without any reference to the theoretical mechanisms of evolutionary change. As far as they’re concerned, that can only mean a rejection of evolution.[231] But the plain fact is that evolutionists have adopted cladistics precisely because it operates as a powerful *independent* crosscheck of their theoretical modeling. That’s how dinosaur paleontologists have brought birds to roost as feathered theropods, as well as resolving other less popularly known phylogenetic controversies.[232]

But there’s a twist to this, because cladistics operates under what may be thought of as the flip side of the “no cousins” rule. Recognizing the Map of Time problem (where no fossil animal can ever be known as thoroughly as living forms), cladograms pointedly take no stand on ancestor/descendant relationships. That’s true even should you dig up a Gaston that did evolve *directly* from some Alphonse—cladistic parsimony will go no farther than to put the two in the same “sister-group.” Cladists are therefore just as much sticklers for the technicalities as epidemiologists who identify a statistical correlation between smoking and lung cancer, without ever claiming to tag the exact molecule that may have triggered an individual case of illness. Pouncing on this ambiguity, which the creationist-in-the-street hasn’t the foggiest clue about, antievolutionists have approached cladistic taxonomy with the same spirit of brazen stonewalling as tobacco executives when they insisted no direct link existed between smoking and emphysema. Probably the most notorious example of authority quoting in the systematics venue concerns the remarks of the late Colin Patterson, who stuck his foot in his mouth on several occasions and has been the citational darling of creationists ever since. As a combination cladist and evolutionary gradualist, Patterson candidly reflected the transatlantic consternation British neo-Darwinist paleontologists have experienced under the persistent siege of cocky American punctuated equilibrium—topics that subsequently dominated Eldredge’s *Reinventing Darwin*.[233]

Which brings us back to what Eldredge’s assorted invertebrates signify for the credibility of creationist taxonomy. While Michael Denton’s typological balloon floated around the 1980s fossil record at anoxic levels, we have seen how Phillip Johnson felt free to drop altitude a decade later and confidently hoist Niles Eldredge up into the basket with that bulk cargo of mollusks and marine arthropods. How well these serve the purposes of Intelligent Design may be judged by performing a simple thought experiment. Let us suppose that Johnson’s oft-repeated mantra is correct: that all the fossil zigzags Eldredge described in *Reinventing Darwin* were but “cyclical variations within the type.” Surely then we would have that calm and stately creationist Nirvana—the “pervasively anti-Darwinian” ideal of Johnson’s dreams.

With only one tiny flaw … the stasis Eldredge was calling attention to shows up *at the species level*.[234] The only way this condition could be turned to the advantage of designed lineages would be to directly equate “species” with “type.” After all, higher taxa are but aggregates of species—so especially if species tend to stasis individually, allowing more than one of them to occupy a “type” would mean the “type” itself *wouldn’t* be static, composed as it would necessarily be of a range of morphologically distinct members. Just think “mammal type” and you’ll get the idea here: bottlenose dolphins, fruit bats, anteaters, lions, gazelles, moles, and Phillip Johnson … if they’re all the *same* “type” then whatever practical meaning would “stasis” have left?[235]

Only there’s a fly in the typological soup: if only species are allowed to be “types,” where would speciation fit in on the Intelligent Design menu? From Ayala’s fruit flies to the ring species of birds, natural species leak *demes* and *avatars* left and right. So even if natural speciation occurs only occasionally, allowing them to split off at all would in principle render the species “types” just as leaky. Since the whole point of “types” is that they cannot transform via any natural process into another “type,” in order to salvage stasis, speciation is going to have to go—and “microevolution” will have to be restricted to the species level right along with stasis. With that Intelligent Design taxonomy would just have backed itself up into the early 19th century, when it was still possible to believe that speciation couldn't take place, and land them cozily beside the more conservative branch of contemporary Scientific Creationism.[236]

That Johnson's logical undercarriage failed to strike any of these speed bumps was completely understandable, for several reasons. One of these we'll get to shortly—but the most obvious one is that his invocation of Eldredge never bothered with any of the specifics of invertebrate evolution to begin with. Certainly Johnson never considered how Sheldon's trilobites or Lieberman's brachiopods might have been related to one another, let alone how to fit them into the typological framework that was theoretically integral to the Intelligent Design conception of creation.[237]

Niles Eldredge certainly has had nothing comforting to say about the idea that all of the trilobite phylum could be submerged into one unifying "type." Indeed, he has pointedly disparaged those creationists who think "if you've seen one trilobite you've seen them all, and all the changes paleontologists have documented in this important group of fossils are just variation within a basic kind."[238]

And things don't stop there. Once you are committed to the existence of fixed "types," it is a requirement that *all* the attributes of member animals must fall within the allowable microevolutionary jiggles exemplified by, for example, the Galápagos finch "type." Eldredge hit on that matter in his works devoted more specifically to creationism: "Trilobites are as diverse and prolific as the mammals, and examples of evolutionary change are as compelling examples of evolution as any of which I am aware. Airily dismissing 350 million years of trilobite evolution as variation within a basic kind is actually admitting that evolution, substantial evolution, has occurred."[239]

Which means if Intelligent Design tries to "accept" microevolutionary speciation while simultaneously allowing different static species to fall within a "type," they'll have just impaled themselves on the same painful paleontological spike that Eldredge has positioned under the ultra-Darwinians. That's because (as creationists have been so fond of pointing out) it is the transitions from one species to another that are often missing in the fossil record—and so the intermediates that must have existed *within the type* would likewise only have been rarely preserved.[240]

But "rarely" isn't quite the same as *never*, even when it comes to the phyletic gradualism Johnson is out to demolish. So it was that Eldredge explicitly affirmed in *Reinventing Darwin* that "though our data frequently are too poor to demonstrate gradual change through selection, we do in fact have some documented examples of smooth transitions that are very much in agreement with natural selection."[241] Now Johnson may be excused for having skipped over that little observation, since Eldredge didn't stop to offer any examples of such smooth transitions (as a popularization intended for a general audience rather than a technical exposition, *Reinventing Darwin* was distinctly shy on background citation).[242] Presumably Eldredge thought that particular issue (the existence of natural speciation *per se*) both settled and of little interest to his main subject of whether the overall species pattern indicated stasis. Had he known Phillip Johnson would be subsequently surfing his book for ammunition, however, he might have been more diligent, and offered a few of the many available examples of more gradual transitional change known among the invertebrates.[243]

Nor does the repertoire of evolutionary transitionals stop with those big invertebrates that Johnson is apparently thinking of when he brings the subject up. It includes also the tiny planktonic organisms that are, if anything, the most ubiquitous of marine invertebrate fossils.[244] So if the extent of invertebrate preservation was supposed to be a measure of how unsuccessful "Darwinism" is, then the incessant rain of planktonic detritus on the ocean floor ought to have been part of Johnson's first line of defense. But that would have required him to transcend Eldredge's authority quote and do some peripheral research on his own. Had he done so, he might have learned that the microscopic foraminifera have graduated to star status, where the planktonic fossil record shows as variegated a texture of gradual and punctuated change as that of the larger invertebrates or their extremely distant vertebrate cousins. Indeed, a succession of foraminifera have occasionally been trapped in enough detail to show one branch of its population sheering off in a rapid punctuation burst as a new species, while the main body ground along a more gradual path into yet another distinct species. Two transitions for the price of one![245]

This sort of thing isn't quite what Johnson had in mind when he proclaimed the static character of the invertebrate fossil record. But then, surveying the seas from high atop the Intelligent Design tepuí, he had managed to turn the whole issue inside out, hadn't he? The extent to which species "stasis" helps the creationist cause depends not on the duration of the subsequent rut, but whether or not there are recognizable intermediates leading up to them from some previous species track. It's the existence of those intersections, and not the mileage on the side roads, which should have been engaging Johnson's attention—things like the transitional sequence described by Patrick Doyle and Florence Lowry in their recent work on invertebrate evolution:

> Gradualism can be credibly defended where the record is complete and sufficient representatives of the group under study are available for study. Marine plankton, such as planktonic forms of the foraminifera (Chapter 16), are particularly useful in this regard. Their small size, abundance and widespread distribution make them useful subjects in evolutionary studies. The evolution of the genus *Orbulina* in the Miocene is an example of rapid change over a relatively short time span of 0.5 million years, in which all intermediate forms are known in an exceptionally complete stratigraphical sequence (Figure 4.7). Following this short, rapid burst, *Orbulina* remained unchanged to the present day, a span of 16 million years of stasis. Should the fossil record have been less complete, this event may have been represented by a sudden speciation event followed by a period of stasis.[246]

Now you might well wonder what Johnson would make of this information, contradicting as it did his generalization that marine invertebrates posed an intractable problem for Darwinism. In the normal world of scholarly logic a "generalization" is supposed to rest at some point on actual examples. And where it is so grounded, anyone offering the opinion should be easily motivated to trotting out illustrative instances (if only to show up any critic with the temerity to challenge the validity of said generality). But in my e-mail correspondence with Johnson on this matter in the summer of 1998 I learned that he had no intention of discussing the specifics, or of defending his scholarly logic when it came to his selective interpretation of *Reinventing Darwin*. He simply repeated the Eldredge stasis quote, as if that constituted an examination of the evidence itself.

I then brought up the *Orbulina* example in a last-ditch effort to prod him into addressing at least one corporeal marine invertebrate among those abstract creatures populating his giddy generality. At that point Johnson abruptly rolled up his end of the conversation. His response (in its entirety): "Well, I see you don't get it, and you aren't going to get it. When you are in a Darwinian way of thinking, everything looks Darwinian—even stasis. You have to step outside before you can see the other side. Have a nice day."[247]

Moving beyond the smiley face of his salutation, here I have to agree with Johnson. I *don't* get it, and never will.

Perhaps it has been my tepid scholarly upbringing that has put me at such a disadvantage. The Creationism Lite "low-fact" diet of "meaningless concessions," dehydrated generalities, and meatless "other examples" seems a thin regimen, though it has obviously supplied Johnson with all the apologetic stamina necessary to clear-cut his way through the thicket of logical reasoning. For my part, I cannot comprehend how Johnson can think he has properly "tested" the evolutionary prospects of the invertebrates without mentioning any of them along the way. But then, that was exactly how he'd approached the vertebrate fossil record from the start in *Darwin on Trial*, remember? Only with their all-too-visible macroevolutionary sequences *Aves* and *Mammalia* there was no talk of "testing" with them. They were merely "a confirming example or two" … which Johnson summarily lobbed out the window at the first suitable sharp turn.[248] And as for those new whale fossils, they weren't perceived as an evolutionary "test" either—let alone a positive one. No, only the invertebrates have been allowed to "test" evolution. And that is because Johnson has pigeonholed them as a Darwinian negative. Their "test" was therefore deemed conclusive and final (exit Darwin, end of argument). For Johnson, the "testing" of evolution turns out to be a one way street—and a pretty narrow one, at that.[249]

But just as Michael Behe's double standard on the primacy of "details" revealed the deeper methodological flaws of the irreducible complexity defense, Phillip Johnson's peculiar take on scientific testing leads us to the heart of why Theistic Realism is never going to make it as a viable scientific enterprise. In *Defeating Darwinism* Johnson decided that the "Lack of Testability" was a logical problem for *evolution*, and for the following reasons:

> Either creation or evolution can be stated in both safe and risky forms. If I say I believe in creation on faith, no matter what the evidence is, then we can't test my belief by scientific observations or experiments. But if I say the evidence indicates that living organisms are necessarily the products of intelligent design and that life never could have emerged by purely natural means from a prebiotic soup of chemicals, my statement invites scientific testing. Theories of chemical and biological evolution aim to contradict my hypothesis of intelligent design, by showing that purposeless natural processes can do the creating by evolution. The question is whether they have been successful in doing this—that is, whether the theories have passed the experimental test or failed it.
>
> Darwin's theory of evolution was originally stated in risky form. It predicted, for example, that fossil hunters would eventually find a great many transitional intermediates between the major groups (they didn't) and that animal breeders would succeed in creating distinct species (they didn't). Today the theory is usually stated in risk-free form. Naturalistic evolution is identified with science itself, and any alternative is automatically disqualified as "religion." This makes it impossible to hold a scientific debate over whether the theory is true (it's virtually true by definition), which explains why Darwinists tend to think that anyone who wants such a debate to occur must have a "hidden agenda." In other words, critics couldn't seriously be questioning whether the theory is true, so they must have some dishonest purpose in raising the question.[250]

And off Johnson is again tilting his philosophical windmills. But one should note that when Johnson affirms how "my statement invites scientific testing" he isn't offering to do any of that work himself. To the contrary, it is clearly all up to the proponents of naturalistic evolution to refute "my hypothesis" through the presentation of their own technical evidence. But apart from the naturalistic origin of life (very much an open question, as we'll see later), such contenders as the reptile-mammal transition ("major groups" in anybody's book) would seem to have been adequately "tested" and decided in evolution's favor already. So of what practical value is Johnson's call for *further* testing and debate, given how unwilling he has been to hear even the loudest of positive Darwinian signals?

With this deft sleight-of-hand Phillip Johnson has gone Michael Behe one better when it comes to scheduling the Tortoise's victory over the evolutionary Achilles. Where Behe tried to banish Achilles from the field to allow the creationist Tortoise uncontested access to the finish line, Johnson has contrived matters so that *only* Achilles needs to run the race. All that is needed is to change the competitive rules, inserting a "Sisyphian clause" to automatically invalidate successful outcomes. That should keep Achilles busy. Meanwhile, the Tortoise can amble on over to the winner's circle at his own pace to claim the prize by default, perhaps on the ingenious grounds that because Achilles hasn't yet *won* a race, obviously the Tortoise must have—so please get on with it and hand over the medal.

Well, not so fast. The one character in this shadow play kept safely isolated from all potentially embarrassing "testing" is the Intelligent Design creation model itself. Although Johnson speaks of "my hypothesis" we know from his extensive writings that there is nothing to it apart from the general assertion that life didn't originate naturally and (somewhere along the line) the creator had been creating things. This is even more circuitous an approach than Duane Gish had taken with the fauna of Madagascar. In *Creation Scientists Answer Their Critics* Gish had simply neglected to apply his own views—but no one for a moment would contend the ICR sage didn't know exactly what he thought was responsible for it all (up to and including that divinely ordained global Flood). Such craven silence is not Johnson's defect here … but monumental obtuseness is. For Johnson not only has nothing substantive to offer as "my hypothesis"—he pointedly excuses antievolutionists from any obligation to provide one.

Here is the second (and far more serious) reason why Johnson missed the point of Eldredge's book so cleanly. The practice of science invariably involves *comparison*—fact to fact, theory with theory, and let the best argument win. But clearly the "Anything You Can Do (I Can Do Better)" rule is not on the Theistic Realism methodological agenda, as Johnson was quite up front about in *Reason in the Balance*:

> Two things about my approach to the subject seemed to baffle, and sometimes infuriate, my critics. First, I insisted on distinguishing naturalism from science, whereas my critics insisted that the two are virtually the same thing. Second, I felt no obligation to offer my own theory about how life was created in the first place, or how complicated things like plants and animals might have evolved from similar organisms—if indeed they did. My purpose was to show that what is presented to the public as scientific knowledge about evolutionary mechanisms is mostly philosophical speculation and is not even consistent with the evidence once the naturalistic spectacles are removed. If that leaves us without a known mechanism of biological creation, so be it: it is better to admit ignorance than to have confidence in an explanation that is not true. My critics regarded my purpose as perverse, or as reflecting an ignorance of "how science works."[251]

Ignorance may well be bliss for Johnson, but whether he likes it or not science does not presently operate under the "all or nothing" approach to evidence Theistic Realism has in store for it. Nor did Johnson offer any historical justification that it ever has, where theories were jettisoned not because a competitor turned up to explain things better, but solely due to the theory failing to accommodate some aspect within its domain.[252] Rather than take a stab at reconciling his doctrinal expectations with the known history of science, Johnson promptly scuttled off to the philosophical attic—turning to "Conflicting Creation Stories," where he declared that "Darwinian evolution is not primarily important as a scientific theory but as a culturally dominant creation story."[253]

That Johnson isn't especially concerned whether science really does depend on "methodological naturalism" to successfully function (or that, "once the naturalistic spectacles are removed," Theistic Realism would be as blind as the proverbial bat) has been clear enough from his own exploration of the facts of evolutionary nature.[254] But we do know that Johnson is fully apprised of the intimidating epistemological implications of the "history of science" problem—and just how little he cares to discuss them—because of this luminous passage a bit further on in *Reason in the Balance*:

> The very atheistic physicist Steven Weinberg described the central point at issue, in commenting on my critique of Darwinism in his own book, *Dreams of a Final Theory*. Weinberg did not dispute any of my specific scientific arguments against the validity of blind watchmaker evolution. He was willing to concede that evolutionary theory may be encountering some difficulties with the evidence, but he thought that to make very much of this is to misunderstand the nature of science. In his own words:
>
> > Johnson argues that naturalistic evolution, "evolution that involves no intervention or guidance by a creator outside the world of nature," in fact does not provide a very good explanation for the origin of species. I think he goes wrong here because he has no feeling for the problems that any scientific theory has in accounting for what we observe. Even apart from outright errors, our calculations and observations are always based on assumptions that go beyond the validity of

> the theory we are trying to test. … In the writings of today's paleontologists and evolutionary biologists we can recognize the same state of affairs that is so familiar to us in physics; in using the naturalistic theory of evolution biologists are working with an overwhelmingly successful theory, but one that is not yet finished with its work of explication. It seems to me to be a profoundly important discovery that we can get very far in explaining the world without invoking divine intervention, and in biology as well as in the physical sciences.[255]
>
> [*The text continued under the heading* "The Excluded Middle"*:*]
>
> To my argument that blind watchmaker evolution owes its support more to naturalistic philosophy than to empirical science, Weinberg responded in effect that science and naturalism are basically the same thing, because "the only way that any sort of science can proceed is to assume that there is no divine intervention and to see how far one can get with that assumption."
>
> If Weinberg means that any divine intervention brings science to an end, his statement exhibits what in logic is known as the fallacy of the excluded middle. The possibility that divine intervention may occur sets limits to the scope of scientific understanding, but it emphatically does *not* imply that all events are the product of an unpredictable divine whimsy. On the contrary, the very notion of "natural law" grew out of the concept of a lawmaker. If that lawmaker also created our minds in the image of his own, then it is not surprising that we have the reasoning powers that make science possible.
>
> As we have seen, the existence of conscious, reasoning minds has no logical connection to a natural order ruled by a blind watchmaker that cares for nothing but survival and reproduction and therefore ought to have been satisfied with cockroaches and weeds. The universal lawmaker has the power to make exceptions, just as a worldly sovereign has the power to pardon lawbreakers, but such exceptional acts do not make the laws unimportant. Medical science, for example, remains a very useful discipline whether or not there are instances of miraculous cures that are in principle beyond scientific explanation.
>
> Similarly, the discipline of biology will not only survive but prosper if it turns out that genetic information really is the product of preexisting intelligence. Biologists will have to give up their dogmatic materialism and discard unproductive hypotheses like the prebiotic soup, but to abandon bad ideas is a gain, not a loss. Freed of the metaphysical chains that tie it to nineteenth-century materialism, biology can turn to the fascinating task of discovering how the intelligence embodied in the genetic information works through matter to make the organism function. In that case chemical evolution will go the way of alchemy—abandoned because a better understanding of the problem revealed its futility—and science will have reached a new plateau.[256]

While it was considerate of Johnson to interpolate for the reader what Weinberg "in effect" meant, the "very atheistic" scientist seemed to have no trouble communicating his views for himself. And the gist of his argument was not that acceptance of "divine intervention brings science to an end," but rather that Johnson's ham-fisted conception of Theistic Realism might. The paragraph leading up to the "divine intervention" remark had made it plain that Weinberg was talking about the methodology of scientific investigation. Most ironically, Weinberg had accepted at face value Johnson's ultimately "meaningless concession" of microevolution:

> Johnson concedes that evolution has occurred and that it is sometimes due to natural selection, but he argues that there is no "incontrovertible experimental evidence" that evolution is not guided by some divine plan. Of course, one could never hope to prove that no supernatural agency ever tips the scales in favor of

> some mutations against others. But much the same could be said of any scientific theory. There is nothing in the successful application of Newton's or Einstein's laws of motion to the solar system that prevents us from supposing that every once in a while some comet gets a small shove from a divine agency. It seems pretty clear that Johnson raises this issue not as a matter of impartial open-mindedness, but because for religious reasons he cares very much about life in a way that he does not care about comets. But the only way that any sort of science can proceed is to assume that there is no divine intervention and to see how far one can get with this assumption.[257]

Weinberg then continued with the main passage Johnson quoted. But what was contained in that *ellipsis*? Nestled in the "excluded middle" of Weinberg's remarks was a single sentence, so short it obviously wasn't removed for space. It concerned the class of empirical theorizing that would not pass muster were Johnson's approach to science the historic norm. And as examples go, it's a lulu: "*There never was a time when the calculations based on Newton's theory of gravitation or any other theory were in perfect agreement with all observations.*"[258]

Newtonian gravitation proves an ideal illustration of how "anomalies" were definitely not taken as disconfirmation, as one would suppose Theistic Realists would be obliged to when negative results showed up. Any eccentricities in the gas giant Saturn's orbit were initially invisible due to the vagaries of observation and calculation. But as telescopes improved a whole new planet turned up (Uranus), and its existence put a fresh spin on the possible presence of other planets even further out. Once it became clear that there were indeed anomalies in the orbit of Uranus, Newtonian theory was used to predict the position of the planet Neptune, just as miniscule quirks in Neptune's motion spawned the search that eventually discovered Pluto.[259]

By the mid-19th century similar orbital glitches were spotted for Mercury, and the same presumption came into play: there must be another planet orbiting closer to the sun—one understandably difficult to spot by virtue of its proximity to the brilliant solar disc. Except this time the astronomers were wrong. There was no tiny planet "Vulcan" to perturb Mercury's motion. But the methodological lesson is that those astronomers hunting for it had no reason not to rely on their experience of Newtonian success—that is, until Einstein came along to offer a better explanation for that effect (the bending of space-time through relativity) *and a practical means to test it*. When the deflection of starlight predicted by Einstein was indeed measured during the 1919 solar eclipse, astronomers dropped Vulcan like a hot potato as the cosmological paradigm shift swiftly dislodged the old Newtonian constants. Of course, Einstein's cosmology wasn't immune from some fudge factors either, but that is only par for the scientific course, where it is *relative* utility that marks the ultimate acceptance of a scientific theory.

If evolutionists have been pursuing a few imaginary "Vulcans" today, then Intelligent Design needs to establish that as Einstein did for Newton: by putting forward their own alternative model capable of carrying the day through explanatory superiority. And if they are triumphant in that enterprise, it does not entitle creationists to inflate those instances into a catchall dismissal of the reality of all the other "Neptunes" evolutionary theory has uncovered in its stead—such as the reptilian transitions to *Aves* and *Mammalia*.

Now the prospect of several centuries of physical science imploding under the deadening pressure of Theistic Realism was evidently a topic Johnson did not have a ready answer for—and which he didn't especially want his readers to notice, either. So *snip* … and the problem disappeared down the rabbit hole, leaving Johnson free to change the subject to one more to his liking: the rosy vision of science freed of naturalistic dogma, profitably jotting down the divine magistrate's "exceptional" adjustments to the lawfully operating natural order. A natural order from which all traces of unguided evolution have been surgically removed, of course—all without somehow killing the scientific patient.[260]

Alas, the scientific method was not invented expressly to give Charles Darwin something to do. Those scientists responsible for quantum theory or Big Bang cosmology in this century have been using the same methodological tool kit as evolutionary biologists or paleontologists, and so there is no practical way to tease out only the Darwinian bits creationists find so unacceptable.[261] But then, that's hardly been Phillip Johnson's focus, has it? By this stage of the debate Johnson has gone completely over the top, mutating every issue into a branch of "materialist philosophy" with all the single-mindedness of the alien seedpods in *Invasion of the Body Snatchers*. The result is a skewed looking glass world where each of Johnson's critics wear the mask of Richard Dawkins, and coincidentally suffer from the very defects Johnson himself has so tenaciously displayed. Consider his parting words to Kenneth Miller in the PBS online debate:

> "Evolution," as defined by the NABT, is a materialist philosophical doctrine that contradicts the best available scientific evidence. You say that we who doubt are prejudiced, are ignoring mountains of scientific evidence, and so on. Baloney. The crucial mechanism that supports the materialism rests upon a huge, unjustified extrapolation from very limited evidence of variation in fundamentally stable populations. Neo-darwinism survives only by the selective use of evidence, and because materialist philosophy has no alternative.[262]

But of prominent contemporary creationists, Johnson has been up at the head of the class when it comes to evidential selectivity (frequently peaking at "nonexistent"). Nor does it seem that Johnson has any alternative waiting in the wings except his own *non-materialist* philosophy, by which he might evaluate the patterns of change visible in the paleontological record, or the concomitant natural speciation detectable in the living world. As we've seen, Johnson has never explained what a *justified* extrapolation would be concerning those "fundamentally stable populations"—and without concrete example, his conviction that this would not run headlong into unregenerate Darwinism collapses into pure cant. This is a pretty state of affairs for someone so assured of his legal facility "in analyzing the logic of arguments."[263]

Just how far Johnson is willing to go in transforming all opposition into icons of what he wishes to oppose may be seen with another of his recent hobbyhorses: a book review by Richard Lewontin. The subject was Carl Sagan's *The Demon-Haunted World*, a work concerned with the persistence of superstition and irrationality in a modern world otherwise so capable of sound scientific reasoning. But Lewontin had a philosophical bone to pick with Sagan:

> So why do so many people believe in demons? Sagan seems baffled, and nowhere does he offer a coherent explanation of the popularity at the supermarket checkout counter of the *Weekly World*, with its faked photographs of Martians. Indeed, he believes that "a proclivity for science is embedded deeply within us in all times, places and cultures." The only explanation that he offers for the dogged resistance of the masses to the obvious virtues of the scientific way of knowledge is that "through indifference, inattention, incompetence, or fear of skepticism, we discourage children from science." He does not tell us how he used the scientific method to discover the "embedded" human proclivity for science, or the cause of its frustration. Perhaps we ought to add to the menu of Saganic demonology, just after the spoon-bending, ten-second seat-of-the-pants explanations of social realities.[264]

For Lewontin, there is only one sure-fire guarantee against falling into belief in the supernatural (a deep basket which includes the God of Abraham along with tabloid extraterrestrials). It is nothing less than an "*a priori* adherence to material causes to create an apparatus of investigation and a set of concepts that produce material explanations, no matter how counter-intuitive, no matter how mystifying to the uninitiated."[265] Being an orthodox Marxist, that was one easy admission for Lewontin to make, but that unsurprising opening was all Phillip Johnson took to embark on yet another roll, repeatedly citing Lewontin's remarks in order to further his own apologetic claim that "evolution is not a fact, it's a philosophy."[266]

The problem with this reasoning is that Lewontin let no hint that any particular features of his evolutionary beliefs were less reasonable or supported by evidence than that the earth revolves around the sun. Indeed, as Lewontin pointed out (and Johnson even remarked on), he had debated that very comparison with Biblical creationists back in 1964, offering with Carl Sagan evolutionary evidence he regarded as "absolutely compelling."[267] Furthermore, the examples Lewontin gave of "counterintuitive " explanations that might be "mystifying to the uninitiated" consisted not of anything relating to evolution, but rather to quantum physics and the vast scale of the universe—again, as Johnson was well aware.[268]

One might fairly have called Lewontin on this point, objecting that the chain of reasoning leading to the acceptance of quantum theory or the immensity of the universe is just as solid as that backing up "descent with modification." These cornerstones have made the scientific cut because they generate specific predictions about the content of the observable universe—tests which each has successfully passed. For the *microcosmos* of quantum theory, the ghostly swirls in a cloud chamber verify the existence of a swarm of subatomic particles, precisely as the red-shifted spectra of distant galaxies have confirmed their yawning temporal recession on the *macrocosmic* scale. And the discovery of intermediates like those "whales with legs" supports the evolutionary conception that *uniquely* proposed the prehistoric existence of so atypical a fauna. As none of these links in their respective evidential chains requires acceptance "on faith" in the sense that one believes in the divinity of Jesus or the enlightenment of Buddha, Lewontin's absolutist materialism (rooted in some increasingly musty Marxist ideology) raises an unnecessarily rigid metaphysical firewall.[269]

But that minor cavil doesn't resolve the logical dilemma posed by how Johnson thought to capitalize on Lewontin's avowed materialism. Why was it *evolution* that was "not a fact" here, rather than the quantum physics or stellar distances Lewontin actually gave as prime illustrations of concepts the materialist is supposed to accept in spite of their seeming injury to common sense?[270] Well, jumping to those more direct conclusions would have sounded a trifle too like Robert Gentry or Henry Morris, wouldn't it? And that is exactly the difficulty nipping at the heels of Johnson as he tries to rewrite the rules of science to make the world a safer place for Theistic Realism. Johnson latched onto the antievolutionary option here with such exclusivity not because there is some logically identifiable (or defendable) way to distinguish the "fact" and "philosophy" of it that wouldn't also apply to abstruse physics or cosmology. Johnson advanced his parochial interpretation solely because it is evolution—*and evolution alone*—that he wants out of the picture.[271]

Johnson's approach to scientific theory, therefore, is a mess at two levels. First, it simply makes mincemeat of the tactical procedures of serious inquiry. A "fact" of nature (say, the jaw configuration of a Triassic therapsid being intermediate between reptile and mammal) manifests its significance within the competitive framework of hypothesis formation. If one theory insists such a thing shouldn't exist, as the nonevolutionary dogma implicitly does, then its occurrence weighs against that view—and *for* its logical macroevolutionary alternative. We know that Johnson will not play this comparison game, since the outcome does not match the one he desires. But just because Johnson is never going to make it as a practical scientist, this seems a questionable justification for rearranging the rules until such muddleheaded thinking is mistaken for normal behavior. Science not being an advisable career move for him, he could consider following fellow-lawyer John Grisham into the realm of fiction—though one might argue that Johnson has indulged in that pastime enough already.[272]

Were Phillip Johnson selling furniture instead of metaphysics, the downside of his offering would be hard to overlook. He would be venturing into a field long dominated by the Evolutionary Furniture Company, which has been churning out high quality product for over a century, with legions of satisfied customers in biology, paleontology, and allied disciplines. But along comes Johnson and his Theistic Realism IPO, which splurges on a glossy media campaign decrying the inferior quality of the Evolutionary standard, and advising potential customers that in short order only their new product will be worthy of purchase. But in the meantime, there is no Theistic Realism showroom to inspect this impending collection—not even a catalog with an artist's conception of what might eventually be in store. Yet the scientific customer is supposed to stop using their historically productive evolutionary desks and cabinets (tossing them and their contents out the window perhaps) and put in their order sight unseen for the promised Theistic Realism replacements … delivery date unspecified. But there are still *prices* attached, to be sure—pretty stiff methodological ones (payment in advance, if you please).

Which leads us to the second area where Johnson's methodological rhapsody gets carried away. What makes him think that the Theistic Realism Furniture Emporium is going to be the only new kid allowed on the block? As we've seen, there is a crusty old concern that has been offering an alternative line of office furnishings for even longer than the evolutionary giant … though their specialty has never been practicality so much as servicing the finicky interior decoration needs of their rather traditionalist clientele. Consequently, none of the Creation Science drawers actually pull out, and the handles are stuck on only with weak glue. But they do at least have a visually attractive product, along with a sizable and resolute sales force all too anxious to promote their decorative esthetic among a larger public once the fussy evolutionary requirement that furniture be *useful* is done away with.

And lest one forget (though evidently Johnson has) the Creation Science operation isn't the only one waiting in the wings. In many fields there is a positive glut of screwball start-ups that await only a relaxation of the scientific method for encouragement. From psychic healers haunting the periphery of the medical profession, to smorgasbord kooks who link the New World Order with Satan and UFOs, the din is already audible to anyone who steps outside the cushy confines of those academic conclaves extolling the virtuosity of Intelligent Design theory.[273]

So whether the Darwinian Achilles is banished from the course or forced to race till he drops, Creationism Lite has yet to answer this important qualification question: won't *all* the little Tortoises get to play?

Now *that* will be a competition to see!

NOTES to Chapter 4

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[1] What a difference a few centuries make. Epidemics of "vampirism" were being quite seriously recorded in European annals as late as the 18th century, Robbins (1959, 521-525)—thus placing the "undead" as contemporaries of Isaac Newton and Johann Sebastian Bach. For the cultural and literary side of the contemporary vampire, see Ramsland (2002).

[2] See Pennock (1999, 189-194) for only the most recent time philosophers have had to explain ontological versus methodological naturalism.

[3] Dembski's 1996 essay, "What Every Theologian Should Know about Creation, Evolution, and Design," was obtained via the ARN website; the italics were Dembski's. Dembski (1999a, 119-120) reiterates the position. Of course, the easiest way to illustrate what science is supposed to be able to "clearly see" about creation would be through a broad array of concrete examples. For instance, explaining whether the gossamer collection of photons known as "Andromeda galaxy" is more or less scientifically "real" in the absence of methodological naturalism than the purported eyewitness historical accounts of supernatural vampires.

[4] Creationist perception of the scientific method is not illuminated by the boilerplate in Wendell Bird (1989, Vol. 2, 11-56) or Ratzsch (1996, 162-171). Terminological juggling was most evident when lawyer Bird (1989, Vol. 1, 25) declared the "theory of abrupt appearance" did "*not* necessitate reference to a creator or ad hoc explanation based on acts of a creator." He defined this "as scientific data and scientific interpretations that indicate discontinuous abrupt appearances but not supernatural causes"—all without letting on what *natural* causes could possibly undergird such a view. Bird (1989, Vol. 1, 30-31) may have been aiming for a tactical doctrine immune from the legal tussles conventional creationism has experienced with the Supreme Court. So while there are "creationist" and "evolutionist" religions according to Bird (Conservative Evangelicalism versus Theological Liberalism, for instance), there "are no religious bodies that hold to a belief in the theory of abrupt appearance." To what extent this theological situation has something to do with "abrupt appearance" being a virtually meaningless confection, Bird did not investigate. Interestingly, Bird studied under Robert Bork at Yale Law School, and Bork served as an advisor on a 1978 paper Bird did on equal time for creation science in education, McIver (1988a, 3) and Eve & Harrold (1991, 147).

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[5] Like most in the early 19th century, young Charles Darwin was impressed with Paley's Watchmaker argument, until his voyage on HMS *Beagle* brought him face to face with the staggering diversity of living "watches." Cf. Gould (2002a, 262-271) on the change in Darwin's perspective. Darwin's rejection of a designing intelligence in favor of natural processes producing the *appearance* of design was what particularly incensed the religiously inclined, such as the 19th century "Calvinist par excellence" Calvin Hodge, as noted by Livingston (1987, 100-105). And Richard Dawkins' articulation of the present naturalistic Darwinian position in his 1986 book *The Blind Watchmaker* likewise raises the ire of Phillip Johnson.

[6] Kenneth B. Miller, "Scientific Creationism versus Evolution: The Mislabeled Debate," in Montague (1984, 52).

[7] As recounted in note 110 of chapter three. There is, of course, a great deal still to be learned about the developmental genetics of horse evolution (for example, how cement emerges on their teeth to protect against where, and the modalities by which that improvement occurred in fossil horse lineages). Research in this area is still fairly preliminary, Diekwisch (2001). Concerning horses specifically, cf. "Coronal Cementogenesis in the Teeth of the Horse" given by Sahara *et al.* at the 2003 meeting of the International Association for Dental Research (abstract at iadr.confex.com/iadr/2003Goteborg/techprogram/abstract_28489.htm). Terling *et al.* (1998), Weiss *et al.* (1998), Lézot *et al.* (2000) and Smid *et al.* (2004) identify some of the hormonal and genetic players in cementogenesis, which includes the homeogene Dlx-2, part of an ancient gene family among vertebrates, Stock *et al.* (1996).

But rather than recognizing these open areas within an overall evolutionary framework, creationists sidestep the whole package. Unfortunately for the antievolutionary argument, clues from developmental biology don't stop with horses—or with the mammalian inner ear. The internal anatomical shifts implied by the change in torsion spiraling in fossil mollusks are recapitulated in living mollusk larvae, Marc Dando, "Marine Invertebrates," in Waller (1996, 183). The role of developmental triggers in evolutionary change has been stressed by Steven Stanley (1996, 22-23), offering as example the varied career of the bivalve *byssus*, "the bundle of threads by which they attach to rocks." The byssus originally appeared 400 million years ago as a feature to anchor juvenile clams to the seafloor; related burrowing clams retaining this option into adulthood ultimately led to more varied rock-clinging versions like the mussels.

