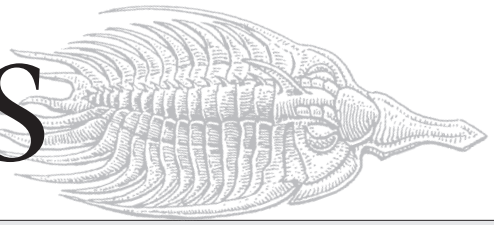
REPORTS OF THE NATIONAL CENTER FOR SCIENCE EDUCATION

DEFENDING THE TEACHING OF EVOLUTION IN THE PUBLIC SCHOOLS

Volume 27, Numbers 3-4 **MAY-AUG, 2007**

CONTINUES *NCSE REPORTS & CREATION/EVOLUTION*

CONTENTS



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Cover: Deer Creek Falls,
Grand Canyon National Park
Photography by Alana Gishlick

FROM THE EDITOR

Despite a continuing string of setbacks in legal, political, and educational settings "intelligent design" and its advocates soldier on. This issue of *RNCSE* explores recent manifestations of ID — illustrating both its rapid rate of mutation in the face of its low fitness (in terms of scientific fecundity) and its deep roots in the religious anti-evolutionism that produced creation science.

Despite its ignominious defeat in Dover, ID has not slunk off to lick its wounds. The euphemisms have changed again, but the ID proponents keep pressing the attack. Joe Felsenstein examines William Dembski's ideas about specified complexity and "conservation of information" in his article. The fatal problem with Dembski's arguments for evolution, he says, is that selection is not random and that the specification in natural selection is not *information*, but *fitness*.

ERRATA

In Joseph Lazio's "How does the sun shine?" (*RNCSE* 2006 Sep/Oct; 26 [5]), the masses in the comparison of helium and hydrogen atoms (p 31) were incorrect. The sentence should read: "One helium atom has a mass of 6.648×10^{-24} g while four hydrogen atoms have a mass of 6.694×10^{-24} g."

On p 25 of *RNCSE* 2006 Nov/Dec; 26 (6), the title of Andrew J Petto and Laurie R Godfrey's new anthology was given as *Scientists Confront Creationism and Intelligent Design*; the title is in fact *Scientists Confront Intelligent Design and Creationism* (it is, of course, hard to tell the difference between the two). WW Norton has announced that the paperback edition will revert to the original title with a twist: *Scientists Confront Creationism: Intelligent Design and Beyond*.

The Culture Shocks show on which NCSE's Eugenie C Scott appeared was #805, not #809 as reported in "News from the membership" (*RNCSE* 2006 Nov/Dec; 26 [6]: 12–14). It is available on-line at <http://www.cultureshocks.com/archives.html>.

Turning to the classroom, Jason Borenstein shows that examining ID arguments as serious propositions exposes their weaknesses ... but only if students have proper scientific background. In this case, taking up the "teach the controversy" challenge will expose the scientific bankruptcy of the "evidence against" evolution.

Jack Keyes and Nancy Broshot have taken up Borenstein's challenge after a fashion. They provide a course in basic scientific literacy that allows students to grapple with the evidence that supports scientific ideas and to understand the nature and practice of scientific inquiry.

Finally, Mark Perakh looks in vain for a dialog between ID supporters and the rest of the scientific community. Pointed critiques of Dembski's proposals are mainly unanswered.

THE CANYON IS STILL GRAND!

In a special section, we have three items on the Grand Canyon. Genie Scott fills us in on the 2007 NCSE "two-model" raft excursion in the Canyon. Glenn Branch and Wesley Elsberry report on several aspects of the controversial sale of *Grand Canyon: A Different View* in book stores within the park. That this issue is still unresolved after more than four years is itself an issue.

BOOKS TO CONSIDER

There have been so many new books relevant to the public understanding and support of evolution and science that we once again have expanded this issue into a double issue to accommodate the reviews that have been pouring in.

Randy Olson and Lauri Lebo review two of the books on the Dover trial. William Patterson and Aubrey Manning review biographies of two prominent scientists in the development of our modern understanding of the history of the earth and the biological variation of living things on the planet.

Finn Pond's review of *Darwin in the Genome* shows that our understanding of the nature of the genome and genetic change is still evolving. The more we study, the more we learn.

RNCSE 27 (3–4) was printed in November 2007.

NEWS

The ICR Moves to Dallas

The Institute for Creation Research (ICR) announced recently that it had relocated its headquarters to a new campus in Texas. In the August 2007 issue of *Acts & Facts* (available on-line at <http://static.icr.org/pdf/af/af0708.pdf>), Henry Morris III wrote:

> [I]n order to expand ICR's efforts in research, education, and dissemination, we recognize the need to recruit and train the next generation of creation scientists who will develop the mission for generations to come. To accomplish that vital objective, and to fulfill the international ministry opportunities the Lord has opened for us, the board of directors authorized the relocation of ICR to the new Dallas campus, with most of the operations to be in place by the end of this year. (p 9)

Morris also pointed to the high cost of operations in southern California as a factor in the decision, explaining that donors' contributions will go further and produce more in the new location.

ICR museum will remain in Santee, California (near San Diego) with some staff and researchers, but Morris announced the relocation of most of the other operations:

> All new science and professional staff will be recruited and located at the new Dallas campus. The Graduate School will also relocate to Texas, as much of the new educational emphasis is now online, with a new MS degree program in Science Education already underway. ICR's online Creationist Worldview study program, launched in January 2007, continues to add new students each month. The new facilities in Dallas will also expand the life sciences laboratories to facilitate the GENE project, housing two electron microscopes, computer labs, large classrooms, as well as additional offices for new faculty. *Acts & Facts* readers and other friends of ICR will be kept abreast of the relocation process over the next few months. (p 9)

The move is expected to be complete by the end of 2007.

[*Thanks to John R Cole for alerting us to the news.*]

Workshop on Teaching Evolution at the University of Colorado

Sarah Wise and Matt Young

For the second year, Sarah Wise, Mike Robeson, and Cathy Russell of the University of Colorado, Boulder's Science Discovery Unit have organized a workshop on "Teaching Evolution: Meeting the Challenge" at the University of Colorado, Boulder. The program was aimed at college and public school teachers, including elementary school teachers. The workshop's purpose was to "feature a full day of practical one-hour workshops and panel discussions on Teaching Evolution, interspersed with opportunities to interact informally with other participants." During the workshop, resources relating to teaching evolution were displayed in common areas, and many are available for download at the event website (*see sidebar, p 5*).

Approximately 70 people attended the workshop. Of those, about 50% were high-school teachers; 15% were teachers from middle or elementary levels; 25% were university faculty, staff, or students; and 10% were from other scientific organizations such as the Denver Zoo and the Boulder Open Space Department. In a survey given in conjunction with the workshop, 57% of respondents reported that they self-censor their teaching of evolution to some degree and/or receive pressure to avoid teaching evolution from their school or community. This figure was highest among middle-school teachers (86%) and informal educators (62%), while the incidence among high school teachers was lowest (33%).

For those interested in organizing and holding similar events,

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Sarah Wise is a PhD candidate in the Department of Ecology and Evolutionary Biology at the University of Colorado, Boulder, where she investigates the evolution and development of teeth. She has her MEd from San Francisco State University. Her outreach work with teachers was supported by a fellowship from the NSF's GK12 program.

Matt Young is Senior Lecturer in Physics at the Colorado School of Mines and formerly a physicist with the National Institute of Standards and Technology. He is President of Colorado Citizens for Science and Senior Fellow with the Jefferson Center for Science and Religion. With Taner Edis he coedited Why Intelligent Design Fails: A Scientific Critique of the New Creationism *(New Brunswick [NJ]: Rutgers University Press, 2004).*

Resources from the Colorado Teachers' Workshop

Interested readers may find information on the workshop here: <http://www.colorado.edu/eeb/EEBprojects/teaching/workshops.html>.

Many of the materials that were presented at the workshop can be viewed here: <http://www.colorado.edu/eeb/EEBprojects/teaching/workshopresources.html>.

A report on the outcome of the workshop is posted here: <http://www.pandasthumb.org/archives/2006/06/symposium_on_te.html>.

Matt Young interviewed organizer Sarah Wise about the workshop.

Matt Young: *What gave you the initial idea to hold a workshop like this one?*

Sarah Wise: I attended a lecture by Patty Limerick, a well-known historian and the director of the University of Colorado's Center of the American West. She and her colleagues hold forums on controversial issues in the West, providing information that help the public gain perspective on those issues. While her group hadn't ever focused on evolution, her example inspired me to take action and provided a model for me to work from.

How did you get funding for the workshop?

The first workshop, which was a half-day, was funded by the Department of Ecology and Evolutionary Biology, an NSF-funded University of Colorado GK12 program, and the Colorado Citizens for Science. This year nearly all of the funding came from the University's United Government of Graduate Students (UGGS), which contributed $750 through its regular event-funding program. The EEB department graciously bailed us out when we had a cost overrun, however. We also received generous donations from Qdoba, Izze, and a local bakery, which we acknowledged during the introductory remarks and in the program.

The all-day workshop cost about $1000, not counting donations. This included $160 for breakfast, $530 for lunch, $210 for photocopies, and $100 for other office supplies. We did not charge a registration fee specifically in order to maximize access for teachers.

How did you motivate your department to get involved?

I didn't have to work too hard at that — our department chair had been involved in the first year's event, so he was very supportive and readily agreed to cover expense overruns, let me use the department copier, and obtained the assistance of our office staff. The staff was essential in getting the copying done, lunch set up and cleaned up, and the website designed and uploaded with content. It was easy to use our e-mail listserver to recruit other graduate students to help on the day of the event. A team of graduate students has organized to plan next summer's event, so I can now move into an advisory role.

How did you arrange academic credit and CDE (Colorado Department of Education) credit?

To maintain their certification, teachers have to earn a certain number of professional development credits. Additionally, some teachers can get a salary increase if they earn college credits. We arranged for participating teachers to earn college credit, at a minimal cost, if they requested it. Alternatively, teachers could apply to receive professional development credit from the CDE at no cost.

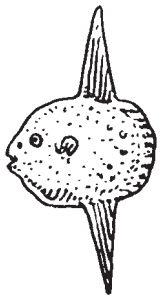
Arranging for these credit incentives was easy. The Biological Sciences Initiative at the University has an arrangement with the continuing education department at the Colorado School of Mines, so it was a simple matter to arrange college credit through CSM. The CDE required me to submit a form for each participant and to ensure that those participants had actually attended all 7.5 hours of the workshop, so I circulated a sign-up sheet at each session and cross-checked it with an attendance form that each participant filled out at the end of the event.

You had 16 presenters, counting the panelists. How hard was it to find presenters?

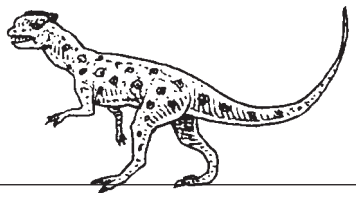
I was pleasantly surprised by the variety and quality of presenters who made their way to me. The 16 educators who presented came from a network of nearly 30 interested parties. The most significant of these was the participant list from the original half-day event, which I used to make a call for proposals. A few others contacted me after I posted the same announcement on a listserv for Colorado science educators. I met others by attending various area lectures and events having to do with evolution. Being connected to the university was very helpful overall in organizing presenters, since 15 of the potential presenters were affiliated with CU as a former student, current student, or faculty member.

You held the workshop on a Monday shortly after school was out. Why during the summer?

It was not possible to reserve the university lecture hall and other rooms during the academic year. I also wanted to avoid times of the school year when teachers are under a lot of pressure. The weekend was an option for reserving rooms at the university. I had been told, however, that weekend events are fairly unpopular with teachers, and they are definitely unpopular with university people. I considered a Monday holiday but found through an e-mail survey that holidays were also unpopular with teachers. I think the week after school gets out is good, and the week before school starts again may be even better. Of course, scheduling is complicated by the fact that school districts have different starting and ending dates. On the other hand, I have also been told that you get more no-shows in the summer than on school-year Saturdays. This year we had 30 no-shows, which was disappointing. If we do a summer event next year, we'll overbook a few to avoid this problem.



UPDATES

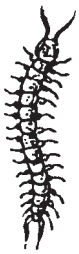


Colorado, Boulder: Threatening notes were e-mailed to and left at laboratories in the Ecology and Evolutionary Biology Department on the University of Colorado, Boulder, campus in early July 2007. The *Denver Post* (2007 Jul 10) reported, "The messages included the name of a religious-themed group and addressed the debate between evolution and creationism," and quoted a campus police officer as saying, "There were no overt threats to anybody specifically by name ... It basically said anybody who doesn't believe in our religious belief is wrong and should be taken care of." A report in the *Colorado Daily* (2007 Jul 16) added the details that the notes were "marked with skull and crossbones" and compared biology professors to child molesters. Police are investigating, and have increased their patrols in and around the science buildings on campus. The chief suspect is reportedly a Messianic Jew named Michael Korn. Jeffry B Mitton, the chair of the university's Department of Ecology and Evolutionary Biology, told Wired News (2007 Jul 17) that Korn's "picture has been circulated on flyers saying: 'If you see this guy dial this number'" but added that it was his understanding that Korn and his wife left the Boulder area suddenly.

Florida, Palm Beach County: A local parent's censorship effort was frustrated when the Palm Beach County School Board voted unanimously on July 11, 2007, to deny her request to remove eighty books discussing what she regards as objectionable topics from the school libraries in the Palm Beach County schools (*South Florida Sun-Sentinel* 2007 Jul 12). Although Laura Lopez objected primarily to books discussing homosexuality, abortion, and atheism, the *Palm Beach Post* mentioned evolution as among her targets (2007 Jul 21), and a columnist for the same newspaper wrote, "Oh, and another thing, she's sick and tired of the public schools for spreading all that nonsense about The Big Bang theory, because as she says, 'the world was created 6000 years ago.' I agree with her that the public schools are very light in their teaching of those early days when people were *Tyrannosaurus* food. And if that's your issue — making sure that your children learn that the collected wisdom of science is dead wrong — then public schools are in regrettable shape" (2007 Jul 18). Lopez's request was denied by two schools and by the superintendent of the school system before it reached the school board; she plans to return with a petition supporting her request and to explore the possibility of taking legal action with the American Center for Law and Justice (*Boca Raton News* 2007 Jul 13).

Kentucky: Answers in Genesis's Creation Museum continues to spark controversy. Noting that the Northern Kentucky Convention and Visitors Bureau's website describes the museum as aiming to "counter evolutionary natural history museums that turn countless minds against Christ and Scripture," Daniel Phelps, the president of the Kentucky Paleontological Society, protested the inflammatory description. His protests were ignored by the agency until the story was broken in the media. Phelps told the *Cincinnati Enquirer* (2007 Aug 26) that it was inappropriate for the tax-supported tourism agency to express such a view. "There's many people who are very religious, and they don't have a problem with evolution," he added. "If the creationists want to say things like that on their own Web site, that's their business."

A spokesperson for the agency told the *Enquirer* that the language was taken from Answers in Genesis, explaining, "We simply provide a listing and description on the Web site as a service to them," but declined to comment on whether the agency would



And, finally, what may be the big question for some: How much time did you spend?

About 80 hours during the semester, 40 in the last week before the workshop, and about 20 hours in follow-up work such as arranging for credit and assembling data. Other grad students spent about 40 hours altogether, but most of that was the day of the workshop, unless they were presenters. Presenting, by the way, is an excellent opportunity for a grad student to get some experience.

Any further advice for people who want to organize a series of workshops of their own?

Carpe diem! If this appeals to you, there's no reason to delay action. There will always be pressures on your time, and the issue is perennially controversial. On the other hand, just a few e-mails are likely to net you some committed, passionate helpers. Don't be shy about asking for help from local businesses, universities, and museums. I am willing to answer questions any time; just e-mail me at findbliss@hotmail.com.

We have high hopes that this workshop will be repeated annually and further that it will be emulated in other states and at other universities.

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consider revising the description of the Creation museum. Phelps responded, "It's a local attraction, and they should be listed on their Web site ... But they don't need to say anything negative about a regular natural-history museum, and I just was amazed." A spokesperson for Answers in Genesis defended both the agency's use of the ministry's description of the museum and the accuracy of the description itself, saying that natural history museums indeed turn countless minds against the Bible "when they present an evolutionary view that's in contrast with what the Bible says."

Shortly after the *Enquirer* broke the story, the Northern Kentucky Convention and Visitors Bureau quietly revised its website to provide a less inflammatory description of the museum, which is now described as offering "[a] walk through history via the pages of the Bible — exploring how scripture provides an eyewitness account of the beginning of all things." Phelps told the *Enquirer* (2007 Sep 1), "Well, at least it's not inflammatory ... I worry about separation of church and state, but at the same time, it is a local tourist attraction, so it's probably not something we should be concerned about anymore." Neither representatives of the tourism agency nor spokespeople for Answers in Genesis were available for comment, the *Enquirer* reported.

Massachusetts: In a recent oped in the *Boston Globe* (2007 Aug 9), Sally Lehrman discussed the challenges confronting evolution education even in Massachusetts, a state not conspicuous for its level of anti-evolution activity. "A well-thought-out curriculum in science does not guarantee that evolution will be taught in all its glory — or even coherently," she observed, noting that science teachers often express a lack of confidence in their knowledge of evolution (as the AAAS's president Gilbert S Omenn reported in 2006; see his report available on-line via <http://www.aaas.org/programs/centers/pe/evoline/>) and that in Massachusetts, teachers licensed for biology are not required to have taken a course on evolution.

Massachusetts's science standards received a grade of A from the Fordham Foundation in 2005, and its treatment of evolution received a score of 3/3, with the comment, "Especially impressive for instruction in biological diversity and evolution is the recently posted high school material, free as it is of common errors and glosses." But Lehrman observes, "Some teachers assign their evolution module a slot at the end of the year, then run out of time. Some speed right through it," for, as NCSE's Education Project Director Louise Mead told her, "The state standards say nothing about what goes on in the classroom."

Complicating the situation even in Massachusetts are the efforts of creationists. Lehrman notes the very latest tactic: "A new high-school textbook from the Discovery Institute, *Explore Evolution*, claims to teach students critical thinking but instead uses pseudoscience to attack Darwin's theories." (For a preliminary assessment, see *RNCSE* 2006 Nov/Dec; 26 [6]: 15–16.) And she adds, "The National Center for Science Education, which tracks trends in schools, has compiled a frightening list of bills and local proposals intended to open the door for creationist teaching in science education."

Texas: On July 17, 2007, Don McLeroy was appointed by Texas governor Rick Perry (R) to chair the state board of education, succeeding Geraldine Miller. A member of the board for the last eight years, McLeroy was described by the *Dallas Morning News* (2007 Jul 18) as "aligned with social conservative groups known for their strong stands on evolution, sexual abstinence and other heated topics covered in textbooks" and as "[o]ne of four board members who voted against current high school biology books because of their failure to list weaknesses in the theory of evolution."

In a statement issued on July 17, 2007, Texas Freedom Network's president Kathy Miller chided Governor Perry for his choice, writing, "Texas parents should be troubled that the governor has appointed as head of the state board a clear ideologue who has repeatedly put his own personal and political agendas ahead of sound science, good health and solid textbooks for students. Even worse, Mr McLeroy will now be in charge of the board's scheduled revision of the state's science curriculum standards, an area where he has already cast his lot with extremists who want to censor what our schoolchildren learn."

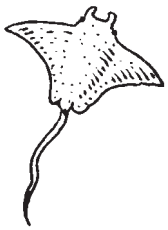
The state's newspapers also expressed concern about McLeroy. Referring to previous ideological struggles in which the board was involved, the *Dallas Morning News* (2007 Jul 19) worried, "The elevation of veteran board member Don McLeroy to the chairman's post raises concerns that the board is headed back in that direction," and urged McLeroy to steer clear of "the bitterness of past culture wars." Similarly, the *Austin American-Statesman* (2007 Jul 22) commented, "McLeroy's elevation to chairman comes as the board begins a revision of science standards for public schools. That could prove embarrassing for Texas if McLeroy pushes for standards that push theology over science."

A document on McLeroy's personal website entitled "Historical Reality" (<http://www.donmcleroy.com/Textbooks/Historical_Reality.htm>) and dated September 8, 2003, offers a glimpse of McLeroy's understanding of evolutionary science. Relying on discredited sources as Michael Behe's *Darwin's Black Box*, Jonathan Wells's *Icons of Evolution* and Percival Davis and Dean Kenyon's *Of Pandas and People* as well as on tendentious misreadings of legitimate science and on long-ago-debunked creationist claims, McLeroy there argued that common descent is "only a hypothesis, and a shaky one at that." He then urged his colleagues on the board to reject the books then under consideration — a plea that was ultimately ignored.

McLeroy's views on evolution were again in the news after the Texas Freedom Network accused him, in a press release dated August 7, 2007, of harboring "a shocking hostility to both sound science education and religious tolerance." TFN's charge was based on the transcript of a 2005 talk McLeroy gave at Grace Bible Church in Bryan, Texas, on the debate over teaching evolution and "intelligent design". "This recording makes

clear the very real danger that Texas schoolchildren may soon be learning more about the religious beliefs of politicians than about sound science in their biology classes," TFN President Kathy Miller said.

Discussing his 2003 vote against high school biology books because of their failure to list supposed weaknesses in evolutionary theory, McLeroy lamented that the other board members were not swayed by "all the arguments made by all the 'intelligent design' group[s], all the creationist 'intelligent design' people," adding, "It was only the four really conservative, orthodox Christians on the board [who] were willing to stand up to the textbooks and say they don't present the weaknesses of evolution. Amazing." TFN's Kathy Miller observed, "[I]t appears that Don McLeroy believes anyone who disagrees with him can't be a true Christian."



Following Phillip Johnson, McLeroy portrayed "intelligent design" as a "big tent" in his talk, explaining, "It's because we're all lined up against the fact that naturalism, that nature is all there is. Whether you're a progressive creationist, recent creationist, young earth, old earth, it's all in the tent of 'intelligent design'." He urged his listeners, biblical inerrantists like himself, "to remember, though, that the entire 'intelligent design' movement as a whole is a bigger tent. ... just don't waste our time arguing with each other about some of the, all of the side issues." Yet he described theistic evolution — which is opposed to naturalism as he defined it — as "a very poor option," continuing, "no one in our group represents theistic evolution, and the big tent of intelligent design does not include theistic evolutionists. Because intelligent design is opposed to evolution. Theistic evolutionists embrace it."

"McLeroy's statements during his lecture are particularly insulting to Roman Catholics and millions of other Christians who see no conflict between their religious faith and accepting the science behind evolution," TFN's Kathy Miller commented. "He might as well have put up a sign that said, 'Only my kind of Christian need apply.'" Texans are currently bracing for a new round of anti-evolution activity aimed at undermining the treatment of evolution in the state science standards (the Texas Essential Knowledge and Skills, or TEKS), to which textbooks submitted for adoption in Texas are required to conform.

National: Despite the worries expressed by pro-science activists in Ohio, Kansas, and elsewhere, Ken Willard was elected to the position of president-elect of the National Association of State Boards of Education in July 2007. According to a July 13, 2007, press release from NASBE, "Willard will begin his term of office in January 2008 and then serve as president of the association in the following year." The only other candidate for the position withdrew for personal reasons; there were efforts among pro-science activists to run a write-in campaign, although there is no provision for write-in votes in NASBE's by-laws. It was Willard's service on the Kansas state board of education that provoked concern: Jack Krebs of Kansas Citizens for Science told the *Lawrence Journal-World* (2007 May 23) that Willard's advocacy for "intelligent design" was not the only worrying aspect of his candidacy. (For background, see *RNCSE* 2007 Jan–Apr; 27 [1–2]: 4–9.)

National: *The Atlas of Creation*, a massive volume by the pseudonymous Islamic creationist Harun Yahya distributed throughout Europe in early 2007, is now being circulated to scientists in the United States. *The New York Times* (2007 Jul 17) reported that copies of the book are "turning up, unsolicited, in mailboxes of scientists around the country and members of Congress, and at science museums in places like Queens and Bemidji, Minnesota. At 11 x 17 inches and 12 pounds, with a bright red cover and almost 800 glossy pages, most of them lavishly illustrated, *Atlas of Creation* is probably the largest and most beautiful creationist challenge yet to Darwin's theory, which Mr Yahya calls a feeble and perverted ideology contradicted by the Koran."

Among the recipients were University of California, Berkeley, paleontologist Kevin Padian (who serves as president of NCSE's board of directors) and Brown University cell biologist Kenneth R Miller (a Supporter of NCSE). Both marveled at the production values of the *Atlas*, with Miller estimating that such a book would cost at least $100 in a retail bookstore, but both were dismissive of its content, with Padian commenting that Harun Yahya "does not really have any sense of what we know about how things change through time." Padian added that he thought that the distribution of the *Atlas* would have little effect in the United States: "We are used to books that are totally wrongheaded about science and confuse science and religion."

It is unclear how the recipients were chosen. The *Times* noted the irony that Padian and Miller, who served as expert witnesses for the plaintiffs in *Kitzmiller v Dover*, in which teaching "intelligent design" creationism in the public schools was ruled to be unconstitutional, were on the list, as was Ohio State University biologist Steve Rissing (a member of NCSE), a long-time defender of education evolution. It is also unclear how the campaign is funded. Truman State University physicist Taner Edis (a member of NCSE), author of the recent book *An Illusion of Harmony: Science and Religion in Islam* (Amherst [NY]: Prometheus Books, 2007), told the *Times* that Harun Yahya's activities are generally described in the Turkish press as funded by "donations," adding, "But what that can mean is anybody's guess."

Toward the end of the article, the *Times*'s reporter wrote, "As the scientists ponder what to do with the book — for many, it is too beautiful for the trash bin but too erroneous for their shelves — they also speculate about the motives of its distributors." (The *Times* was unable to reach the shipper; the publisher, Global Publishing of Istanbul; or Harun Yahya himself.) NCSE's executive director Eugenie C Scott commented, "My hypothesis is, like all creationists, they believe that they have a startling truth that the public has been shielded from, and that if they present the facts, in quotation marks, that the scales will fall from the eyes and the charade of evolution

will be revealed." She added, "These people are really serious about this."

