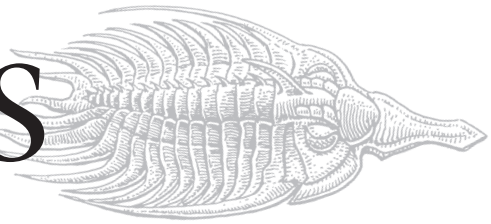
REPORTS OF THE NATIONAL CENTER FOR SCIENCE EDUCATION

DEFENDING THE TEACHING OF EVOLUTION IN THE PUBLIC SCHOOLS

Volume 25, Numbers 5–6 **SEP-DEC, 2005**

CONTINUES *NCSE REPORTS* & *CREATION/EVOLUTION*

CONTENTS



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VOLUME 25, NR 5–6, SEP–DEC 2005
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Cover: *Edmontosaurus annectens*, photographed by AJ Petto at the University of Wisconsin, Madison, Museum of Geology

FROM THE EDITOR

Anyone who has seen the remains of ancient organisms cannot help but be amazed at all the ways that life has appeared and changed in he course of the last several billion years. Perhaps nothing matches the awe that is produced by encountering the bones of giant reptiles, especially the large carnivores like *Tyrannosaurus rex*. These fossils are undeniable reminders of a world that was different in the past than it is now (we certainly are thankful for that), and so it is perhaps not surprising that anti-evolutionists invest so much energy in arguing that dinosaurs cannot be millions of years old, but only thousands. Indeed, dinosaurs figure prominently in the creationist museums of the Institute for Creation Research and Answers in Genesis.

Dinosaurs are a big draw in museums around the world, and in this issue, NCSE board member Robert "Mac"West reviews the "lay of the land" in natural history and general science museums. How well are museums seizing the opportunity to leverage the public's fascination with dinosaurs into a clear presentation of the evolutionary foundations of all our knowledge of these great reptiles? And how well do they transfer that knowledge to other exhibits and organisms? According to West, this can best be described as "an area for improvement". The record is spotty, and often the presentation tactfully avoids using the "e-word" even though all the information, conclusions, and interpretations are firmly based in evolution. Is this just a missed opportunity, or is it a careful response to public pressure?

It took less than a week after an article in *Science* by Mary Schweitzer and her colleagues on the recovery of some nonmineralized components of dinosaur bone before creationists were filling up internet venues with this "proof" that the earth must be young. Joe Skulan points out that some of the popular misunderstandings of fossilized remains may stem from the ways in which scientists write and talk about them. Regardless of the final verdict on the recovery of non-mineralized tissues from fossil remains, Skulan points out that we ought to be more careful about how we use the word "fossil" — or at least be clear on what we mean.

Another perennial argument by anti-evolutionists revolves around the Second Law of Thermodynamics. These arguments, of course, are not sound, but Steven Morris proposes a new rebuttal: he calculates how long it would take to provide enough energy from the sun to support the appearance of the current biomass of living things on the planet. Even with the radiation of much of this energy back out into space, the accumulation of the appropriate amount of energy occurs within a surprisingly short amount of time.

IN THE NEWS

It may be "over in Dover" but anti-evolutionism is not resting in other parts of the country. There was serious legislative action in Utah, as Glenn Branch reports, and bills in several other states, which have either been defeated or failed to progress to a vote. In Wisconsin, however, a legislator introduced a bill that will define science for the public schools in a way that will implicitly exclude "intelligent design" and other forms of creationism.

RECAPITULATIONS

Every so often, something we publishes draws a powerful response. This is the case with John C Greene's reflections on the Clarement Conference (in *RNCSE* 2004 Sep/Oct; 24 [5]: 34–7). NCSE member Sheldon Gottlieb objected strongly to some of Greene's conclusions and suggestions. Greene's reply is also included.

IN PRINT

Look to our book reviews section for assessments of a variety of interesting publications. Sonya Bahar reviews a book aimed at helping a general audience grasp the connection between thermodynamics and life. Tim Berra appreciatively reviews Mark Isaak's *The Counter-Creationism Handbook,* which also includes information on thermodynamics. Apparently, this is a topic that is difficult to explain well to non-specialists, as both books have shortcomings in this area, our reviewers report. And in a detailed review essay of *Icons of Evolution*, Matt Cartmill examines the chapter on human evolution, concluding, "In the final analysis, then, Wells's book is dishonest."

All this and more ... in this issue of *RNCSE*.

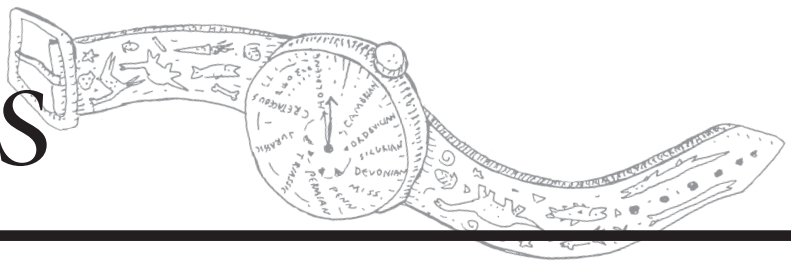
RNCSE 25 (5–6) was printed in May 2006.

ERRATA

A photograph on p 18 of *RNCSE* 2005 Jan–Apr; 25 (1–2) appeared without a caption. The picture is of NCSE's Wesley R Elsberry.

In Jason Wiles's "Is evolution Arkansas's 'hidden' curriculum?" (*RNCSE* 2005 Jan–Apr; 25 [1–2]), the reference to the age of Ordovician rocks (p 32) is incorrect: rocks from the Ordovician Period would be between 440 and 490 million years old, not 300 million years old.

NEWS



On, Wisconsin?

Andrew J Petto, University of Wisconsin, Milwaukee

GRANTSBURG

Over the past few months, the Badger State has seen a good deal of action in the creationism/evolution arena. Grantsburg is back in the news, as Superintendent Joni Burgin and School Bboard President David Ahlquist shared with other members of the Wisconsin School Board Association what they "learned" from its recent experiences with its beleaguered policy on teaching evolution (see *RNCSE* 2004 Nov/Dec; 24 [6]: 9–11).

The final text of the board's policy on teaching evolution read:

> Students are expected to analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information. Students shall be able to explain the scientific strengths and weaknesses of evolutionary theory. This policy does not call for the teaching of creationism or intelligent design.

A report in the *Burnett County Sentinel* (2006 Feb 1) made it clear that the board considers the policy a great success and a model for other boards to follow. President Ahlquist characterized the policy this way: "Our curriculum policy asks our science department to address Darwin's theory, but also address the controversy, especially over macro-evolution, and teach it critically." The article also reports that the school board has developed an implementation guide, but to date, the only document about how to implement the policy is a copy of a document reprinted without attribution from the Discovery Institute's website.

The *Sentinel* also reported that the school board distributed 25 copies each of *Icons of Evolution* and *How to Teach the Controversy over Darwin Legally*. Citizens in Grantsburg are looking into how the board acquired those resources. Parents are poised to challenge inappropriate materials in the science classroom, but so far, none has been introduced into the life sciences classroom, despite Ahlquist's assurance to the *Sentinel* that "Grantsburg is in the first year of teaching evolution critically."

WEST BEND

Two parents presented the West Bend School District with an official complaint about the textbooks being used for college-prep and Advanced Placement biology classes. On February 6, 2006, the parents made a presentation to an special committee consisting of library specialists, the assistant superintendent of curriculum and instruction, the science supervisor, biology teachers, the superintendent of schools, and two members of the University of Wisconsin faculty. The parents also requested a presentation by David Menton, who billed himself as a retired cell biologist and faculty member from Washington University Medical School, but who did not mention that he was in Wisconsin on a tour sponsored in part by Answers in Genesis (<http://abide-in-truth-events.cephasministry.com/answers_in_genesis.html>).

The parents said they wanted evolution taught "critically" and presented a stack of articles from the research literature with lots of highlighting to show how often and severely scientists themselves were critical of evolutionary theory, presumably as an indication that this information should somehow find its way into the curriculum. The materials included the usual random collection of cutting-edge research and unsettled questions. As is generally the case, however, none of the articles challenged the big picture of evolution as a history of life on earth traced through patterns of descent from common ancestry. Nor would they require any significant change in the material taught at the high school level, except to point out that some of these ideas were still under investigation. Indeed, the three texts that were being challenged included language that did indicate areas of unsettled research and unanswered questions.

Menton's presentation was wide-ranging. His main approach in arguing that the books ought to be replaced seemed to be to point out items in the texts that he contended were erroneous. However, he made several errors in his presentation. For example, he said that a presentation on Robert Bakker's work on the histology of dinosaur bones erred in its conclusions that the pattern demonstrated that dinosaurs were warm-blooded. However, the material in the text was an illustration of the hypotheticodeductive method of scientific investigation, which Menton dismissed with personal incredulity: "I don't know how you could develop a hypothesis to test *that*!" Indeed, that was his response to a number of the examples in the text, which were usually making a different point than the one he was criticizing.

Menton's main rhetorical srategy seemed to be an argument from authority. He invoked his years of teaching at Washington University

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Medical School to say that he never used any aspect of evolution to do his work and neither did any of the physicians he has ever queried. In fact, he put up a slide of Dobzhansky's famous "in light of evolution" quote and declared flatly that there was absolutely no need to know any evolution in order to "do" biology. By the same token, it is probably unnecessary to know any computer science to send e-mail, but without computer science, the computer would be just a pile of electronic parts.

What the parents (and Menton) wanted was for the teachers and the school to *criticize* evolutionary theory as less robust and well-supported than its presentation in the textbooks indicates. According to science supervisor Paul DeChant, there are several opportunities in the text where the authors provide "challenge questions" that allow the students to apply a critical analysis to specific questions in evolution (and other topics) and to their answers. The committee chose not to engage the presenters in debate and not to make statements, except to answer questions of fact from the presenters about the contents of the course. The committee reached its final decision on February 20, 2006, that changes in text and curriculum were unwarranted.

Legislative action

In what seemed like a culminating event, State Representative Therese Berceau (D–Madison) ventured into the controversy by introducing a bill to support teaching evolution in public schools. She was appalled by Wisconsin's low grade for its science education standards and by moves such as the one by the Grantsburg School Board. The bill was co-sponsored by Representative Spencer Black (D–Madison) and introduced at a press conference in the morning of February 7, 2006, with the support of over a dozen faculty and research staff from the University of Wisconsin, Madison.

At the press conference, Berceau read the text of the short bill (see sidebar) that, if enacted, would limit the content of the science curriculum to testable hypotheses and natural phenomena and would require that the state agencies and public schools use a definition of science formulated by the National Academy of Sciences. In her prepared remarks, she identified the weakening of science education as one of the main problems faced by science education in a time when the nation and the state are ever more dependent on the scientific advances that scientific research provides. She characterized the current "controversy" over evolution and scientific naturalism as "invented" and not existing within science. Finally, she pointed the irony of President Bush's recent call at the nearby 3M Company's corporate headquarters for leading the world in research and development and staying on the cutting edge of technology in light of his recent embrace of "intelligent design" and teaching "all views" in the public-school classroom. Berceau concluded by justifying the use of a statute because it would provide a legal obligation for school districts, as well as a legal remedy for aggrieved parents, to assure that only real science was taught in the science classroom.

Biochemistry professor Michael Cox cited the connection between economic well-being and scientific research. He pointed out that the concentration of scientific and biomedical research companies in Boston, San Francisco, and Madison is not accidental. Not only does good science education provide researchers for these endeavors, it also provides a well-trained work force, bringing economic benefits to the community. Without such support for science education, he suggested, these benefits might easily migrate out of state.

Biochemistry professor Alan Attie followed Cox's lead by pointing out that inventions based on scientific research conducted at the UW Madison campus have generated a $1.5-billion–dollar endowment for the university, over $800 000 per year in research grants, and 100 spin-off companies. Compare this to the record for the past 200 years of "intelligent design", said Cox, and the choice is obvious. There is not one patent, not one invention, not one discovery, not even any original research articles generated by ID; it is a sterile field.

Philosopher of science Elliott Sober agreed, "If [ID] is science, then scientists can stop doing research and just proclaim that what we observe is there because an intelligent designer wanted it to be." In his remarks, he said that the bill addresses an important issue that public education faces.

Berceau's bill (AB 1143) now goes through the regular legislative process. She is hoping for a lively debate that draws attention to the real issues for science education. Prospects of the bill's passage in the heavily Republican legislature are dubious.

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Science Education Bill (AB 1143) Introduced in the Wisconsin Legislature

AN ACT to create 118.018 of the statutes; relating to: science instruction in public schools.

The people of the state of Wisconsin, represented in senate and assembly, do enact as follows:

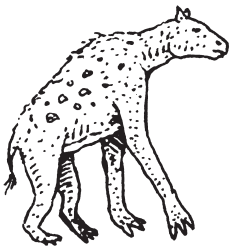
SECTION 1. 118.018 of the statutes is created to read:

> 118.018 Science instruction. The school board shall ensure that any material presented as science within the school curriculum complies with all of the following:
>
> (1) The material is testable as a scientific hypothesis and describes only natural processes.
>
> (2) The material is consistent with any description or definition of science adopted by the National Academy of Sciences.

Anti-Evolution Legislation in Utah

Glenn Branch
NCSE Deputy Director

Senate Bill 96, sponsored by Senator Chris Buttars (R–District 10), was filed in the Utah Senate on January 4, 2006. As introduced, SB 96 would have, if enacted, directed the Utah State Board of Education to require "that instruction to students on any theory regarding the origins of life, or the origins or present state of the human race, shall stress that not all scientists agree on which theory is correct" and to "ensure that all policies and positions of the State Board of Education relating to theories regarding the origins of life or the origins or present state of the human race: (i) do not endorse a particular theory; and (ii) stress that not all scientists agree on which theory is correct."



As previously reported in *RNCSE* (2005 May–Aug; 25 [3–4]: 8–11), SB 96 is the culmination of about six months' worth of public anti-evolution statements by Buttars, beginning with his announcement of plans to introduce legislation calling for the teaching of "divine design" — "Divine design," he told the *Salt Lake Tribune* (2005 Jun 3), "doesn't preach religion ...The only people who will be upset about this are atheists." Perhaps in reaction, the Utah state Board of Education unanimously adopted a position statement on September 2, 2005, that described evolution as "a major unifying concept in science and appropriately included in Utah's K-12 Science Core Curriculum"; the policy statement presumably would have been rescinded if SB 96 had been enacted.

SB 96 was approved by the Senate Education Committee by a 4–2 vote along party lines on January 17, 2006. According to the *Salt Lake Tribune* (2006 Jan 18), Buttars defended the bill during the committee hearing by saying, "There is no consensus on the origins of life or how man became as he is today ... 'All the bill states is 'Don't overstate what you know.'" The extent of Buttars's own knowledge is suggested by his description, also reported in the *Tribune*, of the absence of transitional forms: "There is evolution within species ...There are big dogs and little dogs, big cats and little cats, but you haven't seen a 'dat.' You don't see intermediate species." Brett Moulding, the state's core curriculum director, reportedly cited the well-documented bird–reptile transition by way of counterexample.

SB 96's supporters on the committee insisted that, despite Buttars's prior statements about his intent in introducing such legislation, the bill was not intended to promote a particular religious view and would not "force any other theory to be introduced," according to a detailed account of the committee hearing that appeared in the *Tooele Transcript-Bulletin* (2006 Jan 19). Brett Moulding noted that if so, the bill was unnecessary, since "the core curriculum understands that science conclusions are tentative and therefore never final ... They're always subject to revision with new evidence." But if the bill were to require the presentation of a scientifically credible alternative to evolution, he said, "I cannot think of one."

The editorial reaction of the S*alt Lake Tribune* (2006 Jan 18) to the vote was unsparing. Referring to Buttars's discussion of evolution, the editorial commented, "every

THE ACLU OF UTAH ON SB 96

[*The following letter was dated January 19, 2006, and is reprinted by permission.*]

Dear Senator,

I write on behalf of the American Civil Liberties Union of Utah to express our concerns regarding the constitutionality of Senate Bill 96 "Public Education — Instruction and Policy Relating to the Origins of Life," and to urge you to vote against the bill.

SB 96 is the latest in a series of anti-evolution statutes and policies that have attempted to forbid, limit, or otherwise undermine the teaching of the scientific theory of evolution in public schools. Challenges to evolution have included laws or policies that prohibit the teaching of evolution; that require the presentation of anti-evolutionary views, including religious views not based on scientific evidence, such as creationism or intelligent design; and that, like SB 96, require statements or disclaimers questioning the validity of the scientific theory of evolution.

Courts have reviewed all of the above strategies and consistently ruled against them. Attached is an excellent summary of four major court decisions regarding the constitutionality of anti-evolution statutes and policies, which was prepared by the National Center for Science Education. All of the laws or policies in question were found to violate the Establishment Clause of the First Amendment of the United States Constitution, because they all had the purpose of furthering a religious doctrine or protecting that doctrine from a seemingly competing theory.

The two most recent cases regarding the teaching of evolution are not included in the attached list, and they deserve special attention because of their relevance to SB 96. The first is *Selman v Cobb County School District*. In January 2005, a federal court ordered a Georgia school district to remove stickers from school science textbooks that warned that evolution is "a theory, not a fact," because those stickers were an unconstitutional government intrusion on religious liberty. *Selman* is currently on appeal. The second case, decided just last month, is *Kitzmiller v Dover Area School District*. In that case, a federal court found that a Dover, Pennsylvania school district policy requiring that high school science teachers read a statement questioning the scientific theory of evolution and presenting "intelligent design" as an alternative was an unconstitutional endorsement of religion.

Both the *Selman* and *Kitzmiller* courts noted the sectarian motivation behind the school districts' selection of one, and only one, scientific area for particular scrutiny. In both cases, district officials ignored areas of science where there is more controversy than evolution, and instead chose the one scientific theory that has long been a target of

time the West Jordan Republican opens his mouth to address the subject, he removes all doubt about the fact that he has absolutely no idea what he's talking about," adding, "Senate Bill 96 would probably be the first article, section or clause in our state statute book that is a downright lie." Noting that Governor Jon Huntsman Jr (R) hopes to improve science and mathematics education in the state, the editorial concluded by suggesting that "[t]he governor should have his veto pen at the ready for this one."

Meanwhile, the ACLU of Utah was not idle, sending a letter (see p 6) to members of the state senate urging that they vote against SB 96. The letter cited applicable case law, including *Selman v Cobb County* and *Kitzmiller v Dover*; in both of these recent cases, the letter explained, the court "noted the sectarian motivation behind the school districts' selection of one, and only one, scientific area for particular scrutiny," just as in SB 96. Concluding, the ACLU of Utah urged the Senate to "take note of the current legal landscape regarding the constitutionality of statutes and policies like SB 96, and ... not [to] risk an expensive and unnecessary lawsuit by passing the bill."

Similarly, in a letter dated January 19, 2006, Americans United for Separation of Church and State urged Utah senators to oppose SB 96. American United's letter argues, "Although SB 96 does not mention 'intelligent design' or creationism by name, there is no doubt that the bill ... comes out of religiously motivated opposition to the scientific theory of evolution," adding, "we have no doubt that if this statute were challenged, it would be found unconstitutional." The letter concludes, "Undermining evolution is not only detrimental to the science education of our children, but is also unconstitutional. We urge you to vote against SB 96, and to support science education and religious liberty."

A story in the *Deseret Morning News* (2006 Jan 19) provided useful background on the variety of religious attitudes toward evolution, especially within the Mormon church, to which a majority of Utahns belong. Highlighted was *Mormonism and Evolution: The Authoritative LDS Statements (*Draper [UT]: Greg Kofford Books, 2005*)*, a compilation of statements issued or sanctioned by the First Presidency of the Church of Jesus Christ of Latter-Day Saints from 1909 to 2004, edited by two Utah science professors, William E Evenson and Duane E Jeffery. Jeffery told the *Morning News*, "There has been a belief, for years and years and years, that Mormonism and evolution are diametrically opposed," a belief that the book seeks to dispel.

Jeffery, a professor of biology at Brigham Young University and a member of NCSE's board of directors, helped to coordinate the efforts to educate elected officials and the public at large about the scientific standing of evolution, as well as to support those in the state's educational organizations, such as Brett Moulding, who opposed the bill. The controversy, unprecedented in Utah, also provoked scientists to act. For example, Greg Clark, a professor of bioengineering at the University of Utah, told *Stanford Medicine* (2006 Summer; 26 [2]), "[T]his was an attack on science itself ... As a scientist, educator and the father of a middle-schooler, I felt a moral obligation to speak out" — which he did, testifying before the state board of education and the Utah Senate.

religiously-motivated hostility. SB 96 suffers from this same defect.

Additionally, by singling out evolution for particular scrutiny and by playing on the common, non-scientific understanding of the term "theory," the courts found that the district policies misled students about the scientific support for evolutionary theory and the workings of the scientific method. It is likely that a court would similarly find that SB 96 unconstitutionally interferes with scientific instruction for ideological, rather than scientific, reasons.

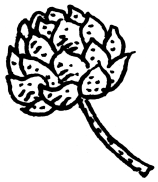
Often, disclaimer policies require or suggest the teaching of non-scientific religious theories, such as "intelligent design" or creationism, and SB 96 may also be read to require the teaching of similar alternative theories regarding the origins of life. But even if the bill does not have this requirement, that does not save it from Establishment Clause problems. The unconstitutional sticker that the Cobb County School District was required to remove from science textbooks contained a statement much like SB 96. It stated:

> This textbook contains material on evolution. Evolution is a theory, not a fact, regarding the origin of living things. This material should be approached with an open mind, studied carefully, and critically considered.

Similarly, SB 96 encourages students to "critically analyze theories," to "consider opposing viewpoints," and to "form their own opinions." It is important to note that neither SB 96 nor the Cobb County sticker mention alternative theories. In its decision, the *Selman* court noted:

> Defendants persuasively argue that the Sticker in this case does not explicitly reference any alternative theory of origin, religious or otherwise. Nor does the Sticker explicitly urge students to consider alternative theories of origin or remind them that they have the right to maintain their home teachings regarding the origin of life. Nevertheless, the Sticker here disavows the endorsement of evolution, a scientific theory, and contains an implicit religious message … which is discernible after one considers the historical context of the statement that evolution is a theory but not a fact.

Americans have the right to believe, practice, and profess their religious beliefs in the public square, and the ACLU defends those rights. However, the government should not accommodate those religious beliefs by misleading public school students about the scientific basis for evolutionary theory. We sincerely hope the Utah State Senate will take note of the current legal landscape regarding the constitutionality of statutes and policies like SB 96, and will not risk an expensive and unnecessary lawsuit by passing the bill.



