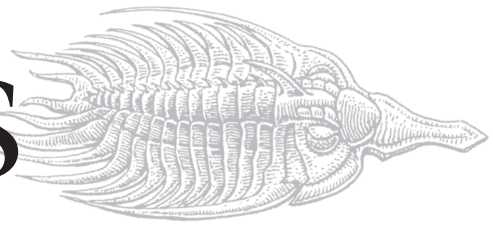
NCSE

REPORTS OF THE NATIONAL CENTER FOR SCIENCE EDUCATION

DEFENDING THE TEACHING OF EVOLUTION IN THE PUBLIC SCHOOLS

Volume 29, Number 6 Nov-Dec, 2009

CONTENTS



REPORTS OF THE
NATIONAL CENTER FOR SCIENCE EDUCATION
DEFENDING THE TEACHING OF EVOLUTION IN THE PUBLIC SCHOOLS
CONTINUES *NCSE REPORTS* & *CREATION/EVOLUTION*

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Cover: Untitled (Two boys fighting in schoolroom while two others try to prevent teacher from entering room). Photo by Fritz W Guerin, circa 1907. Courtesy of the Library of Congress, LC-USZ62-65702.

Other artwork ©Ray Troll, 1997
For more information on Ray's work explore his website at <www.trollart.com>.

Back to school!

For this issue we are looking at the question of how we teach and learn evolution. There is good news from three classroom studies: evolution education works! That is, learning about evolution is enhanced and reinforced when students have the opportunity to study more *evolution*.

In our first article, Andrew Kramer, Arthur Durband, and Daniel Weinand show that students who progress through anthropology courses centered on issues in human evolution demonstrate increasing levels of understanding of basic principles of evolutionary biology. To their surprise, almost none of the demographic variables (years in school, geographic origin, and so on) had any significant impact on students' understanding of evolution, but participation in these courses showed statistically significant changes.

Beth Lueck and Greg Butcher took a different approach when presented with a "teachable moment". They seized the opportunity to survey students before and after viewing NOVA's docudrama *Judgment Day*. After the viewing, there were significant declines in the number of students positively inclined toward "intelligent design", but what was perhaps more significant perhaps was a great reduction in the proportion of students who professed to have no opinion or no answer to questions about the legitimacy of ID.

Our third study is in the Features section and is a first look at data from a national survey of secondary science teachers. Using a survey instrument that requires that teachers give both the correct answer and the correct rationale, Patricia Palko explored not only high-school teachers' knowledge, but also their *understanding* of evolution.

Our last original article is a look at the political landscape of evolution education. Rebecca Lewis argues that scientists' reluctance to engage in the public debate — the one on educational policy and content — is a formula for disaster. Staying aloof is not an option, and anti-evolutionists have understood this for decades. Our cover photo resonates with this idea: educators and scientists must intervene in the creationism/evolution conflict in the public schools.

And in his regular column on the people and places of evolution, Randy Moore returns to the Creation Evidence Museum. Randy's original article on the CEM ran in the last issue, but as we were in press, he wrote to say that he was visiting the new, improved CEM, so we invited him to bring us this update.

IN THE NEWS

In Hong Kong, proposals to modify science education contained a number of well-worn ID catchphrases. Local activists rallied to oppose these changes, and the official word was that they will not be required in the curriculum. However, Virginia Yue notes that the Education Board still has not issued specific instructions to schools that retract the original policy.

Anti-evolution activity is still alive and well all over the world. In Louisiana, the Louisiana Science Education Act just keeps on keeping on. As schools move to implement the act, look for problems to emerge.

A legislator in Massachusetts has introduced a bill that she acknowledges will open the door for creationism in the schools. And a "religious liberty" policy in Iowa is running into trouble.

BOOK REVIEWS

Our book reviewers look at books and media about Darwin and his legacy. Reviewer Keith Thomson recommends Ralph Colp Jr's revised book about Darwin's illness for readers who like a good mystery — and who are interested in the details of 19th-century medicine, while John Waller examines *Darwin's Sacred Cause*.

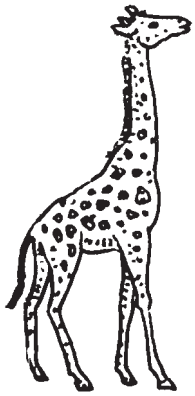
Carol Anelli deems Richard Milner's *Darwin's Universe* to be a readable and "delicious" view of "Darwin's pervasive influence" on our intellectual history. Timothy Goldsmith praises *The Genius of Charles Darwin*, a video presentation hosted by Richard Dawkins. as giving a clear explanation of evolutionary science as well as a demonstration of the "vacuous arguments of evolution's critics". And who better than Kevin Padian to review a collection on *The Paleobiological Revolution*?

RNCSE 29(6) was printed in January 2010

NEWS

A Creationism Row in Hong Kong

Virginia Yue



In March 2009, the ultramodern city of Hong Kong became an unlikely battleground in the war on evolution.

The Hong Kong Education Bureau is currently conducting a series of initiatives to update the city's school system, and a new curriculum for high schools was scheduled for implementation in September 2009. Its development attracted little notice from the public until a problematic statement was discovered in the draft biology curriculum: "In addition to Darwin's theory, students are encouraged to explore other explanations for evolution and the origins of life, to help illustrate the dynamic nature of scientific knowledge." Nowhere else in the science curriculum was there a similarly worded clause invoking "other explanations" as rivals to an established scientific theory.

Scientists at the University of Hong Kong, including Dean of Science Sun Kwok, Science Faculty Board Chairman David Dudgeon, former manager of its Genome Research Centre William Mak, and Associate Professor of Earth Sciences Jason Ali, expressed their concerns about this language to the *South China Morning Post*. The scientists argued that the draft guidelines on teaching evolution tacitly encouraged schools to promote creationism in their biology lessons. In the same article, the *Morning Post* reported that over thirty of Hong Kong's government-aided schools openly endorsed "intelligent design" or creationism as "alternative explanations" (Heron 2009a). (These schools are fully funded by the government and required to follow its curriculum, but are owned and administered by private organizations, usually religious in nature. A smaller number of schools are actually owned and operated by the government.)

Yet the Education Bureau was reluctant to act and insisted that there were no problems with the clause cited. In early March 2009, I, and others who were concerned, started a Facebook group, "The Concern Group for Hong Kong Science Education" (<http://www.facebook.com/board.php?uid=50382348521>).

Standing up for evolution

We decided to approach the issue by asking the Education Bureau to clear up the confusion caused by the remarks of some educators who endorsed creationism, and by starting a website to document the whole incident and to pool together resources for understanding evolution and debunking creationism.

With help from friends in local activist groups, we were able to contact Cyd Ho, the Chairperson for the Legislative Council Panel on Education. The panel is a committee of legislators tasked with monitoring and discussing the government's educational policies, and with making recommendations about them to the Council as a whole; while it has no direct authority over the Education Bureau, its opinions carry considerable weight with the latter body. Ho agreed to put forward our case to the Panel for its attention.

On April 16, 2009, we submitted a paper to the panel. In this paper, we observed that the present draft guidelines contained a loophole permitting the teaching of "intelligent design" and other nonscientific material in science classes, and we criticized the Education Bureau for ignoring the advice of scientists and educators. We noted the consensus of the international scientific community that evolution is the only well-supported theory for the diversity of modern life, and added that *Nature* had reported on the scientific community's concern over the guidelines (Cyranoski 2009). Finally, we urged the Education Bureau to review and reconsider its curriculum, to address the nature of science and the question of whether creationism or "intelligent design" qualify as scientific theories, and to clarify what sort of alternatives to evolutionary theory and abiogenesis would be allowed by the curriculum.

Our submission to the Panel was reported in a local newspaper, the *South China Morning Post*, by reporter Liz Heron who was independently following the story (Heron 2009b). On April 24, a local news program ("The Pulse," on Radio Television Hong Kong) also reported the curriculum row. As a result of our submission and the ensuing publicity, the Legislative Council's Panel on Education urged the Education Bureau to provide a written response.

Meanwhile, our group had contacted a senior official in the Education Bureau, whom we met in early May. The official was initially reluctant to acknowledge our concerns, however, saying that this was an "academic debate". From other sources, we learned that a group of sixty or so people was also "interested" in this issue; we found out later in May that they were the stealth "intelligent design" proponents in Hong Kong. To our surprise, they included principals of elite high schools, molecular biologists, and even a

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Virginia Yue is an information technology professional and native-born citizen of Hong Kong. She was raised in evangelical Christianity, but became a freethinker in 2007. She is the co-founder and webmaster, with Adrian Mok, of the Hong Kong Concern Group for Science Education.

dean from a local university. We realized that we were faced with a very tough challenge.

As early as April, I had gotten in touch with NCSE to seek help. When the "Group of 64" (as it came to be known) sent a letter to the panel on May 11 (Heron 2009c), recommending that the problematic language be retained, we referred it to NCSE for analysis, which pointed out that "intelligent design" propaganda filled the group's writing: references to the Discovery Institute's Dissent from Darwin list, claims that the Cambrian Explosion challenges evolution, and the like. Although the Group of 64 did not mention creationism by name in its letter to the panel, the argument was clearly designed to defend it; it criticized the practice of methodological naturalism in science and asserted that life could not originate through "natural processes".

NCSE had provided a great deal of background information on the nature of science and the scope of scientific support for evolution, which we used in our first submission to the Panel. For our second submission, on May 19, we again used NCSE's help to debunk the Group of 64's claims; an expanded version of this analysis was placed on our website.

The Panel on Education was very busy and hardly talked about the creationism issue for weeks. While we waited anxiously for the Education Bureau's response, debates in the form of letters to the editor raged in the *South China Morning Post*, and "intelligent design" proponents spammed our Facebook page.

We enlisted two academics to advise us, while I and Adrian Mok maintained the website. I also attended as many panel meetings as possible to follow up.

The whole saga was revealing to us in a number of ways:

> The extent of creationism in our school system and academia was beyond our imagination; the Group of 64 includes professors from six academic institutes.
>
> The ignorance of the public about this subject was also surprising — many do not understand why evolution is important and what is problematic about creationism, and thought that it would be beneficial to add any extra material to the curriculum.
>
> The way local "intelligent design" proponents work is a mirror of their US counterparts: quote-mining, misrepresenting both science and "intelligent design", and concealing their true motives for attacking evolution. NCSE's assistance in tracking down misquotations and sourcing creationist claims was very useful in combating these tactics.

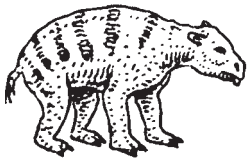
In June we began the signature campaign for a public petition to the Education Bureau. This petition called for a review of the new curriculum with respect to its implications for the teaching of pseudoscientific material, and the release of a statement emphasizing the importance of evolution in biology and the inappropriateness of discussing creationism in science class. To our pleasant surprise, we received over 700 signatures, including those of eighty academics from all over the world,

Norman Levitt Dies

Norman Levitt, Professor Emeritus of Mathematics at Rutgers University and a fierce critic of pseudoscience, died on October 23, 2009, in New York City, according to the obituary in eSkeptic (2009 Oct 26; available on-line at <http://www.skeptic.com/eskeptic/09-10-26>). Born on August 27, 1943, in New York City, Levitt received his BA from Harvard University in 1963 and his PhD from Princeton University in 1967. After a brief stint at New York University, he spent the rest of his career at Rutgers University, with visiting professorships at Århus University, Stanford University, and the University of British Columbia; he retired from Rutgers in 2007. A specialist in topology, he authored *Grassmannians and Gauss Maps in Piecewise-Linear Topology* (Berlin: Springer-Verlag, 1987), but he was better known to the general public for his critiques of pseudoscience and obscurantism, including *Higher Superstition: The Academic Left and Its Quarrels with Science* (Baltimore [MD]: Johns Hopkins University Press, 1994), coauthored with Paul R Gross, and *Prometheus Bedeviled: Science and the Contradictions of Contemporary Culture* (New Brunswick [NJ]: Rutgers University Press, 1999).

While creationism was hardly Levitt's only target, he was certainly concerned about it, especially in its recent manifestation of "intelligent design," which he described — in a press release (available on-line at <http://ncse.com/webfm_send/379/1>) announcing SciPolicy's *amicus curiae* brief (available on-line at <http://ncse.com/webfm_send/383>) for the plaintiffs in *Kitzmiller v Dover* — as "not new science, fringe science, nor even junk science. It is merely window-dressing for a movement that is social, political, and, above all, theological down to its core, and which never had the least intention of doing disinterested science." In the wake of the *Kitzmiller* verdict, he castigated the sociologist Steve Fuller's testimony on behalf of "intelligent design" in a review of Fuller's *Science vs Religion? Intelligent Design and the Problem of Evolution* (Cambridge: Polity Press, 2007) for *Skeptic* (2008; 14 [1]: 73–7; available on-line at <http://www.skeptic.com/eskeptic/07-12-19#feature>) and reviewed Michael Shermer's *Why Darwin Matters: The Case Against Intelligent Design* (New York: Times Books, 2006) for *Reports of the NCSE* (2006 Nov/Dec; 26 [6]: 18–9; available on-line at <http://ncse.com/rncse/26/6/review-why-darwin-matters>). His widow Renée Greene Levitt asks for memorial contributions to be sent to NCSE in lieu of flowers.

UPDATES



California, Mission Viejo: Teacher James Corbett will not be financially liable for damages or legal fees after he was found by a court to violate the constitutional rights of a student by describing creationism as "superstitious nonsense" (for background, see *RNCSE* 2009 May/Jun; 29 [3]: 15–22, 27–9; 2009 Sep/Oct; 29 [5]: 8–9). The *Orange County Register* (2009 Sep 16) reported,

> Judge James Selna had issued a tentative ruling last month indicating he would effectively bar 17-year-old Chad Farnan of Mission Viejo from recovering any monetary damages or legal fees in the nearly 2-year-old case, but did not make that ruling final until today. "Corbett is shielded from liability — not because he did not violate the Constitution, but because of the balance which must be struck to allow public officials to perform their duties," Selna said in a 33-page decision issued from his Santa Ana courtroom.

Although Farnan had not sought damages, his attorney Robert Tyler previously told the *Register* (2009 Aug 31), "It's not about the money, but sometimes you have to hit the school district in the pocketbook to make them realize that teachers don't have the right to do this." Farnan's attorneys plan to appeal the decision. NCSE's collection of documents relating to the case, *CF et al v Capistrano Unified School District et al*, is available on-line at <http://ncse.com/creationism/legal/c-f-v-capistrano-usd>.

California, Riverside: The teaching of evolution at La Sierra University and within the Seventh-Day Adventist Church, with which La Sierra is affiliated, was in the headlines when *Inside Higher Ed* (2009 Sep 1; available on-line at <http://www.insidehighered.com/

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among them Steven Weinberg and Daniel Dennett!

Tempered success

As our signature campaign reached its close, good news arrived: on June 22, 2009, the Education Bureau issued a five-page document, excluding "intelligent design" and creationism from the biology curriculum. The *Morning Post* reported this as a "Victory for Darwin" (Heron 2009d); *Nature* followed suit, reporting that the Bureau had "vindicated biologists — and disappointed creationists" (Anonymous 2009).

Was it a total victory for Darwin, though? We were not quite convinced. The language about "other explanations" was still in the draft curriculum and had not been satisfactorily explained. Furthermore, the document issued by the Bureau appeared to have been directed primarily to the media; there was no indication that it would be disseminated to Hong Kong's educators as well. On August 15, we submitted our petition to the Bureau, expressing the position of the general public as well as the opinion of the scientists.

On September 9, we received a formal response from the Bureau, with language similar to that of the document it had previously issued. The Bureau stated that "Creationism and Intelligent Design are not included in the Biology Curriculum framework nor are they considered as an alternative to Darwin's theory. … Only evolution is included as it is supported with evidence to explain the origin of species." It also clarified that "other explanations" should be discussed only to shed light on the historical development of evolutionary theory, and invoked the theories of Jean-Baptiste Lamarck and Alfred Russel Wallace as examples of such explanations. However, the Bureau did not express any intent to write these clarifications into the curriculum itself, or to announce them to the schools of Hong Kong. Furthermore, the Bureau gave no explanation at all of why and when "other explanations" of "the origins of life" might be appropriate for discussion. We fear, therefore, that the Bureau's response may not yet signal any actual change in educational policy. We are currently composing another formal reply to the Bureau, and hope that further media exposure will encourage it to take genuine action.

Although our concerns about the treatment of evolution in the biology curriculum are somewhat abated, we continue to defend the teaching of evolution in Hong Kong. Over the months we have populated our website (<http://sites.google.com/site/hkscienceeducation/Home>) with lots of articles, FAQs, and links. We hope it will continue to be a useful resource for local educators — who, as we discovered during the course of our efforts, are likely to be besieged for many years to come by those wanting creationism to be taught alongside evolution.

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news/2009/09/01/evolution>) published a piece discussing a controversy between a recent graduate of the university and his biology professors. After Gary Bradley, a professor of biology, reproached a student, Carlos Cerna, for failing to demonstrate his understanding of evolution in a paper, Cerna replied, "I don't see why I'm 'getting the shaft' for questioning these [scientific] methods, especially at an Adventist university." When the e-mail exchange was leaked on-line, a popular evangelist in the church, David Asscherick, protested, "when naturalistic evolution is taught as fact or as the preferred and normative worldview, then we can be sure that the enemy has breached our lines." Subsequently, Jan Paulsen, the head of the church, issued a statement (available on-line at <http://news.adventist.org/statements/an-appeal.html>), reaffirming the church's position "of belief in a literal, recent, six-day Creation." Addressing teachers at church-affiliated colleges, he added

> [You will] expose them to the elements and concepts of evolution. That is understood. As your pastor, however, I appeal to you that when you take your students out on the journey, you bring them safely back home before the day is over. And their home must always be in the world of faith.

Inside Higher Ed reported that Bradley, who is semi-retired:

> doesn't plan to turn his class into a theological seminar, or to present evolutionary theory only to then dismantle it for students. While he's fine with helping students work through struggles of faith, Bradley says he won't undercut decades of peer reviewed scientific research in the interest of religious consistency.

Idaho, Nampa: Nampa Classical Academy, a charter school scheduled to open in September 2009, was contemplating teaching creationism, according to the *Idaho Press-Telegram* (2009 Aug 12), which reported its headmaster as saying, "There are several versions of creationism. ... We're going to explore different theories of it," but added that she "stopped short of saying creationism would be a specific part of the school's curriculum." The Academy was subsequently in the headlines when the Idaho Public Charter School Commission, reviewing its proposed curriculum, ruled that it cannot use the Bible as a primary source of instruction, since the Idaho Constitution expressly prohibits any use of sectarian or denominational texts in a public school classroom, regardless of the nature of the use. On September 1, 2009, the Alliance Defense Fund filed suit against the state of Idaho on behalf of the Academy; creationism is unmentioned in the complaint. Nampa is a town of about 80 000, twenty miles west of Boise.

Iowa, Spencer: A proposed "religious liberties" policy for the schools of Spencer, Iowa — a town of about 12 000 in the northwest of the state — was discarded, according to the *Des Moines Register* (2009 Aug 26). The policy reportedly contained a proposal to offer an elective course, "Critic [*sic*] of Darwinism, a scientific approach," which would "provide a balanced review of evidence for and against the theory of evolution, using texts which include *Darwin's Black Box* by M Behe" (for background, see *RNCSE* 2009 Sep/Oct; 29 [5]: 10). But the *Register* reported that the idea of such a policy is not dead. When the redrafted policy was published in the *Spencer Daily News* (2009 Sep 10), there was no mention of the elective course on "Darwinism" or of evolution. The Sensuous Curmudgeon blog (<http://sensuouscurmudgeon.wordpress.com>) later discovered from the school board's minutes for its meeting of September 22, 2009, that the two members of the board who were most involved in promoting the "religious liberties" policy, Barbara Van Wyk and David Schlichtemeier, were retiring from the board.

Louisiana: The Louisiana Science Education Act opened the door for creationism to be taught in the state's public schools, and now the Board of Elementary and Secondary Education is propping the door open, the Louisiana Coalition for Science charges. In a September 28, 2009, press release (available on-line at <http://lasciencecoalition.org/2009/09/30/creationists-dictate-bese-policy/>), the LCS noted:

> On September 16, the Board of Elementary and Secondary Education (BESE) ignored the recommendations of science education professionals in the Louisiana Department of Education (DOE) and allowed the Louisiana Family Forum (LFF), a Religious Right lobbying group, to dictate the procedure concerning complaints about creationist supplementary materials used in public school science classes under the 2008 Louisiana Science Education Act (LSEA).

Enacted in June 2008 over the protests of scientists and educators across the state and around the country, the LSEA (enacted as Louisiana Revised Statutes 17:285.1) provides that:

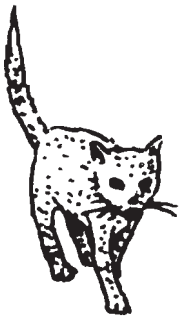
> A teacher shall teach the material presented in the standard textbook supplied by the school system and thereafter may use supplemental textbooks and other instructional materials to help students understand, analyze, critique, and review scientific theories in an objective manner, as permitted by the city, parish, or other local public school board unless otherwise pro-

> hibited by the State Board of Elementary and Secondary Education.

(For background, see *RNCSE* 2008 Jul/Aug; 28 [4]: 4–10.)

Subsequently, in January 2009, BESE adopted a policy about what types of supplementary classroom materials will be allowable under the LSEA. Most notably, a provision that "materials that teach creationism or intelligent design or that advance the religious belief that a supernatural being created humankind shall be prohibited for use in science class" was deleted, according to a report from the Associated Press (2009 Jan 15).

Unaddressed by the policy, however, was the question of how to handle complaints about inappropriate supplementary materials. The Baton Rouge *Advocate* (2009 Sep 17) reported, "The department [of education] recommended that any complaints undergo an initial review by a three-member panel named by the agency, then go to the state board for a final decision." But a BESE committee revised the procedure so that "two reviewers will be named by the department to review the science materials in question as well as one reviewer each named by the challenger, the school and the publisher" of the challenged materials.



Thus, the *Advocate* summarized, "people bothered by materials in a science classroom could file a complaint with the state Department of Education. A hearing would then be set where each side could tell its story. Reviewers, who are supposed to be experts, can ask questions. The five reviewers would file reports on whether the materials violate the rules. The department can also make a recommendation. The state board would then make a final decision." There are conflicting reports about whether the policy was adopted by BESE at its September meeting or whether it will be considered for adoption by the BESE at its October meeting.

In any case, the policy is seriously flawed, according to the Louisiana Coalition for Science:

> There is no guarantee that the three non-DOE reviewers, especially the school district's and the publisher's appointees, will have the requisite expertise to evaluate contested materials. A school district that permits the use of creationist materials is likely to choose a creationist reviewer. The publisher of creationist materials is virtually certain to choose a creationist. ... In short, as BESE's complaint procedure is now drafted, DOE's expert reviewers will be in the minority, and DOE staff will not be allowed to independently assess the reviewers' reports but must instead transfer the reports directly to BESE for evaluation.

Massachusetts: Will a Massachusetts bill entitled "An Act Relative to Protecting the Religious Freedom of Students" encourage the discussion of creationism in public school science classes? That's what a cosponsor of the bill, Representative Elizabeth Poirier (R–14th Bristol), told the *Cape Cod Times* (2009 Oct 79). The bill, House Nr 376, received a hearing on October 6, 2009, at which, according to the *Times*, "No one testified against the bill, which has bipartisan support and is expected to pass favorably through the Joint Committee on Education."

Evolution is in fact not mentioned in the bill, which would require school districts in the state to:

> adopt and implement a local policy that allows for a limited public forum and voluntary student expression of religious views at school events, graduation ceremonies, and in class assignments, and non-curricular school groups and activities. ... Districts shall treat such expression ... in the same manner as the expression of a secular view. Districts are prohibited from discriminating against any student on the basis of a student's expressed religious views.