Canada, Roxton Falls: Evolution education was cited as among the reasons that a Mennonite community in Roxton Falls, Quebec — a town of 1300 about seventy miles east of Montreal — is considering departing the province. The *National Post* (2007 Aug 16) reported, "Fifteen English-speaking Mennonite families in this small community in the Monteregie Region say they won't send their children to government-approved schools, balking at the teaching of evolution, the acceptance of gays and lesbians and low 'morality standards.'" The families moved to Quebec from Manitoba in the 1990s; reports about unsanctioned schools in 2006 (see *RNCSE* 2006 Jul/Aug; 26 [4]: 13–16) led to a government investigation of the Mennonite private school in Roxton Falls, which fails to adhere to Quebec's official curriculum. Warned of possible legal consequences, the families are considering moving to Ontario or New Brunswick; at least in Ontario, independent schools are not required to teach evolution. A spokesperson for the Quebec ministry of education explained, "We are not trying to prevent them from living their life the way they want, but they have to obey the law when it comes to educating their kids."

Turkey: Wordpress, a San Francisco-based platform for bloggers, announced on its own blog on August 19, 2007, that the Turkish government apparently blocked all access to the blogs it hosts, due to a court decision obtained by Adnan Oktar, whose organization Bilim Aratırma Vakfı publishes a host of Islamic creationist books under the pen name Harun Yahya. Oktar reportedly objected to the unflattering treatment of him on a number of blogs hosted by Wordpress, which reproduced a letter purportedly from Oktar's lawyer explaining the block and demanding that Wordpress "remove and prohibit any blogs in your site that contain my client's name Adnan Oktar or his pen name Harun Yahya or various combination of these 4 names" (see <http://wordpress.com/blog/2007/08/19/why-were-blocked-in-turkey/>). Deutsche Presse Agentur reported (2007 Aug 20) that a lawyer for Oktar explained that the court first ordered Turk Telecom to block a few sites but, because the allegedly libelous content was relocated to different Wordpress sites, "we applied to the court to order that all websites of Wordpress be blocked." DPA added, "The sites that Oktar's lawyers wanted removed were written by Edip Yuksel and his supporters. Yuksel is described as an Islamic reformist who is based in the United States and who has frequently criticized Oktar."

Vatican City: Speaking to a group of Italian priests on July 24, 2007, Pope Benedict XVI again addressed the topic of evolution. Referring to debates over creationism in Germany and the United States, he suggested that evolution and belief in God the creator are presented "as if they were alternatives that are exclusive — whoever believes in the creator could not believe in evolution, and whoever asserts belief in evolution would have to disbelieve in God," as the *New York Post*'s article (2007 Jul 26) translated it. "This contrast is an absurdity," he continued, "because there are many scientific tests in favor of evolution, which appears as a reality that we must see and enriches our understanding of life and being. But the doctrine of evolution does not answer all questions, and it does not answer above all the great philosophical question: From where does everything come?" A transcript of his remarks, in Italian, is available on the Vatican's website.

The Pope's most recent remarks, although brief, suggest that he is continuing to maintain a form of theistic evolutionism, as he reportedly did in his contribution to *Schöpfung und Evolution* (Augsburg: Sankt Ulrich Verlag, 2007), the proceedings of a seminar on creation and evolution that he conducted with his former doctoral students in September 2006; according to Reuters (2007 Apr 11), "In the book, Benedict defended what is known as 'theistic evolution,' the view held by Roman Catholic, Orthodox and mainline Protestant churches that God created life through evolution and religion and science need not clash over this" (see *RNCSE* 2006 Nov/Dec; 26 [6]: 8). Although Cardinal Christoph Schönborn's 2005 *New York Times* op-ed "Finding Design in Nature," which seemed to express sympathy for "intelligent design" creationism, was widely feared to herald a possible shift in the Catholic Church's attitude toward evolution, subsequent developments, including a series of clarifications from Schönborn, have for the most part indicated otherwise.

Kentucky Park Naturalists Visit "Creation Museum"

The opening of the Answers in Genesis Creation Museum has brought a steady stream of people to northern Kentucky, and some of them are also visiting state parks. The naturalists on the park staff interpret and explain the natural history of the parks to visitors, and, according to a report in the Lexington, Kentucky, *Courier Journal* (2007 Sep 1), visitors who have come from the Creation Museum are challenging these interpretations. So, in an effort to learn more about the source and basis of visitors' objections, Chief Naturalist Carey Tichenor announced that a group of staff members will visit the Museum in early November 2007.

Tichenor emphasized that the park naturalists do not want to try to dissuade park visitors from their religious beliefs. "We will tell [visitors] if they want to believe what they saw at the Creation Museum that's fine and good," he said. "And then we explain to them why we are saying what we say at the park — which is interpreting the scientific evidence produced for the site."

Kentucky Secretary of Commerce George Ward, whose cabinet portfolio includes the Department of Parks, told the *Courier Journal*, "This trip will let our naturalists be better prepared to deal with questions they get, and they will continue to talk about the scientific explanations at their parks." However, when asked about the state's promoting the creation museum through its visitors' bureau (see p 6), Ward said, "[W]e also have a role to promote tourism in Kentucky, and we see the Creation Museum as a tourism attraction."

NCSE NEWS

Comings and Goings

Glenn Branch, NCSE Deputy Director

It's mid-August 2007 as I'm writing, and it's been a bit of a whirl here in the office: one staff member is preparing to depart and four new staff members — two full-time, two part-time — are settling in. I hope that you'll join me and the rest of the staff in welcoming the newcomers and bidding farewell to the departing staffer.

Nick Matzke

Nick Matzke, Public Information Project Director, is leaving NCSE to begin a PhD program at the Department of Integrative Biology at the University of California, Berkeley. He came to NCSE in early 2004, planning to spend a year here before starting a PhD program (see *RNCSE* 2004 Jan/Feb; 24 [1]: 16); we feel fortunate to have had him around for two extra years. In addition to working at NCSE, he somehow found the time not only to blog regularly at The Panda's Thumb but also to contribute to the scholarly literature, coauthoring articles for *Nature Immunology*, *Natural Reviews Microbiology*, and *Proceedings of the National Academy of Sciences (USA)*, and contributing a chapter tracing the beginnings of "intelligent design" to the mid-1980s litigation over creation science to the new edition of *But Is It Science? The Philosophical Question in the Creation/Evolution Controversy* (Amherst [NY]: Prometheus Books, forthcoming). *Seed* magazine (2006: 2 [7]: 62) profiled him as one of its nine "Revolutionary Minds".

It was in the *Kitzmiller v Dover* case, however, that Matzke's star shone brightest. The staffer who was originally assigned to the case when it seemed as though it was just going to be a routine affair, he was instrumental throughout the case, providing a wealth of scientific expertise and practical advice to the legal team representing the plaintiffs. In his book on the case, *40 Days and 40 Nights* (New York: Collins, 2007), Matthew Chapman humorously wrote of Matzke, "The NCSE staffer initially assigned to the Dover flare-up, he now briefed the lawyers on the arcane ins and outs of science. Bespectacled, in his thirties, he was tall and large and peered down at you with a look of beleaguered doubt, as if to say, "You're asking me this question about science, but you know and I know that you're not going to understand my answer, so, although I find this stuff fascinating, wouldn't you really rather go for a beer?" We'll be buying him one or two as we bid him a fond farewell. At Berkeley he can be reached at matzke@berkeley.edu.

Wesley R Elsberry

Wesley R Elsberry, Information Project Director, took a year's leave from NCSE to work as a Visiting Research Associate in the Lyman Briggs School of Science at Michigan State University. There he is collaborating with Robert T Pennock on a project examining the evolution of intelligent behavior using the artificial life platform Avida. He writes, "This project brings together a number of the topics that have interested me throughout my life: computation, evolutionary biology, and cognitive science." Joining NCSE to take care of the computers in Elsberry's absence on a part-time basis is **Stuart Fogg**, who brings extensive — and much-needed — experience with networking, Windows, Unix, and Macintosh systems with him. Also now working part-time for NCSE is **David Almandsmith**, formerly a volunteer, who is helping with a number of clerical and administrative tasks; he replaces **Alex Wing**, who worked part-time here from December 2005 to June 2007.

David Almandsmith

Joshua Rosenau is NCSE's new Public Information Project Director, joining **Susan Spath** and replacing **Nick Matzke**. Rosenau comes to NCSE from the University of Kansas, where he was a graduate student in the Department of Ecology and Evolutionary Biology; he expects to complete and defend his dissertation on *Modeling Limits on Species' Ranges* by the end of 2007. In Kansas, he witnessed at first hand the antics of the creationist majority on the state board of education to undermine the treatment of education in the state science standards, and worked with the Kansas Coalition for Science and Kansas Citizens for Science to expose the problems with the majority's evolution-unfriendly version of the standards. His blog Thoughts from Kansas — which will have to be renamed now! — is part of the popular ScienceBlogs collection run by the publishers of *Seed* magazine, and he belongs to the National Association of Science Writers. At NCSE, he will be working to help parents, teachers, and citizens in general who are facing challenges to evolution education in their communities; he will also be helping to improve NCSE's communi-

Joshua Rosenau

cation with the public and the press. (His e-mail address here is rosenau@ncseweb.org.)


Anne D Holden

Finally, **Anne D Holden** is NCSE's new Postdoctoral Scholar, replacing, after a hiatus, **Alan Gishlick**, who is now a visiting assistant professor in the Department of Geology at Gustavus Adolphus College in Saint Peter, Minnesota. Holden comes to NCSE from the University of California, Berkeley, where she was a postdoctoral researcher in the Department of Integrative Biology, working with Leslea Hlusko; she earned her PhD in biological anthropology from Cambridge University, with a dissertation entitled *Sahara Passage: The Post-Glacial Re-colonization of North Africa by Mitochondrial L Haplotypes and its Role in Modern African Genetic Diversity*. In addition to her scientific work, she is keenly interested in communicating science to the general public: a member of the National Association of Science Writers, her publications include essays published on-line in *The Naked Scientists* and *Inklings*. At NCSE, she will be helping to develop new educational and scientific resources and also, we hope, assisting in writing grants to enable NCSE to continue and expand its efforts to defend the teaching of evolution in the public schools. (Her e-mail address here is holden@ncseweb.org.)

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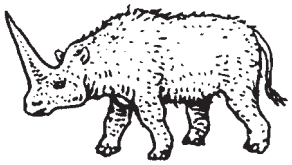


News from the Membership

Glenn Branch, NCSE Deputy Director

From time to time we like to report on what our members are doing. As the following list shows, they — and we — have a lot to be proud about!

NCSE Supporter **Francisco Ayala** was interviewed by *US Catholic* (published by the Claretian Missionaries) for the cover story of its August 2007 issue (pages 13–6). Ayala addressed evolution and the overwhelming evidence for it, the scientific vacuity and theological shortcomings of "intelligent design", the recent discussion within the Catholic church about evolution, and the future of the science/religion dialogue. With respect to Cardinal Christoph Schönborn's 2005 op-ed in *The New York Times* that was widely perceived as questioning evolution, Ayala said:

> I think he was taken advantage of. It turns out the vice president of the Discovery Institute in Seattle, an 'intelligent design' think tank, is a friend of Schönborn. He persuaded the cardinal to write about 'intelligent design', and the institute's public relations firm sent the article to *The New York Times*.
>
> Within a month after it broke, three of us wrote a letter to the pope: a Catholic biologist named Kenneth Miller, who had written a wonderful book on the subject; a physicist named Lawrence M Krauss; and me. We suggested there would be severe consequences for the Catholic Church in relation to science if Schönborn's piece were allowed to stand.
>
> Within a month Schönborn essentially retracted the article in a speech at one of the Catholic universities in Vienna. He put his talk, in German, on his website. Of course not too many people here are likely to read long speeches in German. Then he issued a statement to the press saying that he was misunderstood and what he meant is not what he actually said.

Ayala is the Donald Bren Professor of Biological Sciences in the Department of Ecology and Evolutionary Biology at the University of California, Irvine; his latest book is *Darwin's Gift* (Washington [DC]: Joseph Henry Press, 2007).

Sean B Carroll reviewed the latest production of "intelligent design" proponent Michael Behe for *Science* (2007; 316: 1427–8), contending that in *The Edge of Evolution* "Behe makes a new set of explicit claims about the limits of Darwinian evolution, claims that are so poorly conceived and readily dispatched that he has unwittingly done his critics a great favor in stating them." "Behe's chief error," he wrote, "is minimizing the power of natural selection to act cumulatively as traits or molecules evolve stepwise from one state to another via intermediates." The error is manifest both in Behe's reasoning — Carroll cited a number of problems, particularly a lack of quantitative thinking — and in his neglect of relevant scientific facts, causing Carroll to wonder, "Is it possible that Behe does not know this body of data? Or does he just choose to ignore it?" He concluded: "The continuing futile attacks by evolution's opponents reminds me of another legendary confrontation, that between Arthur and the Black Knight in the movie *Monty Python and the Holy Grail*. The Black Knight, like evolution's challengers, continues to fight even as each of his limbs is hacked off, one by one. ... The knights of ID may profess these blows are 'but a scratch' or 'just a flesh wound,' but the argument for design has no scientific leg to stand on." Carroll is a professor of biology at the University of

Wisconsin, Madison, and a Supporter of NCSE. For descriptions of reviews of *The Edge of Evolution* by **Jerry Coyne**, **Kenneth R Miller**, and **Michael Ruse**, see below. Additionally, see *RNCSE* 2007 Jan–Apr; 27 (1–2): 38–40 for a review by **David E Levin**, and *The New York Times* Sunday Book Review (2007 Jul 1) for a no-holds-barred review by Richard Dawkins.

Two of the three scholars newly elected as Fellows of the Committee for Skeptical Inquiry (formerly the Committee for the Scientific Investigation of Claims of the Paranormal) are affiliated with NCSE: **Sean B Carroll**, a professor of molecular genetics at the University of Wisconsin, Madison; the author of *Endless Forms Most Beautiful* (New York: WW Norton, 2005) and *The Making of the Fittest* (New York: WW Norton, 2006), and a Supporter of NCSE, and **Barbara Forrest**, a professor of philosophy at Southeastern Louisiana University, coauthor with **Paul R Gross** of *Creationism's Trojan Horse: The Wedge of Intelligent Design* — now available in paperback (New York: Oxford University Press, 2007) — and a member of NCSE's board of directors. For details, see *Skeptical Inquirer* (2007 Sep/Oct; 31 [5]: 8–9). Of interest in the same issue of *Skeptical Inquirer* are a column discussing recent public opinion polls on evolution (p 5–6), a box discussing one Canadian's campaign to convince the government to support evolution (p 6), a review of the recent Broadway revival of *Inherit the Wind* (p 11), a note about **Andrew Fraknoi**'s award from the Astronomical Society of the Pacific (p 14; see below), and a response by the authors of *The Top 10 Myths about Evolution* to *Skeptical Inquirer*'s review of their book (p 66).

Jerry Coyne devoted 7500 words to reviewing Michael Behe's *The Edge of Evolution* in the June 18, 2007, issue of *The New Republic*, providing a great deal of useful background information in the process. Coyne, like **Sean B Carroll** (see above), worried about the propaganda value of the book, writing, "The general reader, at whom *The Edge of Evolution* is aimed, is unlikely to find the scientific holes in its arguments. Behe writes clearly and engagingly, and someone lacking formal training in biochemistry and evolutionary biology may be easily snowed by his rhetoric." In fact, however, Behe's arguments betray "a profound, almost willful ignorance of the evolutionary process," and his offered alternative of "intelligent design" is "infinitely malleable in the face of counterevidence, cannot be refuted, and is therefore not science." Coyne summarized: "Behe's new theory remains the same old mixture of dead science and thinly disguised theology. There is no evidence for his main claim of non-random mutation, and scientists have plenty of evidence against it. His arguments against the Darwinian evolution of complex organisms are flawed and misleading. And there is not a shred of evidence supporting his claim that the goal of evolution is intelligent life." Coyne is a professor in the Department of Ecology and Evolution at the University of Chicago. For descriptions of reviews of *The Edge of Evolution* by **Sean B Carroll**, **Kenneth R Miller**, and **Michael Ruse**, see above and below.

Writing in *Trends in Biochemical Sciences* (2007; 32 [7]: 301–10), **Barbara Forrest** and **Paul R Gross** took the case against "intelligent design" to biochemists. Forrest and Gross are the authors of the definitive history of the "intelligent design" movement's so-called Wedge strategy, *Creationism's Trojan Horse: The Wedge of Intelligent Design* — now available in paperback (New York: Oxford University Press, 2007) with a new chapter on *Kitzmiller v Dover*, in which Forrest, a member of NCSE's board of directors, was a pivotal expert witness for the plaintiffs. The abstract of their article:

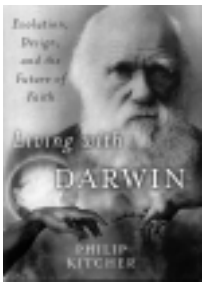
> Creationists are attempting to use biochemistry to win acceptance for their doctrine in the public mind and especially in state-funded schools. Biochemist Michael Behe is a major figure in this effort. His contention that certain cellular structures and biochemical processes — bacterial flagella, the blood-clotting cascade and the vertebrate immune system — cannot be the products of evolution has generated vigorous opposition from fellow scientists, many of whom have refuted Behe's claims. Yet, despite these refutations and a decisive defeat in a US federal court case, Behe and his associates at the Discovery Institute continue to cultivate American supporters. They are also stepping up their efforts abroad and, worryingly, have achieved some success. Should biochemists (and other scientists) be concerned? We think they should be.

Although Forrest and Gross survey Behe's involvement with creationism from before his book *Darwin's Black Box* to the aftermath of the *Kitzmiller* trial, Behe's new book *The Edge of Evolution* (New York: Free Press, 2007) — which has already taken a pounding in review after review after review — is not discussed in the article. But Forrest and Gross in effect already saw it on the horizon, for in their concluding paragraph, they write, "If there is a single most important lesson for scientists and concerned citizens, it is that creationists never give up. They merely change their strategy with each defeat, necessitating corresponding adjustments and constant vigilance by their opponents."

Andrew Fraknoi was named the recipient of the 2007 Robert H Emmons Award for Excellence in College Astronomy Teaching by the Astronomical Society of the Pacific. In a May 15, 2007, press release, the ASP wrote, "A distinguished astronomy educator with a national reputation, Mr Fraknoi is a long-time very popular community college instructor, textbook author, co-founder of the *Astronomy Education Review*, prolific writer and speaker, founder of the 'Cosmos in the Classroom' workshops for college faculty, and former Executive Director of the ASP." Fraknoi teaches astronomy at Foothill College in Los Altos Hills, California; he is a coauthor of the valuable publication "An ancient universe: How

astronomers know the vast scale of cosmic time" (*The Universe in the Classroom* 2001 Fall; 56: 1–23; available on-line via <http://www.astrosociety.org/education/publications/tnl/56/index.html>).

Philip Kitcher appeared on the Center for Inquiry's podcast Point of Inquiry for July 13, 2007, discussing his latest book, *Living with Darwin: Evolution, Design, and the Future of Faith* (New York: Oxford University Press, 2006), with host DJ Grothe. (Visit <http://www.pointofinquiry.org/?p=118> to listen.) *Living with Darwin* received a glowing review from H Allen Orr in the *New York Review of Books* (2007 Aug 16; 54 [13]: 33–5). Orr wrote, "Kitcher's survey of creationist thought is superb and his conclusion unequivocal: all three creationist positions are hopelessly flawed. They are dead science." And concluding his review, he added, "In a time of strident pronouncements on the intersection of science and religion, Kitcher has introduced a calm and human voice. We Darwinians could do much worse than to listen to it." A Supporter of NCSE, Kitcher is the John Dewey Professor of Philosophy at Columbia University. He is the author of many books, including the classic critique of young-earth creationism, *Abusing Science: The Case Against Creationism* (Cambridge [MA]: MIT Press, 1982), which Orr credited with playing a part "in the demise of scientific creationism".



William F McComas is the winner of the 2007 Evolution Education Award from the National Association of Biology Teachers, according to a press release issued on August 29, 2007, by the American Institute of Biological Sciences. The award, sponsored by AIBS and the Biological Sciences Curriculum Study, recognizes innovative classroom teaching and community education efforts to promote the accurate understanding of biological evolution. "Only by recognizing and discussing the challenges of evolution instruction and by developing and sharing strategies for its solution can we hope to return evolution to its rightful place as the unifying concept of modern biology," McComas was quoted as saying in a press release issued on August 27, 2007, by the University of Arkansas, where he is the Parks Family Professor of Science Education in the College of Education and Health Professions. He will receive the award, which includes a plaque and a prize of $1000, at the NABT national conference in Atlanta, Georgia, in November 2007, where he will deliver the inaugural Kendall/Hunt Lecture in Biology Education. A long-time member of NCSE, McComas is the author of numerous articles on science education and the editor of two books, the latest being *Investigating Evolutionary Biology in the Laboratory* (Dubuque [IA]: Kendall/Hunt 2006).


William F McComas and friend
Photo: Kim McComas

NCSE Supporter **Kenneth R Miller** weighed in with his critical review of the new book from "intelligent design" proponent Michael Behe, published in *Nature* (2007; 447: 1055–6). Miller began with the sociopolitical context, writing, "Michael Behe's new book, *The Edge of Evolution*, is an attempt to give the intelligent-design movement a bit of badly needed scientific support. After a spectacular setback in the 2005 Dover, Pennsylvania, intelligent-design trial ... , and the 2006 electoral losses in Ohio and Kansas, the movement could use some help — and Behe is eager to provide it."

But Miller quickly moved to the content of the book, focusing on a central calculation that, Behe alleges, reveals the "limits of Darwinism." On the contrary, Miller wrote: "at the heart of his anti-Darwinian calculus are numbers not merely incorrect, but so spectacularly wrong that this badly designed argument collapses under its own weight ... It would be difficult to imagine a more breathtaking abuse of statistical genetics. ... A mistake of this magnitude anywhere in a book on science is bad enough, but Behe has built his entire thesis on this error."

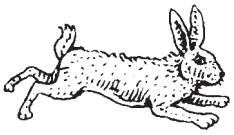
Concluding, Miller returned to the sociopolitical context: "No doubt creationists who long for a scientific champion will overlook the parts of this deeply flawed book that might trouble them, including Behe's admission that 'common descent is true', and that our species shares a common ancestor with the chimpanzee. Instead, they will cling to Behe's mistaken calculations, and proclaim that the end of evolution is at hand. What this book actually demonstrates, however, is the intellectual desperation of the intelligent-design movement as it struggles to survive in the absence of even a shred of scientific data in its favour."

Miller is Professor of Biology at Brown University, the coauthor (with Joseph Levine) of three widely used high school biology textbooks, and the author of *Finding Darwin's God: A Scientist's Search for Common Ground Between God and Evolution* (San Francisco: Cliff Street Books, 1999), and the forthcoming *Devil in the Details: Evolution and the Battle for America's Soul* (New York: Viking/Penguin, 2007). He is also a Supporter of NCSE and received its Friend of Darwin award in 2003; he testified for the plaintiffs in *Kitzmiller v Dover*, the case in which it was ruled that it is unconstitutional to teach "intelligent design" creationism in the public schools. For descriptions of reviews of *The Edge of Evolution* by **Sean B Carroll, Jerry Coyne**, and **Michael Ruse**, see above and below.

Kevin Padian reviewed three books about *Kitzmiller v Dover*, in which teaching "intelligent design" creationism in the public schools was found to be unconstitutional, in the July 19, 2007, issue of *Nature* (448: 253–4). "A gullible and obstinate school board in the middle of Pennsylvania's rolling hills was just crazy enough to buy [intelligent design]," he wrote, "and that was the start of the now-famous Dover case." Summarizing

the different approaches of the books, Padian explained:

> The author of *40 Days and 40 Nights*, Matthew Chapman, is a great-great-grandson of Charles Darwin; his presumed vested interest in the proceedings is tempered by his own history as a school dropout, a movie screenwriter and a Brit with a perpetually bemused view of colonial antics. Still, his odyssey is a fulfilling one, and he seems genuine enough to get himself invited into many homes where insights and passions run deep. Gordy Slack, author of *The Battle Over the Meaning of Everything* and an experienced science writer and editor, likewise brings his own family baggage (his father is a staunch fundamentalist) to his account, but his reporting is more linear and his background research deeper. Edward Humes in *Monkey Girl* is even more scholarly and thorough in his approach, and contextualizes the trial historically. Unlike Chapman and Slack, he does not insert himself into his narrative, but his views of the proceedings are no less clear.



Padian praised all three of the books as "entertaining and informative," giving the nod to Humes's *Monkey Girl* on account of its comprehensiveness; he also mentions a fourth book, by local reporter **Laurie Lebo**, to appear on the trial, which, he said, "promises even more lively details of this perfect storm of religious intolerance, First Amendment violation and the never-ending assault on American science education." (Lebo's book, entitled *The Devil in Dover: A Journalist's Story of Dogma v Darwin in Small-Town America*, will appear in 2008.)

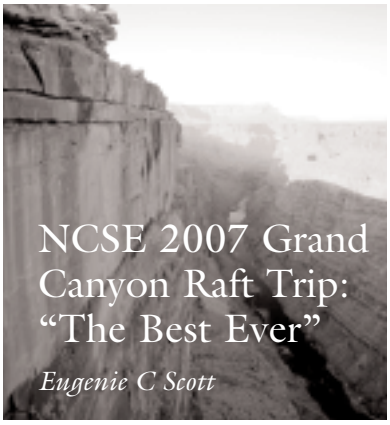
The president of NCSE's board of directors, Padian himself testified on behalf of the plaintiffs in the *Kitzmiller* trial; in his decision, Judge Jones commented, "Dr Padian's demonstrative slides, prepared on the basis of peer-reviewed scientific literature, illustrate how Pandas systematically distorts and misrepresents established, important evolutionary principles." A transcript of his expert witness testimony in the trial, complemented with the slides that he displayed in the courtroom, is available on-line at <http://www2.ncseweb.org/kvd/exhibits/Padian/Padian_transcript.html>.

