GRAFFITI WITH FOOTNOTES

Volume 1, Number 1

A Report on the ASA Conference Debate on Pandas and People Textbook

On Sunday, July 23, 1995, at its annual meeting, the American Scientific Affiliation (ASA), an organization of Christians in the sciences, sponsored a debate on the supplemental biology textbook *Of Pandas and People: The Central Question of Biological Origins*, 2nd ed. (Dallas, TX: Haughton, 1993). This 170 page book, written by the biologists Dean Kenyon and Percival Davis, has engendered controversy since it was first published in 1989. Intended for use in public school classrooms as a constitutionally unobjectionable presentation of the notion of "intelligent design," *Pandas* has found opposition wherever it is considered by state textbook adoption panels or school boards.

Pandas raises many issues, among them the scientific soundness of "intelligent design," the empirical adequacy of neo-Darwinism, and the proper content of science education. Thus, members of the ASA resolved to air these differences in a debate, and invited Michael Behe, an associate professor of biochemistry at Lehigh University, and Kenneth R. Miller, a professor of biology at Brown University, to take opposing sides, with Behe defending *Pandas*, and Miller critiquing it.

Paul Nelson attended this meeting. What follows are his observations.

This is my report on the recent (July 23) ASA Behe/Miller debate about the book *Of Pandas and People*. Actually, I'll have much more to say about my conversations with Ken Miller than about the debate itself. Like Mike Behe, I'd judge the debate a draw, or, perhaps more accurately, a stalemate. Ken wanted to hear how we (the design guys) explained the fossil record and earth history, and we wanted Ken to explain how complex biological systems evolved.

Because neither Mike nor I had much to say about the fossil record, and because Ken pled ignorance about the actual mechanisms of evolution, I think the audience was left in some frustration (or confusion). *Pandas* took some genuine hits from Ken, but none, I think, that would sink the book. Certainly (as Mike pointed out), Ken's own textbook *Biology* (Prentice-Hall) has problems – some of which Ken very honorably offered to fix in the next edition – and I think nearly all the problems Ken mentioned with *Pandas* are reparable, without affecting the book's distinctive intelligent design thesis.

That thesis, of course, can't be "fixed" (removed to accomodate methdological naturalism) without destroying *Panda's* very raison d'etre. But I'll come to that issue later.

When Steve Meyer originally approached me about taking his place as "resident philosopher" at the debate, he mentioned that Ken was going to be Mike's opponent. When I heard that, I couldn't say no. Ever since I began reading his essays on the creation/evolution debate, in the early 1980s, Ken has struck me as the opponent I'd least like to face in a debate – in other words, as the most effective and articulate spokesman for the received view of evolution. When I heard him speak at the 1993 AAAS meeting in Boston, on intelligent design (and why organisms showed evidence of unintelligent design), I thought, now here's someone I'd like to talk to, one-on-one, about evolution, because unlike the agnostics I usually talk to at the University of Chicago, who find problems with every evolutionary idea, he sure seems to know how the process works.

As it turned out, Ken had little to say about the mechanisms of evolution – except that they were unsolved problems in an active area of research, and all sciences have unsolved problems (necessarily, one might argue). Ken had a *lot* to say about earth history and the fossil record, which he has consistently called the central issue in the origins debate. I'll try to explain below why I think Ken has an important point, but one that is, finally, peripheral to deepest division between design and naturalistic evolution.

My introductory talk touched on the history of *Pandas* (quite briefly), but dealt mainly with the falsity of methodological naturalism. A stock argument for excluding *Pandas* from public school classrooms turns on the principle that science pedagogy should reflect the content of our best scientific knowledge (theory and observation) and practice (method). Since Darwin's time (the argument runs), biology has employed only natural causes, and biologists reason only naturalistically about the origin of organisms; *Pandas* employs intelligent causes and design reasoning; therefore, *Pandas* doesn't belong in science pedagogy.

But it's manifestly false that biologists employ only naturalistic reasoning about organisms, and the literature of evolutionary theory is marked by teleology (albeit "reverse teleology," as I called it, forgetting to my later embarrassment to credit Daniel Dennett with the term "reverse engineering").
I gave five examples from the recent literature, from a variety of genres: two biology textbooks, Helena Curtis's *Biology* and the Luria, Gould, and Singer volume *A View of Life*; a major encylopedia entry, Ayala's Macropaedia article on evolution from the Encyclopedia Britannica; a technical paper by National Academy of Sciences president Bruce Alberts; and a technical volume on natural selection by George Williams, published in an Oxford series. Each passage contained design reasoning, in some cases

(interestingly, the two textbooks) explicitly theological – “why would God have done this?”