In commenting on a similar bill in Virginia (HB 1135 in 2008), Dena Sher of Americans United for the Separation of Church and State urged legislators to amend the bill to ensure that classwork is still "graded according to academic standards of substance and relevance," observing that otherwise "this statute could be understood to force biology teachers to give equal credit to students who, when asked questions about evolution, answer with religious views about creation" (quoted in Jeremy Leaming, "Americans United confronts bills threatening church-state separation nationwide", *Church & State* 2008 Apr). The version of the bill that was eventually passed and enacted in Virginia was amended along the lines that Sher suggested.

Missouri, Sedalia: The design of a t-shirt worn by the Smith-Cotton High School band became the center of a public controversy in Sedalia, a town of 20 000 in central Missouri. According to the *Sedalia Democrat* (2009 Aug 28), "The shirts, which were designed to promote the band's fall program, are light gray and feature an image of a monkey progressing through stages and eventually emerging as a man. Each figure holds a brass instrument. Several instruments decorate the background and the words 'Smith-Cotton High School Tiger Pride Marching Band' and 'Brass Evolutions 2009' are emblazoned above and below the image."

After receiving complaints when the shirts were worn in a parade, a district administrator decided to recall the shirts, citing the need for the district to maintain religious neutrality: "If the shirts had said 'Brass Resurrections' and had a picture of Jesus on the cross, we would have done the same thing," he explained. A parent and teacher added, "I don't think evolution should be associated with our school." A subsequent editorial in the *Democrat* (2009 Aug 29) argued:

> We find nothing wrong with the T-shirts and believe the students should be able to continue wearing them if they choose to. It's a play on words that did not endorse or blaspheme any faith. ... School administrators overreacted to the pressure from some par-

ents who obviously saw the image as promoting the theory of evolution and a threat to their own Christian beliefs.

The story gained national attention — producing a flood of comments that overwhelmed the *Democrat*'s on-line comment section as well as a bonanza for the printer of the t-shirts, Main Street Logo (<http://www.mainstreetlogo.com/>), which "became inundated with phone calls and e-mails from people wanting to buy a shirt," according to the *Democrat* (2009 Sep 4).

National: A controversy at Bloggingheads erupted after a proponent of "intelligent design" was a guest on the popular on-line discussion show. Founded by journalists Mickey Kaus and Robert Wright in 2005, Bloggingheads (<http://bloggingheads.tv/>) features discussions and interviews ("diavlogs") conducted via webcams. In July 2009, Bloggingheads presented a discussion between historian Ronald L Numbers and young-earth creationist (and "intelligent design" proponent) Paul Nelson, which raised a few eyebrows but elicited relatively little in the way of protest. Then, in August 2009, Bloggingheads presented a discussion between linguist John McWhorter and "intelligent design" proponent Michael Behe, in which McWhorter's attitude toward Behe's claims was uncritical at best. Subsequently, the discussion was removed from the Bloggingheads website, with a note stating:

> John McWhorter feels, with regret, that this interview represents neither himself, Professor Behe, nor Bloggingheads usefully, takes full responsibility for same, and has asked that it be taken down from the site. He apologizes to all who found its airing objectionable.

A spate of conspiracy theorizing in the creationist blogosphere then ensued, with both Behe and David Klinghoffer describing the removal as Stalinist on the Discovery Institute's Evolution: News and Views blog. Shortly thereafter, the discussion was restored; Robert Wright explained:

> The decision to remove it from the site was made by BhTV staff while I was away and unavailable for consultation. ... It's impossible to say for sure whether, in the heat of the moment, I would have made a decision different from the staff's decision. But on reflection I've decided that removing this particular dialog from the site is hard to justify by any general principle that should govern our future conduct.

In the wake of the controversy over Behe's appearance, Wright was pressed by a number of Bloggingheads contributors to clarify Bloggingheads' policies on asking creationists to participate, and not all of them found his answer satisfactory: journalist Carl Zimmer and physicist Sean Carroll announced on their blogs that they would no longer contribute to Bloggingheads.

United Kingdom: The British Humanist Association, in a press release dated August 20, 2009 (available on-line at <http://www.humanism.org.uk/news/view/346>), called upon the British and Irish Association of Zoos and Aquariums, as well as a number of government and tourism agencies, to dissociate themselves from Noah's Ark Farm Zoo, a creationist attraction near Bristol. The BHA's director of education and public affairs, Andrew Copson, said, "We believe Noah's Ark Farm Zoo misleads the public by not being open about its creationist agenda in its promotional activities and by advancing misunderstandings of the natural world." A spokesperson for the zoo told the *Guardian* (2009 Aug 27),

> We are offering our visitors the chance to look at the evolution/creation debate. As it is a free country, that is within our right. Contrary to a small minority of people's claims, we do not teach false science. This is clearly shown within the zoo with one exhibition talking about Darwin and another offering another point of view.

Few responses from the agencies petitioned by the BHA were reported: a spokesperson for the North Somerset Council told the *Guardian*, "The zoo licensing system ... does not comment on or is involved in personal beliefs," and BBC News (2009 Aug 26) reported, "Visit England has said it only checks the zoo under its Visitor Quality Assurance Scheme and has no opinion on content."

International: A recently published statement on current scientific knowledge on cosmic evolution and biological evolution from the Pontifical Academy of Sciences concludes:

> The extraordinary progress in our understanding of evolution and the place of man in nature should be shared with everyone. ... Furthermore, scientists have a clear responsibility to contribute to the quality of education, especially as regards the subject of evolution.

The statement appears in the proceedings of "Scientific Insights into the Evolution of the Universe and of Life" (available on-line via <http://www.vatican.va/roman_curia/pontifical_academies/acdscien/documents/rc_pa_acdscien_doc_20020103_index_general_en.html>), a plenary session of the Pontifical Academy of Sciences held from October 31 to November 4, 2008.

Nobel laureate Christian de Duve summarized the plenary session: "The participants unanimously accepted as indisputable the affirmation that the Universe, as well as life within it, are the products of long evolutionary histories," noting that there was also wide agreement among the participants on the common ancestry of life on earth. "Evolution," he added, "has acquired the status of established fact. In the words of His Holiness John Paul II, it is 'more than a hypothesis'." The centrality of natural selection to evolution was also recognized, although de Duve acknowledged "the need to refine some of the conceptual bases" of natural selection "in the light of recent findings."

De Duve added:

> On the other hand, no one, at least among the scientists,

NCSE NEWS

News from the Membership

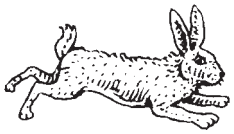
Glenn Branch

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!

Bruce Alberts was elected to the California Academy of Sciences Board of Trustees, according to a September 21, 2009, press release from the Academy. A professor in the Department of Biochemistry and Biophysics at the University of California, San Francisco, Alberts served two terms as president of the National Academy of Sciences and is now editor-in-chief of *Science*. The California Academy of Sciences is a multifaceted scientific institution committed to leading-edge research, to educational outreach, and to finding new and innovative ways to engage and inspire the public.

NCSE is delighted to congratulate **Brian Alters**, a member of NCSE's board of directors, on receiving the prestigious McNeil Medal for the Public Awareness of Science from the Royal Society of Canada, in recognition of "his world-famous work on the promotion of education about evolution." In a congratulatory letter, Principal Heather Munroe-Blum of McGill University described the award as a "wonderful tribute" to Alters's "talents, outstanding achievements and exceptional contributions to public awareness of science."Alters is the Tomlinson Chair in Science Education and Sir William Dawson Scholar at McGill University, where he also founded and directs the Evolution Education Research Centre. He is the author of several books, including *Defending Evolution: A Guide to the Creation/Evolution Controversy* (Sudbury [MA]: Jones and Bartlett 2001), coauthored with Sandra M Alters. He testified as an expert witness on science education for the plaintiffs in *Kitzmiller v Dover*. Alters was awarded NCSE's "Friend of Darwin" award in 2005.

NCSE Supporter **Stephen G Brush**'s monograph *Choosing Selection: The Revival of Natural Selection in Anglo-American Evolutionary Biology, 1930–1970* was published as volume 99, part 3 of the *Transactions of the American Philosophical Society*, and promptly awarded the John Frederick Lewis Award, which recognizes the best book published by the Society in a given year, for 2009. The publisher writes, "This monograph describes the establishment of the hypothesis that Charles Darwin's 'natural selection,' reformulated by RA Fisher, JBS Haldane, and S Wright in the light of Mendelian genetics, is the primary or exclusive mechanism for biological evolution. During the 1930s, alternatives such as Lamarc[k]ism, macromutations, and orthogenesis were rejected in favor of natural selection acting on small mutations, but there were disagreement about the role of random genetic drift in evolution. By the 1950s, research by T Dobzhansky, EB Ford, and others persuaded leading evolutionists that natural selection was so powerful that drift was generally unim-



defended the recently advocated theory of 'intelligent design" ... Several of the arguments cited in support of this theory were shown to ignore recent findings. In particular, the theory was rejected as intrinsically non-disprovable, resting, as it does, on the *a priori* contention, neither provable nor disprovable, that certain events cannot be naturally explained. These views did not satisfy some theologians who stressed the role of design in creation, an affirmation which, in turn, raised the questions of where and how design is manifested. The issue was not settled during the meeting.

"Intelligent design" was also the topic of Maxine Singer's contribution to the plenary session. Singer traced the history of the anti-evolution movement in the United States, from Scopes-era attempts to ban the teaching of evolution, through the McLean, Edwards, and Kitzmiller cases, to the present spate of "academic freedom" bills such as Louisiana's, which "permits teachers to speak of evolution as 'controversial' and is an invitation to teachers to present alternative, nonscientific explanations." She added, "The young governor of Louisiana, Bobby Jindal, signed the bill, making it law although he had been a biology major at Brown University."

"Intelligent design is one of the more recent subterfuges used to try to get creationist idea into school science curricula," Singer explained. Its proponents "say their methods are scientific. But they do not describe experiments or systematic observations and do not publish in recognized, peer-reviewed journals." In the face of resistance to evolution exemplified by "creation science" and "intelligent design," Singer concluded, "we are unlikely to convince those who view their religious faith as in fundamental conflict with scientific evolution. ... The most important task for scientists and the only one that has a chance to succeed is assuring that science and evolution are taught properly in school science classes."

International: The phenomenon of Islamic creationism was addressed by two major newspapers, *The New York Times* (2009

portant. This conclusion was accepted by most; however, a significant minority of biology textbooks and popular articles mentioned drift in the late 1960s." Brush is Distinguished University Professor of the History of Science Emeritus at the University of Maryland.

Lorence G Collins was featured in National Geographic Channel's documentary *The Truth Behind Noah's Ark*, which was broadcast on several dates in November 2009. "The program uses only about five minutes of the four hours of the interview with me, but I liked the way the program used what I had to say," Collins commented by e-mail. "In the program, I suggest that the anchor stones [supposed relics of the ark] are basalt and that there is no basalt within 500 miles of the site in Mesopotamia where Noah supposedly would have built the ark. Actually, the rock is anorthosite (an igneous rock composed mostly of plagioclase feldspar) with so many inclusions of black magnetite granules in it that it looks black like basalt. However, the audience would have no idea what anorthosite is but would be familiar with basalt so I chose to use that word." Collins is Professor Emeritus of Geology at California State University, Northridge; his writings on creationism and related topics are available on-line at <http://www.csun.edu/~vcgeo005/creation.html>.

After *The New York Times* published Nicholas Wade's review of Richard Dawkins's *The Greatest Show on Earth* (New York: Free Press, 2009) on October 11, 2009, a number of NCSE members wrote to chide Wade for his complaint that Dawkins's attitude toward creationists was uncivil and dogmatic and for his stating, "Creationists insist evolution is only a theory, Dawkins that it's only a fact. Neither claim is correct." **Daniel C Dennett** wrote, "one would think *The Times* would finally recognize that the intelligent design campaign is a hoax and dishonest to the core, and stop giving it respectability in its pages," and NCSE Supporter **Philip Kitcher** wrote, "Although philosophers may quarrel with aspects of Dawkins's arguments on a range of issues, he has a far firmer and more subtle understanding of the philosophical issues than that manifested in Wade's review"; both of their letters appeared in the October 25, 2009, issue of the newspaper. In addition, a number of further letters appeared on-line on October 23, 2009 (see <http://papercuts.blogs.nytimes.com/2009/10/23/letters-scientists-respond-to-our-review-of-richard-dawkinss-greatest-show-on-earth/>), among them **Eric Delson**'s, suggesting the adoption of the locution "the law of evolution" in preference to "theory" or "fact".

Raymond Eve and Chawki Belhadi contributed "Darwin in Texas: What teachers of evolution believe" to *Skeptic* (2009; 15 [2]: 12–3), describing the study they conducted for the Texas Freedom Network on the views of Texas college instructors on the teaching of evolution. (See *RNCSE* 2009 Jan/Feb; 29 [1]: 7.)

> In summary, there is little support in our data for any assertion claiming that there are plenty of highly qualified skeptics of evolution who are being silence by fear of being "expelled from the academy." Rather, it appears that the best summation of our data would be, "Teach *what* controversy???"

Also of interest in the same issue are **Christopher Baum**'s "It's time to teach the controversy" (42–6), arguing that there is "no better way both to neutralize the threat and seize the opportunity than to make a rigorous scientific discussion of creationism one of the core elements of our standard biology cur-

Nov 3) and the Boston *Globe* (2009 Oct 25), after a recent conference at Hampshire College on evolution in the Muslim world. (Videos of the conference presentations are available on-line via <http://evolutionandislam.hampshire.edu/>.)

The *Globe*'s article began arrestingly, with the news that the Arabic-language version of Al Jazeera's website — a major news source in the Middle East — triumphantly misdescribed the recently described early hominid *Ardipithecus ramidus* as "evidence that Darwin's theory of evolution was wrong."

"It's hard to say exactly how much support the theory of evolution enjoys in the world's Muslim countries, but it's definitely not very much," the *Globe* noted. The *Times* added, "The degree of acceptance of evolution varies among Islamic countries," citing Pakistan as a country where evolution is covered in high school biology texts, with the aid of Qu'ranic verses.

In Turkey, however, "the teaching of evolution has largely disappeared, at least below the university level, and the science curriculum in public schools is written in deference to religious beliefs," the *Times* reported. Both articles attributed the disappearance of evolution in Turkish schools to the activities of Adnan Oktar — widely known by his pseudonym, Harun Yahya.

The *Globe* commented, "Oktar's main concern — that evolution is the tool of atheists bent on destroying Islam — does resonate there and in other Muslim countries." Islamic creationists "do not quarrel with astronomers and geologists," the *Times* explained, "just biologists, insisting that life is the creation of God, not the happenstance consequence of random occurrences." Both articles also reported that, like their Christian counterparts, Islamic creationists take especial issue with the idea of human evolution in particular.

"[T]he fact that there is a creationist debate at all can be seen as a sort of progress," the *Globe* observed. "In the most conservative parts of the Muslim world, creationism isn't a political or philosophical force because it doesn't need to be — there aren't enough people who believe in evolution, or have even been exposed to it, to require a counter-doctrine."

riculum"; NCSE Supporter **David Morrison**'s "2012 and counting: A NASA scientist answers the top 20 questions about 2012" (47–53); and NCSE deputy director **Glenn Branch**'s review of the updated edition of *But Is It Science?* edited by **Robert T Pennock** and NCSE Supporter **Michael Ruse** (62–4).

When Supriya Jindal, the wife of Louisiana's governor Bobby Jindal, was making the rounds of the state to stress the importance of science and mathematics education, **Barbara Forrest** took the opportunity to write:

> Concerning the importance of math and science education, Mrs Jindal could do the state another service by speaking to her husband about the creationist bill that he signed into law as the 2008 Louisiana Science Education Act. Louisiana is suffering tangible harm because of her husband's signing this bill. ... The only way to undo the damage now is to repeal the LSEA. This would be a service to Louisiana's school children by helping to insure that they receive a quality science education that prepares them for the 21st century world. Surely, Mrs Jindal can use her influence with her husband to persuade him to spearhead the repeal of this harmful, unnecessary law.

Her letter appeared in the August 19, 2009, *Hammond Daily Star*. A member of NCSE's board of directors, Forrest is also a founder of the Louisiana Coalition for Science (<http://lasciencecoalition. org/>).

Mark E Hahn wrote to the *Cape Cod Times* to protest a bill in the Massachusetts legislature, House Nr 376, which, according to a cosponsor, would encourage the discussion of creationism in public school science classes (see Updates, p 6–11). The bill, he wrote:

> is not only unnecessary, but also potentially damaging to the education of our children. Statements from supporters of the bill illustrate the danger of this legislation as currently written. For example, state Rep Elizabeth Poirier is quoted as saying, "Perhaps in science class, when evolution is discussed, a student would be able to bring up creationism." Creationism is not science and does not belong in science class. Our students deserve to be taught legitimate scientific information, not pseudo-science and non-science that would serve only to confuse and mislead them.

Hahn is a senior scientist in the Biology Department at Woods Hole Oceanographic Institution.

NCSE congratulates **Scott Hatfield** on winning *Discover* magazine's "Evolution in two minutes or less" video contest, for "Evolution: The song." The contest's judge, biologist and blogger **PZ Myers**, explained, "He turned evolution into a rock anthem. And it's a very catchy one, too. ... Scott jumps out in your face and grabs your attention with a musical version of the big concepts. It's great stuff." Also winning honors were Stephen Anderson's "Evolution in 120 seconds" (the viewer's choice winner); Maggie Tse, Tony Cheng, and Stella Chung's "Where do we come from? Where are we going?" (the runner-up); Benjamin's "It's ... EVOLUTION"; and Whitney Gray's "Why elephants do not have wings." To see all the videos, visit <http://discovermagazine.com/contests/evolution-in-two-minutes-or-less/>. Hatfield is a high school biology teacher in Fresno, California.

Timothy H Heaton contributed "Recent developments in young-earth creationist geology" to *Science and Education* 2009; 18 (10): 1341–58. "Young-earth creationism has undergone a shift in emphasis toward building of historical models that incorporate biblical and scientific evidence and the acceptance of scientific conclusions that were formerly rejected," he wrote in his abstract.

> The RATE Group admitted that massive amounts of radioactive decay occurred during earth history but proposed a period of accelerated decay during Noah's Flood to fit the resulting history into a young-earth timeframe. Finding a mechanism for the acceleration and dealing with the excessive heat and radiation it would generate posed major problems for the project. Catastrophic plate tectonics was proposed to explain continental movements in a short timeframe and serve as a trigger for Noah's Flood, but other creationists rejected the idea citing hopeless chronological problems. Creationists have also sought to explain the order of the fossil record and the Ice Age in a young-earth timeframe. An examination of these efforts demonstrates the anti-scientific nature of using the Bible as a non-negotiable framework for earth history.

Heaton is Professor and Chair of Earth Sciences at the University of South Dakota.

Alice Beck Kehoe's *Controversies in Archaeology* (Walnut Creek [CA]: Left Coast, 2008) was published. The publisher writes:

> Atlantis, ancient astronauts, and pyramid power. Archaeologists are perennially bombarded with questions about the "mysteries" of the past. They are also constantly addressing more realistic controversies: origins of the First Americans, the ownership of antiquities, and national claims to historical territories. ... Kehoe offers to introductory students a method of evaluating and assessing these claims about the past in this reader-friendly, concise text. She shows how to use the methods of science to challenge the legitimacy of pseudoscientific proclamations and develop reasonable interpretations on controversial issues. Not one to shy away from controversy herself, Kehoe takes some stands — on transpacific migration, shamanism, the Kensington Runestone — which will

> challenge instructor[s] and students alike, and foster class discussion.

The reviewer for *Choice* recommended the book for all libraries. Kehoe is in the Department of Anthropology at the University of Wisconsin, Milwaukee.

Elizabeth J Lawlor developed Evolution Mosaic, a new educational website about human origins (<http://elearn.mtsac.edu/elawlor/mosaic>). She writes, "Evolution Mosaic aims to teach the concept of mosaic evolution — different body parts evolved at different times due to different selective pressures — and to make it accessible to [g]rades 6 through college by nesting more complex material in pull-down panels." Lawlor is Professor of Anthropology at Mount San Antonio College.

NCSE Supporter **Keith B Miller** and **Judy Scotchmoor** organized a symposium on The Nature of Science and Public-Science Literacy for the North American Paleontological Conference, held in Cincinnati, Ohio, June 21–26, 2009. Among the speakers were **Daryl Domning**, asking "Who should speak for evolution? Atheists or theists"; **Stephen Matheson**, asking "Why is there no controversy surrounding theistic embryology? Dissecting critical responses to theistic evolution"; Miller, discussing "The meaning and importance of methodological naturalism"; **Patricia Princehouse**, discussing "Abusing fossils — creationists & the meaning of history"; **Steve Rissing**, discussing "Public perception of the nature of science: Ten lessons learned from the Ohio intelligent design creationism brouhaha"; **Andrew J Petto**, discussing "Teaching and learning about the history and diversity of life"; and Scotchmoor with a number of her colleagues from the University of California Museum of Paleontology, discussing "Shifting the paradigm: Moving toward a more realistic portrayal of how science works."

Kenneth R Miller's *Only a Theory: Evolution and the Battle for America's Soul* (New York: Viking, 2008; reviewed in *RNCSE* 2009 May/Jun; 29 [3]: 40–1) was a finalist for the National Academy of Science's 2009 Communication Award, losing to Neil Shubin's *Your Inner Fish: A Journey Into the 3.5-Billion-Year History of the Human Body* (New York: Pantheon, 2008) — showing, at least, that the judges are highly appreciative of efforts to expound evolution to a general audience! A Supporter of NCSE, Miller is Professor of Biology at Brown University.

A special issue of the *Journal of Effective Teaching*, a peer-reviewed electronic journal devoted to the discussion of teaching excellence in colleges and universities, is devoted to the topic of teaching evolution in the college classroom. Featured are **Randy Moore**, Sehoya Cotner, and Alex Bates's "The influence of religion and high school biology courses on students' knowledge of evolution when they enter college"; Katherine E Bruce, Jennifer E Horan, **Patricia H Kelley**, and Mark Galizio's "Teaching evolution in the Galápagos"; Patricia H Kelley's "A college honors seminar on evolution and intelligent design: Successes and challenges"; Alexander J Werth's "Clearing the highest hurdle: Human-based case studies broaden students' knowledge of core evolutionary concepts"; Aditi Pai's "Evolution in action, a case study based advanced biology class at Spelman College"; and Caitlin M Schrein, **John M Lynch**, Sarah K Brem, **Gary E Marchant**, Karen K Schedler, Mark A Spencer, Charles J Kazilek, and Margaret G Coulombe's "Preparing teachers to prepare students for post-secondary science: Thoughts from a workshop about evolution in the classroom." All are freely available on-line in HTML and PDF formats via <http://www.uncw.edu/cte/et/articles/Vol9_2/index.htm>.

The fourth edition of **Bruce D Olsen**'s *Understanding Biology through Evolution* (Raleigh [NC]: Lulu Press, 2009) was published. The publisher writes, "Written especially for non-majors, the concise explanations of core biology concepts are accompanied throughout with helpful illustrations and tables. The author's objective is to illustrate how the concept of evolution is the key to understanding the major sub-disciplines of biology, including genetics, ecology, biodiversity, botany, and zoology." Olsen is an adjunct professor of life sciences at Los Angeles Trade-Technical College.