Kevin Padian and his colleagues captured the cover of *Science* with their paper "A late Triassic dinosauromorph assemblage from New Mexico and the rise of dinosaurs" (*Science* 2007; 317: 358–61). In a July 19, 2007, press release, Padian was quoted as explaining the significance of the research reported in the paper: "Up to now, paleontologists have thought that dinosaur precursors disappeared long before the dinosaurs appeared, that their ancestors probably were out-competed and replaced by dinosaurs and didn't survive ... Now, the evidence shows that they may have coexisted for 15 or 20 million years or more." Speaking of the first two authors of the paper, graduate students Randall Irmis and Sterling Nesbitt, who excavated a host of new fossils from the Hayden Quarry at Ghost Ranch, Padian added, "Randy and Sterling were clever to find all this stuff; these guys have just done terrific work." Professor of Integrative Biology at the University of California, Berkeley, and Curator of Paleontology at the University of California Museum of Paleontology, Padian is also president of NCSE's board of directors.

Writing in the Toronto *Globe and Mail* (2007 Jun 2), **Michael Ruse** offered his assessment of Michael Behe's *The Edge of Evolution* with his customary affability, describing Behe as "warm and friendly" and saying that *Darwin's Black Box* "makes the case for ["intelligent design"] in the most user-friendly manner possible." But he was disappointed by *The Edge of Evolution*, which in comparison to *Darwin's Black Box* seemed "a bit of a sad sack. Nothing very much new, old arguments repeated, opposition ignored or dismissed without argument." What seems to interest Ruse the most about *The Edge of Evolution* is the degree to which it embraces claims that are anathema to young-earth creationists: "What does surprise me is how emphatic Behe now is in putting a distance between himself and the older Creationists. For a start, he stresses his commitment to evolution. He thinks the world of life is as old as is claimed by any more conventional biologist. He also wants to give natural processes of change a role in life's history." But in the end, Ruse found the book saddening: "with so many important issues waiting for attention in our society, I am just a bit depressed that anyone would think that something like ["intelligent design"] is worth pushing or that it gains so much attention others have to spend time refuting it." Ruse is a professor of philosophy at Florida State University and a Supporter of NCSE. For descriptions of reviews of *The Edge of Evolution* by **Sean B Carroll**, **Jerry Coyne**, and **Kenneth R Miller**, see above.

NCSE's executive director **Eugenie C Scott** was awarded the Viktor Hamburger Outstanding Educator Prize for 2007 from the Society for Developmental Biology, during the First Pan American Congress in Developmental Biology, held June 16–20, 2007, in Cancun, Mexico. The prize, established in honor of Viktor Hamburger, a pre-eminent embryologist and developmental neuroscientist of his era, recognizes individuals who have made outstanding contributions to developmental biology education. Previous recipients include Robert DeHaan, NCSE Supporter **Bruce Alberts**, Leon Browder, Lewis Wolpert, and Scott Gilbert. Founded in 1939, the Society for Developmental Biology seeks to promote the field of developmental biology and to advance our understanding of developmental biology at all levels.

Eugenie C Scott



NCSE 2007 Grand Canyon Raft Trip: "The Best Ever"

Eugenie C Scott

From July 17 to July 24, 2007, twenty-two NCSE members accompanied paleontologist Alan D Gishlick and me on two motorized rafts down the mighty Colorado River on a journey of over 300 miles. We began our trip at the traditional raft put-in at Lee's Ferry near Marble Canyon, Arizona, early in the morning of July 18. For the next seven days, we rafted the river — including running dozens of rapids, some of them at the 8–10 rating level — hiked side canyons, enjoyed delicious food, and camped at night under the brilliant Arizona stars.

Gishlick did a terrific job of helping us understand the geology of Grand Canyon, the 1200 meters or more of strata having been laid down as this part of the Colorado Plateau experienced a variety of ecological conditions over time. As we traveled down the river and back in time, NCSE's own "Gish" explained how different strata reflected different depositional conditions ranging from deep seas to marshes. He showed us fossils and explained how they help us to understand the ecological environment at the time the strata were laid down, and then explained how the canyon itself had been carved by a combination of the natural tendency of water to seek its own level, and the slow uplift of the Colorado Plateau.

My job, on the other hand, was to explain the creationist version of the formation and cutting of the Canyon, which took me far less time. (Short version, which is not much shorter than the long version: The Flood.) I do not think that the raft trip participants — the list included the usual assortment of biologists, chemists, physicists, computer scientists, and teachers — were especially persuaded by creationist science, and in fact they brought up many problems with the creation science "model".

The fellowship was excellent, the science was first-rate, and the weather was beautiful (remember: I grew up in Wisconsin, and dry hot weather is heavenly to me). The lack of rain meant the normally ruddy Colorado River stayed clear almost to the end of our trip. Washing oneself in the Colorado takes a bit of getting used to, assuming one does not usually bathe in chilly water, but after a day of hot sun, it feels great. Personally, I cannot wait to go back next year.

And if any readers or friends want to join me, the dates are from July 30 to August 6, 2008. We will be there for the start of the Pleiades meteor shower — always a treat. Visit NCSE's website <http://www.ncseweb.org/GC2008/> for information about the trip. Get in touch with Nina Hollenberg at NCSE if you want to sign up. A deposit of $500 will hold your place. But hurry: as I write, there are only 12 places left!

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Renewed Concern About Creationism at Grand Canyon National Park

Glenn Branch,
NCSE Deputy Director

Toward the end of 2006, Public Employees for Environmental Responsibility — "a national non-profit alliance of local, state and federal scientists, law enforcement officers, land managers and other professionals dedicated to upholding environmental laws and values" — charged the National Park Service with stalling on a promised review of a creationist book sold at the bookstores at Grand Canyon National Park. Although the park's bookstores are operated by a separate non-profit organization, the Grand Canyon Association, the National Park Service is responsible for approving the items that are sold there. In August 2003, the NPS approved the sale of *Grand Canyon: A Different View*, edited by Tom Vail and published by Master Books, the publishing arm of the Institute for Creation Research. *A Different View* expounds a young-earth creationist view of the geology of the canyon, and proclaims, "all contributions have been peer-reviewed to ensure a consistent and biblical perspective." In his review of the book (*RNCSE* 2004 Jan/Feb; 24 [1]: 33–6), the geologist Wilfred Elders described it as "'Exhibit A' of a new, slick strategy by biblical literalists to proselytize using a beautifully illustrated, multi-authored book about a spectacular and world-famous geological feature," adding, "Allowing the sale of this book within the National Park was unfortunate. In the minds of some buyers, this could imply NPS approval of young-earth creationists and their religious proselytizing."

After the sale of *A Different View* was approved, the superintendent of the park appealed to the NPS headquarters for "a review of the book in terms of its appropriateness," and the Chief of the Park Service's Geologic Resources Division recommended its removal, saying that it "does not use accurate, professional and scholarly knowledge; is not based on science but a specific religious doctrine; does not further the public's understanding of the Grand Canyon's existence; [and] does not further the mission of the National Park Service." Meanwhile, the sale of the book became a matter of public controversy (see *RNCSE* 2004 Jan/Feb; 24 [1]: 4–5). Elders's review appeared in *Eos* (the weekly newsletter of the American Geophysical Union); the presidents of the American Paleontological Society, the American Geophysical Union, the National Association of Geoscience Teachers, the Association of American State Geologists, the Society for Vertebrate Paleontology, the American Geological

Institute, and the Geological Society of America signed a joint letter to the NPS, urging that *A Different View* be removed "from shelves where buyers are given the impression that the book is about earth science and its content endorsed by the National Park Service" (see *RNCSE* 2004 Jan/Feb; 24 [1]: 19); and stories about the controversy appeared in the *Los Angeles Times* and *The New York Times*. A spokesperson for the NPS repeatedly assured the press and Congress that the promised review would be forthcoming.

In its December 28, 2006, press release, however, PEER charged, "Despite promising a prompt review of its approval for a book claiming the Grand Canyon was created by Noah's flood rather than by geologic forces, more than three years later no review has ever been done and the book remains on sale at the park." Jeff Ruch, executive director of PEER, commented, "As one park geologist said, this is equivalent of Yellowstone National Park selling a book entitled *Geysers of Old Faithful: Nostrils of Satan*." In a December 28, 2006, letter, PEER urged the new director of NPS, Mary Bomar, to remove the book from sale at the park's bookstores and museums as well as to "[p]rovide training to the interpretive staff at Grand Canyon NP regarding how to answer questions from the public concerning the geologic age of the Canyon and related matters; and ... [a]pprove an updated version of the long-stalled pamphlet 'National Park Service Geologic Interpretive Programs: Distinguishing Science from Religion' for distribution to agency interpretive staff." It ought to be noted that PEER was not accusing the NPS of forbidding its interpretive staff to present the scientific facts about the canyon's age and geology. Unfortunately, careless wording in its press release suggested otherwise, and PEER's credibility suffered as a result, obscuring PEER's important charge that the NPS is not providing its staff with the resources it needs to present the scientific facts about the canyon's age of geology effectively, especially when faced with park visitors who have questions about, or even embrace, views that reject those facts on religious grounds.

Prompted by PEER's press release, the controversy over the sale of *A Different View* began to attract attention again in the media, with the *Arizona Daily Sun* (2007 Jan 4) offering a report in which a spokesperson for the NPS was quoted as saying, "We do not use the creationist text in our teaching, nor do we endorse its content. However, it is not our place to censor alternate beliefs." The *Sacramento Bee* (2007 Jan 4) suggested, in a forceful and cogent editorial entitled "Don't use parks to promote creationism," "A new year and a new National Park Service director mark an opportunity for change. Here's an easy one. Settle the 3-year-old controversy about a creationist account of the Grand Canyon." The editorial argued that "Mary Bomar, the new National Park Service director, should send a message that programs and materials in national parks present the best scientific evidence and don't endorse any particular religious beliefs," and concluded by urging Bomar to do so quickly:

> Remove the book from sale from within the park; its proper place is for sale in private bookstores outside the public park. Equally important, finish the long-delayed pamphlet ... and distribute it to park rangers. The nation's public parks are not the place to promote religious theories about the formation and development of Earth.

A spokesperson for the NPS, David Barna, told *The New York Times* (2007 Jan 5) that there was no formal review of whether the bookstores ought to discontinue selling *A Different View* in part because of differences among the NPS's specialists. According to the *Times*, "When officials got together to discuss the book, the geologists and natural resource specialists would say, 'Get this book out of here,' Mr. Barna said. 'But the education and interpretation people would say: 'Wait a minute. If your science is so sound, the fact that there are differences of opinion should not scare you away.'" In a written statement, the *Times* reported, Barna "notes that Park Service management policies require reliance on 'the best scientific evidence available' and, as a result, rangers tell visitors that "the Colorado River basin has developed in the past 40 million years." But the *Times* also reported, "the guidelines also say that material available from concessionaires in national parks should adhere to the standards used to evaluate Park Service materials." PEER's executive director Jeff Ruch was quoted as contending that selling the book promoted fundamentalist Christian views: "This is government establishment of religion in a fairly fundamental way, if you pardon the pun."

Ronald Bailey, the science columnist for *Reason*, heard NCSE's executive director Eugenie C Scott speak about the controversy at the James Randi Educational Foundation's event The Amazing Meeting V, and promptly went to Grand Canyon National Park to see *A Different View* for himself. He reports, "As I was buying it, I asked the clerk what she thought about it. 'We're not allowed to say anything about it,' she said covering her mouth with her hand in the 'Speak No Evil' monkey fashion. 'Oh come on,' I cajoled, but the clerk refused any further comment. Later I went in search of it at the other south rim Park Service bookstore at Desert View. In this much smaller bookstore, Vail's slender Flood geology volume was mixed in among the other photo books. Again, I asked this clerk what she thought, and she smiled and replied, 'All I will say is that it's got some really beautiful photographs'" (2007 Jan 26; available on-line at <http://reason.com/news/show/118334.html>). Acknowledging that the NPS-overseen bookstores carry books that present and discuss the creation myths of Native Americans, Bailey nevertheless drew the crucial distinction: "unlike books on native creation myths, Vail insists that he is making scientific claims about how rock layers are laid down, fossils formed and the canyon carved."

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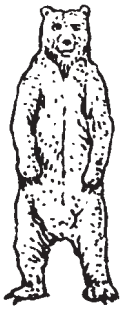
Dry Rot, Not Arson: National Park Service and Science

Wesley R Elsberry

In the Grand Canyon, Arizona has a natural wonder which is in kind absolutely unparalleled throughout the rest of the world. I want to ask you to keep this great wonder of nature as it now is. I hope you will not have a building of any kind, not a summer cottage, a hotel or anything else, to mar the wonderful grandeur, the sublimity, the great loneliness and beauty of the canyon. Leave it as it is. You cannot improve on it. The ages have been at work on it, and man can only mar it.
— Theodore Roosevelt



In 2007 the nation marks the 60th anniversary of the signing of the bill setting aside land for Theodore Roosevelt National Memorial Park. Roosevelt was a large figure in the movement to establish the national park system, so it only seems appropriate to take up an issue about how the National Park Service is operating now.

Public Employees for Environmental Responsibility (PEER) issued a press release (available on-line at <http://www.peer.org/news/news_id.php?row_id=801>) on December 28, 2006, pointing out that the National Park Service (NPS) was at that point three years delinquent in delivering a promised review of its sale of a creationist book, Tom Vail's *Grand Canyon: A Different View* (Green River [AR]: Master Books, 2003; reviewed in *RNCSE* 2004 Jan/Feb; 24 [1]: 33–6). The release, unfortunately, included ambiguous phrasing whose most likely reading yielded a false claim that NPS had issued a "gag order" to its rangers and docents in the Grand Canyon national park to stay silent on the geological age of features in the park.

I investigated the situation with the national park interpretative exhibits, curricula, and bookstore merchandise. While there has not been an explicit "Don't talk about the age of the earth or park geology" directive issued to rangers and docents, there is entirely too much credulous stuff that offers to take anti-science sources seriously. Rangers and docents *are* officially encouraged to tell park visitors about the "tenets and explanations of Creationism". In evidence of a state of neglect when it comes to the accuracy of merchandise in the parks, it turns out that Tom Vail's *Grand Canyon:A Different View* is not the only anti-science tome available for sale in park gift shops; Vine Deloria Jr's *Red Earth, White Lies* (New York: Scribner, 1995; reviewed in *RNCSE* 1998 Nov/Dec; 19 [6]: 10–4) may also be picked up at various stores.

Several people have accurately criticized the overblown claim of the original PEER press release concerning a gag order on interpretative staff telling visitors about deep time, essentially exonerating NPS of committing arson in its approach to science. But I feel that many have overlooked other data that indicate a general administrative strategy of encouraging dry rot instead — de-emphasizing the science content associated with park interpretative programs and credulously relating creationism and other anti-science stances.

The NPS Policy Muddle

There is a clear statement in the NPS policy guidelines (available on-line at <http://www.nps.gov/policy/mp/policies.html>) about the relationship between sensitivity to multiple points of view and scientific validity (see section 7.5.3, "Resource Issue Interpretation and Education"):

> In instances in which programming affects resources managed by other agencies, such agencies should be consulted during program planning. For interpretation of resource issues to be effective, frontline interpretive staff must be informed about the reasoning that guided the decision-making process, and interpreters must present balanced views. Acknowledging multiple points of view does not require interpretive and educa-

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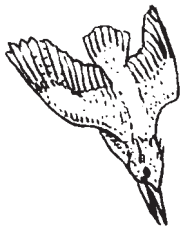
tional programs to provide equal time or disregard the weight of scientific or historical evidence. Resource issue interpretation should be integrated into both on- and off-site programs, as well as into printed and electronic media whenever deemed appropriate by the park manager.

This policy, if it had been followed, would have short-circuited everything that I will discuss: the Vail and Deloria books would have been rejected for sale in park bookstores, and no mention of creationism would have gone into a policy document insisting on accuracy in knowledge of the resource. It will become obvious that this particular component of policy has been roundly ignored.



Creationism as an Officially Sanctioned Talking Point

In order to find the evidence of dry rot in the NPS administration's approach to science, one must peel back the right bit of drywall. The relevant place to look is in the NPS "Interpretive Development Program", Module 340, "Advanced Knowledge of the Resource" (available on-line at <http://www.nps.gov/idp/interp/340/kr.htm>).

There are two chunks that appear to have been written with anti-evolution–speak in mind (emphasis added):

> III. Accuracy and current information — Why?
>
> Interpretation that is accurate provides a verifiable and comprehensive description, is errorless, and conforms to facts. An interpreter must always be accurate. All resource meanings, with enough knowledge and understanding, can and must be interpreted accurately. For example: an interpreter can accurately describe and explain the theory of Evolution *as well as the tenets and explanations of Creationism*. Likewise an interpreter can accurately describe and explain theories, perceptions, and understandings from the past that effect [*sic*], conflict with, and/or contribute to theories, perceptions, and understandings in the present.
>
> Interpretation that is current incorporates recent and ongoing discussion of the resource and its subject matter. This includes questions being asked by scholars, specialists, *and the general public* as well as what they are thinking and saying about the work that is being done. There can be multiple current explanations, theories, and interpretations that complement and/or conflict with each other. *Currency also includes understanding of the general acceptance and use of a position by the professional community as well as popular culture and specific groups of people.* An interpreter uses current information to provoke or provide additional opportunities for the audience to make their own intellectual and emotional connections to the resource.

and

> B. Effective interpretation requires comprehensive knowledge, understanding, and explanation of multiple resource meanings and audience perspectives — *not just popular and current ones*, in order to:
> 1. be relevant;
> 2. demonstrate familiarity with diverse sources of knowledge and opinion, which engenders trust in the open-mindedness of the interpreter;
> 3. demonstrate respect for audience points of view;
> 4. encourage dialogue;
> 5. provoke or provide diverse audiences with opportunities for personal intellectual and emotional connections with the meanings of the resource;
> 6. allow audiences to make decisions for themselves. (See: Appropriate Techniques: Connecting Multiple Resource Meanings to Multiple Audience Interests and Perspectives component.)
> 7. provide context for NPS perspectives.

As the saying goes, keep an open mind — but not so open that your brains fall out. Elsewhere on the NPS website, treatment of "creationism" is discussed in terms of the relationship between ranger and park visitor, as NPS reiterates that rangers must be able to make the park features relevant to all visitors. We know from repeated Gallup polls that more than 40% of the US population, and thus about the same proportion of park visitors to the Grand Canyon, is likely to reject ages that suggest that the earth is older than about 10 000 years (see *RNCSE* 2004 Sep/Oct; 24 [5]: 19).

It is one thing to counsel park rangers and docents to be respectful of visitors and their beliefs, as does the NPS website, but quite another to encourage them to explain creationism to park visitors in contravention of policy section 7.5.3 (quoted above). The presence of "creationism" within a discussion of "knowledge of the resource" and tied to an example of "accuracy" is not credibly or even arguably about visitor relations; this is in effect an assault upon the ability of science to distinguish explanations that are supported by evidence from those that are contradicted by evidence, and which privileges the latter. It is contrary even to the plain meaning of the lead sentence of the paragraph within which it is embedded. That's not knowledge, and it certainly isn't accurate.

To ascertain how these policies play out in practice in the parks, I called the Public Affairs office at Grand Canyon National Park and was directed to Leah McGinnis. Identifying the source, I read her the passage containing the example of using creationism to establish accuracy in knowledge of the resource. She said that she was not familiar with the document and could not comment on it. I asked what role the document played in determining interpretative programs. She said that she did not know about the specific docu-

ment, but assured me that interpretative staff was delivering "science-based information" to the public.

The date of last modification of the section is given as September 2001. It is difficult to imagine how an official policy encouraging the use of creationism in interpretation would not directly affect the work of the interpretative staff in the national parks. Even if the Public Affairs office does not have the complete picture of what is being brought to bear upon interpretative staff, the document's content is ominous — setting up an impossible task for interpreters trying to adhere to the NPS administration's stance on providing accurate science to park visitors, following section 7.5.3 of the policy guidelines, and the directives in Module 340.

Malign Neglect: Anti-Science Sections in Bookstores

In addition to the disputed book by Tom Vail, there is another notorious anti-science tome gracing official park service bookstore shelves. That book is Vine Deloria Jr's *Red Earth, White Lies*. A commenter on Phil Plait's Bad Astronomy blog (see comment 23 at <http://www.badastronomy.com/bablog/2006/12/29/bush-white-house-still-promoting-creationism/>) claimed that this book is a legacy of approval during the Clinton administration, though I have been unable to confirm a date of approval for it. I was incredulous that NPS would approve such a polemic for sale by park bookstores, so I called one of the stores, the Walnut Canyon National Monument bookstore, and asked for stock and price information. (Yes, it is in stock, and it is priced at $18.95.)

NPS contracts out its bookstores to concessionaires and cooperating associations. So is it just the concessionaire or cooperating association making the decision? For the Grand Canyon in particular, the bookstores are run by a cooperating association, the Grand Canyon Association. Because I was not able to view the contracts online, I can only presume that the contracts in Grand Canyon National Park are handled as in the Glacier Bay park, where the contract (available on-line at <http://www.nps.gov/glba/parkmgmt/upload/GLBA001-04.pdf>) plainly says that NPS reserves the right to reject any merchandise offered by the concessionaire or cooperating association.

> (1) The Director reserves the right to determine and control the nature, type and quality of the visitor services described in this CONTRACT, including, but not limited to, the nature, type, and quality of merchandise, if any, to be sold or provided by the Concessioner within the Area.

The cooperating association relationship to NPS is even closer than a contract with a concessionaire. For example, the space NPS provides for the GCA is within the Visitor Center on the North Rim, and a separate building within the Visitor Center Complex on the South Rim.

I asked Grand Canyon National Park Public Affairs spokesperson Leah McGinnis about the book approval process. She told me that a book submission involves NPS park review, and that for the Grand Canyon National Park, that is a five-person endeavor. Each person has a set of criteria they apply to their review of the book. One of those includes the "fit with other materials and merchandise," a clear strike against the anti-science titles noted. The "Park Service Review" person, though, applies the clearest criterion relevant in this case, that the book must be accurate. Whatever else goes on in the approval process, it still is the case that NPS's own policies state that inaccurate books will be rejected. Objecting to the presence of books like Vail's in the Grand Canyon bookstores is not, therefore, endorsing "book-banning" or censorship; it is criticizing a governmental entity's dereliction of its responsibility to conform to its established policies.

What's more, the fact that a title is stocked and sold in park bookstores sends the clear message that NPS approves of the content as an accurate account of its subject matter. So placement of a book in a NPS park bookstore means much more than the offer for sale of the same book by a commercial vendor such as Amazon.com, Barnes and Noble, or Borders. Those firms do not vouch for the *accuracy* of what they sell to the public; the National Park Service does. Once it becomes clear that a mistake was made in the selection process for a book being sold on park premises, review and action should follow with all due bureaucratic speed. Neglecting the issue of the suitability of the Vail book for three to four years is not competence in action.

The only way to preserve the integrity of its scientific credibility is for the NPS to review, without delay, the suitability of offering for sale in the NPS bookstores the Vail book and other legacy anti-science titles, under the Park Service Review criteria already in place. The scientific experts at the Grand Canyon should be relied upon to determine the accuracy of fact claims made in the books. Their opinion should be heeded, not dismissed with post-modernist posturing. The dry rot in attitudes toward science needs to be examined, investigated, and excised from the National Park Service. The bluff plain-talking president Teddy Roosevelt would surely be disappointed in the manner in which his legacy has been treated.

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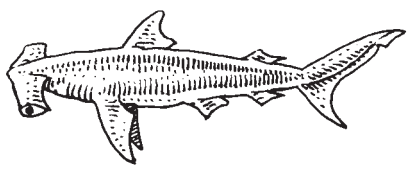
[*A longer version of this article was posted on The Panda's Thumb blog on April 25, 2007; see <http://www.pandasthumb.org/archives/2007/04/more_national_p.html>.*]



Has Natural Selection Been Refuted?

Joe Felsenstein

"Intelligent design" (ID) is the assertion that there is evidence that major features of life have been brought about, not by natural selection, but by the action of a designer. This involves negative arguments that natural selection could not possibly bring about those features. And the proponents of ID also claim positive arguments.

Critics of ID commonly argue that it is not science. For its positive predictions of the behavior of a designer they have a good point. But not for its negative criticisms of the effectiveness of natural selection, which are scientific arguments that must be taken seriously and evaluated. Look at Figure 1, which shows a cartoon design from T-shirts sold by an ID website, Access Research Network, which also sells ID paraphernalia (I am grateful to them for kind permission to reproduce it).

As the bulwark of Darwinism defending the hapless establishment is overcome, note the main lines of attack. In addition to recycled creationist themes such as the Cambrian Explosion and cosmological arguments about the fine-tuning of the universe, the ladder is Michael Behe's argument about molecular machines (Behe 1996). The other main attack, the battering ram, is the "information content of DNA" which is destroying the barrier of "random mutation".

The "irreducible complexity of molecular machines" arguments of Michael Behe have received most of the publicity; William Dembski's more theoretical arguments involving information theory have been harder for people to understand. There have been a number of extensive critiques of Dembski's arguments published or posted on the web (Wilkins and Elsberry 2001; Godfrey-Smith 2001; Rosenhouse 2002; Schneider 2001, 2002; Shallit 2002; Tellgren 2002; Wein 2002; Elsberry and Shallit 2003; Edis 2004; Shallit and Elsberry 2004; Perakh 2004a, 2004b; Tellgren 2005; Häggström 2007). They have pointed out many problems. These range from the most serious to nit-picking quibbles.