Despite the outpouring of concern about SB 96, the bill was passed by the Senate on January 23, 2006, by a 16–12 vote. The version of the bill that was passed would have directed the Utah State Board of Education to require "that *if* instruction is *given* to students on any theory regarding the origins of life, or the origins or present state of the human race, *then that instruction* shall stress that not all scientists agree on which theory is correct" and to "ensure that all policies and positions of the State Board of Education relating to theories regarding the origins of life or the origins or present state of the human race: (i) do not endorse a particular theory; and (ii) stress that not all scientists agree on which *scientific* theory is correct." (The emphasized phrases were added by a floor amendment during the Senate's debate.) The bill was subsequently introduced in the House of Representatives on January 24 and referred to its Committee on Education on January 31.

The *Salt Lake Tribune* (2006 Jan 21) reported that despite Buttars's attempts to eliminate SB 96's allowing religious advocacy in the classroom, "religion is the reason he proposed the bill and religion drove most of the debate," adding, "Comments on the Senate floor commending God's creation of man and condemning atheists for pushing their 'religion,' could potentially end up as evidence in court should the bill become law." Senate Majority Leader Peter Knudson (R–District 17) reportedly objected to comments by Buttars that opposition to the bill is driven by "secularists and atheists" and explained that it is possible for religious people to accept evolution. "I will tell you that is not the spirit by which we should be debating this legislation," Knudson said.

In its January 24, 2006, editorial "Not fit to survive: A bad bill was made even worse," the *Salt Lake Tribune* objected especially to the addition of "scientific" in the bill, writing, "By adding the word 'scientific' at critical points, the bill stopped saying that there were other ideas about the origins and development of life on earth and started saying that there were other 'scientific' ways of explaining those things. There are not. There are religious, philosophical and mythical alternatives to evolution, none of them in conflict with scientific thinking unless someone is stubborn enough to demand a fight to the death where none need exist." And the *Provo Daily Herald* (2006 Jan 24) commented, "Buttars and his Senate colleagues want to push creationism into the public school curriculum. In truth, this is an attempt to insert a state-endorsed brand of religion into secular life."

The bill was in the national spotlight thanks to a story published in *The New York Times* (2006 Feb 5). Kirk Johnson reported that although in Utah, "about 90 percent of the elected officials are members of the Church of Jesus Christ of Latter-day Saints. Prayers are commonplace, and lawmakers speak of their relationship with God in ordinary conversation," support for the bill was questionable. "Some leaders in both parties" — including the Senate majority leader and the majority and minority whips in the House — "have announced their opposition to the bill," Johnson wrote, "and most lawmakers say that with less than a month left in the legislative session, its fate remains a tossup."

A commendable feature of Johnson's story was its insistence on reporting the scientific consensus properly. After quoting Buttars as saying, "I got tired of people calling me and saying, 'Why is my kid coming home from high school and saying his biology teacher told him he evolved from a chimpanzee?'" Johnson noted, "Evolutionary theory does not say that humans evolved from chimpanzees or from any existing species, but rather that common ancestors gave rise to multiple species and that natural selection — in which the creatures best adapted to an environment pass their genes to the next generation — was the means by which divergence occurred over time. All modern biology is based on the theory, and within the scientific community, at least, there is no controversy about it."

Part of the reason for the resistance to SB 96, Johnson speculated, is due to the distinctive nature of Mormon theology: "Mormonism, with its emphasis that all beings can progress toward higher planes of existence, before and after death, has an almost built-in receptivity toward evolutionary thought that other religions might lack." Also relevant, according to Kirk Jowers, a professor of political science at the University of Utah, is the minority status of Mormonism in the nation. In the case of school prayer, he told the *Times*, there was "kind of a realization that if you push to have prayer in school, then outside of Utah, the prayer would not typically be a Mormon's prayer, so is that road you want [to] go down?"

Meanwhile, in the House Committee on Education, SB 96 was undergoing further revision. In particular, the directive to the state board of education to emphasize the disagreement among scientists with regard to "any theory regarding the origins of life, or the origins and present state of the human race" was replaced with a directive to "stress that no scientific theory, hypothesis, or instruction regarding the origins of life or the origins of species has been indisputably proven." The new revision of the bill was narrowly passed by the committee on February 8, 2006, and returned to the House.

In the House, however, the bill was promptly gutted. On February 27, 2006, Representative Stephen Urquhart (R–District 75) amended the bill's text, leaving only "The State Board of Education shall establish curriculum requirements related to scientific instruction." The gutted bill was then defeated "to stop the Senate from having the ability to revive the issue," or so the *Salt Lake Tribune* (2006 Feb 27) explained. Buttars told the *Tribune* that it was "doubtful" that he would propose a similar bill in the future. Joe Conn of Americans United for Separation for Church and State rejoiced, telling *The New York Times* (2006 Feb 28), "If the creationists can't win in a state as conservative as Utah, they've got an uphill battle." And the *Salt Lake City Weekly* (2006 Mar 2) quipped, "We're not in Kansas anymore. At least not this year."

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UPDATES

Alabama: On January 10, 2005, two identical bills — House Bill 106 and Senate Bill 45 — were introduced in the Alabama legislature, under the rubric of "The Academic Freedom Act," and referred to the Committees on Education of their respective chambers. These identical bills purport to protect the right of teachers to "present scientific information pertaining to the full range of scientific views in any curricula or course of learning" and the right of students not to be "penalized in any way because he or she may subscribe to a particular position on any views." In language reminiscent of the so-called Santorum Amendment removed from the No Child Left Behind Act, they specify that "[t]he rights and privileges contained in this act apply when topics are taught that may generate controversy, such as biological or chemical origins." Presumably attempting to avert the charge that their provisions would violate the Establishment Clause of the First Amendment, the bills also provide, "[N]othing in this act shall be construed as promoting any religious doctrine, promoting discrimination for or against a particular set of religious beliefs, or promoting discrimination for or against religion or non-religion."

HB 106 and SB 45 closely resemble previous anti-evolution bills — three bills introduced in 2005 (HB 352, SB 240, and HB 716) and two bills introduced in 2004 (HB 391 and SB 336) — all of which failed. SB 45's sponsor, Senator Wendell Mitchell (D–District 30), was a cosponsor of SB 240 and SB 336, of which he reportedly said, "I think there is a tremendous ill-balance in the classroom when you can't discuss all viewpoints. This bill will level the playing field because it allows a teacher to bring forward the biblical creation story of humankind" (*Montgomery Advertiser*, 2004 Feb 18). HB 106's sponsor, Representative Scott Beason (R–District 51), was the sole sponsor of HB 716. New to HB 106 and SB 45 is section 7:

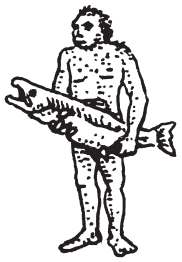
> Nothing in this act shall be construed as protecting as scientific any view that lacks published empirical or observational support or that has been soundly refuted by empirical or observational science in published scientific debate. Likewise, the protection provided by this act shall not be restricted by any metaphysical or religious implications of a view, so long as the views are defensible from and justified by empirical science and observation of the natural world.

Indiana: Anti-evolution legislation materialized in Indiana, but not in the form originally threatened by its sponsor (see *RNCSE* 2005 May–Aug; 25 [3–4]: 15–7). According to the *Indianapolis Star* (2006 Jan 11), Representative Bruce A Borders (R–Jasonville) introduced House Bill 1388 in the Indiana House of Representatives on January 10, 2006. Although Borders was quoted in the *Star* (2005 Nov 2) as describing himself as "passionate" about "intelligent design" and declaring his intention to submit a bill making it a required subject in Indiana's public schools, HB 1388, if enacted, would only mandate that "[i]n adopting textbooks for each subject ... the state board shall not adopt a textbook if the state board knows the textbook contains information, descriptions, conclusions, or pictures that are false."

The target of the bill is clearly the treatment of evolution in textbooks; Borders was quoted by the *Star* as saying, "Many of the things that have been used to support macroevolution have been proven to be lies. ... It will take those out." Borders also acknowledged to the *Star* that his change in strategy was due to the December 2005 decision in *Kitzmiller v Dover*, which held that it is unconstitutional to teach "intelligent design" in the public schools." NCSE Deputy Director Glenn Branch commented that the fallback strategy of deprecating evolution "is increasingly going to dominate the creationism–evolution landscape" following the *Kitzmiller* decision.

Fran Quigley of the Indiana Civil Liberties Union told the *Star*, "I can't imagine that the state board [of education] needs to be told by the General Assembly not to give false information to our schoolchildren." Obviously aware of Borders's purpose in introducing HB 1388, however, he added, "If this is an effort to run evolution out of the science curriculum, it fails to account for the fact that the scientific theory of evolution has been corroborated by hundreds of thousands of independent observations ... No persuasive evidence has been put forth in 150 years to contradict the theory of evolution." House Speaker Brian C Bosma (R–Indianapolis), who was previously enthusiastic about "intelligent design" legislation, downplayed the legislature's current interest, and Representative Jerry Denbo (D–French Lick), who drafted a bill of his own that would allow teaching "intelligent design", decided not to introduce it: "There's no hope," he told the *Star*.

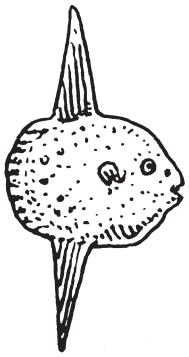
Michigan: House Bill 5606 was introduced in the Michigan House of Representatives on January 24, 2006, and referred to the Committee on Education, chaired by the bill's primary sponsor, Brian Palmer (R–District 36). If enacted, HB 5606 would amend the state's school code in a number of ways, including requiring the Michigan Department of Education to adopt course content expectations for science that "include using the scientific method to critically evaluate scientific theories and using relevant scientific data to assess the validity of those theories and formulate arguments for and against those theories."



Although evolution is not mentioned in HB 5606, its language about using "the scientific method to critically evaluate scientific theories" and using "relevant scientific data to assess the validity of those theories and to formulate arguments for or against those theories"

is taken verbatim from HB 5251, which specifically targets "the theories of global warming and evolution" (see *RNCSE* 2005 May–Aug; 25 [3–4]: 8–11). Palmer was a cosponsor of HB 5251, as well as of 2003's HB 4946, which would have amended the state science standards to refer to "the theory that life is the result of the purposeful, intelligent design of a Creator."

Palmer was reported by the *Detroit Free Press* (2006 Jan 28) as disclaiming any intention to raise the issue of "intelligent design": "I think some people like to see a bogeyman," he said. But the primary sponsor of HB 5251, Representative John Moolenaar, regarded it as relevant; the *Free Press* reported that in his view, "Palmer's [bill] does not require the teaching of intelligent design, but ... such a decision would be up to local school boards. He said Darwin's theory of evolution is under legitimate scrutiny, and that science students should know about the theory's possible weaknesses."



The Michigan educational community was reportedly unhappy with the bill. Margaret Trimer Hartley, spokeswoman for the Michigan Education Association, the state's largest teacher's union, told the *Free Press*, "We don't need to further complicate the process by bringing in the argument of intelligent design or any other battle over specific curriculum." Kathleen Booher, the executive director of the Tri-County Alliance, representing school districts in three counties, objected to the legislative attempt to micromanage curriculum: "They're stepping out of their expertise when they're doing that," Booher said.

Minnesota, Minnetonka: A proposal to revise the Minnetonka school district's guidelines regarding evolution failed on December 15, 2005. (Minnetonka is a suburb of Minneapolis, with a population of about 50 000 people.) "Intelligent design" was a hot topic during the last election for school board, according to the *Minneapolis Star Tribune* (2005 Dec 6). The chief voice for "intelligent design" on the board was Dave Eaton, who was involved in efforts to undermine the teaching of evolution in the Minnesota state science standards (see *RNCSE* 2004 Mar/Apr; 24 [2]: 14–7 and 2003 May–Aug; 23 [3–4]: 5–10) and who visited Grantsburg, Wisconsin, in November 2004 to lobby the school board there (see *RNCSE* 2004 Nov/Dec; 24 [6]: 9–11, 11–2).

According to the *Star Tribune*, "Eaton said the existing Minnetonka guidelines regarding evolution contain 'careful wordsmithing' to create the impression that evolution has been established as fact. He said the district's science curriculum must get away from dogmatically teaching the theory as fact." Among the guidelines to which he took objection was "Students will understand that the great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms." Eaton sought to revise the guideline to remove the suggestion that the diversity of life is indeed due to evolution.

At the December 15 meeting of the board, according to the *Star Tribune* (2005 Dec 16), Eaton explained that the guideline "goes too far" and claimed that the new state science standards require that students learn that evolution is "a theory, not a fact." Nevertheless, his proposal to revise the guideline was rejected by a 4–2 vote; Bill Wenmark joined Eaton.

TonkaFocus, a local group concerned with education in the Minnetonka public schools, was credited with warning the board that adopting Eaton's proposal might result in a lawsuit; information on the controversy in Minnetonka is available on the TonkaFocus website <http://www.tonkafocus.org/>.

Mississippi: Two anti-evolution bills were introduced in the Mississippi legislature in January 2005. Senate Bill 2427, introduced in the Mississippi Senate and referred to the Committee on Education on January 10, 2005, would have, if enacted, ensured that "[n]o local school board, school superintendent or school principal shall prohibit a public school classroom teacher from discussing and answering questions from individual students on the issue of flaws or problems which may exist in Charles Darwin's Theory of Evolution and the existence of other theories of evolution, including, but not limited to, the Intelligent Design explanation of the origin of life." The chief sponsor of SB 2427 was Senator Charles Edwin Ross (R–District 20). Co-sponsors were Senators Patrick Alan Nunnelee (R–District 6) and William Gardner Hewes III (R–District 49). SB 2427 died in committee on February 28, 2006.

House Bill 953, introduced in the Mississippi House of Representatives and referred to the Committee on Education on January 16, 2005, would have, if enacted, enabled Mississippi school boards "[t]o authorize the teaching of 'creationism' or 'intelligent design' in the public schools." Moreover, "[i]f the school's curriculum requires the teaching of evolution, then the teaching of 'creationism' or 'intelligent design' shall be required." The chief sponsor of HB 953 was Representative Mike Lott (R–District 104); the cosponsors were Representatives Virginia Carlton (R–District 100), John L Moore (R–District 60), Gary V Staples (R–District 88), and Carmel Wells-Smith (R–District 111). Wells-Smith introduced anti-evolution legislation in previous legislative sessions: HB 888 and 1101 in 2002, HB 1397 in 2003, and HB 1288 in 2004. HB 953 died in committee on January 31, 2006.

Missouri: House Bill 1266 was introduced in the Missouri House of Representatives on January 9, 2006. Dubbed the Missouri Science Education Act, HB 1266 would, if enacted, require public school science teachers in grades 6 through 12 to comply with a list of "best practices" in order "to support the truthful identity of scientific information and minimize misrepresentation while promoting clarity, accuracy, and student understanding" and "to support the objective teaching of scientific information and minimize dogmatism while promoting student inquiry, healthy skepticism, and understanding." The only topic explicitly identified as in need of such revisions is evolution; the bill provides that "If a theory or hypothesis of biological origins is

taught, a critical analysis of such theory or hypothesis shall be taught in a substantive amount." The sponsor of HB 1266 is Representative Robert Wayne Cooper (R–District 155), who in 2003 introduced two bills calling for "intelligent design" to be taught in the Missouri public schools. HB 911 would have required that "[i]f scientific theory concerning biological origin is taught, biological evolution and biological intelligent design shall be taught and given equal treatment"; it also contained a provision that would have terminated the employment of teachers and administrators who failed to accord with the bill's dictates. HB 1722 would also have required "the equal treatment of science instruction regarding evolution and intelligent design". Both of these previous bills died in May 2004, when the legislative session ended.

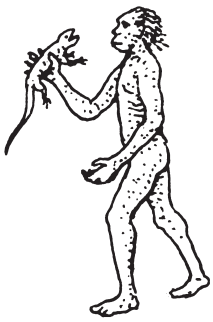
New Jersey, Princeton: Delivering the George Romanes lecture at Oxford University on December 1, 2005, Shirley Tilghman, the president of Princeton University, discussed "intelligent design" as a case study "of the dangers that arise when science, politics and religion find themselves at cross-purposes on issues of importance to the future." A distinguished molecular biologist and a member of the National Academy of Sciences, Tilghman observed, "It is virtually impossible to conduct biological research and not be struck by the power of Darwin's theory of natural selection to shed light on the problem at hand. Time and again in the course of my career, I have encountered a mysterious finding that was explained by viewing it through the lens of evolutionary biology." Yet, she added, "under the banner of 'intelligent design,' Christian fundamentalists in the United States have launched a well-publicized assault on the theory of evolution."

After reviewing and criticizing the central claims of "intelligent design", she said, "There is considerable disagreement within the scientific community regarding the best way to respond to this assault on evolution. One view is to dismiss or trivialize it by pointing out, for example, that everything we know about the human knee would suggest that no intelligent being could possibly have designed it. Another faction argues that the scientific community should ignore the opponents of evolution, for by engaging in the public debate over creationism, one inevitably lends credence to its premises." "The third strategy," she continued, "is to enter the public debate on the side of science and evolution, and to do so firmly but respectfully." She expressed her preference for the third strategy, citing Brown University biologist (and NCSE Supporter) Kenneth R Miller as one of its practitioners.

Her lecture, entitled "Strange bedfellows: Science, politics and religion," is available on-line at <http://www.princeton.edu/president/speeches/20051201/index.xml>. Tilghman is not the only university president publicly to criticize creationism recently: Timothy P White of the University of Idaho (see *RNCSE* 2005 Jan–Apr; 25 [1–2]: 15–7) and Hunter R Rawlings III of Cornell University (see below) have also done so.

New York, Ithaca: Hunter R Rawlings III, the interim president of Cornell University, devoted the bulk of his State of the University speech to addressing "the challenge to science posed by religiously-based opposition to evolution, described, in its current form, as 'intelligent design.'" In his speech (delivered on October 21, 2005; available on-line at <http://www.cornell.edu/president/announcement_2005_1021.cfm>), Rawling accurately and incisively reviewed a number of historical and current controversies over evolution education, calling on universities like Cornell to become engaged: "With a breadth of expertise that embraces the humanities and the social sciences as well as science and technology, we need to be engaging issues like evolution and 'intelligent design' both *internally*, in the classroom, in the residential houses, and in campus-wide debates, and also *externally* by making our voices heard in the spheres of public policy and politics" (emphasis in original). His speech was greeted with a standing ovation, according to the *Cornell University Chronicle* (2005 Oct 21), and received wide press coverage, including in *The New York Times* (2005 Oct 22). Rawlings, a classicist, served as president of Cornell from 1995 to 2003, and is now serving again while a replacement for his successor, Jeffrey S Lehman, is sought. (Interestingly, Lehman was also involved with the creationism/evolution controversy: as a lawyer with Caplin & Drysdale, he prepared a friend-of-the-court brief in *Edwards v Aguillard* on behalf of 72 Nobel laureates and 17 state academies of science.) Rawlings is not the only university president publicly to criticize creationism recently: Timothy P White of the University of Idaho (see *RNCSE* 2005 Jan–Apr; 25 [1–2]: 15–7) and Shirley Tilghman of Princeton University (see above) have as well.

North Dakota: Debate over "intelligent design" is unwelcome in North Dakota — at least in the high school debate competitions. According to *The Forum* of Fargo, North Dakota (2005 Dec 28), the North Dakota High School Activities Association decided that the topic of whether "intelligent design" ought to be taught in the public schools, recommended by the National Forensic League as a debate topic for January 2006, was too controversial. Robert Hetler of the NDHSAA explained, "We're doing this because we don't want to exclude any students from public forum debate at state," adding, "Some schools were afraid parents wouldn't allow their kids to do this one." The executive secretary of the National Forensic League took the decision in stride, commenting, "It's up to the states to determine what's in the best interest of their students." Hetler told the *Forum* that about five of the fifteen high schools in the state with debate teams expressed concerns about the topic; a number of debate coaches were quoted in the article, expressing various opinions of the NDHSAA's decision. North Dakota's debaters will use the recommended debate topic for February instead. A subsequent editorial in *The Forum* (2005 Dec



30) decried the NDHSAA's decision as "a mushy heap of political correctness" and commented that as a debate topic, "intelligent design" "has it all: powerful conflicting ideas, political implications, religious elements and articulate advocates on both sides."The editorial also acknowledged that "[t]he majority of scientists and most public school districts reject intelligent design as science."

Oklahoma: No fewer than three anti-evolution bills were introduced in the Oklahoma legislature before the legislative session began on February 6, 2006.

First, House Bill 2107, dubbed the Academic Freedom Act, which if enacted would provide:

A. Every public school teacher in the State of Oklahoma shall have the affirmative right and freedom to present scientific information pertaining to the full range of scientific views in any curricula or course of learning.

B. No public school teacher in the State of Oklahoma shall be terminated, disciplined, or otherwise discriminated against for presenting scientific information pertaining to the full range of scientific views in any curricula or course of learning.

C. Students may be evaluated based upon their understanding of course materials, but no student, in any public school shall be penalized in any way because the student may subscribe to a particular position on scientific views.

D. The rights and privileges contained in the Academic Freedom Act apply when topics are taught that may generate controversy, such as biological or chemical origins of life. Nothing in this act shall be construed as requiring or encouraging any change in the state curriculum standards for public schools.

E. Nothing in this act shall be construed as promoting any religious doctrine, promoting discrimination for or against a particular set of religious beliefs, or promoting discrimination for or against religion or nonreligion.

The reference in (D) to "biological or chemical origins of life" is a clear indication that the bill is aimed specifically at evolution, as is the legislative finding that "existing law does not expressly protect the right of teachers identified by the United States Supreme Court in *Edwards v Aguillard* to present scientific critiques of prevailing scientific theories." HB 2107 was introduced by Representative Sally Kern (R–District 55).

The second, House Bill 2526, would, if enacted, authorize school districts to include "intelligent design" in "any public school instruction concerning the theories of the origin of man and the earth which includes the theory commonly known as evolution." Teachers would be allowed to "use supporting evidence deemed necessary for instruction on the theory of intelligent design," subject to the approval of their school districts, but not to "stress any particular denominational, sectarian, or religious doctrine or belief." HB 2526 is evidently modeled on Pennsylvania's HB 1007, introduced in the House of Representatives there on March 16, 2005. The most significant difference is that HB 1007 contains a provision stating that its dictates "shall not be construed as being adverse to any decision which has been rendered by an appellate court," while there is no such provision in HB 2526. The sponsor of the bill is Representative Abe Deutschendorf (D–District 62), who was listed in 2000 as the coauthor of a House version of a Senate bill, SB 1139, which would have required the state textbook committee to "ensure that the textbooks include acknowledgment that human life was created by one God of the Universe." His bill unanimously passed in the House, but was never enacted.

Third, Senate Bill 1959, introduced by Senator Daisy Lawler (D–District 24), if enacted would provide:

A. Every teacher in a public school in this state shall be authorized to present information and allow classroom discussions that provide for views that may pertain to the full range of scientific views in any science course.