Kevin Padian discussed — and debunked — "Ten Myths about Charles Darwin" in the October 2009 issue of *BioScience* (59 [9]: 800–4). He wrote:

> Darwin is one of the most revered (and at times reviled) figures in Western history. A great many 'facts' about him and his ideas are the stuff of textbook myths, others are inaccuracies spread by anti-evolutionists, and still others are conventional historical mistakes long corrected but still repeated. I present 10 such misconceptions, and some quick and necessarily incomplete rebuttals.
>
> Examples of these myths are:
>
> Darwin was a "mere companion" to Captain Robert FitzRoy on the HMS *Beagle*
>
> Darwin's epiphany about natural selection came while visiting the Galápagos Islands
>
> Darwin stole the credit for natural selection from Alfred Russel Wallace
>
> Gradual change is slow and steady
>
> Human evolution was shaped mainly by natural selection
>
> Sexual selection is all about how many offspring you leave
>
> Darwin was a confirmed atheist who had a deathbed conversion to Christianity

Padian concluded, "Myths will always arise and abound ... It is hoped that this myth-busting scholarship will soon filter down to revisions of textbooks that discuss Darwin and to public discourse about his life and work." President of NCSE's board of directors, Padian is Professor of Integrative Biology at the University of California at Berkeley

and also Curator of Paleontology at the University of California Museum of Paleontology. (Thanks to *BioScience* for graciously making Padian's article freely available on-line at <http://caliber.ucpress.net/doi/full/10.1525/bio.2009.59.9.10>.)

Stanley Rice made three appearances dressed as Charles Darwin in 2009. One was in a panel discussion at the University of Oklahoma in February; another was in a symposium at the AAAS Southwest and Rocky Mountain Section annual meeting in March. But the most unusual and risky one was for a discussion forum open to students and faculty at his home institution, Southeastern Oklahoma State University, on February 18. He was accompanied by a stuffed, toy blue-footed booby and a Darwin bobble-head. After being introduced by a colleague who bore a noticeable resemblance to Alfred Russel Wallace, Rice gave a brief "auto"-biographical overview of Darwin's life, then opened the floor for questions. Neither Rice nor anyone else knew what to expect from an open discussion about evolution in rural Oklahoma, the heart of creationland. The audience consisted of about seventy students, many of whom appeared to come and leave unconvinced by evolution. Two young women in full Japanese kimonos showed up during a break in a rehearsal for *The Mikado*. Neither the audience nor the speaker intimidated each another, and several observers commented that it was a truly positive experience. A professor in the Department of Biological Sciences at Southeastern Oklahoma State University, Rice is the author of *Encyclopedia of Evolution* (New York: Facts on File, 2006; re-issued in paperback as New York: Checkmark, 2007) and *Green Planet: How Plants Keep the Earth Alive* (New Brunswick [NJ]: Rutgers University Press, 2009).

NCSE Supporter **Michael Ruse** reviewed Joan Roughgarden's *The Genial Gene: Deconstructing Darwinian Selfishness* (Berkeley [CA]: University of California Press, 2009) for the Toronto *Globe and Mail* (2009 Sep 19), writing that Roughgarden "loathes and detests sexual selection, thinking it one of the greatest biological fallacies, inadequate in theory and unsupported by evidence. As revealed by the title of her new book, *The Genial Gene: Deconstructing Darwinian Selfishness*, she opposes tooth and nail the underlying genetic self-centered approach of much modern evolutionary biology. She wants to replace it with a warmer, friendlier way of thinking, based on something she calls 'social selection,' where organisms get together for the benefit of each other rather than just for No 1." But, he adds, "being warm and friendly and co-operative because this is nicer appears no less problematic than selfishness."

A few weeks later, Ruse reviewed Richard Dawkins's *The Greatest Show on Earth: The Evidence for Evolution* (New York: Free Press, 2009) for the *Globe and Mail* (2009 Oct 2), writing, "No one can write about science as well as Dawkins, and again and again one is left breathless with admiration for the skills of the storyteller." He took issue, however, with the book's discussion of the problem of evil: "Dawkins cannot refrain from having another crack at the evolution-is-cruel-and-hence-God-cannot-possibly-exist argument ... To which I suspect Christians will respond: Whoever thought they needed Dawkins and evolution to tell them about any of this? The problem of evil goes back a long way before Darwin; this is not to say that it can be solved, but it is to say that evolution does not uniquely have an essential role in refuting Christianity." Ruse is Lucyle T Werkmeister Professor of Philosophy and director of the Program in the History and Philosophy of Science at Florida State University.

NCSE's executive director **Eugenie C Scott** received the Fellows Medal, the highest honor of the California Academy of Sciences, in a ceremony in San Francisco on October 13, 2009. According to a press release from the Academy issued on October 8, 2009:

> Scott has been a pioneering researcher and activist in the creationism–evolution controversy for over 25 years. ... In 2005, NCSE served as a consultant for the plaintiffs in the *Kitzmiller v Dover Area School District* case, in which Judge John Jones ruled against the teaching of intelligent design in public schools. Dr Scott has received national recognition for her work and holds honorary degrees from McGill, Rutgers, Mt Holyoke, the University of New Mexico, Ohio State, and the University of Wisconsin-Milwaukee. She is the author of *Evolution vs Creationism*, and co-editor of *Not in Our Classrooms: Why Intelligent Design Is Wrong for Our Schools*.

Scott also was elected to the California Academy of Sciences in 1994. In receiving its Fellows Medal, she joins such distinguished evolutionary scientists as Peter H Raven, G Ledyard Stebbins, and **F Clark Howell**.

NCSE's executive director **Eugenie C Scott** made a cameo appearance in Jane Haddam's *Living Witness* (New York: Minotaur, 2009), the 24th in the popular mystery series featuring Gregor Demarkian. In Snow Hill, Pennsylvania, the school board has just adopted a policy about "intelligent design" more than a little reminiscent of Dover's ill-fated policy; when a member of the board who opposed the policy is badly beaten, Demarkian is called to investigate. In one scene, Scott appears on a television in the background, being interviewed by Larry King; Franklin Hale (a member of the board who supported the "intelligent design" policy) comments, "That's Eugenie Scott ... That's a name, isn't it? *Her* mother must have thought she was just too perfect. Now she runs something called the National Center for Science Education." His interlocutor replies, "It's just — well, she's on the list. I mean, that organization is on the list. To testify in the trial" (p 223). Other NCSE members to be mentioned or quoted include **Tim Berra**, **Steve Dutch**, **Barbara Forrest**, **Douglas Futuyma**, **Mark Isaak**, and **Donald R Prothero**. In an appendix, Haddam gives NCSE a gener-

ous plug, thanking Scott, **Glenn Branch**, and the whole staff of NCSE "for all the work they do on behalf of science education" (p 391).

NCSE's executive director **Eugenie C Scott** is on the revamped and expanded Board of Advisers of *Scientific American*, announced in the magazine's November 2009 issue. Acting editor-in-chief Mariette DiChristina explained that the advisers "have agreed, as friends of the magazine, to assist in our mission of being for you, our readers, the best source for information about science and technology advances and how they will affect our lives. The advisers give us feedback on story proposals and manuscripts from time to time." Other members of the board include Nobel laureate Steven Weinberg of the University of Texas, Austin; Lawrence Lessig of Harvard Law School and the Center for Internet and Society; Lawrence M Krauss of Arizona State University; John P Moore of Cornell University; Jeffrey Sachs of the Earth Institute; Arthur Caplan of the University of Pennsylvania; Nobel laureate David Gross of the University of California, Santa Barbara; Leslie C Aiello of the Wenner-Gren Foundation for Anthropological Research; and Martin Rees of Cambridge University. Scott's previous involvement with *Scientific American* includes reviewing **Robert T Pennock**'s *Tower of Babel: The Evidence against the New Creationism* for its August 1999 issue and contributing "The latest face of creationism," coauthored with NCSE's **Glenn Branch**, to its January 2009 issue on "The Evolution of Evolution." She was also honored as one of the *Scientific American* "10 for 2009" for her "outstanding commitment to assuring that the benefits of new technologies and knowledge will accrue to humanity."

Thomas Stubbs's "Darwin's Revolution" — a photograph of which appeared on the cover of *RNCSE* 2009 Jan/Feb; 29 (1) — won a cash prize from the Old Town Gallery in Tustin, California, where it was featured in a special Evolution & Change exhibit of prints. It was the second gallery prize for "Darwin's Revolution", which previously won a prize at the A Shenere Velt Gallery in Los Angeles. The medium is oil over lithographic transfer on copper. Based in Pomona, California, Stubbs is a well-known artist as well as an art instructor at a number of southern California colleges. For more information on his work, visit <http://thomasstubbs.net/>.

Donald Waller was in the news for his work, with Thomas Gibson, on carnivorous plants. According to the *Wisconsin State Journal* (2009 Sep 20), Waller and Gibson were intrigued by:

> the remarkable characteristics of the Venus flytrap, one of the oddest of a very strange group of plants that have evolved ingenious ways to trap and eat insects. How, the scientists wanted to know, did a plant come to have teeth-like spines? And a hair-trigger trap so refined that it snaps its leaves closed on its victims in a flash?

The answer: "With information gleaned from previous genomic work, computer models and studies of the plants, Gibson and Waller theorized in an article published in the journal *New Phytologist* ["Evolving Darwin's 'most wonderful' plant: Ecological steps to a snap-trap"; 2009; 183 (3): 575–87] that the plant, over some 65 000 years, developed more effective trapping mechanisms so that it could snare and eat larger, more nutritious insects. The better nutrition gave it an evolutionary edge in the nutrient-poor bogs where it grows." Waller is Professor of Botany and Environmental Studies at the University of Wisconsin, Madison.

Howard Winet, Adjunct Professor of Orthopedic Surgery and Lecturer in Bioengineering at the University of California, Los Angeles, wrote to recount his ongoing efforts to educate his colleagues about natural selection. "I have been at this task for 40 years and have been incorporating the concept in both my biomaterials (6 years) and bioengineering ethics (3 years) courses," he commented. He also has been giving presentations on evolution and natural selection at professional conferences, including:

> Using Evolution Theory as a Teaching Thread Linking Bioengineering Ethics and Biomaterials Courses
> Biomedical Engineering Society, San Diego, 2007
> — focusing on immunology and the concept of clonal selection and animal altruism
>
> Using Evolution to Prime Debates in Bioenginering Ethics Courses
> 5th International Conference on Ethical Issues in Biomedical Engineering, 2009
> — focusing on evolutionary psychology
>
> Teaching the Role of Natural Selection in Biocompatibility
> Society for Biomaterials, San Antonio 2009
> — focusing on clonal selection and biofilm bacteria evolution
>
> The Role of "Optimization" in the Study of Biomechanical Adaptation: The Fallacy of Adaptationism
> 10th International Bone Fluid Flow Workshop, Hershey PA, 2009
> — focusing on **Stephen Jay Gould** and **Richard C Lewontin**'s "The spandrels of San Marcos"

"I have also presented lectures under the title 'The nature of scientific truth' at a number of venues, both bioengineering and orthopedic," Winet adds. "The audiences were not uneducated people. Yet they revealed gaps in understanding that help explain why most scientists have difficulty dealing with religious fundamentalists."

Scott versus Comfort

NCSE's executive director Eugenie C Scott was invited to debate on the God & Country blog of *US News & World Report* against Ray Comfort, a creationist who recently distributed copies of *On the Origin of Species* with his own introduction. The debate ran from October 29 to November 3, 2009. The debate, according to Dan Gilgoff, who maintains the blog, elicited "more feedback than any other issue on this blog" in a comparable time period. (For all the posts, visit <http://www.usnews.com/blogs/god-and-country>.)

In her first post, Scott urged students to accept the free copy of the *Origin*, but not to waste time reading Comfort's introduction — especially the middle section. "[It's] a hopeless mess of long-ago-refuted creationist arguments," she observed, "teeming with misinformation about the science of evolution, populated by legions of strawmen, and exhibiting what can be charitably described as muddled thinking." After giving a number of examples of scientific errors in Comfort's introduction, she added, "I have faith that college students are sharp enough to realize that Comfort's take on Darwin and evolution is simply bananas."

Eugenie C Scott

Scott also noted that the copy of Comfort's version of the *Origin* that she received from the publisher was missing four chapters, as well as Darwin's introduction. In his response, Comfort claimed that the next edition includes the missing material: "Not one word will be omitted." Scott observed, "It's still missing a crucial diagram from Chapter 4 as well as the epigraphs from Bacon and Whewell, which Darwin chose with care."

"I stick by my advice," Scott wrote in her second post. "Students who are interested in learning about science can skip Comfort's introduction, which, despite a few cosmetic revisions, remains a hopeless mess of long-ago-refuted creationist arguments." And she concluded, "Anyone who honestly examines the data supporting evolution — even a young-earth creationist [such as Bryan College's Todd C Wood, whom Scott quoted as acknowledging, "Evolution is *not* a theory in crisis"] — concludes that the science is strong. If you reject evolution, you are doing it for religious reasons. You're entitled to your religious opinions — but not to your own scientific facts."

More from and about the debate in a future issue of *RNCSE*.

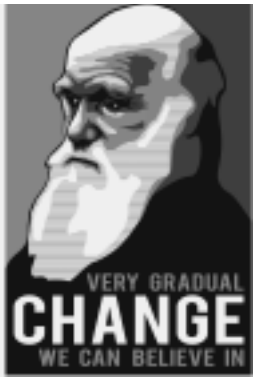
(Very Gradual) Change We Can Believe In

Mike Rosulek

Last February, I wanted to acknowledge Darwin's 200th birthday on my blog, so that my vast readership of approximately ten people would be aware of it. In order to spice up what would have been an otherwise short and boring blog post, I thought it would be nice to include something light-hearted but still in the spirit of Darwin Day.

Having only limited creativity, my first instinct was to repeat something I'd done before: make a parody of the now-famous Shepard Fairey Obama "HOPE" poster, this time featuring old man Darwin and his bushy beard. When you think about it, the Obama campaign's rhetoric of "change" is right in line with the Darwinian idea of adaptation. Once I hit upon the "adaptation" of the Obama slogan "(very gradual) change we can believe in," I knew I was on to something good (even though "believe" is not the best word when referring to established scientific fact).

Well, I did not get the design done in time for Darwin Day, but I kept at it. In the back of my mind, I figured that there might be some people (myself among them) who would want the design on a poster or a t-shirt. I thought to myself, if I could come up with a way to sell these, I might make a few bucks out of this whole deal. Perhaps



even $50, if I got lucky! With that in mind, I unsuspectingly and casually posted the design to my website. Maybe eventually I would get around to finding a way to sell the design on t-shirts.

I thought it would make sense to donate any profits to some appropriate charity. NCSE seemed the most obvious beneficiary for Darwin-themed sales, and I was sure that they would appreciate the twenty bucks I was expecting to raise. In the spirit of procrastination, I wrote on my blog that I would "soon" be selling the design on some t-shirts and posters, with proceeds benefiting NCSE.

As it turns out, my idea caught on faster than a drug-resistant bacterial mutation. My blog post was picked up by Reddit, then Pharyngula, boingboing, and so on. I woke up the next morning to almost 100 emails from people asking me when they could get Darwin on a t-shirt. When the dust finally settled, my estimate of this idea's popularity was off by a mere factor of 100! At the time of writing this, sales from the merchandise (posters, shirts, buttons, and stickers) have generated almost $4500 for NCSE, and orders are still trickling in three months later.

The designs (old man Darwin with a variety of slogans) are still for sale, and all proceeds will continue to benefit NCSE. You can find all the designs and a link to the Zazzle storefront at <http://mikero.com/darwin/>. Thanks to everyone who bought merchandise to support NCSE and to support my fifteen minutes of fame!

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NCSE Honors "Friends of Darwin" for 2007

Glenn Branch

Every year, NCSE honors a few exceptional people for their support of evolution education and/or their service to NCSE. The "Friend of Darwin" awards are proposed by the staff and approved by the board at its annual meeting; the recipients for the award for a given year are thus selected in the spring of the following year. NCSE usually arranges for the awards to be presented to their recipients by their family, colleagues, and friends, so it often takes a while before a public announcement is possible. And then sometimes there are further delays! Here, finally, are the Friends of Darwin for 2007.

Ed Brayton is cofounder and president of Michigan Citizens for Science, a grassroots organization that works to prevent non-scientific and faith-based ideologies from entering Michigan's public school curricula. MCFS lobbied effectively against a series of anti-evolution bills in Michigan, ranging from a bill requiring that teachers tell their students about "the theory that life is the result of the purposeful, intelligent design of a creator" to a pair of "academic freedom" bills, and for improvements in the treatment of evolution in the state's content expectations. With MCFS, on The Panda's Thumb blog, which he helped to found, and on his popular blog Dispatches from the Culture Wars (<http://scienceblogs.com/ dispatches/>), Brayton has been a consistent, forceful, cogent — and frequently hilarious — voice defending the integrity of science education.

Robert T Dillon Jr is associate professor in the Department of Biology at the College of Charleston and president of South Carolinians for Science Education, a grassroots organization dedicated to improving the quality and defending the integrity of science education in the schools of South Carolina. Contending with a steady stream of anti-evolution legislation and sporadic attempts to undermine the treatment of evolution in the state science standards, Dillon was instrumental in testifying, and recruiting colleagues to testify, for the importance of teaching evolution. After Dillon received his award, Rodney Wilson of SCSE commented, "without Rob stepping up to lead and put a face (and voice) on our organization, we'd still be a loosely knit group of folks outraged at what people try to pass as science in our state."

Brandon Haught is the communications director of Florida Citizens for Science, which defends and promotes good science in Florida. In 2007 and 2008, during the furor over the place of evolution in Florida's state science standards and the following spate of anti-evolution legislation, Haught worked tirelessly to inform the media, post blog entries, and maintain the FCS website. When the creationist activity dwindled, he remained active, writing a report on the battle for *RNCSE* and op-eds for local newspapers, organizing a program to coordinate donations to benefit science education in Florida's public schools and contributing a fascinating series of posts about the history of anti-evolutionism in Florida to the FCS blog (<http://www.flascience.org/wp/?p=828>). And he accomplished all of this while working full-time and attending college part-time! Haught is training to become a science teacher.

A distinguished theoretical physicist now at Arizona State University (where he leads the new Origins Initiative), the author of popular books such as *The Physics of Star Trek* (New York: Basic Books, 1995) and *Hiding in the Mirror* (New York: Viking Penguin, 2005), and a leading commentator on issues of science and society, **Lawrence M Krauss** nevertheless finds the time to defend the integrity of science education against creationism, too. His advocacy during the fight over the place of evolution in Ohio's state science standards, from 2002 to 2006, was unparalleled, and his response to Cardinal Schönborn's 2005 op-ed in *The New York Times*, which included a response in the *Times* and a letter to the Pope, helped to convince the Vatican to reaffirm its commitment to the compatibility of evolution with Catholicism.

As a writer, editor, and columnist for *Scientific American* and the host of its weekly "Science Talk" podcast, **Steve Mirsky** has been outspoken in defense of evolution. Particularly appreciated were his profile of NCSE's executive director Eugenie C Scott in the February 2006 issue of *Scientific American* (294: 36–8); his extensive coverage of the creationist propaganda film *Expelled*, including a podcast and a column listing "Six things in *Expelled* that Ben Stein doesn't want you to know"; his presentation of the kilosteve award to Steven P Darwin, Steve 1000 in NCSE's ongoing Project Steve; and his podcast on Ray Comfort's version of the *Origin of Species*. Mirsky's columns have been collected as *Anti Gravity: Allegedly Humorous Writing from Scientific American* (Guilford [CT]: Lyons Press, 2007).

Joe Wolf is president of Florida Citizens for Science. Wolf retired to Florida after a career in operations research and service on a local school board in Ohio. Rather than devoting his retirement years to his passion for botany and gardening, Wolf took the reins of Florida Citizens for Science. He spearheaded FCS's efforts to ensure that Florida's old science standards, regarded as among the worst in the nation, were replaced with standards that accurately reflected evolution's central role in modern biology. Wolf worked tirelessly to organize rallies, press conferences, movie screenings, citizen outreach to the state board of education and the legislature, and a statewide network of energized activists. Wolf and FCS have now turned to the task of providing teachers with the resources they need to implement those standards.

We thank these and all NCSE members for their support of our organization and our mission. We cannot — and do not — do it alone!

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Teaching the "E-Word" in Tennessee: Persistence of Anti-Evolutionary Ideas

INTRODUCTION

The publication of Charles Darwin's *On the Origin of Species* can be reasonably argued as marking the beginning of modern biological science. Since 2009 is the sesquicentennial of this momentous event, we thought it would be appropriate to report on how well some fundamental ideas of science in general, and evolution in particular, are understood by today's university students enrolled in introductory and advanced biological anthropology courses. For the past decade, we have administered a survey during the first day of class designed to gauge how well these students understand science and evolution. Additionally, the survey has the dual purpose of facilitating and guiding the ensuing conversation on the subject after the answer-sheets are anonymously completed and returned.

In this paper we will describe the survey instrument that is administered and discuss the information it intends to elicit. We will then present results derived from quantitative and textual analyses of these data collected from a decade of completed surveys. Finally, we will discuss our occasionally surprising and counterintuitive findings, speculate about their causes, and suggest some remediation that may serve to dispel common misconceptions about science and evolution among university students.

FIG 1

SCIENCE & EVOLUTION SURVEY

Instructions: Please indicate whether you think Questions 1– 4 are true or false by circling the appropriate response on the answer sheet. Please supply your response to Question #5 and fill in your demographic data on the answer sheet, too.

1. Science has proven that evolution is true.
2. Evolution is not science; it is just a theory.
3. Creationism is a legitimate scientific alternative to evolution.
4. If you believe in evolution, you cannot believe in God.
5. In your own words, please define "evolution" (on the answer sheet).

SCIENCE & EVOLUTION ANSWER SHEET

1. T F
2. T F
3. T F
4. T F
5. Evolution:

Your age:___ Your sex: M F

Your class standing (circle one) Fr So Jr Sr Gr

Where did you go to high school?

(City or Town, and State):

How much biology have you had? (circle one).
none H.S. only 1st semester in progress
1 semester >1 semester

THE SURVEY INSTRUMENT: ITS ORIGIN AND RATIONALE

The "Science and Evolution" survey (Figure 1) was developed by the senior author to structure and stimulate a discussion with his students during the first day of his introductory physical anthropology class at the University of Tennessee. He felt that this was necessary because he had noticed that some common misconceptions and misunderstandings concerning evolution were consistently being voiced by his students' questions in class, as well as in private conversations outside of class. He decided that directly addressing these issues at the beginning of the semester would benefit all students by encouraging them to share their thoughts on a subject that engendered strong feelings and was generally perceived as controversial and unsettled.

The survey provides four statements whose truth or falsity the student is asked to evaluate. Additionally, the survey includes a request for the student to define "evolution" in their own words. They are asked to supply their responses anonymously on a provided answer-sheet that also collects demographic information from the respondents including age, sex, class standing, home town and state, and how much biology education they had received prior to taking this class.

The first statement "Science has proven that evolution is true" is intended to elicit a discussion concerning the limitations of empirical science. Many students misperceive science as a mechanism by which universal truths are proven. It is important to convey, however, that all empirical scientific statements are tentative and must have the capacity to be falsified if adequate counter-evidence is brought to bear. The discussion emphasizes the dynamic nature of science and contrasts scientific versus dogmatic statements. Interestingly we have noticed, after years of these discussions, that students often answer this question correctly (False) for the wrong reasons and incorrectly (True) for the right ones. Many students with anti-evolutionary sentiments respond that this statement is false simply because they cannot accept evolution (often on religious grounds) while not objecting to the mischaracterization of science's ability to prove an idea true. Conversely, students who more vigor-

Andrew Kramer is Professor and Head of the Department of Anthropology at the University of Tennessee, Arthur Durband is an Assistant Professor of Anthropology in the Department of Sociology, Anthropology, and Social Work, at Texas Tech University, and Daniel Weinand is a research associate in the Department of Earth and Planetary Sciences and Adjunct Assistant Professor of Anthropology at the University of Tennessee. All three have researched and published on human evolution, are interested in improving science education, and are motivated to dispel students' evolutionary misconceptions by their teaching of anthropology.

Student Misconceptions and the

Andrew Kramer, Arthur C Durband, and Daniel C Weinand

ously yet naively accept the evidence for evolution argue that this statement is correct while similarly not realizing that empirical science is not in the business of "proof" or "truth".