In this article, I want to concentrate on the main arguments that Dembski has used. With a few exceptions, many of the points I will make have already been raised in these critiques of Dembski — this is primarily an attempt to make them more accessible.

Joe Felsenstein is in the Department of Genome Sciences and the Department of Biology at the University of Washington, Seattle. He has worked in theoretical population genetics and on the inference of phylogenies. He is the author of Inferring Phylogenies *(Sunderland [MA]: Sinauer, 2004) and of* PHYLIP, *the first widely distributed program package for reconstructing phylogenies.*

Digital codes

Stephen Meyer, who heads the Discovery Institute's program on ID, describes Dembski's work in this way:

> We know that information — whether, say, in hieroglyphics or radio signals — always arises from an intelligent source. .... So the discovery of digital information in DNA provides strong grounds for inferring that intelligence played a causal role in its origin. (Meyer 2006)

What is this mysterious "digital information"? Has a message from a Designer been discovered? When DNA sequences are read, can they be converted into English sentences such as: "Copyright 4004 BCE by the intelligent designer; all rights reserved"? Or can they be converted into numbers, with one stretch of DNA turning out to contain the first 10 000 digits of π? Of course not. If anything like this had happened, it would have been big news indeed. You would have heard by now. No, the mysterious digital information turns out to be nothing more than the usual genetic information that codes for the features of life, information that makes the organism well-adapted. The "digital information" is just the presence of sequences that code for RNA and proteins — sequences that lead to high fitness.

Now we already knew that they were there. Most biologists would be surprised to hear that their presence is, in itself, a strong argument for ID — biologists would regard them as the outcome of natural selection. To see them as evidence of ID, one would need an argument that showed that they could only have arisen by purposeful action (ID), and not by selection. Dembski's argument claims to establish this.

Specified Complexity

How does his argument work? Dembski (1998, 2002, 2004) first sets forth an Explanatory Filter to detect design. To make a longish story short, it concludes in favor of design whenever it finds Specified Complexity. He requires that the information in question be complex, so that the probability of that DNA sequence's occurring by chance would be less than 1 in 10^{150}. Dembski chooses this value to avoid any possibility that the sequence would arise even once in the history of the universe. If this complexity were the only issue, his argument could instantly be dismissed: any random sequence of 250 bases would be about as improbable as this. Similarly, any random five-card hand in a card game has a chance of only one in 2 598 960 and this rare an event occurs every time we deal, so that the rarity is not a cause for concern.

This is where the "specified" part comes in.

The Arguments of William Dembski

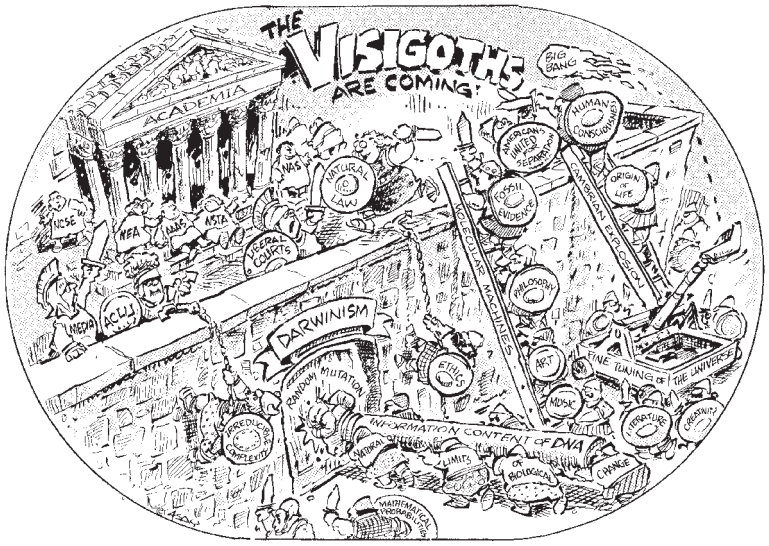


FIGURE 1. *A summary of the major arguments of "intelligent design", as they appear to its advocates, from Access Research Network's website <http://www.arn.org>. Merchandise with the cartoon is available from <http://www.cafepress.org/accessresearch>. Copyright Chuck Assay, 2006; all rights reserved. Reprinted by permission.*

Dembski requires that the information also satisfy a requirement that makes it meaningful. He illustrates this with a variety of analogies having different kinds of meaning. In effect, he is saying that the relevant quantity is the probability that a random sequence of DNA is as meaningful as the one observed.

The image on the left of figure 2 (p 22) shows an example. It is a 101-by-100–pixel image. If our specification were, say, that the image be very much like a flower, the image on the left would be in contention (not surprisingly, as it started as a digital photograph of a zinnia). Of all the possible arrangements of 10 100 black-and-white pixels, it is among the tiny fraction for which the images are much like a flower. There are 2^{10100} possible such images of this size, which is about 10^{3040}, a vast number. We do not know how many of these would look as like, or more like, a flower than this, but suppose that it is not greater than 10^{100}. That means that, if we choose an image randomly from all possibilities, the probability that an image would look this much (or more) like a flower is less than $10^{100}/10^{3040}$, which is 10^{-2940}.

The image on the right would not be in contention in any contest for images that looked like a flower. Like the left image, it has 3511 black pixels, but they seem to be arranged randomly. Both images have the same information content (10 100 bits), but the image on the left looks like a flower. It not only has information, it has information that is specified by being in a flower-like arrangement. This is a useful distinction, which Dembski attributes to Leslie Orgel. I cannot resist adding that a related concept, "adaptive information", appears in one of my own papers, perhaps the one least frequently cited (Felsenstein 1978).

Sequences in the genome that code for proteins and RNAs, and associated regulatory sequences, have specified information. Although Dembski (2002: 148) mentions a number of possible different criteria, the one that will concern us here is fitness. Sequences contain information that makes the organism well adapted if it has high fitness, and the specified information will be judged by the fraction p of all possible sequences that would have equal or higher fitness.

(Dembski also defines specified information in another way — using concepts from algorithmic information theory and saying that information is specified if it can be described simply. A perfect sphere would then be more strongly specified than an actual organism. But this has nothing to do with fitness or with explaining adaptation. I will concentrate here on explaining adaptation.)

Specified complexity does one thing — when it is observed, we can be sure that purely random processes such as mutation are highly unlikely to have produced that pattern, even once in the age of the universe. But can natural selection produce this specified complexity? Dembski argues that it cannot — that he can show that these strongly nonrandom patterns cannot be designed by natural selection.

To support that argument, Dembski makes two main arguments. The first involves a Law of Conservation of Information — he argues that it prevents the process of natural selection from increasing the amount of adaptive information in the genome. The second uses the No Free Lunch theorem to argue that search by an evolutionary algorithm cannot find well-adapted genotypes. Let us consider these in turn.

Conservation of Information

For his concept of the Law of Conservation of Information, Dembski points to a law stated by the late Peter Medawar. In its clearest form it states that a deterministic and invertible process cannot alter the amount of information in a sequence. If we have a function that turns one DNA sequence X into another one Y, and if this function is invertible, then there is also a reverse function that can recover the original sequence X from the sequence Y. Any information that was present in the original sequence cannot have been lost, as we can get the original sequence back.

This is fairly obviously true. For example, if we take the picture of the flower above, and scramble the order of its pixels, we destroy its resemblance to a flower. But if we did so using, say, a computer random number generator (a pseudorandom number genera-

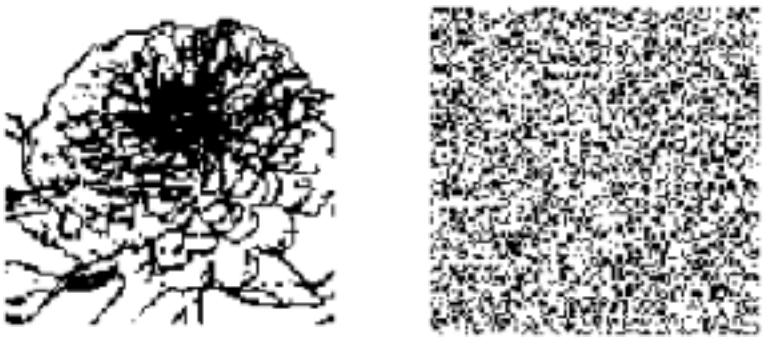


FIGURE 2. *Two 101 x 100 pixel images, each with 3511 black pixels and the rest white. Both have equal information content. Which one has specified complexity, as judged by its resemblance to an image of a flower?*

tor) to make a permutation of the pixels, we could record the permutation we used, and use it at any time to unscramble the picture. The original information is conserved, because it has been hidden by the scrambling, but not really lost.

Does this mean that such a process cannot increase or decrease the amount of information in the genome? Yes, if we simply mean information, but no, if we mean specified information. Here I am disagreeing with Dembski on a critical point. In his reformulation of Medawar's theorem "the complex specified information in an isolated system of natural causes does not increase" (Dembski 2002: 169). Note that he is discussing not simply information, but specified information. Now look again at the pixelated flower. I said that the second figure had the same number of black pixels, distributed randomly. The reason I knew this is that the second picture is simply the first picture with its pixels scrambled. I generated the permutation using a pseudorandom random number generator and can easily tell you how to generate it yourself, so that you can do the scrambling yourself and get exactly the same result, and you can also make the tables needed to unscramble the picture. So no information was lost.

But the amount of specification certainly was lost. The second picture would be instantly rejected from any "like a flower" contest. When we use the permutation to unscramble the picture, we create a large amount of specification by rearranging the random pixels into a flowerlike form. We blatantly violate Dembski's version of Medawar's theorem.

DEMBSKI'S PROOF

Why am I saying this, when Dembski does sketch a proof of his Law of Conservation of Specified Complexity? How can he have proven the impossible? *He does this by changing the specification*. If the original permutation, from the first picture to the second, is called *F*, we can call the reverse permutation, the one that converts the second picture back into the first, *G*. Dembski's argument points out that the first picture has the specification "like a flower". The second picture has an equivalent specification: "when permuted by *G*, like a flower". For every picture that is more like a flower than the first picture, there is one that we would get when applying the permutation *F* to it. That permuted picture will of course satisfy the second specification to the same extent in that, when permuted back by *G*, it too is more like a flower.

So both pictures have specifications that are equally strong, and that is the essence of Dembski's proof. Dembski's proof has been strongly criticized by Elsberry and Shallit (2003; Shallit and Elsberry 2004), who pointed out that it violates a condition that the specification has to be produced from "background information", and thus has to be independent of the transformations *F* and *G*. The specification of *G* is not.

But even if their criticism of Dembski's proof were dismissed, and Dembski's proof accepted as correct, in any case Dembski's proof is completely irrelevant. We want to explain how DNA sequences come to contain information that makes the organism highly fit (by coding for adaptations). The specification that should interest us is this one: "codes for an organism that is highly fit". Dembski is applying his proof by arguing that it shows that no random or deterministic function can increase the specified information in a genome. The permutations I have been using as examples are deterministic functions, and his theorem would apply to them. If a genome codes for a highly fit organism, so that it satisfies the specification, when it is permuted it does not satisfy it. The scrambled genome is dreadfully bad at coding for a highly fit organism. And when we use the unscrambling permutation *G* on it, we create the specification of the information, for this original specification which uses fitness.

The flaw in Dembski's argument is that, to test the power of natural selection to put specified information into the genome, we must evaluate the same specification ("codes for an organism that is highly fit") on it before and after. If you could show that the scrambled picture and the unscrambled picture do equally well in satisfying that same specification, you would go far to prove that natural selection cannot put adaptive information into the genome. Our flower example shows that there is a big difference in whether the original specification is satisfied before and after the permutation. Scrambling the sequence of a gene may not destroy its information content, if we have used a known permutation that can later be undone. But the scrambling certainly will destroy the functioning, and thus the fitness, of the gene. Likewise, unscrambling it can dramatically increase the fitness of the gene. *Thus Dembski's argument, in its original form, can be seen to be irrelevant.* And when put into a meaningful form by requiring that the specification we evaluate is the same one before and after, the example presented here shows his argument to be wrong.

GENERATING SPECIFIED INFORMATION

Evolution does not happen by deterministic or random change in a single DNA sequence, but in a population of individuals, with natural selection choosing among them. The frequencies of different alleles change. Considering natural selection in a population, we can clearly see that a law of conservation of specified information, or even a law of conservation of information, does not apply there.

If we have a population of DNA sequences, we can imagine a case with four alleles of equal frequency. At

a particular position in the DNA, one allele has A, one has C, one has G, and one has T. There is complete uncertainty about the sequence at this position. Now suppose that C has 10% higher fitness than A, G, or T (which have equal fitnesses). The usual equations of population genetics will predict the rise of the frequency of the C allele. After 84 generations, 99.9001% of the copies of the gene will have the C allele.

This is an increase of information: the fourfold uncertainty about the allele has been replaced by near-certainty. It is also specified information — the population has more and more individuals of high fitness, so that the distribution of alleles in the population moves further and further into the upper tail of the original distribution of fitnesses.

The Law of Conservation of Information has not considered this case. Even though the equations of change of gene frequencies are deterministic and invertible, when the gene frequencies are taken into account there is no law of conservation of information. The amount of information changes as the gene frequencies change (it can go either up or down, depending on the case). The specified information as reflected by the fitness does obey a law — in this simple case fitness constantly increases, as a result of the action of natural selection. *So the only law we have is one that* does *predict the creation of specified information by natural selection.* One might object that we have not actually created specified *complexity* because the increase in information has been only 2 bits, rather than the 500 bits (150 decimal digits) which is Dembski's minimum requirement for specified complexity. But what we have done is to describe the action of the mechanism that creates specified information — if this acts repeatedly at many places in the gene, specified complexity would arise. *Thus one of the two main arguments used by Dembski can be seen to be wrong, when we consider a population.*

No Free Lunch?

The second pillar of Dembski's argument is his use of the No Free Lunch theorem. This gave his 2002 book its title, and Dembski (2002: xix) declares the chapter on this to be "the climax of the book". The theorem was invented by computer scientists (Wolpert and Macready 1997) who were concerned with the effectiveness of search algorithms. It is worth giving a simple explanation of their theorem in the context of a simple model of natural selection. Imagine a space of DNA sequences that has to be searched. Suppose that the sequences are each 1000 bases long. There are $4 \times 4 \times 4 \times \ldots \times 4 = 4^{1000}$ possible sequences, which in alphabetic order would go from AAAA…A to TTTT…T. Now imagine that our organism is haploid, so that there is only one copy of the gene per individual, and suppose that each of these sequences has a fitness. A very tiny fraction of the sequences is functional, and almost all of the rest have fitness zero.

Suppose that we want to find an organism of high fitness, and we want to do so by looking at 10 000 different DNA sequences. The best we can do, of course, is to take the highest one we find among these. Now note that 4^{1000} is about 10^{602}, a number far greater than the number of elementary particles in the universe. It is not unreasonable to guess that the fraction of DNA sequences that has a nonzero fitness is tiny — let's be very generous and say 1 in 10^{20}.

One way we could search would be at random. Pick one of the DNA sequences, then pick another completely at random, then another completely at random, and continue on until 10 000 different ones have been examined. As we are picking at random, each pick has essentially one chance in 10^{20} of finding a sequence with nonzero fitness. It should immediately be apparent that we have almost no chance of finding any sequence with nonzero fitness. In fact we have less than one chance in 10^{16}. So a completely random search is a really terrible way to increase fitness — it will overwhelmingly often find only sequences that cannot survive. In effect, it is looking for a needle in a haystack, and failing.

Of course, evolution does not do a completely random search. A reasonable population genetic model involves mutation, natural selection, recombination and genetic drift in a population of sequences. But we can make a crude caricature of it by having only one sequence, and making, at each step, a single mutational change in it. If the change improves the fitness, the new sequence is accepted. Suppose that we continue to do this until 10 000 different sequences have been examined. We will end with the best of those 10 000.

Will this do better? In the real world, it will if we start from a slightly good sequence. Each mutation carries us to a sequence that differs by only one letter. These tend to be sequences that are somewhat lower, or sometimes somewhat higher, in fitness. On average they are lower, but the chance that one reaches a sequence that is better is not zero. So there is some chance of improving the fitness, quite possibly more than once. A fairly good way to find sequences with nonzero fitnesses is to search in the neighborhood of a sequence of nonzero fitness.

The No Free Lunch (NFL) theorem states that if we consider the list of all possible sequences, each with a fitness written next to it *and if we average over all the ways that those fitnesses could be assigned to the sequences*, then no search method is better than any other. We are averaging over all the orders in which we could write the fitnesses down next to the list of sequences. Almost all of these orders are just like random associations of fitnesses with genotypes. That means that search by genetic mutation could not do any better than a hopelessly bad method such as complete random choice of sequences. The NFL theorem considers all the different ways fitness could be associated with genotype. The vast number of those are like random scramblings. For those assignments of fitnesses to genotypes, when we mutate a sequence by even one base, the fitness of the new sequence is the same as it would be if it were drawn at random from among all other possible sequences.

This randomization destroys all hope of finding a better fitness by mutating. Each single-base mutation is then just as bad as changing all of the bases simultaneously. It is as if we were on the side of a mountain and took one step. In the real world, this would carry us a bit up or a bit down (though sometimes over a cliff). In the No Free Lunch world, it

would carry us to the altitude of a random spot on the globe, and that would most often plunge us far downward. In sequence space the prospects are even more gloomy than on the globe, as all but an extremely tiny fraction of sequences have fitness zero, and thus they have no prospects.

The NFL theorem is correct, but it is not relevant to the real world of evolution of genomes. This point has been overlooked in some responses to Dembski's use of the theorem. For example, H Allen Orr in *The New Yorker* (Orr 2005) and David Wolpert in a review of Dembski's book (Wolpert 2003) both argue against Dembski by pointing out phenomena such as coevolution that are not covered by the NFL theorem. In effect, they are conceding that for simple sequence evolution, the NFL theorem rules out adaptation by natural selection. In arguing this way, they are far too pessimistic about the capabilities of simple sequence evolution. They have overlooked the NFL theorem's unrealistic assumptions about the random way that fitnesses are associated with genotypes, which in effect assumes mutations to have disastrously bad fitness.

Mutations

In the real world, mutations do not act like this. Yes, they are much more likely to reduce fitness than to increase it, but many of them are not lethal. I probably carry one — I have a strong aversion to lettuce, which to me has a bitter mineral taste. This is probably a genetic variation in one of my odorant receptor genes. It makes salad bars problematic, and at sandwich counters I spend a lot of time scraping the lettuce off. But it has not killed me — yet. The great body of empirical information about the effects of mutation in many organisms makes it clear that a great many mutations are not instantly lethal. They do on average make things worse, but they do not plunge us instantly back into the primordial organic soup.

In Dembski's NFL argument a single base change would have the same effect, on average, as changing all the bases in the gene simultaneously. A single amino acid substitution in a protein would have the same effect as replacing the whole protein by a random string of amino acids. This would make the protein totally inactive. That changes of a single base or a single amino acid do not have this sort of effect is strong evidence that mutations are much more likely to find another almost-functional sequence nearby. The real fitness landscape is not a scrambled "needle-in-a-haystack" landscape in which a sequence of moderately good fitness is surrounded only by sequences whose fitness is zero. In the real world, genotypes near a moderately good one often have moderately good fitnesses.

Empirical evidence

Note that if Dembski's arguments were valid, they would make adaptation by natural selection of any organism, in any phenotype, essentially impossible. For that would require adaptive information to be encoded into the genome by natural selection. According to Dembski's argument we would not need to worry: bacteria infecting a patient could not evolve antibiotic resistance. Human immunodeficiency viruses (HIV) would not become resistant to drugs. Insects would not evolve resistance to insecticides. Dembski's designer would be busy indeed: he would need to design every last adaptation, leaving out only a few that might be purely accidental.

Dembski himself seems unable to draw this self-evident conclusion from his own argument. He acknowledges that "the development of antibiotic resistance by pathogens via the Darwinian mechanism is experimentally verified and rightly of great concern to the medical field" (Dembski 2002: 38). But by saying that he undercuts his own argument — if correct, his argument would actually prove that the adaptive information in the bacterial genome could not be created by natural selection, except by the pure accident of mutation and genetic drift, unaided by natural selection.

His argument will also be news to animal and plant breeders. They use simple forms of artificial selection such as breeding from the individuals that have the best phenotypes. These forms of selection are like natural selection in that they do not use detailed information about individual genes — they do not require a particular detailed design. Dembski's argument implies that the breeders' efforts are in vain. They cannot create changes of phenotype by artificial selection, as this should be as ineffective as natural selection. Artificial selection provided Darwin with such powerful examples that he opened his book with an entire chapter on "Variation Under Domestication" in which he discussed case after case of changes due to artificial selection, but Dembski does not discuss artificial selection at all, mentioning it only once, in passing (in Dembski [2004] it is on page 311).

Smuggling?

Dembski (2002, sections 4.9 and 4.10) is not unaware of arguments that smoother fitness surfaces than the needle-in-a-haystack ones would allow natural selection to be effective. For example, Richard Dawkins (1996) has a computer program to demonstrate the effectiveness of selection, which evolves a meaningless jumble of 28 letters into the phrase "Methinks it is like a weasel" by repeatedly mutating letters randomly and then accepting those offspring sequences that most closely match the target phrase. Each match improves the fitness, so that mutations that make the phrase closer are readily available. Dembski argues, however, that the information in the resulting phrase is not created by the natural selection — it is already there, in the target phrase. He calls this the "displacement problem" (2002, section 4.7).

> But invariably we find that when specified complexity seems to be generated for free, it has in fact been front-loaded, smuggled in, or hidden from view. (Dembski 2002: 204)

Computer demonstrations of the power of natural selection to bring about adaptation do often have detailed targets that natural selection is to approach. It is easier to write the programs that way. In real life, the objective is higher fitness, and achieving that means having the organism's phenotype interact well with real physics, real chemistry, and real biology.

In these more real cases, the environment does not provide the genome with exact targets. Consider a population of deer being preyed upon by a population of wolves. We have little doubt that mutations among the deer will cause changes in the lengths of their limbs, the strength of their muscles, the speed of reaction of their nervous system, the acuity of their vision. Some of these will enable the deer to escape the wolves better, and those ones will tend to spread in the population. The result is a change in the design of the deer. But this information is not "smuggled in" by the wolves. They simply chase the deer — they do not evaluate their match to detailed pre-existing design specifications.

There have been computer simulations that mimicked this process. The most fascinating is that of Karl Sims (1994a, 1994b, 1994c), whose simulation evolves virtual creatures that swim or hop in intriguing and somewhat unpredictable ways. The creatures are composed of connected blocks that can move relative to each other, and they are selected only for effective movement without screening for any details of the design. All that is required is genotypes, phenotypes, some interaction between the phenotypes and an environment, and natural selection on one property — speed. There is no "smuggling". A similar simulation inspired by Sims's is Jon Klein's (2002) *breve* program, available for download.

Evolvability

Dembski makes another argument about the shape of the fitness function itself. If it is smooth enough to allow evolution to succeed, he argues that this is the result of more smuggling:

> But this means that the problem of finding a given target has been displaced to the new problem of finding the information **j** capable of locating that target. ... To say that an evolutionary algorithm has generated specified complexity within the original phase space is therefore really to say that it has borrowed specified complexity from a higher-order phase space ... it follows that the evolutionary algorithm has not generated specified complexity at all but merely shifted it around. (Dembski 2002: 203)

He is arguing that the fitness surface itself must have been specially chosen out of a vast array of possibilities, and that this means that one started with the specified complexity already present. He is saying that the smoothness of real fitness functions is not typical — that without a large input of specified information one would be dealing instead with needle-in-a-haystack fitness functions where natural selection could not succeed.

Now, it *is* possible to have natural selection alter the fitness function. There is a small literature on the "evolution of evolvability". Altenberg (1995) showed a computer simulation where natural selection causes the extent of interaction among genes to become less, so that the genotypes tend to become ones that have a smoother fitness function.

But even this may not be necessary. Different genes often act in ways separated in space and time, and that reduces the chance of their interacting. A mutant affecting one's eye pigment typically does not interact with a mutant at a different gene affecting the bones in one's toe. That isolation does not require any special explanation. But in a world that has a needle-in-a-haystack fitness function everything interacts strongly with everything else.

In effect, that world has everything encrypted. If you get a password or a lock combination partially correct, you do not partly access the computer account or partly open the safe. The computer or the safe does not react to each change by saying "hotter" or "colder". Each digit or letter interacts with each other, and nothing happens until all of them are correct. But this encryption is not typical of the world around us. Password systems and combination locks must be carefully designed to be secure — and this design effort can fail.

The world we live in is not encrypted. Most parts of it interact very little with other parts. When my family leaves home for a vacation, we have to make many arrangements at home concerning doors, windows, lights, toilets, faucets, thermostats, garbage, notifying neighbors, stopping delivery of newspapers, and so on. If we lived in Dembski's encrypted universe, this would be impossible. Every time we changed the thermostat setting, the windows would come unlocked and the faucets would run. Every time we closed a window, the newspaper delivery would resume, or a neighbor would forget that we were leaving. (It's worse than that, in fact. The house would be totally destroyed.) But, as we live in the real universe, we can cheerfully set family members to carrying out these different tasks without their worrying about each other's actions. The different parts of the house scarcely interact.

Of course a house is a designed object, but it is not particularly hard to have its parts be almost independent. When architects train, they do not have to spend much of their time ensuring that the doors, when closed, will not cause the faucets to run.

We live in a universe whose physics might be special, or might be designed — I wouldn't know about that. But Dembski's argument is not about other possible universes — it is about whether natural selection can work to create the adaptations that we see in the forms of life we observe here, in our own universe, on our own planet. And if our universe seems predisposed to smooth fitness functions, that is a big problem for Dembski's argument.