B. No public school teacher in this state shall be terminated, disciplined, or otherwise discriminated against for presenting scientific information authorized pursuant to subsection A of this section.

C. Nothing in this act shall be construed as requiring or encouraging any change in the state curriculum standards for public schools.

D. Nothing in this act shall be construed as promoting any religious doctrine, promoting discrimination for or against a particular set of religious beliefs, or promoting discrimination for or against religion or nonreligion.

While evolution is not mentioned in the text of SB 1959, the phrase "the full range of scientific views" presumably originates in the so-called Santorum language removed from the No Child Left Behind Act. Moreover, Sections A and B resemble sections A and B of HB 2107, section C is identical to the second half of section D of HB 2107, and section D is identical to section E of HB 2107. Unlike HB 2107, however, SB 1959 is silent about "academic freedom," *Edwards v Aguillard*, and "topics ... that may generate controversy, such as biological or chemical origins of life."

Texas: As the extended controversy over biology textbook adoption in Texas came to a conclusion in the fall of 2003 (see *RNCSE* 2003 Sep–Dec; 23 [5–6]: 4–7), a different textbook controversy was brewing. On October 30, 2003, Trial Lawyers for Public Justice filed suit against five past and present members of the Texas State Board of Education for rejecting Daniel D Chiras's text-

book *Environmental Science: Creating a Sustainable Future*, 6th ed. (Sudbury [MA]: Jones and Barlett, 2001). Although the textbook was recommended by the commissioner of education and passed by the official review panel, the board voted to reject it after two Texas conservative policy organizations attacked it as anti-Christian, anti–free-enterprise, and anti-American (see *RNCSE* 2004 Jan/Feb; 24 [1]: 10–15). In its brief (available on-line at <http://www.tlpj.org/briefs/TLPJ_DC;64359;1.pdf>), TLPJ argued that the board's actions thus infringed the First Amendment rights of both Chiras and of Texas students by "limiting the author's expression and by denying access to that expression on the basis of the content and viewpoint of the author's speech."

On July 23, 2004, Barbara MG Lynn, a US district judge in the Northern District of Texas, granted the defendants' motion to dismiss. Even if the plaintiffs were correct in alleging that the textbook was rejected because the defendant board members "disagreed with Chiras's conclusion that the root cause of environmental problems is economic growth, because the oil and gas industry's position was not adequately presented, and because the textbook did not accurately reflect the traditional, conservative values of most Texans," Lynn reasoned, "these alleged motives ... may constitute 'legitimate pedagogical concerns' even though they are viewpoint-discriminatory." Referring to the Texas Education Code, she concluded that they were indeed legitimate pedagogical concerns. (The decision is available on-line at TLPJ's website: <http://www.tlpj.org/briefs/dismissal%20order.pdf>.)

TLPJ subsequently appealed the decision to the Fifth Circuit Court of Appeals, but to no avail. On December 12, 2005, a three-judge panel upheld the lower court's decision, although on different grounds. The ruling summarized: "First, the selection of textbooks by the state for use in public school classrooms is government speech, and is not subject to the forum analysis of *Hazelwood* or the viewpoint neutrality requirement. As a result, there is no forum to which Appellant Chiras can claim a right of access. Second, even assuming that public school students possess a cognizable right to receive information, that right does not extend to the selection of textbooks for use in the classroom." (The ruling is available on-line at <http://www.ca5.uscourts.gov/opinions/pub/04/04-10998-CV0.wpd.pdf>.) Co-counsel Adele Kimmel of the TLPJ told the Student Press Law Center, "We are, of course, disappointed by the Court's ruling, and we are considering whether to petition the US Supreme Court for review" (2005 Dec 15; available on-line at <http://www.splc.org/newsflash.asp?id=1151>).

United Kingdom: Lord May of Oxford, the president of the Royal Society of London, criticized "intelligent design" — which he described as a "disguised variant" of creationism — in the course of his fifth and final anniversary address to the Society on November 30, 2005. His address was webcast (<http://www.royalsoc.ac.uk/page.asp?tip=1&id=3861>) and also posted in PDF form on the Royal Society's website (<http://www.royalsoc.ac.uk/downloaddoc.asp?id=2414>). In the published version of his address, he wrote (p 21–2, notes omitted):

> Today, however, fundamentalist forces are again on the march, West and East. Surveying this phenomenon, Debora MacKenzie has suggested that — in remarkably similar ways across countries and cultures — many people are scandalised by "pluralism and tolerance of other faiths, non-traditional gender roles and sexual behaviour, reliance on human reason rather than divine revelation, and democracy, which grants power to people rather than God." She adds that in the US evangelical Christians have successfully fostered a belief that science is anti-religious, and that a balance must be restored, citing a survey which found 37% of Americans (many of them not evangelicals) wanted Creationism taught in schools. Fundamentalist Islam offers a similar threat to science according to Ziauddin Sardar, who notes that a rise in literalist religious thinking in the Islamic world in the 1990s seriously damaged science there, seeing the Koran as the font of all knowledge.
>
> In the US, the aim of a growing network of fundamentalist foundations and lobby groups reaches well beyond "equal time" for creationism, or its disguised variant "intelligent design", in the science classroom. Rather, the ultimate aim is the overthrow of "scientific materialism", in all its manifestations. One major planning document from the movement's Discovery Institute tells us that "Design theory promises to reverse the stifling dominance of the materialist world view, and to replace it with a science consonant with Christian and theistic convictions". George Gilder, a senior fellow at the Discovery Institute, has indicated that this new, faith-based science will rid us of the "chimeras of popular science", which turn out to be ideas such as global warming, pollution problems, and ozone depletion.

Lord May has won a number of international awards, including the 1996 Crafoord Prize for "pioneering ecological research in theoretical analysis of the dynamics of populations, communities and ecosystems." Between 1995 and 2000 he was Chief Scientific Adviser to the UK Government and Head of the Office of Science and Technology. He became a member of the House of Lords in 2001 and was appointed to be a member of the Order of Merit in 2002. Founded in the 1660s, the Royal Society is one of the most prestigious scientific societies in the world.

[*NCSE thanks Ron Fredrickson and Vic Hutchison for information used in this article.*]

NCSE NEWS

News from the Membership

Glenn Branch, NCSE Deputy Director

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

Philip Baringer responded to a confused editorial in the *Lawrence* (Kansas) *Journal-World* (2005 Sep 7) by explaining, "the issue is not that some people believe in creation and some believe in evolution. No one should 'believe' in evolution in the same sense that they believe in their religion. Evolution is a science. Scientific knowledge should always be taken as provisional, subject to change when new evidence comes along. Scientists and science educators do not want anyone to 'believe' in evolution, but rather to understand the theory and to understand why scientists accept it as the best explanation of how species developed over time. Scientists get upset with creationists when they try to blur the distinction between science and religion, when they repeatedly assert things that are factually incorrect about science and when they try to distort the science curriculum in public schools in order to promote narrow religious views. That's what the fuss is about." His letter appeared on September 14.

Writing to the editor of the *Idaho Statesman*, **Gary L Bennett** noted an ironic juxtaposition in a previous issue of the newspaper: "On page 3 of the Main section we learn that 'Scientists find chimps, people are 96 percent identical' while on page 9 we learn the embarrassing fact that 42 percent of our fellow citizens are so uneducated as to reject evolution. If one ever needed proof that creationists don't study, that was it." His letter appeared on September 22, 2005, as did a letter from **Terry Maley**, who responded to a previous letter presenting a bogus probability argument on behalf of creationism. Maley wrote, "These probability 'computations' about the likelihood of a DNA molecule or protein happening by 'random chance' are dead wrong because they assume, for example, that H_2O is just as likely as O_2H and that there were no initial conditions that would make it more likely for the production of carbonic acid than sulfuric acid," and also noted that the argument was compromised by its using *post facto* probabilities.

Marshall Berman contributed "Intelligent design: The new creationism threatens all of science and society" to the October 2005 issue of *APS News*, the newsletter of the American Physical Society. Citing the Wedge document, Berman argued, "The current Intelligent Design movement poses a threat to all of science and perhaps to secular democracy itself." Noting that "[t]he movement is highly political, very astute, extremely well-marketed, disingenuous, and grossly misunderstood by most Americans," he calls upon his scientific colleagues to help to defend science: "Replacing sound science and engineering with pseudoscience, polemics, blind faith, and wishful thinking won't save you when the curtain of 'Dark Ages II' begins to fall!" Berman has served as vice president of the New Mexico State Board of Education and Executive Director for Education of the Council on Competitiveness.

Tim Berra's op-ed "Chimps may help show what makes us human" appeared in the Mansfield, Ohio, *News Journal* (2005 Oct 5), in the wake of the publication in *Nature* of a draft sequence of the chimpanzee genome — an "elegant confirmation of evolution," Berra remarked, that Darwin could not have imagined. After explaining the similarities and differences of the chimpanzee and human genomes in general terms, Berra noted that the new knowledge of the chimpanzee genome may help researchers to find a treatment or even a cure for AIDS and Alzheimer's disease. He pointedly compared the prospects opened by the discovery to the sterility of "intelligent design," which, he noted, "offers no research program for the future, no predictions, and cannot be tested scientifically since it advocates supernatural explanations that [lie] outside the scientific method." Berra is professor emeritus in the Department of Evolution, Ecology, and Organismal Biology at the Ohio State University, Mansfield, and author of *Evolution and the Myth of Creationism* (Stanford: Stanford University Press, 1990). [*Thanks to Andrew Lutes for the news.*]

NCSE deputy director **Glenn Branch** contributed "The battle over evolution: How geoscientists can help" to the September 2005 issue (available on-line in PDF form at <http://www.sepm.org/sedrecord/SR 3-3.pdf>) of *The Sedimentary Record*, published quarterly by the Society for Sedimentary Geology. "Eighty years after the Scopes trial," Branch writes in his abstract, "evolution is still under attack in the public school science classroom. Geoscientists are in a unique position to help, but in order to do so, they need to appreciate the history of the controversy, to understand the variety of ways in which creationists attempt to compromise evolution education, and to work together to use their scientific expertise effectively in the education policy arena."

Just as the first challenge to the constitutionality of teaching "intelligent design" in the public school science classroom was underway in the trial of *Kitzmiller v Dover*, **Matthew J Brauer**, **Barbara Forrest**, and **Steven G Gey** offered a definitive assessment of the legal issues involved in their law review article "Is it science yet? Intelligent design creationism and the Constitution," published in *Washington University Law Quarterly* (2005; vol. 83, nr 1). With almost 150 pages of closely reasoned argument and almost 600 footnotes of meticulous documen-

tation, "Is it science yet?" (available on-line in PDF form at <http:// law.wustl.edu/WULQ/83-1/p 1 Brauer Forrest Gey book pages.pdf>) is sure to become the leading treatment of the constitutionality of teaching "intelligent design" for the foreseeable future. The abstract of the article reads:

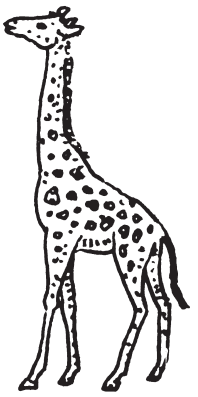
> On several occasions during the last eighty years, states have attempted either to prohibit the teaching of evolution in public school science classes or counter the teaching of evolution with mandatory references to the religious doctrine of creationism. The Supreme Court struck down examples of the first two generations of these statutes, holding that they violated the Establishment Clause of the First Amendment. A third generation of creationist legislation is now being proposed. Under this new generation of creationism legislation, science teachers would present so-called "intelligent design" theory as an alternative to evolution. Intelligent design theory asserts that a supernatural intelligence intervened in the natural world to dictate the nature and ordering of all biological species, which do not evolve from lower- to higher-order beings. This article considers whether these intelligent design creationism proposals can survive constitutional scrutiny. The authors analyze the religious, philosophical, and scientific details of intelligent design theory, and assess these details in light of the constitutional doctrine developed by the Court in its previous creationism decisions. The Article discusses several factors that pose problems for intelligent design theory, including the absence of objective scientific support for intelligent design, evidence of strong links between intelligent design and religious doctrine, the use of intelligent design to limit the dissemination of scientific theories that are perceived as contradicting religious teachings, and the fact that the irreducible core of intelligent design theory is what the Court has called the "manifestly religious" concept of a God or Supreme Being. Based on these details, the authors conclude that intelligent design theory cannot survive scrutiny under the constitutional framework used by the Court to invalidate earlier creationism mandates.

Brauer is a scientist on the research staff of the Lewis-Sigler Institute for Integrative Genomics at Princeton University; with Daniel R Brumbaugh he contributed "Biology remystified: The scientific claims of the new creationists" to *Intelligent Design Creationism and its Critics*, edited by **Robert T Pennock** (Cambridge [MA]: MIT Press, 2001). Forrest is Professor of Philosophy at Southeastern Louisiana University and a member of NCSE's board of directors; with **Paul R Gross** she wrote *Creationism's Trojan Horse: The Wedge of Intelligent Design* (New York: Oxford University Press, 2004). Gey is the David and Deborah Fonvielle and Donald and Janet Hinkle Professor of Law at Florida State University, and is considered to be one of the country's leading scholars on religious liberties and free speech.

Jim Bullion contributed a letter to the editor of the *Bellingham Herald* (2005 Dec 7, with a correction following on Dec 8), noting that "[p]oorly informed critics of evolution are contriving a debate about evolution's validity when non exists within the scientific community, except for a tiny fringe motivated mostly by fundamentalist religion." He cited *Science and Creationism* (published by the National Academy of Sciences), the *Encyclopedia Britannica*, and David Quammen's cover article in the November 2004 issue of *National Geographic* to illustrate his point.

Prompted by his dissatisfaction with a lecturer (Keith Lockitch of the Ayn Rand Institute) whose defense of evolution was coupled with a portrayal of science as intrinsically atheistic, **Robert Camp** contributed an op-ed to the *Orange County Register* (2005 Dec 2), noting, "It is not unusual, in fact it's nigh inescapable, for conversations about creationism to veer into dispute as to the relative merits of theism and atheism. But it's usually the creationists who mistakenly think this philosophical dichotomy encapsulates the issue. Here, however, was a defender of biological evolution struggling in the same quicksand that gobbles up so many on the other side. Why was he determined to cast these scientific and pedagogical issues as a battle between reason and religion? Because it suited his personal agenda. Despite his ostensibly sensible beginning, he was really there to talk about 'rational' atheism and 'irrational' religion." For the complete text of his op-ed and a report on Lockitch's lecture, visit Camp's blog at <http://litcandle.blogspot.com>.

NCSE Supporter **James E Darnell Jr's** article "Defending science education against fundamentalist attacks" appeared on the website of *Teachers College Record,* a journal of research, analysis, and commentary in the field of education published by Teachers College, Columbia University, on September 13, 2005. Describing the anti-evolutionist movement as "an impediment to science education that the country can surely do without," Darnell reviewed the overwhelming evidence for evolution before suggesting a solution: effective political action, along the lines of the pro-evolution-education resolution introduced by Senator Ken Toole in the Montana legislature in 2005 (see *RNCSE* 2004 Nov–Dec; 24 [6]: 15–20). He concluded, "Although Toole's proposal for a resolution never got out of committee, it should be a call to arms for those who wish America's children to be educated in modern science without interference from fundamentalists. Politicians who fail to understand this problem and move to deal correctly with it must be held to account. It is not, I believe, overly dramatic to claim that America's future depends on stopping this interference with science education, perhaps as a first step in assuring the continued separation of church and state in this country."



Ernie Conrad Dies

Long-time NCSE member Ernie Conrad died at age 74 on November 20, 2005. He graduated from Eureka High School and served during the Korean War on board the *USS Yorktown* as a combat medic. He graduated from the University of Utah, then taught for 40 years for Grant Union School District at Don Julio and Rio Linda Senior High, where he was named Teacher of the Year in 1994. He established curriculum in anthropology for high school, originated the "Knowledge Bowl", and presented "character" discussions of World War II events. In summer, Ernie worked as a park ranger/lecturer at Lassen and Mesa Verde National Parks. He received a grant from the National Endowment for the Humanities to work at the "Flower Dew One Hundred" project in Virginia excavating early colonial settlements. In October 2005, he co-authored a McGraw-Hill supplemental college textbook, *Readings in Physical Anthropology*. He was also a long-time member of the Humanist Association of the Greater Sacramento Area (HAGSA). Ernie was a scholar and very funny man who will be missed.

[*Adapted from the death notice that appeared in the* HAGSA News *(<http://hagsa.org/news/>) and the obituary in the* Sacramento Bee *(2005 Nov 22).*]

Among those who wrote to the editor of the *Kansas City Star* in the wake of the Kansas Board of Education's vote to adopt science standards in which the scientific standing of evolution is systematically impugned was **Bryce Hand**, emeritus professor of geology at Syracuse University. Hand wrote in part, "Yes, there is controversy surrounding evolution, but only among non-scientists. Those who reject evolution present no arguments scientists haven't heard (and adequately countered) again and again and have no special knowledge that scientists have overlooked. Organic evolution is so well established that to allow room for doubt is to misrepresent science." His letter appeared on November 10, 2005.

NCSE Supporter **Richard Lewontin** reviewed two books for *The New York Review of Books* (2005 Oct 20; 52 [6]; available online at <http://www.nybooks.com/articles/18363>): NCSE Supporter **Michael Ruse**'s *The Evolution–Creation Struggle* (Cambridge [MA]: Harvard University Press, 2005) and Peter J Richerson and Robert Boyd's *Not by Genes Alone* (Chicago: University of Chicago Press, 2005). Introducing his review, Lewontin wrote:

> The development of evolutionary biology has induced two opposite reactions, both of which threaten its legitimacy as a natural scientific explanation. One, based on religious convictions, rejects the science of evolution in a fit of hostility, attempting to destroy it by challenging its sufficiency as the mechanism that explains the history of life in general and of the material nature of human beings in particular. One demand of those who hold such views is that their competing theories be taught in the schools.
>
> The other reaction, from academics in search of a universal theory of human society and history, embraces Darwinism in a fit of enthusiasm, threatening its status as a natural science by forcing its explanatory scheme to account not simply for the shape of brains but for the shape of ideas. *The Evolution–Creation Struggle* is concerned with the first challenge, *Not By Genes Alone* with the second.

It was a pleasure to see that in his discussion of the first of these reactions, Lewontin cited the late **Otis Dudley Duncan** and Claudia Geist's recent paper "The creationists: How many, who, and where?" (*RNCSE* 2004 Sep/Oct; 24 [5]: 26–33).

PZ Myers and his popular blog Pharyngula (<http://scienceblogs.com/pharyngula) were featured in a pair of publications: *City Pages* (2005 Nov 23; 26 [1303]; available on-line at <http://citypages.com/databank/26/1303/article13908.asp>), a weekly paper in the Minneapolis/St Paul area, and *Nature* (2005 Dec 1; 438: 548–9). The article in *City Pages*, entitled "The mad scientist", said of Myers, "Sometimes he is the mild-mannered professor, absorbed by scientific minutiae. But when the spirit moves him, he is a fiery cultural critic, bent on keeping the religious right from hijacking school curricula even if it means taking apart their arguments point by point in settings where people used to know better." The article in *Nature*, about the use of blogs in the scientific community, quoted Myers as saying, "The standard scientific paper is irreplaceable as a fixed, archivable document that defines a checkpoint in a body of work, but it's static, it's very limited ... Put a description of your paper on a weblog, though, and something very different happens ... People who are very far afield from your usual circle start thinking about the subject. They bring up interesting perspectives."

Colin Purrington, who teaches biology at Swarthmore College, presented a talk entitled "Why is everyone picking on evolution, for God's sake?" to the Faculty Lunch at Swarthmore on September 21, 2005. In the announcement for the talk, Purrington wrote, "Now that the furor over a Sun-centered solar system is finally dying down, faith-based attacks on scientific knowledge have turned to evolution, the theory that Charles Darwin popu-

larized 146 years ago. My presentation will begin with a summary of this sordid drama and why the nation is currently focused on a court case soon to start in nearby Dover, Pennsylvania. I will spend the bulk of my time analyzing general strategies that might (and might not) be effective countermeasures to anti-evolutionism, with special emphasis on several projects I initiated during my leave year." (To see these countermeasures, visit Purrington's Evolution Outreach Projects website: <http://www.swarthmore.edu/NatSci/cpurrin1/evolk12/evoops.htm>.)

NCSE's executive director **Eugenie C Scott** was presented with NABT's Honorary Member Award, given to those who have attained "distinction in teaching, research, or service in the biological sciences," at the National Association of Biology Teachers convention held in Milwaukee, Wisconsin, from October 5 to October 8, 2005. Also receiving the award was **Randy Moore**, a professor of biology at the University of Minnesota, Minneapolis, and until recently the editor of *The American Biology Teacher*. Previous recipients of the prestigious award include the Nobel-Prize–winning geneticist Hermann J Mueller, the late biologist **John A Moore**, and NCSE's founder **Stanley Weinberg**.

The trial in *Kitzmiller v Dover* — the first legal challenge to the constitutionality of teaching "intelligent design" in the public schools — was one of the five biggest stories in bioscience for 2005, in the view of *The Scientist* (2005 Dec 5; 19 [23]: 14). NCSE's **Eugenie C Scott** and **Glenn Branch** provided a brief assessment for the journal, writing, "*Kitzmiller v Dover* represents the most important American creationism/evolution trial in 23 years." Comparing the trial with 1982's *McLean v Arkansas*, Scott and Branch note, "With the recent electoral rout of the Dover school board, the defendants are unlikely to appeal if the plaintiffs prevail. Because higher courts will thus remain mute on the constitutionality of teaching ID, additional Dovers may be anticipated, until the issue finally reaches the Supreme Court." Meanwhile, they add, "savvier anti-evolutionists are likely to emulate the Kansas State Board of Education by promoting policies impugning evolution without directly requiring creationism" — a strategy that will be jeopardized if the decision in *Selman v Cobb County* (holding that evolution disclaimers are unconstitutional) is upheld on appeal.

Writing to the editor of the Wilmington, North Carolina, *Star-News*, **Pete Soderman** lamented what he views as the Bush administration's war on science, especially with regard to evolution: "The fact of Darwinian evolution is the absolute cornerstone of biology, supported by a mountain of incontrovertible evidence, and every scientific and educational body in the world, yet our president 'thinks' that we should give equal time to teaching a repackaged supernatural fairy tale. Even his own science advisor disagreed with him." His letter appeared on November 4, 2005.

Zev Stern responded to Rabbi Daniel Lapin's op-ed column "My way or Foxman's way" (*The Jewish Press* 2005 Nov 11), itself responding to a speech in which the national director of the Anti-Defamation League, Abraham Foxman, warned of the possible consequences of the triumph of the Christian right. Toward the end of his letter (*The Jewish Press* 2005 Nov 29), Stern noted, "Rabbi Lapin cannot seem to write a column without a gratuitous attack on the theory of evolution. I [wish] that he and his ilk would, just once, leave us biologists alone and attack quantum theory or the theory of relativity. If Rabbi Lapin would examine the work of Rav Kook and others he might find that the theory of evolution is no more incompatible with our faith than are the theories of chemistry and physics, but of course Rav Kook is treif in certain circles that, 60 years after the Holocaust, are still ideologically mired in the ghettos of Europe to which Christian believers had consigned us for so long." (Abraham Isaac Kook [1865–1935], to whom Stern refers, was a prominent Jewish scholar and rabbi who regarded evolution as compatible with Jewish theology.)