The theme of science's capabilities and limitations is further developed during the conversation stimulated by the second statement: "Evolution is not science, it is just a theory." The phrase "just a theory" is used as a springboard to highlight the difference between the common usage of the word theory (equating it with a guess or a hunch) versus its scientific meaning as a powerful explanation that has withstood the test of time. We discuss the difference between fact and theory in the anti-evolutionary context that often has tried to mandate that evolution is not taught as "fact" but only as "a theory." We emphasize to our students that good science teachers do exactly that: evolution (as a scientific theory) explains the facts of the fossil record, comparative anatomy, genetic distance and so on.

We then focus on two commonalities that are shared by all scientific theories (including evolution): natural causation and falsifiability. We emphasize that explanations in science can only invoke natural causes whose evidence may be detected by our senses or our instrumentation. Therefore, anything in our observable universe is potentially open to scientific investigation. Nevertheless, anti-evolutionists often contend that evolution fails as a scientific theory on the second criterion of falsifiability since it is so all-encompassing that no evidence can be brought to bear that would cause it to be abandoned. Therefore, these anti-evolutionists claim that evolution is a dogma that has been elevated to the status of a secular state religion. However, we counter these claims with our students by asking them if they can imagine any evidence that could potentially be uncovered tomorrow, next year or in the coming decades that would cause us to discard our current understanding of human evolution. Inevitably, one student provides exactly that kind of challenge: what if a fully human skeleton were to be found in direct association with dinosaurs? We joke that we would be out of a job if that discovery were made but we stress that is the kind of naturally-occurring evidence that has the potential to overturn human evolutionary theory. At this point, we also share the dictum that "extraordinary claims require extraordinary evidence" exemplified by the anti-evolutionary contention of human and dinosaur footprints preserved together at the Paluxy River in Texas (*see p 39*). Paleontologists subsequently demonstrated that the "human" tracks were made by three-toed dinosaurs and today these claims of Texan human/dinosaur contemporaneity have been disavowed by most anti-evolutionists.

The third statement "Creationism is a legitimate scientific alternative to evolution" is included to illustrate the fundamental differences between scientific and non-scientific (including religious) explanations. In this discussion, we focus on the Judeo-Christian creation story and ask our students "What are the first five words of Genesis?" They respond: "In the beginning, God created …" and acknowledge that since this is an invocation of supernatural causation, it is not a scientific explanation. We then press them to elaborate and most often they come to the realization that the presence or absence of God cannot be tested. This discussion demonstrates to our students that "scientific creationism" as well as its current manifestation as "intelligent design" both fail as science on the dual criteria of natural causation and falsifiability. At the end of this conversation, however, we clearly state that creationism is absolutely a legitimate religious alternative to evolution, while reaffirming that it is simply not a scientific one.

The last statement that we ask them to evaluate is likely the most important from the students' perspective: "If you believe in evolution you cannot believe in God." We kick-start this discussion by having them ask us if we believe in evolution. The surprise is palpable in the room when we answer that we do not, because belief implies taking something on faith. Rather, we accept evolution based on the preponderance of supporting evidence that has accumulated over the years. The ensuing dialog reveals the striking diversity of students' personal philosophies that many have constructed allowing a belief in God alongside an acceptance of evolution. These accommodations run the gamut from progressive evolution to deism to theistic evolution. We acknowledge that some religious doctrines are not compatible with an acceptance of evolution, particularly the more fundamentalist denominations of Christianity, Judaism, and Islam that interpret their holy texts as inerrant and historically factual. We note, however, that most of the mainstream organizations representing these religions have publicly stated that they perceive no inherent conflict between their religion and evolution.

We use this opportunity to restate that science is mute on many of the "big" questions: "Is there a God?", "Do we have ultimate purpose?", "Is there life after death?" and we acknowledge that religion has

traditionally been the primary source of guidance on these issues. We then steer the discussion to what we believe to be the root cause of the creationism/evolution conflict in the United States today: the inappropriate intersections forged by some between the religious and scientific cognitive fields (Bunge 1984). We explain that the belief that evolution and God are mutually incompatible is ironically shared by both extremes along the creationism/evolution spectrum. On the one hand, there is the fundamentalist hell-fire and brimstone preacher who claims that those who believe in evolution are going to hell; while on the other there is the atheist evolutionist whose materialist philosophy does not allow God to exist (for example, Dawkins 2006). We support the "nonoverlapping magisteria" (NOMA) principle (see Gould 1997) that explains how these conflicts can be avoided if the boundaries between religious and scientific "ways of knowing" are acknowledged and respected by all. We convey these distinctions by asking our students to describe the kinds of questions appropriately addressed by these two distinct knowledge spheres, and they quickly come to realize that science is best equipped to answer "what?", "when?", "where?" and "how?" while we most often turn to religion to answer "why?" We conclude by refocusing on the atheist evolutionist. First, we reaffirm their right to claim on personal philosophical grounds that there is no God, just as we defend anyone else's right to believe in a supreme being. However, we strenuously object when these scientists use their academic bully-pulpits to contend that their atheistic conclusions are scientifically grounded.

Materials and Methods

The Dataset

The data used here were collected from the survey described above over a ten-year period (1998–2007) to students enrolled in three physical anthropology courses at the University of Tennessee. These courses are titled Human Origins (Anthropology 110, a lower-division, introduction to physical anthropology course), Human Paleontology (Anthropology 495, an upper-division majors course) and Paleoanthropology (Anthropology 582, a graduate-level course). The total sample includes 1079 surveys; 860 completed in the introductory class, 176 from Anthropology 495, and the remaining 43 from the graduate-level course. The modal student from this sample was a 19–year-old female sophomore from Tennessee who had completed high-school biology only and was enrolled in Anthropology 110.

Hypothesis Testing

Since we were primarily interested in investigating initial student understanding of science in general and evolution in particular, we focused most of our analytical attention on the data provided by our 860 introductory students. These data were a rich source of information that allowed us to test a number of null hypotheses regarding the student scores on the true/false statements. The null hypotheses stated that student scores should not differ by class standing, age, what year they enrolled in the course, how much biology they had had previously, and geography (including in-state versus out-of-state, urban versus rural, and differences in home region). Secondarily, we wanted to compare the performance of our upper-division and graduate students to each other as well as to the introductory students.

The student definitions of evolution provided an additional source of compelling data. Using these definitions, we were able to test student familiarity with the classic definition of microevolution ("change in gene frequency within a population over time") as well as the more generalized usage ("biological change over time"). We were also able to evaluate the prevalence of misunderstandings and misrepresentations of evolution through analyses of these definitions. For example, we could identify student definitions that invoked progress, supernatural causation and Lamarckian notions of "wants" or "needs." As in the true/false data described above, we compared definitions of evolution between the students enrolled in the introductory, major and graduate courses.

Analytical Procedures

The quantitative true/false data were analyzed in SPSS 15.0 for Windows (version 15.0.1, released November 22, 2006). Descriptive demographic statistics and frequencies of correct answers were first generated then the null hypotheses described above were evaluated by a series of univariate analyses of variance tests.

The evolution definitions were analyzed in SPSS Text Analysis for Surveys 2.1 (released in 2007). Each student definition was input to the program verbatim and evaluated for how well it matched the classic microevolution and general evolution definitions (described above). In addition, each was analyzed to determine if and how many invocations of misrepresentative concepts (such as progress, supernatural causation, and so on) were included in their definitions.

These text analyses were accomplished by instructing the program to compare each student definition of evolution to an "ideal" definition. For example, the first textual analysis evaluated the input definitions in comparison to the classic microevolutionary "**change** in **gene frequency** within a **population** over **time**." The ideal definition should reflect the five words that are bolded in the previous sentence. Any definition that included all five terms would earn a maximum score of 5. In addition, the program has the flexibility to include user-input synonyms for each relevant term so in the above example "genetic" and "allele" could substitute for "**gene**" while "generations" and "the ages" would be treated as synonymous with "**time**". Similarly for the more generalized definition of "**biological change** over **time**" (which had a maximum score of three) the program was instructed to accept "life" and "species" for "**biological**." Finally, to evaluate the definitions that invoked misrepresentative concepts, the program was instructed to identify (up to six) terms that reflected the following: 1) progress (including advance/advancement, better/best, improve/improvement, perfect/perfection), 2) supernatural causation

(including God, the Creator), 3) exclusive application of the concept only to humans (no mention of other life), 4) equating evolution with individual growth and development, 5) ultimate origins (of life, the earth, the universe) and 6) Lamarckian notions (including wants or needs).

Results

Quantitative Hypothesis Tests

A maximum score of 4 was achieved if the student responded that all four statements were false. Less than 10% (81/860) of the students in Human Origins, the introductory physical anthropology course, achieved the maximum score, and the average for these students was 2.55 (62.5%). The scores of these students for the first three questions were similar, ranging from 51% to 58% correctly answered, while the frequency of correct scores for Statement #4 ("If you believe in God, you cannot believe in evolution.") was much higher at 92% (Figure 2).

As would be expected, the students enrolled in the upper-division Human Paleontology course scored significantly better ($p < .001$) than the introductory students with an average number correct of 2.99 (=74.8%). Similarly, the graduate students enrolled in Paleoanthropology outscored ($p < .01$) the majors in Human Paleontology with an average score of 3.35 (83.8%; Figure 3).

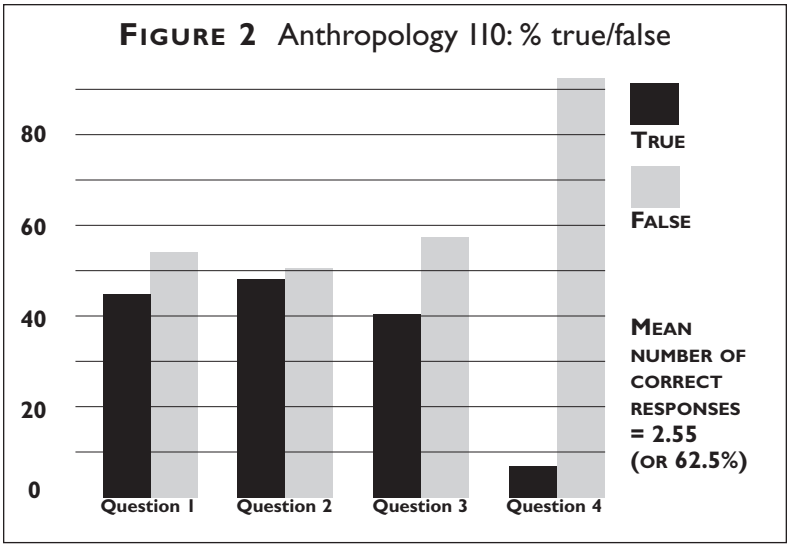
The demographic diversity present among the introductory students provided a rich source of data to test a number of commonsensical and intuitive ideas concerning which student subsamples better understood science in general and evolution in particular. For example, we presumed that these data would demonstrate that seniors would score better than freshmen, that students who had already completed college-level biology would score better than those who had not, and that students who graduated from urban high school districts in Tennessee would score better than those who graduated from rural high schools. None of these expectations was borne out by the data analysis; the analysis of variance tests would not allow us to reject any of the three null hypotheses of no difference among these groups.

We were similarly unable to reject our other null hypotheses of no difference in performance based on comparisons between younger (17–18 years old) college-age students versus older (20–21 years old), and Tennessee versus non-Tennessee residents. However, as we delved more deeply into the issues of age and geography, significant differences did appear. For example, "non-traditional" college students (defined here as age 30 and older) scored better (2.79 versus 2.61) than their 17–22 year old classmates ($p < .05$). When we looked at these data regionally, students who went to high school in the northeast scored significantly better (3.22 versus 2.64) than those from the southeastern US ($p < .001$).

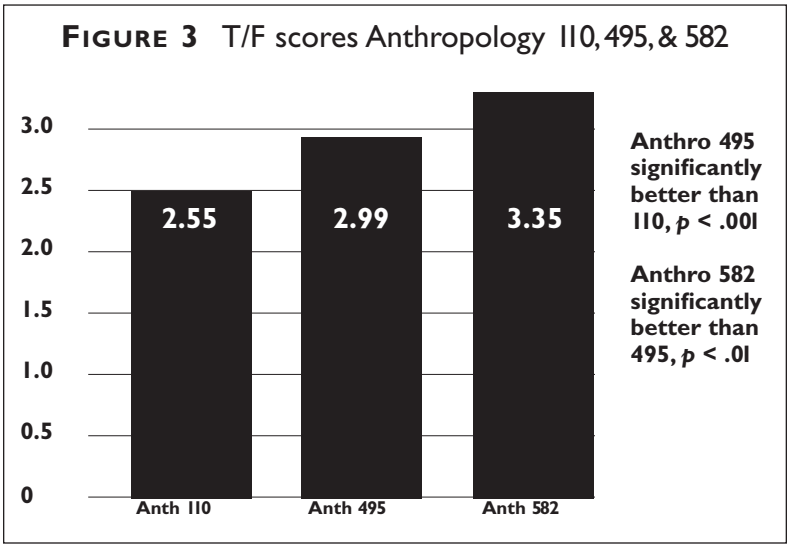
Evolution Definitions

Student definitions of evolution that included all five relevant terms (or their synonyms) reflecting the classic microevolutionary meaning ("**change** in **gene** **frequency** within a **population** over **time**") were exceedingly rare. In fact, of the total number of definitions recorded (over 1000) in the decade of survey collection, only two received the highest score of 5 by incorporating all of the necessary words. Not surprisingly, both of these definitions were provided by graduate students in the Paleoanthropology class including this example from a 38-year-old female from Connecticut who was enrolled in the course in 2003: "change in gene frequencies within a population over time due to differential reproductive and survival rates." The modal score for the entire sample when the student scores were evaluated against the "ideal" microevolutionary definition was in fact 0 (34.4%), meaning that over one-third of the students did not use a single required term or its synonym in their definition.

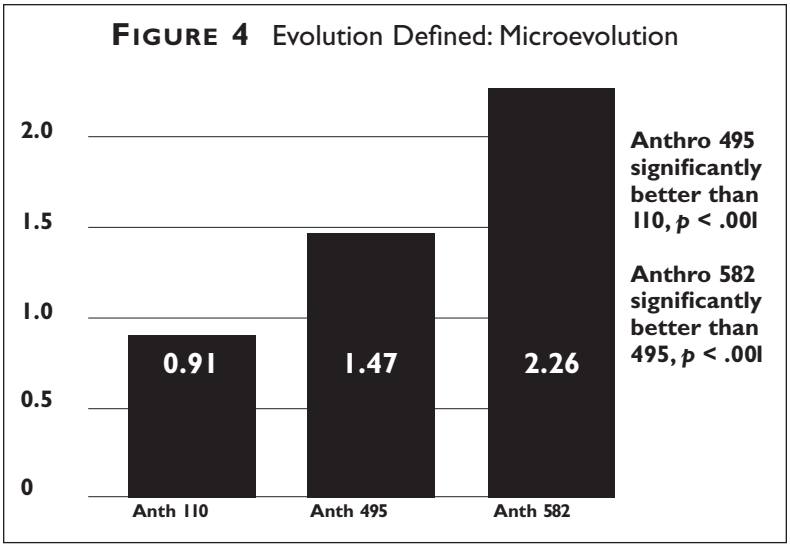
Nearly 30% of the sample used one term and approximately the same percentage invoked two. However, only 3.7% used three, and 1.2% used four. As would be expected, the upper-division majors



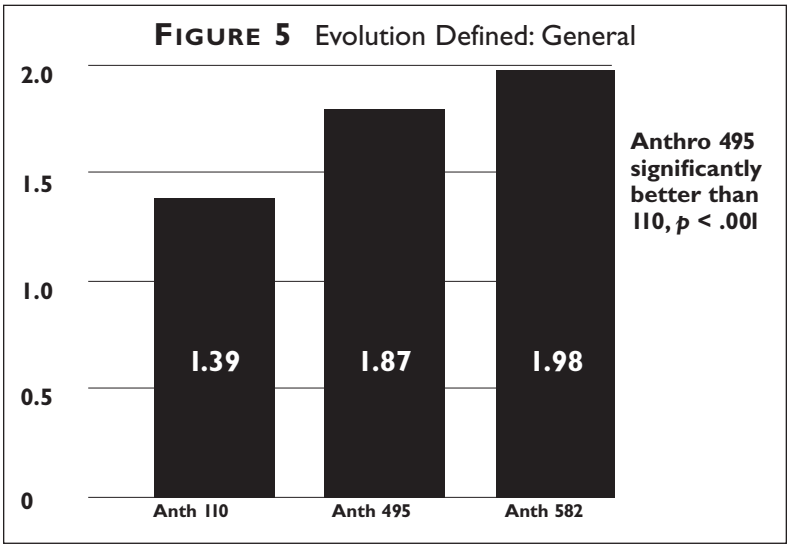
Percentage of students answering true/false questions correctly



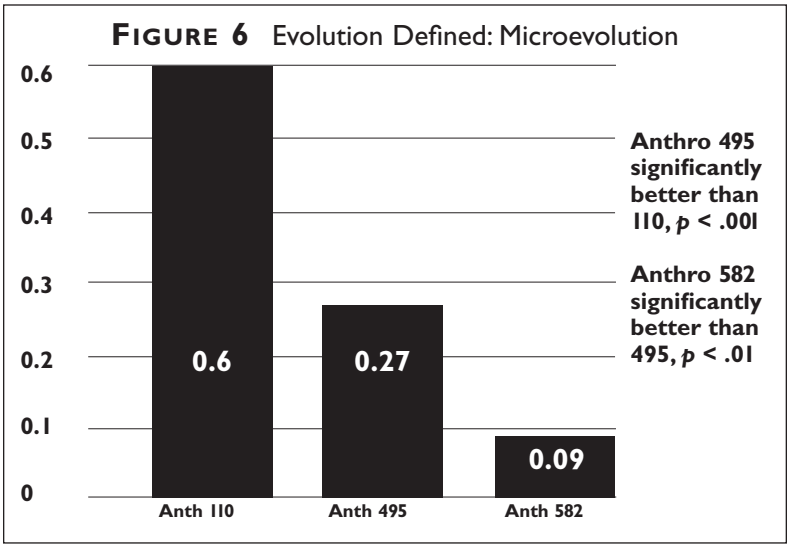
Percentage of students answering true/false questions correctly by level of instruction



Average number of five essential concepts correctly stated in the standard definition of microevolution by level of instruction.



Average number of three essential concepts correctly stated in the standard definition of evolution by level of instruction.



Average number of six common misconceptions represented in students' definitions of evolution by level of instruction.

enrolled in the Human Paleontology course used more of the required terms in their definitions than the introductory students (1.47 versus 0.91; $p < .001$) while the graduate students taking Paleoanthropology outperformed the Human Paleontology undergraduates (2.26 versus 1.47; $p < .001$; Figure 4).

When the student definitions were evaluated against the more general definition of evolution ("**biological change** over **time**"), a much higher percentage of respondents (17.2%) achieved the highest possible score of 3. The following is an example of one of these definitions provided by a 22-year-old male junior from Tennessee enrolled in the introductory class in 2002: "[evolution] is the gradual change of a species over a long long period of time." However, nearly the same percentage of students did not use any of the three required terms (17.9%), while 30% used one and 35% incorporated two of the words or their synonyms into their definitions. Again, as would be expected, the upper-division majors enrolled in the Human Paleontology course used more of the required terms in their definitions than the introductory students (1.87 versus 1.39; $p < .001$) while this time the graduate students taking Paleoanthropology did not significantly out-perform their Human Paleontology counterparts (1.98 versus 1.87; Figure 5).

When the student definitions were evaluated with respect to the six misrepresentative concepts, we were pleased to note that the modal definition did not include any of these ideas (61%) and that the "poorest" of these definitions included a maximum of three misrepresentations (1.4%). Examples of definitions that earned scores of 3 included one from a 21-year-old female junior from Tennessee who enrolled in Anthropology 110 during the summer term of 2006: "The beginning of time. Who or what created the Earth & all humans. My opinion evolution is God who created all things." This definition invoked ultimate origins (of time and earth), supernatural causation and the exclusivity of the concept as applied only to humans. Another score of 3 was earned by a 25-year-old male senior from Tennessee who enrolled in Anthropology 110 during the summer term of 2006: "The natural progression of life from simple to complex (based on species' adaptive needs)." His definition invoked progress, the inevitability of increasing complexity and the Lamarckian notion of adaptive need. Similar to the cross-class results described above, the upper-division majors in the Human Paleontology course used significantly fewer misrepresentative concepts in their evolution definitions than did the introductory students, while the graduate students in Paleoanthropology invoked these concepts even less frequently than the anthropology majors (Figure 6).

Discussion

The results of the true/false statement analyses were both encouraging and troubling regarding student attitudes and preconceptions about science and evolution. We were pleased to note that on average nine of ten students consistently did not believe that their

continued on page 27

Why Teach Evolution?

Why does teaching evolution remain so socially and politically controversial? Is it "fair" to teach only evolution in public schools? Does this policy help or does it harm the students in these schools?

What is biological evolution?

In the biological sciences, evolution is a theory of change that accounts for the pattern of similarities and differences among living things on earth. Evolution is a theory of emergence of new varieties of life forms, not a "theory of origins" that accounts for how life began. There are currently a number of proposed models and hypotheses for the beginning of life as we know it, but evolution begins after life is established on earth.

What about macroevolution?

Scientists use the terms macroevolution and microevolution to describe different *perspectives* on life's history, not fundamentally different processes. Macroevolution describes the result of evolutionary changes we can observe over time in response to mass extinctions, global climate changes, and other large-scale events that affect the abundance and distribution of species. The fossil record shows how forms of life change from one geological time to another, and preserves organisms that share features both with organisms that appeared earlier in time and also with organisms that emerge later. These transitional features show the continuity among groups of organisms even while they demonstrate the changes that occur among them. So, in macroevolution, we focus on patterns of evolutionary changes that occur between species, while in microevolution, we focus on patterns of evolutionary changes that occur within species and evolving lineages. These two terms refer to different perspectives on the process of evolutionary change, but not to fundamentally different processes.

Why is evolution mandated in science education standards?

There are two main reasons that biological evolution is mandated in science educations standards. First, it is the fundamental, unifying theory that underlies all the life sciences. It has formed the basis of productive and active research for 150 years and continues to do so. This is why evolution is universally accepted among professional biology researchers.

The second reason is that science education standards emphasize learning the process of science and especially scientific inquiry. The first step in this process is to develop testable questions that can be answered by scientific investigation. These questions are guided by scientific theories and their answers continue to show the value of biological evolution as a theory for forming useful, answerable questions in biology.

Isn't evolution only a theory?

A scientific theory is a framework that guides research, not an idle speculation or a "hunch." These theories are systematic, well-tested explanations that account for a broad range of observations. Biological evolution is a scientific theory that explains the pattern and process of variation and similarity among living things in terms of the common ancestry of life forms. It continues to guide useful research and answer new questions even after 150 years.

Why are no other theories required in the science education standards?

Many scientific theories are required in science education standards. For example, students learn atomic theory, which is the foundational theory for understanding the basics of chemistry and physics — including the periodic table of the elements. Other, advanced theories, such as quantum theory, or unsettled ones, such as superstring theory, are less likely to be included. Not every scientific theory is taught in public schools; to be included the theory must be widely accepted by scientists and be fundamental to the scientific disciplines in the curriculum.

Isn't evolution controversial?

Biological evolution is a scientifically settled theory. Among scientists, this means that its fundamental principle — the shared ancestry of living organisms — has overcome all scientific challenges. However, the general public is uncomfortable with evolution because of what some people perceive as the moral, or cultural implications of evolution. Moral, cultural, and political dilemmas can never be resolved only by scientific inquiry. These dilemmas can also never be resolved by ignorance, so it is especially important for students to have a complete and accurate understanding of the contemporary theory of biological evolution so that they recognize that the controversy is not a scientific one.

What about critical thinking?