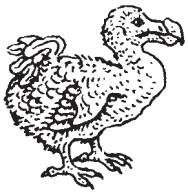
Bibliographic note: Dembski's critics

Of the major arguments here, two are, I believe, my own. One is the argument that Dembski's Law of Conservation of Complex Specified Information could not succeed in proving that information cannot be generated by natural selection, because his Law requires us to change the specification to keep the amount of specified information the same. The other is the argument that changes of gene frequency by natural selection can increase specified information. The other major arguments will be found in some of the papers I cited. In particular, the argument that the No Free Lunch theorem does not establish that natur-

al selection cannot do better than pure random search was also made by Wein 2002, Rosenhouse 2002, Perakh 2004b, Shallit and Elsberry 2004, Tellgren 2005, and Häggström 2007.

In conclusion

Dembski argues that there are theorems that prevent natural selection from explaining the adaptations that we see. His arguments do not work. There can be no theorem saying that adaptive information is conserved and cannot be increased by natural selection. Gene frequency changes caused by natural selection can be shown to generate specified information. The No Free Lunch theorem is mathematically correct, but it is inapplicable to real biology. Specified information, including complex specified information, can be generated by natural selection without needing to be "smuggled in". When we see adaptation, we are not looking at positive evidence of billions and trillions of interventions by a designer. Dembski has not refuted natural selection as an explanation for adaptation.



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With all the attention recently devoted again to *Grand Canyon: A Different View* and to flood geology in general, it is time to turn, perhaps with a sigh of relief, to scientifically accurate and historically informed literature on such topics. For your reading pleasure, we present books in three categories: on the Grand Canyon itself, featuring both scholarly and popular titles about the geology and the history of the Canyon; on the discovery of "deep time" — the vast temporal expanse that young-earth creationism struggles to deny; and on the roots of flood geology in the Genesis tale of Noah and the Flood. Check out the following books, all of which are now available through the NCSE web site: <www.ncseweb.org/bookstore.asp> — look in the "In the latest *RNCSE*" section. And remember, every purchase through the web site benefits NCSE!

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About the Grand Canyon

Hiking the Grand Canyon's Geology
by Lon Abbott and Terri Cook
For the Hiking Geology series of The Mountaineers Books, Lon Abbott and Terri Cook have produced a hiker's guide to the Grand Canyon that explains the geology in loving expert detail, literally step by step. Eighteen excursions are detailed, ranging — as the publisher writes — "from the most popular rim-to-river trails (Havasu Canyon Trail) to gentle, half-day rim walks (Red Butte Trail) to rugged and remote multi-day backpack trips (Lava Falls Route)" and including useful information on permits, lodging and camping, and mule rides. The authors both teach at Prescott College, where they lead hiking trips to study geology in the field.

Grand Canyon Geology, second edition
edited by Stanley S Beus and Michael Morales
From the publisher: "This second edition of the leading book on Grand Canyon geology contains the most recent discoveries and interpretations of the origin and history of the canyon. It includes two entirely new chapters: one on debris flow in the Canyon and one on Holocene deposits in the canyon. All chapters have been updated where necessary and all photographs have been replaced or re-screened for better resolution. Written by acknowledged experts in stratigraphy, paleontology, structural geology, geomorphology, volcanism, and seismology, this book offers a wealth of information for students, geologists, and general readers interested in acquiring an understanding of the geological history of this great natural wonder."

Grand Canyon: Solving Earth's Grandest Puzzle
by James Lawrence Powell
From the publisher: "Vast and majestic, the Grand Canyon represents one of science's most challenging puzzles: How did this massive canyon come to be? This is the story of the search for the answers, and the first account of the consensus geologists have reached in the last few years. A scientific detective tale packed with colorful characters, *Grand Canyon* follows the explorers, adventurers, and geologists whose efforts led to the understanding of the canyon's mysteries. ... An eloquent, breathtaking narrative, *Grand Canyon* is a fascinating true story that is as epic as its subject." Powell is also the author of *The Mysteries of Terra Firma: Exploring the Age and Evolution of the World*.

An Introduction to Grand Canyon Geology
by L Greer Price
Geologist L Greer Price worked for the National Park Service for ten years, mainly in Grand Canyon National Park, and his experience in explaining the geology of the canyon to the parks visitors is evident on every page of his brief (64-page) introduction, enlivened with dozens of photographs. Basic geological principles, including plate tectonics, structural features and their significance, and the role of erosion, are introduced and emphasized throughout; a glossary and a full index enhance the book's usefulness. Proceeds from the sale of the book benefit the educational programs of Grand Canyon National Park.

About deep time

The Age of the Earth
G Brent Dalrymple
The Age of the Earth begins with a plain answer: "Four and one-half billion years." But keep reading! Dalrymple's comprehensive, authoritative, and altogether magisterial account of the methods used

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to determine the age of the earth is, according to the reviewer for *The Quarterly Review of Biology*, "an enormously important book written by an expert for the general scientific public. It is must reading for all interested in the antiquity of nature." Dalrymple, a Supporter of NCSE and a recipient of the National Medal for Science, is Professor Emeritus in the College of Oceanic and Atmospheric Sciences at Oregon State University.

Ancient Earth, Ancient Skies: The Age of Earth and Its Cosmic Surroundings
by G Brent Dalrymple
Whereas *The Age of the Earth* was aimed at the general scientific public, *Ancient Earth, Ancient Skies* is aimed at the common reader, and it succeeds magnificently in clearly explaining the methods and results used by scientists in ascertaining the age of the earth and of the universe. Writing in *RNCSE* (2005 Jan–Apr; 25 [1–2]: 45–46), Timothy Heaton described *Ancient Earth, Ancient Skies* as "a much-needed contribution to scientific education ... [that] takes a pivotal and complex topic and makes it very easy to understand by non-scientists. ... This book deserves a place in every school and public library."

Measuring Eternity: The Search for the Beginning of Time
by Martin Gorst
In *Measuring Eternity*, Martin Gorst provides a readable and engaging account of attempts to ascertain the age of the world. Ranging from the time of Ussher, La Peyrère, and Burnet all the way to the Hubble Space Telescope, the book provides delightful glimpses of a variety of eccentric characters devoted to the development of a scientific chronology. "The world has not only existed much longer than was once believed," he writes toward the end of *Measuring Eternity*: "we now know that it is larger and more varied, richer and more complex, than Ussher and his contemporaries could ever have imagined."

The Dating Game: One Man's Search for the Age of the Earth
by Cherry Lewis
"It is perhaps a little indelicate to ask of our mother Earth her age, but Science acknowledges no shame." So quipped Arthur Holmes, one of the major figures in the history of attempts to determine the age of the earth, and the subject of Cherry Lewis's lively biography, *The Dating Game*. The reviewer for *Earth Sciences History* writes, "it is always a pleasure — and alas, not a common pleasure — to read a really well-written geological biography. Cherry Lewis is to be congratulated not only in producing one such biography, but also in setting forth with commendable lucidity the evolving scientific concepts by which the Earth's dating was achieved."

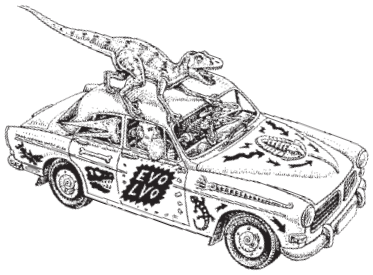
About flood geology

Noah's Flood: The Genesis Story in Western Thought
by Norman Cohn
With the aid of 75 illustrations, including 20 color plates, the distinguished medieval historian Norman Cohn explores the origins, development, and variety of interpretations of the familiar tale of the Noachian deluge. Writing in *Nature*, the historian of geology Martin Rudwick described *Noah's Flood* as "[a]n attractive brief survey of the fortunes and uses of the Flood story, ranging from ancient Mesopotamia to the equally alien territory of twentieth-century American creationism ..." and commended it to "anyone with an interest in the historical roots of modern scientific study of the Earth." The author is the Astor-Wolfson Professor Emeritus of History at the University of Sussex.

Genesis and Geology
by Charles Coulston Gillispie
Subtitled "A study in the relations of scientific thought, natural theology, and social opinion in Great Britain, 1790–1850", *Genesis and Geology* "proposed to give an account of the immediate background of the pattern of scientific disagreement which culminated in disputes about Darwin's book and to attempt to analyze the causes of that disagreement." Originally published in 1951, *Genesis and Geology* was reprinted by Harvard University Press in 1996, with a new introduction by the historian of geology Nicolaas Rupke re-evaluating the book in light of the subsequent forty-five years of historical scholarship.

The Creationists
by Ronald L Numbers
Reissued in 2006 with new chapters on the global spread of creationism and the advent of the "intelligent design" movement, Ronald L Numbers's monumental study remains the pre-eminent work on the history of creationism — and on the history of flood geology. "There is, of course, no simple answer to the question 'Why flood geology?'", Numbers explains. "But the testimony of countless converts suggests that the lion's share of credit — or blame — for the popularity of flood geology must go to John C Whitcomb Jr and Henry M Morris, who in *The Genesis Flood* gave George McCready Price's Adventist flood theory a proper fundamentalist baptism and then skillfully promoted it as biblical orthodoxy."

When the Great Abyss Opened: Classic and Contemporary Readings of Noah's Flood
by J David Pleins
In his lively, ambitious, and engaging study, Pleins — Professor of Religious Studies at Santa Clara University — investigates the cultural significance of the story of Noah's flood, discussing the connections and conflicts among geology, archeology, myth, literature, the Bible, and popular culture (A chapter is devoted to "Fundamentalist literalism and 'creation science'"). Michael Ruse writes, "This fascinating book opens up a completely new light on a topic about which we all think we know something and about which we learn we knew very little. One of the great myths of Western culture is seen in a completely fresh light, thanks to the labors of J David Pleins."



NCSE on the Road

A Calendar of Special Events, Presentations, and Lectures

Date November 28 through December 1, 2007
City Atlanta GA
Presenter NCSE Staff
Title [Booth in the exhibit hall]
Event NABT annual meeting
Time While exhibit hall is open
Location Hyatt Regency, Atlanta
Contact Carrie Sager, sager@ncseweb.org

Date December 17, 2007
City New Haven CT
Presenter Eugenie C Scott
Title Where the Buck Stops: Who Teachers the Teachers?
Event A talk in the MB&B Seminar Series
Time 4:00 PM
Location Department of Molecular Biophysics and Biochemistry, Yale University
Contact Lynne Regan, lynne.regan@yale.edu

Date January 3–5, 2008
City San Antonio TX
Presenter NCSE Staff
Title [Booth in the exhibit hall]
Event Annual Meeting of the Society of Integrative and Comparative Biology
Time While exhibit hall is open
Location Gonzalez Convention Center
Contact Carrie Sager, sager@ncseweb.org

Date February 9, 2008
City Tallahassee FL
Presenter Eugenie C Scott
Title What Do Creationists Know About Darwin?
Event FSU Darwin Day Celebration
Time TBA
Location TBA
Contact Eugenie C Scott, scott@ncseweb.org

Date February 10, 2008
City Knoxville TN
Presenter Eugenie C Scott
Title What Would Darwin Say About Modern Creationism?
Event 12th Annual University of Tenneessee Darwin Day Celebration
Time TBA
Location TBA
Contact Rachel Goodman, rgoodma3@utk.edu

Date March 28, 2008
City Boston MA
Presenter Eugenie C Scott
Title After Dover: The New Creationism
Event NSTA 2008 National Conference
Time 3:30 PM
Location Boston Convention Center
Contact Delores Howard, dhoward@nsta.org

Check the NCSE web site for updates and details — <http://www.ncseweb.org/meeting.asp>.

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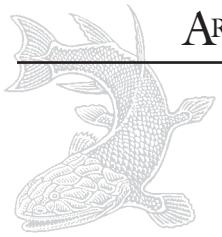

Recurrence of the Same? "Intelligent Design" and the Biology Classroom

Jason Borenstein

In the ongoing and complex issue of teaching evolution in public schools, "intelligent design" (ID) purports to overcome objections to inserting religion into science classrooms and to illustrate conceptual and empirical shortcomings in evolutionary theory. ID supporters argue that students should be made aware of these shortcomings and suggest that "alternatives to evolution" need to be taught. A key issue that needs to be resolved is whether it is a sound pedagogical approach to teach "design" alongside evolution, which may in part be resolved by helping policy makers determine whether ID is a true rival to evolutionary theory — or has any scientific merit at all.

Even though creationism, in its various forms, has typically failed to pass legal muster, the Supreme Court has not categorically forbidden biology teachers from discussing "alternatives to evolution" as long as those lessons do not cause religion and science to be overly intertwined. ID supporters and other critics of evolution typically latch on to the *Edwards v Aguillard* ruling to provide legal grounds for introducing challenges to evolution in the classroom. According to the *Edwards* Court, "teaching a variety of scientific theories about the origins of humankind to schoolchildren might be validly done with the clear secular intent of enhancing the effectiveness of science instruction" (*Edwards v Aguillard* 482 US 578 [1987]: 594). In accordance with their interpretation of this case and other legal precedents, ID supporters seek to take advantage of a "legal opening" to offer what they argue is a secular, scientific body of claims.

Although the teaching of ID has not been specifically required in accordance with most states' science standards, several state school boards and legislatures have considered implementing proposals that would encourage teachers to discuss evidence against evolution (Carroll 2005; Taylor and MacDonald 2002). In Ohio, the state school board explicitly considered incorporating it into the curriculum (Stephens 2004). Missouri's legislature has considered a bill that would require teachers to discuss alternatives to evolution (Anonymous 2004). The school board in Dover, Pennsylvania, became the first one to *mandate* that ID be taught as part of the biology curriculum (Raffaele 2004). Yet a federal judge has since invalidated Dover's policy. At this point, the Discovery Institute, one of the main organizations defending the notion that ID is a credible scientific theory, is not openly advocating that it should be a mandatory part of biology education (Meyer 2002), opting instead for tactics that try to cast doubt on the validity of evolution.

"Teach the controversy"

One of the main arguments in support of teaching ID in public schools is that students need to be aware of the controversy circulating around evolution. If portions of evolutionary theory are truly on shaky ground, then ID supporters suggest that students need to be made aware of this fact. This is the so-called "teach the controversy" approach. Since ID supporters argue that there is substantial evidence contradicting at least some of the claims supporting evolution, students should be apprised of the situation and then make up their own minds on what is true. Further, even if there is evidence to support evolution, students need to be cautioned against merely assuming that it is "fact" just because it is presented in a classroom. According to ID supporters, there is momentum behind the "teach the controversy" approach as evidenced by a document that contains signatures from scientists who believe there are flaws contained within Darwinism (Discovery Institute 2001). Yet the "teach the controversy" approach, as articulated by Stephen Meyer (Meyer 2002), is profoundly misguided.

To begin, Meyer contends, "When two groups of expert disagree about a controversial subject that intersects the public school curriculum students

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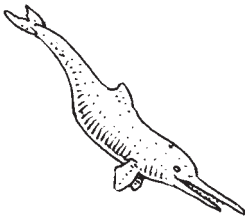
should learn about both perspectives" (Meyer 2002). According to Meyer:

> In such cases teachers should not teach as true only one competing view, just the Republican or Democratic view of the New Deal in a history class, for example. Instead, teachers should describe competing views to students and explain the arguments for and against these views as made by their chief proponents.



Yet it is not possible to present students with each and every dispute that is ongoing within the expert communities, let alone every dispute that is ongoing between scientists. It would be arduous and impractical to cover, as Meyer's logic implies, each particular political party's arguments, such as the ones offered by libertarians, socialists, the Green Party, and the Reform Party, on each controversial political issue. In other words, there are numerous other options beyond "both perspectives" offered by Democrats and Republicans that could be mentioned with reference to the issue. Further, we would certainly want to disregard the opinions of some groups, such as white supremacists and neo-Nazis, even if they do offer a "competing view" on politics. Not every "competing view" warrants consideration even though some might consider them to be rivals.

ID supporters defend the notion that students need to be made aware of "the controversy" in part because they see ID as being among the main candidates to be covered alongside evolution. Yet the logic of Meyer's argument opens the door to discussing various alternative views on the history of life, such as the one offered by the Raëlians that human life emerged on this planet through cloning procedures undertaken by human-like aliens. The Raëlian view is undoubtedly a "rival" (in some sense of the term) to evolution since it attempts to explain how human life on this planet emerged; it does challenge a number of evolution's tenets. Raëlians proclaim that they can offer a competing explanation for how life began and that their view merits serious consideration. As a result, the "teach the controversy" approach implies that such a view would not be discounted as a candidate to be discussed in biology classrooms, which is a profoundly troubling consequence.

Introducing students to each and every rival view as it emerges, such as the one offered by the Raëlians, can give them the wrong impression that each expert's or group's opinion is of equal worth and has the same level of supporting evidence behind it. In accordance with the goal of teaching students about controversies, teachers could plan lessons on witchcraft, astrology, and tealeaf reading, as Paul Feyerabend suggests (Feyerabend 1975), because there are inquirers who use these approaches in order to acquire evidence. Yet there are good compelling reasons to resist this type of thinking, which in part relates to the value and importance of obtaining evidence to support claims before students learn about them. There are plenty of individuals who purport to be "scientific" experts, but the mechanisms of science need time to evaluate and assess the relevant theories in question. It can be unwise to present an expert's arguments until relevant claims have been thoroughly examined by other experts. The implication that rival views are all on even grounds scientifically (have the same level of supporting evidence) does a disservice to how science works.

Thomas Murray describes a similar phenomenon within the context of debates over embryonic stem cell research (Murray 2001). As Murray points out, the manner in which disputes about science are typically presented to the public and to policy makers — by inviting one or two scientists on opposite sides of the spectrum to speak — implies that scientists are evenly divided on an issue. This approach can grossly distort how much consensus there actually is within the scientific community about an issue such as stem cell research. Similarly, if the views of a biologist and an ID supporter are presented at the same forum, it could mislead the audience to think that the scientists themselves are split, for example, on the issue of whether evolution is accepted as fact. Applying this insight to the classroom, presenting "both perspectives" to students implies that each one is on equal footing and that scientists are evenly divided into the two camps. Recognizing this implication does not necessarily prove that ID is false, but the biology curriculum needs to reflect accurately its standing within the scientific community.

Disputing evolution

Meyer and other ID supporters contend that there is active scientific "controversy" about whether evolution's key tenets are supported by evidence. Yet labeling it as a "controversy" about evolution is misleading because the disputes are not primarily *within* the scientific community. The controversy occurs among religious groups, politicians, parents, and advocacy groups. Disputes about whether evolution is a "fact" frequently are waged at school board meetings and at legislative sessions by these groups, but not among scientists in relevant disciplines.

There are of course active disputes within scientific communities regarding the specific mechanisms governing evolution, including the issue of how significant the role of natural selection is. There have also been debates about the tempo of evolutionary change (for example, Eldredge and Gould 1972) and the unit of selection (Sachs and others 2004). Although biologists ardently disagree on some of the details of how evolution works, they are largely convinced that it did in fact occur. According to the National Science Teachers Association, "There is no longer a debate among scientists about whether evolution has taken place" (NSTA 2003). Thus, couching the issue as a "scientific" controversy between the scientists themselves misrepresents how divided the scientific community actual is on the issue. For example, according to Chad Edgington (Edgington 2004):

> …given the diversity of belief on the subject and the lack of accepted, substantiated evidence supporting any theory, whether one is a creationist or an evolutionist is largely a matter of opinion.

Vocal proponents of "intelligent design", such as Michael Behe and William Dembski, offer passionate defenses of their views, but they are noticeably on the outside of the scientific community. Neither creationism nor "intelligent design" is considered to be a viable alternative to evolution by most scientists. Scientists vehemently and consistently challenge the notion that evolution still needs to overcome the burden of proof to vanquish either "rival" theory.

The Public Favors It

The "teach the controversy" approach also takes advantage of the notion that the public seems comfortable with teaching "alternatives to evolution" along with the theory. There is some basis for Meyer's statement that "voters overwhelmingly favor this approach" (Meyer 2002). For example, according to one Gallup poll, 68% of Americans favor teaching both creationism and evolution in biology classrooms (Moore 1999). A Zogby poll suggests that 71% of Americans would prefer that evidence both for and against evolutionary theory be taught (Zogby International 2001). However, even though Meyer's assertion about public opinion may be accurate, it is not necessarily sound educational policy to allow the public to dictate what is taught within a discipline, especially in the sciences where extensive knowledge of technical concepts and background information is typically needed before claims can be properly assessed.

Along these lines, there is evidence to indicate that the public's understanding of science may be inadequate (National Science Board 1998; National Science Board 2000; Russell 1994; Sanchez 1997). For example, many individuals operate with the misconception that antibiotics can help treat a viral infection and that having a flu shot immunizes against the various different strains of the virus. For some time, the public believed that AIDS only affected homosexual populations and later that it could be contracted through casual contact. But it would be profoundly dangerous if these beliefs were perpetuated by teachers, because they are false. Accordingly, ID should not be taught to students *merely* because the public demands it. It should be discussed *only* if ID proponents succeed in convincing the scientific community that ID has supporting evidence behind it.

Promoting "Good Pedagogy"

It has been commonly argued within the context of the "teach the controversy" approach that "academic freedom" (Hacker 2004) and "good pedagogy" (Meyer 2002) demand that alternatives to evolution be taught. It is ironic that ID supporters appeal to these notions to support the inclusion of anti-evolution evidence, considering that biology teachers avoid teaching lessons pertaining to evolution because they fear reprisal from politicians and from parents (Jacoby 2005). Some school administrators have even recommended to teachers that they sidestep the topic (Dean 2005). Further, the Georgia State Superintendent of Schools, Kathy Cox, temporarily removed the term "evolution" from Georgia's science standards "to give teachers some leeway to teach it without having to use a word that antagonizes some parents," (Tofig 2004). In Dover, Pennsylvania, an administrator had to read the district's policy on "intelligent design" to students because teachers refused to do so (Anonymous 2005).

A profound cost associated with distorted arguments against evolution is that widespread misunderstanding about and ignorance of evolutionary theory endure. According to a study by Lawrence Lerner, evolution is poorly treated in the state science standards of at least a third of US states (Lerner 2000). It seems to be the case that American students do not receive adequate instruction about the fundamentals of evolution and do not appreciate how integral evolution is to numerous scientific and non-scientific fields. As a result, misconceptions about evolution are abundant, including the notion that humans are merely a product of "random chance", that evolution is inconsistent with laws of thermodynamics, and that there are no transitional fossils (Rennie 2002).

This is not to say that evolutionary theory is untouchable. As mentioned previously, there are certainly active controversies about evolution and gaps in biologists' explanations. Rather, it is to assert that evolution must be understood thoroughly by students before its merits can truly be assessed. Yet since many students may only be learning a caricature of evolution or perhaps nothing substantive about it, teaching them about challenges to evolution might not be very meaningful (Moore 2001).

Is the proposed solution worse than the alleged illness?

Even though the "teach the controversy" approach has its flaws, the question still remains whether it is warranted to discuss "intelligent design" specifically in biology classrooms. ID proponents contend that their view is scientific and thus should be taught alongside evolution. They claim that design arguments are more attuned to scientific evidence than older versions, including the ones offered by William Paley. Indeed, instead of doing original research, ID proponents have dedicated much time and effort to identifying problems with evolution and suggesting how design might be compatible with a scientific picture of the world.

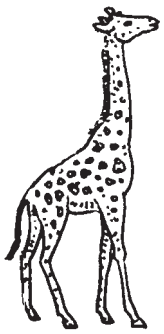
However, it is difficult, if not impossible, to disentangle ID from discussions about religion. Even if ID proponents could be taken at their word that ID could be taught without religious overtones (Behe 2005), questions about the designer will inevitably emerge. Metaphysical and religious assumptions built into any version of ID are not easily separable from the "scientific" lessons that would be offered to students. For example, one of the chief assumptions built into current formulations of "intelligent design" is that the designer is a single entity or "intelligent agent", which means that some contemporary views about the nature of the designer(s) are dismissed. Of course, monotheism tends to be the preferred view of ID supporters but one could legitimately question whether that assumption should be granted and whether it is appropriate to allude to *one* subset of religious views at exclusion of others. As Hume asks, "Why may not

several Deities combine in contriving and framing a World?" (Hume 1779: 192).

Discussion of ID in a classroom opens, perhaps unintentionally, the door to religious conversation about the identity and traits of the designer. Yet it is not clear that it would be wise for biology teachers to stray into religious instruction. Even if a biology teacher can successfully dodge questions about the nature of designer, how will teachers explain the causal mechanisms of the design process? ID proponents do not offer much in the way of an explanation. Creationists, for example, offer a forthright and direct answer on this issue. Duane Gish "bites the bullet", so to speak, and argues, "We cannot discover by scientific investigations anything about the creative processes used by the Creator" (Gish 1979: 40).

Assuming that evolution is accepted to some degree, which ID proponents largely say that they do, at what point do the designer's actions end and evolution begin? One potential hypothesis is that the designer was involved in the initial formation of the universe and that ended the designer's role. Another hypothesis is that the designer is continually involved in designing the universe. Alternatively, the designer may act intermittently. On what basis should a biology teacher (or any human for the matter) distinguish between these competing explanations? Yet it seems crucial that we have some means to sort through these explanations if ID is to help us understand better how the universe works.

Conclusions



When the issue of evolution emerges in the classroom, students should not be left with the impression, with which much of the current debate might leave them, that evolution is scientifically "controversial" and that it is the only area of science where scientists themselves have disputes. In all these issues, the current crop of "intelligent design" proposals significantly misleads students regarding the nature of science and the evidence for evolution. Teaching that evolution is dubious or controversial within the sciences does the students a disservice because the "controversy" is over how science is to be understood and applied in modern society.

If the outgrowth of the legal, religious, and scientific disputes about evolution leads to the emergence of a high school class dedicated to the intersection of science and values, that would be a welcomed addition. Considering how central science is to our lives and how often its social, moral, and religious implications are not examined thoroughly enough, a class that looks at the broader aspects of scientific disputes might be a wise — and desirable — approach.

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The Design Revolution?