Here are the examples:

1. Helena Curtis, *Biology*, 4th ed. (New York: Worth Publishers, 1983), p, 885:

> All mammals, whether a giraffe or a mouse, have seven cervical vertebrae; if one were starting from scratch, one might choose somewhat different body plans for a giraffe, for instance, than for a meadow mouse. The forelimbs of animals as diverse as humans, dogs, whales, chickens, lizards, and frogs are all constructed of bones arranged in the same pattern. All vertebrates have four limbs, never six, or eight, or a hundred, and all have gill pouches...at some stage of development.
>
> Why should an organism created specifically for a particular place in the grand design be modeled on an obsolete pattern and be built of hand-me-down materials?

2. Salvador E. Luria, Stephen Jay Gould, and Sam Singer, *A View of Life* (Menlo Park, CA: Benjamin/Cummings, 1981), p. 581:

> A whale’s flipper, a man’s arm, a bird’s wing, and a dog’s foreleg...perform functions about as different and varied as styles of locomotion in vertebrates can be, yet all are built of the same bones. Why would God have used the same building blocks, and distorted and twisted them in such odd ways, if He had simply set out to make the best swimming, running, and flying machines? The common structure must reflect common descent from an ancestor possessing these bones.
>
> Evolution is proved by its imperfections. But once we decide, on the basis of these imperfections, that evolution occurred, then exquisite adaptations become an impressive record of how finely, and with what precision, evolution can work.

3. Francisco Ayala, “Evolution, The Theory of,” in *The New Encyclopaedia Britannica* (Chicago, 15th ed., 1988), Macropaedia, Volume 18, pp. 981-1009; p. 987:

> From a purely practical point of view, it is incomprehensible that

a turtle should swim, a horse run, a person write, and a bird or bat fly with structures built of the same bones. An engineer could design better limbs in each case. But if it is accepted that all of these skeletons inherited their structures from a common ancestor and became modified only as they adapted to different ways of life, the similarity of their structures makes sense.

4. Bruce Alberts, "The Function of the Hereditary Materials: Biological Catalyses Reflect the Cell's Evolutionary History," *American Zoologist* 26 (1986): 781-796; pp. 786-787:

I would like to stress two facts about the ribosome. First, its catalysis of protein synthesis appears to be an RNA-based process....Second, the mechanism of protein synthesis seems complex and awkward compared to other biological processes that evolved later and were therefore based on protein catalysis....Some important, though tentative, conclusions can be derived from these two observations. It seems, first of all, that RNA-based catalyses are considerably less powerful than protein-based catalyses. As a consequence, it takes much more molecular mass to carry out a reaction catalyzed by RNA molecules than to carry out the same reaction catalyzed by proteins. In terms of a familar analogy, the early cells that used only RNA catalysis were like a computer based on vacuum tube technology: very slow for their size. This is presumably why those cells that developed protein synthesis proliferated at the expense of their neighbors, and came to dominate the earth to such an extent that no cells lacking proteins have survived.

If they are less efficient that protein catalysts, why do any RNA catalysts still exist in cells? The suggestion is that cells, unlike those of us who have recently purchased computers, have been unable to escape the past. Thus, while a "microchip solution" to the synthesis of proteins would presumably be more efficient for the cell, the old mechanism clearly works well enough in its present patched-together form...to be retained. In other words, cells – unlike computers – are not optimally designed. Instead what they are today is in large part a reflection of their past history (Jacob, 1977). The ribosome is a notable example. As a machine for making proteins, the ribosome seems so awkward as to be a bore both for teachers to teach and for students to learn. Its many pieces seem to make no conceptual

sense at all, especially when compared to the elegantly-designed pieces of a DNA replication machine. Only when viewed as a historical relic does the ribosome come alive. Now it suddenly turns into a fascinating object that can help us to understand the pathway by which protein synthesis evolved, and even how early cells might have worked before there were proteins.