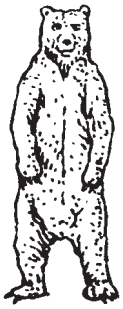
Critical thinking is an important component of a good education. Critical thinking about evolution must start with a solid understanding of what evolution is and how contemporary scientists understand it. "Critical thinking" materials recently offered to school boards by evolution opponents consist of misinterpretations of scientific research about biological evolution. They confuse an active discussion among scientists over the details of evolution with a disagreement about whether evolution has occurred. This is not critical thinking, but hucksterism.

[*This note was adapted from an NCSE resource for teachers that is available on-line at <http://ncse.com/evolution/why-teach-evolution>.*]

Teaching and learning about evolution

Stephen Jay Gould once wrote, "We are not blessed with absolute certainty about any fact of nature, but evolution is as well confirmed as anything we know — surely as well as the earth's shape and position (and we don't require equal time for flat-earthers and those who believe that our planet resides at the center of the universe). We have oodles to learn about how evolution happened, but we have adequate proof that living forms are connected by bonds of genealogical descent." For help in appreciating and explaining the evidence for evolution, and the nature of the scientific enterprise of which evolutionary theory is a vital part, NCSE recommends the following books, all of which are now available through the NCSE website: <http://ncse.com/store> — look in the "In the latest *RNCSE*" section. And remember, every purchase through the web site benefits NCSE!

Illustration by Dave Smith, used with permission of the University of California Museum of Paleontology.



Evolution for tyros

Darwin and Evolution for Kids
by Kristin Lawson
In *Darwin and Evolution for Kids*, Lawson provides a biography of Darwin combined with a sketch of his ideas and their development, along with "engaging and fun activities where children can: make their own fossils using clay, seashells, and plaster; keep field notes as backyard naturalists; investigate whether acquired traits are passed along to future generations; explore the adaptive strategies plants have developed to distribute seeds; observe how carnivorous plants trap and devour their prey; go on a botanical treasure hunt." *Darwin and Evolution for Kids* was selected by National Public Radio's Science Friday as one of the best science books of 2003. For ages 9 and up.

Evolution 101
by Randy Moore and Janice Moore
Randy Moore and Janice Moore's *Evolution 101* aims, in the words of its publisher, to provide "readers — whether students new to the field or just interested members of the lay public — with the essential ideas of evolution using a minimum of jargon and mathematics." It succeeds marvelously. The reviewer for NSTA Recommends writes, "Seldom is a book so well written and so well researched that it ought to be required reading for every thinking person," adding, "Not only should every high school, community, and university library have a copy of *Evolution 101* but every science teacher in the country should as well."

Science, Evolution, and Creationism
from the National Academy of Sciences and the Institute of Medicine
Designed to give the public a comprehensive and up-to-date picture of the current scientific understanding of evolution and its importance in the science classroom, *Science, Evolution, and Creationism* is twice as long as the second edition (published in 1999 as *Science and Creationism*), and teems with new examples of the predictive power and practical importance of evolution. Addressing creationism in its various forms, it concludes, "No scientific evidence supports these viewpoints," and insists, "Given the importance of science in all aspects of modern life, the science curriculum should not be undermined with nonscientific material."

The Top 10 Myths About Evolution
Cameron M Smith and Charles Sullivan
From the publisher: "In this concise, accessible, 'myth-buster's handbook,' educators Cameron M Smith and Charles Sullivan clearly dispel the ten most common myths about evolution, which continue to mislead average Americans. Using a refreshing, jargon-free style, they set the record straight on claims that evolution is 'just a theory,' that Darwinian explanations of life undercut morality, that Intelligent Design is a legitimate alternative to conventional science, that humans come from chimpanzees, and six other popular but erroneous notions. Smith and Sullivan's reader-friendly, solidly researched text will serve as an important tool, both for teachers and laypersons seeking accurate information about evolution."

Teaching evolution

Defending Evolution in the Classroom
by Brian J Alters and Sandra M Alters
Defending Evolution in the Classroom is a necessity for anyone concerned with evolution education. The late Ernst Mayr wrote, "This book should be in the hands of every educator dealing with the subject of evolution," and Eugenie C Scott, executive director of NCSE, agreed: "At last a book for teachers to help them cope with anti-evolutionism. Clearly written and filled with practical advice about the underlying religious and scientific issues prompting student

<http://ncse.com/store>

questions, *Defending Evolution* should be on every teacher's bookshelf." A member of NCSE's board of directors, Brian J Alters directs the Evolution Education Research Centre at McGill University.

Evolution in Perspective: The Science Teacher's Compendium
edited by Rodger W Bybee
From the publisher, the National Science Teachers Association: "If ever a subject could benefit from a strong dose of perspective, it's evolution. This important new book supplies the necessary insights by bringing together the views of leading scientists, professors, and teachers. Working from the premise that only those students whose schools teach them about the nature of science will truly understand evolution, the collection gathers 12 influential articles first published in the NSTA member journal, *The Science Teacher*. ... This collection comes from, and is developed for, the people on the front lines — educators who deal with the controversy."

NSTA Toolkit for Teaching Evolution
by Judy Elgin Jensen
From the publisher, the National Science Teachers Association: "Evolution is — or should be — a major unifying theory in every biology or life sciences classroom, but science teachers, principals, and school administrators all too often hear the question: 'Why teach evolution?' *NSTA Tool Kit for Teaching Evolution*, compiled by NSTA with input from the National Center for Science Education, helps you cogently answer that question." The reviewer for *The Science Teacher* writes, "This small book really packs a powerful punch! It is an important read for all science teachers and provides both arguments and models for good instruction."

Investigating Evolutionary Biology in the Laboratory
edited by William F McComas
In *Investigating Evolutionary Biology in the Laboratory*, William F McComas assembles a host of useful articles that together provide a complete introduction to the strategies and rationales for teaching evolutionary biology in the laboratory, including experiments and exercises. Topics include Foundations of Evolution Education, Examining the Evidence for Evolution, Using the Tools and Principles of Evolution, Variation and Adaptations within Species, Biotic Potential and Survival, Simulating Natural Selection, and The New Evolutionary Synthesis. A long-time member of NCSE, McComas was awarded the Evolution Education Award for 2007 by the National Association of Biology Teachers.

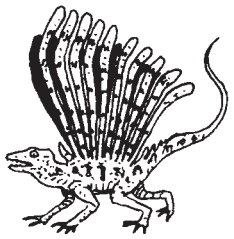
Evolution and the nature of science

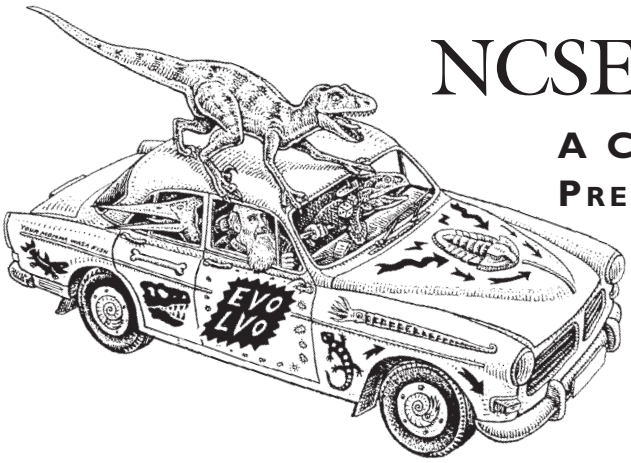
Science As a Way of Knowing: The Foundations of Modern Biology
by John A Moore
From the publisher: "For the past twenty-five years John Moore has taught biology instructors how to teach biology — by emphasizing the questions people have asked about life through the ages and the ways natural philosophers and scientists have sought the answers. This book makes Moore's uncommon wisdom available to students in a lively and richly illustrated account of the history and workings of life. Employing a breadth of rhetoric strategies — including vividly written case histories, hypotheses and deductions, and chronological narrative — *Science as a Way of Knowing* provides not only a cultural history of biology but also a splendid introduction to the procedures and values of science."

Teaching About Evolution and the Nature of Science
from the National Academies of Science
Published in 1998 under the auspices of the National Academies of Science, which provides authoritative scientific advice to the federal government, *Teaching About Evolution and the Nature of Science* is addressed to "the teachers, other educators, and policy makers who design, deliver, and oversee classroom instruction in biology. It summarizes the overwhelming observational evidence for evolution and suggests effective ways of teaching the subject. It explains the nature of science and describes how science differs from other human endeavors. It provides answers to frequently asked questions about evolution and the nature of science and offers guidance on how to analyze and select teaching materials."

The Nature of Science and the Study of Biological Evolution
from NSTA and BSCS
The Nature of Science and the Study of Biological Evolution, as its title indicates, adroitly interleaves a discussion of the nature of science with a broad perspective on evolution. Consisting of a text for high school students and a CD–ROM for teachers, the material discusses the nature and methods of science, the development of the theory of evolution, seven lines of evidence that converge on evolution, population genetics, natural selection, and primate and human evolution. Both the text and the CD–ROM are imbued with the pedagogical acumen characteristic of the National Science Teachers Association and the Biological Sciences Curriculum Study.

The Creation Controversy & the Science Classroom
by James W Skehan and Craig E Nelson
Consisting of two sections, "Modern Science and the Book of Genesis" by James Skehan and "Effective Strategies for Teaching Evolution and Other Controversial Topics" by Craig Nelson, *The Creation Controversy & the Science Classroom*, published by the NSTA, aims to provide teachers with an understanding of the nature of science and the relationship between science and religion. Brian Alters, reviewing the book for *RNCSE*, described Skehan's contribution as "a concise, detail-rich history of some of the relevant issues concerning science and biblical scholarship, with a good relevant criticism of creationism woven throughout," and Nelson's contribution as "to the point, with a great number of useful ideas and strategies packed in a short read."





NCSE on the Road

A Calendar of Special Events, Presentations, and Lectures

Date	February 19, 2010
City	San Diego CA
Presenter	Eugenie C Scott
Title	Communicating on the State and Local Level: How can Scientists Support Policy-Makers?
Event	Annual Meeting of the American Association for the Advancement of Science
Time	8:30 – 10:00 AM
Location	San Diego Convention Center
Contact	Eugenie C Scott, scott@ncse.com

Date	February 19, 2010
City	San Diego CA
Presenter	Eugenie C Scott
Title	Mind Change: Can Out-of-School Learning Contribute to Evolution Literacy?
Event	Annual Meeting of the American Association for the Advancement of Science
Time	10:30 AM – 12:00 noon
Location	San Diego Convention Center
Contact	Eugenie C Scott, scott@ncse.com

Date	February 20, 2010
City	San Diego CA
Presenter	Eugenie C Scott
Title	Science Literacy: How to Train Teachers to Maximize Learning
Event	Annual Meeting of the American Association for the Advancement of Science
Time	1:30 – 4:30 PM
Location	San Diego Convention Center
Contact	Eugenie C Scott, scott@ncse.com

Date	March 25, 2010
City	Tallahassee FL
Presenter	Eugenie C Scott
Title	The Once and Future Creationism: How Creationism Evolves to Fit the Legal System
Event	Public lecture
Time	7:00 PM
Location	Museum of Florida History
Contact	Frank Stephenson, fstephenson@fsu.edu

Check the NCSE website for updates and details — <http://ncse.com/ncse-events>.

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continued from page 22

faiths precluded an acceptance of evolution. From discussions with our students it was apparent that many had developed personal accommodations that allowed these ideas a mutual coexistence. These accommodations were very diverse, spanning across the creation/evolution continuum as described by Scott (1999). Statements from mainstream Judeo-Christian denominations affirming the compatibility of their religious tenets and the evidence for evolution (as described in the National Center for Science Education's *Voices for Evolution*; Sager 2008) probably contributed to this result as well.

We were also encouraged that our expectations of better performance on both the true/false statements and the evolution definitions by the anthropology majors and graduate students were borne out by the data analyses. In every comparison, the majors enrolled in Human Paleontology scored significantly better than the introductory students while the grads in Paleoanthropology outscored the majors in all but one comparison. This result was at least partially due to the fact that a prerequisite for the major Human Paleontology course was the introductory Human Origins class, so an undetermined percentage of majors had completed the survey twice (the first time in Anthropology 110 and the second in Anthropology 495). Therefore, these students had the explicit benefit of previous knowledge derived from their first experience in one of our classes. However, we have no way of ascertaining how many of the respondents had completed the survey multiple times because of the anonymous nature of its administration.

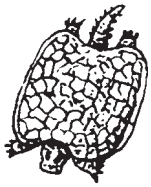
Our most problematic and unexpected results revealed insignificant differences in the number of correct answers to the true/false statements that were provided by certain subsets of students enrolled in our introductory course. We anticipated that seniors would out-perform freshmen, that 21–year-olds would score better than 18–year-olds and that urban high school graduates' scores would exceed those who graduated from rural schools. None of these expectations was verified by our analyses. One possible explanation for the first two findings is that upper-class students taking an introductory course late in their college career may have enrolled simply to satisfy a requirement and were not that motivated to be in the class in the first place. Since the introductory physical anthropology course satisfies a general education natural science credit at the University of Tennessee, this may indicate that these upper-class students did not have much more of a science background than their freshman and sophomore classmates. Most troubling to us was the fact that students who had already completed a college-level biology course did not score significantly better on the true/false statements than their classmates who had only taken high school biology or none at all. This suggested to us that the basic foundations of science and evolution may not be communicated effectively and are not occupying a central role in some college-level biology courses.

Two findings of significant difference within the introductory student cohort were sensible and expected. "Adult learners" (students over the age of 30) scored better than their traditionally college-aged peers (ages 17–22). This may be because the non-traditional students are often more motivated to be in class than their younger counterparts since they generally are paying their own tuition and must balance other demands on their time including work and family. Therefore they are probably better prepared and have more realistic expectations about what the class entails. The second significant finding revealed that students who graduated from high schools in the northeastern US outperformed those from the southeastern portion of our country. This seems to make sense in the context of widely reported national trends in which the urban Northeast is much less resistant to evolution in their public school classrooms than those in the Southeast. This result may also reflect a comparatively greater emphasis on evolution in northeastern state's biology curriculum standards (Lerner 2000; Moore 2001).

The students' evolution definitions were in some respects mildly disappointing, yet often promising and occasionally entertaining. Our textual analyses revealed a telling paucity of familiarity with the classic microevolutionary definition in that none of the over 800 introductory students incorporated all five of the key words into their definition of evolution. However, we were heartened by the finding that over 50% of all students used at least two of the required terms for the more generalized biological definition and that over 60% of all students did not invoke a single misrepresentative concept in their formulations. The most bizarre definition was offered by an 18–year-old male freshman from Tennessee enrolled in Anthropology 110 during the Spring 2002 semester: "Quarks=atoms=molecules=cells=organs=living being. In other words we were spoken into existence." Finally, enjoy this poetic contribution (worthy of Erasmus Darwin!) from a 24–year-old female junior from Tennessee enrolled in Anthropology 110, Fall 2002: "[Evolution] is a study of how human beings came to be from the protozoa swimming in the sea."

Recommendations and Future Work

Our primary recommendation is to encourage instructors of introductory biological anthropology courses to incorporate a discussion of science in general and evolution in particular into an early class period, if not the first of the semester. We have been uniformly pleased at the high levels of enthusiastic response we have had from our students during these conversations and enjoyed the added benefit of addressing these issues right at the beginning of the semester so they do not have the opportunity to fester as the term progresses. One addition we have considered but not (yet) implemented is an "exit interview" to gauge how well these concepts and ideas have been assimilated by our students by the end of the course.

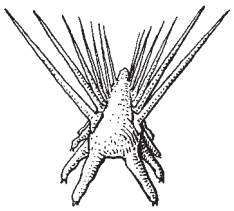


Secondarily, we would encourage instructors of introductory university-level biology courses to integrate evolution as a central theme throughout their courses if they have not already done so. This apparent deficiency was made clear by the subset of introductory physical anthropology students who had completed at least a semester of college-level biology and yet performed no better on the true/false state-

ments than did their classmates with little or no high-school biology. We would expect that neophyte college biology students would benefit from an early, explicit discussion of science and evolution in their classes at least as much as those enrolled in introductory anthropology.

One of our goals for future work with these data is to better understand regional differences in our survey responses. To that end, one of us (ACD) has had the opportunity to administer a large number of surveys to his introductory students at universities in Illinois and Texas. In this paper we have reported insignificant differences in the true/false response rate between the Southeast (primarily represented by Tennessee, of course) and both the Midwest (including Illinois) and Southwest (including Texas). However, those comparisons involved relatively small numbers of students enrolled in the University of Tennessee's introductory physical anthropology courses who graduated from high schools from those regions. These additional data will add hundreds of survey responses from students attending universities after graduating high schools in the Midwest and Southwest and should better allow us to investigate regional differences in student misconceptions about evolution.

The ten years of completed surveys are potentially informative regarding the identification of any temporal trends in these data. Preliminary analyses did not produce significant differences between any of the annual cohorts in their frequencies of correct responses to the true/false statements. However, this result may be biased by the fact that over 75% of the introductory student responses came from two large sections of the Human Origins course taught in 2000 and 2002. More sophisticated quantitative approaches that we intend to employ may reveal statistically meaningful trends over time in the currently available survey data. In addition, the senior author will be teaching another large section of the introductory course during the Fall 2009 semester which will allow large-scale comparisons (class sizes of ~250) between student responses separated by nearly a decade (2000 versus 2009).



Finally, the senior author has collected a number of surveys completed by honors biology students from local high schools that have not been incorporated into these analyses. It may be quite interesting to discern if this advanced subset of high school students share the same misconceptions concerning science and evolution that we have seen among university students enrolled in introductory physical anthropology courses. Whether or not these misunderstandings are as widespread among honors biology high school students as they are among freshman students in introductory anthropology classes at the university, we as college-level instructors will continue to extol the virtues of our survey instrument and especially the discussions it inspires in helping our students dispel some of the most persistently misleading ideas about evolution in America today.

Acknowledgments

We would like to thank Ann Reed and Bob Muenchen, of the University of Tennessee's Statistical Consulting Center, for their assistance in our quantitative and textual data analyses. We thank John Dansby for his excellent work in data entry. We would particularly like to thank the hundreds and hundreds of students who completed these surveys and invited us into their lives, at least for a semester, so that they could learn about the wonders of anthropology.

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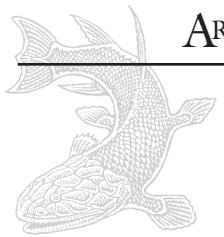
The Smithsonian's New Human Evolution Hall

Katherine Schroer recently reported that the Smithsonian National Museum of Natural History lacked a separate exhibit devoted specifically to human evolution (*RNCSE* 2009 Sep/Oct; 29 [5]: 21–2, 27–30). As of March 17, 2010 — exactly 100 years after the official opening of the museum — that will no longer be true, when a new major exhibit on human evolution will open there. According to the museum's website, "Based on decades of cutting-edge research by Smithsonian scientists, the David H Koch Hall of Human Origins will tell the epic story of human evolution and how humans evolved over six million years in response to a changing world. Following the process of scientific discovery, visitors will explore the evidence for human evolution, come face-to-face with unforgettable representations of early humans, and arrive at a deeper understanding of what it means to be human." For further information, visit the museum's website: <http://www.mnh.si.edu/>.



The Effect of Viewing NOVA's *Judgment Day: Intelligent Design on Trial* Docudrama on College Students' Perceptions of "Intelligent Design" and Evolution

Beth E Leuck and Greg Q Butcher

On November 13, 2007, most Public Broadcasting Service television stations across the United States aired the NOVA docudrama, *Judgment Day: Intelligent Design on Trial*. The two-hour program highlighted the controversy surrounding the decision of the Dover, Pennsylvania, school board to require high school biology teachers to read a statement to their classes that "intelligent design" is an alternative explanation for the theory of evolution. The teachers refused, and several parents subsequently filed a federal lawsuit against the school board for its failure to abide by the constitutional separation of church and state (<http://www.pbs.org/wgbh/nova/id/about.html>). The resulting trial, now often referred to as the "Dover Trial", was meticulously re-enacted in the docudrama, and along with the riveting courtroom testimony, viewers of *Judgment Day* were treated to a crash course in evolutionary theory and the weaknesses of "intelligent design" explanations. The program won praise from many sources, and on April 2, 2008, it was awarded a Peabody Award for broadcasting excellence (see <http://www.peabody.uga.edu/news/pressrelease. php?ID=151>).

After viewing the original broadcast ourselves, we decided that *Judgment Day* offered an educational and entertaining account of the theory of evolution and of a contemporary "evolution war" to which college biology students should be exposed. Therefore, we decided to show the program to students in Centenary College of Louisiana's Biology 101 class (Principles and Methods of Biology) to supplement the section on evolution that students had just completed.

Centenary College of Louisiana is a Methodist-affiliated four-year college in Shreveport, Louisiana. Most of the students enrolled in the college are Louisiana residents, but the college attracts a large percentage of students from Texas and fewer from other states around the country. The college's core curriculum requires all students at the college to take two science courses with laboratories, and Principles and Methods of Biology is the most popular science course available that satisfies core requirements. Because the course is available for both biology majors and nonmajors, it enrolls a mixture of students from academically motivated pre-medical students to students in decidedly nonscience majors, such as music and English, who are simply fulfilling a core requirement. It is a required course for all biology majors, health and exercise science majors, and elementary and secondary education majors.

Five different professors teach six sections of Principles and Methods of Biology, including the two authors of this article. The course design and schedule are collaborative efforts among all five faculty members, and instructors spend the same amount of time on each topic. We introduce evolution as a separate topic approximately two-thirds of the way into the course after students have learned about DNA structure and replication, Mendelian genetics, and meiosis and mitosis. We begin the evolution unit by introducing students to population genetics in the form of the Hardy-Weinberg equilibrium equation, which mathematically demonstrates that characteristics of a population remain constant, or in equilibrium, unless there are extrinsic factors to change them. After having the students discover through calculations that the assumptions of the Hardy-Weinberg equilibrium are not met by sexually reproducing populations, we point out that evolution, as a change in allele frequency in a population over time, is inevitable. Then instructors choose what subtopics of evolution to cover for approximately the next four and a half hours of class time.