[8] Denton (1985, 93) allowed that the horse sequence "is nothing like a perfect continuum of forms, the breaks are distinct and clear, but the overall sequential pattern is so obvious that no one seriously doubts that the modern horse has evolved from the primitive horses of the Eocene era sixty million years ago." Prominent creationists who have failed to follow Denton's lead here were recounted in note 39 of chapter one, and the teacup tempest rages on concerning this supposedly settled point. When Kenneth Miller brought up the horse example in the 1997 "Firing Line" debate, David Berlinski complained that the evidence for it posed a terrible trouble for evolutionists. Miller pressed him to explain why, but no paleontological details were forthcoming. Berlinski was arguably the most obtuse of the "hear no evil, see no evil, speak no evil" antievolutionary trio (Johnson and Behe being the others). Berlinski freely acknowledged that the fossil evidence for the reptile-mammal transition was strong, yet treated this as though it were some inconsequential microevolutionary blip rather than the macroevolutionary appearance of a whole new vertebrate class. Like Johnson (and Duane Gish, for that matter), Berlinski repeatedly invoked the Bermuda Triangle defense, stressing the gaps in chordate and fish origins—but eclipsed even Johnson or Gish by openly saying that he didn't care that there were completely sound geological reasons for those lacunae. Cf. Berlinski (1996b, 20).

[9] Johnson (1995, 71-73), citing Weiner (1994b) and Chadwick (1994). Weiner's article title was an allusion to Bob Kofahl and Kelly Segraves' "Handy Dandy Evolution Refuter," a verdant garden of Creation Science delights Johnson might do well to inspect some time (and see how adept he would be at refuting any of it). Weiner (1994a, 182) also happened to criticize Johnson's *Darwin on Trial* on whether evidence existed to support the suppositional arguments of Dawkins and Gould concerning the origin of complex organs and adaptations. Johnson "speaks sarcastically of 'all this supposing,'" wrote Weiner, and cited in their defense the recent work of Craig Benkman and Anna

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Lindholm on crossbill beaks. Darwin had been puzzled over how such odd crossed mandibles might have originated, but Benkman and Lindholm established by experiment that they didn't have to appear "fully formed" to be useful. In a procedure similar to the one performed to pin down mayfly avionics, crossbill beaks were nipped back (with no harm to the bird) and the utility of the uncrossed forms measured. The "finches began to get better at opening pinecones when the cross in their beaks was still too small to be visible to the eye." Weiner also noted why this process isn't occurring naturally today: "there is no profit to a sparrow or bunting in a deformed, twisted bill, because the crossbill niche is taken," Weiner (1994a, 184). Although this criticism would have seemed a salient point for comment, Johnson did not allude to it, leaving open the possibility that he relied primarily on Weiner's summary and the subsequent book review rather than plowing through *The Beak of the Finch* itself.

[10] Johnson (1995, 73). The peppered moth has become an Intelligent Design exemplar of the best evolutionists can do on the power of natural selection to create new forms—the moths weren't "even changing in color." But their evolutionary import concerns two factors only. First, that natural variations are indeed selected without a designer's intervention—the white peppered moth *Biston betularia* and the black variety *Biston carbonaria* differ by only a single gene, as noted by Weiner (1994a, 273). Then there is the *speed* with which the selection took place: from white to black in a century, fast enough to be measured even by human observers. That isolated allele switch does not demonstrate *big* changes, of course—for that you'd have to be stuck in the midst of one of those exceedingly rare macroevolutionary transitions. Even so, it is difficult to imagine what Johnson would expect a scientist to see in that event. Consider the bird transition. Jump in the Wayback Machine 100 million years and you'd see a flock of almost-birds, not one of which would show any more variation within a human lifetime than a Galápagos finch today. If you'd miss-set the controls and landed 50 million years later you'd *still* see only Galápagos-scale variation—only this time involving a later cast of anatomically modern birds. The big transition would now be *over*, and sorry you missed it. Johnson's reasoning is surprisingly like that of Creation Scientists on the Lewis Overthrust—a feature whose motion millions of years ago cannot be presently measured either. Added irony comes from Johnson having repeated this moth argument in the thick of Kennedy's YEC milieu (where Brown's "hydroplate" theory holds sway).

Recently the famous industrial pollution explanation for the coloring switch came under fire from evolutionist Coyne (1998) in a review of Michael Majerus' book *Melanism: Evolution in Action*, and by Wells (2000a, 137-157) in the ID version. Their misreading of the literature garnered some scathing criticism from several annoyed entomologists, including Majerus (postings at calvin.edu/archive/evolution/199903/0319.html, 0312.html, 199904/0100.html & 0103.html). Both Coyne and Wells erroneously claimed the moths didn't naturally settle on tree trunks as Kettlewell presumed (despite charts by Majerus documenting dozens of moths spotted on trunks). The calvin.edu postings suggested Coyne and Wells relied too heavily on a single source rather than plumbing the data firsthand—cf. also the exchange between Wells, Kim Johnson & Dave Thomas (at nmsr.org/jonwells.html). Colson & Pearcey (1999, 86-87) and Johnson (2000, 67-68) reprised one of Well's cheaper shots: that some photographs of moths resting on trees were faked by being glued in place. Given how unlikely insects are to tarry conveniently in front of experimenters or camera crews trying to assess the behavior of predators, it is more a comment on the limited field experience of armchair anti-naturalists like Wells, Colson & Pearcey or Johnson. But worse, Majerus noted that not only hadn't Kettlewell relied on glued moths, he had specifically photographed live ones being snatched by birds.

[11] Johnson (1995, 73-74); the inclusion was Johnson's.

[12] Johnson (1995, 74). The discussion in Johnson (1991, 25) was another instance of the Skinner/Johnson Gambit. Johnson quoted Futuyma (1982, 119) on the 1977 work that showed how finch anatomy shifted when the environment changed, suggesting they might swing back to smaller birds should conditions return to "normal." Johnson inserted a footnoted remark that "In fact this is exactly what happened. The article 'Oscillating Selection on Darwin's Finches' by Gibbs and Grant [*Nature*, vol. 327, p. 511, 1987] reports that small adults survived much better than larger ones following the wet year 1982-83, completely reversing the trend of 1977-82." Johnson

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was not giving Futuyma a brownie point for making a correct prediction—and definitely not accepting his main point that if the environmental stress continued the finches' modified anatomy might have become locked in. Rather, Johnson's general conclusion was "That larger birds have an advantage over smaller birds in high winds or droughts has no tendency whatsoever to prove that similar factors caused birds to come into existence in the first place. Very likely smaller birds have the advantage in other circumstances, which explains why birds are not continually becoming larger," Johnson (1991, 27). See also notes 19-22 below.

[13] Johnson (1995, 74).

[14] Incidentally, the position of John Morris at the ICR website (BTG No. 72b) on the Galápagos finches and their place in nature is identical to Johnson's view (already quoted in note 53 of chapter one). Just as Johnson and Gish track quite closely on therapsids, so too both Johnson and Morris stressed their variations were merely "cyclical" based on changing conditions. Morris evidenced his sloppier Creation Science scholarship, though, by describing Weiner's work as "a best-selling novel entitled, *The Beak of the Finches*."

[15] Observing speciation in the wild certainly requires patience: the PBS *Scientific American Frontiers* series reported on the *twenty years* a scientist observed spider behavior in the American Southwest, and was just now documenting the behavioral changes that appear to be fissioning one species. Cf. also Strahler (1987, 397-400) and the talkorigins.org/faqs/faq-speciation listing, Nagel & Schluter (1998) on sticklebacks, Grieg *et al.* (2002) on yeast, and the factors in note 19 below. It was thought for a time that speciation might be induced by a genetic "bottleneck" without having to fiddle with the whole competitive environment, but nature is not so easily nudged. See Meffert (1999, 707-708) and Schilthuizen (2001, 63-72) on Rice & Hostert (1993), Templeton (1996) and Rundle *et al.* (1998), as well as the saga of the misidentified *Nereis* worm in Weinberg *et al.* (1992) and Rodríguez-Trellis *et al.* (1996). Incidentally, Rice & Hostert is excerpted in Mark Ridley (1997, 174-186).

[16] Because creationists relegate observations of variation to "types" that they do not themselves define, they never get past the first step of the long chain of inference that results in those dreaded macroevolutionary conclusions. When evolutionists say that the Galápagos finches show "evolution in action," it is in much the same initial sense as if one were to remark that, "Once Galileo observed that balls speed up when rolled downhill, man could fly to the moon." Such a statement has that bold James Burke "Connections" sweep to it, of course, but it's still quite true. Balls accelerate down a ramp because of gravity. Working out how that principle connects to the heavens (through Kepler's laws) resulted in Newton realizing that in theory an object could be launched into orbit—all this long before rocketry made that physically possible. But imagine if you never put any of the pieces of the reasoning chain together. In that event the argument would degenerate into an "official caricature" of "rolling balls don't prove lunar flight!" That is the problem with this pocket lecture in Johnson (1997, 11): "My experience speaking and debating on this topic at universities has taught me that scientists, and professors in general, are often confused about evolution. They may know a lot of details, but they don't understand the basics. The professors typically think that evolution from molecule to man is a single process that can be illustrated by dog breeding or finch-beak variations, that fossil evidence confirms the Darwinian process of step-by-step change, that monkeys can type *Hamlet* if they are aided by a mechanism akin to natural selection, and that science isn't saying anything about religion when it says that we were created by a purposeless material process." Which professors he had in mind for this approbation he did not specify—but we'll see later there is more to this "dog breeding" confusion when it comes to Johnson's own take on evolutionary theory.

[17] Mayr (1991, 5, 18-19) noted that the first Galápagos birds to fly the "fixed type" coop were a trio of mockingbirds (Darwin thought they were varieties until Gould classified them as distinct species). As for the famed finches, morphological studies have homed in on several genera within a group of seed-eating birds, such as the West Indian *Melanospiza richardsonii* and the more common *Volatinia jacarina* of Central and South America noted by Weiner (1994a, 221). Characteristically, Morris & Morris (1996b, 238) did not mention any of the suspects when they cited Peter Grant (1981, 661) on the finches. Phillip Johnson, Richard Milton, & the Morrises

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notwithstanding, genetic analyses have pressed the paternity suit through to the grassquilt genus *Tiaris*, Freeland & Boag (1999), Sato *et al.* (1999; 2001) and Burns *et al.* (2002). Incidentally, Behe (1996, 14) touched in passing on *The Beak of the Finch*, in a paragraph that appears to accept Darwin's finches as physically related. But Behe did not apply this insight to other cases to delineate how much of life's history might be accounted for through such means.

[18] Milton (1997, 146-150), quoting Weiner (1994a, 17, 120). The idea that all the Galápagos finches were one species had been offered before, prior to David Lack's work on the topic in the middle of this century. "That speculation (Peter Grant calls it a 'cry of desperation') could only have come from a scientist who had studied the finches in museum trays and not out in the islands," Weiner (1994a, 162). In an editorial letter exchange I had with several creationists in my local morning newspaper during 1998, a defender of creationism pointedly cited Milton's book as disproving the idea that the Galápagos finches involved separate species.

[19] "Even now, even with hybrids flourishing triumphantly on Daphne Major, most of the finches on the island seldom interbreed," Weiner (1994a, 165). Hybridization involved three *Geospiza* species: female *fortis* with male *scandens* and male *fortis* with female *fuliginosa*, Weiner (1994a, 120-123)—differentials familiar from Ayala's fruit flies described in chapter one. Morris & Morris (1996b, 239) gamely asserted that "The finches are all still inter-fertile, and so continue to constitute one species." Incidentally, in his cursory précis of current thinking on speciation, Milton (1997, 145) alluded (without citation) to "inexplicable anomalies" like "breeding populations (such as of the fruit fly *Drosophila*) that are described as separate species and that do not (or cannot) interbreed, but which are genetically identical." He may have been thinking of Weiner (1994a, 169-170) on the Hawaiian *Drosophila* work of Ken Kaneshiro, though that research involved species whose chromosomes were "almost identical"—what a difference a word makes! Hybridization is a more potent force in speciation than hitherto suspected, fusing as well as fissioning species—see Peter Grant & Grant (1994; 1997), Weiner (1994a, 198-200), Xu (2000), Schilthuizen (2001, 14-20, 28-31, 89-90; 2002), and Zimmer (2002c) on Peter Grant & Grant (2002b). Some hybridizing has taken place in the two African elephant species, which separated into forest and savanna species about 2.5 Mya, but were only recognized as such recently via detailed genetic analysis, Vogel (2001) re Roca *et al.* (2001). Some 10% of living bird species occasionally crossbreed (duck and geese lead with about half their species hybridizing). Culturally mediated bird song also affects speciation, Dugatkin (2000, 151-154) on B. Grant & Grant (1996) … as do beak and body size, Ryan (2001) re Podos (2001)—cf. Gould (2002a, 1287).

[20] Johnson (2000, 185n). Wells (2000a, 172-173) similarly decanted Peter Grant & Grant (1992). Cf. the 2002 criticism of Wells' treatment of Darwin's finches by Dave Wisker at Talk.Origins. The salient taxa are two species of genus *Geospiza*. Weiner (1994b, 40): "The drought of '77, for instance, pushed fortis a quarter of the way in the direction of another species of finch, magnirostris. One quarter of the way toward the origin of a species, in a single year." And Weiner (1994a, 42-43): "Some of the world's biggest *fortis* live on the island of Isabela; some of the world's smallest *magnirostris* live on the neighboring island of Rábida. The largest of the *fortis* on Isabela are, even to Peter and Rosemary Grant, 'almost indistinguishable' from the smallest of the *magnirostris* on Rábida." Such forces could lock *fortis* into a *magnirostris* form in a thousand years—or in only a century if the droughts cycled appropriately, Weiner (1994a, 271). See also Peter Grant (1991) and Badyaev & Hill (2002).

[21] Johnson (2000, 131). For the condensed version, Johnson (1997, 87): "Finch beak variation in no way denies that only God can make a bird." Pennock (1999, 103) remarked on Johnson's missing the point of Weiner's book, but Johnson (2000) did not specifically comment on that. Hank Hanegraaff showed his still looser comprehension of the speciation problem in a September 2003 posting at equip.org: "So while you might be able to breed a Chihuahua with a Great Dane and get a new species of dog, you can't breed two dogs and get a cat, a mouse, or a whale." Likewise Stark (2003, 178) claimed that interbreeding only occurs within a species, "but not across species (no dog/cats or horse/cows)." Stark offered no more sources for this claim than Hanegraaff, which is not in fact true (per note 19 above). Cf. Gish (1993, 309) similarly parsing Simpson (1961b, 90) on hybridization.

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[22] Johnson (1997, 51-52). This Skinner/Johnson double play ran via *Reason in the Balance* back to *Darwin on Trial*. Johnson (2000, 47-48) repeats the "cyclical variation" take on Darwin's finches—since that is the theoretical point in dispute, his refusal to budge from his security blanket is illustrative of the well-padded creationist ideological mindset. Concerning the Danny Phillips controversy, David Hill covered the school board response in "Counter Evolutionary" for Education Week's Teacher Magazine in 1996 (edweek.org/tm/vol-08/03evol1.h08). Like many Biblical antievolutionists, Danny didn't want "creationism" taught in the schools, only a fair presentation of "factual science." But Hill thought the fifteen-year-old's statements were "somewhat disingenuous," since Danny (a pastor's son) felt insulted by evolutionary theory because it "contradicts God's creation of the world." As we'll be seeing in chapter six, more than just evolution is unacceptable under the strictures of Biblical reasoning.

[23] There was a real Henry Drummond (1851-1897), a Scottish evangelist and theistic evolutionist whose opinion of the poor as biologically parasitical is criticized by Zimmer (2000e, 17-19). A parenthetical note: antievolutionary biophysicist Cornelius Hunter (2003, 114) referred to "The eighteenth-century theologian Henry Drummond"—although there is another Henry Drummond (1786-1860), an MP and founder of the Catholic Apostolic Church, he would also more properly belong to the 19th century. Cf. note 12 (chapter five) on Wendell Bird's even looser sense of chronology.

[24] Johnson (1997, 124-125). The chapters being recommended were titled "Tuning Up Your Baloney Detector" (containing the Feynman/Sagan episode), "A Real Education in Evolution" (touching on Niles Eldredge and invertebrate evolution), and "Intelligent Design" (featuring the arguments of Michael Behe). The Feynman, Eldredge, and Behe cases will be explored shortly.

[25] With due homage to the cartoonist Al Capp, creator of *Li'l Abner*, who once caustically remarked how LSD "expanded the mind" in the same way the Bomb "expanded" Hiroshima.

[26] Johnson (1991, 30-31), quoting Futuyma (1982, 122). Pennock (1999, 298) briefly remarked on this paragraph, also noticing that it was Johnson's sole effort at showing the superiority of the design explanation over unguided evolution. (The "uncaring mechanical process" alluded to a quote from Futuyma on sickle-cell anemia to be discussed below.) Peacock tails are only one tiny slice of a very large avian behavioral story, with mating rituals running the gamut from idiotically complex dances to the most elaborate of calls. When it comes to playing with sound, arguably the most astonishing show is that put on by the Australian lyrebird. As shown on David Attenborough's recent BBC series "The Life of Birds," male lyrebirds attract and impress their mates by meticulously reproducing the calls of other neighboring birds. Or at least sounds the lyrebird's sensory processing takes to be the calls of other birds—for among its current repertoire are motorized camera shutters, car alarms, and (most uncanny of all) a dead-on impression of chain saws felling trees. The common element appears to be the consistent and repetitive nature of the acoustic input. If birds are indeed descended from dinosaurs, such behavior may in future offer more clues as to the comparable mating activity of their long-extinct relatives.

[27] See note 37 of chapter three.

[28] Futuyma (1982, 122). Cf. Judson (2002, 81-84) and Reeve & Pfennig (2003).

[29] Weiner (1994a, 289-291) pointed out how evolutionary fortune can favor the unwise—at least for awhile. A dozen early rising Galápagos cactus finches had taken to prying open the flowers to get at the seeds. The stigma being long enough to poke their eyes, they were also in the habit of nipping them off. Keep that sort of thing up and those go-getter finches will prevent the cactus from pollinating. Whether that in turn forces the cactus finches to a very fast dietary change to forestall their own extinction, only time will tell.

[30] Gould (1992, 119). See Gamlin & Vines (1986, 13), Dawkins (1986, 199-215), Mayr (1991, 117-118), Sapolsky (2001) or Schilthuizen (2001, 73-99) on the concept (a hot ticket for sociobiology)—and Andersson & Iwasa (1996), Møller & Cuervo (1998), or Stenseth & Saetre (2003) re Doherty *et al.* (2003) for applications (bird ornamentation and extinction patterns). Interestingly, the carotenoid pigments of the sexually attractive beaks of zebra finches also figure in their immune system, Pennisi (2003c) re Blount *et al.* (2003) and Faivre *et al.* (2003). Re the critical crossfire, Johnson (1993b, 208) cited Mayr (1991, 46) to defend a "saltationist" description

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of Otto Schindewolf after Gould (1992, 119) objected that this didn't do justice to Schindewolf's thinking. Gould was being picky here, but was on target concerning Johnson's "lick-and-promise tour through the history of vertebrates." Gould (1992, 120) noted he failed to mention "the first amphibians, *Ichthyostega* and *Acanthostega* (featured in all paleontological texts) with their conserved features of a fishy past: small tail fins, lateral line systems, and six to eight digits on each limb." Johnson (1993b, 208) truncated that to: "The first amphibians have 'conserved features of a fishy past.' [I do not dispute that one can point to features of various organisms that seem to hint at some process of historical development. The question is, how much do we know about that process? Does a tenable mechanism for transforming a fish into an amphibian, and eventually into a human, really exist?]" The brackets were Johnson's. As for the data, *homeobox* regulatory genes were just then revealing a lot about what "we" know about the origin of the tetrapod limb (cf. Gish's evasions here per note 135, chapter three).

[31] Johnson (1993b, 207), the third person and bracket use as quoted.

[32] Weiner (1994a, 86).

[33] Weiner (1994a, 95).

[34] Endler's work was described in Weiner (1994a, 89-96). Incidentally, in a concluding chapter Weiner (1994a, 297) recounted a chat about that research Endler had with a fundamentalist creationist during a plane trip: "the whole time on the plane, my fellow passenger was growing more and more excited. 'What a neat idea! What a neat idea!' Finally, as the plane was landing, I told him this neat idea is called evolution. He turned purple."

[35] Just how creepy such things can get was deftly shown in Douglas Adams' droll *The Hitchhiker's Guide to the Galaxy*. At one point the time-and-space-traveling protagonists found themselves at *Milliways* ("The Restaurant at the End of the Universe") where guests might observe the end of everything whilst enjoying a fine meal. One of the items on the menu duly presented itself: a genetically engineered cow that not only actively desired to be eaten (and was capable of articulating that intention clearly and unequivocally) but also enthusiastically recommended which pieces of itself were the best cuts. The hitchhikers were so appalled by this offering they ended up ordering salad.

[36] Particularly gruesome is the "root-head" *Sacculina*, which parasitizes crabs by castrating the crustacean and transforming it into "a feeding machine" to sustain the root-head, Gould (1996a). See Zimmer (2000e) and Zchori-Fein *et al.* (2001) for tours of the parasitical zoo. Denton (1985, 220-221) briefly remarked on *Sacculina*, but only proposing its internal metamorphosis as a further problem for evolutionists to account for—not as an indication of some design work more characteristic of a horror movie than a Disney nature special. For the kids, Gish (1990, 50) declared that "Some people believe that metamorphosis is evidence for evolution—that a swimming tadpole 'evolves' into an animal that has legs and spends most of its time on the land. Actually, the process of metamorphosis is an embarrassment to evolutionists. It defies any explanation based on evolution." *Actually* … evolutionists don't believe metamorphosis is an "evolutionary" process in this juvenile sense, but they do suspect such developmental mechanisms have played a role in the evolution of life. Metamorphosis is the rule rather than the exception for invertebrates, where it performs a vital reorganizing function reflecting a change in nutritional resources or living environment. Those vertebrate fish adapting to a terrestrial lifestyle would have every incentive to kick that mechanism back in if they happened to have it lurking around in their genome, thus turning the question around to wonder why the later reptiles and their mammal and bird descendants *disengaged* metamorphosis. Developmental biologists of an evolutionary persuasion like Müller (1996, 289-300) have remained unaware that they are supposed to be embarrassed by metamorphosis as they tease out its secrets. They have learned that a common receptor mechanism prevails for both insects and frogs when it comes to binding the hormones that trigger their metamorphosis (*ecdysone* and *thyroxine* respectively). Interestingly the hormone that prevents premature metamorphosis in amphibians (*prolactin*) crops up in other regulatory sequences. "It's name points to its role in stimulating the production of milk in mammals. In other mammals it acts as **luteotropic hormone** (**LTH**; not identical with the luteinizing hormone, LH) stimulating the conversion of an ovarian follicle into a corpus luteum (yellow body)," Müller (1996, 295). Truman

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& Riddiford (1999) relate insect metamorphosis to changes in developmental endocrinology. See also Wray (1995) on the interesting discoveries concerning larval development in sea urchins, frogs, and the ascidian tunicates, where considerable functional evolutionary adaptations occur at the embryological level within a genus without necessarily being reflected in the adult form.

[37] Johnson (1991, 26). Futuyma (1982, 120) discussed the sickle-cell matter as an example of how adaptive selection works, "but at what a cruel cost!" Berra (54-62) also put sickle-cell anemia among a group of observations that were explained by evolutionary thinking, along with the proliferation of rabbits in Australia and the peppered moth example Johnson found so trivial.

[38] Johnson (1991, 27). Behe (1996, xii) also briefly mentioned sickle-cell, though only as a disease. He drew no philosophical or moral lessons from it.

[39] Morris & Parker (1987, 103-105) and Wendell Bird (1989, Vol. 1, 163). Part of the creationist attitude stems from their negative view of "mutation." Henry Morris (1963, 43-44) set things off on the wrong foot early on in the debate, describing mutation solely as an external disorganization (from radiation or mutagenic chemicals). The idea that cell replication and inadequate error correction play a role internally did not occur to him.

[40] Francisco J. Ayala, "The Mechanisms of Evolution," in Ruse (1988, 135), Whitfield (1993, 74-75) and Nagel (2000), with Hoffman *et al.* (2002) for the broader genetic picture. An aside: sickle-cell represents the unforgiving character of natural selection in the "Darwin Awards" of Wendy Northcutt (2000, 277-279).

[41] Avise (1998, 62-72) listed "The Chromosomal House of Horrors" where genetic defects have been identified so far. Several even involve single nucleotide substitutions àla sickle-cell: "precocious puberty," "postanesthetic apnea," and "Leber's hereditary optic neuropathy."

[42] Avise (1998, 79-80), Ingram (1998, 210-221), Nesse & Williams (1998), Cochran & Ewald (1999), Paul Ehrlich (2000, 41-42, 345-346n), and Zimmer (2000e, 196-199, 207-208; 2001g, 305-307). Of the varieties of cystic fibrosis, 70% involve a deletion of three nucleotides along one chromosome that removes the amino acid phenylalanine, Welsh & Smith (1995, 54-55). Cf. Palumbi (2001, 215-225) on a possible CF link to cholera resistance, and Zimmer (2001g, 222-224) on an AIDS immunity that may track all the way back to the Black Death.

[43] Creation Science has the Fall of Adam to account for genetic degradation. Chittick (1984, 201): "Congenital diseases (diseases inherited through genetics) such as sickle cell anemia or diabetes have become much more prevalent since creation." *P. falciparum* appears to have originated "within the last 5,000-50,000 years," Rich & Ayala (2000), expanding around 10,000 years ago, Joy *et al.* (2003). The sub-Saharan proliferation of mosquitoes (only one of which carries malaria) occurred only as agriculture spread there over the last few millennia, C. Loring Brace, "Humans in Time and Space," in Godfrey (1983, 275), putting the current selective pressure to sustain the malaria-mosquito partnership long after the Genesis creation. Whether their virulent attributes were *designed* into them (or appeared as subsequent "variation within the kind") are technicalities YEC theory has so far avoided. But it doesn't seem far-fetched that some literalist could follow the spirit of the "demon lettuce" syndrome noted by Robert Pennock and infer satanic influence in the development of such post-Fall complexes.

[44] Morris & Morris (1996c, 75) is typical of the conservative creationist view: "One could certainly make the argument that AIDS is a divine judgment on those who deny God and His Word by this flagrant violation of His primeval standard for the human race as given to the first man and woman (see Gen. 2: 22-24)." For reference, Genesis reads: "And the rib, which the Lord God had taken from man, made he a woman, and brought her unto the man. And Adam said, This *is* now bone of my bones, and flesh of my flesh: she shall be called Woman, because she was taken out of Man. Therefore shall a man leave his father and his mother, and shall cleave unto his wife: and they shall be one flesh." Cf. Ecker (1990, 142) on the Morris/ICR view of AIDS. Interestingly, AIDS is one medical question Phillip Johnson has weighed in on, endorsing the view of a group of dissenting scientists who reject the HIV theory of AIDS. Johnson has been involved with the case of Berkeley microbiologist Peter Duesberg since the early 1990s, and included a chapter "The Circus of Death" in Johnson (1998a, 161-166) on the general theme of how political pressure from gay activists supposedly encouraged faulty scientific research. Duesberg (1996) contends AIDS is the

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result of drug use and the generally nasty lifestyle choices of the gay subculture, and such views have taken on a practical urgency after having been adopted controversially by South African President Thabo Mbeki, Cherry (2000). Unfortunately, Duesberg's argument depended on arbitrarily defining "AIDS" so broadly as to minimize the HIV virus correlation with the diagnostic feature of a plunge in the specialized CD4+ "helper" T-lymphocytes, as well as downplaying the number of infections caused when hemophiliacs were treated with HIV-tainted blood. A 1994 survey of Duesberg's claims by *Science* magazine found them contradicted by the available data, Jon Cohen (1994), eliciting letters pro and con (including ones from Duesberg) in *Science* during 1995 for January 13 & 20 (pp. 157-160, 313-316), and April 21 (350-351). A letter from the "Group for the Scientific Reappraisal of the HIV/AIDS Hypothesis" proposing an independent investigation appeared in *Science* (February 17, 1995). Besides Duesberg and Phillip Johnson, the signatories were: Eleen Baumann, Tom Bethell, Harvey Bialy, Celia Farber, Charles L. Geshekter, Robert W. Mavor, Russell Schoch, Gordon T. Stewart, Richard C. Strohman, and Charles A. Thomas, Jr. A 1995 *Skeptics* article by Steven B. Harris (at skeptic.com/03.2.harris-aids.html) also investigated points raised by Duesberg and Robert Root-Bernstein (the anatomist from note 192 of chapter three concerning human ribs, who has been less absolute in his HIV/AIDS skepticism than Duesberg). See also Robert Ehrlich (2001, 33-56). Kenneth Miller (1999, 300n) briefly remarked on Johnson's interest in the AIDS debate, while Pennock (1999, 299-300) related it to the "demon lettuce" problem and the possible role of theological judgments in the Theistic Realism version of science. Nowak & McMichael (1995) describe how HIV invades the immune system; Cohen (2001) tracks the difficult search for an AIDS vaccine. A special *Scientific American* series summarizes the current mainstream HIV-AIDS view: Mann & Tarantola (1998), Bartlett & Moore (1998), Richman (1998), Mellors (1998), Wilfert & McKinney (1998), Coates & Collins (1998), Baltimore & Heilman (1998), Buchbinder (1998) & Beardsley (1998). Incidentally, David Baltimore is something of Duesberg's bête noire, with Duesberg (1996, 388-389, 363, 406-408) remarking on Baltimore's purported "censorship of Duesberg," his "opposition to Duesberg's honors," and "vulnerability of"—tags applied in the index listings in Duesberg (1996, 706). Baltimore has also been recently embroiled in controversy over his steadfast defense of the integrity of a subordinate accused of data fabrication, summarized by Friedly (1996)—reminding us that even among Nobel laureates life is not always a breeze.

[45] Behe (1996, 113-114) likewise called attention to I-cell disease (where slight defects can fatally gum up the works in the "irreducibly complex" intracellular transport system) without considering its "meaning" or "purpose." But if the transport system was designed, how attentive is the craftsman who fails to exert suitable quality control? Translated into a human context the picture is far different: imagine the responsibility of an engineer of a self-replicating airplane that has a pesky natural tendency to accumulate disastrous internal modifications (causing the wings to fall off or the plane to crash on its own into hillsides). No matter how stunningly clever elements of the product may be, that stray accident proneness would be sufficient to inspire a ream of class action suits. The question of which biological goofs are liable to correction at source is not a new one, especially for religious philosophies that actively entertain the idea of divine interaction at the physical level. I am reminded of the skeptical 19th century visitor to Lourdes who remarked how many crutches there were, yet no *wooden legs*. After all, the physical restoration of a lost limb would actually require a miracle.

[46] Stephen J. Gould, "Creationism: Genesis vs. Geology," in Montague (1984, 133-134).

[47] Behe (1996, 25).

[48] Behe (1996, 64-65, 70-72, 85-87, 109-110, 125-126). Regarding antecedents, the engineering complexity of the rotary flagellum had been highlighted by Denton (1985, 223-225). Through Behe's promotion, that example has attained star billing on the Intelligent Design circuit. When it came to the clotting cascade, Kenneth Miller (1999, 305n) remarked how Behe "used archaic terminology that has long disappeared from modern textbooks. Factor X is 'Stuart Factor,' Factor XII is 'Hageman Factor,' Factor IX is 'Christmas Factor,' and so on." This observation illuminated something that struck me about Behe's account: how closely it tracked the parallel argument in *Of Pandas and People* (on which Behe served as a Critical Reviewer). The blood coagulation charts

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in Davis & Kenyon (1993, 143) and Behe (1996, 82) are virtually identical, from their anachronistic terminology clear down to the captions. Neither Behe nor *Pandas* referenced their clotting sources, but consider also the stilted prose style. Davis & Kenyon (1993, 143-144): "The intrinsic and extrinsic pathways cross over at several points. Hageman factor, activated by the intrinsic pathway, can activate proconvertin of the extrinsic pathway. *Proconvertin* can then feed back into the intrinsic pathway to help *PTA* activate Christmas factor. Thrombin can also trigger both branches of the clotting cascade," while later on the page it was explained that antihemophilic factor "helps *Christmas factor* in the conversion of Stuart factor to its active form." Behe (1996, 85): "The intrinsic and extrinsic pathways cross over at several points. Hageman factor, activated by the intrinsic pathway, can switch on proconvertin of the extrinsic pathway. Convertin can then feed back into the intrinsic pathway to help activated PTA activate Christmas factor. Thrombin itself can trigger both branches of the clotting cascade by activating antihemophilic factor, which is required to help activated Christmas factor in the conversion of Stuart factor to its active form, and also by activating proconvertin." ("Convertin" was the alternate term Behe used for the active form of proconvertin.)

[49] Re note 247, chapter three. Mathematician William Dembski (1998a) thinks "the dam burst" for the design option with *Darwin's Black Box*. Down at the grassroots buzzword level, conservative ideologue Bob Enyart dubbed giraffe necks "irreducibly complex" on the late-night "Politically Incorrect" show in August 1999. (Enyart also flatly asserted that fossils proved dinosaurs and people coexisted and that the Book of Job had an anatomically correct description of a dinosaur.) Evolutionary ripostes have not always been detailed, which tended to reinforce the creationist conviction that Behe is "on to something" after all. Dorit (1997), Alters (1999, 103), Schick & Vaughn (1999, 178) and Eldredge (2000, 139-140) were fairly cursory. Avise (1998, 237n), Hellman (1998, 200n), Davies (1999, 280n), Harold (2001, 266n) and Dennett (2003, 128n) dismissed Behe to peripheral footnotes—though Dennett did reference his longer 1997 commentary, "The Case of the Tell-Tale Traces: A Mystery Solved; a Skyhook Grounded" (at ase.tufts.edu/cogstud/papers/behe.htm). Examples from the more substantive Cavalier-Smith (1997), Kenneth Miller (1999, 130-164) and Pennock (1999, 263-272) will be duly noted below. Cf. also Pigliucci (2001), Shanks & Joplin (1999) with rejoinder by Behe (2000), and the assorted Internet coverage (most notably at the Talk.Origins Archive).

[50] Behe (1996, 232-233). Extracts from this passage were prominently featured as a chapter teaser in Hunt (1998, 18). Behe (1996, 234-243) had gone on to attribute this state of affairs partly to a desire to minimize conflict by keeping religion and science separated along a demilitarized zone, but more fundamentally to a "scientific chauvinism" that keeps hunting for naturalistic explanations anyway. This latter perspective Behe chalked off variously to institutional inertia, a stuffy adherence to methodological naturalism, and an aversion to admitting supernatural forces like God (identity unspecified) into the picture.

[51] Behe (1996, 62).

[52] Li (1997, 20). "It could take 100 years, for example, for the largest existing system to perform a complete protein-folding computation," Sterling (2001, 39). Behe *et al.* (1991) was aware of the problem; cf. Attwood (2000), George Rose (2000), Kallenbach (2001) on Silverman *et al.* (2001), Montelione (2001) re Bonanno *et al.* (2001), and King *et al.* (2002) on the limits of "bioinformatics." Not that designer genes and proteins help ID—Darwinian selection often assists in the "designing." See Zhang *et al.* (1997), Crameri *et al.* (1998), Stokstad (1998) re MacBeath *et al.* (1998), Yano *et al.* (1998), Chang & Donoghue (2000), Juárez *et al.* (2000), Bolon & Mayo (2001), Yano & Kagamiyama (2001) or Barlow & Hall (2002). Though there is the occasional glitch, such as the retraction in *Nature* (May 23, 2002, p. 468) re Altamirano *et al.* (2000) and Petsko (2000).