5. George C. Williams, *Natural Selection: Domains, Levels, and Challenges* (New York: Oxford University Press, 1992), Oxford Series in Ecology and Evolution, eds. R.M. May and P.H. Harvey; pp. 72-73:

...every organism shows features that are functionally arbitrary or even maladaptive. ... My chosen classic is the vertebrate eye. It was used by Paley as a particularly forceful part of his theological argument from design. As he claimed, the eye is surely a superbly fashioned optimal instrument. It is also something else, a superb example of maladaptive historical legacy. ... Unfortunately for Paley's argument, the retina is upside down. The rods and cones are the bottom layer, and light reaches them only after passing through the nerves and blood vessels.

Of course the eye can still play its role as a precise visual instrument. The tissues intervening between the transparent humors of the eye cavity and the optically sensitive layer are microscopically thin. The absorption and scatter of light is ordinarily minor, and functional impairment seldom serious. Yet the fact of maladaptive design, however minimal in effect, spoils Paley's argument that the eye shows intelligent prior planning, and the visual effect is real and routinely demonstrable. ... Another [problem] is caused by the optic nerve arising on the wrong side of the sensory layer so that it must go through a hole in the retina to get to the brain. The diameter of the nerve is far greater that that of any retinal blood vessel. That means a large hole, and wherever it is there will be no vision. This is the reason for the blind spot, about 30 degrees right of the point of vision in the right eye, 30 degrees to the left in the left. The visually lateral position of each nerve exit means that the eyes are blind to different parts of a given scene. Our retinal blind spots rarely cause any difficulty, but "rarely" is not the same as "never". As I momentarily cover one eye to ward off an insect, an important event might be focused on the blind spot of the other.

> There would be no blind spot if the vertebrate eye were really intelligently designed. In fact it is stupidly designed, because it embodies many functionally arbitrary or maladaptive features, of which the inversion of the retina is merely one example.

Now, to ask students to accept such reasoning uncritically – how, for instance, can Bruce Alberts possibly regard his claim that "the mechanism of protein synthesis seems complex and awkward" (p. 786) as an "observation"; to accept the problematic conception of God or the designer at work; or to accept the judgments of suboptimality, WITHOUT providing any means for mounting a counter-argument or critical analysis, is not only pedagogically disastrous, it is intellectually unfair. As the aphorism has it, if one can argue against design, one can argue for design.

So, I quipped, paraphrasing Voltaire, if a book like *Pandas* didn't exist, it would be necessary to invent it. Design reasoning didn't leave biology with Darwin. Our (the biological community's) perception of organismal design changed – but that's a highly arguable matter.

(Take the panda's pseudothumb and the "backwards" human retina, both of which Ken featured in his 1993 AAAS talk, but neither of which he discussed at the ASA debate. There is, as far as I have been able to discover, absolutely NO literature on the functional suboptimality of the panda's pseudothumb. Every direct reference from the panda natural history literature that I've found [as opposed to the theological arguments for evolution literature, e.g., Gould's 1980 panda's thumb essay] praised the structure in the highest terms: "like a forceps" (Schaller et al.), "with the utmost precision" (Perry), etc. More to the point, it is unclear how one would do the optimality analysis required by the theological argument. The argument compares actual pseudothumbs with the structure God or an optimal designer would have made. Good luck with getting a fix on the latter structure.)

(The "backwards" retina is another non-starter. Typically authors, even smart ones like George Williams, expend zero intellectual horsepower on figuring out why the vertebrate retina might benefit from having its photoreceptors facing away from incoming photons. "Gee, that's stupid," they write, "look at the blind spot which results!" Indeed, there is a blind spot. But George Ayoub, a biologist at Westmont College, sent me a manuscript with half a dozen good reasons for photoreceptors to face "backwards," any one of which might justify the design solution entailing a blind spot – unless one is playing the "God wouldn't have done it that way" game, where God's design equals any hypothetically optimal structure right off the top of one's head – in which case I would like an eye completely impervious to puncture, that adjusts instantaneously to changing light levels, etc., etc. This is a cheap and slovenly way to argue for the truth of evolution, and when I find it in a text I lose respect for the author.)