Centenary College students enrolled in Principles and Methods of Biology appear closely to reflect national trends in the understanding of evolution. For example, in one section of the course, when asked to

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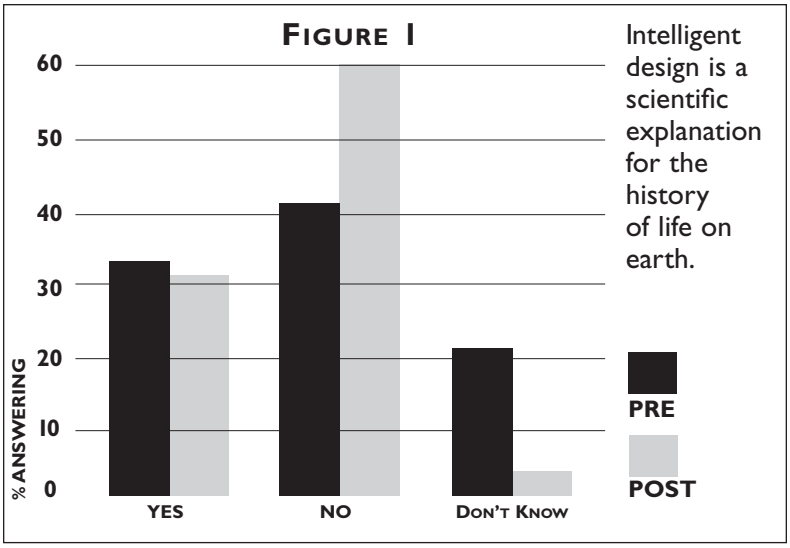
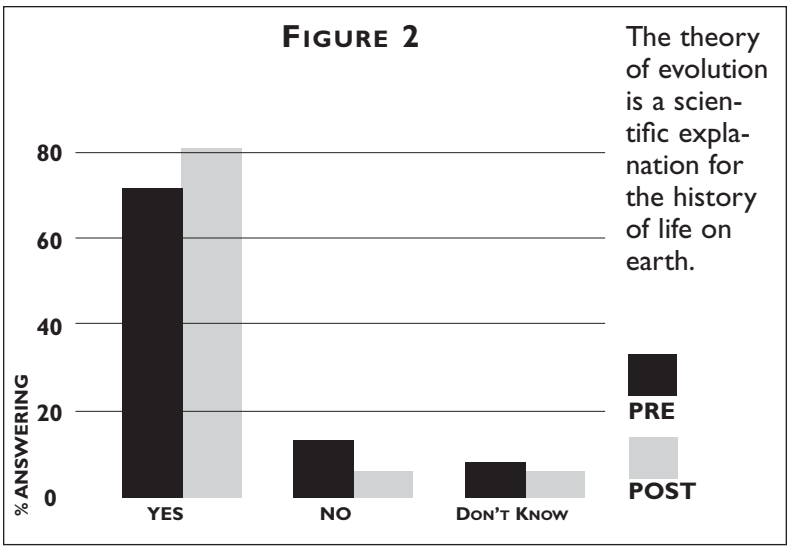
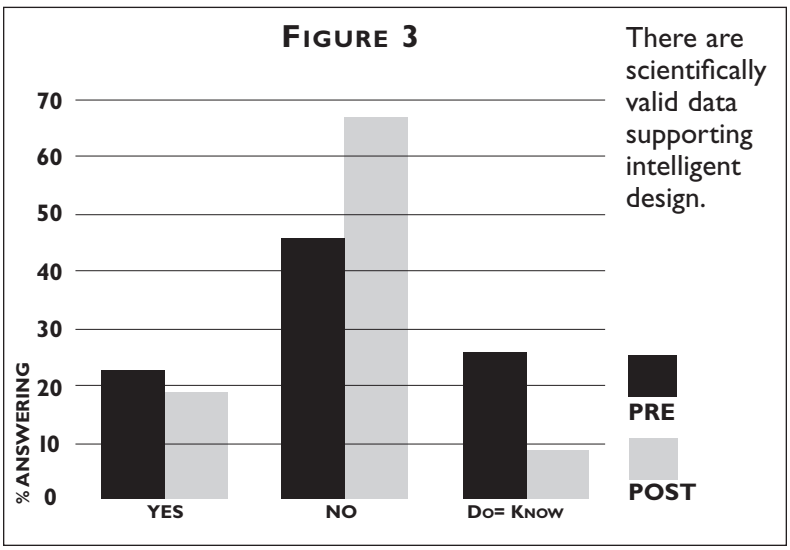






rate the statement "Humans evolved from monkeys," 44.4% of the students answered "true". In 2006 the National Science Foundation found that 47% of males and 40% of females correctly answered "true" to the statement "Human beings, as we know them today, developed from earlier species of animals" (<http://www.nsf.gov/statistics/seind08/c7/tt0705.htm>), implying that 53% of males and 60% of females had an "alternative" understanding of human evolution. One of us (Leuck) has asked students about their high school backgrounds in terms of evolutionary theory since 2000. Approximately 50% of the students polled answer that evolution was not mentioned at all in their high school biology class, or that it was implied but not explicitly taught.

These results are at odds with a teacher survey conducted by Berkman and others (2008), in which only 11% of the high school teachers surveyed stated that they do not cover evolution at all or devote fewer than two hours to it. However, the authors point out that their data support two explanations for differences in teachers' emphasis on evolution: teachers' personal beliefs and the number of college-level science courses they have taken (Berkman and others 2008; *see p 37–8*). In northwest Louisiana, where Centenary College is located, the majority of individuals with a religious affiliation are Southern Baptist (<http://www.bestplaces.net/city/Shreveport-Louisiana.aspx>), a denomination known for its literal interpretation of the Bible (<http://www.sbc.net/bfm/bfm2000.asp#i>). Therefore, many teachers in the region may have strong religious beliefs that affect their treatment of evolution in the classrooms, possibly contributing to the lack of knowledge of evolutionary theory typically expressed by Centenary College students in Biology 101.

With the above factors in mind, we decided to offer extra credit points to our student enrolled in Principles and Methods of Biology to attend an evening showing of *Judgment Day*. We had just completed the unit on evolution, the semester was coming to a close so students were anxious about their grade in the course, and our experience is that students respond favorably to an offer of extra credit in a course, no matter how trivial the number of points (we offered 3 points for attending the program out of a total of 600 points available in the course). We scheduled showings of *Judgment Day* on two consecutive evenings at two slightly different times to accommodate as many students as possible. Of 140 students enrolled in the course, 95 (68%) attended one of the showings of *Judgment Day*.

Student responses to Judgement Day

Prior to the scheduled showings, one of us (Butcher) developed a survey form with six short statements to which students could respond "Yes," "No," or "Don't know". As students walked into the auditorium where *Judgment Day* was shown, they were handed two copies of the survey statements. Both copies had an identical number on them so we could track the before-and-after responses of individuals who would still remain anonymous. Students filled out one form prior to watching *Judgment Day* and filled out the second form after watching the program. Pre-surveys were collected before showing the program, and post-survey forms were collected as students left the room after the showing. All data analysis was based on comparing each individual's pre- and post-program answers.

We were surprised that no student at either showing had ever heard of the Dover trial (we asked for a show of hands). We observed that the number of characters introduced in the film and the complex maneuverings prior to and during the trial were confusing to many students who became restless during the program. However, we were actually surprised that the answers to the survey statements indicated that the students had been paying more attention than their behavior suggested during the program.

Depending on the statement, more than one-third of the students who viewed *Judgment Day* changed at least one answer on the post-program survey from their answers on the pre-program survey. The answers most likely to be changed related to statements targeting students' understanding of "intelligent design". Twenty-four percent of the students changed their answers to Statement 1 (Intelligent design is a scientific explanation for the history of the earth) from "Yes" or "Don't know" to "No" after viewing *Judgment Day* (Figure 1), and 26% changed their answers to Statement 2 (There are scientifically valid data supporting intelligent design) in the same direction (Figure 2). More students who answered "Don't know" changed their answers than students who answered "Yes," indicating that the program was particularly effective in changing the minds of students who were unsure of "intelligent design"'s role as a scientific explanation (Figure 2). In the end, 70% of the students who watched *Judgment Day* believed that there are no scientifically valid data supporting "intelligent design".

Although not as dramatic as the results for Statements 1 and 2, the change in answers to Statement 3 (Intelligent design should be taught in the science curriculum of public schools) was also notable. In the pre-program survey 55% of the students answered "Yes" and 45% answered "No" to the statement. "Don't know" was not listed as an option to prevent students from avoiding the issue altogether. In the post-program survey the results were reversed, with 39% answering "Yes" and 61% answering "No".

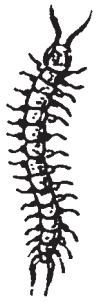
When the number of answer changes to all three statements concerning "intelligent design" were statistically compared to the number of answer changes for all three statements concerning evolution, students changed their answers to the "intelligent design" statements significantly more often than they did their answers to the statements about evolution. These changes may reflect students' unfamiliarity with the premises of "intelligent design" prior to viewing *Judgment Day*. The program appears to have both convinced students that there is no scientific merit to "intelligent design" and to have educated them about the assumption of the movement.

As mentioned previously, the students watching *Judgment Day* had just completed the unit on evolution in Principles and Methods of Biology, and their answers to the statements on evolution appeared to reflect the information gained during that unit. There was a slight increase in students answering "Yes" to Statement 4 (The theory of evolution is a scientific explanation for the history of life on earth) from pre- to post-program survey (76% to 85%) (Figure 3). Similar percentage increases were also observed in Statement 5 (There are scientifically valid data supporting the theory of evolution) from 86% to 92% and in Statement 6 (The theory of evolution should be taught in the science curriculum of public schools) from 91% to 94%. Small percentages of students answered "Don't know" to Statements 4 and 5, but as in the similar statement about "intelligent design" (Statement 3), students were not given the option of answering "Don't know" to Statement 6.

Discussion

Exposing students attending college in Louisiana to evolutionary theory regardless of their majors should be an important goal, considering that the state legislature recently passed, and Governor Bobby Jindal signed, the Louisiana Science Education Act, which allows teachers at the elementary and secondary level to present supplemental material that "promotes critical thinking skills, logical analysis, and open and objective discussion of scientific theories being studied including, but not limited to, evolution, the origins of life, global warming, and human cloning" (<http://www.legis.state.la.us/billdata/streamdocument.asp?did=503483>). This wording is similar to that suggested by the Discovery Institute, an organization that promotes "a belief in God-given reason and the permanency of human nature" (<http://www.discovery.org/aboutFunctions.php>). We have discovered that dramatizing evolution in the manner utilized by *Judgment Day* is a highly effective technique for clarifying the concepts of evolution and counteracting ideas not supported by scientific evidence, such as those expressed by the Discovery Institute.

The lack of high school background in evolution and the short time spent on it in our Biology 101 course were probably partially responsible for the confusion expressed by many students when they answered "Don't know" to the pre-program statements about the validity of "intelligent design". Most introductory college biology courses are constrained in the time spent on evolutionary theory because there are other biological topics that also need to be introduced. To increase high school students' exposure to evolutionary theory prior to their enrolling in a college biology course, a high school biology teacher in Louisiana could request to show his/her students *Judgment Day*. The program appears to meet the "supplemental instructional materials" criterion of the Louisiana Science Education Act (LSEA). Certainly we would argue that viewing *Judgment Day* "promotes critical thinking skills, logical analysis, and open and objective discussion of scientific theories" (see <http://www.legis.state.la.us/billdata/streamdocument.asp?did= 503483>) by its thoughtful coverage of the information presented by witness for both the plaintiffs and defendants. Although the LSEA has all the appearances of a stealth creationism document (Stenger 2001), it does not prohibit a high school biology teacher from requesting to supplement the standard textbook with high-quality scientific material such as *Judgment Day*.



Engaging the Controversy in Science Education: Scientific Knowledge and Democratic Decisions

Rebecca P Lewis

Looking at the headlines of newspapers around the United States these days, it is clear that there is a controversy waging over one of the key concepts taught in science classrooms. Evolution, a scientific theory that has long been a source of contention in the United States, has become a target once again. In the 1920s, the teaching of evolution was contested in the infamous Scopes "monkey" trial. Although it put an end to most of the pending anti-evolution legislation at the time (Linder 2002), the Scopes trial neither led to a clear decision on the violation of the Establishment Clause of the United States Constitution nor ended the debate over the teaching of evolution.

The current challenge to evolution is different from that of the Scopes Trial era, however. Proponents of "intelligent design" (ID) argue for a fundamental change in the way biology is taught in the United States, especially in high school. They propose including materials "challenging various aspects of neo-Darwinian theory . . . developing the scientific theory known as intelligent design . . . [and] exploring the impact of scientific materialism on culture" (Discovery Institute nd). In fact, they assert that American school children should learn about the evolution "controversy", further asserting that teaching evolutionary biology alone (that is, evolution without reference to ID or other alternate "theories") is bad science because it does not include the skepticism that is essential to all scientific research.

The reality is, of course, that no real debate exists in the scientific community about the veracity of the theory of evolution; in fact, most scientists accept the theory of evolution (Witham 1997). What does exist, however — as it always should in science — is a healthy amount of skepticism and questioning of hypotheses based on the theory of evolution (Isaak 2005). In contrast to the lack of debate about evolution in the scientific community, there continues to be a major controversy over the science curriculum. This is played out as states make decisions about science standards, local school boards make decisions about what will be taught in science classrooms, and both decide how to present information to students.

The fundamental question facing the scientific community today is what happens when experts in a field on the one hand and large numbers of citizens

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The evidence from these responses indicates that after the evolution/"intelligent design" controversy was presented to Centenary College students in *Judgment Day*, the students understood that evidence strongly favors an evolutionary explanation of adaptation and speciation. Ideally college students should be taught evolution in an atmosphere that allows them to thoroughly explore its predictive features, as done by Wilson in his Evolution for Everyone course at Binghamton University (Wilson 2005). However, in a more restricted curriculum, showing *Judgment Day* will both increase students' understanding of evolutionary principles and the nonscientific attempts by organizations such as the Discovery Institute to undermine the teaching of the most comprehensive theory in biology. Adding *Judgment Day* to classroom units on evolution at both the high school and college level may be particularly important in states like Louisiana that have a history of resistance to scientific explanations of the origin of life on earth. At the very least, our survey shows that

on the other reach a stalemate concerning knowledge. What happens to the rest of the population, caught in the middle of the conflict, especially high school students and their teachers? This article explores the controversy over the teaching of evolution in the science classrooms of the United States, as well as how decisions concerning who acts as decision-makers and what is *right* will be decided, and the effects of these decisions on science education. Because this controversy is about making decisions about what knowledge is of most worth — indeed whose knowledge is accurate and whose knowledge is not (and who decides both about accuracy and about what should and should not be taught in school), it is fundamentally a debate about democracy and educating people to participate more fully in a democratic society. Indeed, in a country like the United States all curricular debates are eventually political debates, and unless they are recognized as such many important curricular reforms will fail for lack of political sophistication on the part of their advocates.

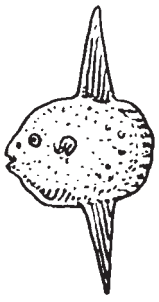
In the United States much education policy is made at the grass roots level. In addition, each of the fifty states makes many of its own decisions about curriculum and academic standards for its schools. This is true despite the fact that since the passage of the No Child Left Behind Act, the federal government is playing an increasing role in school politics both in terms of regulations and in the bully pulpit available to educational leaders. Nevertheless, unlike the situation in many other nations, curriculum decision-making happens in the United States at many different levels and with many different constituencies.

This debate can only be won in the court of public opinion, not in the scientific journals, and the scientific community (researchers and educators) must effectively demonstrate several points: scientific theory need not diminish religious beliefs or interfere with what children are taught in the home or in faith-based communities; schools are expected to teach the knowledge needed for full participation and in the US economy and in a democratic society, but not *all* knowledge; and changing science education for religious purposes fails the larger goals of a democratic society (and this is perhaps the proper order for addressing the chief concerns of the general public). If the scientific community refuses to engage in this public dialog, if it remains "above politics," it should not be surprised if it loses in the court of public opinion and particularly in the electoral process, both of which will affect policy and curriculum because local, state, and federal governments are where these decisions are made. The cost of failure is that we could easily end up in a situation in the United States — or at least in many communities within the United States — in which the democratic system created a school curriculum that teaches very bad science.

While there are actually many different kinds of creationism or religious theories about the origins of life, the current educational debate pits those who support ID against most of the scientific community. Some might see this dichotomy incorrectly as one between religious ID proponents, on the one hand, and secular evolutionists, on the other. Certainly those who oppose evolution on religious grounds will find comfort in ID. However, the central claim that ID proponents make to the public at large is that they have a *scientific* alternative that is being discriminated against. To understand the current debate better, it is important to look closely at what each "side" is saying — both about itself and about the other side, including both the assertions each side makes and the assumptions that underlie their arguments.

Proponents of ID

Creationists offer a long list of arguments against evolution, ranging from claims that evolution is not testable to attacks on various hypotheses related to the evidence of evolution, to moral and religious attacks on scientists and the scientific community. However, proponents of ID often distance themselves from past concepts of creationism (West 2003) — particularly distancing themselves from "young-earth creationists" who believe that the earth is 6000 years old and was shaped by the Noachian Flood. Instead, proponents of ID contend that evolution does not account for the complexity of life as we know it. ID proponents state that life is too complex to have evolved randomly, so there must be an intelligent being that directed or began the design. Advocates of ID dispute critics' assertions that ID is religious in nature and that the intelligent designer identified in this theory is God. They claim that while ID, like evolution, might have "implications for religion ... these implications are distinct from its scientific program" (West 2003). Some proponents have asserted that the changes to science curriculum they seek would simply allow for the teaching of other theories besides evolution.



Judgment Day did an excellent job of educating college students who truly did not understand the nonscientific premises of "intelligent design".

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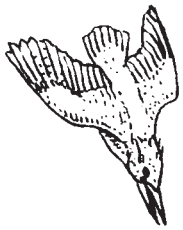
Its proponents have asserted that ID is in fact a scientific "theory" for which evidence can be detected in the natural world and used to explain scientific facts and they cite a range of "evidence" for ID. One claim is that "the ID argument is 'based on biological and physical data generally accepted in science' ... [but it disagrees] with the evolutionists that life could have begun and developed all by itself from undirected material" (Zehfus 2006). Proponents accuse critics of ID as being hypocritical in denouncing ID as pseudoscience, while accepting other branches of science that "depend on drawing the distinction between intelligent causes or intelligent agents and physical causes" (Trobee 2006). For instance, proponents claim that ID is similar in nature to fields such as archaeology and forensic science. They argue that attributing the development of a tool to a certain group of people based on carbon dating or deducing who committed a crime based on DNA evidence is based on a leap of faith that it was an intelligent, identifiable human being who created the tool or committed the crime — much as proponents claim that an intelligent being must have created life.

Proponents of ID claim that evolutionists have stacked the odds against ID through efforts to block the publication of evidence of ID in scientific journals and through efforts by lawmakers and science organizations to promote teaching only "'testable' scientific theories and those okayed by the National Academy of Sciences" (Trobee 2006). These claims assume that the "scientific" concerns that proponents of ID have related to evolution represent a valid scientific inquiry, which the larger scientific community and the professional organizations that support the work of the community reject.



ID proponents claim that the very existence of challenges to evolutionary theory "should be sufficient reason" for teaching ID in schools (Dixon 2006). In other words, since evolution cannot (in their view) explain all of the diversity and complexity of life, then we should teach that there are other theories that do fill in the gaps in our knowledge. Most of the 44 fellows who work for the Discovery Institute do not have advanced degrees in biological sciences, and the Institute conducts "very little ... research into the weaknesses of Darwinism ... of the experimental, lab-oriented, peer-reviewed kind" (Downey 2006). The evidence and arguments of ID are of a more theoretical nature and thus have been presented in creationist-leaning journals and in books. The scientific evidence *for* ID has not been published in peer-reviewed journals in the larger field, proponents say, because of the snobbery of the scientific community and its refusal to look at evidence that contradicts accepted notions (Morris 1998; Derbyshire 2003).

Instead of conducting original research that could be written about in peer-reviewed scientific journals, the Institute focuses its work on a public opinion campaign aimed at having public schools teach both the "strengths and the weaknesses" of the scientific theory of evolution and about the "evolution controversy", which they claim exists. The purpose of this campaign, according to the Institute, is to get the message to the people that the truth about evolution is being suppressed by "Darwinian fundamentalists" (Discovery Institute nd). The Discovery Institute characterizes the majority of the scientific community in this group, because they refute ID despite the "missing links and other problems" of evolution that ID proponents see (Zehfus 2006). Judging by news coverage and popular opinion polls, it seems the ID movement has succeeded in getting its message out and persuading some people to support changing science education to fit religious views.

Critics of ID

Critics of ID claim that ID is simply creationism "camouflaged in scientific language" (Anonymous 2006) or is "parallel but not identical to creation science (Scott and Branch 2002). In addition, the former director of the Vatican Observatory stated that the Catholic Church views the teaching of ID alongside evolution in the science classroom as confusing for students who would not understand that these two contrary ideas are not on equal footing in the scientific community (Anonymous 2005). Even among scientists of Christian faiths who have been surveyed, the idea of ID seems at least partly religious in nature. A survey of scientists at universities in Ohio, one of the states in which the debate over inserting ID into public education has been very prominent, showed more than 90% agreed that ID was a religious notion, that evolution and religious belief were not mutually exclusive, and that understanding ID was not necessary for students to understand the natural world, while knowledge of evolution was (Bishop 2002).

Other critics of ID contend that ID is a philosophical idea, not a scientific theory, and not a replacement for the theory of evolution or for explanations of the natural phenomena that it offers (Gingerich 2005). Since ID is not a scientific theory, they claim, it does not have a place in the science classroom.

It is important to note that all the critics of ID do support the theory of evolution, even if there are disagreements among them about details. Scientific challenges to evidence supporting a theory or the fact that the theory cannot answer all of our questions does not require the immediate acceptance of *any* alternative — the alternative itself must be supported by a chain of evidence. On this point, the scientific community must undo the ID movement's obfuscation of this fact to achieve success in the public debate. However, the scientific community often does not join in this public debate, worrying that doing so would give more credence to ID than it deserves.

Critics of ID often note that the evidence cited by proponents of ID has not been accepted by the larger scientific community and is not published in any of the widely-accepted peer-reviewed journals of science. Critics defend against claims of biased publication criteria by noting that most ID proponents do not actually perform scientific experiments, which would lead to the types of articles published in scientific journals. And of course some of the scientific work on ID done by proponents has been rejected as "bad science", even by supporters of ID.

Critics of ID assume that good science follows

agreed-upon steps and rules in the scientific community. This framework filters out bad science, such as ID. Following this agreed-upon format for inquiry is a fundamental value within the scientific community that represents a mindset difference between scientists and non-scientists, and it is this difference that makes this controversy so difficult for many non-scientists to grasp. This mindset means that the scientific community faces difficulty in representing the strength of its position in the court of public opinion. Proponents of ID try to portray the critics of ID as close-minded and unwilling to accept evidence that does not fit their world view.

What Scientific Debate?

The two sides of the controversy over evolution and the teaching of evolution in schools cannot really be debated in the scientific arena because the two sides view the world differently: science never claims to do more than describe and explain the natural world of science while ID proponents look beyond nature for answers, answers which — by definition — cannot be "science" even if they represent "truth" by some other definition. As stated by one ID critic, the potential conflict is "our definition of science . . . [which] explains the world with hard, observable evidence" while ID proponents consider that science "is not limited to the best 'naturalistic' explanation, but rather to the best explanation, period" (Foley 2006). Within this framework, there is simply no way to have a dialog about what is seen as scientific knowledge.

However, this controversy about science education is taking place in the *public* arena — in schools, and courts — as though there *were* a scientific debate between science and ID. To succeed in this cultural controversy, the scientific community must enter the public arena with a clear and succinct message that evolution need not conflict with religious beliefs and evolution is a sound theory overwhelmingly supported by the scientific community, since these are the successful talking points of those who oppose evolution (currently by promoting ID).

Determining What Is Scientific Knowledge and Who Decides

The cultural controversy over the science curriculum is not really about evolution, but rather is a debate about what knowledge *is* and who decides. It is a controversy over what knowledge is considered valid or of most worth and whose voice(s) are heard (or not heard) in the decision-making about education and knowledge. It is a controversy about the nature of science and scientific knowledge. And it is a controversy about religion, policy, and the contradictions and problems with such debates in the United States. It is difficult for this matter to be decided once and for all in a democracy in which there is widespread popular support for local decision-making. On the one hand, we have experts in the field — including the vast majority of high school biology teachers — who support the scientific theory (and many of whom strongly disagree with teaching it as a *controversial* theory). On the other, seemingly popular support for the teaching of an alternative idea — ID — also exists in spite of a scientific consensus that it is "bad science".

It is essential to understand that, as curriculum theorist William Pinar and his co-authors point out in *Understanding Curriculum*:

> The history of American education is linked with religious movements and controversies . . . [for] despite the constitutional separation between church and state . . . there has been a keen curricular interest in the matters associated with religion. (Pinar and others 2004: 606)

The genius of the "ID debate" from its proponents' perspective has been its successful appeals to public opinion, and then its convincing government officials to take up the cause in light of claims that the majority of Americans support ID (Trobee 2006). In fact, religious groups and advocates of a more theistic society have long worried about what is taught in public schools, and "school curriculum is now scrutinized carefully by religious groups concerned over values embedded in it ... [which] represent a religious belief system called 'secular humanism'" (Pinar and others 2004: 614). Of course, it is a perennial (and popular) argument that teaching evolution promotes the "religion" of "secular humanism".