Diving into Deep Time, Jermann *et al.* (1995) peeled back a gene duplication (around 40 mya) to test an ancestral digestive enzyme of ruminant pancreatic ribonucleases, and assess thereby the adaptive scenario relating the success of ruminants like cows to improved digestive chemistry. Cf. Caro-Beth Stewart (1995), Golding & Dean (1998), D'Alessio (1999), Gee (1999, 164-165) and Benner *et al.* (2002). And there's Sharp (1997) re Messier & Stewart (1997) on the adaptive

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origin of the digestive lysozymes found in colobine monkeys. During the 1997 "Firing Line" debate, Ken Miller cited Atwell *et al.* (1997), who clipped out the "critical" tryptophan residue in the receptor for human growth hormone (hGH). After only seven rounds of cloning, the function resumed by clicking into a different configuration. As their abstract put it, "Such plasticity may be a means for protein-protein interfaces to adapt to mutations as they coevolve." Xie *et al.* (2030) review current views on the evolution of the tryptophan operon (the arena of the Altamirano research noted above), and Yanofsky (2003) chronicles how study of tryptophan metabolism has figured in practical and theoretical research. See also note 85 below on how tryptophan synthesis relates to domain shuffling.

Concerning Atwell *et al.*, Behe harrumphed at the "Firing Line" debate that this example wasn't irreducibly complex. Which quite missed the point: "critical" biochemical components may not be so essential after all, as natural variations can realign into new functional patterns with surprising speed. This is just how bacteria have begun to adapt to man-made chemical toxins, Thwaites (1985), Kandiah *et al.* (2000) and Copley (2000). Cf. Behe's later comments (at discovery.org) with Miller (1999, 143-144, 303-304n). Or Hunter (2003, 155-156n, 158-160n, 162-163n) various citing Gee (1999) and Miller (1999), but not alluding to the Jermann and Atwell topics. Or answersingenesis.org/home/area/feedback/negative7-24-2000.asp with nmsr.org/nylon.htm on the nylon-eating Flavobacterium.

[53] Behe (1996, 67).

[54] Behe (1996, 72). Likewise Behe (1996, 114-115) on intracellular transport. Re Behe (1996, 68, 179, 279n, 285n), Cavalier-Smith (1997) noted his dated sources, and that Behe "deceitfully ignored" relevant work "despite citing the volume containing it as 'evidence' that no paper has ever been published on the subject!" Behe (1996, 182-183) similarly asserted the absence of "evolution" references in biochemistry textbooks, apparently relying on some limited search engines, John Catalano's 1998 talkorigins.org/faqs/behe/publish.html and Ken Miller (1999, 147-149). The lack of "evolution" in an index may only indicate a sloppy compiler, as Laurence A. Moran (one of Behe's targeted textbook authors) noted in a 2002 Talk.Origins posting. I found a similar situation: Benjamin Lewin (1994) didn't index "evolution," though it came up repeatedly in the text, especially as study questions. Tortora *et al.* (1995) had only three index references, which turned out to key on the word "evolution" in the *subject headings*. That restriction missed pages 250-255 on how Darwin and evolutionary thinking illuminated natural classification. As a parochial reflection of the microbiological discipline, a listing of milestones did not include Darwin, but "1981" did honor Lynn Margulis apropos the endosymbiotic "Origin of eucaryotic cells" (more on how antievolutionists overlook this in due course).

[55] Behe (1996, 36). The account concerned Dawkins *v.* Francis Hitching, not the Duane Gish aspect, indicating Behe (1996, 31-36) was derived entirely from *The Blind Watchmaker*.

[56] Tom Bethell (1996, 16): "Behe tells me that his suspicions about evolution were stirred up a decade ago when he read Michael Denton's book, *Evolution: A Theory in Crisis*." Cf. Witham (2002, 130). This side of Denton's antievolutionary legacy may be added to the Denton/Johnson symbiosis described in chapter two.

[57] Behe (1996, 65). Cf. Niehrs & Meinhardt (2002) on developmental cell signaling.

[58] Behe (1996, 41).

[59] Behe (1996, 47).

[60] Pennock (1999, 266) noticed the same evidential lapse in several of Behe's examples.

[61] Behe (1996, 85). The dynamic modeling of coagulation and blood flow is still in its infancy, Scott Diamond (2001) on Kuharsky & Fogelson (2001), and other factors may be involved, Koppaka *et al.* (1996), Safa *et al.* (2001), Deguchi *et al.* (2002) and Majumder *et al.* (2002). Nor is it always clear what a component can do even when scientists think they know what it does biochemically—see Wigler & Mishra (2002) re the genetic circuit tests of Guet *et al.* (2002).

[62] Behe (1996, 72). The illustrations (on page 71) were from 1993 and 1995, and may be compared to the one in Gamlin & Vines (1986, 212).

[63] Miller (1999, 147-148) noted the exact mechanics of the flagellar motor were still a mystery in 1998—cf. DeRosier (1998, 17) and Whiteside (2001, 79-81). It has been easier to identify the

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dozens of genes participating in flagellar assembly and operation, where a gene's absence or modification can have more easily observable effects, Chilcott & Hughes (2000). All of which reminds us that it can be just as theoretically perilous to get ahead of the data as to stay too far behind, from pre-plate tectonic geology to the caveats Barbara Stahl offered about feather evolution. Thus photosynthetic anaerobic bacteria "posed one of the most troublesome problems of comparative biochemistry for more than 60 years" because "the wrong questions were being asked on the basis of fragmentary knowledge," H. Gest, "Evolutionary Roots of Anoxygenic Photosynthetic Energy Conversion," in Ormerod (1983, 215). Indeed, before the role of DNA was spotted in the 1950s any "Darwinian" explanation for life that tried to get too detailed would be like finishing a puzzle with a huge piece missing. Behe has continued to press the assertion that evolutionists ought to have been able to explain the rotary flagellum from the onset, as in his 1997 *Boston Review* rejoinder to Orr (Introduction, note 40). He also selectively cited Lucy Shapiro (1995, 525) on how complicated the flagellar assembly system is. He did not quote this from the next paragraph: "some of the regulatory mechanisms used for flagellar construction appear also to be used for phage assembly and, surprisingly, for the selective transport of virulence factors from the bacterial cell to their animal or plant hosts," citing research like Russel (1994). See Young *et al.* (1999) and Cornelis (2000) for further work on the virulence angle, with Hueck (1998) detailing how key components of the variegated pathogenic Type III secretion systems reflect horizontal gene transfer from counterpart genes used in the flagellar system. Ian Musgrave (rnaworld.bio.ku.edu/ribozone/resource/transport/Ian%20Musgrave_flagella.htm) follows up this point re Behe. We'll take a further tour through the secretion/flagellum connection in the final chapter, concerning William Dembski's approach to detecting (or admitting) when biological features *aren't* designed.

[64] Behe (1996, 72-73). Viewing the cilium as microscopic Paley Watch stumbles on several problems. As Kenneth Miller (1999, 140-143) pointed out, while the 9+2 structure is quite common (found from algae to human sperm), it is by no means unique. Many combinations of the parts are known to result in perfectly functional systems—and all entirely self-assembled by the organism. Cf. also Monastersky (2001b, A11). Thus, unlike Louis XVI tinkering with his clocks, biological timepieces require no external intervention for their concerted operation—which means arguing for their irreducible complexity should at some point have impelled *Darwin's Black Box* into an essay on proprietary nucleotide sequences. That it was not was a further clue to the limitations of biological experimentation, either creationist or evolutionary.

[65] Behe (1996, 177). His inspiration, Michael Denton, has a similar blind spot for connecting relevant information. A particularly bald example concerned pleiotropism, where genetic modifications affect more than one area of the body. Denton (1985, 149): "Not only are most genes in higher organisms pleiotropic in their influence on development but, as is clear from a wide variety of studies of mutational patterns in different species, the pleiotropic effects are invariably species specific." *Invariably* species specific? That should have suggested that pleiotropisms might play a role in the speciation process he purportedly accepted, but that connection did not occur to him—nor in Denton (1998, 333, 337) either. See Rice & Hostert (1993), reprinted in Mark Ridley (1997, 174-186), and Schilthuizen (2001, 139-141) on how pleiotropy does relate to speciation. Cf. also Wagner (2000a) re overlapping gene functions and Travisano (1997, 477-478) on bacterial analogues. Wendell Bird (1989, Vol. 1, 95) quoted Denton (though italicizing "most genes" and "species specific" in his version) apropos the seeming absence of genes corresponding to physical structures regarded as homologous in an evolutionary sense. Unfortunately for Bird, the late 1980s happened to be just when biologists began discovering those missing genetic homologies. Starting with the homeobox genes described in chapter one, they turned out to operate rather deeper in the developmental process than earlier investigators had been looking. Bird's analysis therefore beautifully illustrated both the analytical limitations of authority quotes selected to dispose of a complex subject, as well as the practical predictive sterility of his "abrupt appearance" model.

[66] De Blij (1994, 62); see Williams (1988) and Wettlaufer & Dash (2000, 52-53) for current ideas on the internal dynamics of thunderclouds, Collins (2000) on superconductivity, and note 115

(chapter 3) on the Lewis Overthrust. Out on the pro-creationist Christian fringe, Kennedy (1997, 133) dispensed with such grubby technicalities, declaring natural catastrophes such as hurricanes, tornadoes, floods, earthquakes, and famines "ultimately are a consequence of human sin." One may quibble that famines are often the product of human activity, but as for the rest Kennedy advised that these may be our folly too: "Humans, in their pride and capacity for poor choices, may be taunting God by dwelling in areas where disasters occur so frequently." He did not specify where the divinely blessed disaster-free zones were.

[67] Behe (1996, 68). Citing "Farries, T. C., and Atkinson, J. P. (1991) 'Evolution of the Complement System,' *Immunology Today, 12,* 295-300," Behe (1996, 137) similarly complained that "No quantitative calculations appear in the paper." But Behe did not elaborate on what sort of calculations he had in mind, or how meaningful they would have been given the present state of knowledge of structural biology.

[68] See Singh & Ribet (1997) for the Fermat problem. 19th century mathematician Bernhard Riemann offered a similarly tempting notation, as Devlin (2002, 50-51) recounted in his coverage of current unsolved mathematical problems.

[69] Understanding gene expression depends a lot on observing system malfunctions (either naturally or through experimental ablation). The effects of tiny variations and bonding at the molecular level under less dramatic circumstances are not so clear, as reflected in Benjamin Lewin (1994). Johnson (1995, 83-84) glided past this issue only insofar as it played out in *The New York Review of Books* between the often-acrimonious Stephen Jay Gould and Richard Dawkins camps concerning the interplay of contingency and inevitability in macroevolutionary processes. Cf. Dennett (1995, 275-278) here. Johnson focused on Gould's "angry" 1992 review of Helena Cronin's *The Ant and the Peacock*: "Gould asserted forcefully that most important bodily characteristics are 'emergent properties' of organisms which are not produced in any direct way by individual genes or even combination of genes. Instead, these properties are products of such complex interactions among genes that they cannot *even in principle* be adequately known or predicted at the genetic level." This could have inspired Johnson to consider the limitations of experimentation and prediction in genetic analysis, especially apropos what "Darwinists" are supposed to be able to conclude about the development of life. But Johnson jumped to another conclusion: "If Gould is correct on that point, then to select for individual genes or even gene combinations is not to select for predictable properties in the adult organism. But in that case, how can the complex adaptations that Dawkins and Cronin seek to explain be built up by a process of mutation and selection?" Here Johnson has confused *predictability* with *causality*—for even emergent and unanticipated genetic shifts would still have their net effect, and be subject to inheritance as a package. Promoting this misunderstanding into a difficulty for evolution, Johnson then chided that "Gould did not ask himself that question, nor did he draw his readers' attention to the problem. Instead he went on to reject what he called the 'uniformitarian vision of extrapolation,' which is the fundamental Darwinian principle illustrated by the finch-beak example with which this chapter began." See Segerstråle (2000, 321-322, 422n) for another take on the Gould-Cronin fracas. Incidentally, Johnson's successor at the "Weekly Wedge Update" post, Mark Hartwig, showed similar astigmatism in an obit on Gould (May 22, 2002) when he inexplicably appeared to equate Gould's *Wonderful Life* contingency thinking with a belief in adaptive determinism!

[70] Behe (1996, 92-93) abstracted the Doolittle argument, citing "Doolittle, R. F. (1993) 'The Evolution of Vertebrate Blood Coagulation: A Case of Yin and Yang,' *Thrombosis and Haemostasis,* 70, 24-28." The specific steps involved: (1) tissue factor (TF), which comes into contact with the blood after injury, is produced by gene duplication from a protein that binds EGF domains. (2) Gene duplication for a protease produces prothrombin with EGF domains attached, serving as an attachment site for the exposed TF. (3) The thrombin receptor comes from gene duplication for a protein that sticks to the cell membrane, while cleavage by the TF-activated prothrombin effects cell contractility or clumping. (4) A thrombin-sensitive protein is modified to make fibrogen. (5) Antithrombin III comes from gene modification for a protein of similar structure. (6) Modified proteases that function as antibacterial agents (able to bind to bacterial protein) generate plasminogen, with domains to bind to fibrin. (7) Gene duplication of

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antithrombin (or similar protein) yields antiplasmin. (8) A cross-linking protein that can be triggered by thrombin appears. (9) Tissue Plasminogen Activator (TPA) appears and modification of its domains allows it to bind to several substances, including fibrin. (10) Prothrombin is modified by the acquisition of a "gla"-domain, which allows binding to calcium and negative-charged surfaces. (11) Proaccelerin is produced through gene duplication. (12) Factor X ("Stuart Factor") is duplicated from the gla-modified prothrombin of step 10; its ability to bind to proaccelerin can cause activation by prothrombin independent of TF activation. (13) Factor X is duplicated to make proconvertin, allowing prothrombin to bind better to fibrin; in conjunction with TF, proconvertin activates Factor X by cutting it. (14) Factor X is modified to make Factor IX ("Christmas Factor"); for a time both are able to bind to proaccelerin. (15) Proaccelerin produces antihemophilic factor, and further modification allows it to interact with Factor IX. (16) Prothrombin is modified to produce Protein C, which inactivates proaccelerin and antihemophilic factor by cutting. (17) Gene modification of prothrombin shifts the binding domain to fibrin from EGF (no longer needed for interaction with TF). See Jiang & Doolittle (2003) for current work in this area.

[71] Behe (1996, 93-96), under the heading "HOW"S THAT AGAIN?" The inclusions and ellipses were in the text; "Calvin and Hobbes" referred to a 1990 piece reprinted by Behe (1996, 23) where the comic strip protagonists used a magic cardboard box as a time machine.

[72] Pennock (1999, 271). Doolittle responded in "A Delicate Balance" for the *Boston Review* (see bostonreview.mit.edu). Recalling his 35 years devoted to understanding the evolution of blood clotting, "it appears I have wasted my career." Ken Miller (1999, 152-160) quoted that in his survey of how much of Doolittle's work on clotting dynamics Behe left out of *Darwin's Black Box*. Cf. Zimmer (2001g, 328-330). Doolittle also raised the issue of utility: in 1987 he and colleague D. F. Feng "predicted that certain of the genes encoding the blood clotting cascade would be absent in jawless fish. This prediction was made on the basis of comparing the sequences of blood clotting factors in mammals and estimating how long it had been since the gene duplications leading to their existence. In particular, we noted that fish should not have both Hageman Factor and prekallekrin, two of the factors described in Behe's outline of blood clotting in his book." While a study on this "in lampreys and hagfish has not yet been undertaken," Doolittle was "willing to wager a goodly sum about the outcome. What I want to know, however, is whether Behe will accept such a result as proof of the concept, or whether he will—in typical creationist style—simply try to find a way out." Behe responded at discovery.org in July 2000 (the link to Doolittle's article was invalidated by placing a "." instead of the "-" in www-polisci.mit.edu/bostonreview/BR22.1/doolittle.html). Behe didn't mention Doolittle's jawless fish wager, let alone whether he was apt to accept it. Instead he focused on a concluding point Doolittle made concerning "knockout mice" (where specific genes are deleted to observe the effects) and how Doolittle had "misread" the source paper, Bugge *et al.* (1996). Doolittle had concluded: "Recently the gene for plaminogen [*sic*] was knocked out of mice, and, predictably, those mice had thrombotic complications because fibrin clots could not be cleared away. Not long after that, the same workers knocked out the gene for fibrinogen in another line of mice. Again, predictably, these mice were ailing, although in this case hemorrhage was the problem. And what do you think happened when these two lines of mice were crossed? For all practical purposes, the mice lacking both genes were normal! Contrary to claims about irreducible complexity, the entire ensemble or proteins is *not* needed. Music and harmony can arise from a smaller orchestra. No one doubts that mice deprived of these two genes would be compromised in the wild, but the mere fact that they appear normal in the laboratory setting is a striking example of the point and counterpoint, step-by-step scenario in reverse!" Behe quoted all but the last sentence (noting the "plaminogen" typo), and treated this as arguing that "a simpler clotting cascade might be something like the one that lacked plasminogen and fibrinogen, which could be expanded into the modern clotting system by gene duplication." From that assumption, Behe went on to note that the hybrid mice were indeed far from "normal," in that the Plg$^{-/-}$/Fib$^{-/-}$ mice were still susceptible to hemorrhaging (especially in pregnancy). That was possibly what Doolittle had in mind about the viability of the hybrid mice in the sentence Behe did not quote. Jonathan Sarfati accepted Behe's version of events in a rejoinder to Rennie (2002b) at

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answersingenesis.org/news/scientific_american.asp, adding his own *ad hominem* about "a lot of bluff by the atheist Doolittle, or at least poor reading comprehension." Behe has also stuck to his guns, as in a July/August 2002 debate in *Research News & Opportunities in Science and Theology* (researchnewsonline.org) when he caught Michael Ruse not attending too closely when quoting Doolittle's "plaminogen" statement. Looking to the original paper, Bugge *et al.* described how wound healing in the Plg$^{-/-}$/Fib$^{-/-}$ mice proceeded normally, *without excessive bleeding* (apparently the ability of blood to dry on its own was sufficient to prevent minor leakage). Bugge *et al.* (1996, 717): "despite slow progress in wound repair, wounds in Plg$^{-/-}$ mice eventually resolve with an outcome that is generally comparable to that of control mice. Thus, an interesting unresolved question is what protease(s) contributes to fibrin clearance in the absence of Plg?" As live birth wouldn't have been involved in pre-vertebrate ancestors, a secondary clotting system may not have required the sort of precision mammals need to minimize fatal hemorrhaging. Ken Miller made a similar observation in his recent rejoinder (re note 132 below). The possible role of bacteria (àla sickle-cell) also appeared, as Bugge *et al.* (1996, 717) noted how "bacterial Plg activators such as streptokinease and staphylokinase may provide a selective advantage to microorganisms in escaping fibrin-based immobilization and penetrating host tissue barriers." Instead of exploring such variables, Behe emphasized how "**EVIDENCE OF COMMON DESCENT IS NOT EVIDENCE OF NATURAL SELECTION**." Only that begged the question of whether common descent nonetheless reflected a naturalistic process (the subject that so exercises Intelligent Design). Behe dodged that issue by tightly defining "Darwinism"—as with critic Keith Robison, who offered at Talk.Origins a possible intermediate series that used neutral mutations (ones that do not immediately alter primary function) to assemble some of the clotting components. Behe dismissed that as irrelevant because "while Robison's scenario does indeed build a new step in the cascade, it doesn't do it by Darwinian means." The exclusion of neutral mutations from the "Darwinian" tool kit will come as news to a lot of evolutionary biologists. Behe's approach may be contrasted with Edelman & Gally (2001) on the exciting evolutionary synergy implied by the same data set available to Behe.

[73] Behe (1996, 111-112). For the gate through the cell membrane, he imagined one that "toughened the membrane" as wooden beams reinforce a wall. "Could that protein somehow turn into a gated channel? This is like asking if wooden beams in a wall could be transformed, step by Darwinian step, small mutation by small mutation, into a door with a scanner." For the signal recognition particle (SRP) that pauses protein assembly and keeps it *unfolded*, Behe suggested one that "would help a protein fold rapidly." For the piece identifying proteins at the gate he proposed an enzyme to deposit "a large carbohydrate group" sufficient to "prevent it from passing through any future gate that looked like a modern gate." None of these were quantified or related to the gene sequences—or the current literature, as Cavalier-Smith (1997, 163) noted. Cf. Rothman & Orci (1996) and Mellman & Warren (2000) on vesicle mechanisms, Leabman *et al.* (2003) and Shu *et al.* (2003) on technical implications, and notes 129-131 below.

[74] Now a critic could step in here to object that aren't evolutionists assuming their concept to be true just the same as Behe? Well, not quite. The evolutionist has the whole weight of prior experience to rely on in much the same way as cosmologists do when applying Newtonian physics to calculate the path of a spacecraft. (Presuming one doesn't get English and metric mixed up, of course, as some NASA boffins did recently, with the result being one lost Martian probe.) Behe was putting himself in the Einsteinian position of declaring the Newtonian presumption wrong—a perfectly valid claim, provided you get over the hurdle of explaining the existing phenomenon as well or better, along with making new testable predictions. As we'll see later on in the chapter, this matter of how new theories are supposed to go about challenging old ones turns out to be a major philosophical defect of Intelligent Design.

[75] Behe (1996, 280-281n). He didn't say what the "other considerations" affecting the successful duplication of genes might be. The sources in notes 78, 85 & 87 below are less reticent.

[76] Behe (1996, 140-141).

[77] Pennock (1999, 169-170); ellipsis in the text. Population dynamics apply to bacteria too, e.g. Schneider *et al.* (2000) and Cooper *et al.* (2001) on variations in *E. coli*. Punctuated equilibrium

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also plays its part, as Gould (2002a, 808-810, 931-935) noted of Lenski & Travisano (1994), Elena *et al.* (1996) with commentary by Mlot (1996), and Papadopoulos *et al.* (1999).

[78] Benjamin Lewin (1994, 701): "Duplication of the entire gene allows one copy to evolve via mutation, while the other retains its original function. Such genes are likely to code for proteins that have related functions." Steroid receptors appear to have evolved from estrogen receptors in this way, Thornton (2001) and Thornton *et al.* (2003). Thus a duplication of receptors that originally had an affinity only for the final ligand in a biosynthetic pathway permit some to react to the intermediates in the series, opening up new biological responses through "ligand exploitation."

[79] Behe (1996, 87, 125-126) further objected to the preservation of intermediate components.

[80] Assessing the constraints of metabolism isn't easy—cf. Allen & Palsson (2003) on prokaryote protein synthesis. Michael Denton pioneered Behe's position in a chapter on "The Puzzle of Perfection." Denton (1985, 335): "The cell, however, manufactures all its component structures, even the most complex, by fully automated assembly techniques which are perfectly regulated and controlled." Reassuring news for doctors dealing with leukemia or cancer patients—everything works just perfectly, except when it doesn't.

[81] Li (1997, 271, 273), citing J. A. Black & G. H. Dixon in *Nature* (218: 736-741) and A. E. Mourant, A. C. Kopec, and K. Domaniewska-Sobczak, *The Distribution of the Human Blood Groups and Other Polymorphisms* (Oxford University Press). One may contrast Li's prediction on what the allele is likely to do in the general population with Morris & Morris (1996b, 39): "A 'beneficial' mutation, even if natural selection is there waiting to conserve one if it comes along, is simply a figment of the evolutionary imagination. None has yet been documented in 'real life'—that is, a mutation beneficial to the creature experiencing it." This *twenty years* after the Mourant work. And such findings have continued—e.g. Manché *et al.* (1999), Imhof & Schöltterer (2001), Remold & Lenski (2001), Riehle *et al.* (2001) on beneficial mutations and gene duplications in *E. coli* … or Bull *et al.* (2000) and Holder & Bull (2001) on viruses.

[82] Behe (1996, 103).

[83] In this respect a reminder how frisky biochemical reactions are. The ribosomes certainly read nucleotides in a hurry: most bacteria stitch together 15 amino acids per *second* (thus requiring only twenty to chain a typical one), Benjamin Lewin (1994, 174)—and *E. coli* blazes along at nearly a *thousand* nucleotides per second, Baker & Bell (1998, 295). Eukaryotic organisms poke along at only several amino acids per second, suggesting a selectivity that may turn out to be of some relevance in understanding the evolutionary process.

[84] Behe (1996, 280n).

[85] See Li (1997, 269-308) on gene duplication, TPA and company. "A major force in evolution is clearly the duplication of genes, either as intact units or as collections of exons or even individual exons," Benjamin Lewin (1994, 704). These include repetitive "satellite" DNA fragments in the second insulin gene of rats and mice, Lewin (1994, 709-717, 758-760), and Wang & Gu (2001) on the caspase family used by mitochondria to initiate programmed cell death (apoptosis). Similar processes of evolutionary co-opting and modification appear in bHLH and Sp transcription factors, Morgenstern & Atchley (1999) and Kolell & Crawford (2002), RNA degradation, Haigis *et al.* (2002) and Symmons *et al.* (2002), and MDR (a superfamily of 583 "medium-chain dehydrogenase/reductase" proteins involved in formaldehyde metabolism and alcohol fermentation), Riveros-Rosas *et al.* (2003).

Levine & Tjian (2003) spot the role of differential expression of duplicated genes; cf. Alami *et al.* (2003) on linker-histones. Duplications can proliferate when fissioning multiple functions, Force *et al.* (1999), Lynch & Force (2000), Lynch *et al.* (2001)—and Pennisi (2000) on Lynch & Conery (2000) with discussion in *Science* (August 31, 2001, p. 1551). Cf. Locascio *et al.* (2002), and Axel Meyer (2003) re Gu *et al.* (2003). See also Kliebenstein *et al.* (2001) on thale cress (*Arabidopsis*), fast becoming the *Drosophila* of plant genetics as its lean genome facilitates experimental duplications to expose subchromosomal mechanisms, Jelesko *et al.* (1999) and Ziolkowski *et al.* (2003).

To what extent chromosomes or even whole genomes have been duplicated in evolutionary history (rather than smaller genetic segments) remains uncertain, Pennisi (2001c) and Gu & Huang

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(2002). Friedman & Hughes (2001; 2003), and Makalowski (2001) re Hughes *et al.* (2001), Ledent & Vervoort (2001) & Robinson-Rechavi *et al.* (2001), argue against large-scale duplications in vertebrate history; Larhammar *et al.* (2002), David *et al.* (2003), Eichler & Sankoff (2003), Panopoulou *et al.* (2003), Salaneck *et al.* (2003), Koszul *et al.* (2004) and Vandepoele *et al.* (2004) support various episodes.

Beyond overall duplication, new pathways and proteins can evolve by "domain shuffling" of components, which includes the idea that ancestral enzymes would have had broader substrate affinities than their more specified molecular descendants. A notable example concerns one of the commonest of protein folds, the family of $(\beta\alpha)_8$-barrel enzymes composed of eight repetitions of the β/α barrel. The TrpF version (involved in the synthesis of the amino acid tryptophan in prokaryotes) appears to have evolved from the histidine-generating version HisA. Not only were Jürgens *et al.* (2000) able to elicit TrpF activity from HisA through random mutations, Barona-Gómez & Hodgson (2003) identified a possible "molecular fossil" of the ancestral form (PriA) from a living bacterium that retains the broader specificity. Hartmann *et al.* (2003) isolated the single amino acid shift responsible for regulation pattern specificities in other members of the $(\beta\alpha)_8$-barrel family, and Joerger *et al.* (2003) produced a similar change experimentally via a single mutation (broadening an NAL synthase to include the DHDPS function "as efficiently as DHDPS itself"). Farther back on the evolutionary chain, the catalytically promiscuous β/α core may in turn have developed from an ancestral half barrel, Miles & Davies (2000) re Lang *et al.* (2000). There are "promiscuous" sites in other proteins that can pave the way for new functions, James & Tawfik (2001; 2003) and Mayans *et al.* (2002).

[86] Behe critics Jerry Coyne (1996b) and Kenneth Miller (1999, 157) noted something else evidently related to trypsin: thrombin, which acts in cell division as well as being one of the key proteins in the blood clotting mechanism. In a typical antievolutionary argument, Hunter (2003, 27-28) focused on what is not yet known, offering the origin of serine proteases as an evolutionary problem—rather than dealing with the implications of what might have happened to the existing molecular machinery (recall that Hunter cited Miller's book, per note 52 above).

The common practice of gene sharing (where the same polypeptide acts as an enzyme in some contexts and a structural protein in others) includes a dozen different molecules serving as eye lens crystallins in both vertebrates and invertebrates, Li (1997, 306-307), Werten *et al.* (2000) and Zimmer (2002b). The diversity of structural chemistry in the invertebrates is likely to inspire plenty of future evolutionary research. For example, the exoskeleton of crustaceans is composed of the same polysaccharide chitin the cephalopod squids use, while arthropods rely heavily on the protein sclerotin, and marine worms favor collagen, Marc Dando, "Marine Invertebrates," in Waller (1996, 123).

[87] Li (1997, 299). One may also note Li (1997, 276-278) on the role of exon duplication in the apolipoproteins, where their many variant sizes are "largely due to differences in the number of repeats in the last exon." This variety allows the acquisition of new functions—though by no means have all of these been identified: they "may be involved in neural regeneration, immunoregulation, and modulation of growth and differentiation."

[88] While a codon triplet specifies each amino acid in the exon, in many eukaryotes the start-stop markers for the introns are apparently based on nucleotide *pairs*. A GT pair signals the beginning of the intron, whereupon the ribosome proceeds to edit that out of the RNA copy until it hits an AG indicating exon resumption, Benjamin Lewin (1994, 914-915). Exactly why this is so remains unclear. Other factors taking part in gene assembly include RNA and protein "trans-splicing," Malek *et al.* (1997) and Wu *et al.* (1998), contributing to some amazingly tricky transcriptional dynamics, Landweber *et al.* (2000).

[89] Behe (1996, 127, 282n). Incidentally, de Duve (1995, 223-224) pointed out that molecular biologists were genuinely surprised when split genes were discovered in 1977, since the insertions seemed such a wasteful and potentially dangerous operation (running the risk of introducing error in DNA processing). Nature, of course, doesn't bother one whit over waste or error—the only evolutionary criterion being how well does it work out. Clearly complex living systems manage

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despite a host of eccentric mechanisms clunking along in the genetic basement. Cf. Maniatis & Tasic (2002) on the evolutionary implications of the mechanisms used to edit introns out of RNA.

[90] Behe (1996, 175) mentioned introns thus: "Genes from higher organisms were shown to contain interruptions (called introns) in the coding sequence. Some genes had dozens of introns; other genes just one or two. So now a biochemist could publish comparisons of the sequence of the introns in the genes from different species, as well as studies of the total number of introns, their relative positioning in the gene, their length and base composition, and a dozen other factors." And that was as far as it went. Previously, Denton (1985, 243) skipped over introns just as lightly, never perceiving them as monumentally important markers as to what games might be going on at the genetic level. By contrast, *Of Pandas and People*, failed to mention introns at all—nor any of the other genetic recombination mechanisms one would have thought an instruction source could not have overlooked were the idea to genuinely prepare the student to engage the scientific issues in an informed manner.

[91] Rachel Nowak (1994, 609-610): "Evolutionary theorists agree that introns are the remnants of primitive RNA life forms that somehow became incorporated in cells, and evolved with them." See Benjamin Lewin (1994, 679-701) for the genetic mechanisms involved. The frequency of interrupted genes rises abruptly as you move from yeast (5%) to fruit flies (83%) and mammals (94%)—a pattern suggesting complex organisms got to be the way they are through a process that inevitably produced as much peripheral foam as macroevolutionary beer. Relationships natural and otherwise may be inferred by tracing such telltale copying errors, as Max (1986) and Avise (1998, 35-36) have noted for DNA and Bennett *et al.* (2003) about chain letters.

[92] Discussions of the globin superfamily run from the prototypically abstract Dawkins (1986, 175) to the more detailed Avise (1998, 97-98) or Li (1997, 289-292, 427-428). Benjamin Lewin (1994, 682) noted that, "The globin and DHFR [mammalian "dihydrofolate reductase"] genes present an example of a general phenomenon: *genes that are related by evolution have related organizations, with conservation of the positions of at least some of the introns. Variations in the lengths of the genes are primarily determined by the lengths of the introns.*" (Italics in the original.) See Henikoff *et al.* (1997) for a survey of major gene families in terms of evolutionary taxonomy, and Bailly *et al.* (2003) on the direction of some recent research.

[93] Behe (1996, 174).

[94] Behe (1996, 90).

[95] Behe (1996, 284-285n). For a contrasting evolutionary perspective on the biochemical similarities between the visual cascade and the hormonal system, see Stryer (1987, 48-50). The four hormonal *G* proteins share about half of the DNA coding with their transducin counterparts in visual processing. Both systems in turn appear to be structurally similar to the even more fundamental elongation factor *Tu* employed in bacteria for protein synthesis. Incidentally, Stryer was one of the researchers who actually identified the players in the visual cascade, again illustrating how work in these fundamental areas tends to be undertaken by those scientists who are looking for basic evolutionary processes. See Golding & Dean (1998, 358-359) and Terai *et al.* (2002) on opsin evolution, and Gould (2002a, 1131-1132) re Saranak & Foster (1997) on how rhodopsin functions in fungal response to light.

[96] Behe (1996, 175), reiterating the position of Behe (1996, 138). Behe (1996, 176): "Like the sequence analysts, I believe the evidence strongly supports common descent. But the root question remains unanswered: What has caused complex systems to form?" In a 1996 posting at the Access Research Network website reacting to criticism of his book, Behe insisted that he did not "dismiss" the fossil record. "In fact, I mention it mostly to say that it can't tell us whether or not biochemical systems evolved by a Darwinian mechanism. My book concentrates entirely on Darwin's mechanism, and simply takes for granted common descent." Similar sentiments appear in his contribution to Arnhart *et al.* (2000, 28-29). Though in his 1997 *Boston Review* rejoinder to Orr, Behe seemed also to define common descent as "all the cells in your body descended from one fertilized egg cell."

[97] Behe's nebulous conception of "descent" may have been influenced again by Michael Denton. "It is true that both genuine homologous resemblance, that is, where the phenomenon has a clear

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genetic and embryological basis (which as we have seen above is far less common that is often presumed), and the hierarchic patterns of class relationships are suggestive of some kind of *theory of descent*. But neither tell us anything about *how* the descent of evolution might have occurred, as to whether the process was gradual or sudden, or as to whether the causal mechanism was Darwinian, Lamarckian, vitalistic or even creationist. Such a theory of descent is therefore devoid of any significant meaning and equally compatible with almost any philosophy of nature," Denton (1985, 154-155). Likewise, in the "Firing Line" debate Phillip Johnson tossed off another of his "meaningless concessions," blithely asserting that "of course I don't deny that there is such a thing as descent with modification—the question is, how much it explains." But what Johnson has never clarified by specific example (other than the restrictive one of finch beaks) is *what* is it that is to be explained. Because he never progressed to the point where he considered the species overlaps of the players in the reptile-mammal transition, for instance, the set of data to be accounted for was invariably off his analytical scope.

[98] Behe (1996, 22). Attached to the fifth sentence (on fossil gaps) was this rather pointless endnote observation: "For example, as the expected pattern left by speciation events that occurred in isolated populations," Behe (1996, 278). Since no examples were given, Behe let himself off his own hook as to whether fossil distributions could be legitimately ignored when it comes to evolutionary paleontology, which by its nature deals with extinct lifeforms (ones for which a detailed biochemistry is inherently unknowable except through *post hoc* evolutionary reasoning). Incidentally, the relegation of parenthetical commentary to notes rather than to clauses in the main text is an occasional foible of technical authors, such as notes 18-20 in McMenamin (1998, 252n). For a pithy quote on footnote etiquette, cf. Barrow (2000, 303).

[99] Behe (1996, 230).

[100] Behe's laundry list swallowed modern biological science. "Similarly, evolutionary biologists have recognized that a number of factors might have affected the development of life: common descent, natural selection, migration, population size, founder effects (effects that may be due to the limited number of organisms that begin a new species), genetic drift (the spread of 'neutral' nonselective mutations), gene flow (the incorporation of genes into a population from a separate population), linkage (occurrence of two genes on the same chromosome), meiotic drive (the preferential selection during sex cell production of one of the two copies of a gene inherited from an organism's parents), transposition (the transfer of a gene between species by nonsexual means), and much more. The fact that some biochemical systems may have been designed by an intelligent agent does not mean that any of the other factors are not operative, common, or important," Behe (1996, 229-230). But Behe gave no examples recognizing their "operative, common, or important" effects in the real world. Should there ever be a Theistic Realism competition for "meaningless concession," Phillip Johnson would do well to watch his back.