Back to the story. I then sat down and Mike and Ken slugged it out. Mike has already summarized his talk, and Ken's, so I'll just point out a couple of things. Ken is an ace at this format. He spoke clearly (and loudly enough, in a hall with fans and open windows; I was accused of mumbling), quickly, and with humor, disarming his audience by donning an "ASA" baseball cap (which refers to the *Amateur Softball Association*, in which he's an umpire), and showing a slide of Daniel in the lion's den. Furthermore, Ken had several detailed (well-illustrated) indictments to make about *Pandas*, in the main concerning its representation of the fossil record.

One indictment that seemed to score with the audience concerned the land-dwelling mammal to fully-aquatic whale transition, where *Pandas* discusses missing fossil intermediates in the sequence. Ken pointed out that intermediate forms had since been discovered (and cited Mike Behe also wondering about missing intermediates) – then quoted me, from a *Moody Monthy* article by Mark Hartwig (provided to Ken by Eugenie Scott, as he told me; hard for me to believe that *Moody Monthly* is among Ken's usual reading) as saying, in effect, "big deal – the fossils don't tell us anything we didn't already know." These design guys are weasels: they complain about missing fossils, and when the fossil are produced they shrug their shoulders.
Total weasels.

Score one for Ken!

Trouble is, I was quoted entirely out of context. Had Ken presented my full argument, my statement wouldn't have looked nearly so weasel-like, and might even have made some sense to the audience. In the Moody interview, I argued that design theory has always recognized that organisms fall into groups of greater and lesser similarity: that's the "big deal" aspect. But without an evolutionary mechanism to explain how one type of organism becomes another distinctively different organism, *there's no reason to believe an apparent continuum of morphology* (which the whale fossil sequence is) represents an "actual" continuum of ancestor-descendant or cousin-cousin relationship. I mentioned the critical mechanism problem in the interview, Mark wrote it up and Moody published it – but Ken left it out.

Here's what I said, as it appears in the article:

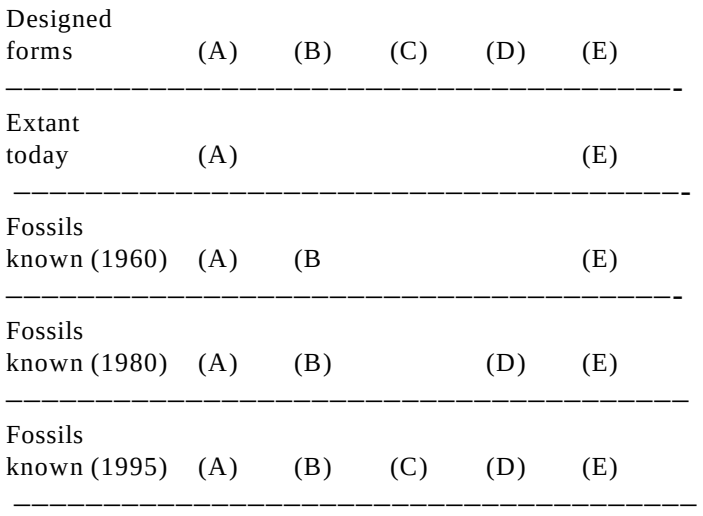
> Advocates of intelligent design don't deny the similarity of some life forms. But similarity is not enough to prove a transition from one form to another. "There's no biological mechanism we know of that can produce that kind of change," Nelson says. "So I don't see why there's any reason to think it ever happened."

Without that point, however, I look like a weasel.

Let’s face it, one can always string fossils together along apparent morphological continua. But, as the cladists recognized in the 1970s, whether those fossils actually stand in an evolutionary relationship to each other is another question altogether. [1]

Here’s the argument I made to Ken after the debate. Suppose “morphological space” was more fully occupied in the past – e.g., that there was a greater diversity of aquatic and semi-aquatic mammals (so that between land-dwelling and fully aquatic mammals one would observe several types along the continuum).

Then that diversity is winnowed by extinction, so that morphological space today is less fully occupied. As new fossil forms are discovered, we “re-fill” morphological space, but we’re not uncovering evolutionary ancestors or cousins. We’re simply taking a greater sample from the diversity of morphologies that once existed:



The filling of “gaps” here is only a sampling phenomenon.

Now, it may be that the morphological continuum (A) –> (E) represents an actual historical relationship of descent with modification (where A –> E are ancestor-descendant, or share a common ancestor). Or it may not.

The critical question is one of mechanism. Is it possible for mammals to vary sufficiently for – to take the case of whales – their skulls to be completely remodelled, so that the nostrils (nares) move all the way up to the top of the head? (Indeed, all the other cranial bones must change their size and shape as well.) If not, we’re looking at an apparent, not actual, continuum. The designed forms are transformationally discrete, with independent histories.