At its base, this is a controversy about liberty in a democracy — pitting the liberty of parents and religious groups against the liberty of other parents and against the US Constitution, which holds that there will be no establishment of religion by the government nor any suppression of citizens' religious beliefs. In Deborah Stone's *Policy Paradox* (2002), the noted policy analyst and scholar offers a theory of policy analysis that helps us understand that the goals of policy decisions, such as liberty, are ambiguous concepts that mean different things to different people. Thus, policies enacted to meet ambiguous goals such as promoting liberty and equity (like mandating the teaching of the "evolution controversy" to be "fair" to different constituencies) can be supported by the majority of people, only to have people be upset with the consequences of these policies because the results of the policies do not meet people's differing conceptions of the goal. This means that a policy in education that is meant to promote a critical stance towards evidence, which is healthy and necessary in science, can be used to criticize science itself in the name of "academic freedom". Academic freedom has, in fact, been the rallying point of the ID movement, which has demanded that public opinion should be listened to and that academics (whether university-level or at the K–12 level) should be given the freedom to present the challenges to evolution.

In 2005, a federal court ruled that ID is a religious belief and that teaching ID violates the Establishment Clause of the US Constitution. Yet school boards and state legislators from Minnesota to South Carolina to Kansas have heard about ID and want to introduce the notion that evolution is disputed and does not answer "all of our questions" or that ID can answer questions of origin that evolution cannot. Despite past court decisions (and all the scientific evidence), the *public* debate will continue because it is neither a legal nor a scientific one.

We live in a political environment in which "the people" will ultimately make decisions about curriculum — either through school boards or electing officials — including the officials who appoint state and federal judges. Therefore, the scientific community must engage in the public dialog to make it clear that policies promoting criticism of evolution or the teaching of ID will not help us to achieve our goals of liberty and prosperity. For example, Margaret Spelling, Secretary of Education under President George W Bush, emphasized the administration's contention that US ability in math and science is not up to par with the rest of the developed world — leading the administration to fund "an ambitious program intended to boost the quality of math and science instruction in the nation's schools" (Murray 2006). People do not need to understand all the arguments relevant to evolution to understand that diluting the science curriculum with ID is simply not compatible with this goal.

Distorting science education to match the religious worldview of a small part of the population does a disservice to our democracy and our country in its global economic pursuits, ill equipping students to participate in the scientific world economy that is seen as key to our national interests and prosperity. However, the remedy for the attack on evolutionary science is not more pronouncements from on high (for example, the National Academy of Sciences 1998 — or other professional or even religious organizations), it is engagement in the democratic process that shapes the science education that our public school provides. This is a strategy that anti-evolutionists have understood and mastered.

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A chance to help NCSE's archives!

NCSE's archives house a unique trove of material on the creationism/evolution controversy, and we regard it as part of our mission to preserve it for posterity — as well as for occasions such as the *Kitzmiller v Dover* trial in 2005, in which material from NCSE's archives helped to establish the creationist antecedents of the "intelligent design" textbook *Of Pandas and People* and of the "intelligent design" movement in general. We cordially invite you now to help NCSE's archives keep up-to-date by purchasing books for NCSE through our wish list at Amazon.com. Visit <http://www.amazon.com/gp/registry/wishlist/39U1UMFQ22WED/>.

The State of High School Biology Teachers' Understanding of Evolution

Patricia Palko

When asked, "Human beings, as we know them today, developed from earlier species of animals", only 43% of randomly selected Americans answered "True" (National Science Board 2006). Furthermore, no more than 48% of the public could choose an accurate definition of evolution (People for the American Way Foundation 2000).

The woeful state of evolution comprehension is not surprising considering that formal education ends in high school for most of the American population. The Current Population Survey estimates that 28% had attained a bachelor's or higher degree (National Center for Education Statistics 2008). Although some high school graduates may have attended college without matriculating, there are no indications of how many of these students completed a college science course, particularly in the field of biology. Therefore, high school teachers provide the last formal instruction most students will receive in evolution. There have been many assessments of teachers' religious beliefs and the acceptance and teaching of evolution (see, for example, the University of Minnesota Biology Program faculty publications webpage at <http://www.cbs.umn.edu/bioprog/publications/> for a compendium of Randy Moore's work). However, there have been very few measures of their conceptions of evolution and none attempt to determine the source of misconceptions.

Therefore, James E Platt (of the University of Denver) and I developed the Classroom Test of Evolution (CTER) aimed at learning more about secondary teachers' understanding of evolution. It is based upon recent research on evolutionary misconceptions (for instance, see Brian Alters [2005] for an excellent treatment on general misconceptions; Mier and others [2007] for problems reading phylogenetic trees; and the NCSE website at <http://ncse.com/evolution/education/problem-concepts-evolution> for Eugenie Scott's discussion regarding the terms "cause, purpose, design, and chance"). The assessment was reviewed by evolutionary experts for content.

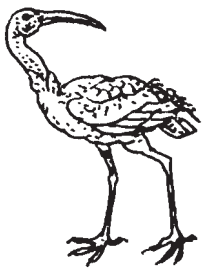
The CTER consists of 26 multiple-choice items designed to measure an understanding of the following aspects of evolution:

- natural selection
- acquired characteristics
- vestigial structures
- homology
- convergent evolution
- reading phylogenetic trees
- speciation
- common ancestry
- transitional fossils
- and the nature of evolution.

Almost all of the items are paired in the style of Lawson (1994): questions are sequenced in such a way that the answer to the second question identifies the reasoning behind the response to the first question. For example, in one set of questions, the first asks the respondent to identify which of a group of organisms is most closely related to lungfishes and the second inquires why biologists accept this to be true. Respondents must answer both questions correctly in order to receive credit.

The test was administered anonymously online. The respondents also provide demographic information, such as location and educational background. Over 700 high school biology instructors nationwide completed the survey. The majority were from the western or midwestern public schools, although the schools were roughly equally distributed between urban, suburban, small city, and rural locations.

Out of a possible 13 points, the mean score was just a 6.35. Yet unlike the American public, most teachers could correctly identify the evolutionary relationship of humans to other, related species. They performed well on questions concerning acquired characteristics and vestigial structures, as well.



However, several items asking teachers to interpret phylogenetic trees received no better than a 52% correct response rate, and for one set of questions, this rate dropped to a dismal 10.5%. Just under 35% were able to identify homologous characteristics in two organisms as being derived from biological features in their most recent common ancestor, and a mere 17.3% were able to define transitional fossils. Other problematic areas were discerning the effects of mutations on the genome and predicting the results of a selection event on a population.

Rutledge and Mitchell (2002) show that student knowledge about and understanding of evolu-

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Going Back to Glen Rose

Randy Moore

FIGURE 1 *Carl Baugh's new Creation Evidence Museum just outside of Glen Rose, Texas.*

In the last issue of RNCSE, *Randy Moore's account of the Creation Evidence Museum gave an overview and history of the facility and its founder. In October 2009, Randy wrote that he was going to have the opportunity to visit the museum again, so we asked him to write this follow-up.*

I CAN'T MAKE THIS STUFF UP

In November 2009, I visited beautiful Glen Rose, Texas, and could not resist stopping by Carl Baugh's Creation Evidence Museum. Baugh has moved his YEC-and-more "Creation in Symphony" message from his creaky double-wide trailer to a new two-story building. His message remains largely unchanged: visitors continue to hear about God's stretching the fabric of the heavens, God's putting Adam to sleep and taking a rib to make Eve, God's using a geyser to shoot water 70 miles into

Randy Moore (with Mark Decker) is coauthor of More Than Darwin *(Berkeley [CA]: University of California Press, 2009) and (with Mark Decker and Sehoya Cotner) the upcoming* Chronology of the Evolution–Creationism Controversy.

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tion are affected by that of their instructors and our analysis of CTER data reveals that teachers possess many misconceptions. We continue to analyze these data with an eye toward developing science education curriculum to help correct teachers' misunderstandings. In the meantime, we need to be aware that students may be graduating high school with the baggage of their teachers' misconceptions.

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the air, and God's aligning the molecules of the universe to create magnetic fields and the "appearance of age" (for example, birds were created in mid-air).

Some of the museum's exhibits are also unchanged (for example, visitors can still see a man-made hammer embedded in early Cretaceous rock).

Other exhibits have been upgraded. For example, "the world's first hyperbaric biosphere" — which was originally about the size of a large barbecue-pit and connected to an oscilloscope — is now 62 feet long. That chamber simulates the pre-Flood environment (for example, increased magnetic fields to "help healing and cellular communication"). Baugh claims that the biosphere's environment has increased the lifespan of fruit flies (and, by implication, helps explain the long lifespans of biblical patriarchs), increased the growth of certain fish (and, by implication, helps explain the large sizes of early humans), and "altered snake venom at the molecular level." (I was relieved to see a sign stating that "We do not and will not experiment on humans.")

The Creation Evidence Museum is most famous for its "Flintstones Fossils" — that is, fossils claiming to show that humans lived with dinosaurs. The newest exhibit is a fossil discovered by amateur geologist Alvis Delk of Stephenville, Texas, showing a track of *Acrocanthosaurus* intruding on a 11" human footprint of *Homo bauanthropus* in Cretaceous rock (Figure 2). This fossil, which was excavated in 2000 but displayed only recently, is accompanied by another fossilized track of *Acrocanthosaurus* beside a fossilized handprint of *H bauanthropus* in Cretaceous rock. These fossils, which have been "verified with x-rays" at "a professional laboratory", are part of the Sir George Series (named in honor of His Excellency Governor General Ratu Sir George Cacobau of Fiji). Also on display is a large photo of Baugh.

FIGURE 2 *The "Alvis Delk Print" showing a track of* Acrocanthosaurus *(right) intruding on a footprint of* Homo bauanthropus *(left).*

There are numerous tables of YEC books, DVDs, posters, and other materials for sale. I have the dubious distinction of making the first purchase at the new museum.

Business is good at the Creation Evidence Museum. On the days I was there, the museum was full. It is a depressingly entertaining place; astounding claims can be found throughout the facility. But the most curious display is on the second floor of the museum. There, overlooking everything, is a 12'-high statue (Figure 3).

When I saw the statue from a distance, I assumed that it was a memorial to a YEC pioneer such as George McCready Price, Henry Morris, or perhaps even Baugh. But I was wrong. It's a statue of Tom Landry, a former coach of the Dallas Cowboys professional football team.

Is football-creationism next?

FIGURE 3 *A statue of Dallas Cowboys football coach Tom Landry oversees another busy day at the Creation Evidence Museum.*

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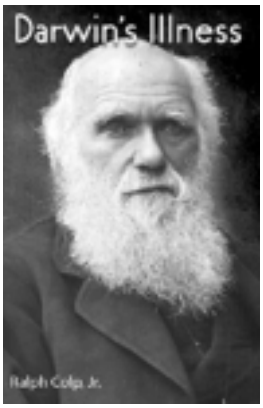
HOMO BAUGH-ANTHROPUS?

It is no surprise that the supposed Cretaceous hominid *Homo bauanthropus* is recognized only by Carl Baugh. The species name, he explains, is in honor of "a physically superior royal tribe in Fiji" (quoting from p 368 of his 1989 dissertation, available on-line at <http://www.creationevidence.org/~creatio1/carlbaugh.htm>). Discussing Baugh's claims in 1985, the physical anthropologist Laurie Godfrey identified the footprints as falling into three classes: clear toe impressions of tridactyl dinosaurs, poor dinosaur tracks obscured by infillings of mud, and misinterpreted invertebrate burrow casts of *Thalassinoides* (see "Foot notes of an anatomist" in *Creation/Evolution* 5 [1]: 16–35; available on-line at <http://ncse.com/cej/5/1/foot-notes-anatomist>).

BOOK REVIEWS



DARWIN'S ILLNESS

by Ralph Colp Jr
Gainesville (FL):
University of Florida
Press, 2008. 337 pages

Reviewed by Keith Thomson

Poor Darwin; one has to feel sorry for him, not just because he was ill so much of the time, but also because the world now knows so much about his heart palpitations, the color of his urine, and his bowel movements! But the man himself seems to have relished all the details of his symptoms, set out for many years in a diary and in lists sent to an unending supply of doctors and quacks. He is famous for taking "cures" at expensive spas, such as the one run by Dr James Gully (principally involving cold baths and a strict diet). It is remarkable that such a perennially sick man got such a prodigious amount of work done.

Thirty-two years ago, Ralph Colp Jr, a psychiatrist, gave us a comprehensive view of Darwin's illnesses and some best guesses as to their causes in his influential book *To be an Invalid* (Chicago: University of Chicago Press 1977). Now he has revised that work in the light of the many new ideas that have been suggested about what ailed the great man. In this new edition Colp has carefully transcribed Darwin's "Diary of Health" of 1849 to 1855, but sadly the details of contemporary nostrums that enlivened the first edition have been removed.

Just how ill was Darwin? Colp makes it clear that he was unwell, on and off, for his whole life. The contradictory patterns of Darwin's illnesses started in his youth. He was both a strong athletic youngster and quite psychologically tender. Evidence suggests that he was deeply affected by the death of his mother, when he was only eight. He stammered and always had a weak stomach (especially at breakfast). As a teenager he began to suffer bad eczema on his face (especially the lips) and hands and this was always associated with anxiety and stress.

At Cambridge he seems to have suffered periodic depression. Just before the *Beagle* voyage (1831–1836), while miserably delayed in Plymouth, he developed palpitations and, it is thought, paresthesia in which his finger tips became numb. During the voyage itself, he suffered surprisingly little from the sorts of stomach upsets and fevers that one might expect from someone exploring fearlessly on horseback across South America. But on at least two occasions he was seriously laid up for weeks at a time.

After the *Beagle* voyage, while he was working feverishly to establish himself as a writer and geologist in London, he found that hard mental work led immediately to severe headaches, the ever-present eczema, palpitations, dyspepsia, and exhaustion. He was already on the way to becoming an invalid. In early to mid-1838 he added a whole new phase of symptoms involving much vomiting, "stomach" pain, extreme flatulence (belching), an acid stomach, night waking, an ulcerated tongue in the morning, and more severe eczema of the face and hands. At more than six feet and 148 pounds, he was marginally underweight. Readers may be surprised at some of his more obviously psychological symptoms, which included hysterical crying, "rocking", feeling that his stomach was "cold", seeing black dots, feeling a sensation of "walking on air", "dying sensations", ringing of the ears, and exhaustion and self-loathing. Interestingly he did not suffer much from fever or diarrhea; his intestinal difficulties were centered on the esophagus, stomach, and duodenum. One is almost shocked by the extent and duration of the agonies that Colp has documented.

Many doctors were consulted and most cures worked for a little while. One such was dilute muriatic (hydrochloric) acid — an odd prescription for an acid stomach. Other doctors prescribed bismuth and calcium. He always had a craving, verging on an addiction, for sugar, and moving to what we would term a "better" diet usually helped, as did sitting upright, exercise, and a little wine.

This is a book for anyone interested in Darwin's complex life and the nineteenth century, with special interest for historians of science and medicine and for social historians. Every reader will naturally turn diagnostician and one's first instinct is to visit upon Darwin those conditions of which one has first hand experience. Over the years many theories have been proposed — from repressed homosexuality (!) to lactose intolerance and Crohn's disease. A long-standing favorite of Colp's is Chagas's disease, although to make the case for Chagas's, he has to invoke both an early latent phase and then a kind of secondary version later.

Darwin's obsessive preoccupation with health may in fact give us a clue to the causes of his symptoms. All the evidence points to a direct causal link between stress and his varied symptoms. The 1838 deterioration in his health coincided with his marriage and almost simultaneous recognition of the Malthusian principle that set the seal on his theory of natural selection — the secret ("like confessing a murder") that he was keeping

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Keith Thomson, Professor Emeritus of Natural History at Oxford University and Senior Research Fellow at the American Philosophical Society, is a biologist and historian of science. His latest book is The Young Charles Darwin *(New Haven (CT): Yale University Press, 2009).*

from his colleagues and the extremely religious Emma. His health improved in the 1850s when he was engrossed in studies of barnacles and again in his last few years.

The range of Darwin's symptoms suggests, at the least, extreme hypochondria and a kind of chronic anxiety syndrome, coupled with — and perhaps causing — a variety of upper alimentary disturbances. But the story of Darwin's health is like a mystery novel from which the last chapter has been deleted. Short of exhuming his body from Westminster Abbey, we probably will never fully know what ailed him. Meanwhile, except for the fact that its index is truly abysmal, this is a really valuable book. Everyone seeking to understand Darwin should read it and choose among the rival explanations of what brought him so low while he was achieving such greatness.

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Darwin's Sacred Cause: How a Hatred of Slavery Shaped Darwin's Views on Human Evolution

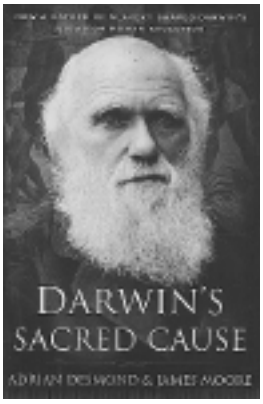
by Adrian Desmond and James Moore
New York: Houghton Mifflin Harcourt, 2009. 448 pages

Reviewed by John Waller

In 1991 Adrian Desmond and James Moore teamed up to write a wonderful book. Called simply *Darwin* (New York: Warner Books, 1991), this biography of Charles Darwin rightly won plaudits from fellow historians and a wider reading public, both camps awed by the authors' depth of research, their fluency of expression, and their ability to bring the tumultuousness of Darwin's England to life. A central theme informed Desmond and Moore's account: the belief that Darwin was made sick, scared, and highly sensitive by the association of evolutionist thought and political radicalism. It was not a new argument but they explained it with tremendous brio. In addition, they presented natural selection as an idea born, in part, of the relentless competition and jostling for position which defined the new industrial order. Their clever, atmospheric, and enthralling biography put Darwin firmly back in his time and place without diminishing the reader's appreciation for the great man's qualities as a scientific thinker.

Eighteen years later Desmond and Moore have produced another striking book that will once more get historians talking and challenge staid stereotypes about how Darwin arrived at one of the most important realizations in modern science. *Darwin's Sacred Cause* argues, in short, that Darwin developed his evolutionary theory not with the coolness of a scientist interested only in higher truths, but with a hatred for slavery so intense that he was hag-driven to prove that all human peoples were of one blood and ancestry. Proving that organisms can change over time, through natural and sexual selection, was part of a campaign, consciously and unconsciously waged, to bring an end to the evils against which his family had fought and from which he had recoiled on the *Beagle* voyage. Darwin might have obsessed about mockingbirds, fossil sloths, interbred pigeons, and overbreeding humans, but the "driving force" of his evolutionist thinking was the moral crime of slavery.

The result is fascinating and provocative. Written with much of *Darwin*'s flair and energy, Desmond and Moore tell an untold story of how Darwin's repugnance at slavery continued throughout his life, flaring up at times with all the emotional intensity of when he saw a female slave whipped in Argentina and an old lady's collection of screws kept to crush the fingers of recalcitrant slaves. This book does the great service of humanizing Charles Darwin. We see how keenly-fought debates over the nature of non-white peoples, their ultimate origins, even their capacity for interbreeding, occupied much of Darwin's time and helped shape the reflections which led him to his mature theory. Along the way the reader receives a vivid, detailed, and utterly engaging lesson in the racial debates of Victorian Britain and America, with believers in a single origin for all humans as described in Genesis pitted against the often pro-slavery exponents of polygenesis, the idea that each race had been created separately. It is in the context of these conflicts, fought out in clubs and societies but with implications for plantations and slave markets, that Darwin formulated an evolutionary riposte to the polygenists. Or so *Darwin's Sacred Cause* argues.



This stirring thesis raises many unanswered questions. If Darwin was so hell-bent on using science to undercut slavery, why not opt for a monogenist argument that all men and women were descended from Adam and Eve? Why bother bringing plants and animals into the picture at all? Moreover, the problem with making transmutation the basis for a critique of slavery was that it posed the question of how far back the splits among races had occurred. A few thousand years? A few million? Tens of millions? Since fossil hunters had yet to find a convincing human precursor, the branching among human races could theoretically be thrust back a very long way indeed. Inveterate racists could — and did — assert that the common ancestor of human races lived many millions of years ago, while the opponents of slavery opted for a more recent division. Evolutionary theory did not vouchsafe any one position. Nor does all the evidence as marshalled by Desmond and Moore neatly fit their hypothesis (as they at times concede). For if the brutality of slave-owning regimes put so much fire in Darwin's belly, why did he

John Waller is Assistant Professor of the History of Medicine at Michigan State University. His latest book is A Time to Dance, A Time to Die: The Extraordinary Story of the Dancing Plague of 1518 *(London: Icon Books, 2008).*

write with cool indifference about the "inevitable" extinction of peoples like the Australian aboriginals? And why did he feel the need to insist that "savage" peoples were the moral and intellectual inferiors of whites?

One of the most remarkable features of this book is its originality. Desmond and Moore's *Darwin* was far less bold in its analysis: historians had long pointed out that a fear of social ostracism contributed to Darwin's delaying publication of his theory and even Karl Marx had recognized the clear affinities between the theory of natural selection and the often highly creative state of competition which fuels capitalist society. This time, however, Desmond and Moore are presenting a thesis which has been played in hushed tones, if at all, by previous Darwin scholars.

For this very reason their racy, rollicking style may not have been the most appropriate choice. A comparison to Darwin's *On the Origin of Species* is germane. Knowing that his theory was going to be hotly contested and painfully aware of some important gaps in his data, Darwin presented his theory in the form of "one long argument", meticulously piecing together thousands of individual facts. In fact, the *Origin* has been compared aptly to a legal brief. So Darwin told the reader at every turn what he was arguing and how far his evidence went. He also did something unlike any attorney worth his fee: he devoted a chapter to acknowledging and then trying to argue around a set of thorny problems with this theory.

Darwin's great book was compelling because it is at once authoritative, brimming with data and candid about its limitations. Desmond and Moore's *Darwin's Sacred Cause* is also "one long argument", but it is written in the form of a breathless narrative replete with rhetorical flourishes. This makes it a superb and edifying read. But it also means that readers may find it hard to judge the quality of the evidence. There is no attempt to compare the relative importance of, say, slavery and mockingbirds, or Fuegians and finches. In fact, at one point we are reminded that "humans were not the sole source of insights into transmutation" (p 124). This would sound like outrageous understatement were it not for the fact that the preceding pages contain barely a mention of fossils or biogeography. Clearly Desmond and Moore know as much about the scientific basis of Darwin's science as anyone alive. Nevertheless their style lacks the disarming clarity which left many of Darwin's readers feeling that they were being told it as it is.

In sum, this is another splendid book from Desmond and Moore, the product of vast learning and deep sympathy, conveyed with often lyrical prose. If there are difficulties with the claims they make, they have at least provided, as Darwin said of his fledgling theory in 1837, a "theory by which to work." Time will tell if it has the strength to survive.

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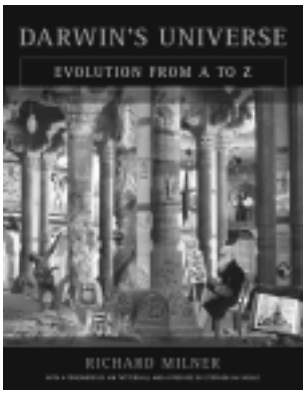

Darwin's Universe: Evolution from A to Z

by Richard Milner
Berkeley (CA): University of California Press, 2009. 488 pages

Reviewed by Carol Anelli

My past few weekends have been spent deliciously sampling and savoring the more than 400 main entries in Richard Milner's recent tome, *Darwin's Universe: Evolution from A to Z.* The copyright relates the publication history of the work, but also hints at the jocularity secreted within the book's many pages: "The present book … has evolved from two ancestral forms titled *The Encyclopedia of Evolution*, published in 1990 and 1993." Milner's work, while authoritative and scholarly, is anything but a somber, run-of-the-mill encyclopedia of alphabetically arranged entries. This substantive volume is at once an eclectic romp and an illuminating *vade mecum* for anyone interested in evolutionary science and Darwin's pervasive influence on human thought, behavior, and endeavor.