How William Dembski Is Dodging Questions About "Intelligent Design"

Mark Perakh

Who is William A Dembski? We are told that he has PhD degrees in mathematics and philosophy plus more degrees—in theology and what not — a long list of degrees indeed (Dembski 1998: 461).

We all know, however, that degrees alone do not make a person a *scientist*. Scientific degrees are not like ranks in the military where a general is always above a mere colonel. Degrees are only a formal indicator of a person's educational status. A scientist's reputation and authority are based only to a negligible extent on his degrees. What really attests to a person's status in science is publications in *professional* journals and anthologies and references to one's work by colleagues. This is the domain where Dembski has so far remained practically invisible. All his multiple publications have little or nothing to do with science. When he writes about probability theory or information theory — on which he is proclaimed to be an expert — the real experts in these fields (using the words of the prominent mathematician David Wolpert [2003]) "squint, furrow one's brows, and then shrug."

When encountering critique of his work, Dembski is selective in choosing when to reply to and when to ignore his critics. His preferred targets for replies are those critics who do not boast comparable long lists of formal credentials — this enables him to dismiss the critical comments contemptuously by pointing to the alleged lack of qualification of his opponents while avoiding answering the essence of their critical remarks. (See, for example, Dembski's replies to some of his opponents [Dembski 2002b, 2002c, 2002d, 2003a].) These replies provide examples of Dembski's overarching quest for winning debate at any cost rather than striving to arrive at the truth. For example, in his book *No Free Lunch* (Dembski 2002a), he devoted many pages to a misuse of Wolpert and Macready's (1987) No Free Lunch (NFL) theorems. (Some early critiques of Dembski's interpretation of the NFL theorems appear in Elsberry [1999, 2001]. A detailed analysis of Dembski's misuse of the NFL theorems is given, in particular, in Perakh [2004a].)

Dembski's faulty interpretation of the NFL theorems was strongly criticized by Richard Wein (2002a) and by David Wolpert (2003), the originator of these theorems. Dembski spared no effort in rebutting Wein's critique, devoting to it two lengthy essays (Dembski 2002b, 2002c). However, he did not utter a single word in regard to Wolpert's critique. It is not hard to see why. Wein, as Dembski points out, has only a bachelor's degree in statistics — and Dembski uses this irrelevant factoid to deflect Wein's well-substantiated criticism. He does not, though, really answer the essence of Wein's comments and resorts instead to *ad hominem* remarks and a contemptuous tone. (Wein 2002b replies.) He cannot do the same with Wolpert who enjoys a sterling reputation as a brilliant mathematician and who is obviously much superior to Dembski in the understanding of the NFL theorems of which he is a co-author. Dembski pretends that Wolpert's critique does not exist.

Dembski has behaved similarly in a number of other situations. For example, the extensive index in his latest book *The Design Revolution: Answering the Toughest Questions About Intelligent Design* (Dembski 2004a) completely omits the names of most of the prominent critics of his ideas. Totally absent from the index to the book are the following names of serious critics: Rich Baldwin, Eli Chiprout, Taner Edis, Ellery Eels, Branden Fitelson, Philip Kitcher, Peter Milne, Massimo Pigliucci, Del Ratzsch, Jeff Shallit, Niall Shanks, Jordan H Sobel, Jason Rosenhouse, Christopher Stephenson, Richard Wein, and Matt Young. All these writers have analyzed in detail Dembski's literary output and demonstrated multiple errors, fallacious concepts, and inconsistencies which are a trademark of his prolific production. (I have not mentioned myself in this list

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although I have extensively criticized Dembski both in web postings [Perakh 2002, 2003a, 2003b, 2003c] and in print [Perakh 2004a, 2004b]; he never uttered a single word in response to my critique, while it is known for a fact that he is familiar with my critique; the above list shows that I am in good company.)

Thomas D Schneider, another strong critic of Dembski's ideas, is mentioned in the index of *The Design Revolution* but the extent of the reference is as follows:

> Evolutionary biologists regularly claim to obtain specified complexity for free or from scratch. Richard Dawkins and Thomas Schneider are some of the worst offenders in this regard.

Contrary to the subtitle of Dembski's book — *Answering the Toughest Questions About Intelligent Design* — this remark can hardly be construed as an answer to Schneider's questions. But even this is more of a mention than most serious critics get from Dembski.

Essentially, all the critics listed above have asked Dembski a number of specific questions regarding his concepts. The absence of any replies to the listed authors suggest that the title of Dembski's new book should have properly been *The Design Revolution? Dodging Questions about Intelligent Design.* Is Dembski also of the opinion that selectivity in choosing when to respond to opponents and when to pretend they do not exist is compatible with intellectual honesty?

Premature reports of the demise of "Darwinism"

One of beloved themes of Dembski's diatribes is his claims that "Darwinism" (the creationists' term for evolutionary biology) is either dying or is already dead (see for example Dembski 2004a). In that assertion, Dembski joins a long list of "Darwinism"'s deniers who started making such claims almost immediately after Darwin published his magnificent *On the Origins of Species.* Predictions that "Darwinism" (read: evolutionary biology) will very soon be completely abandoned by the majority of scientists, claims that it has already died, assertions that it cannot withstand new discoveries in science — all this stuff has been a regular staple of the anti-Darwinian crowd for 148 years (see Morton 2002). Despite all these claims, evolutionary biology is alive and well and the evidence in favor of most of the Darwinian ideas is constantly growing.

Dembski asserts time and time again that evidence favoring "Darwinism" was always weak and that new discoveries make it less and less plausible. His claim (bolstered by the Discovery Institute's so-called "Scientific Dissent from Darwinism" advertisement), concludes that this lack of evidence is causing more and more biologists to abandon Darwinian ideas. In fact, he is proclaiming something he desperately *wants* to be true but that in reality is utterly false — at least if the evidence from the current research literature is any indication. It is hard to believe Dembski himself does not know that his claims are false. Indeed, Dembski is well aware of Project Steve (Dembski 2003b), conducted by the National Center of Science Education (http://www.ncseweb.org/resources/articles/3541_project_steve_2_16_2003.asp). This endeavor by NCSE has unequivocally demonstrated that the overwhelming majority of scientists, and more specifically of biologists, firmly support evolutionary biology based largely on Darwinian principles. According to these data, the ratio of scientists who are firm supporters of the neo-Darwinian synthesis to those who doubt the main tenets of modern evolutionary biology is estimated, as of March 10, 2004, to be about 142 to 1. Dembski knows about this ratio and even tried to dismiss its significance (Dembski 2003b) by asserting that Project Steve was "an exercise in irrelevance" because the support of evolution by the majority of scientists is "obvious" anyway and was not disputed. It is remarkable that such a statement plainly contradicts Dembski's incessant claims in his other writing about scientists' allegedly abandoning "Darwinism" in droves; this contradiction apparently does not make Dembski uncomfortable. Of course self-contradictory claims in Dembski's output are too common to be surprising.

Dembski is a relatively young man and will most probably continue emanating repetitious philippics against "materialistic science" for many years to come. Science is not impressed, though (and hardly will be), by a relabeled creationism, supported not by evidence but only by casuistry in a pseudo-mathematical guise. (The purely religious motivation underlying Dembski's relentless attacks on evolutionary biology — in which he has no training or relevant experience — and on "materialistic science" in general is obvious from his numerous statements to non-scientific audiences — see, for example, Dembski 2004b, in which he told his audience,"When you are attributing the wonders of nature to these mindless material mechanisms, God's glory is getting robbed").

A scientific revolution?

In his latest book, Dembski (2004a) says:

> I take all declarations about the next big revolution in science with a stiff shot of skepticism. Despite that, I grow progressively more convinced that intelligent design will revolutionize science and our conception of the world (p 19).

Is the Design Revolution, so boldly forecast by Dembski, indeed imminent? I suspect that Dembski is in for a deep disappointment. He may continue generating noise within the shadow region underneath science, but at some point in the future all this brouhaha that "intelligent design" allegedly will replace "materialistic science" most probably will result in adding one more item to the amusing collection of absurdities that already contains Barrow and Tipler's Final Anthropic Principle with its prediction of a never-dying intelligence (Barrow and Tipler 1986; Gardner 1986), Tipler's further prediction of the imminent resurrection of the dead as computer-reincarnated entities (Tipler 1994), homeopathic quasi-

medicine, and other fads and fallacies that so easily earn cheap popularity among the benighted crowds. Paradoxically, these "scientific revolutions" occur regularly in the same country where efforts by the avant garde of honest scientists and inventors lead the world in the progress of technology and genuine science. Dembski's work may be remarkable among these only in its quantity.

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Teaching Evolution Better

A special issue of the *McGill Journal of Education* (vol 42, no 2) focusing on evolution education is now freely available on-line. In their preface, the issue's editors, Jason Wiles of McGill University and Anila Asghar of Johns Hopkins University, write:

> the teaching and learning of evolution has faced difficulties ranging from pedagogical obstacles to social controversy. These include two distinctive sets of problems: one arising from the fact that many evolutionary concepts may seem, at least initially, counterintuitive to students, and the other deriving from objections rooted in religion. Despite the overwhelming acceptance of evolution among scientists and despite evolution's centrality to modern biology, virtually all national polls indicate approximately one-half of North Americans reject evolution — suggesting that they think scientists, textbooks, and teachers are simply wrong.

Three themes are emphasized throughout the issue: "the need for improved teacher training in pedagogical techniques and content knowledge with regard to evolution, the need for effective classroom tools for teaching evolution, and the need to confront specific issues related to social controversies surrounding evolution education."

Contributors include Randy Moore; Anila Asghar, Jason R Wiles, and Brian Alters (a member of NCSE's board of directors); Robert T Pennock; Judy Scotchmoor and Anastasia Thanukos; Jeff Dodick; and NCSE's executive director Eugenie C Scott. Also included are opinion pieces by Craig E Nelson and Massimo Pigliucci and book reviews by NCSE's deputy director Glenn Branch and Andrew J Petto (the editor of *Reports of the National Center for Science Education*). To read their various articles, visit <http://mje.mcgill.ca/issue/view/54>.

Responding to ID in a Freshman College Class

Jack Keyes and Nancy Broshot

Introduction

For several years we have taught a course, Science as a Candle in the Dark, to help students deal with questions about the foundations of their belief systems and to promote science and skepticism as a way of inquiry. Our goal was to help students learn how to challenge ideas in a constructive manner that would lead to further insight and understanding. We examine issues where religion and science tend to interdigitate. Another goal was to help students begin to understand ambiguities that arise when religion and science seem to conflict. We take no religious position in this class; the students have a right to their own beliefs and religious views. We emphasize the differences between science and religion. We discuss the conflict between evolution and creationism to focus attention on problems that seem to arise between these two domains.

The majority of our first-year students are creationists whose beliefs span the spectrum from young-earth creationism to "intelligent design" (ID). They have been told evolution is "only a theory" with troubling gaps that scientists do not acknowledge. Part of the problem is that many public schools ignore evolution, and teachers are afraid to broach it. One high school biology teacher in Oregon said he would not touch it with a ten-foot pole. Another said she uses only the word "change" — the word "evolution" is not used in her classes. This seems to be a common experience in our state and perhaps throughout the US. We have found that most of our incoming students were woefully ignorant of evolution. The only place most students were exposed to evolution concepts was in biology classes, but frequently not until they enrolled in college level courses. Even after learning about evolution, some students remained unconvinced. We have students in our program who memorize everything about evolution needed to pass a test, but state flatly they do not "believe in" evolution.

We try to help our students to understand the issues surrounding this divisive artificial controversy. In our classroom, we have advantages over other venues. First, we have a captive audience and adequate time to explain the science behind evolution and argue against creationism. Second, the seminar is not a biology class, so we do not sacrifice critical science content for this issue. Finally, we have the advantage of having sufficient time to discuss evolution and religious beliefs in the classroom; we are not confined to sound bites and a 5– to 20–minute terse counterargument. We have time to educate the audience.

Approach to the course

Science as a Candle in the Dark examines the issues of evolution versus creationism. Until recently, we presented evidence for evolution, but gave no time for presenting creationist or ID views. Students are assigned readings from Carl Sagan's *The Demon-Haunted World* (1996), Stephen Jay Gould's *Rocks of Ages* (1999), Chet Raymo's *Skeptics and True Believers* (1998), and an article on evolution by Ernst Mayr. This year we are adding Edward J Larson's *Summer for the Gods* (1997) to provide more extensive historical background. We give about six hours of lecture on the subject of evolution itself including the history of evolutionary thought, as well as evidence for evolution. We present clear arguments for evolution to help students understand what evolution is. We have had success with more than half of our students as evidenced by them questioning creationist explanations because of the class. Unfortunately, we do not persuade them all; many true believers do not budge despite our efforts.

We begin reading from Sagan's book. This taps into students' sense of awe and wonder of their world and begins their education in skepticism. We emphasize the careful and precise use of definitions and concepts. When we bring up the concept of skepticism, we help students understand that skepticism is not pejorative. We teach them to differentiate between skepticism and cynicism as part of their vocabulary. Using Sagan's examples, we illustrate how easy it is for them to be gullible and believe everything they hear or read in popular media. We emphasize that skepticism is a tool to separate factual knowledge and ideas from misinformation. We introduce them to Sagan's Baloney Detection Kit, an excellent tool students can use when evaluating ideas.

In our discussions, we explain that religion is a different domain from science. We classify the paradigms (Gould's Non-Overlapping Magisteria) of religion and science as Type I and Type II teaching disciplines or knowledge. Type I is reli-

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gious belief or knowledge based in faith, not evidence; it is a philosophical construct evolving from the suppositions of faith. We explain this kind of knowledge is not wrong or bad; it is just a different magisterium from that of science. We give several examples of different kinds of Type I beliefs, but avoid discussing which, if any, are correct, pointing out that such views are typically faith-based and not something we can debate. We emphasize that Type I beliefs cannot be tested using scientific methods.

We define Science as Type II knowledge, which is testable and based in evidence, not faith. We define science as a method of inquiry so it is not misinterpreted as just another religion. We emphasize that science, unlike Type I knowledge, uses skepticism as one of its tools. We define and distinguish between the concepts of hypotheses, theories, and scientific laws. It is too easy for proponents of creationism to talk about creationist or ID theories, implying these are scientific theories, when they are Type I beliefs with no testable supporting hypotheses. Using clear definitions and making sure that students use words correctly in our discussions helps us to clarify real issues in evolutionary science. Clear understanding of terminology sets limits about the discussions that follow.

Using Type I and Type II terminology avoids some of the emotional pitfalls associated with words such as faith, religion, and evolution. This helps defuse the animosity some students have toward science and scientists. Because many fundamentalists see scientists as atheists, we want to avoid the dismissal of our teaching just because students think we do not share the same worldview. We refer to Kenneth Miller's *Finding Darwin's God* (1999) as evidence that not all scientists are atheists. We try to defuse stereotypes and keep students interested and open to new ideas.

We review several articles that help students to begin developing skeptical skills. They read about and challenge ideas such as therapeutic touch and the use of polygraphs as lie detectors, and learn how courts of law misinterpret science because the judiciary often lacks adequate science knowledge or proper expert testimony.

Assigned readings from *Skeptics and True Believers* by Chet Raymo gives students a sensitive view of how one scientist looks at the universe from a perspective of gentle skepticism and wonder. The first contact with the subject of evolution is from Raymo's book. We show *Inherit the Wind* with Spencer Tracy and Frederic March playing the protagonists. Whereas the film distorts what really took place, it accurately describes the emotional tone permeating the current debate about evolution. We want students to get the drama from the Scopes Trial and understand what creationists mean when they say "Scopes Monkey Trial". True believers in the class squirm with the portrayal of fundamentalists in the film. We take advantage of this discomfort by asking them if the film expresses how they feel. Typically, they deny such feelings, and this gives the opportunity to question what the issues really are. We point out the real issue: Type I beliefs from religion cannot explain ideas and theories in the Type II magisterium of science and vice versa. That issue is blurred in creationist arguments.

Students are then assigned readings from Gould's *Rocks of Ages* that explain what really happened in Dayton, Tennessee, in 1925. The farcical part of the issue becomes clearer and students are amused at what really happened. This is followed with six hours of lecture on the history of evolutionary thought, the evidence for evolution, and the history of life on Earth. During and following the presentation, students are encouraged to ask questions about evolution.

Next, students read Greg Easterbrook's article "The new fundamentalism" (2000). In this cleverly written opinion piece, Easterbrook advocates "teaching the controversy", the darling of the ID movement. He also advocates changing the definition of science from natural explanations to logical explanations. He expresses a cynical view of biologists and attacks biologists openly. We ask students to write two responses to the article. One must agree with Easterbrook's contentions and state why. The other takes the opposite position. The purpose is to encourage students to articulate in writing and discussions their understanding of the issues. This assignment helps students evaluate their own beliefs and separate science from religion. It also provides insight into how ID proponents distort and twist arguments about evolution, and gives us the opportunity to help students express their arguments clearly and concisely focusing on careful use of definitions and concepts. We want no blurring of concepts and issues.

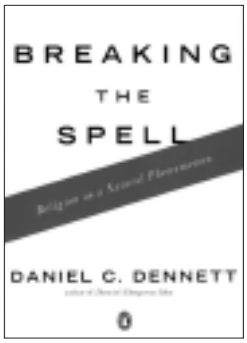
Icons of Evolution

We show the video *Icons of Evolution (*based on the book of the same title by Jonathan Wells) to provide an opportunity to take a hard look at ID. This video takes the student to the core of the issues from the perspective of the ID enthusiast. The video is intelligently designed to *deceive* the viewer. Showing this video to church groups and school boards would likely convince the lay public that evolution is a "theory in crisis". In reality, the video is a mendacious attack on the integrity of scientists and scientific research. We follow the video with an extended discussion of issues raised by Wells and his ID colleagues.

We challenge several basic arguments central to the video's thesis and cast doubt on the veracity of the entire video. Several well-written articles available from the NCSE debunk *Icons of Evolution* and we use these to help make the case against the video. Two of these examples are familiar to *RNCSE* readers: the case of Roger DeHart, and the misuse and misinterpretation of data from evolutionary studies.

Roger DeHart, a teacher in the Burlington-Edison school district in Washington state, presented ID and other creationist misinformation about evolution to his high school biology class. *Icons of Evolution* portrays Dehart as a victim and martyr to generate sympathy and create the view that science and school boards unfairly undermine alternative (creationist) views. The fairness doctrine used by ID advocates plays a major role in this first part of the video.

BOOK REVIEWS



BREAKING THE SPELL: RELIGION AS A NATURAL PHENOMENON

by Daniel C Dennett
New York: Viking, 2006. 464 pages

Reviewed by John C Greene

In this sizeable book, Dennett, a philosopher already famous for his earlier work *Darwin's Dangerous Idea* (1995), undertakes to convince his readers that religious beliefs have no empirical foundation and hence should be abandoned to prevent religious fanatics from destroying the world in a nuclear holocaust. In developing his argument Dennett relies on two sources: Charles Darwin's theory of organic evolution by natural and sexual selection and Richard Dawkins's theory of cultural evolution by the copying and competition of "memes" (ideas, rhymes, behavior patterns, and so on) which lodge themselves in the brain and compete for survival in human societies. Religious memes — gods, spirits, and so on — have no reality except as memes because their extra-human existence cannot be proved scientifically by observation and experiment.

Armed with this criterion of believability, Dennett presents an imposing array of scientific studies of religion by philosophers of religion, sociologists and psychologists, anthropologists, and neuroscientists. His purpose, he confesses, is to "cajole" his readers into abandoning some of their religious convictions and thereby to alleviate the world's "moral crisis" and make possible scientific solutions to the world's momentous political decisions by "delv[ing] into the evolutionary history of the planet" (p 53).

It then turns out that the reasons we love the things we love — religion, romantic love, folk art and

John C Greene earned his PhD in American history from Harvard in 1952. He taught at several Midwestern universities before settling down at the University of Connecticut from 1967 to 1987. His book The Death of Adam: Evolution and Its Impact On Western Thought *(Ames [IA]: Iowa State University Press, 1959) was the first of several books on the rise and development of evolutionary thought, climaxed with* Debating Darwin: Adventures of a Scholar *(Claremont [CA]: Regina Books, 1999).*

However, the Burlington-Edison Committee for Science Education's website on this issue (<http://www.scienceormyth.org>) gives a different picture of what happened. DeHart, a die-hard creationist, taught creationism in his classes. The school board and superintendent initially worked out an agreement with DeHart, which he subsequently deliberately broke. Our students, at first sympathetic to DeHart, did not like his duplicity. For *Icons* to be effective, it is necessary to have sympathy for the fairness argument and for DeHart. We told our students that science has nothing to do with fairness; it is evidence that counts. That approach also helped undermine sympathy for DeHart.

Once sympathy for DeHart is challenged, the students are open to a more critical analysis of the deliberate deceptions, omissions, and distortions of science that make up most of the "evidence" in *Icons*. For example, the video argues that if antibiotics are removed, bacteria revert to the wild type that lack resistance; therefore bacterial resistance has not "evolved". Whereas bacteria do revert under certain circumstances, *Icons* ignores evidence showing bacteria subjected to the selective pressure of antibiotics for longer periods of time retain the resistance even after the antibiotics are withdrawn. In essence, research on bacterial resistance to antibiotics supports evolutionary theory and does not contradict it.

APPLICATION TO THE CURRENT SITUATION IN THE USA

Scientists are at a disadvantage when ID rears its head in school board meetings and community meetings. Our approach requires a significant amount of time and a willingness of the audience to listen and think about these issues. Addressing these issues in the classroom context is an ideal setting for grappling with the real arguments that ID proponents make. The value of exposing and examining ID arguments in detail was shown during the *Kitzmiller* trial in Pennsylvania when plaintiff's witnesses were given a chance to testify. The arguments took time, money, and careful examination by a judge who listened. This is a rare opportunity, but we are heartened that whenever anti-evolutionism has had its day in court, the courts have had no difficulty seeing through its pretences to scientific respectability.

In the classroom, however, we *can* take the time to explore, compare, and evaluate arguments, and

music, sugar and spice, and so on — are not the reasons we give when asked about them. The real reasons, Dennett argues, are evolutionary reasons, free-floating rationales that have been developed by natural selection, that "blind, mechanical, foresightless sifting-and-duplicating process that has produced the exquisite design of organisms" (p 79–80).

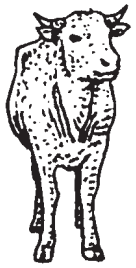
The second part of *Breaking the Spell* devotes four chapters to the "current version" of what scientific "proto-theories" tell us about how religions came to be what they are. It all began, says Dennett, with mutations in hominin genes enabling humans to speak. Language then spread rapidly, perhaps by sexual selection (women like to talk and hence would choose talkative males as partners). Language then gave rise to a virtual world of imagination, a world of intentional agents with beliefs and desires, a world gradually shaped by natural selection so as to improve cooperation within, but not among, social groups. Eventually — here Dennett cites Richard Dawkins — these "proto-memes" produced what neuroscientists call the "god center" in human brains, paving the way for shamans to take charge as "stewards" of the beliefs and practices of folk religions. As religions were "domesticated", carefully crafted reasons for these beliefs and practices replaced earlier free-floating rationales.

As folk religions evolved into organized religion and priests took over as stewards of the sacred memes, Dennett continues, secrecy, deception, and the devising of doctrines designed to protect the body of beliefs from being discredited by scientific methods emerged, and rival systems of religious memes competed for adherents in the religious market place.

Moving forward in time, Dennett presents David Hume's essay "Of Miracles" and William James's *The Varieties of Religious Experience* as models of the empirical study of religion. Like Darwin's cousin Francis Galton, Dennett proposes a scientific study of the efficacy of prayer. On this question and on the question whether religion is good for people Dennett finds the evidence "mixed". On the related question whether religion is the foundation of morality he concedes that "nothing approaching a settled consensus among researchers has been achieved" (p 280). At the same time he aligns himself with the "brights" — atheists, agnostics, freethinkers, secular humanists and others — who have "liberated" themselves from specifically religious allegiances and who "channel [their] charity and good deeds through secular organizations" because they do not want to be "complicit in giving a good name to religion" (p 300–1).

Dennett then mounts a spirited defense of "scientific materialism" — "the theory that aspires to explain all the phenomena without recourse to anything immaterial." Spirituality, he insists, does not require believing in "anything supernatural". Instead it is grounded in an "awestruck vision of the world" viewed with a "humble curiosity" and a sense of wonders and beauties still to be discovered by scientific inquiry (p 303). The presumed relation between religion and moral goodness, Dennett declares, is an illusion.

In a final chapter, "Now What



we are not constrained by time limits for testimony or sound-bite reporting. One advantage is that students begin to understand the difference between scientific arguments and *ad hominem* attacks. We also engage the emotional responses of people who feel that their belief systems or values are under attack by scientists, especially those who teach evolution. By addressing these issues head on in the classroom, we helped our students see that we were not afraid to confront the issues, but that we wanted to have a conversation that was rational and fair — and one that did not distort the scientific studies that support evolution.

We began teaching this class because we were frustrated with the assault on reason promulgated by creationists. We were concerned that teachers should not be forced to teach science through the lens of creationism. Instead we decided to confront creationism, especially ID, directly and honestly with an understanding that both religion and science are part of human culture, but with the understanding that the two domains do not overlap. We found students are interested in learning about these issues. Not addressing them gives the argument to the creationists. We thought it was time to confront the issue. Most of our students have appreciated the opportunity to learn the facts about evolution and the conflict generated by "intelligent design" proponents and other creationists.

Acknowledgments

Mark Terry, as well as Glenn Branch and Alan Gishlick from the NCSE, provided essential information and resources for our rebuttal to *Icons of Evolution*.