That's what I said to Ken, as he was putting away his slides. He replied, "Yeah, Paul, I know, with you it's always 'mechanism, mechanism, mechanism.' But there's more to it than that."

What the "more" is ain't clear to me.

But Ken's major argument, and one which I think is very effective, concerned the overall pattern of fossil distribution in space and time. This isn't an argument for evolution so much as it is an argument against design. *Pandas*, said Ken, implies a creator/designer who never quite manages to get it right. The designer fashions species that go extinct with astonishing frequency, then designs new, slightly different species which themselves go extinct, again and again throughout geological time – always tinkering with his work, designing every couple of months here and there over the Earth's surface.

Is this believable? asked Ken. (At dinner, he said to me, "It's a silly conception of the designer.") Darwin writes, in an early species notebook (D 36):

> How far grander than idea from cramped imagination that God created. (warring against those very laws he established in all <nature> organic nature) the Rhinoceros of Java & Sumatra, that since the time of the Silurian, he has made a long succession of vile Molluscous animals– [2]

"Has the Creator since the Silurian gone on making a long succession of vile molluscous animals...the Rhinoceros of Java and Sumatra. Miserable limited view." This aesthetic argument, which Ken forcefully recapitulated, is very powerful. It is of course possible that a designer acted as a straightfoward reading of the fossil record would imply – but is that a designer we'd want to "praise" for his work?

This argument is effective (where, I think, panda's thumb-type arguments are not) because the opponent of design has only to "read off" the fossil record directly. Nothing needs to be said or assumed about what the designer would have done (as in the panda's thumb argument), or how existing designs are sub- optimal.

Indeed, the opponent of design can grant the reality of design, and simply say, OK, it looks like the designer took several million years to get mammals right. The necessary rhetorical work (against design) is done entirely by the fossil record, and the vast periods of time involved. No more assumptions are involved than (a) the earth is 4.5 billion years old, and (b) different forms of organisms appeared at different times.

“This is the central issue for me,” Ken said to me after the debate, “as it was for Darwin.” The designer implied by a straightfoward reading of the fossil record and earth history is simply unbelievable.

Is that designer unbelievable? It’s a theological problem, but no less real or difficult for that. (More evidence that the science/theology divide is far hazier than the usual accounts would have it.) Faced with the aesthetically counterintuitive possibility that the designer was continually tinkering over geological time, Ken opts for Darwin’s designer, who set up the system at the beginning – once, for all – and let it run. (Below, I’ll discuss in some detail an exceedingly interesting and fruitful metaphor that Ken offered, in response to a question from the audience: although not fruitful in the way Ken might have thought!)

Here’s a prediction. This problem of how the designer acts in time and space is one which design theorists are going to have to address, carefully, because scientists like Ken want answers before they’re going to consider design as a plausible causal account. “Call it a theological argument if you want,” said Ken in his talk, “but it’s a genuine problem nonetheless.” I think he’s right (but would love to hear arguments from the group about how confused I am).

Of course, the central arguments for design obtain whatever the open puzzles about the designer’s action in space and time. Behe’s notion of irreducible complexity, for instance, applies to the molecular systems of pre-Cambrian protists (assuming they were biochemically similar to their modern counterparts), and would hold whether the systems in question were a couple of billion years or five minutes old. Here, the naturalistic evolutionist faces informational hurdles – in generating specified structures which are jointly necessary for function – for which no testable mechanism exists.

This may be the place to mention Ken’s answer to a question from the audience about Ken’s own views on God and evolution, because it applies to the question of mechanism. Ken is a Roman Catholic (he elicited a great laugh from the audience by joking, “this is probably the first time Protestant scientists have listened to a debate between two Roman Catholics”) who has consistently called himself a theist in his writings (in fact, a “creationist,” that word, exactly, in a 1984 essay, if by “creationist” one understands “any...scientist who professes a religious belief”). In reponse to the question, “how do you think God acted?” Ken told the following story.

“I knew a nun while I was a graduate student in Colorado,” he said, “who was also a biologist. She gave a lecture on evolution, which she fully accepted, and was asked during the question period how she could believe in a God who created through evolution. How did that fit with her theology?”