In his foreword, Ian Tattersall captures the book's scope and quirky conceit: "… you will look in vain for a solemn exegesis of the Hardy-Weinberg equilibrium or of speciation theory. The rule is that if Milner is fascinated by it, you'll find it in here; if he finds it boring or overworked in other books, you'll search in vain" (p 1). Fortunately for us, Milner's fascinations become our own, owing to his literary gifts and unconventional gamut of interests. I dare say that ivory tower dwellers and lay audiences alike will find much to relish in Milner's bill of fare. The late Stephen Jay Gould justified Milner's unique approach. In his "Appreciation," adapted from the book's first edition, Gould opines: "If we make an artificial division into high and vernacular culture, and consider just the former in a narrowly confined and misplaced concept of importance, then we will never understand the impact of science in society" (p 2). An endearing snapshot of Gould and Milner as childhood chums, posing in front of a reconstructed dinosaur skeleton, serves as homage to Gould and accompanies his essay.

Darwin's Universe features a plethora of illustrations, many unexpected or rare, e.g., the cartoon characters, Betty Boop and Mickey Mouse (under the entry "Cuteness, evolution of"); the great comedic actor Buster Keaton, photographed in a 1923 silent film (under the entry "Caveman"); a crowd of astonished onlookers

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surrounding Clever Hans (the 1920s "talking" horse phenomenon); an image of a 1938 Ringling Brothers and Barnum & Bailey poster advertising "Gargantua the Great" (under the entry "Gorillas"); a photo of the Sinclair Oil dinosaur being barged down the Hudson River for the 1964 World's Fair (under the entry "Brown, Barnum (1873–1963)"); and satirical sketches of society rendered by Richard Owen (1804–1892), who merits his own entry as "zoologist, paleontologist," to which one might add, "Darwin's nemesis." Owen's sketches are published here for the first time, as are family photos from the Darwin family and many illustrations from Milner's personal collection.

In addition to Owen, many historical figures (such as AR Wallace, TH Huxley, Charles Lyell, Lamarck, Francis Galton, and JD Hooker) and more recent luminaries (such as Theodosius Dobzhansky and George Gaylord Simpson) are represented, but so, too, are lesser-known figures (such as Errol Fuller, John Hampden, and Leo Lesquereux). Similarly, famous events gain entry (such as the 1860 Oxford debate between Bishop Samuel Wilberforce and TH Huxley), as do some obscure ones (such as the 1876 Slade trial, subtitled, "Darwin vs Wallace on spiritualism"). As Milner puts it, "I have attempted … to rescue many 'unknown' incidents from oblivion" (p 5). Thus it was news to me that *HMS Beagle* was named for the dog, that portions of this famous vessel were sold for scrap in 1870, and that the vessel's remains are believed to lie buried beneath tons of mud in a marsh in Essex, England.

Milner's disquisitions reach far beyond science and are so surprisingly inclusive as to both stimulate the intellect and enchant the soul. In this regard his eclecticism evokes James Burke's *Connections*, a PBS series that readers may know from its companion book of the same name. The following two examples evidence Milner's ability to create a tightly woven tapestry from seemingly disparate ideas, people, events, and tidbits. (1) For the entry entitled "Tennyson's *In Memoriam* (1850)" (subheading: "Evolutionary Requiem"), several of the 136 stanzas in this poem are reproduced. We learn that this work is the source of the famous phrase "Nature, red in tooth and claw," provided solace to Queen Victoria upon the death of her beloved Prince Albert, was quoted endlessly by Victorians, was inspired by the writings of both Lyell and Robert Chambers (the anonymous author of *Vestiges of Creation*, a controversial best seller on organic evolution, published fifteen years before Darwin's *Origin*), and was so popular that the title of poet laureate was conferred on Tennyson shortly after the poem's publication. (2) For the entry entitled "Sunday League" (also known as the Victorian "Sabbatarian" Controversy), Milner opens with an excerpt from Dickens's *Little Dorrit*, in which London on Sundays is portrayed as a "gloomy, close, and stale" city that offered no diversions for the overworked, common laborer because all zoos, museums, and even libraries were closed on the Christian Sabbath. This prohibition, the work of the Lord's Day Observance Society, met with opposition in 1853 with the organization of the National Sunday League. The League promoted "elevating recreation" on Sundays and its journal, the *Sunday Review*, found sponsorship among Dickens, Darwin, Huxley, and other progressive thinkers. Under the auspices of the League, Huxley presented the first scientific lecture ever given on a Sunday, for which he was charged with "keeping a disorderly house." Huxley's presentation led to *Lay Sermons* (1879), his collected lectures from that period.

Milner has a penchant for certain topics, including primate evolution; notable anthropologists, archeologists, and paleontologists; and science fiction films (such as *Quest for Fire, 2001: A Space Odyssey, King Kong, Jurassic Park*, and the Tarzan flicks). I was captivated by the biographical entries on Haldane and Mayr, and was pleased to see entries on "Biological exuberance," "Darwinian medicine," "Lysenkoism," "Peer review," "Science," and the various challenges to evolution (including creationism, fundamentalism, and "intelligent design"). Particularly useful are entries that provide important updates (for example, on the peppered moth, Darwin's finches, evo-devo, mimicry, and the Creation Museum). *Darwin's Universe* includes a bibliographic list for each entry. Two delightful, unexpected treats appear in the appendix — I will not spoil the surprise by describing them — but the entire work is engrossing and highly recommended for a stimulating, interdisciplinary perspective of Darwin's reach.

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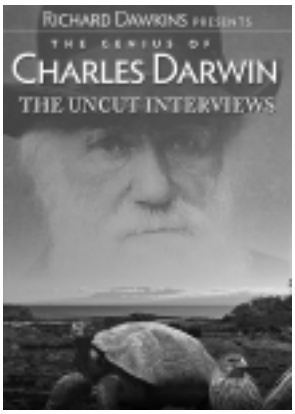
MEDIA REVIEW

The Genius of Charles Darwin



presented by
Richard Dawkins
Silver Spring [MD]:
Athena, 2009.
DVD, 2 disks,
139 and 260 minutes

Reviewed by Timothy H Goldsmith

In recent years Richard Dawkins — formerly Simonyi Professor for the Public Understanding of Science at Oxford University — has achieved a measure of notoriety for his outspoken atheism; indeed, he possesses a collection of tasteless e-mail to show for it. However, *The Genius of Charles Darwin* — a three-episode pro-

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gram (139 minutes) he narrated for Channel 4 in the United Kingdom — is principally concerned with scientific evidence and critical thinking in teaching about evolution and the difficulties posed by fundamentalist Christians. This is an excellent program, both for Dawkins's clear presentation of evolutionary principles and the informative display of vacuous arguments by evolution's critics.

Episode 1: Life, Darwin & Everything is a synopsis of Darwin's accomplishments, starting with English religious and philosophical views of nature at the start of the nineteenth century. This episode is constructed around Dawkins's several hours of interaction with a small group of teenage British school children whose religious family backgrounds have made them refractory to understanding the reality of evolution. This episode provides a basic primer in biological evolution and an invitation to children to think for themselves. Not surprisingly, Dawkins conveys the message that belief in the supernatural is neither necessary nor relevant to understanding and appreciating the beauty and complexity of the natural world.

Episode 2: The Fifth Ape. People are fascinated by other primates, yet uncomfortable with the idea we have a shared heritage. As Queen Victoria put it, apes are "painfully and disagreeably human." Dawkins takes the viewer to East Africa and the profusion of fossils relating to human origins. There we also meet Bishop Boniface Adoyo, the chair of the Evangelical Alliance of Kenya, who is convinced that he is not related to the fossils and wants to bar their public display in an evolutionary context. The bishop conveys a fundamental misunderstanding of evolution, which Dawkins attempts to rectify.

This episode discusses the evolution of human nature, focusing on the question of altruism: how and why natural selection produced individuals who suspend self-interest and behave kindly towards one another. (A tip of the hat to Robert Trivers would have been appropriate, for Trivers showed how reciprocal altruism can be in the self-interests of the participants' genes and thus evolve, even when the participating altruists are members of different species.) I share Dawkins's view that in humans the propensity for reciprocal acts of altruism probably evolved in small groups of people, building on an older and biologically broader predisposition to take care of close kin.

Dawkins visits the psychologist Steven Pinker to talk about evolved moral impulses, the affective feelings such as sympathy and gratitude that support altruistic behavior. Dawkins's brief discussion with the primate behaviorist Frans de Waal bears close listening, for it shows how important misunderstandings can occur between fellow scientists. De Waal does not understand the metaphor of the selfish gene as referring to the genes' central role in natural selection. Instead he connects it with selfish behavior, not recognizing that the concept of reciprocal altruism implies an evolved capacity with deep roots in the human (or even ape) psyche. The roots of altruism are so deep that people frequently feel empathy or extend help when stirred by the plight of a total stranger. Although the program only scratches the surface, this important subject cuts the heart out of the creationist assumption that evolution has nothing to say about moral feelings.

As part of an anti-evolutionary argument, some people assert that the goalless, soulless, struggle for existence is an unacceptable model for human affairs, a proposition with which Dawkins is in full agreement. He points out, however, that for many conservatives, the dog-eat-dog competition of business seems natural. He argues that the comparison of business with evolution is only an analogy, for the complexities of economic and biological systems are very different.

Dawkins's discussion of reciprocal altruism is the meat of this episode, but it takes a bizarre detour into human sexual selection and female choice. The scene opens on a street in downtown New York with Dawkins standing next to the Naked Cowboy, who is writhing in his jockey shorts with sweet young things waiting to cling to him. Then it moves to interviews with young women who wish to become pregnant via sperm donors whose profiles they first vet. From all this we learn that women's interest in a mate includes kindness as well as looks and intelligence. Amazingly, resources are not mentioned.

Episode 3: God Strikes Back. Viewers who know little of Darwin's personal life will be interested in his change in religious views and his dissatisfaction with his children's school that failed "to let the science do the talking." Today, there is still controversy about letting science do the talking when the subject is evolution. To set the stage, Dawkins visits with John Mackay, a fundamentalist Australian preacher who believes that knowing requires seeing, and as we cannot see atoms or past events, science must therefore be faith. A British chemistry teacher who believes the world is less than 10 000 years old illustrates an infrastructural problem for science education. Wendy Wright of Concerned Women for America gives us a glimpse of the current arguments of those anti-evolutionists who nevertheless acknowledge small evolutionary changes within a species. Discussion with Rowan Williams, the Archbishop of Canterbury, provides yet another theological view, one comfortable with the reality of evolution but poetic about whether God ever intervenes in the affairs of the world. With Randolph Nesse, Dawkins addresses the false notion of "intelligent design": evolution is not intelligent and cannot go back to the drawing board to correct mistakes; it must build on what it has already done. Consequently evolutionary adaptations are fraught with compromises and imperfections.

Although I share Dawkins's views about religion, I think his interview with four British school teachers displays a surprising naivete. Dawkins is convinced that science teachers in public schools are tiptoeing too respectfully around religious beliefs that are inconsistent with scientific facts. The teachers explain that their job is to teach science, not religion — a good model for this country if we are to remain consistent with judicial rulings. Teaching young children what we mean by evidence and how science provides understanding for so many features of the world presents a significant chal-

lenge. It is hard to know whether, when, and how children will accommodate a conflict with their family's religious views; for most it requires time and a measure of experience with life. Moreover, in a democracy public education is burdened with politics, so it is not possible to offer a general recommendation where in the educational system prior to university this challenge can be effectively introduced. Dawkins seems to have forgotten that it was his father, not a schoolteacher, who introduced him to the concept of evolution and drew him so enthusiastically away from religion.

The Genius of Charles Darwin shows wonderfully the science that Darwin set in motion, yet further reflection also suggests more distant vistas. Belief systems are frequently formed in childhood and resist later alteration. We pride ourselves on having rational brains despite our ready capacity to deny valid information that does not comport with cherished beliefs. There are doubtless evolutionary reasons for this imperfection, despite its contribution to misplaced romantic attachments, economic disasters, and military defeats. Belief in the supernatural is widespread and present in all cultures (itself a fascinating evolutionary outcome), but the manifestations are very diverse and cultural in origin. All the major religions share some common rules for behavior that function to stabilize relations within the group. This cultural convergence is the work of brains with shared, evolved features for social living. There is much to understand in evolutionary terms about our extraordinary cognitive capacities as well as our inevitable tragic frailties.

Disk 1 also contains three evolutionary vignettes, each developed around one of the reptiles on the Galápagos Islands. These are full of information about other organisms, the environment, and history. The script is elegant and is Dawkins at his best. I recommend these 24 minutes to anyone planning a visit to the Galápagos as well as those who have already been.

Disk 2 contains unedited interviews with individuals who appear in *The Genius of Charles Darwin.* Dawkins's discussion with the science teachers is compelling; they are clearly skilled professionals, understand the educational problems posed by complex material, and are not cowed by the Oxford presence. Teachers who are introducing children to evolution may find this discussion interesting. Randolph Nesse talks about how an understanding of evolution enriches the practice of medicine, a relatively new subject. Wendy Wright displays remarkable indifference to evidence and John Mackay an astonishing self-assurance in his pinched understanding of the power of science. In contrast, Dawkins's conversation with the philosopher Daniel Dennett illuminates how these two articulate humanists see the joy and goodness of life ennobled by the human capacity to understand our origins and our connections to the rest of nature.

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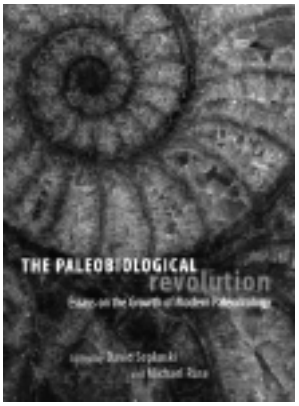
The Paleobiological Revolution: Essays on the Growth of Modern Paleontology

edited by David Sepkoski and Michael Ruse
Chicago: University of Chicago Press, 2009. 584 pages

Reviewed by Kevin Padian

For many years we have needed a collection of essays and historical reminiscences on just how the paleobiological revolution, or in another sense the emergence of macroevolution as a field, got started in the 1960s and 1970s. Looking back on the scientific literature of the time, and contrasting it to what came before, is much like looking at the cultural impact on a civilization when it is invaded (by Romans, Americans, or Visigoths — complete your own preferred metaphor). The world of paleontology changed completely because in addition to all the traditional kinds of study in taxonomy, stratigraphy, and so on, here was all this new theory that harnessed an incredible store of information and started asking questions about the major features of life and its environments through time. The chapters in this book remind us not only how far the field has come, but also how incredibly central it is to the study of any kind of evolution, even if most population biologists are oblivious to it. The world of evolutionary biology changed utterly as well, although most evolutionary biologists still do not realize it. This book is a masterpiece, brilliantly conceived and written, and it is essential to the conceptual training of every evolutionary biologist.



The editors are David Sepkoski and Michael Ruse, neither one a biologist or paleontologist. However, David, the son of Jack Sepkoski, clearly absorbed the developing *Zeitgeist* of the field as he grew up, and the collection of contributing authors is amazing. Not only that: the editors have generally gotten terrific (and usually concordant) historical accounts from the participants. But this is not a collection of "how I won the war" stories. The major participants who launched this field (some not realizing that they were doing so, others very consciously so) were responding to a broad common perception that the basic data of paleontology for too long had been considered incapable of contributing anything to evolutionary theory, and so remained the mere "handmaiden" to geology (in a frequently used phrase) that could only help the real scientists tell them what age their rocks were and who lived in them.

A "turning point" in the recent history of macroevolution as a field, and one on which several

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authors focus, is the brief essay in *Nature* in 1984 by the biologist John Maynard Smith. Maynard Smith had been at the now-legendary Macroevolution conference in Chicago in 1980, organized by Joel Cracraft and others, and although he never really understood very well all the things that were going on, he had begun to see the importance of the emergence of this young field. Famously, Maynard Smith remarked at the end of his paper, "Palaeontology has been too long absent from the high table. Welcome back." That was seen as vindication by many, as snobbism by others, but the interesting thing was that the paleobiologists had been setting their own table for years, and the fare was rather more interesting than what was at the "high table" of population theory and quantitative genetics.

Maynard Smith found punctuated equilibria, the *enfant terrible* of macroevolutionary theory, among the most promising new developments, although he changed his mind some years later (again, not really understanding the evidence or how to evaluate it) and wound up repeatedly vilifying Stephen Jay Gould in print, for reasons that must have been deeper than mere science. But macroevolution was far more than a reassessment of the tempo of morphological change through time, or even the mode of speciation as seen in the fossil record. It also featured the concerted efforts to understand the actual record of diversity through time and to separate it from various biases; the emergence of the study of extinction — background and mass; the development of the field of paleoecology as a quantitative, experimental, historical science; and the study of the relationship between paleontology's pattern data of evolution in the long run and population biology's process data of generational variability and change.

Sociologically and scientifically, it's interesting to see what has been included in this book and what has been left out. The strong emphasis on paleobiology at the University of Chicago is no accident: that school encompassed the quantitative revolution in the field, and its eponymous journal was begun there. Many of its major thinkers, including Ralph Johnson, Tom Schopf, later Dave Raup and Jack Sepkoski, and later Dave Jablonski, Sue Kidwell, and many others, made Chicago the Action Central of macroevolution (where else to hold the 1980 conference?).

Many contributors to this book detail the geographic currents of cross-fertilization through migrations of students and professors, productive meetings and conferences, and reviews of manuscripts. The emphasis, as a result, is almost entirely on invertebrate paleontology. And this actually explains the omissions. Oddly enough, there is almost no mention of phylogenetic systematics (cladistics), which revolutionized all of biology beginning in the 1970s. However, invertebrate paleontologists were slow to catch on, probably because they thought they could track evolution stratigraphically and did not need independent phylogenetic analysis of characters, and also because most of their critters' skeletons had far fewer characters to code than those of vertebrates. It took many years before invertebrate specialists moved beyond taxonomy to phylogeny, or used phylogenetic analysis to improve the understanding of missing diversity in their records.

There is in fact very little about fossil vertebrates, plants, or microorganisms in this book, even though specialists in each field contributed heavily to macroevolutionary questions. It is also puzzling why no assessment of Leigh Van Valen's work is included, inasmuch as his "Red Queen hypothesis" is truly one of the seminal papers of the last century, having influenced macroecology, game theory, sexual selection, extinction theory, and optimality theory. Nor was this his only influential paper. Van Valen, a long-time maverick in Chicago, is often perceived as a radical but is perhaps the most ultra-Darwinian of all evolutionary thinkers. Many have used his work without fully comprehending his compass, which is overdue for assessment.

But these omissions can be explained by a simple fact: the invertebrate folks have most of the best fossils. This gives us the most complete record of layer-by-layer change through time, often with exquisite preservation and copious samples amenable to statistical study as significant as can be done on living organisms (and with much more extensive temporal range). Vertebrate fossils are generally fewer, more poorly constrained stratigraphically, and liable to be scattered or distorted; fossil plants are generally preserved as isolated organs, not whole parts, and so their study has mostly focused on anatomy, morphology, and physiology of individual forms and sometimes communities. But both these fields have been able to do what most studies of invertebrates have not (or not as fully): document the origin and evolution of major adaptations of the major groups through time — another dimension largely omitted from the "official" paleobiological revolution, at least as recorded in these pages.

Stephen Jay Gould is so well known that he can serve as a pretty average example of why the material enables the questions. Gould saw the advantage of the methodological clarity of phylogenetics, but never used it much; he focused on morphological change in stratigraphic context, on morphological theory, and on extinction. He gave little thought to how major groups and major adaptations evolve (apart from the Cambrian Explosion, a subject for several authors here). He did not see how functional morphology could contribute much in the way of new theoretical insights for evolution, which is fair enough, but he also did not see how we could harness the study of functional evolution to phylogenetic trees to test hypotheses about major innovations. He was more interested in extinctions than originations, like most invertebrate paleontologists, and why not? After all, the geologic periods were originally recognized on the basis of invertebrate extinction events. This is not to criticize, but to provide some perspective on why certain questions are (can be) studied based on certain material, and others not. It is equally true that if we are interested in looking at the

origin of major adaptive change, we would not choose fruit flies.

There are so many wonderful papers in this book that it is hard to choose favorites, but for me different papers are favorites for different reasons. I will just name several in order of appearance. Patricia Princehouse provides one of the most nuanced and perceptive articles on the evolution and reception of punctuated equilibria ever written, replete with personal interviews that will sometimes surprise. I found myself saying continually, "yes, yes, that's exactly what happened," and more of this kind of insight is needed in the history of evolution. Manfred Laublicher and Karl Niklas provide an absolutely exquisite essay on the morphological tradition in German paleontology mostly during the Modern Synthesis, which helps to explain why so much of Europe and so many of the fields allied to it were left out, and why it was so difficult to get back in the game.

I really liked both of David Sepkoski's essays on the development of paleobiology and especially punctuated equilibria, although I would take issue with him on some interpretations of how "radical" these ideas were meant to be. He is coming out soon with his own book on the history of the field, which is greatly anticipated. Arnold Miller's contextual and detailed chronicle of the "Consensus Paper" on the shape of invertebrate diversity through time is a real masterpiece, putting everything into perspective and relying on his own experience with the players in question as well as their accounts. Dick Bambach's essay on his own personal journey from traditional paleoecologist to macroevolutionary theorist is one among many (and perhaps *primus inter pares*) frank, stimulating, perceptive, self-aware accounts that should inspire any graduate student in any field to learn how truly great scientists develop (other essays by Richard Fortey, Bill Schopf, Jim Valentine, and Tony Hallam also qualify). Rebecca German offers a trenchant and very useful first-hand commentary on the development of the field from her perspective as a student and colleague of many of the major players. And the *envoi* by David Jablonski on where paleobiology should go from here is about the best possible thing for a working paleontologist, as well as a beginning student, to read in order to learn from a true master where things stand and where the future can be.

The sole clinker in the book is Joe Cain's screed on Gould's alleged "ritual patricide" of George Gaylord Simpson, an act that Cain maintains was necessary in order for Gould's punctuated equilibrium to succeed and replace Simpson's pioneering work. Cain is allowed vituperative attacks without substantiation, including a table of Gould's alleged misdeeds with no references or citations at all. He completely misrepresents Gould's great respect for Simpson (Gould once called *Tempo and Mode in Evolution* "the closest thing to a one-man show" in the field), ignores Gould's knowing historiographic contextualization of Simpson's contributions (including the pressure Simpson faced to water down *Tempo and Mode*'s emphasis on quantum evolution, rewritten in *Major Features of Evolution*), and overlooks the universally accepted fact that the extrapolationist role to which Simpson's paleontology was confined by the Modern Synthesis gurus stalled out any possible theoretical contributions that paleontology could make to evolutionary theory. I did not know Simpson but I knew Gould well, and we discussed his respect for Simpson's contributions. This essay is character assassination, not scholarship, and the editors should be embarrassed for including it.

Apart from this, the essays in *The Paleobiological Revolution* should become standard reading for all evolutionary biologists, especially those in the field of paleontology, and the authors and editors should be justifiably proud of the first major treatment of the genesis and history of what has brought the whole field of evolution to a higher table.

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Errata

In Raymond A Eve's "Reflections on a visit to the Creation Museum" (*RNCSE* 2009 Sep/Oct; 29 [5]: 31–3), the reference on p 33 to Eve and others 2001 should have been to Eve and others 1995.

In Lorence G Collins's "Yes, Noah's Flood may have happened, but not over the whole earth" (*RNCSE* 2009 Sep/Oct; 29 [5]: 38–41), there were a number of copyediting errors. In column 3 of p 39, "30 km above sea level" should have read "30 m above level" and "the additional 360 to the Persian Gulf" should have read "the additional 360 km to the Persian Gulf"; in column 2 of p 40, "32 km miles wide" should have read "32 km wide"; and the first equation of the appendix, "$\sqrt{(2rh+h2)}$", should have read "$\sqrt{(2rh+h^2)}$."

Thanks to Lawrence S Lerner for noting both sets of errors.

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