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Do We Do?", Dennett describes his depiction of religion as "a family of 'proto-theories' in need of further development," acknowledging that it "is not yet established and may prove to be wrong" (p 309–10). His only "categorical prescription" is: *do more research*. To ensure that the scientific researchers are well trained for their task, he suggests that priests, imams, and theologians prepare an "entrance exam" which researchers must pass before beginning their research. They can then tackle such questions as: Is religion the product of blind evolutionary instinct or rational choice? Confessing that he is "deeply moved" by religious ceremonies, music, and art, although unpersuaded by the doctrines which gave birth to them, he concludes with his "central policy recommendation": "… that we gently, firmly educate the people of the world, so that they can make truly informed choices about their lives" (p 339).

Can we accept Dennett's reliance on Dawkins's much disputed theory of "memes" as cultural replicators and the supposed analogy between the copying of "memes" and the replication of biological traits? Dennett acknowledges the objections raised to this analogy by some of the scientists he cites as exemplifying the scientific study of religion and does all he can to answer them in Appendix A of his book. But this is not the only difficulty confronting Dennett. Religions such as Judaism and Christianity are historical religions claiming historical validation by the testimony of witnesses, as, for example, the resurrection of the crucified Jesus.

How would a scientist set out to prove that, in principle, miracles can never occur? The question whether they *have* occurred in any particular case must be settled by historical evidence, but Dennett shows very little interest in history or in historians like Thomas Cahill, Garry Wills, and John Pairman Brown who have taken the trouble to master the languages and perspectives of the ancient world. Like David Hume, one of his favorite philosophers, he excludes miracles as incompatible with the laws of nature (Hume's criterion) or with "scientific or philosophical materialism" (Dennett's criterion). But there is nothing scientific about materialism as a philosophy, which the *Oxford American Dictionary* defines as "the opinion that nothing exists but matter and its movements and modifications."

Among philosophers the mathematician-logician-philosopher Alfred North Whitehead took the lead in rejecting the concept of matter and expanding the idea of experience to embrace all natural entities, each entity prehending (taking into its own being the rest of the universe in some degree) in its occasions of experience. Among scientists the population geneticist Sewall Wright concluded that for humans "reality consists primarily of streams of consciousness. This fact must take precedence over the laws of nature of physical science in arriving at a unified philosophy of science, even though it must be largely ignored in science itself" (1977: 80). In science, he adds, the richness of the stream of consciousness is impoverished because the scientist restricts his investigation to "the so-called primary properties of matter" (p 80), which, ironically, can be measured only by voluntary actions. Wright concludes that we must acknowledge the necessity "of dealing with the universe as the world of mind" (p 85).

On the subject of the historical relations between science and religion in the Western world Dennett's remarks are equally sketchy. He concedes that priests collaborated with astronomers and mathematicians in fixing the dates of religious festivals, but he seems unaware of the numerous books and articles on important developments in medieval science by scholars like Marshall Claggett, David Lindberg, and Carl Boyer, or of the religiosity of Johannes Kepler, Robert Boyle, and Isaac Newton, to say nothing of scientists such as John Dalton, Michael Faraday, Clerk Maxwell, and the early English geologists and paleontologists, or of the polls taken of the religious views of twentieth-century scientists.

Dennett seems equally ignorant of the views of writers like Whitehead, Michael Foster, Reijer Hooykaas, and Denis Alexander who have argued cogently that the Christian world view helped to pave the way for the rise of modern science by conceiving nature as a contingent phenomenon intelligible only by empirical investigation, by raising the status of the manual trades essential to Bacon's experimental method, and by glorifying natural philosophy and natural history as the study of God's works (for example, Alexander 2001).

What, then, shall we conclude about Dennett's wide-ranging effort to discredit religious beliefs in the hope of preventing a nuclear holocaust? Shall we permit his "memes" (that is, ideas) to infect our brains, or shall we use our brains to detect the weaknesses in his argument? No doubt his intentions are good. He believes in spirituality ("whatever that is") but not in a human spirit (something science cannot conceptualize or explain). He concedes that science cannot give us moral values but thinks it can accumulate a "pool of knowledge" from which we can infer "what is just and what is good." Apparently he is not aware of the words of the Hebrew prophet Micah: "What does the Lord require of you but to do justice, love kindness, and walk humbly with your God," a prescription which TH Huxley, known as "Darwin's bulldog", considered "a wonderful inspiration of genius". "But what extent of knowledge [Huxley adds], what acuteness of scientific criticism, can touch this? Will the progress of research show us the bounds of the universe and bid us say 'Go to, now we comprehend the infinite?'" For his part Dennett relies on "respect for truth and the tools of truth-finding".

"'What is truth?' said jesting Pilate, and would not stay for an answer," wrote Francis Bacon, an early advocate of experimental science. Bacon does not answer Pilate's question, but in an essay "Of Goodness and Goodness of Nature" he links goodness to the character of the Deity and to the theological virtue of charity. He writes: "The desire of power in excess caused the angels to fall; the desire of knowledge in excess caused man to fall: but in charity there is no excess; neither can

angel nor man come in danger by it. ... But above all if he [the good man] have St Paul's perfection, ... it shows much of a divine nature, and a kind of conformity with Christ himself" (Bacon 1909). Apparently this early prophet of a new kind of science based on observation and experiment had none of the animus against religion which inspires the author of *Breaking the Spell*.

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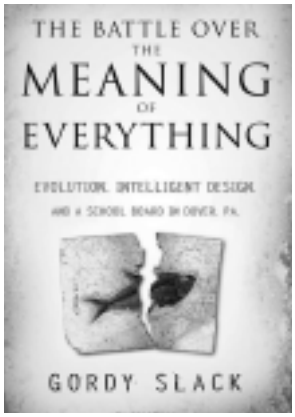
The Battle Over the Meaning of Everything

by Gordy Slack
San Francisco: Jossey-Bass, 2007.
240 pages

Reviewed by Randy Olson

In a time of despair over social and political decay in the US, Gordy Slack's *The Battle Over the Meaning of Everything* is a truly uplifting tale. It is the story of how community activists, concerned parents and passionately driven lawyers came together in Dover, Pennsylvania, to defend the constitution and keep religion out of science classrooms. It all happened less than two years ago, so this is history in the making. The American spirit is as alive and feisty as ever.



At stake in the Dover battle was whether "intelligent design" (ID) could be taught in public schools as an alternative to evolution. If you thought this was tedious, academic, or even trivial, think again. Slack helps us realize there was a an element of "What if the South had won?" or "What if the Nazis had won?" to the conflict. To contemplate "What if the 'intelligent designers' had won?" is to glimpse the entire nation headed in an unsettling direction. The Dover trial had the potential to be as powerful in cultural dynamics and precedent setting as a reversal of *Roe v Wade*.

The book opens with Slack sitting down for a fateful lunch with Berkeley law professor Phillip Johnson, "the George Washington of 'intelligent design'", seven years before the trial. They square off on the two fundamental views of the world — theistic versus materialistic — which define the core of the ID-vs-evolution conflict. Johnson advocates a world of meaning and purpose, and casts evolution as its antithesis. Slack concedes personally "an inclination, a proclivity, a prejudice towards a world devoid of intention."

Slack details with a light yet concise touch the defining moments of the trial, pinpointing the two focal points of the case: the broad question of whether ID is science, and the specific question of whether the Dover school board violated the establishment clause of the First Amendment (separating church and state) when it insisted that a four-paragraph statement about ID be read in ninth-grade science classes.

By the end of the trial, the ID-supporting board members had been shown to be boldly dishonest (detailed in a chapter with the wonderful title, "Liars for Christ"), their best scientist (Michael Behe) came off as contradictory and bumbling, and the ID movement at large was shown to be downright deceitful (the ID textbook *Of Pandas and People*, purchased by a board member for the school's library, was shown to be formerly a creationism textbook for which the term "creationism" had simply been searched and replaced with the term "intelligent design").

In the end, Slack reports what the world of evolutionary biology already knew: this conflict was not about science. It was about the politics and communication dynamics that swirl around science, and about the people willing to take on the scientific establishment in pursuit of a religious agenda. It was about the philosophical divide between camps who acknowledge different ways of understanding the world. With skillful simplicity, Slack draws the distinction between methodological materialism (MM) and philosophical materialism (PM). The former is an absolute necessity of science — to exclude the possibility of supernatural forces. The latter is merely an optional add-on, making it possible for scientists to also be religious.

Slack's book is a solid piece of work which provides both reporting and contextualization of the events at Dover. It is also written by a man with a very human heart, as is evident in the finest, albeit brief, passage of the book. Though clearly not the theist his father, a creationist, is, Slack concedes a moment of his own spiritual vulnerability when he admits having prayed as if he believed in God when his son lay in a hospital bed. That one brief nod to the powers that be makes clear that the author is not yet willing to totally commit himself to either end of the MM–PM spectrum. And that is what makes his writing so human and so worthy of reading.

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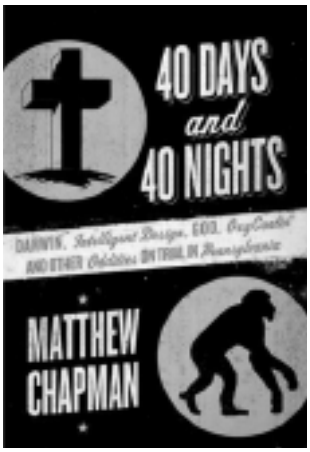
40 Days and 40 Nights: Darwin, Intelligent Design, God, OxyContin, and Other Oddities on Trial in Pennsylvania

by Matthew Chapman
New York: Collins, 2007. 272 pages

Reviewed by Lauri Lebo



One of the most interesting aspects of the "intelligent design" battle that waged in the now famous community of Dover, Pennsylvania, was watching the national media at work. For when journalists descend on a small town, the local press tends to view the impending deluge of coverage cautiously and with trepidation.

In covering stories over the years that have drawn wide media attention, my fellow journalists and I have witnessed the routine. Prominent reporter flies into town, spends a few hours observing us as if we are rare and exotic zoo animals. Reporter jumps back on plane, tapping away on laptop a collection of anecdotes, using smug shorthand that all too often passes for insight. With sweeping generalizations, everyone in the town becomes the same. We locals have collected our favorites of such stereotypical assertions. The one I most enjoy is from a 2001 *Time* story about York, a town only a few miles from Dover. The writer referred to the city as "a hard-knock river town" — even though the closest river, the Susquehanna, is twelve miles away.

So when the national and international spotlight shone on Dover, those of us reporters who had been covering the story from the beginning were wary. In the end, we need not have been. For the most part, I found the national coverage to be thankfully free of such broad-brush stereotypes that plague this kind of parachute journalism.

Perhaps the best evidence of this is the trio of recently released books about the trial. Edward Humes, the author of *Monkey Girl* (New York: Ecco, 2007), and Gordy Slack, who penned *The Battle Over the Meaning of Everything* (San Francisco: Jossey-Bass, 2007), have written competent accounts. The third book, *40 Days and 40 Nights*, was written by Matthew Chapman, the great-great-grandson of Charles Darwin. The title is a reference to the trial's span of time, as well as … well, you already know … the number of days God had it rain on the world to cause the Noachian Flood.

Readers of *RNCSE* know well the details of the first, and likely only, constitutional challenge of "intelligent design". The Dover Area School Board, in the fall of 2004, required that 9th-grade biology students hear a four-paragraph statement that said evolution "was just a theory" and that "intelligent design" is "an explanation of the origin of life that differs from Darwin's view." Students were also referred to the pro-"intelligent design" textbook, published by the Foundation for Thought and Ethics, *Of Pandas and People*. Eleven parents, who viewed the statement as an assault on the First Amendment's prohibition of governmental advocacy of religion, sued the district.

The resulting six-week trial was a gripping interplay of fascinating scientific testimony, intelligent design exposed as fraud, and moving accounts by parents, teachers and yes, reporters, who described the divisiveness that the school board's actions inflicted on the community.

Judge John E Jones III, in a thoughtful and precise 139-page opinion, not only chided the "breathtaking inanity" of the school board members who lied under oath, but ruled that "intelligent design" was a religiously based concept and was not science.

As I covered the trial, I had taken the view of an insider looking out and wondered how we are perceived. Chapman, as a native Briton, is the consummate outsider looking in, wondering who we are and what motivates us.

Kevin Padian, president of NCSE's board of directors and one of the trial's expert witnesses, wrote in his review in *Nature* (2007; 448: 253–4) of the Dover books, "Is the American tradition one of philosophical and political idealists, or of persecuted pilgrims who then turn around and ostracize anyone who doesn't agree with them?"

It is a great question and Chapman explores it quite effectively. In a chapter recounting the trial testimony of Georgetown University theologian John Haught, Chapman writes of the joining of forces between conservative Protestants and Catholics. "Fundamentalists of all kinds have taken the idea of God and whittled it down into an ecumenical baseball bat which all can use to crack the heads of those they fear or hate. In the war against materialism, all allies are welcome" (p 117).

Perhaps the national media was so drawn to the story because what took place in Dover seems to serve as a reflection of what is playing out in Washington DC and across the country. Chapman frequently references this parallel. As he writes about Dover's school board president Alan Bonsell, "He reminded me of President Bush in some ways. His faith seemed to have given him a confidence unwarranted by the facts" (p 25).

Chapman genuinely seems to want to understand the issues that played out in Dover and that led to the "intelligent design" showdown. At the beginning, he makes it clear that he develops a real affection for the characters that have made this story both so endearing and so compelling. He also seems to grasp, as evidenced in his account, that to take one person out of the story no doubt would have changed the story remarkably. In Chapman's mind, everyone seems

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Lauri Lebo covered Kitzmiller v Dover *for the* York Daily Record. *She has also written a book about Dover's intelligent design battle, published by* The New Press, *and due to be released in the spring of 2008.*

to have played a significant part, even Matthew McElvenny, the trial's technology specialist, who delivered the graphics and exhibits each day onto a courtroom screen with nonplussed precision. Chapman calls McElvenny "the Wizard of Oz".

In his interviews, Chapman manages to uncover enticing tidbits of information. In his most delightful chapter, "Marilyn Monroe is alive and well," he writes about Angie Yingling, one of the school board members who, at first, supported the ID policy. The interview careens about like a roller coaster, and Chapman just holds on tight and enjoys the ride.

Chapman can also deliver an amusing turn of phrase and apt descriptions of the players. His summation of Nick Matzke, one of the plaintiffs' NCSE advisors, is dead-on and funny — although his description of plaintiffs' attorney Eric Rothschild, in comparing him to a defense attorney with nine children, as "the more sperm-conservative Jew" is a bit … hmm, how to describe … icky?

Still, Chapman's strength is that he grasps that perhaps the truth is more complicated and messy than the either/or proposition that Padian suggests — that the American tradition is neither solely one of persecuted and self-righteous pilgrims, nor one of tolerant idealists. For within every small town, there are both.

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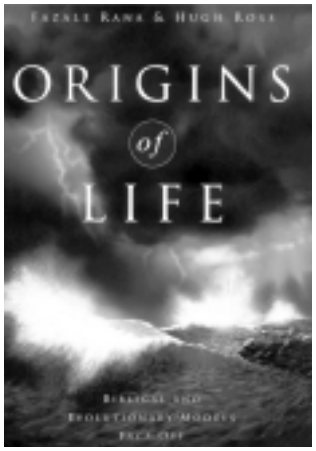
Origins of Life: Biblical and Evolutionary Models Face Off

by Fazale Rana and Hugh Ross
Colorado Springs (CO): NavPress, 2004. 298 pages

Reviewed by Gary S Hurd



The standing of evolutionary biology is independent of the origin of life. This has been true from the publication of Darwin's *On the Origin of Species* in 1859. In that work, Darwin allotted less than a page toward the end of 670 pages of text to the question. The last two sentences of the sixth edition read:

> Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone circling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.

And in an 1871 letter to the botanist Joseph Hooker, Darwin wrote:

> It is often said that all the conditions for the first production of a living organism are present, which could ever have been present. But if (and oh! what a big if!) we could conceive in some warm little pond, with all sorts of ammonia and phosphoric salts, light, heat, electricity, &c., present, that a proteine [*sic*] compound was chemically formed ready to undergo still more complex changes, at the present day such matter would be instantly devoured or absorbed, which would not have been the case before living creatures were formed.

Darwin added, "It is mere rubbish thinking at present of the origin of life; one might as well think of the origin of matter."

However, faced with mounting evidence in support of evolutionary biology coming from scientific fields from genetics to paleontology, the origin of life has become an obsession with creationists who assert that science's failure to create life *de novo* is "proof" of supernatural creation. The first book-length argument of this sort was published in 1984. Written by Charles B Thaxton, Walter L Bradley and Roger L Olsen, *The Mystery of Life's Origin* argued that there is a scientific "crisis" in origin-of-life research, the Miller-Urey experiment was actually a failure, the early earth was oxidized and thus incapable of supporting amino acid synthesis, scientists are "dogmatic materialists" and manipulate their experiments to produce their desired results, and the second law of thermodynamics requires that order cannot appear spontaneously. There is even the introduction of a language model of DNA coupled to an "information entropy" argument.

Bradley and Thaxton reprised their information argument in 1994 for a book edited by Biola University philosophy professor JP Moreland entitled *The Creation Hypothesis.* Prominently displayed on the cover of the book are the names of Hugh Ross and the young William Dembski. In their chapter, "Information and the Origin of Life" (p 173–210), Bradley and Thaxton introduce the notion that "design detection" was similar to archaeology, the search for extraterrestrial intelligence (SETI) particularly as depicted in Carl Sagan's fiction, and forensic investigations. They also apply Leslie

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Orgel's 1973 concept of "specified complexity" to life and rephrase it as a sort of measure of information. In short, Bradley and Thaxton's short chapter on the origin of life set the agenda for William Dembski's whole career. Similarly, *The Mystery of Life's Origin* is a cornerstone of Rana and Ross's book.

One of the goals of *Origins of Life*: *Biblical and Evolutionary Models Face Off*, according to the introduction, is to update *The Mystery of Life's Origin*. Fazale Rana has a chemistry PhD from Ohio State, and Hugh Ross has his PhD from the University of Toronto in astronomy. Together, they are leaders of Reasons to Believe (RTB), an old-earth creationist organization founded by Ross. Their strong arguments regarding the age of the earth are welcome antidotes to young-earth dogmas promoted by such outfits as Answers in Genesis. Rana and Ross are most certainly creationists, however, asserting that the biblical God actively intervenes in biology to "… create each and every new species of life on Earth"; in particular, "God supernaturally and miraculously created Adam from the 'dust of the earth' …" (<http://www.reasons.org/about/8_myths_about_rtb.shtml>). (See Numbers 1993 and Scott 2005 for a discussion of the various flavors of American creationism.)

The errors begin immediately. There are errors of fact, logic, and scholarship. There is a standard dose of quote mining mixed in as well. The creationists' current favorite scientists to quote-mine on the origin of life are Robert Shapiro (a creationist's favorite since his 1986 book), Peter Ward (paydirt from the 2000 book *Rare Earth* co-written with Donald Brownlee), and Hubert Yockey (possibly the mother lode, with half a dozen citations). *Origins of Life* also offers ample cheap innuendo that scientists lack integrity, are "desperate," and "… are keeping quiet …" about the so-called research failures Rana and Ross claim to expose. All this before the end of chapter 1.

More importantly, the "RTB Model" predictions offered by Rana and Ross are not and cannot be differentiated from the predictions of modern origin-of-life research when they are testable at all. The creationist face of the subtitle's "face off" is a hollow mask. The proffered predictions from this "biblical model" appear on pages 43–4:

> 1 Life appeared early in Earth's history while the planet was still in its primordial state.
>
> 2 Life originated in and persisted through the hostile conditions of early Earth.
>
> 3 Life originated abruptly.
>
> 4 Earth's first life displays complexity.
>
> 5 Life is complex in its minimal form.
>
> 6 Life's chemistry displays hallmark characteristics of design.
>
> 7 First life was qualitatively different from life that came into existence on creation days three, five, and six.
>
> 8 A purpose can be postulated for life's early appearance on Earth.

Predictions 1–3 are identical with those of origin-of-life research. From geochemistry, it is known that the chemical signatures of life are present in the earth's oldest sedimentary rock (Rosing 1999, which is actually cited by Rana and Ross). A decade earlier than Rana and Ross, and well before Rosing's confirmation, Antonio Lazcano and Stanley Miller predicted that life appeared in as little as 10 million years following the establishment of favorable conditions (Lazcano and Miller 1994, 1996). Part of the second RTB prediction is trivial — life today began at some point and then persisted. The rest — the notion that the early earth was particularly hostile to life — is absurd. Modern life is found from alkaline to acidic conditions, from below freezing to near boiling temperatures, from harsh sunlight to total darkness, from alpine lakes and hyper-salty lagoons to the driest sands, in solid rock miles beneath the surface, and in forms dependent on molecular oxygen and in others destroyed by it.

The term "specified complexity" was coined by Leslie Orgel in his 1973 book *The Origins of Life: Molecules and Natural Selection*. He wanted to draw the distinction between life and the non-living organization of crystals, which lack complexity, and non-living complex organic aggregates such as tars, which lack organization (that is, specificity). Given the importance that Rana and Ross give this notion of complexity in their model predictions 4 and 5, and their frequent call on "complex organization" and "function", I am unable to understand why they failed to explore its meaning. Equally puzzling is why they failed to mention that this was a central part of our scientific exploration of life for over 30 years. Predictions 4 and 5 can be dismissed.

Prediction 6, presenting the chemical "hallmark characteristics of design," would be an astounding breakthrough, and something that "intelligent design" creationists have all failed to provide in spite of a decade of promises. Alas, Rana and Ross also demur, apologizing that such a difficult topic is beyond the scope of their book, and promising a future book that will present "a comprehensive case for biochemical design" (page 43).

Their last two "predictions" are no such thing. They are at most scriptural interpretations or theological directives and leave no room for independent confirmation of any kind. Rana and Ross provide no means to differentiate their creationism from mainstream science, and try to usurp long-established scientific results for their "biblical model".

Lacking any valid predictions from the RTB model, there was little reason for me to persevere with the book, so I attribute my continued reading to masochism. The situation was not improved when I reached the "predictions" Rana and Ross claimed are the logical scientific consequences of origin-of-life research. These are listed below from pages 58–60:

> 1 Chemical pathways produced life's building blocks.
>
> 2 Chemical pathways yielded complex biomolecules.
>
> 3 The chemical pathways

that yielded life's building blocks and complex molecular constituents operated in early Earth's conditions.

4 Sufficiently placid chemical and physical conditions existed on early Earth for long periods of time.

5 Geochemical evidence for a prebiotic soup exists in Earth's earliest rocks.

6 Life appeared gradually on Earth over a long period of time.

7 The origin of life occurred only once on Earth.

8 Earth's first life was simple.

9 Life in its most minimal form is demonstrably simple.

The first "prediction" is amply demonstrated experimentally and by direct observations from geochemistry and astrochemistry. The second claim seems innocuous; after all, complex biochemicals are produced everyday by chemical pathways. However, Rana and Ross augment the second claim by explaining that it means that DNA, RNA, proteins, membranes, and cell walls "condensed" from the prebiotic environment. This does considerable violence to actual origin-of-life research and theory, which offer specific hypotheses about how such biomolecules formed and outlines cumulative sequences, rather than proposing life simply "condenses".

The third claim, that a rich chemistry existed under early earth conditions, is harmless enough until Rana and Ross piggyback the false assertions of their fourth prediction: The claims that modern origin-of-life researchers imagine a "placid" early environment for "long periods of time" and that such an environment would be favorable for the origin of life are unfounded. Nor are they necessary corollaries to the proposed third prediction.

The fifth proposed consequence for a natural origin of life, that some original remnant of the prebiotic environment must exist, is neither necessary nor cogent. However, such an evidentiary demand can be satisfied in two obvious ways. First, there are multiple examples of amino acids, sugars, and even vesicle-forming lipids from products extracted from meteors, and detected in space by spectroscopy. These are the least altered fragments of our ancient solar system. As it turns out, Rana and Ross cite a small part of this literature, only to dismiss it. Second, isotopic studies provide some indications that even under the horribly destructive dynamics of the earth, some vestige could still exist (Pavlov and others 2001).

Their sixth proposed "scientific prediction" is simply untrue, as is their seventh. It is in fact an area of considerable research and discussion whether there were multiple origins of life, and whether this can ever be untangled. Work by Carl Woese (especially 1998, 2002) argues strongly that multiple origins will never be disentangled. It is with a respect bordering on awe that I contemplate how Charles Darwin allowed for this in the last page of his *Origin of Species*, writing that life was originally breathed "… into a few forms or into one."

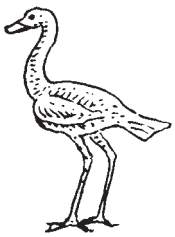
Rana and Ross's claim that science predicts first life to be "simple" is incoherent because they have never defined complexity. The scientific conception of life has always entailed complexity, and Rana and Ross's argument cannot be evaluated without some anchor to make it meaningful. According to the scientific literature, the earliest life was simple compared with later life, and complex compared to most chemistry. Efforts are under way to find, as well as to theoretically predict, the minimal complexity of a living organism, and these results will also inform origin-of-life research.

One of the frustrations reviewing a book one finds fault with is suppressing the desire to mention all its errors, or worse attempting to correct them. Regarding Rana and Ross, this would require a longer work than their original. Failing that, a modest goal is to ask if they have met the goals they set forth in the introduction to their book. First, they wished to update the creationist classic *The Mystery of Life's Origin*. Second, they wished to set out their model of the origin of life. A striking departure from most creationist approaches is that Rana and Ross promise explicit predictions for a "face off" with mainstream scientific theory.

So how did Rana and Ross fare in their efforts to update *The Mystery of Life's Origin*? They have failed. They have many references more recent than 1984, but no new ideas. Many references they do give are incorrect, incomplete, or misinterpreted. Every old objection raised by Thaxton, Bradley, and Olsen is recycled by Rana and Ross — from the idea that the second law of thermodynamics prohibits life to the claim that there is no explanation for chiral biomolecules, there is nothing new.

The origin-of-life model offered by Rana and Ross fails on two grounds. First, their biblical model slips in considerable scientific material without acknowledgment, and they then failed to present any evidence for those parts that are original. Second, they have offered a caricature of origin-of-life research in their so-called "naturalistic predictions." The greatest difference of course is that science never appeals to divine intervention to do the heavy lifting.