[101] Johnson (1998a, 48-56) failed to hit the technical aspects when reviewing *Darwin's Black Box* in tandem with Dawkins' *Climbing Mount Improbable* for *First Things* (October 1996) in "The Story-teller and the Scientist" (available at leaderu.com/ftissues/ft9610/Johnson.html). For Johnson, Dawkins was the superficial storyteller and Behe the methodical scientist. "Biochemists are not likely to challenge Behe in any fundamental way at the factual level. The scientific way to refute the irreducible complexity thesis is to publish the papers detailing how the complex biochemical systems could have evolved, and the scientists already would have done that if they could," Johnson (1998a, 55-56). Johnson had no suspicion that the "if they could" wasn't the fault of Darwinian theory so much as the experimental restrictions of structural biology—and the reason why Behe's own arguments were incomplete. A full chapter of Ankerberg & Weldon (1998, 195-208) repeated Behe's conclusions without qualification.

Briefer but equally accepting: Denton (1998, 275), Hanegraaff (1998, 63-65, 183-186n), Dembski (1999a, 146-149), Minnery (2001, 75-76), Norman L. Geisler ("Why I Believe the God of the Bible Is the One True God") & Walter Bradley ("Why I Believe the Bible Is Scientifically Reliable") in Geisler & Hoffman (2001, 93, 169-170), Witham (2002, 128-129) and Barr (2003, 110). Indeed, Dembski (1998a, 26) heroically pegged *Darwin's Black Box* as the great harbinger: "Here for the first time were the outlines of a full-fledged scientific research program for design in

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biology." Whether this will pan out any more than Kurt Wise's promised recalibration of the fossil record remains to be seen. While a substantive ID research agenda may indeed be "waiting in the wings," Peterson (2002) could detect no overt sign of its existence among any of the available designer enclaves (particularly the Discovery Institute).

[102] Behe (1996, 136). Unfortunately, *Darwin's Black Box* did not explain in what way the findings of comparative immunology were "valuable."

[103] Stansfield *et al.* (1996, 316-336) reflects the limits of what is known about the immune system. While there was plenty of functional detail, it was clearly not enough to define the questions adequately for serious speculation on the origin of the system. One element notably absent was whether master developmental genes play a role in the overall scheme. If there are any, they weren't known to the authors in 1996; without such pivotal toeholds a thoroughly molecular explanation for the mechanism would be a tough climb indeed. Not that the authors weren't willing to pose such questions in other instances when the evidence suggested something more concrete—such as wondering whether the general intron editing arrangement came from self-splicing introns that use similar procedures, Stansfield *et al.* (1996, 349-350).

[104] Beck & Hubicht (1996). The accompanying Litman (1996) discussed the shark immune system, the nearest guide for early vertebrates like the extinct placoderm fishes; cf. Mestel (1996). Like mammals, sharks use a dual operation: "Cellular immunity" (*T* cells from the thymus glom onto antigens directly) and "Humoral immunity" (*B* cells from the spleen spew immunoglobulin antibodies flagging the antigens for attack by specialized cells—sharks differ in having four antibody classes, of which only one overlaps our mammalian five). Sharks vary most in pre-linking many of their genes on the chromosomes, allowing for faster response to familiar threats, but less open to novelty. Land vertebrates developed the opposite broad-brush mode of a genetic redundancy that is sometimes less efficient. The origin of the complete system involves three main elements: the receptors giving lymphocyte *B* and *T* cells their ability to recognize invaders, the major histocompatibility complex (MHC) genes that generate the proteins allowing "self" to be distinguished from "nonself," and the gene-shuffling proteins that keep the whole team primed for a successful defense. Behe (1996, 137) touched base here peripherally, re the brief survey by Bartl *et al.* (1994) on how "understanding of the evolution of vertebrate immunity is slowly emerging from studies of" related chordates, which Litman had recommended for Further Reading (incidentally, Baltimore is the fellow of controversy from note 44 above). That approach was insufficient for Behe: "The authors then argue that sharks, which are very distantly related to mammals, appear to have all three components. But it's one thing to say an organism has a completed, functioning system, and another to say how the system developed." And quite another to elbow aside all the effort whereby that question could be answered. Details on the molecular dynamics of T cell receptors have only recently been identified, Ian Wilson (1) (1999) on Reinherz *et al.* (1999). See also Laird *et al.* (2000) on Shintani *et al.* (2000) re the evolution of adaptive immunity, and Schmid-Hempel & Ebert (2003) on larger theoretical contexts. In the prediction department, Bartl *et al.* suggested the immune system RAG gene might have been a retroposon (recently confirmed per note 130 below). While Behe (1996, 126) thought the difficulties of working out a Darwinian origin of immunity were "enough to make strong men blanch" he did not indicate which of the assorted MHC alleles constituted the original designed one(s). Curiously, several are "associated with resistance to *Plasmodium falciparum* malaria," Li (1997, 264). Matt Inlay's 2002 posting on "Evolving Immunity: A Response to Chapter 6 of *Darwin's Black Box*" (talkdesign.org/faqs/Evolving_Immunity.html) offered subsequent research like Spanopoulou *et al.* (1996), Lewis & Wu (1997), Medzhitov & Janeway (1997), Takahashi *et al.* (1997) and Levashina *et al.* (2001) to question whether the immune system is even IC, let alone that it is intractable in evolutionary terms.

[105] Beck & Hubicht (1996, 62-63). Suspecting invertebrates would show cytokine correlates (like interferon and interleukin) that participate in vertebrate immunity, they noted subsequent research showing this in worms and tunicates. Ji *et al.* (1997) explore the tunicate evidence concerning "the components and function of the pre-vertebrate complement system." Mammalian MHC genes relate to immunoglobulin (Ig) genes, the invertebrate allorecognition system, and cell receptors in

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urochordate blood, Nei *et al.* (1997), Grosberg & Hart (2000) and Khalturin *et al.* (2003). Hoffmann *et al.* (1999), Kairies *et al.* (2001) and Kim *et al.* (2002) explore conserved signaling pathways (such as MAP kinase) and general coagulation mechanics in the evolution of innate immunity. Cf. also Baker *et al.* (1997) on plant response to microbial attack. Kenneth Miller (1999, 158-160) highlighted Russell Doolittle's correct prediction that nonclotting fibrinogen would be found in invertebrates, and his role in identifying the gene duplication responsible for lobster fibrinogen (done in 1990, thus well before Behe's book). Among chelicerates, horseshoe crab lectins (related to fibrinogen) developed a different role in their coagulin-based immune response, Gokudan *et al.* (1999), Kawasaki *et al.* (2000) and Osaki *et al.* (2002). Meanwhile, Behe (1996, 132-136) discussed the regulators triggering or degrading the complement cascade as another potential IC case. As with clotting, Behe offered no experiments apropos the functionality of potential precursors.

[106] Behe (1996, 189). While Mills (1998) gymnastically mentioned mitochondria minus endosymbiosis, Dembski (1999a, 176; 2002, 319) dubbed symbiosis "speculative" without reference to mitochondria. Wendell Bird (1989, Vol. 1, 100, 210) fielded both evasions, including an authority quote by Philip Whitfield—ironic given his subsequent agreement with the theory, Whitfield (1993, 28-29). Wells' *Icons of Evolution* skipped the subject of mitochondrial endosymbiosis altogether—cf. Henry Morris doing the same in "A House Divided" (BTG No. 134a, February 2000, at icr.org/pubs/btg-a/btg-134a.htm). Interestingly, Wells (2000a, 265) peripherally referenced Schwartz & Dayhoff (1978), though without noting its content, which included Schwartz & Dayhoff (1978, 398) explicitly noting how their preliminary analysis of genetic data lent support to the endosymbiotic origin of mitochondria and chloroplasts. For the biology: Gamlin & Vines (1986, 156-158), de Duve (1995, 162-166; 1996), Stansfield *et al.* (1996, 361-365), Dawkins (1998b, 225-231), Kurland & Andersson (2000), Mayr (2001a, 45-48), Zimmer (2001g, 111-115), Ryan (2002), and Palenik (2002) re Martin *et al.* (2002). Cyanobacteria appear also to have lent plants cellulose synthase, Nobles *et al.* (2001), and Gupta (1998), Martin & Müller (1998), Maynard Smith & Szathmáry (1999, 59-78), Margulis *et al.* (2000) and Hartman & Fedorov (2002) explore the contenders for the endosymbiotic origin of eukaryotes. Johnson (2000, 72) pigeonholed Margulis re his review of Brockman (1995) in *Books & Culture* (September 1995), reprinted in Johnson (1998a, 101-107). "Two of the biologists interviewed by Brockman (Brian Goodwin and Lynn Margulis) explicitly reject the neo-Darwinian model when it is extended beyond the modest finch-beak and peppered-moth-color examples where it finds its only empirical support," Johnson (1998a, 104-105). Margulis was chiefly exercised over Richard Dawkins' glib dismissal of James Lovelock's "Gaia" hypothesis, which regards the earth's biosphere as a self-calibrating system that might even be viewed as a single "organism" (Dawkins described this idea as "not dangerous or distressing except to academic scientists who value the truth"). The Gaia hypothesis is relevant to detecting life on Mars: a Gaia model would have life overpowering a planet much as it has on earth—not hanging on as a subterranean remnant. Dawkins (1998b, 224) continues to disdain the "bad poetic science" of an intentionally cooperative earth, while backhandedly acknowledging that Margulis' "gentle" version of Gaia is "in a superficial sense not too far from being right." Cf. Margulis & Sagan (1997), Lenton (1998) and Ryan (2002, 99-114, 177-187) with the skeptical George C. Williams, "*Gaia*, nature worship, and biocentric fallacies," in Mark Ridley (1997, 398-407) and Gould (2002a, 612). British biologist Brian Goodwin relegated adaptive selection to infra-species microevolution ("dogs" staying "dogs," which analogy presumably caught Johnson's eye) and mixes ecological postmodernism ("The whole capitalist trip is an awful treadmill that's extremely destructive.") with mathematical mysticism. Goodwin is searching for the underlying "laws" of evolution that would govern morphological change with the same precision as fluid dynamics do the spiral of a whirlpool. Such investigation is in its infancy, as reflected by Laughlin *et al.* (2000) and John Whitfield (2001). In this sense Goodwin is poised at Behe's molecular keyhole, though from the evolutionary side looking back. Neither scientist related their still thoroughly evolutionary views to matters like the reptile-mammal transition which critics like Johnson object to. See Brockman (1995, 35, 37, 69-70, 86-87, 89, 97-110, 130-146) on the Margulis/Goodwin fireworks.

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[107] Behe (1996, 69) rejected Margulis' proposal "that cilia resulted when a type of swimming bacterium called a 'spirochete' accidentally attached itself to a eukaryotic cell. The idea faces the considerable difficulty that spirochetes move by a mechanism (described later) that is totally different from that for cilia. The proposal that one evolved into the other is like a proposal that my daughter's toy fish could be changed, step by Darwinian step, into a Mississippi steamboat." Behe didn't get around to describing the spirochete mechanism, which moves by undulating waves generated by internal flagella whose structure and genes appear at least partly related to other bacteria, Motaleb *et al.* (2000) re Heinzerling *et al.* (1997) and Ge *et al.* (1997; 1998). See Margulis & Mark McMenamin, "Marriage of Convenience," and Margulis & Michael F. Dolan, "Swimming Against the Current," in Margulis & Sagan (1997, 35-58), Ryan (2002, 90-93), and wikipedia.org/wiki/Evolution_of_Flagella for pros and cons on the spirochete hypothesis. Cf. Stansfield *et al.* (1996, 366): "How did the bacterial flagellin system become replaced by the eukaryotic tubulin system and what, if anything, remains of the symbiont?" They noted *pillotinas* (symbiotic spirochetes living in the hind gut of termites) use microtubulelike proteins—though whether this was a homologous feature or one derived from the host's system they couldn't say based on the available evidence. De Duve (1995, 138-142) mentioned the parasitical diplomonad *Giardia lamblia* and its microtubular flagella, surveyed in detail by Adam (2001). A "living fossil" among eukaryotic microorganisms, *Giardia* engulfs extracellular objects in the manner suspected in the symbiosis model, but its lack of mitochondria and chloroplasts positions it prior to the major spurt of endosymbiotic activity, Kabnick & Peattie (1991), Gray *et al.* (1999) and Harold (2001, 175-188). Though note Morrison *et al.* (2001), and Roger & Silberman (2002) re Williams *et al.* (2002). Besides sliding filaments and tubules, there are also "springs and ratchets" and even a single-molecular rotating form, Mahadevan & Matsudaira (2000) and Kinosita *et al.* (1998). Recently it has been learned that the microtubule-based kinesin motors and the actin-based myosin motors are built on a shared molecular core structure. Vale & Milligan (2000, 94): "At the heart of kinesin and myosin motors is an allosteric core whose actions are not so different from those of many well-studied enzymes." Cf. Maly & Borisy (2001), and Duke (2002) on Badoual *et al.* (2002).

[108] See Gamlin & Vines (1986, 44) and Liu & Hall (2004) on lichens and their evolution, Maynard Smith & Szathmáry (1999, 101-107) on symbiosis generally, with Bolhuis *et al.* (2000), van Hoek *et al.* (2000), Ané *et al.* (2004) and Lévy *et al.* (2004) for recent research. Concerning mtDNA, Benjamin Lewin (1994, 218): "Why have changes been able to evolve in the mitochondrial code? Because the mitochondrion synthesizes only a small number of proteins (~10), the problem of disruption by changes in meaning is much less severe. Probably the codons that are altered were not used extensively in locations where amino acid substitutions would have been deleterious. The variety of changes found in mitochondria of different species suggests that they have evolved separately, and not by common descent from an ancestral mitochondrial code."

[109] Avise (1998, 93-94). See also Wallace (1997), Philip Cohen (2000) or Guy Brown (2000) on mitochondria at play, and Ecker (1990, 65-66) for a survey of biological imperfection arguments. Although evolution critic Hunter (2003, 29, 32-33, 57) sprinkled discussions of ATP and mitochondria through his argument (without direct source citation) he managed not to link up any of the endosymbiotic pieces.

[110] Nesse & Williams (1998). George Ayoub and Michael Denton (ARN's *Origins & Design* 17:1 & 19:2) and creationist ophthalmologists Peter Gurney (trueorigin.org/retina.htm) and George Marshall (answersingenesis.org/docs/1145.asp) offer gymnastic counter-arguments on the reverted retina. Several contrast how well the vertebrate eye works in air, while the cephalopod one is fine under water—a display of misplaced concreteness, since it doesn't explain why fish share the eye arrangement of their terrestrial vertebrate cousins. Cf. the tangential Denton (1998, 354-359) with Dawkins (1986, 16, 93), Harris (1997) & Gould (2002a, 1126-1127) on squid eye genetics as explored by Tomarev *et al.* (1997), and Zimmer (2001g, 128-131). "Darwinian medicine" explains why farmers and doctors are sternly advised to restrict pesticide and antibiotic use because selection theory shows their overuse only accelerates resistance, Weiner (1994a, 251-266). Ironically, at the 1998 Whitworth "Creation Week" Phillip Johnson abstracted the recent National

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Academy of Sciences evolution guidelines to this sole point, claiming it offered bacterial resistance as *the* reason why evolution should be taught. The report did mention this matter in Chapter 2, "Evolution as a Contemporary Process," but among many instances where evolutionary thinking illuminates real life situations (let alone the particulars of the fossil record). In print, Johnson (1998a, 92-97) took the NAS guidelines to task for its "head-in-the-sand" refusal to recognize that the policy of teaching naturalistic evolution "isn't working." Reality check: penicillin-tolerant bacteria do this by extensive gene shuffling, including lateral gene transfer (LGT) between species (a trick bacteria are good at), Li (1997, 372-374)—though single amino acid substitutions arising repeatedly in mosquitoes have contributed to their insecticide resistance, Weill *et al.* (2003). Cf. Lawrence & Ochman (1998), Bogarad & Deem (1999), Jain *et al.* (1999), Bergstrom *et al.* (2000), Notley-McRobb & Ferenci (2000), Schilthuizen (2001, 25-27) and Palumbi (2001). Incidentally, LGT among Precambrian *Bacteria* and *Archea* complicates fitting *Eukarya* into the picture, as genes could have been acquired apart from a direct ancestor/descendent connection, Doolittle (1999; 2000). Hillis (1999b) re Bush *et al.* (1999) offers another application of evolutionary biology: predicting how the flu virus is likely to mutate in the future. Or Dennett (1995, 234-235) on how "genetic imprinting" (the preferential expression of maternal or paternal genes) has been successfully predicted in species. The only way to spare creationists such continuing chagrin would be for evolutionists to stop applying their theory to nature and abstain from observing its success.

[111] Nesse & Williams (1998, 92). Dembski (1999a, 150) downplayed the appendix thus: "The human appendix, formerly thought to be vestigial, is now known to be a functioning component of the immune system." He cited Davis & Kenyon (1993, 128), which drew on the same sources ("H. Kawanishi, 1987, *Immunology* 60, 19-28; K. Bjerke, P. Brandtzaeg, and T. O. Rognum, 1986, *GUT* 27, 667-674.") as Mills *et al.* (1993, 82). For contrast, Gish (1993, 43-44) offered medicine as one of three instances where "evolutionary theory has retarded progress in science." According to Gish, "For many years research on the true importance and function of such organs and structures as the pineal gland, the tonsils, and the appendix were neglected because, according to evolutionists, these were useless vestiges left over from our evolutionary history. The number of unnecessary and even harmful tonsillectomies and appendectomies that have been performed because of evolutionary teachings is probably in the millions." No references were given. The other two areas were embryology—supposedly sidetracked by the "biogenetic law" (the old idea that embryos literally retrace their evolutionary history)—and "the cost, in countless thousands of man-hours of research, of devising evolutionary phylogenies which not only serve no practical purpose but all of which are eventually discarded." At least Gish will never be accused of wasting even a few man-minutes on the comparable topic of creationist taxonomy.

Selective quotation and minimalist biology contribute to creationist claims here (for example, the immune aspect of the appendix appears to apply to herbivorous mammals other than humans, where the organ can be removed without notable health effects). See several pertinent Talk Origins pieces posted in 2003 by Douglas Theobald: "The vestigiality of the human vermiform appendix: A modern reappraisal" (talkorigins.org/faqs/vestiges/appendix.htm) and "Citing Scadding (1981) and Misunderstanding Vestigiality: Another Example of Poor Creationist Scholarship" (talkorigins.org/faqs/quotes/scadding.html) co-authored with Reed A. Cartwright. Hunter (2001, 32, 179n) invoked Scadding.

[112] Behe (1996, 225), citing Kenneth Miller (1994, 29-30). This would be the same Miller article Phillip Johnson did not want to unnecessarily distract his readers with regarding hen's teeth in chapter two (re note 145).

[113] Behe (1996, 223-224). In contrast, Davis & Kenyon (1993, 122) were less concerned with "detecting" design than *proclaiming* it: "For the design proponent, there is another explanation of the origin of analogous features in unrelated groups. The design proponent assumes that the similarity of features can be accounted for on the basis of *design requirements*."

[114] Behe (1996, 199) even skipped the implications of his own examples, where a natural blood clotting protein "has some drawbacks, so innovative researchers are trying to *make a new protein* in the laboratory that can do a better job." He noted this only as a case of biological intelligent design (by us this time)—not as an instance where a human engineer was out to intentionally

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correct the flubs of an omnipotent deity. Where might this fall on the Tower of Babel "hubris index," I wonder? Likewise, Phillip Johnson's review of John Brockman's book *The Third Culture* appealed to Brian Goodwin's criticism of neo-Darwinism without pondering the Intelligent Design implications of something he alluded to concerning the rhythmic cycles of life. As Goodwin put it, the "chronobiology" of natural systems explains why perfectly healthy people can drop dead of anoxia—the heart simply switches to another natural resonant mode, fibrillation: "it's oscillatory, it's rhythmic, but it just doesn't happen to pump blood very well," Brockman (1995, 98). Cf. Goodwin (1994, 59-64) and the current review of the scientific problem by Dana MacKenzie (2004).

Incidentally, Johnson (1998a, 105-106) also quoted the caveats renowned biologist George Williams had about Dawkins' view of gene selection—but did not explore Williams' contribution to the new field of Darwinian medicine. Williams noted his fruitful collaboration with physician Randolph Nesse in Brockman (1995, 45-46), commenting that "there is no kind of medical problem for which the theory of natural selection will not be relevant, for curing or preventing a disease." Other creationists have simply pigeonholed the problem of the "meaning" of imperfect design, such as Morris & Morris (1996b, 47): "But even if there really are any vestiges or imperfections, this would be evidence for degeneration, not for evolution." Dembski (1999a, 261-264) was even more direct in reflecting the theological underpinnings of this attitude when he attributed suboptimal design to "the perversion of design in nature" in "a fallen world." Cf. Ruse (2001, 120-121). Interestingly, Schroeder (2001, 9-11, 84) bucks the antievolution trend by accepting an experimental God whose bungled original designs included our inverted eye wiring.

[115] Kenneth Miller (1999, 289) touched on this theme: "Authentic love requires freedom, not manipulation. Such freedom is best supplied by the open contingency of evolution, and not by strings of divine direction attached to every creature." Barry Richardson (2001, 71-73) offers a similar sentiment. This leitmotif doesn't play a particularly prominent role in the Bible, however. The Sodom incident of Genesis 19:1-28 has elements of it, but not as much of a lesson in compassion. Lot recognized his two visitors as angels, and promptly bowed to the ground. But the rowdy homosexual inhabitants of Sodom were less perceptive, and in their iniquity demanded of Lot that he surrender his guests "that we may know them" (the Biblical euphemism for sexual intercourse). At this point Lot offered his own daughters instead—which may be taken as a curiously amoral invitation for gang rape, though if the idea was to placate a gay *male* mob it looked more like a calculatedly empty gesture (for background, see note 175, chapter six). The angels eventually struck all the discourteous Sodomites blind, Lot and the family made their exit from the city, and the area was blasted with fire and brimstone (whereupon Mrs. Lot underwent that famous reverse desalinization episode when she looked back to marvel at the spectacle). For students of the psychological quirks of Biblical morality, finding no men roundabout the cave where they were living as refugees, Lot's daughters got their father drunk enough on wine that they could sleep with him without his knowing. "Thus were both the daughters of Lot with child by their father," Genesis 19:36. No obvious approbation was attached to these instances of incest, however. Potter (1933, 49) listed the Lot case as two of the nineteen instances of incest reported in the Bible, offering the examples of Cain and Seth (Genesis 4:17,26) as possible addenda. Regarding some of the implications of Biblical incest, D. James Kennedy's fascinating views on early genetic diversity will be encountered in chapter six.

[116] See Benjamin Lewin (1994, 721-722) or Max (1998). The fixation of a pseudogene depends on population size as well as how often mutations are likely to inactivate a gene (averaging about 1/100,000 per generation), Li (1997, 285-287) and Vartanian *et al.* (2001). Interestingly, prokaryotic life appears to have a more active housecleaning system, since pseudogenes are virtually unknown among them. But snipping out this drive-wheel of genetic change may very well be the reason why bacteria have tended to remain *bacteria*—cf. Levin & Bergstrom (2000) and Andersson & Andersson (2001). I am reminded of the pithy observation of Freeman Dyson (1985, 76), who likened the rule of the genes to "the government of the old Hapsburg Empire: 'Despotismus gemildert mit Schlamperei', 'Despotism tempered by sloppiness.'"

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[117] Behe (1996, 225-227), with ellipses and inclusions in the text. The passage began under the heading "WHAT DOES IT DO?" while the last four paragraphs were sectioned as "LONG, LONG TIME AGO." Citations were to Futuyma (1982, 207) and the Miller *Technology Review* article.

[118] Dembski (1998a, 25) raised this vacuity to an axiom: "Intelligent Design presupposes neither a creator nor miracles. Intelligent Design is theologically minimalist. It detects intelligence without speculating about the nature of the intelligence." Likewise Dembski (1999a, 107, 247).

[119] Futuyma (1982, 127).

[120] Juggling the multiplicity of factors in modern evolutionary theory can prove taxing, as Bert Thompson (1995, 29) showed when authority quoting a 1980 Gould bit obtained via an earlier edition of Sunderland (1988, 121). Or Duane Gish (1993, 318-322) characterizing as "mindless pap" some remarks of Joel Cracraft, "Systematics, Comparative Biology, and the Case against Creationism," in Godfrey (1983, 169, 176-177). While criticizing the emptiness of creationist "kinds," Cracraft noted the developmental constraints that channel chance mutation and speciation. Gish (1993, 322) concluded: "Have I somehow misunderstood what Cracraft is trying to explain? Am I wrong in supposing that the evolutionary scenario he proposes on p. 176 is contradictory to the neo-Darwinian scenario he cites on p. 169?" Well, since he did ask … yes!

[121] Behe (1998, 35): "We are not inferring design from what we do not know, but from what we do know." Or Morris & Morris (1996b, 255): "The fact that biologists do not yet know the function of pseudogenes does not prove that they do not have any!" Morris & Morris (1996b, 251-253), Dembski (1999a, 150) and Walkup (2000) bet on "junk" DNA/RNA being primarily functional (such as pseudogenes for regulatory functions) as though that dispatched Darwinism. Hunter (2003, 122) goes so far as to suggest that evolutionary theory actively balks at finding functionality (presumably on the grounds that this points to design).

Unfortunately, evolutionary scientists seem unaware of how circumscribed their research imagination supposedly is. Examples of researchers persisting to explore the very points Hunter thinks they don't include Rachel Nowak (1994), Kidwell & Lisch (2000; 2001), Mattick & Gagen (2001), Zimmer (2001h), Dennis (2002), Wickelgren (2003), and Lee (2003) re Hirotsune *et al.* (2003). Concerning that latter, cf. Paul Nesselroade ("The Case of the Pseudogenes," May 23, 2003) riffing off Michael Behe's open letter to *Nature* (all available at arn.org). Introns are as liable to mess things up, though, as in forms of muscular dystrophy, Brook *et al.* (1992), Tapscott (2000) on Mankodi *et al.* (2000), and Tapscott & Thornton (2001) on Liquori *et al.* (2001).

But novel functions can emerge, from *Alu* (note 131 below) to Logsdon & Doolittle (1997) on Chen *et al.* (1997a,b), Cheng & Chen (1999) and Zimmer (2001g, 326-328) on the gene (with introns) co-opted for fish antifreeze! Cf. Lau *et al.* (2001) on other adaptations observed in the regulatory genes of Antarctic fish. Saltational jumps can even come into play, as the activation of an old pseudogene ('unexpressed for millions of years") changed the bonding character of sex pheromones in *Ostrinia* moths, Baker (2002) on Roelofs *et al.* (2002). See Roelofs & Rooney (2003) for subsequent work and de Lame & Eisthen (2003) on implications for understanding the dynamics of pest control.

[122] As described in note 82 of chapter two.

[123] Of relevance here are the legged snakes (re note 120, chapter two) and the early amphibian fossils (note 135, chapter three). The creationist tendency to reduce complex technical issues to shorthand applies just as much to Intelligent Design as Creation Science. For instance, the approach Denton (1985, 176-177) took concerning the labyrinthodont *Seymouria*, a form difficult to classify as "amphibian" or "reptile" precisely because the early Permian contained many forms tending in that direction, as noted by Colbert & Morales (1991, 88). This was not unlike the synapsid reptiles doing their thing later in the Permian and into the Triassic, which *as a group* were developing mammalian features, even though only one order made it all the way to full fur ball status. The exact biology of labyrinthodonts like *Seymouria* cannot be easily told from the fossils alone, particularly concerning the pivotal development of the reptilian waterproof egg, as reflected in Stahl (1985, 268-274). But Denton decided that "a fossil of an immature form closely related to *Seymouria* has been found bearing laval [*sic*] gills (like a tadpole) which suggest that this group of amphibians were wholly amphibian in their reproductive system." Johnson (1991, 173) also played

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the "no cousins" rule: "Stahl notes that the seymouriamorphs come too late in the fossil record to be reptile ancestors and in any event are now considered true amphibians, on pp. 238-39." Well, not quite. In a section labeled "Anthracosaurs ancestral to the reptiles," Stahl (1985, 238-240) had written: "The relative failure of the anthracosaurs as amphibians is paradoxical because the characteristics which distinguished the seymouriamorphs survived in the reptiles and played a part in their success. For a time, paleontologists speculated that the stout-legged seymouriamorphs might have been the first reptiles, but the discovery of a branchiosaur larva of a member of the group and of adult forms with typical amphibian modifications for aquatic life led them to keep the seymouriamorphs in the amphibian fold. Finding true reptiles of Carboniferous age indicates that the first members of the new class must have sprung from an older part of the anthracosaur line, perhaps from relatives of the Upper Carboniferous *Gephyrostegus* (= *Diplovertebron*), a form with small intercentra and ring-shaped pleurocentra. If, as Hotton believes, the Lower Carboniferous *Mauchchunkia* is morphologically intermediate between *Gephyrostegus* and the Upper Devonian *Ichthyostega*, the branch of the anthracosaurs leading to reptiles may have separated very early from the rest of the assemblage. If that was the case, *Seymouria* and its Permian relatives were the very late and somewhat specialized remnants of a stock that had long ago given rise to more promising offspring." Incidentally, this information had not changed from the prior edition, Stahl (1974, 238-240).

Both Denton and Johnson presumed something that the paleontological data could not show: that the contemporary amphibian metabolism is indistinguishable from that of ancestral "amphibians." It simply didn't occur to them that to get from an amphibian to a reptile *a dual mode* survival strategy might have been a necessary stage: a modified "amphibian" mode able to hunker down, bypassing the tadpole state when necessary to develop entirely in the egg. That would be just the thing to make sense of those oddly reptilian "amphibians" like *Seymouria* muddling along in the often-arid Permian environment. And, just as most of the synapsids lost out to later competition (leaving only the specialized mammals to duke it out with the early dinosaurs) the also-ran labyrinthodonts never made it to our own time for their reproductive systems to be scientifically examined by skeptical creationists. Nor did such epistemological considerations leak into Wendell Bird (1989, Vol. 1, 215-216) when he cited Denton and Stahl on these matters. Carpenter (1999, 31-51) surveys current thinking on amniotic egg origins, and Wilkinson *et al.* (2002) illustrates some of the taxonomical implications (and disputes) attending the view that it evolved as an adaptation to a terrestrial environment.

[124] Behe's choice of Futuyma quote may have been to avoid the pitfalls of his own description, where a feature only "resembles" or "appears to be" what it is not. But dandelion petals don't *resemble* petals—they *are* petals … and quite superfluous ones, whose existence needs to be accounted for in the world of Intelligent Design as assuredly as the blood-clotting cascade. See Ecker (1990, 204-206) or Berra (1990, 22-23, 27) on the vestigial organ issue as it relates to creationism, and Loftin (1988, 24-27) and Schilthuizen (2001, 42-47) on cave animals.

[125] Behe backtracked slightly in the ARN posting quoted in note 96 above. No more willing to admit having written imprecisely than Gish did with created "kinds," Behe retired to his "common descent" mantra: "I did not mean (and I did not say) that there is a separate mechanism for generating pseudogenes. I simply mean that the normal process of DNA replication or recombination, which sometimes generates pseudogenes, is very complex, and has not been explained in a Darwinian fashion either by Kenneth Miller or anyone else. (For example, Kornberg & Baker's 1992 edition of 'DNA Replication' has virtually nothing on how any of the steps of replication could evolve in a Darwinian fashion.) The point in my book was that the pseudogene argument is essentially 'God wouldn't have done it that way, so Darwinian evolution must be true.' Pseudogenes may be reasonable evidence for common descent, but the assertion that they show that life was produced by Darwinian mutation/natural selection has to be judged separately." Separately from the mechanisms producing it? Fine parsing indeed!

[126] Behe (1996, 231). Schroeder (1997, 90-92, 113-114) hints at a similar Paleozoic mega-gene.

[127] Kenneth Miller (1999, 163). Orr's *Boston Review* piece (re note 40 of the Introduction) offered similar criticism. As for the actual pattern of fossil history, William Dembski's aforementioned

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essay, "What Every Theologian Should Know about Creation, Evolution, and Design," confidently maintained that Darwinism "fails abysmally when it tries to account for the grand sweep of natural history." He cited Denton's *Evolution: A Theory in Crisis*, which didn't discuss dinosaurs at all and gave only the shortest shrift to the reptile-mammal transition. How Intelligent Design could therefore appreciate "the grand sweep of natural history" while leaving nearly half of it back at the gate, Dembski did not explain—nor did Dembski (1999a, 112) elaborate. For comparison, Eldredge (1999) once again tackles the patterns of fossil history.

[128] Li (1997, 285). Nearly 2500 pseudogenes have been identified, Echols *et al.* (2002). Gould (2002a, 1273-1274) notes similar findings re Meyerowitz (1999) and Kazazian (2000).

[129] Nickerson (1990, 380), Stansfield *et al.* (1996, 354), Maynard Smith & Szathmáry (1999, 97), Weichenrieder *et al.* (2000, 167) and Chen *et al.* (2002). Li (1997, 350-357) examines the variations in several dozen *Alu* sequences. To put the *Alu* 282 bp size in perspective, Benjamin Lewin (1994, 682) noted the majority of exons "code for less than 100 amino acids (often less than 50 in vertebrates), and the general distribution fits well with the idea that genes evolved by the slow addition of units that code for small, individual domains of proteins." And de Duve (1995, 223): "Exons are short and of relatively uniform length, more than two-thirds being between 50 and 300 nucleotides long. In contrast, the length of introns is much more variable, ranging from less than 10 to more than 50,000 nucleotides."

[130] Li (1997, 334-354), McDonald (1998), Maynard Smith & Szathmáry (1999, 96-99), and Kidwell & Lisch (2001, 5-6). "The frequency of transposition is comparable to the spontaneous mutation rate that occurs in bacteria—that is, from 10^{-5} to 10^{-7} per generation," but "because they may be carried between cells on plasmids or viruses, they can also spread from one organism—or even species—to another. Transposons are thus a potentially powerful mediator of evolution in organisms," Tortora *et al.* (1995, 217, 218). Nobel laureate Barbara McClintock discovered transposons in corn in the early 1980s. Examples have since been identified in other plants, bacteria, and animals—including RAG involved in the evolution of the vertebrate immune system, Plasterk (1998) on Agrawal *et al.* (1998). Interestingly, apart from the glancing allusion in note 100 above, transposons were not explored in *Darwin's Black Box*.

[131] Avise (1998, 122), noting also how "a cryptic retroviral-like element" inserted near the *Amy1* gene some 45 mya facilitated starch digestion. Similarly, a mutant bovine pancreatic pseudogene switched on 5-10 mya, Trabesinger-Ruel *et al.* (1996); cf. Jermann *et al.* per note 52 above. See Britten (1994; 1996), Weichenrieder *et al.* (2000), Comas *et al.* (2001), Paule & White (2001, 1293-1294), Makalowski (2003) re Lev-Maor *et al.* (2003) on *Alu* dynamics and insertions contributing to new proteins. More generally, Moran *et al.* (1999) explores the L1 retrotransposons, Dasilva *et al.* (2002) discuss transposon & pseudogene compartmentalization, and Kazazian (2004) summarized the evolutionary implications of retrotransposons.

[132] A case in point is the Krebs TCA cycle, which Harvard graduate student Keith Robison argued at Talk.Origins resembled an IC system until you noticed how the interlocking components come in a variety of precursor combinations. In his 1996 ARN rejoinder Behe reminded that "I pointedly do not argue about things like the TCA cycle." Indeed. And the spirit of "Matthew Harrison Brady" lives on. But the question remains, does the Krebs cycle fail the IC test because *too much is known about it*? See Gamlin & Vines (1986, 152-153) or Tortora *et al.* (1995, 116-118, 133-136, 732) on the overall intricacies of the Krebs cycle. Chen *et al.* (1995; 1996), Hurley *et al.* (1996), Dean & Golding (1997), Golding & Dean (1998, 362-365), and Walden (2002) re Baughn & Malamy (2002) track the ongoing research into what mutations are involved in the various components. Recalling Avise's comment on how mitochondria have their little mitts in the process, at least part of the Krebs cycle has been long since compromised by evolutionary factors. While reporting recent work clarifying the evolution of the Krebs cycle, Kenneth Miller (1999, 145-146, 150-152) made the same critical point about the lactose metabolism cycle—which biologists have been able to tinker with experimentally to prompt the coevolution of its components. Along with the clotting piece (noted above in note 72), Behe's Discovery Institute reply to Miller upped the ante by requiring that more than just one component be reconstituted in a test setting (Miller's rejoinders are available at his website, millerandlevine.com/km/evol/DI/Design.html). Whether

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moving the goalposts in this way will run out of available field first will depend on future progress in experimental biology.