Responding to a full-page article on "intelligent design" in *The Oregonian* (2005 Sep 27), **William Thwaites** wrote, "There are two simple reasons why intelligent design is seriously flawed science at best. First of all, science is really not much more complicated than proposing explanations that can be tested. Evolution can be tested, but if someone suggests that God made this or that organism or structure, how can you test that? It might be true, but it can't be science, because it isn't testable. Another fatal flaw in the thinking of intelligent designers is that no one really knows for sure what can and cannot be selected by natural selection from random mutations. I don't see that the intelligent designers are even trying to answer that question," adding, "Explanations based on the principles of nature tend to be testable. Ideas based on religion tend not to be." His letter appeared on October 2.

NCSE Supporter **Tim D White** and Pieter Arend Folkens's *The Human Bone Manual* (New York: Academic Press, 2005) is now available. The book, writes its publisher, "is intended for use outside the laboratory and classroom, by professional forensic scientists, anthropologists and researchers. The compact volume includes all the key information needed for identification purposes, including hundreds of photographs designed to show a maximum amount of anatomical information."

Why Intelligent Design Fails (New Brunswick [NJ]: Rutgers University Press, 2004), edited by **Matt Young** and **Taner Edis**, was reviewed by Arthur Falk for the *Quarterly Review of Biology* (2005; 80 [3]: 350). Falk wrote, "Not only is the book largely successful, but several articles provide interesting updates on evolution science for nonprofessionals, quite apart from this debate. I recommend the articles about recent work on the evolution of flagella in bacteria ([Ian] Musgrave), of avian flight (**[Alan] Gishlick**), and of wasp net building (**[Niall] Shanks** and [Istvan] Karsai). Teachers of science, even at the high school level, will enjoy using Gishlick's do-it-yourself demonstration of the mechanics of flight, starting with an uncooked chicken."

ICR's Henry Morris Dies

Henry Morris, the founder of the "creation science" movement, died on February 25, 2006, in Santee, California, at the age of 87. Speaking to *The New York Times* (2006 Mar 4), NCSE's executive director Eugenie C Scott described him as "the most important creationist of the 20th century, much more so than William Jennings Bryan." And the historian Edward J Larson, whose *Trial and Error* is the definitive treatment of the legal history of the creationism/evolution controversy, told the *Washington Post* (2006 Mar 1), "He had an enormous influence ... He literally set the terms of the debate for the second half of the 20th century."

Born in Dallas, Texas, in 1918, Morris graduated from Rice University in 1939 and earned a master's degree and a PhD in hydraulic engineering from the University of Minnesota. He taught engineering at the University of Louisiana at Lafayette, Southern Illinois University, and, beginning in 1957, at Virginia Polytechnic Institute, where he served as department chair. As early as 1946, with the publication of *That You Might Believe* (which he described as the first book "published since the Scopes trial in which a scientist from a secular university advocated recent special creation and a worldwide flood"), he was also attempting to establish creationism on a scientific basis.

With the theologian John C Whitcomb, Morris wrote *The Genesis Flood* (1961), the catalyst for the modern creation science movement. Although the basic idea of flood geology was already presented by George McCready Price a generation earlier, *The Genesis Flood* succeeded in popularizing it among fundamentalist Christians, especially those with scientific and technical training. Subsequently, Morris was among the founders of the Creation Research Society, established in 1963, which sought to promote and publish research supporting scientific creationism.

In 1970, Morris retired from mainstream academia, even declining Auburn University's offer of a chair in civil engineering. Instead, he moved to California in order to establish the Creation Science Research Center, a creationist auxiliary to Tim LaHaye's new Christian Heritage College. After a split over tactics, the center was severed from the college; Morris reorganized what remained of the center as the Institute for Creation Research. Morris served as the president of the ICR from 1970 to 1995, when his son John Morris succeeded him; he remained president emeritus of the ICR until his death.

At the ICR, Morris was a prolific writer, with such books as *The Genesis Record*, *The Biblical Basis for Modern Science*, *History of Modern Creationism*, *What is Creation Science?* (coauthored with Gary E Parker), and *The Modern Creation Trilogy* (coauthored with John Morris) to his credit. Perhaps most influential was *Scientific Creationism*, intended for use as a textbook; two versions were issued, a general edition and a public school edition, from which a chapter that "places the scientific evidence in its proper Biblical and theological context" was omitted.

In his ethnography *God's Own Scientists: Creationists in a Secular World*, the anthropologist Christopher P Toumey wrote:

> For most of the creationist activists in North Carolina, Henry Morris and his organization, the Institute for Creation Research, are the only important sources of creationist knowledge and belief. For information, they refer to Morris to lead them through Genesis and geochronology; for inspiration, they turn to Morris himself to steer them past doubt and difficulty. No other authority or influence matters nearly as much.

Although Toumey was writing in 1994, before the rise of the prominent young-earth creationist ministry Answers in Genesis and the visibility of "intelligent design" creationism, Morris's influence is still widely felt. AiG's Ken Ham told *The New York Times*, "All of us in the modern creationism movement today would say we stand on his shoulders." And Paul Nelson, a Fellow of the Discovery Institute's Center for Science and Culture, was quoted in the *Los Angeles Times* (2006 Mar 3) as saying, "Ideas can die because there is just no one to think about them ... I love the fact that Dr Morris kept alive dissent from Darwinian evolution."

While opposing his scientifically bankrupt views, Morris's adversaries credited him with sincerity and cordiality. Brown University's Kenneth R Miller told the *Los Angeles Times*, "I found Morris to be unfailingly polite, a real gentleman and a person who was a sincere and committed Christian." (In chapter six of *Finding Darwin's God*, Miller describes a conversation with Morris, ending, "I had sat down thinking the man a charlatan, but I left appreciating the depth, the power, and the sincerity of his convictions.") And NCSE's Scott also described him as gentlemanly to *The New York Times*, adding, "I feel that he was absolutely sincere about his convictions that the Bible was literally true and that science would support it and creation science was good science."

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Pamela Zohar

Memorials

Karl & Kathy Cunningham, in honor of Earl Cunningham

Harriet Welsh, in memory of her brother Gordon Welsh

The Lay of the Land: The Current Context for Communicating Evolution in Natural History Museums

Robert "Mac" West

[*This is a written summary of the presentation given by West at the opening of the Florida Museum of Natural History's conference "Enhancing Natural History Museum Visitor Understanding of Evolution," Gainesville, Florida, October 22, 2004.*]

Visitor Expectations

Visitors to various kinds of natural history attractions arrive with certain expectations for what they will see and do. This is especially the case for "general visits" — those not driven by a special exhibition or event. People going to aquariums anticipate experiences with sharks, whales, and porpoises (big oceanic things), colorful reef fishes, and maybe some really exotic-looking organisms such as seahorses or jellyfish. Zoo attendees are looking especially for the "charismatic megafauna" — lions, tigers (and bears), elephants, kangaroos, gorillas, and such, as well as newborns, rarities (pandas), and novelties (for example, burying beetles, bats, or capybaras). Visitors to natural history museums fully expect to see, in addition to dioramas filled with taxidermied large mammals and materials from exotic human cultures, an array of dinosaurs and other big extinct things.

Dinosaur diorama in the Milwaukee Public Museum

Thus, it is expected that natural history museums present specimens and artifacts that deal with change over time ... or evolution. As a consequence, natural history museum visitors accept evolution and chronology as the organizer for much of their visit, even if they personally do not understand or even like the concept of evolution.

This expectation is not front-and-center at living collections institutions, which work in the present tense and worry more about the future (habitat destruction, impending extinctions) than the past. Therefore, they have to work harder to bring evolution into their programs. To their credit, a number of zoos and aquariums are addressing evolution and its importance in understanding the diversity of their collections. For example, the St Louis Zoo has had an animatronic Charles Darwin addressing its visitors since 1989, and the Miami Metrozoo recently opened a bird exhibit which explicitly relates living birds to their dinosaurian ancestors. Over the last several

years, many zoos have had temporary exhibitions of animatronic dinosaurs, thus introducing the concept of geologic time, ancient extinctions, and, by implication, the evolutionary process.

Science centers vary enormously in their programmatic capabilities and approaches. Some, which have evolved from natural history museums (for example, the Science Center of Minnesota, the St Louis Science Center, and the Museum of Science, Boston) historically have had paleontology, and thus evolution, as a program element. Others, such as the Maryland Science Center, recently have added paleontology to their array of offerings. Still others approach evolution through their contemporary science programming in genetics and the biomedical sciences. This is the case with the genetics exhibition at the Museum of Science and Industry in Chicago.

Overt Evolution in Natural History Museums

The word "evolution" does not occur all that frequently in natural history museums — even though they are firmly based on the concept. For instance, at the Milwaukee Public Museum, I was a curator of an exhibition about the evolution of Planet Earth, euphemistically called The Third Planet. "Life Over Time" and similar circumlocutions show up regularly, as do gallery titles such as "The Fossil Hall" and "The Dinosaur Exhibit." On the plus side, the American Museum of Natural History has its Hall of Human Biology and Evolution, which complements its five "fossil halls." The San Diego Museum of Man in 2002 opened a new permanent exhibition titled "Footsteps Through Time: Four Million Years of Human Evolution". And the host for this conference, the Florida Museum of Natural History, features the Hall of Florida Fossils: Evolution of Life and Land.

The explicit use of the word "evolution" is much more common outside of the United States. Just as an example, the Polish Academy of Sciences operates the Museum of Evolution in Warsaw. The Evolution Gallery is in the Melbourne Museum, Australia; Russia has its State Darwin Museum; and the Royal Museum of Scotland, Edinburgh, recently closed its Evolution Gallery for refurbishment. The Grande Galerie de l'Evolution is a unit of the Museum National d'Histoire Naturelle in Paris.

In May 1979, the Smithsonian's National Museum of Natural History opened a gallery on its main floor called Dynamics of Evolution. Even before it opened, a suit was filed in federal court asserting that the use of federal funds in NMNH exhibits on evolution was a violation of the separation of church and state. On October 30, 1980, a court of appeals ruled that NMNH exhibitions "that focus on the scientific theory of evolution do not violate the First Amendment requirement of separation of church and state" (*Crowley v Smithsonian*). Even so, on July 22, 1981, Rep William Dannemeyer (R–CA) introduced an amendment to HR 4035 to "prohibit the Smithsonian Institution to use funds for public exhibits and performances to present the theory of evolution as the sole explanation of life's origins." That amendment was defeated on a point of order the same day. Despite these actions, the gallery was closed and replaced after several years. This kind of attention directed toward the e-word certainly caused US institutions to be very cautious about how direct they were in their terminology.

A graphical way to see how terminology is applied to exhibitions dealing with evolution is to tabulate the keywords self-selected by traveling exhibition marketers. The following data, taken from ILE's Traveling Exhibitions Database (October 2004), suggests that there is a preference for talking about the products of evolution — the actual fossils — rather than the process or dynamics.

Keyword	Number	%
Biodiversity	5	0.78%
Dinosaurs	42	6.59%
Evolution	7	1.09%
Fossils	30	4.71%
Genetics	4	0.63%

Today, evolution appears in natural history museums in three exhibition and program locations: paleontology and the fossil record, biodiversity and systematics, and genetics. However, it usually is implied or ignored rather than explicit.

Mounted dinosaur skeletons at the Sam Noble Oklahoma Museum of Natural History

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The original Sue at the Field Museum

PALEONTOLOGY/FOSSIL RECORD

Exhibitions of large and impressive fossils have been staples at natural history museums virtually as long as those institutions have existed. Mermin (2002) provides an excellent review of the development of these exhibitions. He documents, and I attest to this from my own experience, a surge of interest in dinosaurs (in particular) but also other large and extinct exotic vertebrates starting in the 1980s and accelerating into the 1990s and 2000s. Exhibitions developed during that time emphasized ancient environments and the adaptations of animals to them, with some attention to the process of discovery and collection. At the same time, some recognizable personalities emerged as prominent spokespeople for fossils and their importance — the Leakey family, Robert Bakker, and Jack Horner stand out as highly visible individuals at the turn of the century.

From a purely practical perspective, natural history museums highlight their dinosaur/paleontology exhibitions as important visitor attractors and revenue generators. They are prominent in logos, identification graphics, slogans ("Home of the Dinosaurs"), and often stand as physical elements, such as the concrete *Triceratops* on the Mall in front of the Smithsonian's National Museum of Natural History, the *Allosaurus* cast in front of the University of Wyoming's Geological Museum, and the bronze statue of *Torosaurus* that will be placed in front of the Yale Peabody Museum in fall 2005.

In addition to the Third Planet gallery in Milwaukee, which opened in 1983, others have opened in the last twenty years — California Academy of Sciences, San Francisco (closed during construction); American Museum of Natural History, New York; Denver Museum of Nature and Science; Academy of Natural Sciences of Philadelphia; University of Nebraska State Museum, Lincoln; the Field Museum, Chicago (closed for renovation); Cincinnati Museum of Natural History; Museum of the Rockies, Bozeman, Montana; Science Museum of Minnesota, St Paul; Fernbank Museum of Natural History, Atlanta; North Carolina Museum of Natural Science, Raleigh; Texas Tech University Museum, Lubbock; New Mexico Museum of Natural History and Science, Albuquerque; Cranbrook Institute of Science, Bloomfield Hills, Michigan; Canadian Museum of Nature, Ottawa; The Children's Museum in Indianapolis; Sam Noble Museum of Natural History at the University of Oklahoma, Norman; Sternberg Museum, Hays, Kansas; Museum of the Earth, Ithaca, New York; Calvert Marine Museum, Calvert, Maryland; Yale Peabody Museum, New Haven, Connecticut; Texas Memorial Museum, Austin; Field House of Natural History, Vernal Utah; Idaho Museum of Natural History, Pocatello; and others with which I am not familiar or simply have overlooked.

Others are on the way, at the San Diego Museum of Natural History; the Field Museum, Chicago; the Museum of the

Hall of Biodiversity at the American Museum of Natural History

Model of a Triassic mammal in the Behring Hall of Mammals at the National Museum of Natural History

Rockies, Bozeman, Montana; the Royal Ontario Museum, Ottawa; the Carnegie Museum of Natural History, Pittsburgh; the National Museum of Natural History, Washington; the Dallas Museum of Natural History; the Utah Museum of Natural History, Salt Lake City; and the University of Nebraska State Museum, Lincoln; just to name a few.

In addition, the last twenty years have seen numerous traveling exhibitions of animatronic dinosaurs and other extinct beasts, plus casts of the celebrated *Tyrannosaurus rex*, Sue, from the Field Museum. Several organizations travel collections of both cast and real skeletons, generally highlighting dinosaurs.

Biodiversity and Systematics

Virtually every natural history museum has galleries that are devoted either to the major groups of modern animals, the region's or world's biogeographic zones, or (much less common) to basic ecosystems and their inhabitants. While there are numerous halls devoted especially to mammals, birds, fishes, and so on, there are few exhibitions that attempt to integrate the major taxonomic categories and explore their interrelationships.

The American Museum of Natural History has entered this arena twice, once explicitly and once implicitly. The explicit case is the Hall of Biodiversity, which clearly talks about the great diversity of animal life and illustrates it through a visually stimulating wall of diverse specimens. The new Hall of Ocean Life (see West 2003) implicitly celebrates the diversity of life, in its case with the ocean environment as the container of that diversity.

The Eastern Ontario Biodiversity Museum in Kempville, south of Ottawa, is the only institution I can find that identifies itself as such. But, as is the case with most natural history museums, it is primarily interested in the contemporary environments of the region, not the evolutionary mechanisms which generated them.

The World Wildlife Fund circulated a traveling exhibition, Biodiversity 911, for several years, and the Royal Ontario Museum operates the interactive "Hands-On Biodiversity" gallery. Both are prospective in nature, presenting ways to interpret current biodiversity and offering remedies for preventing biodiversity loss in the future.

The Dallas Museum of Natural History is planning a second facility with global biodiversity of a primary theme; the Texas Memorial Museum in Austin recently opened the Biodiversity Discovery Hall, the Coastal Discovery Museum in Hilton Head, South Carolina, has its Biodiversity: A Sea Island Classroom.

While these galleries and programs are the life-blood of natural history museums, evolution is usually a minor thought in their presentation and programming. An exception is the new Kenneth E Behring Family Hall of Mammals at the Smithsonian's National Museum of Natural History. In addition to showing mammalian diversity, it takes mammals back to their common Triassic ancestor in a "meet your relatives" format.

Genetics/Genomics

This topic is considered within the purview of many science museums, and exhibitions and programs about it are increasingly common, especially in science centers. This is clearly an area where museums are trying to present current science and research which is directly relevant to daily life and contemporary issues. Much exhibition and program activity was stimulated by the high public profile of the Human Genome Project as well as by increasing attention to controversies surrounding cloning, genetic profiling, genetically engineered food, and analyses of fetal genetic diseases.

A major permanent exhibition, Genetics: Decoding Life, opened at the Museum of Science and Industry, Chicago, in 2002, and the renovated Tech Museum of innovation includes Genetics: Technology with a Twist. The DNA Zone has been at the St Louis Science Center for many years. Five substantial traveling exhibitions currently are available — Genomics from the American Museum of Natural History, Genome: The Secret of How Life Works from Clear Channel Exhibitions, Genetics! from the Pacific Science Center, The GEEE! In GENOME from the Canadian Museum of Nature, and Traits of Life from The Exploratorium. Three of the above were reviewed in Bossert and West (2002).

A new traveling exhibition, Gregor Mendel: Genius of Genetics, created by the

Vereinigung zur Förderung der Genomforschung (VFG), Vienna, Austria, is opening its North American tour at the Field Museum in fall 2006.

Keyword searches for "evolution" in the descriptions of these genetics exhibitions found it in only two: it appears twice in Clear Channel's Genome teacher guide (once in the WGBH *Evolution* television series web address and once in a quotation from the National Academy of Sciences), and twice in the Mendel description (referring to Mendel's successors who apply genetics to the study of evolution).

Other New Initiatives

The American Museum of Natural History is planning a traveling exhibition on Charles Darwin to open in Fall 2005. Darwin! will include personal effects, collections and books and manuscripts, and examine the modern status of Darwinian evolution.

The Houston Museum of Natural Science is finalizing arrangements with the National Museum of Ethiopia in Addis Ababa to bring the 3.2-million-year-old australopithecine hominid skeleton known as Lucy and other Ethiopian fossils to the US for an exhibition tour from 2006 to about 2009. This proposed exhibition has created a substantial controversy about the wisdom and safety of shipping such a precious and delicate specimen among museums primarily for exhibition, rather than research, purposes.

The University of Nebraska State Museum is spearheading the Explore Evolution Project, partnered with the Exhibits Museum of the University of Michigan, the Kansas Museum and Biodiversity Center at the University of Kansas, the Museum of the Rockies and Montana State University, the Sam Noble Oklahoma Museum of Natural History at the University of Oklahoma, the Texas Memorial Museum at the University of Texas, and the Science Museum of Minnesota. Exhibits will be prepared that focus on seven research projects that have made major contributions to our understanding of evolution; these will open at each participating museum in late 2005 or early 2006.

Summary

The question driving this survey of the "lay of the land" in presenting evolution is: How well is evolution presented and used in these museum exhibitions? The simple answer is "not very well."

Evolution is implicit is virtually all the paleontology and fossil exhibitions, but evolutionary mechanisms and forces are not included. Concepts of time and extinction, as well as major adaptations, are generally presented through phylogenies and cladograms.

Evolution is implicit in biodiversity and systematics exhibitions, but mechanisms are ignored. There are efforts to investigate environmental pressure, but often they are couched in the form of deleterious impacts on the natural world by humans. Some exhibitions (for example, NMNH's) incorporate fossil ancestors and phylogenies.

Evolution is almost totally ignored in the genetics/genomics exhibitions. Even when the impact of genetic changes, mutations, chromosome reorganizations and other basic elements of gene function are discussed, their impact on phenotypes, relationship to the external environment, and heritability over time simply are not mentioned. Genomics exhibitions deal exclusively with the individual present and the future and do not engage in discussions of the even larger picture at the population level.

Natural history museums are the one place that the general public comes face to face with the results of evolution. Because of their engaging exhibits and interactive displays, they provide an opportunity to increase knowledge of evolution, its effects, and its implications for life on earth. Yet, by and large, these institutions approach this opportunity gingerly, if at all. Since the public is already captivated by the array of life forms and environments on display in their exhibits, natural history museums could contribute significantly to scientific literacy and to the acceptance of evolutionary theory by drawing these connections more explicitly in their displays and programs.

References

Bossert C, West RM. 2002. The challenge of exhibiting contemporary science. *The Informal Learning Review* 54: 18–21.

West RM. 2003. The return of the whale. *The Informal Learning Review* 61: 1, 4–5.

Mermin E. 2002. *Putting It On: Negotiating Decisions in the Development of Three Evolution Exhibitions at Natural History Museums.* [MA thesis] San Francisco: John F Kennedy University. 160 p.

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Activity station in Genome: The Secret of How Life Works

Creationism and the Laws of Thermodynamics

Steven L Morris, Los Angeles Harbor College

INTRODUCTION

Pseudoscientists love to use "abracadabra" words to dazzle an ill-informed audience, and for creationists, the word "entropy" fills the bill nicely. The Second Law of Thermodynamics states that, in an isolated system, the entropy tends to increase. As entropy may be considered a measure of disorder, the orderliness of living systems and the complexity of organic molecules are taken by creationists to be a violation of this law of physics, requiring divine intervention.

An example of this sort of thinking is provided by Henry Morris (1989: 32, emphasis in the original):

> The universe is *not* "progressing from featurelessness to states of greater organization and complexity," as Davies and other evolutionary mathematicians fantasize. It is running down — *at every observable level* — toward chaos, as stipulated by the scientific laws of thermodynamics. Local and temporary increases in complexity are only possible when driven by *designed* programs and *directed* energies, neither of which is possessed by the purely speculative notion of vertically-upward evolution.

An even less intellectual effort is provided by Ross (2004: 108):

> One feature of the law of decay (the second law of thermodynamics, or the entropy law) seems especially beneficial in the context of sin: the more we humans sin, the more pain and work we encounter.

Thank God for torture chambers, and congenital diseases!

Steven L Morris received his BSc in astronomy from the University of Toronto and his PhD in physics from the University of Calgary. After two years as a researcher at the Institute of Geophysics and Planetary Physics at UCLA (which included a one-year winter-over at the South Pole, Antarctica!), he spent two years as a physics professor at the University of Puerto Rico before returning to Los Angeles. He currently teaches physics and physical science at Los Angeles Harbor College.