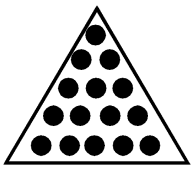
“Well, she replied,” Ken continued, “that it sounded to her like the questioner believed in a God who wasn’t a really superlative pool player.
Imagine a pool player who says, ‘I’m going to sink all the balls on the table,’ and he does so – but only one at a time. ‘My God,’ said the nun, ‘is like the pool player who lifts the triangular rack on the 15 balls, lines up the cue ball, and sinks all the balls with one shot.’”

“And that’s my God, too,” said Ken.

Now, one’s first intuition, on hearing this story, is to say, hm, that would be quite a feat: sink all the balls with one shot. Wouldn’t that be the greatest design, to build the whole universe so all its design unfolded right from the start – with one shot, so to speak?

But there’s a very interesting problem buried in the nun’s metaphor.

No pool player could possibly sink all the balls with one shot. It’s impossible. The pool player can’t put enough physical information into the head of the cue stick (so to speak), transfer that information to the cue ball, and have the cue ball transfer the information (e.g., vectors) into the fifteen balls in the rack formation to have those balls roll into the pockets of the pool table.



Sure, nothing in principle prevents all the balls from rolling into the pockets. After all, after the impact of the cue ball, they have to go somewhere, so why not into the pockets simultaneously?

But the pool player can’t do it, because he can’t forsee (calculate) all the interactions, and even if he could, he couldn’t “get the information” (the interactions) into the head of the cue stick, using only his muscles (which are subject to dynamics of their own), eyes, nervous system, etc.
Furthermore, as the cue ball interacts with the cue stick and the cloth of the table , even before it contacts the rack formation, some information will be lost.

That’s why no one will ever lose $ betting against the player who claims to be able to sink all the balls in one shot.

Now, could God sink all the balls with one shot? Of course. It’s only a problem of mechanics. Presumably there are indefinitely many single shots, which, if only one could make them, would sink all the balls in any pattern one chooses.

But *scientifically speaking*, humans can't "get at" those shots analytically – because we're limited by our finite knowledge and the probabilities we face. Therefore we can safely declare the event impossible (meaning excluded probabilistically).

Now, here's why I think this story becomes a problem for the theistic evolutionist who wants to use it to show how great a designer God becomes (when one accepts evolution). As our scientific descriptions of the universe run back to the Big Bang, we lose information: by that, I mean the "specifications" required, for instance, to provide function in even the simplest organisms, will disappear – they can't be expressed by, or reduced to, physical equations.

Thus, if the theistic evolutionist starts with God creating "the laws of nature," he lacks the explanatory resources to generate organisms later. The physical laws and regularities are too information-poor. That is, they won't generate specified functional (or informational) structures. Well, how about giving those laws some help, by rigging the starting conditions? (Trick shots in billiards displays often begin with the shooter arranging the balls in some carefully specified pattern.)

Again, I don't think that helps. The information required won't go away: one simply has to encode it at another, lower level. (Mike Behe and I once argued about whether a cosmic ray burst might generate all the mutations necessary for a cilium to arise *de novo*; I said, sure, it could, but then one has to explain the vastly unlikely event of simultaneous cosmic ray bursts all striking one cell, etc. The information won't go away.)

So, when the nun says, "I believe in a God who sinks all the balls with one shot," she's really describing a created universe that *wouldn't work*. At least, *we can't say how it would work,* i.e., bring forth organisms from physical regularities in the fullness of time.

What does it mean to say, "we can't say how that universe would work"?
Exactly what it means, I think, in the billiards example. Suppose someone said, "it's possible to sink all the balls with one shot."

"Yes, in principle," we respond. "In reality? Never."

That's equivalent to rejecting naturalistic evolution probabilistically. Then the nun says, "OK, but God could have done it."

Sure, he could have. But, scientifically speaking, we face all the same problems. God's knowledge is not "our" knowledge, and our science is always relativized to our limitations. Thus, to say, "God could have done it" does absolutely nothing to solve the

problem of getting enough information out of the Big Bang to build organisms, and so on.

That's why most theories of theistic evolution, when one looks at them closely, really involve God acting all along the way. One can't tell the other story – where God acts only at the beginning, setting up just physical laws – and get organisms out several billion years later.