[133] See note 40 (Introduction) for Behe's Orr rejoinder. Miller's 1997 "Firing Line" approach included the Atwell article (re note 52 above). More recently, in the April 23, 2002 ID debate at the American Museum of Natural History (transcript available at ncseweb.org) Ken Miller noted how whales lack Hageman Factor (one of the supposedly essential components in Behe's "irreducibly complex" clotting cascade). Behe acknowledged this without backing down on its IC status. Not that Behe (1996, 160) doesn't have a backup call roster: "Other examples of irreducible complexity abound, including aspects of DNA replication, electron transport, telomere synthesis, photosynthesis, transcription regulation, and more."

[134] Johnson (1991, 93) referred to the "almost inconceivable set of adaptive changes" that could lead to a whale or a bat. In his *Real Issue* response to Gould's review of *Darwin on Trial*, Johnson upped that to "impossible intermediate steps." Over in Creation Science, Gish would concur. In his criticism of punctuated equilibrium, Gish (1993, 137): "It may be that Gould and Eldredge tried to imagine what the intermediates looked like, in going from a land animal to a whale, and discovered that such an attempt was impossible."

[135] Denton (1985, 216-218) and Johnson (1991, 178-179). Johnson characterized Dewar (1875-1957) as "a creationist biologist who prominently dissented from the evolutionary orthodoxy in Britain in the 1930s." Dewar cropped up once earlier in Johnson (1991, 166), as "a leader of the English Creation Protest Movement of the 1930s" who "described Darwinist bias in terms that foreshadow the punctuationalist critique of today." As with his distillation of Dean Kenyon, the Dewar case involved a bit more than Johnson let on. Numbers (1992, 145-152) recounted that (like lawyer Johnson) Dewar was a barrister, though also an accomplished ornithologist with a specialty in Indian birds. Flirting for a time with Flood Geology (he remained on friendly terms with Price), Dewar favored a modified Gap theory of creation; on the technical front, he avoided the "meaningless concession" of speciation the old-fashioned way, by denying it took place at all. Following the zigzag path of many an overly enthusiastic convert, Dewar began as a half-hearted Darwinist, only to abandon those beliefs in the waning days of the British raj for social reasons: the harm it was doing "to the morality of the white races." In the foreshadowing department, Dewar also presaged the public face of Scientific Creationism by dropping his similarly literalist religious views from his books. In 1935 he helped found the "Evolution Protest Movement" in Britain with a group of like-minded British eccentrics to combat Darwinism's purported goals of moral degradation (promoted by psychoanalysis), human extinction (via birth control), and political revolution (through communism). Not all that dissimilar panic buttons from those being pressed by Phillip Johnson three score years hence. Morris & Morris (1996c, 179) mentioned the EPM in passing: "Just before he died, the famous Christian scholar C. S. Lewis, who had long supported the idea of theistic evolution, changed his mind," and wrote to "Bernard Acworth, one of the founders of the Evolution Protest Movement" agreeing that evolution was the great radical lie of modern times. Here the Morrises cited Numbers (1992, 153), but that account actually concerned Acworth's unsuccessful attempts to get his friend Lewis to endorse the EPM (Lewis refused, presumably leery of the organization's cloudy reputation). Lewis apparently thought evolution posed no threat to religion until later in life, though the 1951 letter the Morrises quoted via Numbers dated from *a dozen years* before Lewis' death.

[136] Richard Milton went Denton one better, suggesting that the fossil record on whales hadn't improved even since Darwin's day. Darwin had speculated that a variety of bear might over time have adapted to a fully aquatic lifestyle. "What I have called an apparent 'small gap' in his reasoning is in fact a vast gulf in which there are no fossils of intermediate types and no other physical evidence, so the transformation that Darwin at first saw as highly probable has not in fact happened," Milton (1997, 133). No references were cited for this assertion, though Denton (1985) was in his bibliography. Paul Taylor (1995, 43) was equally behind the curve.

[137] Denton (1985, 174). Like Duane Gish and his sliding scale of how many transitionals are to be considered sufficient to establish evolution, Denton felt free to lay down an evidential gauntlet deemed too weighty ever to pick up. "No one would doubt that whales had evolved gradually from

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an ancestral land mammal if there was a complete sequence of forms leading gradually from a small otter-like species through seal-like organisms to the whales," Denton (1985, 93). But Denton (1985, 117) also gave himself an emergency exit: "Even if a number of species were known to biology which were indeed perfectly intermediate, possessing organ systems that were unarguably transitional in the sense required by evolution, this would certainly not be sufficient to validate the evolutionary model of nature. To refute typology and securely validate evolutionary claims would necessitate hundreds or even thousands of different species, all unambiguously intermediate in terms of their overall biology and in the physiology and anatomy of all their organ systems." Here Denton was talking about *living* representatives. But intermediates linking major groups (like the whales) would have existed only in the very distant past, so Denton is requiring the Wayback Machine as a prerequisite for contradicting typology.

[138] Johnson (1991, 53-54). *Darwin on Trial* then pressed ahead with the section on the Cambrian Explosion, whose "pervasive" discontinuities have been explored in chapter two. One may also recall how Johnson treated the origin of two of those mysterious classes (birds and mammals) whose intermediates are most distinctly preserved in the fossil record. With sublime indifference to his own failure to explore the fossil record in anything like the requisite detail, Johnson (1995, 82) later offered that very field as a test bed for evolution. "If the proposition being tested is not only that blind watchmaker evolution *could* produce complex adaptations but that it also *actually did so*, scientific investigation must include an evaluation of the fossil record. If the blind watchmaker thesis is true, fossil evidence should on the whole support the claim that today's complex organisms evolved step-by-gradual-step from specific common ancestors." Johnson then repeated his customary arguments about taxonomical stability, followed by a garbled conception of the extinction debate (remarked on below in note 211).

[139] Denton was rather fond of charts, but not chronology nor illuminating detail. The one in Denton (1985, 175) on whale evolution showed a shrub of branching lines to indicate how many extinct forms there should have been in order to get at a "hypothetical whale ancestor." Starting with a "hypothetical land ancestor," arrows indicated an "unknown sea otter-like species" lying on a sideline of the whale branch, and an "unknown seal-like species" leading to an "unknown sea cow-like species." There were no illustrations attached of any actual cetacean fossils found to relate this to reality, nor any time scale to clue the reader in on how many millions of years would be covered even by that chart. See Lambert & The Diagram Group (1985, 198-199) and particularly Stahl (1985, 486-492) for accounts of fossil whales and their evolution at the time Denton and Johnson were writing.

[140] A similar slip occurred in Hayward (1985, 44-45). Relying on Francis Hitching for his account of "The Mysterious Whale," Hayward listed six features that needed to be explained: their locomotion and absence of a pelvis, skin and thermoregulation, an eye adapted for underwater vision, hearing and echolocation, baleen feeding, and their underwater birth and suckling. Hayward declared that "the fossil evidence shows that all these incredible changes had to happen within a timespan of five to ten million years." Most of Hayward's list couldn't be easily discerned through the fossil evidence anyway, but the first rudimentary cetotheriids (ancestors of the baleen whales) don't make their appearance in the fossil record for another ten million years still, in the Oligocene. Those cetaceans most famed for their acoustic shows don't arrive until the Miocene: the sperm whale 23-25 Ma, and the Humpback only 10-11 Ma, and what exact skills their fossil counterparts may have had in the sonar department cannot be detected in the bones. See Sara-Heimlich-Boran, "Cetaceans," in Waller (1996, 396-397) for a recent survey of the fossil appearance of modern whales. There are, of course, some elements of whale anatomy that may be inferred. The early archaeocetes have a bend in the vertebral column behind the vestigial pelvis that matches that in modern whales, reflecting the activity of the fluked tail. Likewise, the auditory equipment indicated by the skull of *Pakicetus* (considered an early proto-whale) show only partial adaptation to underwater hearing. See Gingerich *et al.* (1990, 155-156) and note 157 below.

[141] Johnson (1991, 84-85). One may note that Johnson's terminology leaves open at least one other potential escape hatch here: Intelligent Design can always decide that the "whale-like" archaeocetes really weren't of the whale "type" after all, thus rendering their intermediate features

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irrelevant to cetacean evolution. Morris & Morris (1996b, 79) have already ridden this approach off the morphological cliff, baldly asserting "that *Basilosaurus* is an extinct marine reptile." How the archaeocetes could qualify as a reptile while *Archaeopteryx* wouldn't is one of the corkscrew marvels of ICR "taxonomy." Interestingly, *Basilosaurus* became a punching bag between Richard Owen and Lamarckian evolutionists, as recounted by Zimmer (1998, 137-144).

[142] Cf. Stahl (1985, 489-490) and Thewissen & Bajpal (2001, 1041-1042) on whale nares. Lambert & The Diagram Group (1985, 199) contrasted the frontal nasal opening in the small Middle Eocene North African *Prozeuglodon* with the rear blowhole of *Aulophyseter*, a North American Miocene sperm whale. Rich *et al.* (1996, 564) illustrates the 3-meter *Prozeuglodon*. *Aulophyseter's* single nostril was positioned asymmetrically, as are those of the modern whale order Odontoceti (toothed whales and dolphins); the baleen Mysticeti order retains high dual nostrils aligned symmetrically. Similarly, the oldest known baleen whale, *Aetiocetus* from 25 Ma, had nostrils in the middle of the skull, not at the top as in later forms (see for example evolution.berkeley.ed/evosite/lines/IAtransitional.shtml or Robert Ewan Fordyce's "The Origins and Adaptations of Mysticetes" at otago.ac.nz/geology/features/paleontology/whales.htm). These early forms were transitional also in retaining teeth.

The nasal shift relates to something else: the unique whale ear (where, unlike other living mammals, the periotic ear bone is not fused to the braincase). A dearth of basal whale fossils at that time prompted Stahl (1985, 491) to note: "It has not been possible to trace the origin of the modern cetacean ear to its source, presumably in some early archaeocete stock, but the discovery of Eocene and Oligocene whales in which the bones of the snout have begun their backward migration is a clue to the antiquity of the existing cetacean lines." In this regard, one might also consider a derived group of early aquatic reptiles from the middle Triassic, the thallatosaurs. "*Askeptosaurus* from marine deposits of Switzerland is a typical member. It had a longer and more streamlined body than mesosaurs or the aquatic eosuchians, and its limbs were smaller too. In contrast to the condition in mesosaurs and aquatic eosuchians, the nostrils of thallatosaurs were placed well back along the snout, a very common vertebrate adaptation to an aquatic life," Colbert & Morales (1991, 192). Which poses the question of why an intelligent designer would have absentmindedly created the early whales with the same front nostrils as the terrestrial mesonychids they so resembled—the creator having already hit on the anatomical improvement of a high nostril for the thallatosaurs. Interestingly, Gish (1995, 204) illustrated *Askeptosaurus*, but did not remark on its nasal layout.

[143] Futuyma (1982, 62). See also Matthew Landau (1982) and Zimmer (1998, 147). Parenthetically, increasing the number of joints per digit would involve hormonal and developmental switches—which can duplicate whole fingers, as has been observed in bird embryology, Müller (1996, 191-193). Natural bone variations crop up all the time, of course (recall Robert Root-Bernstein's 13-ribbed mother from note 192, chapter three), but the whale case has implications for comparative anatomy. A similar proliferation of internal bone structure occurred over time in the flippers of ichthyosaurs (which, like whales, propelled themselves by the tail) and plesiosaurs (that swam using all four limbs). See Stahl (1985, 486) for a comparison of the adaptations of swimming reptiles to those of the mammalian whales.

[144] Futuyma (1982, 63); cf. *Phenacodus* (note 110, chapter three) concerning horse evolution.

[145] Futuyma (1982, 199). See also Edwords (1982d, 5) and Ecker (1990, 205). Strahler (1987, 441): "The same embryos also have a coat of hair, but this is lost before birth."

[146] Denton (1985, 170). The same illustration showed up in Gish (1995, 204), although labeled "*Basilosaurus*." Correctly identified (and spelled), the *Zygorhiza kochii* restoration appeared in Stahl (1985, 486).

[147] Davis & Kenyon (1993, 102), citing Gingerich *et al.* (1990). The whale and mesonychid illustrations were on the previous page, while on that following whales were given a nice solid line from the Eocene to the present on a chart of "*Fossil history of several major orders of mammals*." No indication was given as to how much morphological change was represented by that innocuous brown block lying beneath the icon of a sperm whale.

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[148] Gingerich *et al.* (1990, 156) nicely illustrates the evolutionary reasoning process: "The pelvis in generalized mammals supports reproductive organs in addition to its common use in locomotion. The pelvis of modern whales serves to anchor reproductive organs, even though functional hind limbs are lacking. Thus hind limbs of *Basilosaurus* are most plausibly interpreted as accessories facilitating reproduction. Abduction of the femur and plantar flexion of the foot, with the knee locked in extension, probably enabled hind limbs to be used as guides during copulation, which may otherwise have been difficult in a serpentine aquatic mammal." See also Zimmer (1998, 176-178).

[149] Vestigial limbs show up in cetacean embryos as well as occasionally in adults, Conrad (1982b), Bille (1995, 138) and Zimmer (1998, 148).

[150] Johnson (1991, 178). It was at this point that Johnson quoted Dewar's 1930s description of whale evolution, which included the absurdity of there being whales with intermediate legs. Incidentally, the "July 15" date for Gingerich *et al.* (1990) was evidently a typo.

[151] See Zimmer (1998, 166-169) for a lively description of Gingerich's Egyptian expedition.

[152] Reported by Behe in a 1994 response to a 1992 debate on "Darwinism: Science or Philosophy" held at Southern Methodist University in Dallas (reprinted at the Leadership U website).

[153] Something that was "very similar" to Intelligent Design was how Duane Gish (1995, 200) tackled the Archaeoceti: "*Basilosaurus* was a large serpentine vertebrate found in Eocene rocks in the early 19th century. Its name, which means 'king lizard,' was given to it by R. Harlan in 1834 because he thought it was a reptile. Later others considered it to be a mammal, but the name stuck. In 1990 Gingerich, Smith and Simons announced that in 1987 and 1989 they had mapped 243 partial skeletons of *Basilosaurus* in the Reuglodon [*sic*] Valley in the desert of north central Egypt. In addition to fairly large front teeth and legs, this creature had a complete pair of hind legs, but tiny in size for such a creature. Although they reported that most joints were well-formed, that the patella and calcaneal tuber are large for insertion of powerful muscles, and that the knee has a complex locking mechanism, they believe the hind limbs were too small to assist in swimming and could not have supported the body on land. They therefore speculated that the hind limbs were probably used as accessories to assist in copulation. Evolutionists assume that the pelvic bones found in a few of the modern whales are vestiges left over from terrestrial ancestors. These pelvic bones are not vestigial structures on their way out, however. They serve a very important function. The pelvis of those modern whales that have them serves as the anchor for reproductive organs." Parasitically, Gish then referenced "W. M. A. de Smet, *Z. Saugetierkd* 40:299 (1975)" as though this were his own critical revelation, without intimating that both the observation and citation had already been made by the source Gish was assailing, Gingerich *et al.* (1990, 156). Gish (or his printer) did omit the umlaut in *Säugetierkd*, however.

[154] Gish (1995, 201) made no mention of the diagnostic feature that linked *Pakicetus* to the whales, nor did Morris & Morris (1996b, 77-78). Zimmer (1998, 164) deftly described the hot feature here as "a bone the size and shape of a grape" hanging below the skull. "It looked like the shell in which living whales keep their ear bones sequestered so that they can hear underwater. Gingerich inspected the edge of the shell where it attached to the skull, and he saw an **S**-shaped flourish of bone serving as an anchor. Every whale, alive or extinct, has this little signature of bone, to the exclusion of all other animals on earth." Re mesonychid appearances and lifestyle, cf. Kenneth Rose (2001a, 56, 58) on the Eocene North American *Pachyaena*.

[155] This is the view reflected in Stahl (1985, 487).

[156] See Zimmer (1998, 159-205) for an excellent overview of this process.

[157] As usual, Gish's pirouettes around the facts of cetacean hearing were entertaining to behold. In order to pronounce that "*Pakicetus* was nothing more than a land mammal, with no relation to marine mammals," Gish (1995, 201) called attention to exactly what his sources Gingerich *et al.* (1983) and Gould (1994c) had: that *Pakicetus* couldn't hear directionally under water or dive deeply. Morris & Morris (1996b, 78) likewise claimed, "It was also found that *Pakicetus* was probably unable to hear under water, making it still more doubtful that it was a whale." What Gish and the Morrises tactfully left out of their accounts was that *Pakicetus* did sport the start of specializations for *hearing* under water (even if not yet directionally). Even worse, further finds of *Pakicetus* had already confirmed the transitional character of its hearing, with auditory skills like

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seals, Thewissen & Hussain (1993). Its ear bones also lent support to the theory that cetaceans pulled this off by rotating the ear bones. In *Pakicetus* the incus was intermediate between that of living artiodactyls (pigs, camels, and ruminants) held to be the only other extant relatives of the extinct condylarths (for which the incus bones are unfortunately not yet known). See Spoor *et al.* (2002) for more on the evolution of cetacean hearing.

[158] Technical papers on the subject are Gingerich *et al.* (1994) and Thewissen *et al.* (1994). Unfortunately none of these finds emanate from *Lagerstätten*, so the paleontology can only reveal so much about their anatomy and lifestyle, but that still proved to be a lot. Overviews of the new discoveries include Gingerich (1994), Gould (1994c), John Noble Wilford, "How the Whale Lost Its Legs and Returned to the Sea," in Wade (1998a, 143-148), Chadwick (2001), Haines (2001, 36-41, 60-99), Thewissen & Bajpal (2001) and Zimmer (2001g, 135-141). Parenthetically, the short Wilford article transposed letters and so consistently misspelled *Rodhocetus* as "Rhodocetus." Not even the New York *Science Times* is perfect!

[159] Gish (1995, 201-205), citing the aforementioned Gingerich and Thewissen papers, Berta (1994), as well as "G. A. Mchedlidze, *General Features of the Paleobiological Evolution of Cetacea*, trans. from Russian (Rotterdam: A. A. Balkema, 1986), p. 91)," and "Carroll, *Vertebrate Paleontology and Evolution*, p. 483" for his search of fossil animals. What point Gish thought to make from finding nothing "closely resembling" a hitherto unknown fossil like *Ambulocetus* is difficult to see. Incidentally, Gish (1995, 198) still began the section with a dated quote from the 1955 first edition of Edwin Colbert's *Evolution of the Vertebrates*—despite Strahler (1987, 438-439) having noted the anachronism of relying on the old quote when Colbert's more recent third edition had moved on to the mesonychids. Edwords (1982d, 6) and Matthew Landau (1982, 15) also noted the mesonychid connection. For Gish to retain the Colbert chestnut in 1995 even after being called on it nearly a decade before indicates either deadening scholarly lethargy or how enamored a creationist can be of a favored authority quote. Paleontological progress has also filled in another of Gish's gaps: an early quadrupedal sirenian (*Pezosiren portelli*) from 50 mya, Domning (2001) and Gore (2003, 24-25).

[160] This may also have been to impress Gish's readers with how "knowledgeable" he was on the subject—though since all of this was in the sources he cited this only established his aptitude for parroting other people's conclusions. As there was no use of "(lubricated)" in the Thewissen paper, the objective extent of Gish's independent research in this matter appears to consist of his having consulted a dictionary to discover what *synovial* meant.

[161] Thewissen *et al.* (1994, 211-212). All of these adaptations are linked to the whale way of life, relating to how the jaws and acoustic package are worked out in the skull. The zygomatic arch one may recall from the synapsid reptiles, where the shift in jaw alignment up through that ring of bone was accompanied by a rather significant alteration in their hearing. Although Morris & Morris (1996b, 79) cited the Thewissen piece, they skipped the detailed anatomy to conclude, "*Ambulocetus* is an extinct animal of no apparent affinity with anything else."

[162] Thewissen *et al.* (1994, 212). As we'll see later in the chapter with the Weinberg episode, Phillip Johnson also employs ellipses as a surgical tool to remove subject matter best not thought about in the Intelligent Design universe.

[163] Thewissen *et al.* (1994, 211) had plainly stated: "Toes are terminated by a short phalanx carrying a convex hoof, as in mesonychids, the terrestrial ancestors of cetaceans." An artist's rendition of *Ambulocetus* in John Noble Wilford, "How the Whale Lost Its Legs and Returned to the Sea," in Wade (1998a, 144) illustrates the extent of that animal's toe hooves. These in turn may be compared to the feet shown in the full skeleton of the mesonychid *Pachyaena ossifraga*, in Gingerich *et al.* (1994, 845), a cited source Gish was of course supposedly familiar with.

[164] Gish (1995, 200).

[165] One may compare Stahl (1985, 487) on the pros and cons of relating mesonychid teeth (and their possible adaptation to feeding on mollusks) with those of whales. See Zimmer (1998, 156-158) for mesonychid dining habits. Parenthetically, Gish (1995, 203) cited Thewissen *et al.* (1994, 212) via an *Ibid.* for the mesonychid-like teeth of *Gandakasia* and *Ichthylestes*, though the source was evidently Berta (1994, 181) from the same issue of *Science*.

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[166] Gish (1995, 206). On the next page he described the baleen whales' specialized feeding, but not embryonic tooth buds (which would have been a clue to their evolutionary background). Morris & Morris (1996b) missed this too—and didn't even mention *Rodhocetus*.

[167] Concerning subsequent whale derivation, Stahl (1985, 489) also cautioned that "The serpentine form of the body and the peculiar serrated cheek teeth made it plain that these archaeocetes could not possibly have been ancestral to any of the modern whales." Not unexpectedly, biologist Frank Sherwin ("a creation lecturer at ICR") recently waved Stahl's observation (Impact No. 304, obtained from the ICR website) like a magic wand to make all the rest of the archaeocetes' transitional features disappear. Similarly, Wendell Bird (1989, Vol. 1, 222) quoted "E. Russell, *The Diversity of Animals* 130 (1962)" on the archaeocetes not being ancestral to modern whales or linked with early mammalian stock. As usual for Bird, no particulars (like the nares of *Basilosaurus*) surfaced to clutter his diarrheic flow of quotations.

[168] Ross (1998, 50-52). The first four paragraphs fell under the heading "Sea Mammals' Timing," with the remainder answering the rhetorical question, "Transitional Forms: Proof of Evolutionism?" The "further discussion" in chapter eight consisted of simply repeating that God kept creating new life forms until resting on the seventh day, which covers human history, Ross (1998, 64). The whale osmoregulation paper in question was Thewissen *et al.* (1996).

[169] Zimmer (1998, 148-152). Zimmer was one of two references Ross (1998, 210n) cited here. Rather hilariously, the other wasn't even slightly paleontological: the 1997 *Firing Line* debate on evolution! Evolutionists have, of course, been observing intermediate fossils far longer than the last "several decades," starting at the least with *Archaeopteryx* in the 1860s. Thus the paleontological parlor game of "spot the intermediate" is a notably older scientific pastime than Edwin Hubble's expanding universe in Ross' own ballpark of astrophysics.

[170] Thewissen *et al.* (1996, 380), views affirmed by Thewissen & Bajpal (2001, 1045). The Kuldana Formation is an early to middle Eocene deposit in Pakistan. The 1996 paper noted, "*Pakicetus* and *Nalacetus* are found only in shallow freshwater deposits," while "*Indocetus* is known from the Middle Eocene Harudi Formation of western India and occurs only in neritic beds." In the spirit of Gish's dictionary work, "neritic" refers to shallow water adjoining a seacoast. Concerning seals, cf. Ellis (2001b, 182-197) on their diversity.

[171] One may note that not all marine mammals have gone so far as whales in this regard. Zimmer (1998, 201): "Manatees and other sirenians have been grazing along coasts for 50 million years, and in some ways they're still not ready: they have to drink fresh water occasionally to survive. Run a hose of fresh water overboard off the coast of Florida and they will pay you a visit. Whales, on the other hand, get enough fresh water from the air they breathe and the prey they catch, but also occasionally swallow salt water."

[172] Gamlin & Vines (1986, 16-17) and Whitfield (1993, 80-82) summarize gene flow and isolation mechanisms in speciation, Li (1997, 35-56, 237-267) covers population genetics (re DNA polymorphism) and Wahl & Krakauer (2000) show how population size affects gene mixes. While sexual conflict can drive speciation in large populations, Tregenza (2003) re Martin & Hosken (2003), smaller ones favor gene duplication, Lynch & Force (2000) and Lynch *et al.* (2001). Different parameters apply among asexual bacteria, Tenaillon *et al.* (1999). Ross (1996, 177) tried this argument before: "Only species with extremely large populations and short generation times can change significantly through mutations and natural selection. Only a few such species exist." The Skinner/Johnson Gambit fielded a thicket of incestuous citation, from Ross (1994, 48-50, 73-80; 1995, 123-146) for Bible passages, the origin of life and anthropics, to "Ross, Hugh, 'Science in the News,' *Facts & Faith*, vol. 9, no. 3 (Pasadena, Calif.: Reasons To Believe, 1995), pp. 1-5" (available at reasons.org) on the possible early human artifacts (cf. note 201, chapter five). But *none* of his citations related to population size and speciation.

[173] The heyday of whale diversity was during the Miocene (5 to 25 million years ago), Stahl (1985, 492). Of the 180 known whale genera, though, forty (over 20%) are still living, representing some 78 species. Most whales range around the size of an orca (the largest of the dolphins, somewhat misnamed the "killer whale"), per Plates 45-52 of Waller (1996, 264-281). Most giant marine vertebrates run about fifty tons—from humpback and sperm whales to the larger pliosaurs and

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ichthyosaurs. There is fragmentary evidence that some pliosaurs (such as the scourge of the Tethys Sea, *Liopleurodon*) may have grown as large as a blue whale. Since the blue whale is a passive planktonic grazer, that would put the distinction of largest vertebrate marine predator on the diapsid side. Bambach *et al.* (2002) describe how anatomy and ecology have apparently channeled marine animal diversity over the last half-billion years.

[174] Behe (1996, 181), citing p. 244 of "Lehninger, A. L., Nelson, D. L., and Cox, M. M. (1993) *Principles of Biochemistry*, 2nd ed., Worth Publishers, New York." The Lehninger being a biochemistry text, and not a treatise on vertebrate evolution, was Behe really expecting the whole story to be recapitulated in every volume that draws on evolutionary theory? If so, introductory science texts are going to be weighty indeed. Only why stop with evolution? Suppose a physics text remarks on the moon's orbit being the result of millions of years of incremental gravitational interplay. That would be just as objectionable to Creation Scientists as the whale statement was to Behe. Should such texts then be criticized unless they too provide comprehensive coverage of all the underlying reasoning that led to their conclusions? As we'll see shortly, if Intelligent Design elects to press this matter with Darwinian evolution, there are problems galore in store as well for the acceptance of Newtonian cosmology.

[175] Zimmer (1998, 209-210). "Exaptation" is a neologism coined in 1982 by Stephen Jay Gould and Elizabeth Vrba to cover what has otherwise been referred to as "preadaptations." Cf. Shoshani (1998, 485-486) on the coevolution and exaptation of the water pouch in the development of infrasonic signaling by elephants. An indication of how recent is the new evidence on whales: Larry Barnes (of the Natural History Museum of Los Angeles) co-authored the paper on the discovery of that Washington odontocete in 1996, Zimmer (1998, 269n). Zimmer (1998, 127-129) explains the cetacean "melon" and "monkey lips." Parenthetically, the last sentence of Zimmer's opening paragraph would seem excellent fodder for some future creationist authority quote—provided, of course, one paid no attention to what followed. A similar quote-mining alert may be raised for the many whale evolution caveats surfacing in Ellis (2001b, 202-241, 260-267).

[176] Johnson (1997, 123-124). Each contributed a quartet of letters, starting off with Miller on November 14, 1996, and concluding with Johnson's December 9, 1996 entry—not quite "early 1997," but perhaps close enough for someone lacking an unduly fussy "map of time."

[177] The Hardin episode being as recounted in note 37 of chapter one.

[178] Ernst Haeckel's 1880 "biogenetic law" that "ontogeny recapitulates phylogeny" was a rather presumptuous pre-DNA extrapolation of Baer's Law, about the conserved stages first observed by the father of comparative embryology, Carl Ernst von Baer (1791-1876). Creationists have made much of Haeckel's distortions of embryological illustrations, as Gould (2000a) noted apropos Michael Behe. One may compare the similar opinions expressed by Morris (1985, 72-77), Morris & Parker (1987, 61-68), Sunderland (1988, 133-137), Hanegraaff (1998, 92-96) and Wells (1999; 2000a, 81-109). Davis & Kenyon (1993, 129) parsed the terminology carefully: "A number of current textbooks give partial presentations of this story, very often stating that gill slits appear in the human embryo. But this has been shown false by advances in embryology, and is uniformly rejected by scientific literature." (Cited were "K. L. Moore, 1989. *Before We Are Born*. Philadelphia: W. B. Saunders, p. 134; E. Beck, D. B. Moffat, and D. P. Davies, 1985. *Human Embryology*. Osney Mead Oxford: Blackwell Scientific Publishers, p. 172.") Phillip Johnson (1993b, 71-73, 188-189) alluded generally to embryonic similarities that "are supposed to be vaguely significant." But he will not accept the human possession of embryonic gill arches—even when photographed by the meticulous Nilsson. Conflating that with "gills," in Letter 2 (November 19, 1996) Johnson fumed that "human embryos never possess gills, either in embryonic or developed form, and the embryonic parts that suggest gills to the Darwinian imagination develop into something entirely different." He didn't say what that "something" might be (the vertebrate jaw and mammalian inner ear, as recounted re note 82, chapter one). Johnson (1998b, 30-31) also frowned on Schroeder (1997, 133) for stating that human embryos show "skin folds similar to gill slits."

But embryos most assuredly do build upon their ancestral genetic substrate, Müller (1996, 122-136) and Maynard Smith & Szathmáry (1999, 122-123), and some evolutionary modifications

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occur as Haeckel thought, adding or subtracting steps at the end of development, Zimmer (1998, 60-63). Interestingly, Haeckel's own part in this controversy is more complicated than the creationist gloss makes out, involving 19th century traditions of exaggerated illustrations and the murkiness of Haeckel's own writings that span decades, Richardson & Keuck (2001; 2002). Moving beyond the historical question to the current biological data, terrestrial vertebrates retain far more than just embryonic gill arches. For example, several superfluous branchial arches in the embryonic circulatory system, which "are no longer required to supply gills and must be modified substantially" during subsequent development, Müller (1996, 259), with illustrations of the features on pages 128 & 132. Similarly, "The formation of the empty yolk sac and a nonfunctional allantois [embryonic urinary bladder] in the mammal embryo can only be understood if the development of reptiles is inserted between amphibian and mammalian embryo development," Müller (1996, 125). Which may be compared to Denton (1985, 113): "In some ways, mammalian eggs are closer in their initial pattern of development to those of a frog than to any reptile."

There is conservation of developmental processes during the "phylotypic stage," although this does not preclude substantial internal variations. See Richardson *et al.* (1997; 1998) re such work as Burke *et al.* (1995) and Greco *et al.* (1996), Kirschner & Gerhart (1998, 8424-8426), Gilbert & Bolker (2001), and Arthur (2002). Cf. also Bininda-Emonds *et al.* (2003, 345-346) re Galis & Metz (2001) concerning the extent to which natural variations in that phase involve shifts in timing mechanisms (heterochrony, a subject explored further in chapter five). Methodological considerations also bear on the identification of embryological homology, Richardson & Verbeek (2003). A measure of theoretical ID curiosity in this area may be seen in Wells (2000a, 289) citing Richardson *et al.* (1997), who had criticized a simple concept of the phylotypic stage (in which somite elements were thought not to vary notably among vertebrates). Wells did not speculate *why* there might be such somite variation (or relate these findings to a design framework), which may be compared to technical evolutionary research in this area by Yamaguchi *et al.* (1999), Yoon & Wold (2000), Azevedo & Leroi (2001) and Morin-Kensicki *et al.* (2002).

[179] The whale reference in Miller's Letter 3 (November 23, 1996): "Curiously, you claim the fossil record is 'pervasively anti-Darwinian,' and demand 'common ancestors of the animal phyla.' Demanding specific ancestral forms from the oldest and rarest fossil formations is good strategy, but poor science. In fact, if evolution were incorrect, I should not be able to name any ancestors for modern animals. But, as you know, had you asked for the ancestors of horses, elephants, or whales the fossil record provides them in expanding abundance." Kenneth Miller (1999, 94-99) examined the elephant case in detail.

[180] The ellipsis and misspelling were in Miller's original (Letter 5, November 30, 1996); Kenneth Miller (1999, 315n) has the taxon accurately. We never do get a chance to learn whether Phillip Johnson can get the "h" correctly placed in *Rodhocetus*, since he has yet to discuss that animal.

[181] The passage concluded Johnson's Letter 6 (December 6, 1996). Leaving aside the renewed employment of the Skinner/Johnson Gambit regarding those Chapter 4 "details" in *Darwin on Trial*, there is a possible clue to Johnson's sources concerning his reference to *Mesonyx* as a whale ancestor. Had Johnson been aware of Gingerich *et al.* (1994, 845) the prominent mesonychid character there was *Pachyaena ossifraga*. Futuyma (1982) and Stahl (1985) had not discussed *Mesonyx* at all, while Denton (1985, 170) illustrated the creodont *Sinopa* as a proposed whale ancestor. Meanwhile, *Of Pandas and People* drew on Romer's 1966 *Vertebrate Paleontology* for its skeleton of *Mesonyx*; no page number was specified, but the picture appears in Romer (1966, 244). Considering Johnson's familiarity with the Dean Kenyon case, along with the star status given *Of Pandas and People* in the Intelligent Design community, this may have been a source consulted by Johnson when boning up on his mesonychid terminology for his reply to Miller.

[182] In his 1999 book, *Finding Darwin's God*, Miller explored how natural evolution relates to his own religious convictions. Going by Miller's articulate example, there seems no reason to believe full-blown "Darwinism" requires splitting the world along that "God or matter" divide Johnson insists on. There are certainly debatable points to Miller's position, just as there are with the extreme polarities of ontological naturalism and Johnson's foggy "theistic realism"—these issues shall be investigated further in the concluding chapter.

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[183] Miller in Letter 7 (December 6, 1996), with Miller (1999, 48-53, 103-111) for more on the creative power of natural mutation. When asked by Eugenie Scott in the "Firing Line" debate what he considered the primary problem for evolution, Johnson replied *mechanism*—see also Johnson (1997, 58). But his view of that has digressed far from working theory. Johnson (1997, 44) contended evolutionists use "bait and switch" tactics by employing "Vague Terms and Shifting Definitions." His example was *dog breeding*: "This is not a 'straw man' example, by the way. Selective breeding of animals is a process guided by intelligence, and it produces only variations within the species; yet Darwinists from Charles Darwin himself to the more recent Richard Dawkins and Francis Crick have cited it as a powerful example of 'evolution.'" At the 1998 Whitworth meet, as Johnson insisted how evolutionists offered dog breeding as their main evidence, I ticked off his repetition of it until I ran out of fingers. As we'll see shortly with the Eldredge-hominid case, Johnson appears to extrapolate isolated instances into a trend. In this case, Johnson (1997, 64, 126) deployed a single quotation from Francis Crick's 1988 book, *What Mad Pursuit: A Personal View of Scientific Discovery* (p. 29), where Crick recommended anyone doubting the power of natural selection should read Dawkins' remarks in *The Blind Watchmaker* "to save your soul." Johnson didn't cite Dawkins (1986, 40, 57) directly, but even the Crick bit concerned how little time it had taken to go from wolf to Pekinese. Dog breeding is thus a perfectly valid instance of one part of the process: how quickly selection can work. Dawkins hadn't used it as a stand-in for *natural* selection, which acts on the whole organism in a population, nor was it dropped as proof of what variations trigger speciation *per se*. Avise (1998, 103-104) is similar when he mentioned dog breeding as "another of my favorite examples of artificial selection," or Tattersall (2002, 40-45) on its constraints.