A perfectly adequate response to such nonsense is to point out that the earth is not an isolated system, and therefore the condition required by the Second Law is not met. We can surely say more than just this, however. After all, entropy is not merely some nebulous concept of disorder, but an exactly defined quantity in physics. For example, 18 grams of water at 25° C has an entropy of 70.0 Joules per Kelvin (Lide 2004–5: 5-18; 6-4). Since entropy can be calculated precisely, it is possible to determine what restrictions the laws of thermodynamics really place on evolution. To do this, we should first look at how entropy is defined mathematically.

THE CALCULATION OF ENTROPY

The change in the entropy of a system as it goes from an initial state to a final state is

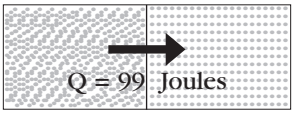
$$\Delta S = \int \frac{dQ}{T} \quad ,$$

which simplifies to

$$\Delta S = \frac{Q}{T}$$

if the temperature is constant throughout the process. In this equation:

- S is the entropy in units of Joules per Kelvin (or J/K),
- ΔS is the change in the entropy during the process,
- Q is the flow of heat in units of Joules (or J) (Q is positive if heat flows into the object, and negative if heat flows out of the object), and
- T is the temperature in units of Kelvin (or K).



continued on page 31

Entropy in Muffins

Why Evolution Does Not Contradict the Second Law of Thermodynamics

Patricia Princehouse, Case Western Reserve University

Anti-evolutionists get a lot of mileage out of this chestnut because it uses scientific terms like "thermodynamics" and "entropy" to bolster their contention that evolution is unscientific. In fact, local increases in complexity/order are not only completely consistent with thermodynamics, but even expected by the theory. Nevertheless, anti-evolutionists contend: "Evolutionary theory stands in obvious defiance of the Second Law" and "Evolution teaches that life increases in complexity, and therefore defies the second law. …The second law says that everything in our world and in the universe is like a wound-up clock that is running down" (<http://www.pathlights.com/ce_encyclopedia/18law03.htm> or <http://evolution-facts.org/Ev-Crunch/c18.htm>; see also <http://www.cryingvoice.com/Evolution/Physics.html>). This ruse works best with an audience that is already inclined to hope that evolution is not true, and requires that the audience does not already understand thermodynamics. This burdens the defender of evolution with having to explain not only all of evolutionary theory but thermodynamics on top. I've found that the following explanation often works pretty well to help folks understand basic implications of the Second Law as it relates to life on earth and evolution.

The Second Law of Thermodynamics has to do with entropy — the entropy of the universe increases during any spontaneous process. A traditional way to understand this is that disorder increases in an isolated (closed) system. This is where some muffins come in handy.

1 Imagine you have 6 muffins hot from the oven and 6 frozen in the freezer. You place the dozen muffins in a special box alternating hot with cold muffins. You place a lid on the box, which will not allow any heat inside the box to escape or any outside temperature to affect the muffins. All heat in the muffins will remain in the box (a closed system).

2 Inside the box, your system is highly ordered: hot, cold, hot, cold. The average temperature in the box is obtained by averaging the temperature of all the muffins together. As time goes by, the heat from the hot muffins mixes with the cold from the frozen muffins to produce a situation where all muffins are the same temperature. Notice that the average temperature is still the same as it was when the muffins first went into the box; only the arrangement of the heat has changed. Entropy has increased; your system is no longer ordered.

3 To keep your system ordered, you would have to have some sort of action or intervention system that would continue to heat the hot muffins and cool the frozen ones. This energy would have to come from outside the system (as it does in the case of a refrigerator, which must be plugged into an external energy source). So you *could* keep the system ordered, but to do so you would have to have an open system (where energy can flow in).

4 Life is similar. You might have two human beings who seek to increase order by making the two human bodies into three. In a closed system, this increase in order would be impossible. But humans exist in an open system where they take matter and energy in and can spin out additional humans at the rate of one every 9–12 months.

5 This is because the earth is not a closed system. Energy from the sun is like a giant generator powering life on earth. Plants increase the order and complexity in their own bodies as they grow from seed to flower (using the sun's light directly plus the minerals and water in the earth and the carbon from the atmosphere). Herbivores use the energy in plants, carnivores use herbivores, and so on. So a huge cascade of complexity is built on the very simple source of energy from the sun.

6 If the earth were a closed system, then every living organism on earth *would* be defying entropy on a daily basis. But . . .

7 The earth is not a closed system; thus, respiration, growth, reproduction, and evolution happen on earth on a daily basis without violating the Second Law of Thermodynamics.

8 Many physicists think the universe as a whole is a closed system. That is, not only will the sun burn out some day with the result that life on earth will no longer have the external energy source it needs (actually worse things will probably destroy life on earth before that, as the sun will probably expand and cook everything well before it burns out), but eventually all the energy in the universe — currently arranged like the muffins in the closed box — will even out to the point where no order will exist at all. When the muffins are all the same temperature, the game is over.

9 However, many physicists think that long before the universe falls into total entropy, other things will happen to the overall structure of the universe, so it hardly makes sense to talk about the entire universe as a closed system anyway.

One caveat: Do not look for the muffin example to cover all of physical theory comprehensively. It discusses entropy in terms of the classical theory of thermodynamics. Quantum mechanics and relativity theory put a different spin on it. Since we do not really have conservation of energy in general relativity, it is hard to say what a really comprehensive thermodynamics will look like once the physicists work it out. However, the more Einsteinian versions of thermodynamics thus far all look far worse for the anti-evolutionist objection than does the classical theory. For a more advanced treatment of classical thermodynamics, see <http://www.entropylaw.com/>.

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Getting Physical

It is not only evolution that is under attack by creationists. Physics, too, is beset. Sometimes physics is misused in order to impugn evolution, as in the perennially popular charge that evolution is thermodynamically impossible — occasionally accompanied by the theological gloss that the Second Law of Thermodynamics is a consequence of the Fall! Sometimes the deliverances of modern physics — especially with respect to the origin of the universe and the age of the earth — are rejected. Small wonder, then, that the American Physical Society noted, "The issues raised by such proposals [to teach creationism in the public schools], while mainly focused on evolution, have important implications for the entire spectrum of scientific inquiry, including geology, physics, and astronomy." For accounts of thermodynamics, the Big Bang, and the age of the earth, ranging from the basic to the technical, check out the following books, all of which are now available through the NCSE website: <http://www.ncseweb.org/bookstore.asp> — look in the "In the latest *RNCSE*" section. And remember, every purchase through the website benefits NCSE!

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

Thermodynamics

The Second Law
PW Atkins
Out of print, but well worth the search, *The Second Law* presents a nonmathematical account of the Second Law of Thermodynamics, teeming with vivid examples, ideas, and images. "Mention of the Second Law," Atkins notes, "raises visions of lumbering steam engines, intricate mathematics, and infinitely incomprehensible entropy. ... In this book I hope to go some way toward revealing the workings of the [Second] Law, and showing its span of application." Originally published in the Scientific American Library series in 1984, and republished, with updates, in 1994 as a paperback. The reviewer for *Nature* described it as "[a] lovely book, beautifully illustrated and presented."

Evolution as Entropy,
second edition
by Daniel R Brooks and EO Wiley
Originally published in 1986, with a second edition following in 1988, *Evolution as Entropy* ambitiously sought to argue that living systems manifest growing complexity and self-organization as a result of increasing entropy (contrary, of course, to the canard that evolution is thermodynamically impossible). Reviewing *Evolution as Entropy* for *BioEssays*, Niles Eldredge commented, "Though no one (probably including the authors themselves) will be inclined to think the book an unmitigated success, it will suffice to report that it is a provocative and stimulating exploration of a line of theoretical analysis that is sure to be followed up extensively in years to come."

Biological Thermodynamics
by Donald T Haynie
From the publisher: "*Biological Thermodynamics* provides an introduction to the study of energy transformations for students of the biological sciences. Donald Haynie uses an informal writing style to introduce this core subject in a manner that will appeal to biology and biochemistry undergraduate students. ... Each chapter provides numerous examples taken from different areas of biochemistry, as well as extensive exercises to aid understanding. Topics covered include energy and its transformation, the First Law of Thermodynamics, the Second Law of Thermodynamics, Gibbs Free Energy, statistical thermodynamics, binding equilibria and reaction kinetics, and a survey of the most exciting areas of biological thermodynamics today, particularly the origin of life on Earth."

At Home in the Universe
by Stuart A Kauffman
"The emerging sciences of complexity begin to suggest," Kauffman writes, "that the order [of the biological world] is not at all accidental, that vast veins of spontaneous order lie at hand. Laws of complexity spontaneously generate much of the order of the natural world. ... Such veins of spontaneous order have not been entirely unknown, yet they are just beginning to emerge as powerful new clues to the origins and evolution of life." Stephen Jay Gould wrote, "Kauffman has done more than anyone else to supply the key missing piece of the propensity for self-organization that can join the random and the deterministic forces of evolution into a satisfactory theory of life's order."

<http://www.ncseweb.org/bookstore.asp>

The Big Bang

The Origin of the Universe
by John D Barrow
"How, why, and when did the universe begin? How big is it? What shape is it? What's it made of? These are questions that any curious child might as, but they are also questions that modern cosmologist have wrestled with for many decades," writes John D Barrow in introducing his popular book on cosmology, one in the Science Masters series. Barrow is Professor of Astronomy at the University of Sussex and is the author of several popular books, of which the latest is *The Infinite Book: A Short Guide to the Boundless, Timeless and Endless* (New York: Pantheon, 2005).

Introduction to Cosmology
by Barbara Ryden
The publisher writes, "*Introduction to Cosmology* provides a rare combination of a solid foundation of the core physical concepts of cosmology and the most recent astronomical observations. The book is designed for advanced undergraduates or beginning graduate students and assumes no prior knowledge of general relativity. ... The book is unique in that it not only includes recent major developments in cosmology, like the cosmological constant and accelerating universe, but also anticipates key developments expected in the next few years, such as detailed results on the cosmic microwave background. For anyone interested in cosmology or astronomy."

The Big Bang, third edition
by Joseph Silk
The publisher writes, "Our universe was born billions of years ago in a hot, violent explosion of elementary particles and radiation — the big bang. What do we know about this ultimate moment of creation, and how do we know it? Drawing upon the latest theories and technology, the new edition of *The Big Bang* is a sweeping, lucid account of the event that set the universe in motion. Award-winning astronomer and physicist Joseph Silk begins his story with the first microseconds of the big bang, on through the evolution of stars, galaxies, clusters of galaxies, quasars, and into the distant future of our universe." Silk is the Head of Astrophysics and Savilian Professor of Astronomy in the Department of Physics at Oxford University.

The First Three Minutes, updated edition
by Steven Weinberg
A classic exposition of the Big Bang by a winner of the 1979 Nobel Prize in Physics, *The First Three Minutes* sought to explain "the new understanding of the early universe that has grown out of the discovery of the cosmic microwave radiation background in 1965." The afterword in the updated edition of 1988 discusses developments in cosmology since 1976. Writing in *The New Yorker*, Jeremy Bernstein remarked, "one comes away from his book feeling not only that the idea of an original cosmic explosion is not crazy but that any other theory appears scientifically irrational."

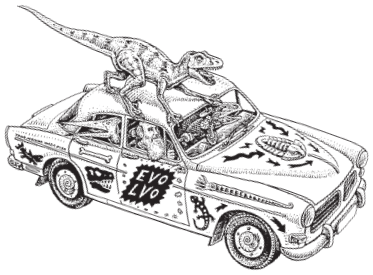
The Age of the Earth

The Age of the Earth
by G Brent Dalrymple
The Age of the Earth begins with a plain answer: "Four and one-half billion years." But keep reading! Dalrymple's comprehensive, authoritative, and altogether magisterial account of the methods used to determine the age of the earth is, according to the reviewer for *The Quarterly Review of Biology*, "an enormously important book written by an expert for the general scientific public. It is must reading for all interested in the antiquity of nature." Dalrymple, a Supporter of NCSE and a recipient of the National Medal for Science, is Professor Emeritus in the College of Oceanic and Atmospheric Sciences at Oregon State University.

Ancient Earth, Ancient Skies
by G Brent Dalrymple
Whereas *The Age of the Earth* was aimed at the general scientific public, *Ancient Earth, Ancient Skies* is aimed at the common reader, and it succeeds magnificently in clearly explaining the methods and results used by scientists in ascertaining the age of the earth and of the universe. Writing in *RNCSE* (2005 Jan–Apr; 25 [1–2]: 45–6), Timothy Heaton described *Ancient Earth, Ancient Skies* as "a much-needed contribution to scientific education ... [that] takes a pivotal and complex topic and makes it very easy to understand by non-scientists. ... This book deserves a place in every school and public library."

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

Time's Arrow/Time's Cycle
by Stephen Jay Gould
In *Time's Arrow/Time's Cycle*, Stephen Jay Gould reconsiders the discovery of deep time by focusing on "the three cardinal actors on the British geological stage — the primary villain and the two standard heroes," that is, Thomas Burnet, James Hutton, and Charles Lyell. Challenging textbook orthodoxies and Whiggish triumphalism in the history of geology, *Time's Arrow/Time's Cycle* was praised by the reviewer for the *Times Higher Education Supplement* as carrying "an enthusiasm, intelligence and sense of purpose that render it a worthy follower to Gould's earlier work." Gould was a Supporter of NCSE until his death in 2002.



NCSE on the Road

A Calendar of Special Events, Presentations, and Lectures

Date June 4–9, 2006
City Pacific Grove CA
Presenter Eugenie C Scott
Title Creationism, Intelligent Design, and Evolution
Time 2:00 PM (each day)
Event Westar Summer Institute
Location Asilomar State Beach
Contact Eugenie C Scott, scott@ncseweb.org

Date October 11–14, 2006
City Albuquerque NM
Presenter NCSE staff
Title (Booth in the exhibit hall)
Time TBA
Event National Association of Biology Teachers National Convention
Location Albuquerque Convention Center
Contact Nick Matzke, matzke@ncseweb.org

Date October 19–21, 2006
City San Francisco CA
Presenter NCSE staff
Title (Booth in the exhibit hall)
Time TBA
Event California Science Education Conference
Location Bill Graham Civic Auditorium
Contact Nick Matzke, matzke@ncseweb.org

NCSE Speakers Available

Name Eugenie C. Scott
Title NCSE Executive Director
Contact scott@ncseweb.org

Name Andrew J Petto
Title NCSE Board Member
Contact editor@ncseweb.org

Name Glenn Branch
Title NCSE Deputy Director
Contact branch@ncseweb.org

Name Wesley R Elsberry
Title NCSE Information Project Director
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Name Nicholas J Matzke
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Name Susan Spath
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continued from page 26

For example, suppose that two cubes of matter at temperatures of 11 K and 9 K are brought together, 99 Joules of heat spontaneously flow from the hotter to the colder cube (as shown), and the cubes are separated. If the heat capacities of the cubes are so large that their temperatures remain essentially constant, the change in entropy of the entire system is

$$\Delta S = \frac{Q_{colder}}{T_{colder}} + \frac{Q_{hotter}}{T_{hotter}} = \frac{99}{9} + \frac{-99}{11} = 11 - 9 = +2 \text{ J/K.}$$

Notice that this change of entropy is a positive quantity. The entropy of any system tends to increase, as energy flows spontaneously from hotter to colder regions.

The Entropy of Sunlight

To examine the change of entropy necessary to generate life on earth, begin with a square, one meter long on each side, at the same distance from the sun as the earth (93 million miles) and oriented so that one side fully faces the solar disk. The amount of radiant power that passes through this area is called the solar constant, and is equal to 1373 Joules/second (Lide 2004–5: 14-2). In the absence of the earth's atmosphere, the entropy of this sunlight would equal this energy divided by the temperature of the sun's surface, known from spectroscopy to equal 5780 K. The result would give the entropy of this amount of sunlight as 0.238 J/K every second.

A more sophisticated analysis of the energy and entropy that reaches the surface of the earth is given by Kabelac and Drake (1992: 245). Due to absorption and scattering by the atmosphere, only 897.6 J of energy reaches one square meter of the earth's surface through a clear sky every second (731.4 J directly from the solar disk, and 166.2 J diffused through the rest of the sky). For an overcast sky, all the energy is from diffuse radiation, equal to 286.7 J, according to Kabelac and Drake's model. The entropy that reaches this square meter through a clear sky every second is 0.305 J/K (0.182 J/K directly from the solar disk, and 0.123 J/K diffused through the rest of the sky). For an overcast sky, all the entropy is from diffuse radiation, equal to 0.218 J/K (see figure, p 32).

So, for one square meter on the earth's surface facing the sun, the energy received every second from a clear sky is 897.6 J, and the entropy received is 0.305 J/K. If we are to apply these numbers to a study of life on earth, we must spread these quantities over the entire earth's surface (of area $4\pi r^2$) rather than the cross-section of the earth (of area πr^2) that receives the rays perpendicular to the surface. Therefore, these numbers must be reduced by a factor of 4 to represent the energy and entropy that an average square meter of the earth receives every second, as 224.4 J and 0.076 J/K, respectively.

The Entropy Budget of One Square Meter of Land

The average temperature of the earth's surface is 288 K (= 15° C = 59° F) according to Lide (2004–5: 14-3). To maintain this temperature, that one square meter must radiate 224.4 J of energy back into the atmosphere (and ultimately into outer space) every second. The entropy of this radiation is

$$\Delta S = \frac{Q}{T} = \frac{224.4}{288} = 0.779 \text{ J/K.}$$

Assuming sunny skies, this one square meter of ground gains 0.076 J/K of entropy every second from sunlight, and produces 0.779 J/K every second by radiating energy back into the sky for a net entropy creation rate of 0.703 J/K every second. In effect, the earth is an entropy factory for the universe, taking individual high-energy (visible) photons and converting each of them into many low-energy (infrared) photons, increasing the disorder of the universe. As long as life on earth decreases its entropy at a rate of 0.703 J/K or less per square meter every second, the entropy of the universe will not decrease over time due to this one square meter of earth, and the Second Law will be obeyed.

How much energy and entropy are contained in life on the earth's land surface, compared to a lifeless earth? The average biomass occupying one square meter of land is between 10 and 12 kg, mostly as plant material (Bortman and others 2003: 145). Taking 11 kg as an average, we can calculate how much energy it would take to create this biomass from simple inorganic chemicals. This can be done by reversing the process, and asking how much energy is released when combustion reduces plant life to ashes. The answer is the heat of combustion, which for wood (which we may take as representative of plant life) is 1.88×10^7 J/kg (Beiser 1991: 431). Multiplying these two numbers together, the energy required to generate the amount of life currently found on an average square meter of land is 2.07×10^8 J.

If this life is generated at the earth's average temperature of 288 K, its entropy decrease will be

$$\Delta S = \frac{Q}{T} = \frac{2.07 \times 10^8}{288} = 7.18 \times 10^5 \text{ J/K.}$$

The earth's bodies of water are relatively sterile, and can be ignored; if life on land can be generated, the sparse amount of life in water can certainly be generated as well.

What the Laws of Thermodynamics Tell Us

We are now able to determine what restrictions the laws of thermodynamics place upon the evolution of life on earth. According to the First Law of Thermodynamics, heat is a flow of energy and must obey the Law of Conservation of Energy. The average square meter of land surface on earth receives 224.4 J of energy from the sun every second, and contains

2.07×10^8 J of energy stored in living tissue. The ratio of these two values is

$$\frac{2.07 \times 10^8}{224.4} = 9.22 \times 10^5 \text{ seconds} = 10.7 \text{ days.}$$

If all the solar energy received by this square meter is used to create organic matter, a minimum of 10.7 days is required to avoid violating the First Law of Thermodynamics.

The Second Law of Thermodynamics states that in an isolated system, the entropy tends to increase. The average square meter of land may balance the entropy increase due to radiation by generating a maximum entropy decrease of 0.703 J/K every second through the growth of life without violating this law. The difference in entropy between this square meter with life and the same square meter in the absence of life is 7.18×10^5 J/K. The ratio of these two values is

$$\frac{7.18 \times 10^5}{0.703} = 1.02 \times 10^6 \text{ seconds} = 11.8 \text{ days.}$$

A minimum of 11.8 days is required to avoid violating the Second Law of Thermodynamics.

The Third (and final) Law of Thermodynamics, which states that S = 0 J/K for a pure perfect crystal at 0 K, has no application to creationism.

Conclusion

Shades of a Creation Week! As long as the evolution of life on earth took longer than 10.7 or 11.8 days, the First and Second Laws of Thermodynamics are not violated, respectively. Even for an overcast sky, these numbers increase to merely 33 and 43 days respectively. As evolution has obviously taken far longer than this, the creationists are wrong to invoke entropy and the laws of thermodynamics to defend their beliefs.

Of course, solar energy is not going to be converted into the chemical energy of organic compounds with 100% efficiency. It takes a growing season of several months to reestablish the grasses of the prairie, and forests can take centuries to regrow. What this study has shown is that the time constraints for these two laws are very similar. Can creationists seriously argue that there has not been enough time for the sun to provide the energy stored in the living matter we find on earth today? If not, then they cannot honestly rely on entropy and the Second Law of Thermodynamics to make their case, either.

References

Beiser A. 1991. *Physics*. 5th ed. New York: Addison-Wesley.

Bortman M, Brimblecombe P, Cunningham MA, Cunningham WP, Freedman B, eds. 2003. *Environmental Encyclopedia*. 3rd ed. New York: Gale Group.

Kabelac S, Drake FD. 1992. The entropy of terrestrial solar radiation. *Journal of Solar Energy Science and Engineering* 48 (4): 239–48.

Lide DR, ed. 2004–2005. *CRC Handbook of Chemistry and Physics*. 85th ed. Boca Raton (FL): CRC Press.

Morris HM. 1989. *The Long War Against God*. Grand Rapids (MI): Baker Book House.

Ross H. 2004. *A Matter of Days*. Colorado Springs (CO): NavPress.