Do we know how life originated on earth? No. Is every one of the innumerable chemical and geological events that led to the origin of life preserved? No. Is this "proof" of a supernatural origin of life? No. Nevertheless, the origin of life will be the last refuge for "God of the gaps" arguments in decades to come.



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ENCYCLOPEDIA OF EVOLUTION

by Stanley A Rice
New York: Facts On File, 2007
(hardcover)
New York: Checkmark, 2007
(paperback)
468 pages

Reviewed by Tim M Berra

It is not often that one reads an encyclopedia from cover to cover, but this task was more enjoyable than onerous. I benefited from reading articles on EUGENICS, EVOLUTIONARY ETHICS, EVOLUTIONARY MEDICINE, THE EVOLUTION OF INTELLIGENCE, THE EVOLUTION OF LANGUAGE ABILITY and many other topics. There is much to commend this book, not the least of which is its dedication to Emma Darwin, Charles's devoted wife and caregiver. There are 215 entries, including biographical sketches of 47 scientists from LOUIS AGASSIZ to SEWALL WRIGHT that capture the essence of a person's contribution to evolutionary science. Each topic begins with its definition followed by details. Many entries, such as FLORES ISLAND PEOPLE, GALÁPAGOS ISLANDS, and MACROEVOLUTION are treated in up to three pages, while LYSENKOISM, RED QUEEN HYPOTHESIS, and UNIFORMITARIANISM are covered on a single page. Major topics such as CHARLES DARWIN, CONTINENTAL DRIFT, and NATURAL SELECTION are given five or six pages, and the SCIENTIFIC METHOD merits seven pages and includes appropriate comments on the Bush Administration's abuse of science. There is a "Further Reading" section for each entry. Many articles are illustrated with helpful black and white drawings or photographs. There are cross-references in each entry. For example, the DONALD JOHANSON sketch leads the reader to AUSTRALOPITHECINES, HOMININ, BIPEDALISM, THOMAS HENRY HUXLEY, and HOMO HABILIS. Other subjects can be located via the index. There is no entry for memes, but the index directs the reader to the RICHARD DAWKINS account where memes are explained. The geological periods are treated in a uniform style that includes dates, climate, continents, marine life, terrestrial plants and animals, and extinctions.

The encyclopedia was written by a very well-read botanist who announces his Christianity in the introduction, but does not allow faith to overrule science. His position is elaborated in one of five boxed essays entitled "Can An Evolutionary Scientist Be Religious?" He says "yes," but he never details how to reconcile the two, nor discusses why he thinks it would be necessary. The other essays include "How Much Do Genes Control Human Behavior?", "What Are the 'Ghosts of Evolution'?", "Why Do Humans Die?", and "Are Humans Alone in the Universe?'. The three-page SCOPES TRIAL entry has a fascinating one-page box comparing the actual trial with the 1960 film, *Inherit the Wind*.

The Charles Darwin biographical sketch hits all the important highlights. The writing is at times thoughtful ("Charles Darwin was to put his inherited wealth to better use than perhaps anyone ever has") and occasionally simplistic ("He was attracted to Emma Wedgwood, who also happened to be his cousin, and she liked him as well, and they were married"). I have a few quibbles as with the statement that Fitzroy chose Darwin for the *Beagle* voyage because of the shape of his nose. Actually, Fitzroy the phrenologist nearly rejected Darwin, but Darwin convinced him that "my nose had spoken falsely" (Barlow 1958: 72). The suggestion is planted that the death of Annie, Darwin's eldest daughter, might have been due to inbreeding, but she actually succumbed to tuberculosis (consumption) (Keynes 2001: 219).

There is a presumable typo on p 32 where *Australopithecus afarensis* is substituted for *A africanus*, which could lead to confusion. No phylogenetic diagrams are given in the discussions of *Australopithecus* or *Homo* and some of the more recent books are not cited (Zimmer 2005). As an ichthyologist I am underwhelmed by the EVOLUTION OF FISHES article. It does not say much about the group of vertebrates that has more members than all other vertebrate classes combined. Rice stated that tetrapods evolved from crossopterygians rather than lungfishes as generally thought today, and he does not cite any major ichthyological texts. Some accounts read like the synthesis that comes from consulting a few sources, but that is to be expected in a single-author work of this scope for the general public. Rice puts an astonishing amount of important information at one's fingertips.

In the Alfred Russel Wallace section, Rice confused Borneo and Sulawesi (Celebes) and garbled the mammalian examples. Wallace's Line passes between Bali and Lombock and Borneo and Sulawesi (Berra 2001). To the west

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of the line (Bali and Borneo) is the Oriental biogeographical realm and to the east (Lombock and Sulawesi) is the Australian realm. Sulawesi has at least one species of marsupial; Borneo has none (Flannery 1995). Five species of native felids occur on Borneo (but not tigers) while no native cats occur on Sulawesi (Sunquist and Sunquist 2002).

The appendix is a masterful 14-page, chapter-by-chapter summary of the sixth edition of *Origin of Species*.

There is relatively little overlap between accounts of the same subject in Milner's *Encyclopedia of Evolution* (1990) and the current volume. Reading both accounts of ROBERT CHAMBERS, for example, will provide more information and insight than reading only one. Many topics treated in one of the encyclopedias are not mentioned in the other, so even if Milner's book is in your library, you still need Rice's encyclopedia. Pagel's (2002) *Encyclopedia of Evolution* is a two-volume, multi-authored work of 1205 pages, which, naturally, can incorporate more details.

Rice's coverage is broad, interesting, relevant, and informative. If you want examples of CONVERGENT EVOLUTION or a primer on CLADISTICS, COEVOLUTION, or CREATIONISM, this is a good place to begin. Reading this book would be excellent preparation for graduate school general exams. It can serve as a ready reference for science journalists, teachers, school board members, and the intelligent layperson. I wholeheartedly recommend this book, and at $24.95, the paperback version is good value.

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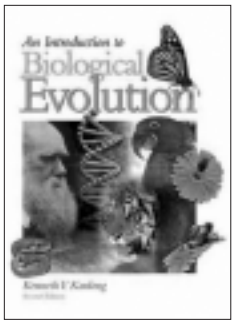
AN INTRODUCTION TO BIOLOGICAL EVOLUTION

by Kenneth V Kardong
Boston: McGraw-Hill Higher Education, 2005. 322 pages

Reviewed by Werner G Heim



There are several excellent textbooks on the market for upper-level courses on evolution for biology majors in colleges and universities, but there are few recent books suitable for a class meant for general liberal arts students or for intelligent adult readers curious about the subject underlying all of modern biology. Kardong's *An Introduction to Biological Evolution* begins to fill the gap. It covers most aspects of the science of evolution, gives an excellent historical introduction, and sometimes points out the broader societal implications of particular aspects.

After a historical introduction, Kardong lays the groundwork with chapters on time and on heredity. The origin of life is covered only briefly, but the course of evolutionary change over time is well presented, perhaps somewhat incongruously in the same chapter with discussions of genetic coding, protein formation, and cellular metabolism. A strong chapter on the evidence for evolution is perhaps placed somewhat too early in the book, before most of the evolutionary mechanism has been discussed. The core material — selection, variation, and speciation — is handled well and in some detail. Perhaps the weakest part of the book is a chapter on life history because the reader might not see the relation of this subject to the evolution process.

The two chapters on human evolution present the material clearly while steering a middle course between the whirlpools of views among paleoanthropological experts. While the dispersal of *Homo sapiens* from Africa is well covered, there is no mention of the genetic tools by which some of these migration paths are studied. One learns little of such techniques as blood typing, haplotyping, mitochrondrial DNA analysis, X- and Y-chromosome analysis, and so on, as tools for migration studies or intra-specific evolution.

A final chapter, "Evolutionary biology: Today and beyond", tells many interesting biological tales but does not always show their evolutionary components. A discussion of the evolutionary patterns seen in the HIV or flu viruses would have helped bring evolutionary biology into the reader's life. Three short appendices — on cell division, taxonomy, and molecular clocks — contain materials of a slightly more technical nature. A glossary helps with the specialized terminology.

There is, however, a glaring omission: The book says virtually nothing concerning the attacks made and being made on the concept of evolution and on the unhindered teaching of this science. Surely an educated citizen should know something of the groups in our society that are attempting to bring their supernaturally-based views into the biological sciences classroom. Equally important, the reader should learn to recognize the axioms and procedures of science so that he or she cannot be fooled by those who falsely claim that their views are equally good science as alternatives to evolutionary biology. The intended readers of this book are or will shortly be the votes who elect members of school boards, state legislators, and governors. If these voters cannot

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distinguish good science from bad or from nonscience, it will not be surprising if their children will be taught something other than good biology.

The author deliberately chose to use colloquial language, sometimes resulting in the use of fifty words where forty might suffice, but making for easy reading. He does not shy away from technical terms when these are needed. The sequence of topics is suitable for class use without major rearrangement and the general continuity is good. While there are the usual misprints and minor problems, the material is, with perhaps a very few exceptions, accurate and properly presented. The black-and-white illustrations are mostly clear and helpful.

In summary, we have here a fine book suitable for the layperson, whether student or not, but one that could be substantially improved in an anticipated second edition.

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Fritz Müller: A Naturalist in Brazil

by David A West
Blacksburg (VA): Pocahontas Press, 2003. 376 pages

Reviewed by Aubrey Manning

I have to confess that the subject of this biography was known to me only by name, as the originator of "Müllerian mimicry" — the concept that prey animals that signal their undesirability as food by warning coloration will tend to converge on the same colors and patterns. The more varied examples of the message "conspicuous black and orange or black and yellow means foul taste" there are around, the fewer chances of any individual's being the unlucky one from whom the predator learns this lesson! All distasteful prey will benefit and so natural selection will be in favor of the convergence that we see: black and orange butterflies, hornets, and tree frogs. It is an elegant concept widely borne out in nature, and one might deduce that its originator would have been a good naturalist. He was indeed; just how good is abundantly brought out in this fascinating book.

There has only ever been one account of his life, written by his cousin, which has never been translated and, although Müllerian mimicry is described in most elementary textbooks, I suspect that the ignorance confessed to above is widespread. Thus we are indebted to David West, an evolutionary biologist who has himself worked on mimicry in butterflies. He has translated the biography and skillfully interwoven it with extensive quotations from Müller's letters, many of which have never been published before.

Müller deserves to be celebrated because he was extremely important in the development of evolutionary ideas following the publication of the *Origin.* When he died in 1897, aged 75, in Brazil, where he had lived and worked since the age of 30, the obituary in *Nature* suggested that, "no other naturalist, save Darwin himself, has given the world so large and original a mass of observations of the kind by which natural selection has been supported." Müller's life as a naturalist is fascinating enough, but there is much more, because this biography gives an intriguing account of mid-19th-century German pioneers settling in the virgin forest areas of Brazil around the mouth of the Itajai river, about 400 miles south of Rio de Janeiro.

Müller was born in 1822. His father was a fairly impecunious pastor, although relatives in pharmaceuticals were prosperous enough. Fritz might have gone into the business but shifted into medical school at the age of 19. He had already begun to rebel against the conservative religious framework of society in Germany at this time; indeed liberal religious groups were in a state of near revolution. Müller was caught up in this ferment — he refused to take his degree because it would have required him to swear an oath involving God — and though he taught for a short time, he felt, like many others, that he must leave the country. This he did comprehensively, never returning to Europe.

He went with his wife, of whom we regrettably know next to nothing, to become a pioneer in Brazil: clearing land, planting crops, building a house. From childhood fascinated by the natural world, he wrote a few letters fretting at his lack of time for scientific exploration of the new world around him, but he obviously enjoyed the challenge of labor, toiling barefoot, building, and growing food. Müller was one of a group of Germans who founded small settlements in southern Brazil and gradually built up a community. It was not easy. The displaced indigenous people were not friendly, nor were the jaguars. There were occasional huge floods. But here Müller began the ceaseless observations and writing about the fauna and flora all around in which he delighted.

His community, Blumenau, was set up within the Santa Catarina province, and it is good to read that sometimes the provincial governors were enlightened people. Müller's scientific background was recognized and valued, and he was asked to teach at the main town on the coast. He did not find it easy to settle back into urban life after pioneering — in particular he missed going barefoot — but he delighted in the opportunity to study the marine fauna, the Crustacea being a special interest. Soon he was able to go back to Blumenau but with a salary from the provincial museum to be a "travelling naturalist", more or less a perfect situation for him. He made many extensive journeys around the Itajai basin.

West weaves all this story together very skillfully with examples of Müller's own writing. Müller was in many ways an extremely modest person,

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although I suspect he was sometimes stubborn and not always tactful in dealing with others. It is noteworthy that he was capable of seeing well beyond racial prejudice. He wrote in 1860 of his pupils,"… the best by far is a black man of pure African lineage. He has an easy grasp of things and a zeal for learning …. That black man is fresh evidence for my opinion, contrary to the prevailing view that the Negroes are an altogether inferior race …" We may note that Müller was not so generous to some of his fellow Caucasians. In 1871, he wrote to his brother back in Germany deploring the fact that obstacles are put in the way of increased immigration, which could allow Germans to predominate in southern Brazil and "... eventually displace the degenerate Latin element." Here, one feels, the heart remains firmly German and we are dealing with cultural rather than racial prejudices!

Müller lived on actively almost to the end, keeping up his ceaseless observation and recording. His was an interesting life in early South American natural history, then, but why is Müller so important in the history of evolutionary science? How did he win that comment from *Nature*'s obituarist? The point is that although he was geographically isolated for all his career, Müller published a great deal in European and Brazilian journals, and he was in active correspondence with most of the great biologists of the day, most notably with Darwin. He immediately accepted evolution through natural selection and realized that his studies of the Crustacea added powerful evidence for Darwin. Müller knew that the diverse adult forms of crustaceans revealed their common ancestry by their development from common larval forms and he worked out their life histories.

Only five years after the *Origin of Species* appeared, Müller collected together a range of diverse studies bearing on evolution and published them with the direct aim of supporting the new ideas, calling his book simply *Für Darwin* (*For Darwin*). Dozens of letters went back and forth between Müller and Darwin. Indeed towards the end of Darwin's life, Müller was one of the few people in the field with whom Darwin kept in touch, constantly asking him for information. In one of his last letters, Darwin writes, "You have such wonderful powers of observation that your opinion would be more valued by me than that of any other man."

West's biography is both a compelling read and a real work of scholarship with abundant references that will enable anyone to go further in the exploration of this remarkable naturalist's life and work. He deserves celebrating as a scientific as well as a Brazilian pioneer. I was disappointed to find that in their classic biography of Darwin, Adrian Desmond and James Moore dismiss Müller's contribution in a few throwaway lines. I feel that Darwin himself would have done better.

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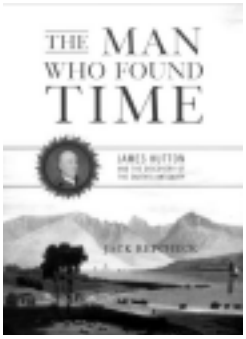
[Fritz Müller: A Naturalist in Brazil *is available from the publisher. Visit <http://pocahontaspress.com/sections/scientific/brazilNaturalist.htm> or call 1-800-446-0467 for details.*]

The Man Who Found Time: James Hutton And The Discovery Of The Earth's Antiquity

by Jack Repcheck
New York: Perseus Publishing, 2003. 256 pages

Reviewed by William Parkinson

Jack Repcheck's book is a well-written account of the career and times of James Hutton. Hutton, a well-known figure in geological circles, is the man credited with discovering so-called Deep Time. Unfortunately, Hutton's contributions to science, unlike those of



Charles Lyell, remain unrecognized by the general public. Repcheck's stated task is to give Hutton his due by enlightening the general public about Hutton's seminal contribution to our understanding of earth history.

As Repcheck paints his portrait of Hutton, he takes us through the period of the Scottish Enlightenment and the history of Scotland at that time. Repcheck does a decent job at situating Hutton in his proper cultural and historical context. Hutton, as Repcheck notes, was part of the Scottish Enlightenment, one of the most astonishing periods of original thought and intellectual contribution in recorded history (earning Edinburgh the moniker of "the Athens of the North"). Other figures of this remarkable era in Scotland are the economist Adam Smith, the sociologist Adam Ferguson, the philosopher and historian David Hume, the poet Robert Burns, the novelist Sir Walter Scott, and the great chemist Joseph Black.

Beyond the general background material of Hutton's life, Repcheck also introduces the reader to Hutton's scientific contributions. First, Repcheck escorts his readers deftly through the phase of Hutton's life when he discovered the rock cycle. Hutton was the first to recognize the importance of erosion in the rock cycle, and the place of eroded sediments in producing sedimentary rocks. Hutton was also the first to recognize igneous intrusion in rocks (such as sills and dykes). At the time, many of his conclusions were quite controversial.

More importantly, though, Repcheck gives a good account of Hutton's discovery of an important geological outcrop and its implications: Siccar Point, Berwickshire, in southern Scotland. This outcrop may

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be called the "other Rock of Ages", for it was here that Hutton was able to convince his skeptics of the antiquity of the earth. This outcrop is composed of Silurian greywacke (known as "schistus" to Hutton) of marine origin (established by the fossils contained in the greywacke), tilted into a vertical orientation. It forms an angular unconformity (that is, two stratified rock units, with the lower one being tilted and eroded while the upper unit, deposited on the lower unit, is at a lower angle than the bottom unit) with the overlying Old Red Sandstone, also of marine origin (again established by fossils), in a normal horizontal position above it.

Hutton, using common sense and a few established principles, was able to figure out the general sequence that produced this particular rock outcrop. The Silurian greywacke had been deposited horizontally in a marine environment, which, Hutton reckoned, took thousands of years to accomplish. Thousands of years more was needed to accumulate enough sediment over this strata to cause the kind of pressure and heat necessary to lithify the graywacke. Later, heat and other additional forces caused the originally horizontal strata to be contorted and lifted up into a vertical plane. The once-submerged rock was then uplifted out of the water and erosion began immediately to wear at the graywacke. Once again the graywacke was submerged under the water (either through subsidence of the land or through a transgression from the sea) and the Old Red Sandstone, which contains a different assortment of fossilized marine life, as well as sediments derived from a different rock source, was laid down on top of the Silurian greywacke. The Old Red Sandstone and the Silurian greywacke that we see today were both covered with sufficient sediment to produce the necessary heat and pressure to lithify the Old Red Sandstone. Finally, both the Silurian greywacke and the Old Red Sandstone (which is today recognized as Devonian in age) were lifted up and exposed to the processes of erosion (for a photograph of the Siccar Point outcrop, see Doyle and others [2001: 20]).

As he worked out the sequence of events for Siccar Point, Hutton realized that this one outcrop could not have formed in the single year of the Flood, or even in the 6000 years generally believed to have transpired since the beginning of Creation. It was an astonishing conclusion! Hutton would later take those who doubted his claims to Siccar Point and use it as an incontrovertible testimony to the antiquity of the earth. It was at Siccar Point that biblical chronology fell to the observations of science, and for that reason alone, it deserves to be better known among the general public.

As for the influence of Hutton's observations, they were enormous, as Repcheck observes. In the end it was Charles Lyell who recognized the significance of Hutton's work, reserving a place of honor for Hutton in his historic textbook *Principles of Geology*. Lyell was taken to Siccar Point after Hutton's death by Hutton's friend James Hall — and Siccar Point worked its magic once again. Lyell became a believer of Hutton's claims. Later, a young Charles Darwin read Lyell, on his trip to the Galápagos Islands, and recognized the significance of Hutton's and Lyell's work for his own developing theory of evolution. Simply put, without Hutton's contribution, we would never have had the theory of evolution from Darwin.

It is when discussing the reception of Hutton's work, in chapters 8–10, that the book really shines. Repcheck chronicles in detail the reception of Hutton's presentation to the Royal Society of Edinburgh in March 1785 and his battle to win over his skeptics; he then progresses to the time when Darwin read Lyell's discussion of Hutton and accepted the conclusions of both men. The three chapters are really the heart of the book and make for engaging reading.

Repcheck documents the resistance to Hutton's ideas both from those still committed to biblical literalism and from the Neptunists, proponents of Abraham Gottlob Werner's idea that the rocks found in the present era were revealed when a "universal ocean" that formerly covered the whole world receded.

I must level one criticism, however. Although Repcheck discusses some of the scientific opposition to Hutton's ideas, he fails to consider the position of the Church of England or the Church of Scotland concerning Hutton. This leaves several questions unaddressed such as: Did the Church of Scotland weigh in on the controversy surrounding Hutton? What about other denominations? What about the so-called chattering classes? Did they accept Hutton's ideas, condemn them, or just ignore them? From the perspective of those interested in church/science issues, this is an unfortunate gap in Repcheck's research. Understanding the interactions with the religious authorities is vital to Hutton's story, and regrettably Repcheck has not included this dimension.

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Darwin in the Genome: Molecular Strategies in Biological Evolution

by Lynn Helena Caporale
New York: McGraw-Hill, 2003.
245 pages

Reviewed by Finn Pond

What if mutations are not random? A mechanism that curtails mutation in critical housekeeping genes while allowing exploratory mutations in certain contingency genes would be a boon to a population of organisms. In a highly variable or changing environment, directed mutations could provide an ideal survival strategy; a species could in a sense regulate its own evolution, not leaving its fate entirely to chance. Is this possible?

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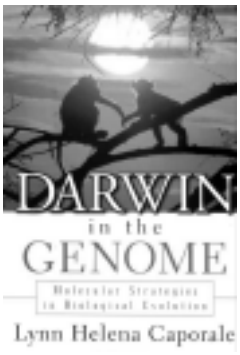

Molecular biologist Lynn Helena Caporale, in her book *Darwin in the Genome: Molecular Strategies in Biological Evolution*, argues that the mechanisms by which genetic variation occur are themselves subject to natural selection. The result, she contends, is that genomes have evolved mechanisms that enhance the possibilities for beneficial mutations and genomic changes, while limiting changes that are likely to be detrimental. In other words, organisms have evolved mechanisms to harness genetic change to their advantage.

Nearly one hundred and fifty years ago, Charles Darwin laid the foundation for a scientific understanding of biological evolution. Darwin built a strong case for the common ancestry of living organisms and gave biologists a mechanism to explain the vast diversity of life; the process of natural selection is his legacy.

Evolutionary theory has not remained static, however. In the first half of the twentieth century, new insights about mutation and the genetics of variation revitalized Darwinism, leading to the development of powerful mathematical approaches to study evolution. Neo-Darwinism, as the synthesis of genetics and natural selection came to be labeled, possessed great explanatory power and continues to dominate much of evolutionary thought. In this view, heritable variations, the raw material for evolution, result from random mutations in a population. Biotic and physical constraints, acting through natural selection, then shape the evolution of a population in a non-random way.

During the past twenty or more years, we have seen an explosion of molecular and biochemical investigations into the nature of genetic systems. Our understanding of how information is stored, maintained, retrieved, and transmitted has changed considerably as a result of genome exploration. Biologists are now more hesitant to talk about "junk DNA", for there are clear examples of non-protein-coding, repetitive DNA sequences that modulate gene expression. We now recognize a variety of small RNA molecules that affect genomic interpretation. We have documented genomic reorganizations by retroviruses and transposons. We now know that the structure of DNA is not uniform throughout a genome, and we have learned that the rate, type, extent, and location of DNA mutations can vary within a given genome.

These new understandings have led some biologists to suggest that the traditional gradualism of neo-Darwinism may not be the only pattern of biological evolution, and that speciation might in some instances have occurred quickly and dramatically through processes such as endosymbiosis, horizontal gene flow, or genomic reorganization by retroviruses.

Caporale presents examples of both non-random and large-scale genomic changes. She describes, for example, how mutational hot spots in genes for vertebrate antibodies can enhance the capabilities of our immune system and how similar hot spots in cone snail toxin genes expand their arsenal of toxic weaponry. Caporale argues that some DNA sequences are more prone to mutational events because of their chemical nature and the biochemistry of DNA replication machinery. She points out that blocks of genetic information can be shuffled within a genome and even passed to the genome of another species. The strength of her book is in collecting and detailing relevant examples from the literature. She maintains throughout that not all mutations are random and that "focused, regulated variation is biochemically possible."

Caporale's idea of "variation-targeting mechanisms" has been criticized for implying foresight in the selection process. She argues, however, that naturalistic mechanisms can explain what appears to be directed purposeful mutation. Caporale offers an approach to working out the molecular and biochemical details, and challenges us to consider the idea that the mechanisms for generating genetic diversity can themselves evolve.

Of course, creationists will attempt to portray such theorizing by biologists as a crisis in neo-Darwinian thought. They will be wrong, as usual. "Survival of the fittest" via natural selection remains the cornerstone of evolutionary theory. Now under discussion are the mechanisms for generating genetic variation; that is, the "arrival of the fittest", with molecular biology demonstrating that genetic change is not limited to an accumulation of random point mutations.

Although written for a lay audience, Caporale's prose is clumsy and cloudy at times, and unfortunately small errors crept into the text, as, for example, when she gives the size of the human genome as three billion base pairs distributed in forty-six chromosomes instead of the haploid number of twenty-three (twenty-four if we make allowance for two different sex chromosomes).

She uses informal language, attributing "anticipation" or "strategy" to genomes. Although it should be clear to biologists that these are rhetorical devices, this distinction may be lost to others, and could provide fertile ground for that creationist specialty, quotation out of context. To talk of genomes as having "worldviews", or to say that "information can flow back from survival to the places in the genome that affect the generation of diversity," will leave some readers uncomfortable.

Despite these weaknesses, I recommend this book to anyone interested in learning more about the molecular complexities of genomes and current discussions on genetic variation.

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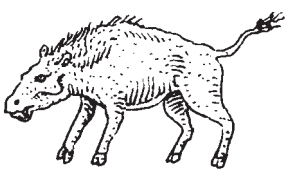

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