When it comes to Darwinian "speciation through natural selection" a lot more must be taken into account, which evolutionists routinely do: from genetic drift and sexual selection among related species, to gene duplication and developmental divergence apropos macroevolution. Examples run from essays in Eldredge (1987) to Barton (2001) on the *TREE* special of Barraclough & Nee (2001), Benton & Pearson (2001), Godfray & Lawton (2001), Hey (2001), Kondrashov (2001), Nichols (2001), Orr (2001a), Panhuis *et al.* (2001), Riesebereg (2001), Schluter (2001), Via (2001), and Turelli *et al.* (2001)—cf. Getz (2003) on the latter along with Porter & Johnson (2002). See also Schilthuizen (2001), Carlon & Budd (2002), Gould (2002a, 714-744), Rieseberg *et al.* (2002), Sáez *et al.* (2003), and Tautz (2003) on Doebeli & Dieckmann (2003).

Apropos canines, Zimmer (1998, 89) noted how breeders depend on "correlated progression" to artificially select traits like upturned snouts: "The extremes that dog heads can reach make clear how their features aren't fixed by some particular genetic map. They respond to any change in surrounding tissue, adapting to produce an organism that can still function as a whole." Variation thus doesn't require starting from scratch—parametric shifts can drag along correlated features, Lange (2002, 5-7) or Chase *et al.* (2002). But not according to Johnson (1997, 94): "Once the problems of informational content and irreducible complexity are out on the table in plain view, well-informed people are going to be amazed that scientists took so long to see that random mutation is not an information creator and that the Darwinian mechanism is therefore irrelevant to the real problem of biological creation." Abstracting this position even further, Johnson (1998a, 68-69) remarked that "I have seen people, previously inclined to believe whatever 'science says,' become skeptical when they realize that scientists actually seem to think that finch-beak or peppered-moth variation, or the mere existence of fossils, proves all the vast claims of 'evolution.' It is as though the scientists, so confident in their answers, simply do not understand the question." In furtherance of my own nominal understanding of questions, it would have been instructive to learn which scientists based their complete evolutionary argument on "the mere existence of fossils." Which is ironic, since creationists like Morris & Morris (1996a, 66, 209) act on the opposite principle: that fossils are inherently corroborative of the Flood.

[184] Johnson's Letter 8 (December 9, 1996), which slid into this peroration on what "they" are up to: "The public advocates for Darwinism approach their subject with a messianic zeal that contradicts their claim to be objective, dispassionate scientists. They reveal or omit evidence

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depending upon whether they think it will help them to convince the public. They rely heavily on ridicule, and on appeals to their own authority, to defend their position." Rather an apt *self-diagnosis*, as it happens. Meanwhile, Johnson (1993b, 163) stressed the kind and cuddly character of the Intelligent Design end of a debate at the 1993 AAAS annual meeting, remarking that Michael Ruse found "me and the other participants to be very likable people." Eldredge (2000, 134, 187n) similarly found Johnson to be "generally affable"—but then he also "grew to respect—and even like—Luther Sunderland" (of whose technical incompetence there is no doubt). I for one have never confused amiability with intellectual accuracy, and can discern no obvious correlation between a cheery disposition and veracity of opinion—or with brilliance of intellect, for that matter. Just as Kent Hovind's bouncy demeanor accommodates absurdly sloppy thinking, so too can one only marvel at the mental agility required for Duane Gish to contort and vault himself around the scholarly landscape. That Phillip Johnson has much the same teddy bear manner as Erich von Däniken in no way rescues the evident scholarly deficiencies of his opaque discussion of therapsids. As a practical matter, the selection pressure among successful apologists favors "pleasant" over "nasty" anyway, since really annoying people tend to put off as many as they persuade. I think most readily of that astringent atheist activist Madalyn Murray O'Hair. Before disappearing under mysterious circumstances a few years ago (apparently bumped off by a larcenous assistant who embezzled funds from her organization), she managed to drive one of her own sons into the arms of evangelical Christianity.

[185] Whether the third participant in the charade, David Berlinski, was actually familiar with the new whale finds was not revealed. Berlinski did press Eugenie Scott: "Could I ask you to give us your best estimate of the number of changes required to take a dog-like mammal to a seagoing whale?" The question took Scott aback, flustering that it was "absurd"—which response Berlinski obviously considered a triumph for his side. But the question *was* absurd, rather like asking, "How many ion charge clusters are there in a storm cloud?" It was not that evolutionists don't have quite specific ideas about what whale evolution entails, as Zimmer's summary above illustrated. But how does one convert that into a *quantity*? Berlinski seems to suffer from the same "physics envy" that afflicts Michael Behe—equating "real science" with numerical formulation. Since the anatomy of whale echolocation related both to breathing and diving, how many reductionist "changes" does that involve: one or three? When Berlinski swung the same brickbat at Kenneth Miller later in the debate, Miller proceeded to explore that very point. He suggested whales probably have fewer functional genes than the hundred thousand or so humans have, and considered it unlikely *all* of them would have required alteration—thus setting an upper limit of maybe 50,000 point mutations. (By the way, spread over ten million years that works out to one gene mutation every few centuries.) Miller appeared ready to whittle that figure down when Berlinski objected that he didn't want to know about genes … he wanted a number pegged to the morphological transformations—as though these somehow were independent of the alleles that encode for them. It was a fascinating confusion to watch, and reinforced why Berlinski can be an antievolutionist (but not a "creationist") who simultaneously believes the fossil record for macroevolution is terrible while conceding the solid representation of its most recent example, the reptile-mammal transition.

[186] The relevant time frame for this purported *Science* article would run from early 1994 (when the Gingerich/Thewissen discoveries became known) to the "Firing Line" airing late in 1997.

[187] Johnson (1998a, 88-89, 95).

[188] A similar round of unnecessarily vague attributions turned up in Johnson (1999): "A Chinese paleontologist lectures around the world saying that recent fossil finds in his country are inconsistent with the Darwinian theory of evolution." LaHaye & Noebel (2000, 80, 317n) reprised Johnson's comments (as filtered through an August 27, 1999 *Human Events* reprint). Frazier (1999) recounts an unsuccessful effort to identify this mystery scientist, and Johnson's stonewalling for fear that others might make trouble for him (an odd circumstance, as someone lecturing "around the world" would presumably not be doing so anonymously). Wells (2000a, 58, 278) claims to be the source for the story, but won't identify the scientist either—though talkorigins.org/faqs/wells/ pinned the venue to a Discovery Institute sponsored symposium in China. Interestingly, Chinese-born marine biologist Paul Chien sounded much the same in his 1998

Whitworth "Creation Week" given in the same chapel hall immediately following Johnson's "dog breeding" speech (notes 183 above & 69, chapter two). For circularity, Chien's interest in Cambrian paleontology was "ignited" by reading Johnson's *Darwin on Trial* (as noted in an online interview with Chien at origins.org/real/ri9701/chien.html).

[189] See Li (1997, 155-160), Zimmer (1998, 212-219), Pennisi (1999), Wong (1999a), Lou (2000), Gura (2000) and O'Leary (2001), and analyses in *Systematic Biology*: Gatesy *et al.* (1999), O'Leary & Geisler (1999), Shedlock *et al.* (2000) and Naylor & Adams (2001). Incidentally, one part of the artiodactyl connection rests on the presence of retroposons in whales, ruminants (such as cows) and hippopotamuses—but *not* in camels or pigs, Milinkovitch & Thewissen (1997) on Shimamura *et al.* (1997), Hillis (1999a) on Nikaido *et al.* (1999), and Nikaido *et al.* (2001). Li (1997, 340-345) explains the evolutionary implications of retroposons and other genetic "retroelements." The diagnostic catch here is *living*, for of course there is no mesonychid DNA to pull for comparison—and 90% of ungulate and 86% of cetacean genera are extinct, Luo (2000, 237). Fortunately, significant new fossils of pakicetids and early artiodactyls have illuminated their relation, Thewissen *et al.* (1998; 2001), Thewissen & Madar (1999) and Gingerich *et al.* (2001), with commentary by de Muizon (2001), Kenneth Rose (2001b) and Wong (2002c). It should be noted that mesonychids and artiodactyls are both specialized forms of the early ungulate condylarths, and remain close cladistic cousins, Thewissen *et al.* (2001, 280).

[190] Novacek (1994).

[191] As Barbara Stahl recounted, per note 167 above.

[192] For those of an internet persuasion, *Science* has an online search engine at their website. Unfortunately, that gizmo only accesses issues back to 1995. Another dead end for the scholarly trail follower.

[193] There was a similar revisionist sweep to Behe's recollection of his use of the 1990 legged *Basilosaurus* find. Behe declared that "In my entire life, I brought up whale fossils one time, at a conference at SMU in the early 90's, whose proceedings were eventually published. (The reason, I think, was that close to the conference the New York Times published a story on whales, and I just added some comments about it to my talk.)." The reader is invited to compare this with Behe's own text (per note 152 above) concerning his use of the *Washington Post* (or was it?) in his freshman "Popular Arguments on Evolution" course.

[194] Kenneth Miller practically threw up his hands in frustration at the "Firing Line" debate when he couldn't get Behe, Johnson, or Berlinski to acknowledge that their side had been wrong on this one, and that paleontologists had scored points in evolution's favor with these new whales. I can sympathize with Miller, having felt much the same way trying to get Johnson to discuss the therapsids at the 1998 Whitworth "Creation Week."

[195] Ironically, Chittick (1984, 121-122) and Hanegraaff (1998, 198-199n) rest their logical scruples on this point. As does D. James Kennedy (1997, 55): "The most basic of all rules of logic is the 'law of noncontradiction.' This is not a rule man created, although most of the great thinkers going all the way back to Aristotle recognized its fundamental truth. When God, the logos, created the universe, He set in motion the laws of noncontradiction as well as other natural laws. Because of this law, which springs from God's essential nature, the cosmos is logical and rational." Further instances of their "logic" arise in chapter six.

[196] Evidence that Johnson's scholarship has grown progressively sloppier (a most curious and perilous affliction for someone previously trained in the meticulous rigors of the law) comes from an essay that appeared in *First Things* (November 1997) and which was reprised in Johnson (1998a, 73). Remarking on the primacy of materialist philosophy for Darwinists like Richard Dawkins, Johnson pronounced, "That is also why Niles Eldredge, surveying the absence of evidence for macroevolutionary transformations in the rich marine invertebrate fossil record, can observe that 'evolution always seems to happen somewhere else' and then describe himself on the very next page as a 'knee-jerk neo-Darwinist.'" In a 1998 e-mail to me responding to my inquiries on the nature of speciation, Johnson likewise tossed off the Eldredge quote and added, "Yet Eldredge describes himself on the next page as a 'knee jerk neo-Darwinist.'" But the "knee-jerk" remark hadn't occurred "on the very next page" but *thirty pages earlier*. Nor was it precisely as

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Johnson quoted it, and when taken in context didn't much help his polemical point. Eldredge (1995, 55): "When lecturing to new audiences, I like to present myself as a 'knee-jerk' neo-Darwinian, at least when it comes to the matter of adaptation and natural selection. It's true enough, and comes as something of a surprise to some who suppose that I will promulgate some wild new theory to supplant traditional canon. People tend to equate punctuated equilibria with some alternate notion of how evolutionary change—adaptive evolutionary change—occurs."

[197] Johnson (1997, 59-61), citing Eldredge (1995, 95) for the "never seems to happen" quotation. Where the "pressure for results" passage occurred was not specified; it does not appear in *Reinventing Darwin*. Johnson's first use of the "never seems to happen" quote appears to have been in his 1995 review of Daniel Dennett's *Darwin's Dangerous Idea*. As reprinted in Johnson (1998a, 63), Johnson remarked that "Whatever is motivating Eldredge to give all that fervent lip service to Darwinism, it obviously is not anything he has discovered as a paleontologist."

[198] Johnson (1997, 61). This was probably the issue Kenneth Miller attempted to raise in his online debate with Johnson late in 1996 (and one may note how Johnson relied on newspaper accounts rather than any journal publications on the subject). Regarding his simplistic notions about species interbreeding, evidently Johnson was unaware of the niceties of "prezygotic isolation mechanisms," as explained back in chapter one by Francisco Ayala—and empirically confirmed among vertebrates in the "ring species" of gulls. As was pointed out in note 47 of chapter one, both Futuyma (1982, 155-156) and Denton (1985, 81-82) referred to this phenomenon, so Johnson was presumably potentially aware of the information. If he did know of it, he certainly hasn't moved on to apply these insights *to other instances*, again illustrating the reluctance (or inability) of creationists to draw meaningful comparisons.

[199] Johnson (1997, 61-62). The use of the "baloney" metaphor stems from a chapter title in Carl Sagan's *The Demon-Haunted World*: "The Fine Art of Baloney Detection." The further reference to Feynman was one of Johnson's more misplaced appeals to authority. Johnson (1997, 46) declared that the "best description I know of the qualities that make an expert trustworthy comes from the late great physicist Richard Feynman, one of the unquestioned heroes of modern science. If a teenager with a passion for science wanted to take one twentieth-century scientist as a model, he or she couldn't do much better than to pick Feynman." (A sentiment I can heartily second.) Johnson then quoted extracts from Feynman's 1974 Cal Tech commencement address ("Cargo Cult Science") which warned how proper reasoning depended on "a kind of leaning over backwards" when it comes to rigorously dealing with all relevant information, Feynman *et al.* (1985, 311, 313). Whereupon Johnson decided to play Plato to Feynman's Socrates: "Let's take Richard Feynman as our primary example of a truly scientific thinker and ask ourselves what he would say about the following statement by Carl Sagan." This consisted of a paragraph from Sagan (1996, 325) on how few Americans (9%) accepted the natural evolution of human beings "with no divine intervention needed along the way." Johnson (1997, 48) asked whether the 91% that reject this idea did so for no reason: "On that assumption, democracy is a farce," requiring the majority to be led like children by the "scientific elite." Johnson considered the other possibility was "that the evolutionary naturalists are the ones who believe what they want to believe, and they are likewise the ones who are less than assiduous in exposing themselves to contrary evidence. Maybe Carl Sagan ignored Richard Feynman's warning: 'The first principle is that you must not fool yourself—and you are the easiest person to fool.'"

Just a few snags here for Johnson's invocation of the heroic Feynman: among Feynman's far-ranging interests over the years were biology and anthropology, and his occasional references to these topics put him squarely in the evolutionary camp, such as considering "humans as animals that have evolved to this particular point." Nor was Feynman in the least religious, with views on the universe and God not noticeably different from Sagan's (Feynman was similarly inspired to criticize New Age beliefs because they often misapplied physics, his own home field). See Sykes (1994, 104, 107, 148-149, 249-251) for reflections on his philosophy by Feynman, family, and friends, and Richard Feynman, "Where the Two Worlds Tangle: There Is a Conflict in Metaphysics," Kurtz *et al.* (2003, 213-216) for his views direct.

Especially when he didn't know the answers, Feynman had a knack for knowing what the right questions were. He also showed not the slightest reluctance in voicing them—such as when he publicly dunked a piece of space shuttle O-ring into a tumbler of ice water during the *Challenger* disaster investigation to demonstrate its brittleness in front of some disgruntled NASA officials. So the absence of any critical remarks by Feynman on the logic of evolutionary theory is telling. Indeed, just how far removed his position was from the posthumous ventriloquist act Johnson put him through may be seen in the theory Feynman helped work out to explain how Darwinian natural selection accounted for the stasis observed in the fossil record (the problem explored by, among others, Niles Eldredge). Informed later by his collaborator that this work had already been done (with the same positive results), "Feynman was elated. 'Hey, we got it right! Not bad for amateurs!' As ever, what mattered to him was the pleasure of solving the problem *himself*. He didn't care whether someone else had solved it first," Gribbin & Gribbin (1997, 227). Johnson (1998a, 156) invoked Feynman once more in the preface to one of his articles (this time identifying him as "Richard Feinberg") about how "the way to advance in academic life is to learn to see what you are supposed to see, whether it is there or not." (There is no indication that Johnson considered this a self-portrait.) Given the discomfiture Feynman (1985, 258-259) once went through at a philosophical conference full of "pompous fools," one wonders what "Feinberg" would have thought of the uses to which his commencement address has been put.

[200] Where hominids come up at all, it is usually in relation to (surprise!) *human* evolution—not as the primary fossil prop for the general evolutionary concept. A representative survey may start with Simpson (1983, 211-215), which covered hominid fossils in barely five pages out of more than two hundred describing the fossil evidence for evolution. Gamlin & Vines (1986) discussed evolution almost exclusively from the standpoint of living organisms; while they mentioned the reptile-mammal transition, human evolution and their attendant hominid fossils were entirely absent. Whitfield (1993, 42-45, 178-181) restricted hominids to a section on human evolution, but investigated the gradualism versus punctuated equilibrium debate by marshaling the *fossil invertebrate* fauna of Lake Turkana (mentioned in note 9 of the Introduction). The Turkana mollusks came up via Futuyma (1982, 84) in the thirty-page chapter he devoted to the general fossil evidence for evolution (followed by a fifteen-page chapter on human evolution). Like Behe's biochemical focus, Phillip Johnson appears to have stationed himself before a localized keyhole of his own.

[201] The Research Notes in Johnson (1997, 125-126): "The quotation from Niles Eldredge about how evolution 'never seems to happen' is from the book *Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (New York: John Wiley & Sons, 1995), p. 95. I have often wondered how Niles Eldredge and Steven [*sic*] Jay Gould can come so close to repudiating Darwinism outright without realizing what they are doing. I think the answer must be that materialism has taken hold so deeply in their minds that they do not understand that it is extremely vulnerable to criticism if the 'blind watchmaker' mechanism is discredited." Johnson is not wont to entertain another alternative closer to home: that it is *he* who doesn't understand what is going on here. A relevant episode concerned Johnson's treatment of plant polyploidy. Gould (1992, 119) criticized Johnson (1991, 41) for stating "that polyploidy (as a result of doubling of chromosomes) can occur only in 'hermaphrodite species capable of self-fertilization'—and therefore can play little role in major change (for self-doubling does not yield markedly new qualities). But the evolutionarily potent form of polyploidy is not the autoploidy that he equates with the entire phenomenon, but alloploidy, or doubling of both male and female components after fertilization with pollen of a different species." The response by Johnson (1993b, 207-208) was unintentionally revealing: "True: even my diligent scientific consultants, who corrected many other mistakes before publication, missed this one. The footnote has been amended accordingly. Nothing of importance to the main argument turns on this detail. I do not think Gould would dispute the point of the footnote: whatever polyploidy may do, it does not explain the creation of new complex organs." At the 1998 Whitworth Creation Week, Johnson offered this as the only instance where he had to revise his text in the light of Gould's criticism. Which may be added to the burgeoning population of creationist straw men, since Johnson cited no evolutionist attributing "new complex organs" to

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polyploidy. Cf. Berra (1990, 14-15), Pennock (1999, 151) or Schilthuizen (2001, 103-107), where the topic is speciation. See also Knight (2002) on chromosome doubling; Simillion *et al.* (2002) or Kellogg (2003a,b) re Bowers *et al.* (2003) & Adams *et al.* (2003) on plant polyploidy; Nadeau & Sankoff (1997) and Amores *et al.* (1998) on *hox* polyploidization in early vertebrate evolution. Given Johnson's avoidance of these subjects, he may need to recruit a new gang of "diligent scientific consultants."

[202] Eldredge (1995, 223). Roger Lewin (1996) covers the theoretical controversy over whether natural selection functions at the group level. Cf. Gould & Lloyd (1999) on "adaptation across levels of selection."

[203] Eldredge (1995, 57). See Gould (1997e) for a similar view, and Gould (2002a, 800-801) on the stasis implications of two recent studies: Losos *et al.* (1997) and Reznick *et al.* (1997), that latter with commentary by Morell (1997). The conceptual difference may be seen when Dawkins (1986, 247-248) thought to minimize the import of species stasis by remarking on how freely internal variations develop—as though speciation were one of them.

[204] Johnson (1997, 114). He may have been thinking of Dawkins (1986, 230): "Both schools of thought despise so-called scientific creationists equally"—though Dawkins also maintained that "there is no difference whatever in the interpretations of 'punctuationists' and 'gradualists'" when it comes to "*major* gaps" like the Cambrian Explosion (Johnson's favorite fossil gap).

[205] Eldredge (1995, 77). Eldredge contends that species will react to environmental change first by "habitat drift" (moving), going extinct if they can't survive that way—and transforming into new species only if the luck of the genetic and ecological draw allows it. Another factor Eldredge (1995, 74) noted: "As has become abundantly clear, many sudden anatomical shifts in the fossil record reflect not evolution but migration from elsewhere of related, but different, stocks." The crux for Eldredge (1995, 67) is that species do not "routinely evolve themselves gradually beyond recognition." See Dawkins (1986, 264-269) for the opposing view.

[206] Eldredge (1995, 218). Steven Stanley was an early advocate of the proposition that Precambrian evolution was so lethargic because bacteria reproduced asexually, and Schopf (1994; 1999, 246-251) locates this shift as one of the two most significant evolutionary developments (the other being the appearance of photosynthetic cyanobacteria). With a subtle appreciation for the wonderful paradox of it, Schopf (1999, 246) summarized "Evolution's Goal Is to Avoid Evolving." I first encountered Stanley's seminal macroevolutionary views in the course of ferreting out the background to the frequent allusions to Stanley's work in Johnson (1991, 50-53, 59, 67, 84, 167, 175)—though one index listing for "Steven Stanley" turned out to have Stanley Miller as the subject, Johnson (1991, 102). Although Phillip Johnson has been uninspired beyond the "stasis" debate aspects of Stanley's work, I offer my considerable thanks to Johnson for inadvertently opening my intellectual doorway to Stanley (1981), which turned out to be a deft exploration of the role climate changes have played in macroevolutionary pulses.

[207] John Thompson (1999, 2117): "The most fundamental result from the past 30 years of study of the evolutionary structure of species is that many, possibly most, species are collections of genetically differentiated populations." The concept of *demes* was in the wind at least by the seminal systematics contribution of Simpson (1961b, 176-177). Eldredge (1995, 174-197) and Gould (2002a, 602-606, 644-652, 701-709, 881-885) discuss that and the newer term *avatars*, with Wakeley (2000) representing a technical application. Cf. Thorpe *et al.* (1996), Schluter (2001), Thorpe & Richard (2001) and Ogden & Thorpe (2002) on the related themes of "biotopes" and "ecotones."

Conceptually, a "static" species "B" may represent groups "aBc." Should "c" split as a new species, though, it is free to develop its own mix of *demes* and *avatars*, which might eventually stabilize as "bCd" or even "Cde." The potent thing about such branching is that variations "d" or "e" were *not* present in the ancestral population "B" (of which "C" used to be a peripheral part), but rather built on C's own diverging path of subsequent natural mutations. That's the difference between real world species variation and the static "microevolution" of antievolutionary mythology. To spot the difference it is necessary to investigate specific examples, not perpetually hover in the stratosphere muttering about "cyclical variation within the type." Drop down to the taxa

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themselves and you may see things like the radiolarian species (genus *Eucyrtidium*) that branched into two over a million years in the Pleistocene, illustrated in Simpson (1983, 172-173), that followed exactly the pattern described by Eldredge.

[208] Eldredge (1995, 122-123).

[209] Eldredge (1995, 151). Imbued "with the patterns of utter stability in marine hard-shelled invertebrate faunas of the Paleozoic," Eldredge (1995, 154) suspects "that little or no evolution occurs unless and until an extinction event occurs to shake up entrenched ecosystems." Cf. Wills & Fortey (2000, 1149-1150) on this issue.

[210] Eldredge (1995, 152-156) offered the appearance of modern scleractinian corals (replacing the extinct Permian rugose corals) and the post-dinosaur mammal radiation. Eldredge (2000, 52-54) explains how scleractinian corals were likely derived from sea anemones rather than as an offshoot of the rugose corals; cf. Rich *et al.* (1996, 135-136), Doyle & Lowry (1996, 245) and Stanley & Fautin (2001). Incidentally, there is a "map of time" aspect to this coral turnover, where the rugose corals disappear abruptly on one side of the divide while the scleractinian corals proliferate on the other in the mid-Triassic. As seen in the family distribution for the groups illustrated in Doyle & Lowry (1996, 35) there is a concurrent void separating the early and later terebratulid brachiopods. But there is no need to suppose that brachiopods were independently created again along with the scleractinian corals—clearly both "gaps" are due to the miserable early Triassic marine record where plate subduction has devoured much of what went on at the start of the post-extinction rebound. Cf. Rachel Wood (2002) on Devonian reef system extinctions. The mammal radiation in the Cenozoic is a more useful example, partly because vertebrates have experienced more ostentatious modification and the terrestrial fossil record for that shift is comparatively improved the closer you get to the present. The earliest mammals found are the least like contemporary models, and with no large carnivores or herbivores among the starting crowd the familiar modern forms took their good sweet time to make it onstage (25 million years for the Carnivora to achieve dominance, for instance). Nor was the path to these specimens a beeline of inevitability, as North American fauna during the Oligocene attests, where bears were the size of stocky foxes and camels resembled gazelles. See Christine Janis, "Victors by Default," in Gould (1993, 170-185, 194) for further details. The range of adaptive morphology for a major group like terrestrial mammals is partly a function of the ecological systems in which the organisms live. Tudge (1996, 116-118) has described these "ecomorphs," where specialized shapes emerge more or less independently of the ancestral lineage if the animal is to get by in a particular niche or lifestyle (whether herbivore, carnivore, or omnivore). Among the plentiful *ecomorphs* repeatedly cropping up among marsupial and placental mammals one may find "cats" (stealthy hunters who sprint for the kill at the end) and "dogs" (pack killers who pursue their prey to wear them out). To some extent, evolution has a tendency to *rhyme*. This understanding is reflected in the "what if" thought experiments evolutionists occasionally undertake, a charming illustration of which would be the extraordinary menagerie of "new dinosaurs" depicted when Dixon (1988b) speculated on where dinosaurs might have gone had the Cretaceous mass extinction not upset their world.

[211] Miller (1999, 102) hit on the same analogy from another direction, with a zoo's "lion and the lamb" exhibit requiring a continual supply of replacement lambs. See Kirchner (2002) and Vermeij (2002) for some of the constraints on adaptive radiations, and Raup (1994, 6761), Erwin (1998; 2001) & Jablonski (1998) on the delayed rebound rate after a mass extinction pulse. Johnson's misunderstanding of the extinction debate long predates his encounter with Eldredge. Johnson (1991, 57): "A record of extinction dominated by global catastrophes, in which the difference between survival and extinction may have been arbitrary, is as disappointing to Darwinist expectations as a record of sudden appearance followed by stasis." He stressed this supposedly anti-Darwinian extinction in a 1994 Stanford debate with William Provine (available at arn.org), recommending David Raup of the University of Chicago as his scientific source. By Johnson (1995, 83) this had hardened to: "many authorities now attribute extinctions primarily to freakish catastrophes, rather than to the hypothetical Darwinian process by which ancestors are supposedly being supplanted continually by better-adapted descendants." There were no references at all in Johnson (1995, 226-228), not even to Raup. Johnson repeated his claim on Hank Hanegraaff's

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"Bible Answer Man" show in December 2000 that "the dinosaurs, and indeed perhaps all extinctions, were brought about by catastrophic event." But just because there were severe dieoffs didn't mean a lot of gradual "Darwinian" extinction hadn't been going on the remaining 95% of the time. And Johnson could have been aware of this, having reviewed Raup (1991) for *The Atlantic* (February 1992), reprinted in Johnson (1998a, 41-47). It was Raup who pioneered the notion of "background extinction rates," and the mass extinction graph in Raup (1991, 80-85) offered a clue that not everything was necessarily taking place at the clusters—cf. Peter Ward (2000, 265) and note 6 of the Introduction. Johnson (1998a, 41) stressed that his review provoked letters to the editor that "were vehemently hostile, but Raup himself wrote to me privately and said I was right on target." Raup has been impressed with Johnson, Witham (2002, 69, 97-102), and does believe that "impact-caused extinctions may actually dominate the extinction record" (personal communication, 2003). Darwin abhorred the idea of mass extinction, and so in that sense Raup's evolutionary views are "anti-Darwinian." But it is of interest to take a look at those "vehemently hostile" letters to measure Johnson's gloss. There were six, of which only two emanated from scientists. None took aim at Raup's position, but were all very doubtful about how *Johnson* framed the debate. Even the three pithiest remarks were fairly tame, though—suggesting Johnson has something of a thin skin. Robert Michael Pyle of Gray's River, WA suggested in the May issue that Johnson was "a law professor slumming among scientists." In June, McGill University genetics professor G. A. C. Bell likened Johnson to that "tawdry band" of literary outsiders who periodically announce the Death of Darwinism (such as George Bernard Shaw or Arthur Koestler); cf. Peter J. Bowler, "Evolution," in Ferngren (2002, 228). When L. J. Marsh of Minneapolis described him in September as "pugnacious," Johnson rejoined: "Rare catastrophes can be fit into a Darwinian framework if we assume that natural selection was at other times killing off the less fit and preserving the most fit. Suppose, however, that extinctions nearly always occurred in catastrophes, and that the victims were as proficient as the survivors at flying, seeing, reproducing, or whatever. That is what David Raup is suggesting. But if ancient species that were relatively unproficient at flying or seeing did not as a consequence dwindle and eventually die out, then what sense does it make to say that 'natural selection' produced improved capabilities in their successors?" A lot of abstract supposing here, all wonderfully divorced from specific example … yet we know of one very famous animal "relatively unproficient at flying" that apparently went extinct independent of any catastrophe: *Archaeopteryx*. Such rarified disconnection from the data makes Johnson's concluding *Atlantic* sentence (p. 13) especially pompous: "Pressing awkward questions like this is not being 'pugnacious'; it is being scientific."

[212] Eldredge (1995, 79-81). He went on to interpret the gradual evolution of members of *Hyopsodus* covered by Gingerich (1974) and the Ordovician trilobites studied by Sheldon (1987) in that light, where marked subspecies variation occurred even when the species average appeared static, Eldredge (1995, 84). Sewall Wright was a geneticist with a pronounced bent toward mathematical theory, and was the first to delineate the pivotal idea of "genetic drift" (substantively refined since the 1960s by Motoo Kimura). Incidentally, the commentary on Sheldon by Maynard Smith (1987) was drolly titled "Darwinism stays unpunctured"—a dart directed at the rival "punctuated equilibrium" view. Cf. Gould (2002a, 684-688, 864-866, 872-874) respectively on Kimura's contribution to evolutionary theory, Lieberman's brachiopods and Sheldon's trilobites.

[213] Eldredge (1995, 131-132) mentioned the increase in human brain size over the past four million years as a real directional change in a population. Twenty-five pages later, Eldredge (1995, 157) made his second reference to human evolution: "There are clearly levels of severity in the interplay between extinction and evolution. Regional extinction can play an important role in species sorting sequences. This was evidently the case 2.8 million years ago when habitat disruption apparently caused the extinction of *Australopithecus africanus*, leading to the appearance of species of *Paranthropus* (an evolutionary sideline—one which produced no discernable increase in brain size) and *Homo habilis* (our own early progenitor, with a marked increase in brain size over *A. Africanus*.)" Eldredge (1982, 123-128) touched on human evolution, but turned to his own specialty of trilobites for further examples of intermediate forms. In his glossy coffee table book on evolution, Eldredge (1991a, 62-68) similarly explored hominid fossils—in a chapter devoted to

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human evolution, of course. When it came to defending the thrust of punctuated equilibrium, Eldredge (1991a, 53-55) again offered *trilobites*, noting the discernable evolution of the number of eye lenses in the *Phacops rana* group from the Middle Devonian and relating that morphological transition directly to the distribution of several *Phacops* species. Eldredge (1995, 147) alluded to this case when he stated, "In my *Phacops rana* lineage, I found two apparent instances of speciation, each involving only minor amounts of anatomical change." Now for Eldredge, a shift in the number of eye lenses in the animal was "minor"—but that was also over a quite short time span, which Eldredge (1995, 121) related to how most speciation bursts would not be captured in the fossil record. Thus "minor" shifts from one related species to another could still add up to major changes in the long term. To give some idea of what degree of genetic interactions may have been going on in the trilobite lens example, cf. Hafen *et al.* (1987) on mutations in the *sevenless* gene that eliminates the UV-sensitive form of retinular (R-cell) photoreceptors in *Drosophila*. These technicalities aside, there is additional irony in the fact that, if anything, punctuated equilibrium is more wedded to the interplay of random chance in evolution than ultra-Darwinism (which seeks to elevate the reproductive success of individual genes to a persistent creative force). Since the accidental character of paleontological turnover is as much a deduction from the evidence as fossil stasis, Johnson was being mighty selective about which of Eldredge's observations he elected to embrace.

[214] Eldredge (2000, 191n). That this was the only time he and Johnson faced off was noted in Eldredge (2000, 134). Johnson's intersection with D. James Kennedy's Young Earth crowd comes to mind (per note 1 of chapter one), and his lecture schedule (obtained from a Johnson website, origins.org/menus/pjohnson.html) tends to bear this out. Johnson had four bookings for May-August 2000, of which only one involved a college: a "God and the Academy" Conference at Georgia Tech. Whether it played out any differently from his 1998 Whitworth appearance, I can't say. But his remaining stints appeared unlikely to bump into anything so demanding as sauropod taxonomy: a "Christian Legal Society Banquet" and lecture at the Church of the Nazarene, in Indianapolis; a "Focus on the Family" teachers conference in Colorado Springs; and the "Cornerstone Christian Music Festival" somewhere in Central Illinois.

[215] Eldredge (2000, 191n). Incidentally, Calvin College was the bailiwick of Howard Van Till, retiring in 1997 after a somewhat bumpy tenure, Witham (2002, 116-122).

[216] I suspect that part of the typologists' problem is the seductive lure of the term "type" itself, which has a mundane general meaning that all too easily makes them think it also has some concomitant scientific content. If the Intelligent Design advocate had used neologisms instead, the reader would have likely spotted the lapse at once and hankered for a definition. For instance, declaring that "the Galápagos finches are all cyclical variations on the schnopnagel"—or "speciation is clearly restricted to the glosnerfob."

[217] Futuyma (1982, 151). Earlier on, Futuyma (1982, 60-61) illustrated the graded forms leading from sharks to rays. Incidentally, missing the point about what taxonomy entails lies at the root of Phillip Johnson's criticism of what he has dubbed "Berra's Blunder." Tim Berra (1990, 118-119) had used the gradual changes in the Corvette sports car as a familiar way to indicate how "selection" can produce "descent with modification" over time. Johnson (1997, 62-63) mistook this as an attempt to illustrate *natural* selection—and Pennock (1999, 260-261) subsequently turned the tables by arguing that Johnson had indeed been tilting at a "straw man." The essence of the Corvette example concerns the nature of classification, which may be applied to intentionally designed objects (from Corvettes to coronets) along with natural processes (geological strata or nebulae); cf. Edey & Johanson (1989, 51-52) on Coke bottles. The point that ought to have been at issue was how incremental modifications in a temporal sequence allow for meaningful taxonomical arrangement. What one does with that information afterward is another matter—though Phillip Johnson of all people has shown no enthusiasm for wrestling with the observed pattern of fossil change and explaining where the natural workings of speciation and developmental modification fail to account for them (from dinosaurs to synapsid reptiles). Instead, in the Research Notes on the Berra point, Johnson (1997, 126) disported that "I was at first stunned to learn that

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many evolutionary scientists do not understand the difference between common design and naturalistic evolution, even after I have explained it to them."

[218] Denton (1985, 132). *Evolution: A Theory in Crisis* need concede to no other creationist a knack for eluding geological context. Denton (1985, 136) affirmed: "But surely no purely random process of extinction would have eliminated so effectively all ancestral and transitional forms, all evidence of the trunk and branches of the supposed tree, and left all remaining groups: mammals, cats, flowering plants, birds, tortoises, vertebrates, molluscs, hymenoptera, fleas and so on, so isolated and related only in a strict sisterly sense." The bulk of these examples rested on the Bermuda Triangle defense (the origin of tortoises and vertebrates most obviously). Fossil ancestors for mammals and birds were hardly imaginary, nor was *Sphecomyrma* (linking two of the Hymenoptera, the wasps and ants). At the risk of sounding petty, I do have to wonder where and under what circumstances Denton would propose science recover an adequate fossil representation for *fleas*. Fleas do have "a questionable Cretaceous record in Australia," Rich *et al.* (1996, 235), but are otherwise no more likely to turn up in the available strata than any other soft-bodied animal of their miniscule size.