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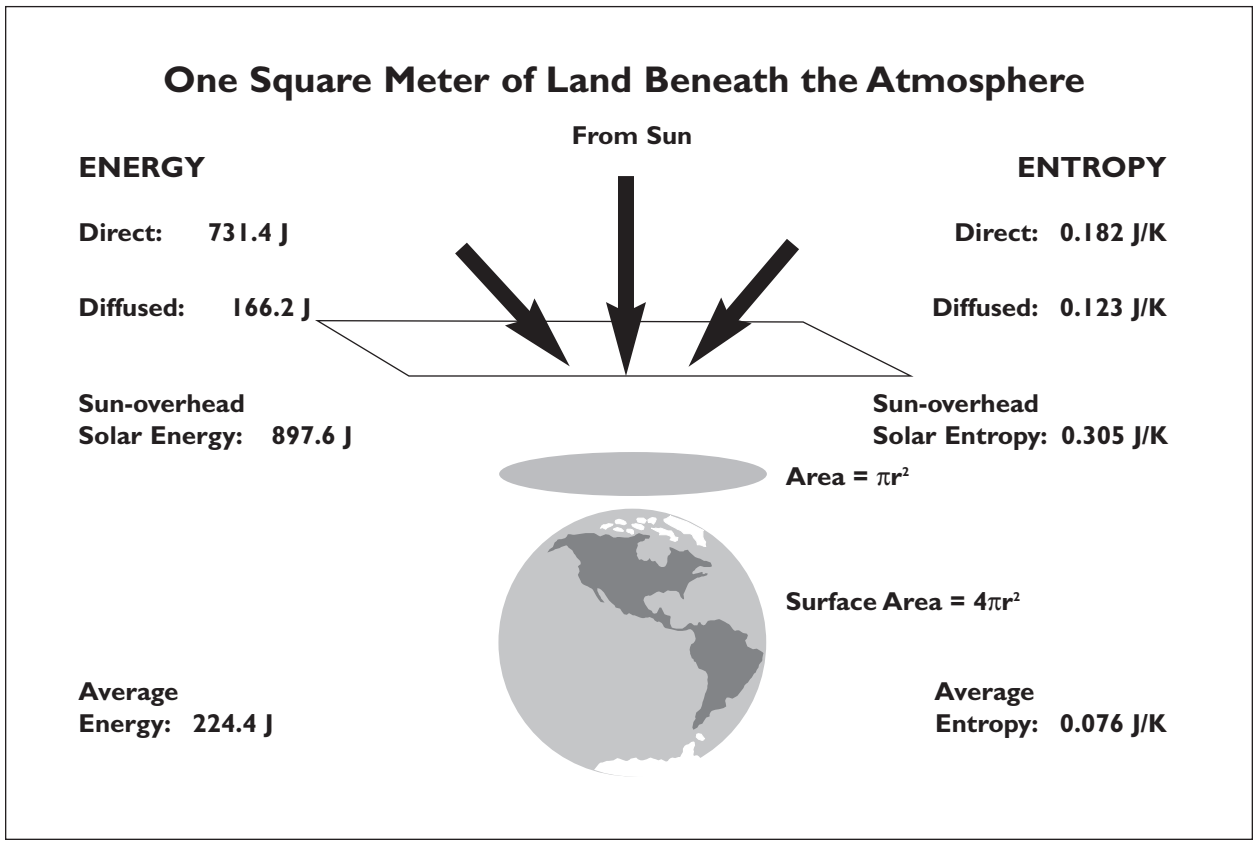


The Life Science Prize

Michael Zimmerman, University of Wisconsin, Oshkosh

In February 1870, Alfred Russel Wallace, the co-founder with Charles Darwin of the concept of natural selection, responded to an advertisement in a journal entitled *Scientific Opinion* placed by members of the Flat Earth Society. The event, most recently told by Ross Slotten in his biography of Wallace (*The Heretic in Darwin's Court: The Life of Alfred Russel Wallace*, New York: Columbia University Press, 2004), was described by Wallace as "the most regrettable" incident in his life. The ad enticed Wallace because, short on funds, he saw an easy way to make some money. The Flat Earthers "offered a prize of £500 to anyone who could prove that the earth was a sphere."The society said it was ready to put up £500 if the contestant would match. An impartial judge would review the evidence and award the money to the winner. As Slotten says, "The offer was perhaps too good to be true, but because of his knowledge of the techniques of land surveying Wallace knew that he could easily win the bet." Indeed, he did — but the Flat Earthers began years of lawsuits and harassment of Wallace.

On February 14, 2004, a slow Saturday, I received an e-mail from a Teno Groppi inviting me to contend for the "Life Science Prize". Like the Flat Earthers over a century earlier, Groppi and his friends outlined a contest in which both parties would put money in escrow and a "judge" would decide on the winner. Groppi said the "Life Science Prize" required a $10 000 deposit from me and from my presumptive opponent, one Joseph Mastropaolo. Groppi went on to add, "If the evolutionist proves evolution is science and creation is religion, he wins the $20 000. If the creation scientist proves that creation is science and evolution is religion, then the creationist collects the $20 000. The standards of evidence will be those of science: objectivity, validity, reliability and calibration. The preponderance of the evidence prevails." Groppi concluded his note with the following challenge: "If the task is too threatening for individual evolutionists, Dr Mastropaolo will entertain suggestions for terms that will bolster the courage of Darwinian dogmatists."

Coming to Terms

Having decided years before that it is futile to debate creationists, and knowing full well that the "Life Science Prize" was a scam designed to lure the unsuspecting into just such a debate, I decided to have some fun. I immediately wrote back saying how pleased and proud I was to be invited to contend for the prize. I also outlined my terms: "We would agree, at the outset, on our definitions. ... For a definition of evolution, we would use that which is in virtually every biology textbook for the past half century: Evolution is a change in allele frequencies in a population over time. For creation we would use that promoted by the Creation Research Society.

"Members of the society," I continued, "had to sign the following oath attesting to the fact that they believe in the following:

1) The Bible is the written Word of God, and because we believe it to be inspired thruout [*sic*], all of its assertions are historically and scientifically true in all of the original autographs. To the student of nature, this means that the account of origins in Genesis is a factual presentation of simple historical truths.
2) All basic types of living things, including man, were made by direct creative acts of God during creation Week as described in Genesis. Whatever biological changes have occurred since creation have accomplished only changes within the original created kinds.
3) The great flood described in Genesis, commonly referred to as the Noachian Deluge, was an historical event, worldwide in its extent and effects.
4) Finally, we are an organization of Christian men of science, who accept Jesus Christ as our Lord and Savior. The account of the special creation of Adam and Eve as one man and one woman, and their subsequent Fall into sin, is the basis for our belief in the necessity of a Savior for all mankind. Therefore, salvation can come only thru [*sic*] accepting Jesus Christ as our Savior.

Alternatively, if you prefer a simpler definition of creation, I would be happy to go with that offered by the now defunct Bible-Science Association. Their statement of faith reads: 'Belief in Special Creation; Literal Bible Interpretation; Divine Design and purpose in Nature; a Young Earth; a Universal Noachian Flood; Christ as God and Man—Our Savior; Christ-Centered Scientific Research.'"

I went on to address two additional points. "You talk about some debate. That confuses me. I'm not sure what the contest you propose has to do with a debate. Certainly you are not implying that a collection of individuals who are not necessarily educated in science, religion, or philosophy somehow serve as the judge for this contest.

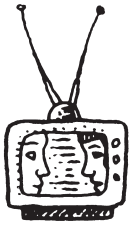
"You also talk about handing the money to 'the judge,' which leads me to believe that you do not really mean that there will be a debate of the sort alluded to above, but you fail to mention who the judge might be. I propose that we select an individual with impeccable credentials in both science and religion. Perhaps someone like Dr Francisco Ayala. He

Michael Zimmerman, an evolutionary biologist, is Dean of the College of Letters and Science at the University of Wisconsin, Oshkosh.

is a past president of the American Association for the Advancement of Science, a member of the National Academy of Science, as well as an ordained [priest]. Of course I would be open to someone else, as long as his or her credentials were appropriate. At a bare minimum, I would require that the judge be a member of the National Academy of Science. I would then propose that both Dr Mastropaolo and I submit a text of, say, no more than 2000 words to the judge outlining our case. The judge will then determine the winner."

"Negotiations"

Groppi wrote back telling me that "change in allele frequency is about as meaningless a definition of evolution as can be offered." And then the fun really began. I had been copying Mastropaolo on my e-mails, and he too railed against my proffered definition of evolution and provided his own "rules" for the debate, including his own definitions. He asserted, for example, that "evolution is the development of an organism from its chemicals to its primitive state to its present state." And he said that the "judge" would be "a superior court judge" since, after all, "there is no science outside the intellectual jurisdiction of the superior court judge." He also began a series of *ad hominem* remarks by stating that I "may not be competent to contend for the Life Science Prize."



I responded by indicating that I might be able to make arrangements for a federal district judge from the 9th circuit in California (assumed to be the most liberal circuit in the country) to serve. Alternatively, I said that I could get a local judge in Wisconsin to participate if he preferred. I also said that, through my connections as a consultant a number of years back to NBC, I might be able to attract the interest of either *Dateline* or Jay Leno. And, I added, that because of my past work as a nationally syndicated newspaper columnist, I should be able to generate some fairly hefty media attention — but he would have to firm up the rules and the definitions, as well as set a firm date for our contest. Mastropaolo repeatedly told me that I had the rules and continued with various *ad hominem* attacks. He wrote, for example, "Evolutionist hallucinators so out of touch with reality are psychotic by medical dictionary definition, and therefore not mentally competent to contend for the Life Science Prize."

When I repeatedly said that the "rules" I had been given made no sense, Mastropaolo composed an e-mail to me in the name of Teno Groppi. He chastised me for not "paying attention," and then, under Groppi's e-mail header pasted in rules from his own web page saying that I had been given those rules days before.

Knowing the opposition

After completing a web search to try to figure out who Mastropaolo was, I sent messages to some of the organizations with which he claimed to be affiliated. I wrote, for example, to the Institute for Creation Research where Mastropaolo claimed to hold adjunct faculty status. The response I got back was fascinating: "Dr Mastropaolo is not on ICR's staff." When I wrote back numerous times pointing out that Mastropaolo regularly claimed affiliation with ICR, I was told that while, in fact, he did hold adjunct status, it did not mean anything and that they did not want to correspond with me any longer!

Mastropaolo was also listed on the advisory council of the Kolbe Center for the Study of Creation, so I wrote to the director, Hugh Owen, explaining about the e-mail fabrication undertaken by Mastropaolo. We engaged in quite an extended exchange while Owen claimed to be "investigating" the matter. Somewhat surprisingly, he asserted what I can only call a belief in situational ethics when he claimed that "in our Catholic Christian tradition, the morality of an action depends on the object chosen, the circumstances of the action, and the end in view," and asserted that Mastropaolo did not really do anything wrong because *my* motives were not pure enough! He then demanded that I apologize to Mastropaolo for my attempts to destroy his reputation or he would contact my "superior".

After I told Owen how to file a formal grievance against me at the University, he wrote a letter to my Vice Chancellor demanding that he do something about my unfair attacks on Mastropaolo. Needless to say, nothing came of his letter. (Indeed over the past two decades, at two different institutions, my supervisors have received many such letters complaining about me because of the very public stances I've taken in support of evolution and sound environmental practices.) Owen also said that he would no longer correspond with me, adding, "I will continue to hope and pray that we will meet in Heaven one day."

Are they really serious?

My experience with the Life Science Prize extended over two months, involved detailed correspondence with numerous people, all of whom made it clear that they would refuse to discuss the matter any further, and each resulted in a letter of complaint to my supervisor. Since the level of frustration evidenced by my correspondents continued to rise with every e-mail, and since the *ad hominem* attacks on me increased over time, I consider the experience to have been a great success. And none of this even considers the fun I was having responding to each e-mail pointing out the lack of substance in the responses I was receiving while begging for an opportunity to work out an agreeable arrangement to permit me to contend for the Life Science Prize. Because all of this was done in a semi-private setting, with copies of the e-mail exchanges being distributed to a select group of people, the circus-like atmosphere usually associated with "debates" never took place.

One last point! Although the rules associated with the Life Science Prize were similar to the challenge to which Alfred Russel Wallace responded, apparently anti-evolutionary forces took their challenges more seriously a century ago; the "winner" of the Life Science Prize would walk away with $20 000 while the "winner" of the flat earth challenge would have earned approximately $91 980 in today's dollars.

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Non-Mineralized Tissues in Fossil *T rex*

Joe Skulan, University of Wisconsin, Madison

In the March 25, 2005, issue of *Science*, paleontologist Mary Schweitzer and her co-authors reported the discovery of intact blood vessels and other soft tissues in demineralized bone from a 65-million-year-old specimen of *Tyrannosaurus rex* housed at the Museum of the Rockies (MOR). Scientists' reaction to this discovery has been cautious; Schweitzer and others have not provided the biochemical data necessary to decide whether or not the "flexible vascular tissue that demonstrated great elasticity and resilience" is, in fact, *T rex* soft tissue. But while scientists have been appropriately skeptical of Schweitzer's claim, many young-earth creationists improperly have seized on it as evidence that the *T rex* fossil from which Schweitzer extracted the putative soft tissue, and fossils generally, are not more than a few thousand years old.

The absolute ages of all fossils ultimately hinge on radiometric dating techniques, the validity and accuracy of which are beyond reasonable doubt. These techniques are derived from the pre-eminent scientific enterprise of the 20th century: nuclear physics. If we did not know enough about radioactive materials to date things, then we would not be able to build atomic bombs. I would eagerly admit that the earth was young if it meant that A-bombs were not real, but that Faustian bargain has been made and we must live with it. Multiple analyses using several independent radiometric techniques show that the rocks in which the MOR *T rex* was found are about 65 million years old. The age of this fossil is a settled fact.

The question that I want to ask here is why creationists see the preservation of soft tissue as evidence that the MOR *T rex* is relatively modern. The answer lies not in the muddled thinking of creationists, but in the careless and ambiguous way that paleontologists themselves discuss "fossils" and explain how fossils form.

Fossils and Fossilization

While "fossil" originally referred to anything that originated in and was dug out of the earth, including gems and metals, the term in English has been used mainly in its modern sense since the early 19th century. But what is this modern sense? This turns out to be a difficult question to answer. Ignoring a handful of etymological fundamentalists, for the past few centuries "fossil" has had two distinct meanings: the remains or traces of ancient life (the time-based definition), and an object of biological origin that has undergone the process of "fossilization" (the process-based definition). The creationist challenge to the age of the MOR *T rex* is an equivocation based on this dual definition:

1. A fossil (time-defined) is old.
2. The MOR *T rex* is not a fossil (process-defined) because the presence of soft tissue demonstrates that it is not fossilized.

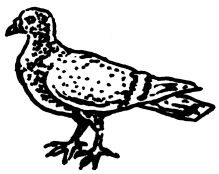
Therefore, the MOR *T rex* is not old.

The argument is invalid because each of the premises defines "fossil" in a different way. Few arguments used by creationists are as easily refuted as this, because most errors in creationists' reasoning are not simple logical fallacies, and arise instead from misinterpretations of empirical evidence and hence requiring detailed refutation. But the equivocal use of "fossil" is not a creationist invention; it is a bad habit that they learned from paleontologists themselves.

It is curious that a term so central to their science should be used so carelessly, but paleontologists rarely differentiate the two definitions of "fossil," and often use them interchangeably, even in situations that demand precision, such as in reference books. For example, Herve Bocherens (1997: 111) writes:

> The chemical composition of *fossilized* vertebrate tissues is the result of the uptake, exchange, and loss of chemical elements, in two different sets of circumstances. First, during the life of the animal. ... Second, during the diagenetic evolution of the mineralized tissues (i.e., *fossilization*) this original organization of the chemical elements is altered ... [emphasis added]

Statements such as these are so common in paleontological litera-



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ture — especially as throw-away remarks in prefaces and introductions — that they tend to roll smoothly off the brain without critical evaluation. But this passage is quite ambigious. *Fossilization,* here defined as the "diagenetic evolution of the mineralized tissues," is a process. Unmineralized tissues apparently cannot undergo *fossilization*. But can unmineralized tissues be *fossilized*?

"Fossilized" also implies a process-dependent definition of "fossil," because, under the time-dependent definition, becoming a fossil simply is a matter of getting old, something that hardly qualifies as a process; calling a bone "fossilized" simply because it is old would be as meaningless as calling an old chair "antique-ized." So if unmineralized tissues can be fossilized, then there must be some way of becoming fossilized other than through fossilization, and *T rex* soft tissue could be described as "unfossilization-ized fossilized tissue." But if unmineralized tissues cannot be fossilized, this would imply that unmineralized tissues cannot be fossils. What, then, are "fossil" leaves, soft-body animal "fossils", and petrified wood?

The topic of Bocherens's article is not fossils *per se*, and the problems I point out here have no real bearing on the bulk of his excellent and informative article. Nevertheless Bocherens's confused discussion of "fossilized" and "fossilization" is typical of the careless way that many paleontologists use "fossil," especially when discussing "unusual" fossils such as ancient soft tissue.

For example, in reference to the purported *T rex* soft tissue in an interview with a BBC reporter (BBC 2005), Schweitzer said:

> This is fossilised bone in the sense that it's from an extinct animal but it doesn't have a lot of the characteristics of what people would call a fossil.

As with Bocheren, this statement sounds reasonable until you think about it. "Characteristics of what people would call a fossil" presumably refers to decay of soft tissue, petrifaction or some other process. But what does "fossilized bone in the sense that it's from an extinct animal" mean? Here Schweitzer clearly intended to use "fossil" in the time-defined way, but instead of simply using the word "fossil", she adds the chronological qualifier "from an extinct animal" to "fossilized" — a term that connotes process. This leads to exactly the same confusion that we encountered in Bocheren. And again, as with Bocheren, I do not mean this as a critique of Schweitzer's science. I cite these passages in order to demonstrate that we think so little about how we use "fossil" and related terms that even careful and accomplished scientists use them in careless and ambiguous ways.

What We Don't Know

What accounts for this confusing hybrid terminology? The answer is the widespread assumption that the two definitions of "fossil" are logically dependent on each other; either because organic remains must be fossilized in order to become old enough to be a fossil, or because as things become old they inevitably become fossilized. These assumptions belong to the vast netherworld of scientific pseudoknowledge; bits of received wisdom that crowd encyclopedias and textbook introductions; answers to questions so basic and obvious that they are overlooked as things that must have been thoroughly discussed and decided generations ago. In the conflict over Schweitzer and her colleagues' discovery, pseudoknowledge confronts pseudoscience.

The standard textbook account of "fossilization" might be termed the "Tin Man" story: soft tissues decay, the resulting cavities are filled with minerals precipitated from groundwater, and the original biominerals transform into or are replaced by other substances. This process results in a replica of the original object in which the original substance has been heavily altered and largely or entirely replaced by other materials.

The Tin Man story of fossilization is something of a fossil itself, having been around in essentially its present form since at least the end of the 18th century. The third edition of the *Encyclopedia Britannica*, published in 1795, describes "Petrafaction" as follows:

> A petrified substance, strictly speaking, is nothing more than the skeleton, or perhaps image, of a body which has once had life, either animal or vegetable, combined with some mineral. Thus petrified wood is not in that state wood alone. One part of the compound or mass of wood having been destroyed by local causes, has been compensated by earthy and sandy substances, diluted and extremely minute, which the waters surrounding them had deposited while they themselves evaporated. These earthy substances, being then moulded in the skeleton, will be more or less indurated, and will appear to have its figure, its structure, its size, in a word, the same general characteristics, the same specific attributes, and the same individual differences. Farther, in petrified wood, no vestige of ligneous matter appears to exist.

More modern variants simply embellish this story with chemical language, substituting atoms, molecules, or minerals for "diluted and extremely minute" substances, for example. Pulling a book off my shelf at random, I encounter this:

> After an animal dies, if it is to become a fossil, it must be buried before the elements destroy the carcass, completely.... After burial, minerals carried by percolating groundwater are deposited in vugs within the bone structure, or they may actually replace bone salts, literally turning the bone to stone. (Jacobs 1993: 47)

Both passages give readers the sense that scientists have a pretty good understanding of what happens to fossils in the ground. In reality we have no such understanding. Indeed, it is only in the past 15 years that paleontological geochemists begun to address, in a serious and organized way, basic questions about why some things endure long enough to become fossils. To date, these efforts have

revealed important details about the chemical behavior of some fossils in some settings, but we are a long way from the kind of systematic knowledge implied by the cited passages.

The new understanding we do have of fossils unfortunately has been used to revamp and reinforce the Tin Man story, rather than to challenge it. For example, in the introduction to their textbook on dinosaurs, Fastovsky and Weishampel (2005: 8–10) write:

> Bone is made out of calcium (sodium) hydroxyapatite, a mineral that is not stable at temperatures and pressures at or near the surface of the earth. This means that bones can change with time, which in turn means that most no longer have original bone matter present after fossilization. This is especially likely if the bone is bathed in the variety of fluids that is associated with burial in the earth. ... If, however, no fluids are present throughout the history of the burial … the bone could remain unaltered, which is to say that original bone mineralogy remains. This situation is not that common, and is progressively rarer in the case of older and older fossils.

This explanation of what happens to buried bones is vastly better than most. It makes the important but seldom articulated point that bone will not necessarily decay just because it is unstable, and leaves open the possibility that unaltered bone and soft tissues can survive. The authors make no implausible claims, and it is possible that a century from now we will know that everything they wrote was entirely correct.

But we are not living a century from now, and in the meantime much of what Fastovsky and Weishampel present as fact is really educated conjecture. We do not know that most fossil bone no longer contains its original bone material; we do not know that for bone to survive unaltered it must be isolated from fluids throughout its history; most importantly we do not know that the preservational state of bone is directly related to its age. As in the previously quoted passages, Fastovsky and Weishampel present their story of how things become fossils as if it were based on well-understood facts. And their story still largely is the Tin Man story: except under extraordinary conditions, fossils undergo the same replacement process that was expounded in the *Encyclopaedia Britannica* over 200 years ago.

It is this habit of presenting conjecture and tentative knowledge as settled fact that makes paleontologists vulnerable to creationist attacks based on "extraordinarily" well-preserved fossils. In reference to the MOR *T rex*, the ICR claims:

> Would evolutionary theory have predicted such an amazing discovery? Absolutely not, soft tissue would have degraded completely many millions of years ago no matter how fortuitous the preservation process. Will evolutionary theory now state — due to this clear physical evidence — that it is possible dinosaurs roamed the earth until relatively recent times? No, for evolutionary theory will not allow dinosaurs to exist beyond a certain philosophical/evolutionary period. (Sherwin 2005)

The discovery of intact *T rex* soft tissue indeed would challenge prevailing scientific thinking, if not, as the author claims, "evolutionary theory". This discovery can be reconciled with the Tin Man story only by invoking extraordinary causes. These invocations come across as makeshift attempts to prop up an exhausted hypothesis — which in fact they are. From the same BBC article previously cited:

> Dr Schweitzer is not making any *grand claims* that these soft traces are the degraded remnants of the original material — only that they give that appearance.
>
> She and other scientists will want to establish if *some hitherto unexplained fine-scale process* has been at work in MOR 1125, which was pulled from the famous dinosaur rocks of eastern Montana known as the Hell Creek Formation. (BBC 2005; emphasis added)

Rich Deem, writing at the creationist site godandscience.org, explains:

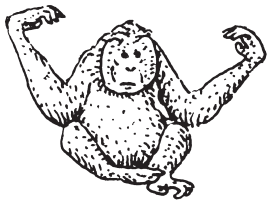
> [Schweitzer] indicated that the bones have a distinct odor, characteristic of "embalming fluids." Therefore, it is possible that the bones landed in *some chemical stew* that preserved the soft tissue inside from decomposition….The new study reveals that the cortical bone within *T rex* [femora] may, under certain conditions, retain cellular and subcellular details. Under normal conditions, fossilization replaces living material with minerals. In this case, the soft tissue was protected from degradation, *possibly through some chemical process*, then desiccated to prevent further changes. (Deem nd; emphasis added)

Creationists know a weak spot when they see one, and dodgy phrases like "some hitherto unexplained fine-scale process" and "some chemical stew" advertise a weak spot like a giant gorilla balloon over a used car lot. The fact that the weakness is in our understanding of fossils, not of evolution or the age of the earth, is a subtle distinction that creationists do not make and their audience does not grasp.