Standing in the line for dinner and discussing this with David Wilcox, we agreed that Ken's story about the nun's billiard metaphor, far from making theistic evolution more plausible, actually made it much less so. Sitting next to Ken at dinner, I mentioned this problem, saying, "do you realize how much information has to be in the head of the cue stick?" – and he smiled.
Then I said, "but of course the story is a great way to get out of the question" – and he nodded.

During and after dinner I was able to ask Ken about the mechanisms of evolution. He said, "Look, Paul, I'm an experimentalist. That's why I concentrate on the fossil record. Give me something I can look at and touch. I don't spend time on hypothetical questions of evolutionary mechanism."

But surely, I replied, he must have "some" story for how (for instance) the eukaryotic cilium came together?

Here Ken drew a diagram on his napkin for me. "Mike Behe didn't actually tell the audience about the full complexity of that structure," he said, sketching a cilium in cross-section (with its familiar "9 + 2" array). "Now, do you realize that cell biologists can't even tell us how cells put their cilia together right now? That we don't even have a good story for how they're assembled? So how do you expect evolutionary biologists to give you a story about how cilia evolved originally?"

"And," he continued, drawing his moral, "do you really want to judge a science on its unsolved problems? If you think that cell biologists will eventually solve the problem of ciliary assembly, then why not make the same allowance for evolutionary theory?"

First reaction: if that were how evolution was taught (here's a complex structure, we don't know it evolved, but we may, someday) I doubt books like *Pandas* would be published, or Ken and Mike would be debating, or I writing this post. But that's not how evolution is taught.

"Darwin's genius was to show how biological design evolved without any need to invoke a Creator." Standard phrase – open any college (and many high school) biology text. But, for all that, a lie. If the explanation existed, one could find them in the

literature. But they're not there; certainly not in anything Darwin wrote, and as Mike Behe will argue in his book, in the many decades since.

Second reaction: unsolved problems abound. Some are genuine, and others – well, let's say they're a tad more unsolved than they should be. From my own dissertation research, I can see perfectly good (powerfully compelling) reasons why complex metazoans don't want to evolve, i.e., vary in the ways required by macroevolutionary scenarios. One can say that "evolving" is the last thing an organism wants to do during its development.

So why do otherwise insightful and savvy scientists think they have to work on this theory? I ask myself (or Jon Wells and I muse, as we did in Indiana at the body plans meeting last October). Because, since Darwin, that's what natural history is all about: showing how organisms came to be "without any need to invoke a Creator." That's the game. Play by the rules or get out.

Baloney. That's not science. It looks to me like many (most?) of the "unsolved problems" of evolutionary theory are driven by naturalism. If design explanations are testable (as I believe they are), and contradict nothing we really know about the world, then they belong in science (and science classrooms) where they can be evaluated.

I wasn't surprised that Ken didn't have much to say about the mechanisms of evolution. What did surprise me was his calling the matter "hypothetical," and drawing an explicit contrast with experimental science. Next to the billiards story, that will stick with me longest, I think.

Getting to know Ken better, and being able to talk with him at length, was alone worth going to Montreat. I now understand what matters to him (evidentially), and why – and how other scientists like him might view the dimensions of the intelligent design controversy.

Paul Nelson

1. The role of fossils in phylogenetic reconstruction, or in systematics generally, has been a major area of controversy throughout the cladistic revolution in comparative biology. The arguments are too extensive to rehearse here – but to capture their essence, the reader need only ask, when met with a claim that a fossil is an "ancestor" of some living organism, or another fossil: *how do we know that to be true?* That question opens onto the whole vista of the debate. See, for an entry into the literature, Colin Patterson, "The Contribution of Paleontology to Teleostean Phylogeny," in *Major Patterns of Vertebrate Evolution*, eds. M.K. Hecht, P.C. Goody, and B.M. Hecht (New York: Plenum, 1977), pp. 579-643; Gareth Nelson, "Ontogeny, Phylogeny, Paleontology, and the Biogenetic Law," *Systematic Zoology* 27 (1978): 324-345; and

Colin Patterson, “Significance of Fossils in Determining Evolutionary Relationships,” *Annual Review of Ecology and Systematics* 12 (1981): 195-223.

2. *Charles Darwin’s Notebooks, 1836-1844*, eds. Paul H. Barrett et al. (Ithaca, NY: Cornell University Press, 1987), p. 343.