[219] Much as Creation Science flood theory hearkens back to outmoded geology, Denton's typology serves to revive the leaden pre-evolutionary views of Cuvier and Richard Owen. Recently Zimmer (1998, 20-21) remarked on the sad tale of the vertebrate "Archetype" Owen came up with ("a lampreylike thing" that "was the blueprint that God referred to as He guided the history of life"). Owen struggled in vain to figure out how the turnover seen in the fossil record actually occurred, but never went beyond proposing "secondary laws he simply called 'creative acts.'" Gould (2002a, 312-329, 1070-1076) contrasted the "European formalism" of Owen's Platonic "archetype" with the British "functionalist" tradition (represented, ironically, by both Paley and Darwin). See Ritvo (1997) for the fascinating philosophical and social background to the struggles going on in 19th century natural science as it tried to make sense of the overload of new taxonomical data before evolutionary theory sorted everything out. Eldredge (2000, 144-146) commented on another taxonomical aspect of designed objects—that they are often hard to organize into the sort of tidy hierarchical nests so characteristic of nature. Much as I have a penchant for playing cards, Eldredge happens to be "an expert in the history of design of the coronet," and that field manifests exactly the opposite characteristic of a Darwinian system. Unlike those "famous" schizochroal trilobite eyes from chapter two, coronets are definitely the product of intelligent design—which means improvements can be made without any deference to where the idea might have come from originally. The resulting murky taxonomy is exactly what doesn't happen in a Darwinian framework of "descent with modification," where changes can only be *inherited*, not *copied* (at least among multicellular organisms, since bacteria do have ways to trade genetic snippets, as indicated in note 110 above). Arduini (1987) argues similarly. This would explain why Behe felt more comfortable with bacterial flagella and the cellular bric-a-brac of the immune system than with whales: the fossil record of complex animals does not follow the pattern of designed systems. Hunter (2003, 128-132) is oblivious to this state of affairs, vaulting off his own limited familiarity with the taxonomical details to contend that the fossil record is replete "component systems" that confound evolutionary theory.

[220] Henry Morris (1985, 9) dropped down the same hole: "if all entities were truly in a state of evolutionary flux, classification would be impossible. In biological classification, for example, it would be impossible to demark where 'cats' leave off and 'dogs' begin." Naturally, Morris did not discuss all the cat-like and dog-like fossils, nor did his homological speculations spread to considering how similar structures can be used for *dissimilar* functions (three different versions of forelimb adaptation in flying vertebrates), or dissimilar structures for the *same* function (the different bat echolocation techniques). In this respect, the brief jab at homology in Morris & Morris (1996b, 239-241) was unadventurous. Had they wanted to explore the matter, the spread of the problem for mammals was available to the Morrises via Futuyma (1982, 77). "Most of the modern orders of mammals are represented by less specialized species as we go back in time, until when we reach the Paleocene, they become so unspecialized that it's harder and harder to distinguish one from another. The condylarths, for example, appear to be ancestral to various

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groups of hoofed animals; but the condylarths are similar to the creodonts, which appear to be primitive carnivores; and many of the creodonts could equally well be classified as insectivores." In contrast, Denton (1985, 105) treated the living world in as meat-and-potatoes a way as any Creation Scientist. "No one, for example, has any difficulty in recognizing a bird, whether it is an eagle, an ostrich or a penguin; or a cat, whether it is a domestic cat, a lynx or a tiger. Moreover, no one can name a bird or a cat which is in any sense not fully characteristic of its class. No bird is any less a bird than any other bird, nor is any cat any less a cat or any closer to a non-cat species than any other cat." Exactly like the Creation Science "kinds" mentioned in note 56 of chapter one, Denton has to leave out any discussion of fossil carnivores in order to keep his "cat" classification from getting fuzzy. Whether his choice of examples also means that "birds" and "cats" were themselves created "types," Denton did not volunteer. But it was interesting that he mixed two such disparate taxonomical categories in the same breath ("birds" comprising a whole class, while "cats" occupy a family), suggesting how arbitrary his choice of exemplars were. Is a "cat" any less a quadrupedal carnivore than a dog, or less a mammal than an elephant? Why then aren't mammals a "type" in which the variation from cat to Phillip Johnson is merely a matter of microevolutionary degree, much as aerial hunters like eagles and flightless aquatic penguins can safely reside in the "bird" category? That Denton's "typology" was ultimately a meaningless concept was affirmed in mime by his second book, Denton (1998), which dropped the whole subject completely.

[221] Denton (1985, 175-176, 211-213).

[222] Denton (1985, 180) suggested that, "The possibility that the mammal-like reptiles were completely reptilian in terms of their anatomy and physiology cannot be excluded." He then drew on a 1968 comparison of the brain size of the mammal-like reptiles with the earliest mammal known at that time, the Late Jurassic *Triconodon*, to conclude that their central nervous systems "were entirely reptilian." But *Triconodon* lived about *50 million years* after the first Triassic mammals (only discovered in the decades since, but certainly coming on the scope when Denton was writing)—whose features are so hard to disentangle from the late therapsids that the boundary between them is practically arbitrary. Denton also managed not to mention the other anatomical features (hair, more upright stance, etc.) that distinguished the later synapsids from their cousins, the anapsid and diapsid reptiles—points noted by Stahl (1985, 397-399). Incidentally, Denton (1985, 181) remarked that "many quite separate groups of mammal-like reptiles exhibited skeletal mammalian characteristics, yet only one group can have been the hypothetical ancestor of the mammals. Again, as with the rhipidistian fishes, the similarities must have been in most cases merely convergence." Here may lie the source for Phillip Johnson's spectral "other examples" mentioned in chapter two—though this claim doesn't help the *Darwin on Trial* prosecution either, since Denton was using "convergence" in an invalid manner (applying it to collectively derived therapsid characteristics rather than to ones of independent origin).

Denton (1985, 112-115) touched on a host of biological clues suggesting how developmental switches may have flipped to generate the mammal transition, but saw these again only as difficulties. For example, "The major vessel leaving the left ventricle in a reptile, which is the major vessel carrying aereated blood from the heart, is formed from the fourth right aortic arch, while in a mammal it is derived from the left aortic arch," Denton (1985, 113). Denton did not speculate about what he thought an intermediate form would look like here (the vessel forming from some *middle* aortic arch?) which might have clarified what role he was willing to grant the developmental process in macroevolutionary change. Incidentally, the genetics of axial asymmetry is still known only poorly, though research is proceeding for a most humane reason: whole body human organ reversals (*situs inversus*) occur in one of every ten thousand people, Coen (1999, 270-271), and can have serious health repercussions in Rieger's syndrome. See Ryan *et al.* (1998), Lin *et al.* (1999), Lu *et al.* (1999), Marszalek *et al.* (1999), Rodríguez-Esteban *et al.* (1999), Supp *et al.* (1999), Tsukui *et al.* (1999) and Schlange *et al.* (2002). Cf. also Henry Gee's online commentary (nature.com/nsu/980806/980806-7.html) and the biography of Rieger's syndrome researcher Michael Rosenfeld (hhmi.org/news/rosenfeld.html).

But more of a theoretical problem was Denton's implicit presumption that modern reptiles represent the ancestral layout from which mammals would eventually develop. Romer (1970, 408-

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414) had explicitly indicated the contrary, but Denton drew on this only for a Figure 317 (p. 411) illustrating heart layouts. While Denton retained most of the long caption for the edited figure he removed some of Romer's text noting how "The mammalian condition has apparently arisen directly from the primitive type preserved in the Amphibia, for in modern reptiles the conus arteriosus shows a division into three vessels, rather than two; one, returning venus blood back to the body, leads only to the left fourth arch. In crocodilians the ventricular septum is nearly complete, and the elimination of the left fourth arch would give the avian condition." (Denton did not discuss the crocodilian example, and deleted its heart layout from the illustration.) Romer (1970, 413) went on to explain "Mammal ancestry diverged from that of the reptiles at an early date, and there is no reason to believe that the system of three heart orifices seen in modern reptiles was ever present in the mammalian line."

[223] Denton (1985, 109-110). Denton argued that the lungfish's "gills and its intestinal spiral valve are one hundred percent typical of the condition found in many ordinary fish, while its heart and the way the blood is returned to the heart from the lung is similar to the situation found in most terrestrial vertebrates." The monotremes' reproductive system and eggs "seem almost fully reptilian, while where they are mammalian, as for example in the construction of their middle ear, or in the possession of hair, they are fully mammalian." Of the living onychophoran *Peripatus*, its circulatory and respiratory systems were "quite typically arthropod in their basic design, while its nervous system and excretary [*sic*] systems are quite typical of those seen in many annelid worms." To keep his typology intact Denton had to play adjective games as gymnastic as Michael Behe did with irreducible complexity. So it was "many" fish and annelids (not all?) … features "similar" to (but not *typologically* identical?) … organs of "most" vertebrates or aspects that are "almost fully" reptilian (are there exceptions?). Denton's particular failure to pay close attention to the fossil background put him in the same muddled category as Duane Gish, since the two "mammalian" traits Denton cited for the monotremes were specifically those traceable back through the therapsids—those extinct forms Denton preferred to sequester on the reptile reservation.

[224] See Simpson (1983, 164-165) on lungfish evolution, reporting his own 1953 analysis of a 1949 study of fossil lungfishes by Stanley Westoll, and the more recent perspective of Gould (2002a, 817-822). Honors for missing the point here might go to Colson & Pearcey (1999, 87-88), who drew on Pearcey's teacher (the late evangelist Francis Schaeffer) for the "devastating" contention that a fish could never have evolved lungs from gills because it would have been unable to breathe in the meantime. Problem #1: who said that lungs had to develop *from gills* in the first place? Problem #2: lungfish (which possess both lungs and gills) actually exist. Since Colson & Pearcey (1999, 499n) cited Michael Denton in another context, they could presumably have known at least this.

[225] Denton's biggest "discontinuity" is the same one Phillip Johnson relies on—the origin of metazoan *phyla* seen in the Cambrian Explosion—though it wasn't labeled as such in his book. Denton (1985, 125): "Even today zoologists find it impossible to relate the major groups of organisms in any sort of lineal or sequential arrangement. This can be seen in the evolutionary trees of the animal kingdom (see Figure 6.2) which were drawn up recently by contemporary zoological authorities. Not only are most groups placed peripherally, giving the trees a circumferential appearance, but many groups are so isolated and unique and of such doubtful affinities that there is complete disagreement as to where they should be placed in the tree. Notice particularly the very different positions of the groups Mollusca and Plathyhelminthes in each of the four schemes." Denton did not explore why such uncertainties existed or whether those disputes really helped his typological argument. Significantly, all four charts (pp. 126-127) concurred on the linked Hemichordata/Urochordata/Chordata complex. Even the two phyla Denton highlighted were not so misplaced as he made out, with mollusks appearing somewhere after plathyhelminthes (flatworms) but before the arthropod/annelid branch. Disagreement concerned how "primitive" forms like flatworms related to limited extant examples. There are only 325 living species of brachiopods, for example—compared to over 12,000 extinct ones, Marc Dando, "Marine Invertebrates," in Waller (1996, 183). Some inferences may be drawn for features like lophophore placement, detectable in the layout of their supports in the shell, Doyle & Lowry (1996, 188).

Brachiopod embryology has also recently been integrated into protostome development, Conway Morris (2000, 4, 8), Martindale & Kourakis (1999) & Gould (2002a, 1148-1155) on de Rosa *et al.* (1999) 18*S* ribosomal RNA sequencing suggests brachiopods lie at the root of a clade branching to flatworms and thence to mollusks and annelid worms, Knoll & Carroll (1999, 213-214). Goldstein & Harvey (1999), Adoutte *et al.* (2000), Gascuel (2000), Le *et al.* (2000), King & Carroll (2001), Lee (2001), Medina *et al.* (2001), Posada & Crandall (2001) and Simon *et al.* (2002) illustrate how genetic analyses affect the construction of rigorous phylogenies and the understanding of the evolutionary processes responsible for those relationships.

[226] The diagram in Denton (1985, 135) had "empirically known forms" in bold lines at the top, and a series of "hypothetical transitional forms" given in thinner lines running back from them. All that is perfectly adequate as a model for conventional evolutionary thinking. Denton's sizable omission was in giving the impression that the transitions were invariably "hypothetical," since we know of intermediate candidates *Evolution: A Theory in Crisis* managed somehow to overlook. Denton gave the same evasive spin to the chart he proffered for the whales, by the way, as previously mentioned in note 139.

[227] Denton (1985, 136).

[228] Denton (1985, 190) alluded to studies which indicated that fairly high proportions of living terrestrial orders and families are represented by some fossils. But Denton acted as though there were no temporal spread involved here. A modern carnivore may have a fossil record stretching back many millions of years, but the farther back you go the more you have to pay attention to specific geological limitations, which Denton of course showed not the slightest indication of doing, particularly in the aforementioned case of the whales. See Doyle & Lowry (1996, 34) for a pie chart indicating the relative proportion of fossil to living described species for various major groups (insects and worms are particularly poor).

[229] Denton (1985, 182): "Further, there is always the possibility that groups, such as the mammal-like reptiles which have left no living representative, might have possessed features in their soft biology completely different from any known reptile or mammal which would eliminate them completely as potential mammalian ancestors, just as the discovery of the living coelacanth revealed features in its soft anatomy which were unexpected and cast doubt on the ancestral status of the rhipidistian relatives." The coelacanth reference concerned the expectation that these "living fossils" might have retained some features revealing the transition to the early tetrapod amphibians. Denton quoted a paragraph from Stahl that began with the observation that "the modern coelacanth shows no evidence of having internal organs preadapted for use in a terrestrial environment. The outpocketing of the gut that serves as a lung in land animals is present but vestigial in Latimeria." As seen in note 111 of chapter two, Denton's quotation of Stahl was not always matched by the 1985 version, and the *Latimeria* quotation reads slightly different as well. Stahl (1985, 146): "the modern coelacanth shows no evidence of having paralleled other rhipidistian descendants in evolving internal organs preadapted for use in a terrestrial environment. The outpocketing of the gut that serves as a lung in land animals is present but vestigial in *Latimeria*." As I don't have the earlier edition of Stahl to compare, it is possible (though unlikely) that she had left out "paralleled other rhipidistian descendants in evolving." But in any event Denton was simply overlooking the much broader range of the fossil rhipidistians by holding up the isolated example of the surviving coelacanth as the test case.

[230] Morris & Parker (1987, 122). Parker frequently invoked Denton's authority on matters ranging from homology to molecular clocks, Morris & Parker (1987, 48-50, 54-55, 60-61, 99-100, 145-146). Similarly, Gish (1993, 315) cited a 1980 piece by Colin Patterson of the London Natural History Museum, which quoted Gareth Nelson on how cladistics was "rediscovering" or "fleshing out" pre-evolutionary systematics. This would have been news to the founder of cladistic analysis, Willi Hennig, who readily concurred with the principle that "macroevolution" not only occurred, but ultimately consisted solely of *microevolutionary* processes, Hennig (1966, 225).

[231] Wendell Bird (1989, Vol. 1, 144) submerged cladistics in a discussion of supposedly conflicting "Approaches to Macroevolution," maintaining that its "proponents refuse to use and in some cases reject macroevolution entirely." An explanatory footnote in Johnson (1991, 134) was only a tad

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less effusive: "Some Darwinists of the old school think that cladism predisposes the mind to think of evolution as a process of sudden branching rather than Darwinist gradualism, and a few cladists have said that, as far as their work is concerned, the hypothesis of common ancestry might as well be abandoned." Gish (1993, 317) opined that "evolutionary biologists despise transformed cladism!" Rather like bears to honey, antievolutionists have long been drawn to evolutionary squabbles over phylogenetic classification, going at least as far back as Henry Morris (1963, 87-90) on the Scientific Creationism side, though Morris & Morris (1996b, 35-37, 244) are more circumspect in alluding to cladism.

[232] Gee (1999) deftly surveys the cladistic revolution. The range of application and criticism run from the references in chapters one (note 59) and two (notes 133 & 193), through Simpson (1983, 169-170) illustrating how cladistic "parsimony" sorted out the evolution of the elephant family, to Dawkins (1986, 275-284) on the controversial theoretical side of cladism. Compare also Conway Morris (1998, 176-180) and Eldredge (2000, 202-203n).

[233] The Patterson affair started in 1979 when the paleontologist replied to a letter by Luther Sunderland asking why he hadn't put illustrations of any specific transitional fossils in a book Patterson had written on evolution. Patterson wrote that he hadn't included any transitionals because he didn't know of any, Sunderland (1988, 101-102). Davis & Kenyon (1993, 106-107), Paul Taylor (1995, 108) and Gish (1995, 349) invoked the Sunderland letter for the claim that Patterson didn't believe there were any transitional fossils in the more general non-cladistic sense. Patterson got in trouble again in 1981 when he spoke at an informal gathering of systematists at the American Museum of Natural History. Unbeknownst to the participants, an attending creationist taped the proceedings, and the transcript has percolated through the receptive antievolutionary community, as covered in Strahler (1987, 354-355). Gary Parker decided Patterson believed evolution "has been *falsified*," Morris & Parker (1987, 58). Wendell Bird (1989, Vol. 1, 152) highlighted the unflattering parallels Patterson found between creationism and evolution, such as when Patterson contended that evolution "not only conveys no knowledge but it seems somehow to convey *anti-knowledge*." Phillip Johnson (1991, 9) also drew on this "remarkable lecture" (whose "bootleg transcript" was circulated by "somebody") for the conclusion that both creationism and evolution were "scientifically vacuous concepts which are held primarily on the basis of faith. Many of the specific points in the lecture are technical, but two are of particular importance for this introductory chapter." The first was Patterson's provocative claim that evolutionists weren't able to identify anything about "evolution" that was "true," and the second concerned the supposedly shady character of the Darwinian mechanism. Cf. Sonleitner (1986, 12) here. Those currently impressed by Patterson's seeming apostasy include Bandow (1991), Ankerberg & Weldon (1998, 139) siphoning Johnson's account secondarily, plus YECers Taylor (1995, 115), Hanegraaff (1998, 33, 170n, 177-178n) and Thompson & Harrub (apologeticspress.org/docsdis/2002/dc=02-sa01.htm) contra Rennie (2002b). Patterson remains a favorite with Tom Bethell (1999b, 20) … trotting him out again in the February 2001 letters section of *The American Spectator* (p. 10) when replying to a conservative correspondent appalled at the magazine's publishing of the antievolutionary Wells (2000a). Concerning the context of the debate, the Research Notes in Johnson (1991, 157) said "I discussed evolution with Patterson for several hours in London in 1988. He did not retract any of the specific skeptical statements he has made, but he did say that he continues to accept 'evolution' as the only conceivable explanation for certain features of the natural world." The key to Patterson's discomfiture with the dethroning of ultra-Darwinist reductionism was briefly (if not inadvertently) touched on by Johnson (1991, 10) when he mentioned that "now, according to Patterson, Darwin's theory of natural selection is under fire and scientists are no longer sure of its general validity." Whether Johnson will fill in the wide but shallow shoes of Luther Sunderland when it comes to chatting up evolutionists without necessarily understanding what was being discussed, only time will tell. Incidentally, a 1997 piece by Lionel Theunissen (available at the Talk.Origins website) explored how Australian creationist Carl Wieland continued to field the Sunderland edition of Patterson's opinions. To clear matters up, Theunissen contacted Patterson in 1993, who explained the context of his views expressed in the 1979 letter and commented on the 1981 AMNH affair: "I gave a fairly rumbustious talk,

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arguing that the theory of evolution had done more harm than good to biological systematics (classification).” Cf. Nelson (1998) on Patterson’s legacy, and Stanley Weinberg (1980, 4) with Eldredge (2000, 17-18, 129-134, 187n, 208-204n) on the persistent Mr. Sunderland.

[234] *Reinventing Darwin* plainly defined the topic thus: “Species stasis—the observation that, once they appear, species tend not to accumulate much anatomical change throughout the remainder of their existence,” Eldredge (1996, 75). The examples in Eldredge (1995, 69-77) consisted of three invertebrate groups and one mammal lineage (Gingerich’s study). The invertebrates involved Lieberman’s aforementioned brachiopods and Sheldon’s trilobites, and one of marine clams by Steven Stanley. An irony here is that Eldredge applied his conception of species stasis as readily to vertebrate mammals as to his own invertebrate specialty, a point which Johnson overlooked entirely. Where the vertebrates excel is how their individually dull species tend to track into whole new taxonomical classes, retooling their internal anatomy and metabolism over several hundred million years to adapt back and forth from sea to land and air. By comparison, as Simpson (1983, 141-143) pointed out, the invertebrates are persistently conservative, originating new species (pardon the pun) at a snail’s pace compared to the vertebrates. Not that this has proven to be a bad survival strategy—compare the ridiculously durable cockroach or mollusk with the ecologically innovative (and extinct) pterosaurs and ichthyosaurs or their contemporary mammalian analogs, bats and whales, many of which are hanging on for dear life in their presently stressed environments. The point is that there are fewer counterparts among the invertebrates to the unique historical parade at the class level from fishes to amphibians to reptiles, and thence to the great split leading to the diapsid *Aves* and synapsid *Mammalia*. So if you want to discuss higher level macroevolutionary transitions, the vertebrates tend to be where the hot tickets are, and both Simpson and later Eldredge ended up offering bats and whales as macroevolutionary exemplars. Parenthetically, Eldredge (1995, 21) remarked that “we are only beginning to find early whales that could still locomote on dry land”—which observation puts him a strong bound ahead of Johnson when it comes to appreciating the intermediate cetaceans.

[235] Gary Parker in Morris & Parker (1987, 142-144) overlooked the typological connection in his gloss on the stasis debate. Milton (1997, 110-115) also failed to get the point. Like Johnson, Milton sought to use fossil invertebrates to undermine Darwinian evolution—and, as Johnson had, he never got around to explaining what sort of process he considered likely to account for the observed pattern of taxonomical turnover. But Milton at least had the saving grace of actually discussing a specific example, the extinct ammonites. Unfortunately his argument succumbed to the same Bermuda Triangle instinct of antievolutionists generally. Milton stressed how distinct the fossil taxa were even though internal variation was broader than the type samples he noted. But the increased shell spiraling characteristic of later ammonites would hardly seem to stretch selective adaptation much—indeed, Simpson (1953, 361) had even highlighted how seemingly saltational jumps in their inner ribs had actually continued a quite gradual increase that only seemed to jump because there was a brief gap in the deposition. Incidentally, Morris (1985, 80) had presumably stepped over this observation when authority quoting Simpson (1953, 360) on the frequent absence of “completely continuous transitional sequences” at various taxonomical levels. Morris did not indicate whether an *almost* “continuous transitional sequence” might satisfy his concerns.

Returning to Milton’s side of the debate, we need to recall that Milton is someone who rejects even that the Galápagos finches have differentiated as separate species. Naturally, none of these data were ever placed in a “map of time” context (understandable, given Milton’s eccentric young earth convictions). When the ammonoid superfamilies are plotted along a timeline there is an obvious sequential arrangement, where a few ammonite superfamilies squeak through each extinction pulse, diversifying into related forms—only to go through more bottlenecks at later extinctions, until they finally failed to make the cut, Simpson (1983, 145-147). But Milton had a different analytical approach, showing as much finesse as he had with sauropod dimensions and sedimentary deposition rates. To establish how elastic evolutionary thinking supposedly was, Milton traced the varied interpretations of ammonites offered by Darwinists in this century, even though reading works on planetary cosmology from the 1920s and 1930s would have been equally as dated and misleading. Scientific understanding develops according to new information, and the

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recognition of sexual dimorphism and the suture processes of cephalopod shells have changed the way ammonites are regarded today. Futuyma (1982, 85) pointed out concerning the Devonian phase of ammonoid evolution that "there is a perfect gradual series from the slightly curved, conical shell of the bactritids (which are not classified as ammonoids) to more and more tightly coiled, elaborate ammonoid shells. The suture pattern, too shows a sequence of gradually increasing complexity in several ammonoid groups." See Doyle & Lowry (1996, 164-166), Saunders *et al.* (1999) and Eldredge (2000, 50-52) on ammonite morphology and evolution—with Gould (1996c, 209-211) on their relevance to evolutionary "progress" and Ellis (2001b, 61-69) or Parker (2003, 65-70) on mysteries concerning their lifestyle.

[236] The practical creationist usage of "type" does indeed tend in this direction, and not only among the North Carolina grass roots pointed out in note 42 of the Introduction. Phillip Johnson (1998a, 68) cordoned off the effects of allowable change at the species level: "Not even the strictest biblical literalists deny dog breeding, finch-beak variations or similar instances of variation within a type." And in that renowned scientific publication the *Wall Street Journal* Johnson (1999) discounted the idea that new species might theoretically emerge among the Galápagos finches over the next few centuries were observed trends to continue—views reprised in Johnson (2000, 48). Cf. note 20 above. Creationist Lubenow (1992, 68) was aware of the uncomfortable implications of allowing speciation in the case of Neanderthal, which may have been a separate species yet still capable of some interbreeding: "the scientific word *species* and the biblical word *kind* are not the same and should never be used as synonyms." Meanwhile, Henry Morris (1985, 71) was willing to allow common ancestry among varieties, "possibly" for species, and "occasionally" at levels above that. Illustrative examples of which were not plentiful (counter reset: 0). Such vagueness has a long pedigree: among 19th century British cattle and dog breeders, *kind* was "a vernacular alternative for *family*," Ritvo (1997, 81).

[237] The eight trilobite lineages Peter Sheldon studied are a case in point, where Johnson paid no attention to what it meant that Eldredge (1995, 71-74) regarded six of them as falling within two "closely related stocks." Three involved the "secondarily blind" trilobites, which possessed a pair of long "genal spines" trailing prominently from their head shields; three more featuring more modest genal spines. Eldredge's discussion contrasted the (to him) peripheral tail segment variations measured by Sheldon with "the much more substantial anatomical differences" distinguishing those lineages. His point was that extrapolating their *low post-speciation wiggles* backwards wouldn't account for the range of their initial diversification. Eldredge's trilobite "stasis" was not a belief that those variations were somehow beyond the pale of natural fluctuation or common descent; cf. Fortey (2000b, 159-181). In this area, Doyle & Lowry (1996, 344-347) note the evident and gradual relatedness of two species within the *Ogygiocarella* genus. It is relevant to recall that Sheldon's studies covered 15,000 specimens from a single Welsh deposit spanning about 2 million years in the Ordovician. Only one of the eight lineages (*Ogyginus*) was on the scene at the start of the sample, though, disappearing later in the column; the remaining seven showed up at various points and again differed in temporal spread. Unfortunately, as detailed as this was, without possessing a much broader physical exposure of comparably graded adjoining slices (permitting documentation of whatever *demes* and *avatars* existed), it would be difficult to isolate which lineages (if any) were merging into their neighbors, or how quickly they might have been doing so. An indication of the scale of information that remains concealed in even the most intensive fossil samplings concerned Sheldon's further study of the *Cnemidopyge* lineage, pointed out by Doyle & Lowry, where progressively more internal fluctuations were revealed the more finely graded the available sampling interval was. Simpson (1983, 160) made a similar point on the Permian foraminifer *Lepidolina multiseptata* (whose increase in size was quite gradual)—as have Goodfriend & Gould (1996) in a study of Holocene snails, Kenneth Miller (1999, 44-45) on speciation in the diatom genus *Rhizosolenia*, and McKee (2000, 91-97) on vertebrate turnover pulses.

[238] Eldredge (2000, 122), a reprise of Eldredge (1982, 118). A taxonomical note from Doyle & Lowry (1996, 222): "Trilobites are variously considered to be a phylum of the animal kingdom in their own right, albeit forming part of a larger group of arthropods, or as a subphylum of the

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Arthropoda. In both cases, the trilobites are gathered into a single class, subdivided at the order level. Classification is based largely upon shell morphology." Trilobite diversity may be seen in Rich *et al.* (1996, 192-212) or the many plates in Fortey (2000b). Cf. Ellis (2001b, 44-51).

[239] Eldredge (2000, 122-123), reprising comparable text in Eldredge (1982, 118). "From my own work I can cite the trilobite genera (from the Lower Devonian of Bolivia): *Kozlowskiaspis—Metacryphaeus—Malvinella—Vogesina*, which are connected by a compelling array of intermediates," Eldredge (1981, 19). As far as I have been able to determine, no creationist has ever paid any attention to this trilobite evidence. That would include Gish (1993, 229-249, 251-366) criticizing Eldredge and Godfrey. More recently, Woodmorappe (2001b) skipped such matters in reviewing Eldredge's revamped *The Triumph of Evolution*. By the way, Woodmorappe also recommended Gish as someone who "ably refuted" Eldredge. Hunter (2001, 26-27, 68, 70-71, 76-79, 101, 149, 179-182n, 187n; 2003, 38, 54, 76-77, 104, 115, 155n, 157-158n, 161n) may take honors here for evading the most information, though. Restricting his outings to selectively quoting Eldredge (1980, 50) and Eldredge & Gould (1988) on the absence of "gradual change" in trilobites, Hunter freely mined Godfrey and both of Eldredge's anticreationist books for ancillary quotes without spotting the statements that belied his characterization of Eldredge's stance on whether anti-Darwinian "discontinuities" existed in the trilobite fossil record. Parenthetically, Eldredge's 1980 article related trilobite evolution to biogeography (a topic Hunter also skipped), and the 1988 item was a response to Maynard Smith's comments on Sheldon (re note 212 above).

[240] A few reminders on the "Map of Time" issue. Doyle & Lowry (1996, 173) pointed out something that by now shouldn't come as much of a shock: "The oldest confirmed octopods are known from a Cretaceous conservation Lagerstätte in the Lebanon." As for the temporal aspect, Eldredge (1995, 99) reminded his readers of the position that he and Gould had taken: "As against five to ten million years of stasis, we claimed that evolutionary change—tied up in speciation events—happens rather quickly. Here we are at the smallest level of resolution of geological time often (but not always) possible with the fossil record. Even tens of thousands of years are usually difficult to decipher in the fossil record. So our estimates of time required for speciation events were much hazier than out estimated average durations of species. I came up with the figure 'five to fifty thousand years,' which was consistent with some of the events we believed we had some direct data on from our own studies." Cf. Sonleitner (1987, 26). On that scale Sheldon's trilobites involved extraordinarily fine sampling intervals of 900 years or less, Doyle & Lowry (1996, 344). But that was for the intervals themselves, not the time in between, which averaged about 5000 years (thus still within the limits of resolution to theoretically detect some instances of speciation). And indeed several lineages showed changes in their tail ribbing Eldredge thought could have been either gradual evolution locally or the migration into the area of very similar cousins. Laurie R. Godfrey, "Creationism and Gaps in the Fossil Record," in Godfrey (1983, 206) on this sampling bias. Eldredge and Gould "agreed that a perfect fossil record *would* document morphological intermediates between species, but they suggested that many of these would exhibit relatively brief and geographically limited existences. Indeed, Eldredge had such a near perfect record of the evolution of the Devonian trilobite *Phacops*. It was a record of stepwise evolutionary change in only two brief intervals during a span of eight million years! One such interval was recorded in a single easy-to-miss quarry in New York State. This quarry contained perfect intermediates between the geographically widespread mother and daughter species. In effect, due to the realities of an *imperfect* fossil record, most such intermediates will simply not be sampled." Cf. Niles Eldredge & Michelle J. Eldredge, "A Trilobite Odyssey," in Eldredge (1987, 61-68). Such uncertainty is inevitable given how real species exhibit variant *demes* and *avatars* that can overlap among closely related species—the cutting edge of the "connect the dots game" of speciation. But would "types" show such overlap? I tried in my 1998 e-mail joust to get Johnson to examine Eldredge's discussion of Sheldon's examples in order to learn whether Johnson thought they were physically related or not (and thus whether they might have constituted "types"), but no dice.

[241] Eldredge (1995, 56).

[242] Then again, it is unclear how deeply Johnson plowed through Eldredge's book before reaching his interpretation. As with Weiner's reference to Johnson in *The Beak of the Finch*, it may be

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relevant that Johnson did not remark on the isolated personal sideswipe in Eldredge (1995, 103), where Johnson was nominated as one of those "of unmistakable creationist bent who profess simple disagreement with evolution." Incidentally, both there and in the index Johnson's first name was misspelled as "Philip" (like the famed contemporary architect of that name). Eldredge (2000) has corrected that spelling oversight.

[243] One may begin with Laurie R. Godfrey, "Creationism and Gaps in the Fossil Record," in Godfrey (1983, 209), who cited Eldredge's trilobite work and the Lake Turkana mollusks as "some of the best known cases" of morphological intermediates. Levinton (1992, 89-90) illustrated the shell modifications over 10 million years as the extinct Miocene scallop *Chesapecten* changed its anchoring habits, remarking that "The chain of ancestors and descendants in the strata is nearly unbroken." See Marc Dando, "Marine Invertebrates," in Waller (1996, 183-186) for the overall evolutionary trends in the shell layout of mollusks and cephalopods; Doyle & Lowry (1996, 169-179) relate the evolution of the shelled cephalopods to modification for internal buoyancy and balance. Except among creationists, discussions of transitional forms these days usually involves the gradual-punctuated debate, such as Doyle & Lowry (1996, 83, 214-215) on the shell changes in a Jurassic oyster and two Cretaceous echinoid lineages. The first two examples were more equivocal than the second echinoid case, where phyletic gradualism was directly indicated through the many known intermediates linking the starting and end genera. A study of variations in the Miocene-Pliocene bryozoan *Metrarabdotos* supported "punk eek," Jackson & Cheetham (1990; 1999), summarized by Kerr (1995a) along with studies of Miocene snails, and also by Gould (2002a, 784-789, 843-845, 867-870). The pattern was especially distinctive in that the static branch species of *Metrarabdotos* tended to have overlapping geographical ranges (a prediction of the punctuation model), as noted by Doyle & Lowry (1996, 341-343). However, the study period (3.5 to 8 million years ago) had sampling horizons separated by intervals running from 20,000 to a *million* years, thus not ruling out more gradual intermediate change were the horizons less coarsely graded. Doyle & Lowry (1996, 321) concluded that the eight case studies of microevolutionary change in fossil invertebrates (Ordovician trilobites, Silurian graptolites, Carboniferous rugose corals, Jurassic bivalves and ammonites, Cretaceous echinoids, and bryozoans) were about evenly split between those favoring phyletic gradualism and punctuated equilibrium. Another case of marine invertebrate gradualism would be the four successive species of the Silurian brachiopod genus *Eocoelia* that graded smoothly into one another (also over a 10 million year span), as mentioned by Simpson (1983, 160-161). Doyle & Lowry (1996, 192-197) again correlated the general evolution of brachiopod shell configuration with their marine environment. The evolution of graptolites is more difficult to study, since their frail internal anatomy seldom prevents their being squashed into a fossil blur. Even at that there are instances where the data are sufficient to trace ancestor-descendant modifications, such as a streamlining of the feeding aperture in the Silurian-Devonian monograptids, Doyle & Lowry (1996, 260-262). And the tiny bivalved crustaceans, the ostracods, showed "a decrease in size from the giants of the Palaeozoic; the number of adductor muscle scars has also been reduced, while the complexity of the hinge has increased," Doyle & Lowry (1996, 298). How such shifts might measure on the "typological stasis index" is, of course, considerably hampered by the lack of one.

[244] The view of Rich *et al.* (1996, 103) is typical: "Many a paleontologist has lived a long and useful life without seeing fossil flagellates, ciliates, or even radiolarians. But no one who deals with so-called invertebrates can afford to overlook the Foraminifera, whose name is commonly shortened to 'forams.' Not only are they the most abundant and best-preserved fossil protists; they also are the most useful of index fossils. No one knows how many oil wells they have helped locate or how many formations they have helped to identify and date."