Often the best defense is a frank admission of ignorance. "How do you explain the presence of soft tissue in a 65 million year old fossil?" Based on what we really know about fossils (and assuming the soft tissues are real and not just globs of glue) the best answer to this journalistic question is "I have no idea. But since we don't know very much about why things become fossils in the first place, that's not surprising. What we *do* know is that this particular fossil is 65 million years old." Neat narratives like the Tin Man story are betrayals of the honest ignorance that is the heart and engine of science.

Things Fall Apart

Everyday experience teaches us that dead organisms and their



traces do not last long when they are exposed to the ordinary wear and tear of the earth's surface: scavengers of all sizes, the effects of sunlight, mechanical and chemical weathering, and so on. From this experience it is easy to apprehend the notion that things spontaneously fall apart unless some process intervenes to preserve them. To the extent that "fossilization" means anything, it means preservation from destruction.

Organic remains must not be destroyed if they are to endure, yet there is a subtle but important error in jumping from this tautology to the view that preservation is an active process. Preservation is nothing more than the evasion of the process of decay. Decay, not preservation, is the active process; and decay can be avoided in many — perhaps in infinitely many — ways. If nothing happens to stop it, a dead organism will become a fossil. This applies to all parts of the organism, soft tissues as well as hard.

Imagine that, before you leave your house in the morning, you put a rock on your kitchen table. When you return home that evening, you expect the rock to be there. It would never occur to you to think of a cause for its still being there, because things that do not happen do not have causes. If nothing happened to change it, the rock still would be there after a week, or a year or a hundred years. *Not* finding the rock where you left it is what would demand an explanation, regardless of how long you left the rock untended.

This reasoning would also apply if you built a house of cards on your kitchen table. A house of cards is intrinsically less stable than a rock, so upon your return you would not be surprised to find that it had collapsed. In fact, you might be surprised to find it still standing, especially if you had been gone for a long time or you owned cats. But even so, if the house of cards did survive, you would not invoke a special process to explain this. You might say "I didn't expect that — it must be stronger than I thought," but I doubt that you would ask yourself what stabilizing force, or process, intervened to spare your creation. Merely extending the time that you left the house of cards standing would not change this. If you checked back in a billion years from now you would be amazed to find your continent in the same place you left it, not to mention your kitchen and its tabletop sculpture. But if you did find the house of cards intact, it still would not demand a cause. Again, things that do not happen do not have causes.

The same is true of fossils. We may be surprised to find fragile structures and materials, that in ordinary experience are impermanent, preserved after millions of years; but preservation does not have a cause. Preservation simply means that *nothing has happened*. This is not to deny that the continued existence of fossils has explanations, and it is true that certain conditions strongly favor the preservation of fossils; but these explanations and conditions are not the *cause* of the fossil's survival, any more than not taking a pain killer is the cause of pain. The fossil owes its survival to its own intrinsic stability.

The Stability of Unstable Things

No part of any organic remain is absolutely stable. For example Fastovsky and Weishampel are correct when they note that apatite in bone is unstable at surface temperature and pressure. Indeed bone apatite is unstable at *any* pressure and temperature and will tend to recrystalize into other, more stable, minerals. But, as Fastovsky and Weishampel point out, this does not mean that bone mineral actually will make this change. The mere fact that something is unstable does not mean that it will decay, just as the fact that a house of cards is unstable does not mean that it will fall down. Decay happens only if the bone is in an environment that permits it.

But even if we know that a material is unstable and is in an environment that permits it to decay, we still know nothing about how quickly that decay will happen. It can be easy to determine the thermodynamic stability of materials, but it is notoriously difficult to predict the rate at which an unstable material actually will decay into something else, or even if it will decay at all. All forms of carbon other than carbon dioxide are thermodynamically unstable in the earth's oxygen rich atmosphere, yet we live in a world full of carbon-based paper, plastic, tables, clothes, and carpets; and have adopted one of the most thermodynamically unstable forms of carbon, the diamond, as a symbol of permanence. Many familiar minerals, including pyrite, feldspar, and quartz, are unstable on or near the earth's surface. Yet we do not marvel at the discovery of intact grains of quartz in half-billion year old sandstone.

Human versus Chemical Time

The crux of the creationist argument that the MOR *T rex* could not be more than a few thousand years old is the commonsense idea that the older the fossil, the more altered it will be. This also is part of the Tin Man story. But the relationship between age and alteration is not as straightforward as common sense would suggest, because the humans experience time differently than molecules and atoms.

The various processes that cause decay tend to work on very short time scales. As humans, we would regard a chemical compound that completely degrades after one minute as extremely unstable, but from a molecule's point of view a minute is a very long time. A molecule that has survived for a minute has beat the odds; it has survived trillions of bond-straining vibrations and contortions, and assaults from an army of chemical agents that destroy most molecules almost the instant they form.

Radioactivity provides us with a well-studied example of how decay processes work. Atomic nuclei contain protons and neutrons. In theory protons and neutrons could be combined in an infinite number of ways. For example, we could combine one proton with 100 neutrons and make a nucleus of hydrogen-101. But this nucleus would be so unstable that it would break apart the instant that it formed. Almost all conceivable combinations of protons and neutrons are so unstable that for all practical purposes they cannot exist.

There are about 4800 exceptions, nuclides that are stable

enough to be studied. About 400 of these nuclides are so stable that they are called "stable nuclides": they either do not decay, or decay so slowly that we have not observed it. The remaining 4400 nuclides are known to decay, with half-lives ranging from a few millionths of a second to over one trillion years.

Among these unstable nuclides, the median half-life is about two minutes. This means that if you randomly assembled nuclei and measured the half lives of those that were stable enough to hold together for a millionth of a second or so, the average half life would be about two minutes. From a human point of view, two minutes is a very short time. But in the first two minutes of its existence, nature has expended half of its destructive arsenal at any randomly constructed nucleus; such a nucleus will experience the same total intensity of destructive forces during its first two minutes that it will experience during the next trillion years. In terms of the likelihood of decay, two minutes is half way to a trillion years. About 97% of unstable nuclides have half-lives shorter than 75 years. So, from a nuclide's point of view, a human lifespan and the age of the universe are about the same.

The same is true of the molecules and crystals that make up organic remains. When thinking of how a dead plant or animal decays, we tend to concentrate on processes that occur on time scales that are easy for humans to observe, and then extrapolate these into the future. But humans observe only the very early stages of decay, a period corresponding to the first few minutes in the life of a nuclide. Even so, we observe the same steep decline in the rate of decay that nuclides display. A raccoon that dies in your attic will decompose rapidly for a month or so, but thereafter will change little for many years. Unless someone moves it, the coyote skull on my shelf will still be there tomorrow, 20 years from now, and 1000 years from now.

From the point of view of a fossil, 1000 years probably is a lot closer to 100 million years than it is to a month. If the preservational state of a fossil correlates in any law-like way with its age, it most likely is with the nth root of its age, and not its age directly.

Conclusion

Anyone who believes that fossils must undergo radical transformations in substance that are proportional to their age will always be confounded by discoveries such as those reported by Schweitzer and others (2005). For over 100 years the scientific world regularly has been surprised by accounts of fossil bones that are so "extraordinarily well preserved" that microscopic details, such as the cavities left by bone cells, still can be seen. Yet such preservation is not only common, but in some categories of fossils it is the rule. Probably most fossil bone preserves microscopic detail, and exquisite preservation also is common in plant, mollusk, and many other kinds of fossils.

Exquisite preservation is surprising only because it clashes with poorly supported preconceptions about what fossils are and how they form, preconceptions that are reflected in loaded yet ambiguous terms like "fossilization." We cannot properly describe any fossil as "extraordinary" unless we first know what "ordinary" is. This is something that paleontologists only are beginning to understand.

The creationists have found a real weakness in the way scientists discuss fossils and hardly should be blamed for using this weakness to their advantage. The creationist challenge provides us with a good opportunity to clarify our thinking, and with object lessons in the dangers of using poorly defined terms when clarity is needed, and substituting time-honored narrative for real knowledge.

References

[BBC] British Broadcasting Corporation. 2005 Mar 24. *T rex* fossil has "soft tissues". Available on-line at <http://news.bbc.co.uk/1/hi/sci/tech/4379577.stm>; last accessed May 1, 2006.

Bocherens H. 1997. Chemical composition of dinosaur fossils. In: Currie P, Padian K, editors. *The Encyclopedia of Dinosaurs*. San Diego: Academic Press. p 111–17.

Deem R. nd. Dinosaur soft tissue found in *T rex* bones. Available on-line at <http://www.godandscience.org/youngearth/dinoblood.html>; last accessed May 1, 2006.

Fastovsky DE, Weishampel DB. 2005. *The Evolution and Extinction of Dinosaurs*. 2nd ed. New York: Cambridge University Press.

Jacobs L. 1993. *Quest for the African Dinosaurs: Ancient Roots of the Modern World*. New York: Villard.

Schweitzer MH, Wittmeyer JL, Horner JR, Toporski JK. 2005. Soft-tissue vessels and cellular preservation in *Tyrannosaurus rex*. *Science* 307: 1952–5.

Sherwin F. 2005. The devastating issue of dinosaur tissue. *Acts and Facts* 34 (6): 5. Available on-line at <http://www.icr.org/pdf/af/af0506.pdf>; last accessed May 1, 2006.

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Judge Jones Speaks

Federal judge John E Jones III, who presided over *Kitzmiller v Dover*, was interviewed by the *Philadelphia Inquirer* (2006 Feb 26; available on-line at <http://www.philly.com/mld/inquirer/news/editorial/13961518.htm>).

Jones said that he addressed the controversial issue of whether "intelligent design" qualified as science because "both sides, plaintiffs and defense, asked me to rule on that issue." He also clarified his statement that "no one [was] in a better position to decide" the issues than he was, explaining, "What I meant was that no one else had sat through an intensive six weeks of largely scientific testimony."

Jones remarked that he wanted the opinion "to stand as a primer so that folks on both sides of the issue could read it, understand the way the debate is framed, see the testimony in support and against the various positions," adding, "it's now evident that it's being used that way."

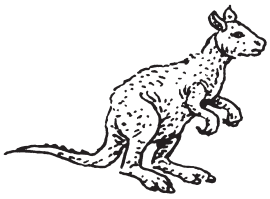
Asked to discuss his ruling further, Jones replied, "The opinion speaks for itself." But in light of the length and completeness of the testimony in the case, he added: "To my mind ... it would be a dreadful waste of judicial resources, legal resources, taxpayer money ... to replicate this trial someplace else."

Framing the Issue: The "Theory" Trap

David Morrison

There is little indication that the hostility of a large part of the American public to the teaching of evolution is abating, in spite of recent court wins. We seem to be losing the battle to explain the central role that evolutionary concepts play in modern science, as indicated by the many sad and disturbing stories in the Jan–Apr 2005 issue of *RNCSE*.

While there are no "silver bullets" in this struggle, there are ways to improve our communications with the public and decision makers, such as school boards. The most obvious is to stop referring to the "theory of evolution". "Theory" is the wrong word for public discourse. In America today, everyone understands "theory" to be a synonym for an unproven hunch or guess. No wonder that a majority of those polled agreed that "evolution is commonly referred to as the theory of evolution because it has not yet been proven scientifically." Those who advocate adding "only a theory" disclaimers in textbooks know that to call evolution a theory is sufficient to undermine its acceptance.



We encounter this problem in almost every discussion of evolution, including those reported in the Jan–Apr 2005 issue of *RNCSE*. Typical is the comment from the Texas legislator quoted on page 16: "Evolution is a theory ... It is a theory, not a fact." The most common rejoinder is to explain that a scientific theory is. William Wisdom, in his fine three-minute statement (p 10), feels he must say, "It is important to understand that scientists do not use the word 'theory' to mean a hunch or a guess or even a hypothesis." Dina Drits in her article on preventing misconceptions in elementary education says that teachers of even young children "should explain the difference between the scientific usage of a term such as 'theory' and the vernacular usage." Most of the formal statements made by professional organizations in support of evolution devote several sentences to explaining that "theory" has a different meaning in science.

In other contexts, a theory is a hunch that a detective comes up with in a murder mystery. It is one of several competing ideas, none of them proved. It is common to say that something is theoretically true, while the facts are otherwise. We should accept this usage. Is it wise, before asking someone to consider that their opinions about evolution might be wrong, to require that they accept a contrary definition for a familiar word? Anyone who teaches knows how hard it is for students to unlearn things they already know and believe.

Words, too, evolve. Just as we no longer use the term "gay" for any light-hearted pleasure (remember the carol with the verse "don we now our gay apparel"?), we need to drop the anachronistic use of "theory". In college science or philosophy classes we can retain the older meanings of words such as "theory" and "hypothesis", but we should not expect the public to revert to this usage.

Even among scientists, however, I rarely hear the "theory of" phrase. When is the last time you read about the Theory of Gravitation, or the Atomic Theory of Matter, or the Theory of Plate Tectonics? These phrases have a vaguely antique flavor. Today, gravitation and atoms and plate tectonics are accepted as legitimate subjects that do not need the preface "Theory of …". The only two areas I know where "Theory of" remains in common use are Theory of Relativity and Theory of Evolution. Among the public, relativity is associated with Einstein, an unworldly genius whose work was abstract and unintelligible. Is that the kind of association we want for evolution?

I suggest that the root problem is allowing the opponents of evolution to frame the discussion. *Framing* involves the selective use of language or context to trigger emotional responses, either support or opposition. The subject is artfully described in the short book by George Lakoff called *Don't Think of an Elephant* (White River Junction [VT]: Chelsea Green, 2004). Channeling the discussion into a debate over the "theory of evolution" is an example of framing.

One possibility is to refer to the fact of evolution. Another is to distinguish between evolution itself (change through time and common ancestry) and Darwinian (or neo-Darwinian) evolutionary theory. There was ample evidence for the fact of evolution even before Darwin, but he supplied the crucial understanding of the mechanism of natural selection. Today, insights from genetics are further clarifying the way evolution works. But in dealing with the public, I prefer discussing simply "evolution", the same way we might discuss plate tectonics or genetics or any other branch of science.

To debate the "theory of evolution" is a trap. It is letting our opponents frame the discussion for their benefit. Once we stop defending the theory of evolution, we are also free to criticize "only a theory" disclaimers in textbooks without apology or diversionary explanations.

David Morrison, a NASA planetary scientist and astrobiologist, is a recent recipient of the Carl Sagan Medal of the American Astronomical Society for his contributions to public understanding of science.

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YOU TELL ME THAT IT'S EVOLUTION ... *Arthur M Shapiro, University of California, Davis*

The study of natural hybridization and hybrid zones has been a lively area in population biology for decades. One of the longest-running case histories is that of the sulphur butterflies, *Colias eurytheme* and *Colias philodice*, which hybridize in cultivated alfalfa fields across most of temperate North America. Rather than having a distinct hybrid zone, they hybridize everywhere they are sympatric, but retain their identities nonetheless. In this regard they behave less like animals and more like plants (oaks, for example, which — to quote Daniel Axelrod — have been hybridizing since the Miocene, but "nothing ever comes of it!").

Discussions of what was "really" going on with *Colias* began in the 1880s and have continued despite numerous conceptual and methodological advances relevant to the problem. But no one had undertaken a study to track the system through many generations until 1981, when I initiated a long-term study of the frequency of hybridization and its relation to population density on a single ranch in northeastern California. The ranch's owner was bemused at, but fully supportive of, the exercise. I sampled every two weeks, following a strict protocol in exactly the same fields from 1981 through 2004; this amounted to approximately 66 generations of *Colias,* a unique data set in the annals of hybrid study.

As the study progressed, the owner grew old and became ill. He sold his ranch and retired, but the new owners let me continue the study. Last fall they informed me they intended to convert most of the fields where I sampled to a different crop. I figured that meant the end of the study, since data from another site would not be truly comparable to the previous data, but over the winter I wrote to the owners to explore potential options — basically to say I would come around in spring, observe the situation on the ground and decide whether or not to continue. I wrote on the letterhead of my academic unit at UC–Davis, the Section of Evolution and Ecology. My letter evoked the following reply, reproduced in its entirety, with the names of the senders deleted for privacy:

Dear Dr. Shapiro:

I am writing to let you know that we are ending our agreement that allows you to study the butterflies on our ranches. Until your letter last December, we were not fully aware of your position with the University. We did not understand that you represented the Dept of Evolution and Ecology. I do not believe that we are of the same conviction as to the creation of our earth. We strongly believe in a literal 6-day creation of earth, by God. That He and He alone sustains all living matter in an orderly fashion. We, as a family, do not support the study of evolution. Because of these differences, we would choose that you no longer continue your studies on our property. We hope and pray that through your studies of God's vast creation that you will come to know Him in a real and personal way.

Sincerely, /s/ Mr and Mrs X

So the study is over, we are finally analyzing the data (and the timing could not have been better), and for the first time in my now 40-year career I have encountered creationism as a factor in my research program. From a sociological standpoint, I am intrigued by the first-person singular pronoun used by the writer of the letter, which nonetheless is signed by Mr and Mrs X (in that form, in one handwriting). Ah, me.

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I know a place ... *Phil Plait, Sonoma State University*

I know a place where the Sun never sets.

It's a mountain, and it's on the Moon. It sticks up so high that even as the Moon spins, it's in perpetual daylight. Radiation from the Sun pours down on it day and night, 24 hours a day — well, the Moon's day is actually about 4 weeks long, so the sunlight pours down there 708 hours a day.

I know a place where the Sun never shines. It's at the bottom of the ocean. A crack in the crust there exudes nasty chemicals and heats the water to the boiling point. This would kill a human instantly, but there are creatures — bacteria — that thrive there. They eat the sulfur from the vent and excrete sulfuric acid.

I know a place where the temperature is 15 million degrees, and the pressure would crush you to a microscopic dot. That place is the core of the sun.

I know a place where the magnetic fields would rip you apart, atom by atom. It is the surface of a neutron star: a magnetar.

I know a place where life began billions of years ago. That place is here, the earth.

I know these places because I'm a scientist.

Science is a way of finding things out. It's a way of testing what's real. It's what Richard Feynman called "A way of not fooling ourselves."

No astrologer ever predicted the existence of Uranus, Neptune, or Pluto. No modern astrologer had a clue about Sedna, a ball of ice half the size of Pluto that orbits even farther out. No astrologer predicted the more than 150 planets now known to orbit other suns. ... But scientists did.

No psychic, despite their claims, has ever helped the police solve a crime. But forensic scientists have ... and do all the time.

It wasn't someone who practices homeopathy who found a cure for smallpox or polio. Scientists did: medical scientists.

No creationist ever cracked the genetic code. Chemists did. Molecular biologists did.

They used physics. They used math. They used chemistry, biology, astronomy, engineering. They used science.

Those places I talked about before — you can get to know them too. You can experience the wonder of seeing them for the first time, the thrill of discovery, the incredible, visceral feeling of doing something no one has ever done before, seen things no one has seen before, know something no one else has ever known.

No crystal balls, no tarot cards, no horoscopes. Just you, your brain, and your ability to think.

Welcome to science. You're gonna like it here.

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[*Originally posted at <http://www.badastronomy.com/bablog/> and reprinted with permission.*]

Response to John C Greene

As I read John C Greene's, "Impressions of the Claremont Conference & Ernst Mayr" in *RNCSE* (2004 Sep/Oct; 24 [5]: 34–7) I became annoyed, nay, incensed, at the conclusions stated in his last two paragraphs.

I found it unacceptable that someone writing for an NCSE publication would even wonder or suggest that to beat the creationists' efforts at removing the teaching of evolution from the public schools, it would be necessary to give evolution "some kind of religious meaning". For justification of his musings, Greene refers to Denis Alexander of St Edmund's College, Cambridge University, and cites his credentials as being that of a molecular immunologist who is also an ardent Christian and an ardent Darwinian. And why is Greene so enamored of these credentials? Because, as he states: "Alexander finds the biblically-based critical realism of the Bible a solid, intellectually coherent, and morally inspiring framework for both science and religion."

There are several advertent or inadvertent implied insults in Greene's conclusion. First, he is insulting anyone who refuses to accept the concept that the "Bible" refers to the Christian Bible. Jews have the original Bible, called the Tanakh (Holy Scriptures or the Holy Books), which the Christians derogatorily refer to as the "Old" Testament. Mormons have a Bible called *The Book of Mormon* and of course, the Moslems have the Koran. He insults those of us who find the Christian Bible to be a morally repugnant religious-political document that has been, for dozens of centuries, and still is the cause of some of the greatest evil that one human could ever inflict on another. How quickly and conveniently people tend to forget the lessons of history.

Greene is insulting anyone who does not "believe" in the Bible. He seems to dismisses completely the possibility that others have not and do not find the Christian Bible to be intellectually coherent and morally inspiring. Thomas Jefferson, no slouch when it comes to being an intellect, saw fit to edit the Christian Bible to make it coherent and morally fit for his consumption.

In addition to these implied insults, Greene adds one more: asking rationalists to accept as valid the typical religious claim to knowledge — the appeal to religious authority and not to empirically derived data. Without knowing more about Alexander's specific beliefs, I cannot comment knowledgeably about how an evolutionist could still believe in a concept such as original sin. As I explain in my book, *The Naked Mind* (Flagstaff [AZ]: Best Publishing, 2003), evolution, by its very nature, destroys the underlying basis of Christianity.

Greene goes on to say that students should be "given a chance to discuss the question freely." There seems to be the implication that this has not been done before. I did it on the college level. Discussing evolution with students who do not even know what science is and what are the basic differences between science and religion is a waste of time. One must spend a considerable amount of time explaining these subjects if there is going to be hope of any meaningful discussion. I discussed issues pertaining to evolution and creationism with non-science majors in the life sciences (Introduction to Biology) and the history of biology courses I taught at the University of South Alabama for over 15 years. I can attest to the fact that trying to teach these subjects to students who are awash with religiosity is very difficult. My experiences have been detailed in *The Naked Mind*.

Greene's suggestion, of having students discuss controversial subjects, without proper foundation, sounds more like a bull session than one designed to teach and enlighten. Before suggesting that these issues be aired in classrooms either at the K–12 or college level so that a variety of student opinions could be heard, Greene and others ought to make sure that students and teachers, irrespective of how open-minded they are, understand the material I mentioned in the preceding paragraph, and also understand fully the meanings of the word "belief" and its derivatives. The subject of belief also is covered in *The Naked Mind*.