[245] The radiolarian example mentioned above in note 207 (showing the "bCd" form of evolutionary change) followed the speciation pattern Eldredge described, but a more intricate relationship occurred in the evolution of *Globorotalia conomiozea* over about a million years in the late Miocene. "The main, temperate, populations display a gradual transformation of *G. conomiozea* during an interval of 0.2 million years, with all measured variables during the interval showing continuous and steady changes. This contrasts with populations in the peripheral, warm tropical

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sections which showed rapid transition to a new species, *G. pliozea*, within an interval of 0.01 million years. After speciation, *G. pliozea* exhibited morphological stasis for a further 0.6 million years. This suggests that at the Miocene-Pliocene boundary, the peripheral tropical populations of *G. conomiozea* became isolated from the main temperate populations, possibly by the separation of water masses, and that from this point the two main population groups adopted different modes of microevolution," Doyle & Lowry (1996, 86-87). The gradual evolution of the temperate *G. conomiozea* tracked through the intermediates *G. sphericomiozea* and *G. puncticulata*.

[246] Doyle & Lowry (1996, 84). Figure 4.7 tracked one species of *Globigerinoides*, followed by three transitional species of *Praeorbulina*, and concluding with two species of *Orbulina*. Another illustration in Doyle & Lowry (1996, 283) showed the main morphological change involved a shift from a clustered group of spheres to a single round shape.

[247] Right about this time Michael Denton and Michael Behe were burnishing Johnson's reputation on the dust jacket of *Objections Sustained*. Denton declared that "Professor Johnson combines a broad knowledge of biology with the incisive logic of a leading legal scholar to deliver a brilliant and devastating attack on the whole edifice of Darwinian belief." And Behe hailed Johnson as "our age's clearest thinker on the issue of evolution and its impact on society." A melancholy indeed—were it but true. Two years after reading of *Orbulina*, Johnson replied to a questioner on Hank Hanegraaff's "Bible Answer Man" show (December 2000) that marine invertebrates showed only "change within the type, there's no change of one thing step by step into something completely different." What he was expecting to see within the available time frame in those "lots and lots of fossils" was a Bermuda Triangle Defense point armchair paleontologists like Hanegraaff (or his listeners) were unskilled to appreciate.

[248] Recall from chapter two Johnson (1991, 79, 174) declaring that "If we are testing Darwinism rather than merely looking for a confirming example or two," *Archaeopteryx* "is not enough to save a theory that posits a worldwide history of continual evolutionary transformation," and how Hopson's discussion of the therapsids "does not qualify, or purport to qualify, as a genuine testing of the common ancestry hypothesis itself."

[249] Johnson has a long way to go in this "testing" department to catch up with the plucky Kent Hovind or Chuck Missler, who have offered sizable cash rewards to anyone who can "prove" evolution to them. While this may be compared to James Randi's standing offer of $1,000,000 for evidence of paranormal phenomena, it is difficult to tell what sort of "evidence" one could submit to persuade them. To grab Hovind's $10,000 booty (since upped to a cool $250,000) one must show "beyond reasonable doubt" that "the universe came into being by itself by purely natural processes (known as evolution) so that no appeal to the supernatural is needed." Hovind assured visitors to his website that "A committee of trained scientists will provide peer review of the evidence offered and, to the best of their ability, will be fair and honest in their evaluation and judgment as to the validity of the evidence presented." Whether "Dr." Hovind's compatriot "Dr." Carl Baugh may be among the august (but unnamed) adjudication committee is uncertain. Cf. Freske (1981a) on creationist (and geocentrist) R. G. Elmendorf's various cash rewards for "proof" of evolution (or that the earth moves).

[250] Johnson (1997, 43-44). Concerning the role of theorization in science, Johnson (1991, 12) epitomized the Intelligent Design double standard: "But consider Colin Patterson's point that a fact of evolution is vacuous unless it comes with a supporting theory." Thus the oxymoron of "creationist paleontology" is all too consistent with the absence of a productive theory on their part, abetted by the position that only naturalistic evolution requires "testing" anyway. Disposing of the positive evidence for "Darwinism" through perpetual counter-testing would be a terrible waste of time for people already convinced that a negative outcome was foregone. And with no theory of their own being put on the line (hence no need to find corroborating evidence), there is zero incentive for active experimentation or fieldwork. By the way, the inability to formulate a coherent testing policy troubles groups as disparate as astrologers, Dean & Mather (2000) … and deconstructivist literary critics of the Bible, Dever (2001, 15).

[251] Johnson (1995, 12). This view reappeared online re Ken Miller: "I'm not proposing another theory; I'm explaining why I'm not convinced by yours." David Berlinski took the same position in

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the “Firing Line” debate, as did Lee Spetner in a 2000 e-mail joust with Edward Max (available at both trueorigin.org & talkorigins.org). Or Richard Milton in “The Mysterious Origins of Man” special in 1996: “Some people have said to me, how can you criticize the theory if you can’t—if you don’t have something to replace it with. Well, I don’t accept that. If the emperor hasn’t got any clothes on, then the emperor hasn’t got any clothes on. It’s not my fault. It seems to me that if Darwinism is wrong, then somebody’s got to point the finger.” Paul Taylor (1995, 48) similarly quoted “Evolutionist” lawyer Norman MacBeth.

[252] The historical view in Thomas Kuhn’s seminal work on this theme, *The Structure of Scientific Revolutions*, particularly depended on recognizing how scientific theories tended to hang on in spite of the occurrence of anomalous evidence unless and until a viable replacement intruded to provoke a “paradigm shift.” Although Kuhn (1970) came up in *Darwin on Trial*, much as with his invocation of Richard Feynman (see note 199 above), Johnson was rather selective about what lessons to draw from Kuhn. The image of Renaissance scientists blinded by their philosophy was of obvious import, given *Darwin on Trial*’s insistence that contemporary evolutionists suffer from the same malady. So Johnson (1991, 121) offered that “Kuhn cited examples of visible celestial phenomena that were not ‘seen’ until the new astronomical paradigm of Copernicus legitimated their existence. If Kuhn had chosen evolutionary biology as a case study, he would have risked being denounced as a creationist.” Johnson’s glib assumption that such an analysis would have looked unfavorably on Darwin appeared to be independent of Kuhn’s own brief discussion of evolutionary theory. Kuhn (1970, 171) remarked how evidence “pointing to evolution, including the evolution of man, had been accumulating for decades.” But Johnson (1991, 184-185) snatched up instead the subsequent connection Kuhn (1970, 172-173) made between his own conception of the unpredictable turns in scientific thinking and the comparable absence of goal-directed processes in Darwin’s approach to nature. Curiously, Johnson did not say whether he agreed with this “Darwinian” view of scientific change or not. (Richard Milton and Vine Deloria have also played off Thomas Kuhn, though in different ways than Johnson, as will be seen in later chapters.)

[253] Johnson (1995, 12). Johnson passed through an interesting transitional phase before arriving at his 1995 stance on the nature of scientific theory. His 1993 Hillsdale essay presented this more equivocal (or conciliatory) version: “I am not suggesting that scientists have to change their rules about retaining and discarding paradigms. All I want them to do is to be candid about the disconfirming evidence and admit, if it is the case, that they are hanging on to Darwinism only because they prefer a shaky theory to no theory at all. What they insist on doing, however, is to present Darwinian evolution to the public as a fact that every rational person is expected to accept. If there are reasonable grounds to doubt the theory, such dogmatism is ridiculous, whether or not doubters have a better theory to propose,” Johnson (1998a, 27). The problem with this position was that in order to regard Darwinism as “a shaky theory” in the first place it would be appropriate to show that the “disconfirming” evidence really was of sufficient weight to offset all the *confirming* evidence that evolutionists have been particularly “candid” about presenting. As for the critical next step in the science game—proposing that “better theory”—the 1993 speech posed that, “if science never discards a paradigm until it is presented with an acceptable naturalistic alternative, then Darwinism’s position is impregnable within science,” Johnson (1998a, 31). But here a revisionist semantic trick has been played: slipping in that “naturalistic” to intimate that evolutionists would reject the creationist alternative solely because of its refusal to be a materialist process. But we know that evolutionists haven’t been faced with the choice of dismissing a scientifically rigorous “creation hypothesis” for any reason, good or bad—simply because creationists of all stripes have yet to put forward one. Apart from the generalized Genesis account favored by Creation Scientists, the nebulous “the Creator creates” folderol of Johnson’s Intelligent Design has no technical substance beyond Behe’s “irreducible complexity.” Regarding the reptile-mammal transition, for example, one presumes there would be created “types” involved, which arrived in some temporal sequence, and would be distinguished from one another on some typological basis. That level of discourse would be exciting to see, to be sure, but in the absence of that, Johnson should have refrained from predisposing what approach evolutionary naturalists would take in criticizing it.

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[254] Somewhat schizophrenically, Johnson (1995, 49) wrote that "The strongest argument against my position is that science is based on naturalism, and the success of science has proved that naturalism is, if not absolutely true, at least the most reliable way of thinking available to us." That was as far as his analysis went on that point, however.

[255] Johnson (1995, 91), citing Steven Weinberg (1992, 247-248). I do wonder, though, just how atheistic one must be to qualify as a "very atheistic" personage?

[256] Johnson (1995, 91-93). A note in passing: once more Johnson has jumped off the wrong teleological bridge in supposing that the blind watchmaker "ought to have been satisfied with cockroaches and weeds." A purely naturalistic process cannot, of course, be "satisfied" (or *dissatisfied*) with anything occurring along the way—it being the whole point of unguided evolution that whatever *can* happen *will*, since there is no foreordained game plan in place to prevent it. Although dinosaurs hogged the land for a hundred and fifty million years, natural selection shall be neither bored nor offended by this condition, any more than gravitation would experience remorse over the damage wrought should an asteroid impact upset the ecological status quo. Indeed, with cyanobacteria playing that monotonous starring role for over a *billion years*, it would seem the proposed Intelligent Designer was just as "satisfied" with that leisurely operation as the Blind Watchmaker is accused of regarding "cockroaches and weeds." In this respect, perhaps Johnson needs to recalibrate his geological watch.

[257] Steven Weinberg (1992, 247). Incidentally, Johnson (1995, 15) continued to skate nimbly around the limits of speciation, biogeography, and so on: "There is no question that evolution of the Darwinian kind occurs, in the sense that types of living organisms have a certain capacity for variation. This is a process commonly called microevolution, and it accounts for such things as the variant characteristics of plants and animals that have been transported to an isolated island environment. The problem is that there is no evidence for, and very much evidence against, the Darwinian assumption that some similar process of step-by-step gradual change produced the basic body plans of plants and animals in the first place or brought about the existence of complex organs like wings and eyes. Conceivably there was some mysterious process by which later groups grew out of earlier ones, but if so, we know very little about it." For a reality check: by 1995, regulatory genes like *homeobox* and *Pax-6* were under active investigation; Marden and Kramer had reported their work on gill flaps as a precursor to insect flight; and the maniraptoran connection to the avian wing was on the hot paleontological burner. None of this rather relevant information has made it through Johnson's impermeable intellectual membrane.

[258] Steven Weinberg (1992, 248)—for once, the italics are mine. See Harold I. Brown (1986), Weinberg (1992, 91-106, 169-170) or Barrow (2000, 115-122) for the wrinkly parts of Newtonian cosmology, and Albert (1986), Sonleitner (1986), Sokal & Bricmont (1998, 64-71) or Martin Gardner (2001b; 2003, 12-18) on the limits of Karl Popper's falsification view as applied by Creation Science or in science generally. There is some circumstantial evidence that Newton tidied up a few minor variables *a posteriori* to better conform his calculations to later observation, Kohn (1986, 36-39). Newton's acceptance in Europe was not instantaneous, with the Germans hanging on until after the 1720s … and the French filtering things through a secularist sieve, Ronald L. Numbers, "Cosmogonies," in Ferngren (2002, 234-244). While some of the concern turned on such problematic features as "action at a distance," later scientists like Laplace were able to announce that Newton's wonderful three laws of motion assuredly accounted for all the physical history of the cosmos. All of which danced around a serious theoretical problem, which was that Newton's calculations required the simplification of gravitational interaction to two bodies (comparatively small earth orbiting really big sun, for example). Trying to calculate precisely what would happen when more than two bodies ran into one another (especially if they were of more similar mass) was not simply difficult—it was *impossible*. Cf. Wolfram (2002, 972-973). Had Phillip Johnson lived in the 17th century and ill-disposed to the magical mechanistic force of "gravitation" that Newtonians were proposing to govern the entire universe, the inherent insolubility of the "three body problem" would have been right up his alley.

[259] The search for Neptune was also plagued by personal and scientific rivalries, Standage (2000). Tyson (2003) covers the fruitless years searching for the trans-Neptunian "Planet X." Some

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nomenclatural tidbits: astronomers naming the new 7th planet after its discoverer Sir William Herschel (who wanted it "the Georgian planet" to honor his patron, George III) were overruled by the tradition of calling them after Greco-Roman deities. This has delighted generations of cocky adolescents dragged on planetarium outings, playing off the unavoidable homonymic English ambiguities of *Uranus*. The first two letters of Pluto afford a way to honor Percival Lowell, whose quest for Planet X fared no better than his Martian canals. See Abell (1973, 217-221) or Patrick Moore (1983, 118-121, 125-126) on planetary discovery and nomenclature.

[260] Not that Johnson is alone up on the creationist tepuí in decrying how modern evolutionary thinking has been the bane of genuine scientific progress. Duane Gish's downbeat opinions on this topic may be recalled from note 111 above. We have Chittick (1984, 115): "Rejection of creation and acceptance of evolution started a general moral decline, and it has affected science as well. Science began to die." Behe (1996, 231) opined: "The theory of intelligent design promises to reinvigorate a field of science grown stale from a lack of viable solutions to dead-end problems. The intellectual competition created by the discovery of design will bring sharper analysis to the professional scientific literature and will require that assertions be backed by hard data. The theory will spark experimental approaches and new hypotheses that would otherwise be untried. A rigorous theory of intelligent design will be a useful tool for the advancement of science in an area that has been moribund for decades." Such exuberance presumably inspired Hunter (2003, 122) to insist that "evolutionary theory, not ID, stifles research."

Muncaster (1997, 6) went so far as to declare that "informed microbiologists now almost unanimously reject *Macro*evolution." (What, he's conducted a survey?) Then there's J. P. Moreland, "Response to Robert C. Newman," in Moreland & Reynolds (1999, 143): "Various Christian and non-Christian scholars have claimed that evolutionary theory is in a period of crisis precisely because it is a dead-end research program if judged by its fruitfulness." Moreland's resources for this consisted of Denton (1986) and Moreland (1994a), which coincidentally just spanned the time between when Denton described the implausible whale intermediates and their unfortunate discovery in Pakistan by those "dead-end" evolutionary paleontologists. Creationists do have this problem with *timing*.

[261] Mayr (1991, 146): "Any scientific revolution or synthesis has to accept all sorts of black boxes, for if one had to wait until all black boxes were opened, one would never have any conceptual advances." Which Niles Eldredge (2000, 193n) found out the hard way: "I once gave a talk at a meeting of the New York metropolitan chapter of the scientific 'fraternity' Sigma Xi, at an IBM research center. Most of my audience consisted of physicists, chemists, mathematicians, and computer experts. I was describing some of the current debates within evolutionary biology, and in so doing I made probably the most naïve statement I have ever uttered in a public forum: I said, in effect, that the fact that evolutionary biologists tend to argue so much with one another probably sounds strange to people working in the physical sciences. That remark was met by an embarrassing gale of laughter. The audience thought it was hilarious that I would suggest that physicists, chemists, and mathematicians routinely agree on their formulas and other expressions of their scientific conclusions. This was years ago, and I was guilty of assuming, as many people routinely do, that the physical sciences are more precise, and therefore less prone to argumentative discourse and profound disagreement." An assumption plaguing Phillip Johnson, where the *results* of the science are somehow disconnected from the *method* used to obtain them. Thus Johnson (1997, 90) opines: "Quantum mechanics unquestionably *works*, but whether and in what sense it can be said to be *true* has just about everyone baffled." Of course, Johnson's interpretative framework is—to say the least—specialized: "Truth (with a capital *T*) is truth as God knows it. When God is no longer in the picture there can be no Truth, only conflicting human opinions," Johnson (1997, 89). But if Johnson is under the impression that contemporary physics is immune from "black box" appeals to unresolved mechanisms and fact-theory mismatches, he may consult Rothman & Sudershan (1998, 11-14) or Devlin (2002, 63-96). Max Planck's "famous black-body theory of radiation" neatly employed oscillations without saying what it was that was oscillating! The quantum model of the atom triumphed even though "the frequency of the hydrogen lines did not exactly fit [Niels] Bohr's formula." More recently, the Mass Gap Hypothesis in Grand Unified

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Theory (GUT) has lunged past a strict mathematical proof for the Young-Mills equation. Which presents an irony: modern PCs owe their existence to the solid state physics built on quantum theory. Had Theistic Realism been on hand to nip that spate of surreal hypothesis formation in the bud, there arguably would never have been an Internet on which Johnson and I might exchange vituperative e-mail. Deloria (1999, 68) missed that side of modern physics too when he opined that "Science is thus terribly complex and sophisticated about minute particles that are irrelevant to just about everything we do or want to do." This may be kept in mind the next time anyone cares to contact Deloria's publisher at fulcrum-books.com.

[262] The NABT allusion was to a 1995 National Association of Biology Teachers resolution that "The diversity of life on earth is the outcome of evolution: an unsupervised, impersonal, unpredictable, and natural process of temporal descent with genetic modification that is affected by natural selection, chance, historical contingencies, and changing environments." Larson & Witham (1999, 91) recently explained that, "Two reputable scholars, religious historian Huston Smith and philosopher Alvin Plantinga, suggested that the board drop the words 'unsupervised, impersonal,' to save biology teachers the grief of having to defend them. The board voted down this proposal. Then, with only hours to spare, [Eugenie] Scott persuaded the board to reverse itself. NABT director Wayne W. Carley said the change was good, honest science. 'To say that evolution is unsupervised is to make a theological statement.' But the vote came across in the popular press as scientists kowtowing to creationists, and thus began what Scott calls '*l'affaire* NABT.' A counter group of biologists disparaged her concern for public relations, insisting that indeed evolution *is* unsupervised and impersonal." Phillip Johnson's view of the NABT flap may be examined in Johnson (1998a, 85-92). My own take on the matter is that the text should have read that evolution was "an *apparently* unsupervised, impersonal" process. If the available paleontological record does represent meddling, then the responsible intelligence has contrived one darned good imitation of one that isn't supervised.

[263] Johnson's antipathy for evolution began from the top down, as indicated in Johnson (1998, 9) or Witham (2002, 65-70). By reading theorists like Dawkins or Gould rather than establishing a familiarity with the paleontological characters first (my own ground up experience with the dinosaurs), Johnson has been sliding along a truncated learning curve. To what extent the legal way of thinking has played a part is uncertain, though Eldredge (2000, 197-199n) does reflect on the antievolutionary proclivities of lawyers Norman Macbeth, Wendell Bird, as well as Johnson. Legal reasoning is not necessarily "scientific," of course, since the two are aimed at different targets: *justice* for the law, and natural *truth* for science. But while a perfectly legitimate body of case law could be founded on patently absurd assumptions, such as an import regulation treating elephants as a form of broccoli, no "science" worthy of the name would countenance so jejune a taxonomy. Both the practice of applied science and the law also veer around absolute morality depending on circumstances. Nuclear weaponry and genetic engineering are by no means "value neutral" concepts, but neither is the law invariably wedded to lofty moral precepts. The Dred Scot decision on runaway slaves in antebellum America was constitutionally perfectly valid, even if morally reprehensible (and politically imprudent to boot, since it did nothing to stem the tinderbox anxieties that flashed into Civil War a few years later). When it comes to the possible role of legalistic circumlocution in Johnson's way of thinking, Pennock (1999, 210-212) has related Theistic Realism to that most lamentable of contemporary scientific social diseases: postmodernist relativism. Pennock (1999, 210) contends that Intelligent Design proponents like Johnson "are relativists about natural human knowledge, and they therefore think science is rotten to its core because it claims that its naturalistic method can discover objective empirical truths. Their strategy, therefore, is to be quiet about the specifics of their own alternative and to seek out scientific discontents, inciting them to a political revolution—an overthrow of scientific naturalism itself—claiming that conditions will be improved once 'theistic realism' is the ruling paradigm and 'theistic science' is in control of knowledge. This is the classic postmodernist approach, for which truth is just politics." Walter Olson detects a similar pomo strain to ID in "Dark Bedfellows" (January 1999, at reason.com/9901/co.wo.darkbedfellows.shtml). But just as the practical methodology of Theistic Realism intersects that of philosophical opponents like B. F. Skinner, Johnson as easily

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objects to the conclusions of postmodernist analysis—which turns out to be as mixed a company for him as the dreaded Darwin-Marx-Freud-Skinner quartet. With "the very influential philosopher" Richard Rorty rejecting "objective truth or an objective difference between right and wrong," Johnson (1997, 91) warned: "It is no good for parents to try to protect their children from the influence of thinkers like Carl Sagan or Richard Dawkins or Richard Rorty. The prominent modernist and postmodernist thinkers embody philosophical currents that permeate academia and the media at every level—in television series like *Star Trek*, for example." Johnson really must be kidding. *Star Trek* does reflect contemporary scientific thinking (from advanced physics to the evolutionary biology that so exercises him) and tolerance for the diversity of sentient beings (and their disparate beliefs) is certainly at the core of "Federation" philosophy. But when it comes to digging in one's heels in defense of absolute rights like freedom, dignity, and self-determination, *Star Trek* commanders have been downright notorious when it comes to "setting things right" (not infrequently commandeering starships in furtherance of the deed). One would be hard-pressed to find fictional characters equipped with more defined moral compasses than those of Kirk and Spock from the original series, or Picard, Sisko, Janeway and Archer in subsequent outings.

[264] Lewontin (1997, 29).

[265] Lewontin (1997, 31). Lewontin wryly recalled when "at the time of the moon landing, a woman in rural Texas was interviewed about the event, she very sensibly refused to believe that the television pictures she had seen had come all the way from the moon, on the grounds that with her antenna she couldn't even get Dallas. What seems absurd depends on one's prejudice. Carl Sagan accepts, as I do, the duality of light, which is at the same time wave and particle, but he thinks that the consubstantiality of Father, Son, and Holy Ghost puts the mystery of the Holy Trinity 'in deep trouble.' Two's company, but three's a crowd."

[266] Johnson (1997, 81), in the chapter following the one on "critical thinking" where he offered Eldredge's invertebrates. Johnson (1998a, 67-70) hit the same themes (including the Eldredge claims) in an essay reprinted from *First Things* (November 1997). The frame here was that "Lewontin eventually parted company with Sagan over how to explain why the theory of evolution seems so obviously true to mainstream scientists and so doubtful to much of the public," Johnson (1998a, 69). Lewontin's "views on the relation of evolutionary theory to atheism" surfaced again in Phillip E. Johnson, "Reflection 2," in Moreland & Reynolds (1999, 267-271). Bethell (1999b, 20) and Colson & Pearcey (1999, 96) sound very similar.

[267] Like Eldredge and examples of gradual natural selection, Lewontin didn't reprise his 1964 argument, as Johnson (1997, 68) duly noted. Lewontin first met Sagan at the Arkansas creationism debate with Henry Morris—cf. Witham (2002, 215-215). Lewontin (1997, 28) did explain that "Sagan and I drew different conclusions from our experience. For me the confrontation between creationism and the science of evolution was an example of historical, regional, and class differences in culture that could only be understood in the context of American social history. For Carl it was a struggle between ignorance and knowledge, although it is not clear to me what he made of the unimpeachable scientific credentials of our opponent, except perhaps to see him as an example of the Devil quoting scripture." Johnson (1998a, 68) asked, "How could the theory of evolution even conceivably be 'proved' to the same degree as 'the fact that the earth goes around the sun'? The latter is an observable feature of present-day reality, whereas the former deals primarily with nonrepeatable events of the very distant past. The appropriate comparison would be between the theory of evolution and the accepted theory of the *origin* of the solar system." A historically debatable point, as it happens—especially given the scientific rules Johnson would like to play under. We "observe" the sun "rising" on the horizon, exactly as it did in Aristotle's day when geocentrism was the accepted reality. It actually took a lot of clever inferential thinking (and a new rival heliocentric theory of superior explanatory power) to change the interpretation of what was "seen"—though not without some bumps along the way, as pointed out in note 2 of chapter one regarding Kepler and circular orbits. Johnson also did not pursue his own analogy to the next step: is the naturalistic origin for the solar system (something Duane Gish would strenuously object to) methodologically distinguishable from the reasoning underpinning that brand of naturalistic evolution both Gish and Johnson assail? Much like Michael Behe and his precision acceptance of

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certain forms of biological modeling and theory, there is a "selective irreductionism" to Johnson's desire to have some scientific ideas really be historically settled and uncontroversial, even though everything about Theistic Realism pulls the rug from under that cheery hope.

[268] Johnson (1998a, 70), drawing on Lewontin (1997, 30-31): "Lewontin laments that even scientists frequently cannot judge the reliability of scientific claims outside their fields of specialty and have to take the word of recognized authorities on faith. 'Who am I to believe about quantum physics if not Steven Weinberg, or about the solar system if not Carl Sagan? What worries me is that they may believe what Dawkins and Wilson tell them about evolution.'" Incidentally, Johnson ran perilously close to colliding with his own logical caboose here, since Lewontin was effectively agreeing with him that Richard Dawkins and E. O. Wilson have been extrapolating their genetic views beyond the evidence. As with his finicky reliance on Gould or Eldredge, Johnson remains otherwise averse to every other class of evolutionary evidence Lewontin might hold to be entirely factual. Again, we have the methodological disconnection of opinion and philosophy from the technicalities that might be used to support one or another position. Johnson is obviously far more comfortable skating around on the philosophical ice than penetrating the cap to see what incriminating fish may be found.

[269] Ironically, Barry Lynn arrived at a similar conclusion unprompted during the "Firing Line" debate, after both Johnson and Bill Buckley lobbed Lewontin's materialist revelation at him. Neither gentleman explained the background context for the quote, however, and Lynn (evidently unaware of its provenance) swallowed their baited hook by criticizing Lewontin for supposedly suggesting that unflinching materialism was a prerequisite for a belief in *evolution*. Lewontin's negativism received criticism from several fellow scientists in letters to *The New York Review of Books* (6 March 1997), noted by Segerstråle (2000, 346)—see also Kenneth Miller (1999, 185-191). Interestingly, Segerstråle (2000, 42-47) comments on Lewontin's uncompromising attitude about how ideological assumptions supposedly lead to "bad science." Lewontin evidently excludes his own ideology from that equation, by the way—cf. Alcock (2001, 20). Segerstråle highlighted the example of Louis Agassiz, whom Lewontin retroactively decried as a "liar" for incorrectly believing that the skulls of blacks closed up faster than whites. Agassiz's touchy racism will be discussed in further length next chapter, but the issue of whether a scientist can be thought of as *lying* when they profess "scientific" opinions that subsequent investigation refutes is a tricky methodological point. Going by such creationist case studies as Duane Gish and Phillip Johnson, ideology affects their method only insofar as the belief system dictates to nature what must be so. Where such convictions are unsupported by evidence, the ideology by necessity falls back on an increasingly faulty procedure as the only practical means of sustaining their position. Operating from within that restricted terrain, the ideologue may well be factually delusional, but is not really "lying" in the sense of the conscious prevarication of the proverbial "used car salesman."

[270] Lewontin (1997, 29) raised another example, the failure of gene therapy: "The prevention or cure of metabolic and developmental disorders depends on a detailed knowledge of the mechanisms operating in cells and tissues above the level of genes, and there is no relevant information about those mechanisms in DNA sequences. In fact, if I know the DNA sequence of a gene I have no hint about the function of a protein specified by that gene, or how it enters into an organism's biology." Genetic systems simply cannot be viewed as fixed blueprints independent of the organism's environment—a point repeated by Lewontin (2000a,b) and others, such as David Moore (2001) or Dusheck (2002). Cf. Griffiths & Neumann-Held (1999) on the hierarchy of factors affecting "the evolutionary gene." Ironically, antievolutionist Bethell (2001) hit some of the same marks, duly picked up on the apologetic daisy chain by the Discovery Institute and thence to the YEC Bible-Science Association (creationsafaris.com/crev04.htm). All this related to how parts of proteins and genes could add up to complicated new functions, of course, but Phillip Johnson missed this connection just as he overshot his criticism of Gould (note 69 above). And again when Johnson (1998a, 77-84) reprinted his commentary on Gould as "The Gorbachev of Darwinism" in *First Things* (January 1998). This concerned a heated 1997 exchange ("the intellectual equivalent of a barroom brawl," as Johnson put it) in *The New York Review of Books* sparked by Gould's characteristically scathing review of the "Darwinian fundamentalism" of Daniel Dennett (1995) and

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company. Rather like first-year college students suddenly overwhelmed by advanced technical disputes beyond their ken, antievolutionists like Johnson and Glynn (1997, 47-48) have missed the gist of the Gould-Dennett debate. Gould (1997a,b) plainly defined his point of attack: the "algorithmic" qualities of adaptive natural selection *do* account for the development of features like eyes that creationists hold to be grand mysteries. What they *don't* explain are long-term evolutionary trends (like why there are hundreds of thousands of beetle species, but only fifty of priapulid worms). Ironically, the two issues may actually be resolved at another level, as Parker (2003, 206-216, 278-289) notes the predominance of sighted organisms since the Cambrian (representing a minority of only six phyla, yet accounting for a whopping 95% of all species, living and extinct). While both camps accept that natural processes are in principle capable of generating the basic morphologies of species encountered in the fossil record, ultra-Darwinians really do manifest an abiding *theoretical* disinterest in their specific historical pattern—for example, Maynard Smith & Szathmáry (1999) skipped conundrums like the dinosaurs entirely. Much of the Gould-Dennett debate turned on the precision implication of some subtle terminology, such as the difference between exaptations (features co-opted for a different function) and "spandrels." Gould & Lewontin's "The Spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist programme," excerpted in Mark Ridley (1997, 139-154), proposed that *non-adaptive* features may likewise be subsequently exapted. See Gould (2002a, 1246-1270) for his final views on the topic. Even spandrels would have come about through natural genetic variation, of course, but would have been *preserved* by hitchhiking among organisms otherwise subject to the stricter form of Darwinian natural selection. A factor in the debate over evolutionary adaptationism and the units of selection that Johnson has been unable to transcend concerns how, unlike the mannered theater of the legal profession, investigative fields like history or paleontology are distinctly contact sports. That this can occasionally descend to farce was illustrated in the 1981 "Nabi" episode, where the Lewontin and Wilson camps lobbed pseudonymous letters and editorials at one another in *Nature* over the limits of sociobiology, Segerstråle (2000, 184-188). Regarding the rhetorical fireworks of Gould and Dennett's mutual accusations of caricature, Johnson (1998a, 80-81) ran the scholarly faults only one way: "Gould has a well-earned reputation for distorting the views of his rivals and adversaries, and so it is not surprising to find that the complaints are justified." Whereupon Johnson (1998a, 81) retired to his Intelligent Design redoubt: "The creative power of natural selection is actually inferred from materialist philosophy rather than proved by scientific evidence, but let that pass. If both sides agree that natural selection isn't the whole story of evolution, then what's the beef? Little wonder that many observers have concluded that there is no substance behind this food fight at the high table, only a clash of overgrown egos." He then reframed the issue along familiar lines, as that "certain conclusions about the pace and manner of evolution necessarily follow, and Gould frequently seems to be denying those necessary conclusions. The dinosaurs can be killed off as rapidly as you like, but all the dinosaurs that died and all the new mammals that replaced them had to have built up in the first place through the gradual accumulation of random mutations by natural selection." One may recall how Johnson has never evinced even the slightest curiosity about the actual evolution of dinosaurs (from the lagosuchids and archosaurs to those saurischian and ornithischian examples I tactically prompted him with in my e-mails). Nor has he dwelt on the finer details of the post-K-T mammal diversification (which includes the origin of *whales* he had by 1998 so conspicuously spiked). Gould's essay and the responses by Dennett *et al.* (August 14 & October 9, 1997) are available online (as Johnson noted ala Garrett Hardin) at nybooks.com/nyrev/. See Jolly (1999, 125-131), Kenneth Miller (1999, 176-178), Harold (2001, 195-196) and Monastersky (2002) for contrasting takes on the main issues. The equally critical review of *Darwin's Dangerous Idea* by biologist H. Allen Orr (1996) is also relevant, as Gould alluded to it while Johnson's redaction did not. Consider also the mutually critical companion reviews of Dawkins (1996) by Gould (1997c) and Dawkins (1997) on Gould (1996c)—with some meringue by Wright (2000, 265-276). Dawkins (1998b, 207-208) nibbled at the debate from the edges, mentioning only Maynard Smith's subsequent criticism of Gould, without reference to what had started the cascade (Gould's criticism of Dennett). The final account by Gould (2002a, 1019-1021) was almost as brief. Ruse (2000,

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231-260) manned the neo-Darwinian side of the tussle more generally. Parenthetically, one may map the various sniping philosophical camps by checking the dust jacket recommendations for *Darwin's Dangerous Idea*. Not a whiff of Gould, Eldredge, or Steven Stanley, naturally enough—instead a string of laudatory charms strung from Dawkins, Maynard Smith, and E. O. Wilson. A broader crew understandably praised it as a stimulating read (which it often was)—these included John Gribbin, Phillip Kitcher, Roger Lewin, Richard Rorty, and the late Carl Sagan.

[271] Johnson may also believe he can be selective in this enterprise because he is under the opinion that disposing of "the Darwinian mechanism" would be sufficient to eliminate a host of unpleasant scientific fallout. Johnson (1995, 70): "Why devote prodigious effort to speculating about how a primitive form of RNA might be produced in a chemical soup if you have no idea how such a molecule could evolve into a cell? Why assume that mind is only matter if you have no idea of how the brain could have evolved? Instead of a generally satisfactory picture of the history of life with a few gaps, science would confront a vast mystery that would become increasingly stark with the gathering of more biological data. When we imagine the consequences that would follow from a discrediting of the Darwinian theory, it is easy to understand why scientists defend the theory so fiercely." Johnson has several things backwards here. From an epistemological standpoint it would be *through* the investigation of molecular systems like RNA or brain chemistry that the process of their evolution might be clarified. But even more fascinating is Johnson's idea that getting rid of Darwinism would somehow mean modern neurological researchers would cease noticing the close connection between the human mind and the organization of neurons in the brain (a topic that will come up again next chapter). Sorry to say, but the cat's already out of the bag on that one—with or without Darwin.

[272] Given the hard work, discipline, and imagination shown by real paleontologists, Johnson's potshots at the field are especially hard to swallow. The image painted in his Eldredge passage of "ambitious fossil hunters" fooling themselves in order to secure their "cover story in *National Geographic* and a lifetime of research funding" was both gratuitously insulting and inaccurate. Which "physical anthropologists" did Johnson have in mind for this general sideswipe? As it happens, Roger Lewin (1987, 155) has pointed out that Louis Leakey used *National Geographic* as his theoretical mouthpiece—since Johnson (1991, 174) cited Lewin, Leakey may well have been one object of his ire. But apart from someone like dinosaur paleontologist Robert Bakker, who has cultivated a media presence from which he has apparently derived considerable ancillary income, paleontology has never been a ready road to financial security. Johnson also spoke of the taxonomical standards "to allow *some* fossils to be authenticated as human ancestors" as though these were being plucked from thin air as easily as Johnson's "other examples." It is certainly true that many who engage in any discipline possess testy personalities or have ideological axes to grind. A good illustration would be Donald Johanson's combative squabbles with colleagues during the 1990s, Swisher *et al.* (2000, 103-129). But as a group physical anthropologists have yet to inspire a suite of "paleontologist jokes" to compare with the popular iconography of *lawyer jokes*.

[273] Johnson's steady disinclination to think about the potential effects of his tinkering with the scientific method is another demerit badge for the "Erich von Däniken of modern creationism." During my recent e-mail exchange, Johnson pronounced that I was "fighting a holy war against the armies of the night, and Darwinism is your main weapon. All our liberties are in danger if doubt about Darwinism is allowed to seep into our minds—right?" I replied: "Wrong. It is not doubt about Darwinism that I object to. It is the methodology you put forward in your assault on Darwinism that I find so unsettling." Put another way, Eldredge (2000, 169): "It's not Phillip Johnson's personal God that I'm after; it's his political agenda—specifically his desire to see science watered down in the classroom." As for the stakes, as Rothman & Sudershan (1998, 74) reminded, "one result of unimaginative, mechanistic thinking was that societies eventually ceased to burn people at the stake for witchcraft." Or, one might add, the practice of exhuming alleged "vampires" for the purpose of postmortem impalement.