As I used to tell my students: This is the USA. You have the constitutional right to believe whatever rationality or irrationality you want. I am not interested in your beliefs — I have had students witness to me — I am interested in what you know and how you know it.

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Reply from John C Greene

Sheldon Gottlieb, ignoring the main body of my "Impressions of the Claremont Conference," becomes enraged that I should suggest the possibility that the struggle to repel creationist attacks on the teaching of evolution in the public schools might be more successful if "evolution" could be given some kind of religious meaning. Phillip Johnson was inspired to lead the crusade against evolution by reading Richard Dawkins's *The Blind Watchmaker*. "To every action there is an equal and opposite reaction," Newton said in a quite different context, but perhaps the same is true in the battle over evolutionary science. Alfred North Whitehead offers a way of giving evolution religious meaning, as John Cobb and David Griffin have shown. Denis Alexander offers a Christian way of ameliorating the conflict. Still other ways are available.

Gottlieb describes himself as a rationalist who believes the test of truth is "empirically derived data". Thomas Jefferson wrote: "We hold these truths to be self-evident: that all men are created equal …" Does evolution prove that, or does Jefferson mean "created equal in the sight of God"? Jefferson was a deist believing in a Creator. During the controversy over the Missouri Compromise he wrote in a letter to a friend: "Indeed I tremble when I think that God is just and that his justice will not sleep forever."

As to discussing controversial issues with students brought up in different intellectual and religious environments without pre-indoctrinating the students, I learned how to do that teaching the Great Books at the University of Chicago, working with students, some of whom were of high school age. When three such students came to my office to ask me: "Dr Greene, is it true that Freud can explain Luther?" I replied: "Yes, that is true. But it is also true that Luther can explain Freud. It all depends on what your terms of explanation are." Although Ernst Mayr was an atheist and I a Christian, we managed to conduct our two decades of "mutual education correspondence" (as Mayr called it) without rancor. His last letter to me, late in his life, concerning an essay of mine titled "Science and spirituality: A dialogue with Ernst Mayr," was signed "Affectionately yours, Ernst." Neither of us believed in "naked minds".

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The Buzz on Evolution in South Carolina

In a recent interview, South Carolina's governor, Mark Sanford (R), displayed a stunning degree of ignorance of evolutionary theory: "The idea of there being a, you know, a little mud hole and two mosquitoes get together and the next thing you know you have a human being is," he opined, "completely at odds with, you know, one of the law of thermodynamics." See *The Post and Courier* (Charleston) 2006 Jan 31; available on-line at <http://www.charleston. net/stories/?newsID=68174>.

Evolution and Religion

From time to time, readers will raise objections like Gottlieb's that RNCSE *in particular and NCSE in general go too far in accommodating religious traditions that grapple with the impact of evolution on their doctrinal positions. This is a good occasion to reiterate that NCSE is religiously neutral and takes no position on the validity of theological or doctrinal perspectives on the meaning and purpose of life. Neither does NCSE take any position on compatibility of evolutionary thinking with specific religious traditions, accepting that it is within the purview of those who follow these traditions to make these judgments.*

We recognize that much of the religious opposition to evolution has come from within a conservative Christian theological tradition, and so it is not surprising that most of the attention of NCSE programs that address the interaction of religious and scientific perspectives frequently focus on organizations representing these traditions. We acknowledge that opposition to evolution, as well as reconciliation with it, is not limited to theologically conservative Christians nor their particular interpretation of Scripture.

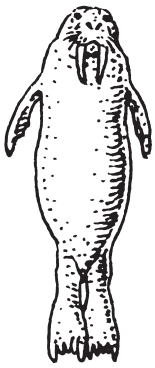
Still, as Greene suggests, finding a way to address the concerns of members of those religious traditions is an active arena in the science–religion dialog and one at which NCSE intends to be an active participant because of the benefits that we expect to accrue from a fuller and more accurate representation of evolution within these traditions.

BOOKREVIEWS

Into the Cool: Energy Flow, Thermodynamics and Life

by Eric D Schneider and Dorion Sagan
Chicago: University of Chicago Press, 2005. 362 pages

Reviewed by Sonya Bahar, University of Missouri at St Louis



As readers of *RNCSE* are undoubtedly all too aware, a familiar creationist argument runs as follows: since the Second Law of Thermodynamics says that disorder is increasing, how can evolution, which involves an increase in complexity, possibly have occurred? The answer has been repeated before almost every school board in the country, and in more than a few courtrooms: first, the Second Law of Thermodynamics addresses an increase in the *total* entropy of a system, but does not in any way preclude *local* decreases, and, second, there are other driving forces aside from the Second Law of Thermodynamics, as the last few decades of research on self-organization in complex systems have amply shown. *How* those other "organizing" forces actually drive evolution, self-organization, and complexity, however, remains a wide-open question and a very active area of interdisciplinary research.

Eric D Schneider and Dorion Sagan weigh in on the argument with their new book *Into the Cool: Energy Flow, Thermodynamics and Life*. Their central thesis is contained in the striking catchphrase "nature abhors a gradient"; they propose that it is the *flow of energy down gradients* that is the central driving force that balances the Second Law's drive toward disorder. It is a striking and provocative thesis and certain to inspire new ways of thinking in many scientists studying complexity in biological systems. Unfortunately, the catchphrase is unlikely to provide as sweeping a solution as the authors propose, and it is packaged in a book that suffers from a number of flaws likely to put off many readers. The book may aim for the sharp clarity of Richard Dawkins, or the charm and scintillating wit of Stephen Jay Gould (the flyleaf even makes a comparison to Darwin!). But, plagued by overblown hyperbole and intellectual sloppiness, it falls far short.

The book begins with a clichéd review of the history of science. Newton enters, straight out of central casting, accompanied by his faithful "clockwork universe", and endless references to apples. A wince-inducing chapter subheading reads: "Clunk *Goes the Clockwork Cosmos*". The section begins with a description of Robert Boyle's work in the "twilight of thermodynamics". One would think that authors who show a deep concern for time's arrow ("Thermodynamics had released the arrow of time," they write on page 36. "It went quivering into Newton's shiny smooth apple, generating heat as friction.") would appreciate the distinction between twilight (end of the day) and dawn (beginning), which is, historically, where Boyle was in relation to the history of thermodynamics. One might be struck by the quivering-arrow metaphor, but the metaphors fall too thick and fast to be taken seriously. "The wake-up call [of thermodynamics] is still reverberating in the collective scientific mind, still groggy from Newton's dreams." "Classical thermodynamics upset the Newtonian applecart." You get the idea.

The authors set up a false dichotomy between the "celestial clockwork" and thermodynamics, which "messed all that up. It measured loss, and implied that — despite the magnificent motions of the planets — time moves in only one direction. The direction of burning." But Newton was familiar with burning: he was an alchemist, whose mystical views strongly influenced his science. Neither scholars nor the readers of a popular science book (and *Into the Cool*, published by a university press, appears to aim to be more than that) should be treated to such a cartoon version of the history of science.

Having dispensed with Newton and Boyle, we enter the history of thermodynamics. Following a discussion of irreversibility, the authors' attempt at metaphor turns ugly as they refer to Ludwig Boltzmann's suicide as "an irreversible act". If this is an attempt at humor, it is unnecessary and cruel.

Into the Cool becomes equally problematic when it moves toward the exposition of the authors' "grand theory" that thermodynamic gradients drive evolution. This exposition, to the reader's great frustration, is approached, but never consummated. The *mechanism* by which a system's motion down a gradient leads to complexity remains unexplained, unless one can infer that this occurs simply because *competition for more efficient methods of exploiting gradients* drives evolution. The authors do make this point, but they constantly imply that more is going on than this — but what that "more" is, they never clearly articulate.

The authors replace clear exposition of a scientific idea by the use of sweeping metaphors that hold little substance. "Separate from the world, we are yet inextricably connected to it." (How are we separate from the world?) A paragraph later: "Metastable processes underlie the selves we mistake for things." And

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finally, one which had this reviewer's metastable self reaching for the unstable equilibrium of a stiff drink,"… the cyclical pendulum of scientific overreaction has perhaps reached its apex, coming to just that point where the potential energy of its historical emphasis is ready to give way to the kinetic energy of physics as a factor in macroevolutionary explanation" (p 152).

Excessive tendency toward metaphor and cliché could be forgiven, were it balanced by clear exposition of a strong idea. The idea of the central role of gradients in the organization of life is tantalizing, intriguing, and definitely worth pondering. But the authors never settle down to a clear exposition of how gradients lead to increased complexity. They skitter from one subheading ("Mousetraps and Dynamite", "Toward a Science of Creative Destruction", and so on) to another, never staying in one place long enough to build a coherent argument. The book is also frustratingly filled with scientific inaccuracies: bifurcation is confused with bistability (Figure 6.1), hysteresis is mistakenly defined as "retardation or lagging" (p 129), population biology is confused with population genetics (p 145), and on the same page we are told that "Darwin connected all living beings through time to a single origin." Did he?

More frustrating than the inaccuracies, and the arguments that begin but are never completed, are the arguments that simply make no sense. The authors decry algorithmic models of complexity, inexplicably conflating such models with the idea that the laws of physics change, and condemning both "inevitable casualt[ies] of a thoroughgoing evolutionary world-view." How does the emergence of complex structures from simple algorithmic rules relate to the notion of the gradual changing of fundamental constants of nature? If there is a connection, it is far from obvious, and it is certainly not explained.

Despite its inaccuracies and hyperbolic atmosphere, *Into the Cool* raises provocative questions as to the role of thermodynamic gradients in the origin of complexity and in evolution. It is a shame that Schneider and Sagan develop these ideas neither clearly nor fully, and fail to set them in the context of other well-studied influences on the development of complexity in living organisms. Had they done so, the authors might have made a much stronger case for the primacy of gradients.

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The Counter-Creationism Handbook

by Mark Isaak
Westport (CT): Greenwood Press, 2005. 330 pages

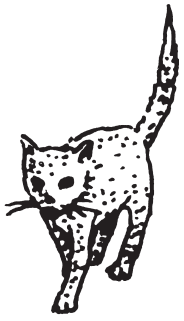
Reviewed by Tim M Berra, Ohio State University

Anti-evolutionists have taken aid and comfort from the political resurgence of the religious right as reflected in the 2004 election. "Intelligent design" creationists are aggressively pushing their agenda in nearly every state and hope to foist nothing less than a redefinition of science upon an unsuspecting public. The scientific illiteracy of the American public allows obfuscation of scientific topics such as global warming, embryonic stem-cell research, and evolution by the current administration. Within this context, Mark Isaak has produced a very useful "baloney detector".

The book rebuts over 400 creationist claims that range from clever to silly in straightforward explanations complete with print and on-line scientific references. The usual creationist chestnuts are all there, but so are hundreds of other weird ideas that are lesser known. The claims are divided into nine topics: philosophy and theology (33 pages), biology (60 pages), paleontology (40 pages), geology (32 pages), astronomy and cosmology (16 pages), physics and mathematics (10 pages), miscellaneous anti-evolution (4 pages), biblical creationism (44 pages), "intelligent design" (18 pages), and other creationism (2 pages). It is amazing that one person can be knowledgeable over all these diverse fields. The author, a computer programmer with a MS in biology from San Jose State University, is extremely well read on a wide range of topics. He has put a great deal of information at the reader's fingertips. Isaak is editor of the "Index of Creationist Claims" on the website <http://www.talkorigins.org>, and this book is an outgrowth of that activity.

The format presents a creationist claim in bold type, then expands it to cite a reference to the claim. This is followed by an eye-catching five-diamond design below which is the scientific rebuttal. Some replies are only a few sentences long; others require several pages. The following is a truncated exchange. Question: "If we are descended from apes, why are there still apes around?" Answer: "Humans and other apes are descended from a common ancestor whose population split to become two (and more) lineages. The question is rather like asking, 'If many Americans and Australians are descended from Europeans, why are there still Europeans around?'" Most topics are easy to follow; however, the explanations of geological dating methods are very technical.

Because the categories are so diverse, even professional scientists will benefit by reading the areas outside their specialties. Did you know that there are several localities where strata from all geological eras exist? Examples given are the Bonaparte Basin of Australia and the Williston Basin of North Dakota. The book also serves as a ready reference to articles you may have read recently, but have



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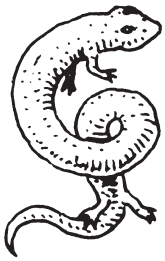
forgotten where to find them. For example, a computer simulation experiment that showed the evolution of complex organismal features was published in *Nature* in 2003. A check of the index under complexity will lead you to this paper by Lenski and others. Counterarguments to recent news items disparaging peppered moth evolution, Haeckel's embryo drawings, and fraudulent Chinese dinosaur/bird fossils are very usefully included. The book has four photos and four line drawings. The skull photographs on p 107 and the aerial views of flood- and non-flood-shaped terrain on p 239 are particularly effective.

Especially in light of recent endorsements of teaching "intelligent design" by prominent public figures such as President Bush and Senate Majority Leader Frist, the section on "intelligent design" creationism bears special mention. Isaak has some training in bioinformatics and his responses to "intelligent design" creationism are well done and most timely, if a bit repetitive and tedious. This section is most helpful for ideas when composing letters to the editor for local newspapers or for defusing creationist arguments to local school boards.



I have a few quibbles, but they are minor. On page 11, Isaak writes, "Biology without evolution is natural history, not biology." I would point out that it was observations in natural history that led Darwin to the possibility of evolution and that natural history is the study of nature, of which biology is a part. In response to the creationist claim "Evolution says you are descended from a monkey," Isaak does not take the opportunity to point out that no biologist says such a thing. Rather, great apes and humans share a common ancestor. On pages 5 and 205, Isaak calls creationism a theory. It is a religious idea, not a scientific theory. Although there is a section devoted to the scientific method, the steps of that method are not spelled out. No type of creationism utilizes the scientific method, and it is the stated goal of the "intelligent design" creationists to redefine science by allowing supernatural explanations. This would turn science on its head. In the discussion of homology on page 86, the author should have mentioned that homologous structures come from the same embryonic germ layer and have the same relationship of parts. In refutation of the creationist fabrication of a deathbed conversion by Darwin, the author does not mention a book devoted to tracking down that lie by one of Darwin's biographers, historian James Moore (*The Darwin Legend*, Grand Rapids [MI]: Baker Books, 1994). In a section on the age of the universe, Isaak gives the age of the earth but does not mention that cosmologists are homing in on 13–14 billion years as the age of the universe. These are small matters, and I suspect that a reviewer with a different background might pick up other omissions, but they do not detract from the merits of the book.

This is a very good and useful book, but at $65 it is much too expensive for the widespread dispersal that it deserves. I encourage the publisher to release an inexpensive paperback version immediately so teachers and concerned parents can own their own copies and will be willing to present them as gifts to school board members. Meanwhile, make sure your local public and school library orders a copy.

The cumulative effect of reading these anti-evolution arguments emphasizes how scientifically ignorant and/or dishonest many creationists are. Unfortunately, since this is a political struggle, not a scientific one, lack of knowledge is not necessarily an impediment in an anti-intellectual culture. It will be interesting to see if science can prevail at the political level in the culture wars with the religious right. Those of us who prefer research to revelation can arm ourselves with the information presented here by Isaak. But we must speak out to influence public opinion, school boards, and politicians. To paraphrase Edmund Burke, the only thing necessary for the triumph of ignorance is for knowledgeable people to do nothing.

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Organisms and Artifacts

by Tim Lewens
Cambridge (MA): MIT Press, 2004.
240 pages

Reviewed by John S Wilkins, University of Queensland

Everyone is tired of debates over "intelligent design" (ID), but equally, philosophers of biology are tired of teleology and functions. As Lewens, an up-and-coming philosopher of biology at Cambridge University, observes, teleology is "boring". Still, we might ask whether or not design in organisms and design in made things are sufficiently similar that we *can*, in fact, draw parallels between them as the ID devotees desire. So despite the fact that this book is about an arcane technical matter in the philosophy of biology, it may be useful to those attempting to come to grips with that other matter.

The context of this book is a recent claim, made by Lewens along with colleagues and collaborators Dennis Walsh, André Ariew, and Mohan Matthen, that natural selection is not, actually, a "force", as Elliot Sober had argued earlier that it was, more particularly, that selective explanations were Newtonesque and that it was a theory of forces. This makes sense if you think that selection can either cause or inhibit evolutionary change depending on how the forces are configured. But Lewens and friends hold instead that selection is the average expectations of the fitness of a population, and that the *actual* selective forces are unique to each case of selection. There is a useful and interesting discussion of the so-called etiological theory of functions, according

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to which a task is a function if tokens of that trait were selected in the past to do that task.

Then, we turn to engineering and artifactual functions. Adaptationist explanations have previously treated organisms as if they were designed, so Lewens therefore discusses the adaptationists approach of Dennett and others. "At least some of the conflict between those who call themselves adaptationists, and those who call themselves anti-adaptationists is, I suspect, a fight over nothing" (page 42). The two versions he calls the "weak" and "strong" reverse-engineering approach attempt to uncover the purpose of a trait in organisms or artefacts. Both rely strongly on the isomorphism of processes between natural selection in nature and design in culture. The major difference is that strong reverse engineering is too quick to conclude that because something *might* have been subjected to the sorts of selection pressures we conjecture, therefore they have been. (An old logical principle has it that if it is real, then it is possible, but not vice versa.) The weak version simply allows that it is *possible* that the artifact was designed/selected in some particular fashion.

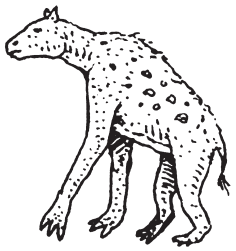
The general claim, which he calls the "artifact model", is this: selection works through filtering a range of available variants in the prior generation through selective pressures, resulting in the predominance of one or a few variants (rinse, repeat). Artifacts are made through a process by which a range of prior cultural resources present candidate solutions which pass through criteria for choice, resulting in one or a few artifacts. The process is isomorphic. The substrates are different, as are the processes of construction.

In ID claims, the priority is given to design, as if it were some magical kind of process. Lewens inadvertently puts the lie to this, noting that both design and selection are the same general kind of process. This is not a new claim — it was made (by Huxley) almost as soon as Darwin published. But it is worth repeating — design thinking as selectionist thinking is helpful to understanding and to problem solving. We find out how a system "solves" a problem this way. However, nothing in this approach presumes that forethought and special methods are involved in either case. We *may* plan ahead, but any engineer or designer will tell you that our designs and goals are one thing; what works is another.

Having put forward the artifact model, Lewens then examines how it relates to five "isms": adaptationism, developmentalism, constructivism, internalism, and externalism. Developmentalists accuse adaptationists of excluding form from functional accounts (he says). Constructivists, led by Richard Lewontin, hold that the conception of adaptation is problematic and ill-formed. Internalists focus on the endogenous properties of organisms, while externalists focus on the properties of their environments (a distinction due to Peter Godfrey-Smith). Lewens maintains that these polar opposites are in fact not opposites but areas in a conceptual map, as it were, in which the organisms can be reconceived in various ways as it suits us. They are aids to problem solving, in understanding how organisms solve problems. They are methodological positions. This discussion is mainly of interest to philosophers.

Chapter 5 is a useful primer on the literature about functions in philosophy of biology. Lewens asks why biologists, but not chemists or physicists, use teleological language when they explain their topics. Of the two main competing view of functions (the etiological, and Cummins's "causal role" [CR] account that a function is any trait that contributes to the capacity of the system), he thinks that a variant on Cummins's function is the better alternative to account for biologists' talk. But there are aspects of functions that CR fails to deal with — the explanatory nature of functional ascriptions (the function of hearts is to pump blood), the normativity of functions (normal hearts are there to pump blood) and the accidental aspects of organisms not being functional (a heart also makes a sound in the chest, but that is not its function). He contrasts this with the "intended effects" (IE) account of the functions of artifacts: that the function of an artifact is what an agent intended it to do.

There is much more in Lewen's book — what is of interest to the readers of this journal is its relation to ID, and there is, indeed, a short section on this (section 7.9). He notes that ID lacks a coherent notion of design and that intelligence is not explanatory in the abstract. As he has given an account of design that is formally equivalent to selection, this is a strong challenge, one I fear that will get exactly the same treatment that all other good-faith critiques of ID have received — stony silence or dismissal from ID's champions. For general readers the book has moderate interest; for those who wish to understand a more solid foundation for considerations of design and organisms, this is well worth a read.



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Icons of Evolution

by Jonathan Wells
Washington DC: Regnery, 2000.
362 pages

Reviewed by Matt Cartmill, Duke University

Why Much of What Jonathan Wells Writes About Human Evolution is Wrong

Why is Jonathan Wells so fiercely hostile to the notion of "Darwinian evolution" — so much so that he thinks this sort of science should be hustled out of America's textbooks and barred from federal research funding? As far as I can tell, what Wells wants to see is a more pious science — a biology that has room in it for God, spirit beings, providence, and miracles — and he regards Darwinian evolution as the greatest obstacle to bringing religious faith back into the natural sciences. He takes his cue here from some prominent

Darwinists who claim that if Darwin was right, then there is no design behind the order of nature. Wells accepts this implication, but prefers to work it backwards: the world is manifestly full of design and intentionality, and therefore Darwinism must be in error.

But how to prove it? A young-earth creationist might dismiss Darwin by quoting the literal words of Genesis; but Wells apparently accepts the geological evidence that the earth and its organisms are billions of years old. He also grants that ancient faunas are unlike modern ones, that species change through time, that descent with modification occurs, that natural selection can act to produce new adaptations, and that human beings are animals, at least as far as their physical bodies are concerned (p 4–5, 213, 245).

All these concessions to biology and geology do not leave Wells much room to evade the obvious Darwinian conclusion from the facts of the fossil record. The tactic he adopts is the argument *ad hominem* — dismissing Darwinism by discrediting Darwinists. In *Icons of Evolution*, he catalogs as many instances as he can where Darwin and other evolutionists have made mistakes, drawn unwarranted conclusions, or allowed their own biases to distort their interpretations. The implied question — "Why should we believe anything that these people say about anything?" — is not put quite that bluntly by Wells, but Michael Behe obligingly asks it in his blurb on the back cover.

Wells devotes his penultimate chapter to the study of human evolution. He begins by posting two theses from Darwin that he finds particularly objectionable: that human beings share ancestors with other animals (especially apes), and that natural selection acting on small variations has been mainly responsible for transforming animals into people. These two doctrines imply, he says, "that humans are nothing but animals, and they are not the pre-ordained goal of a directed process" (p 209).

In trying to dispel these odious corollaries, Wells does not offer any actual arguments for thinking that humans are something other than animals, or that our origins were divinely foreordained. That would be too difficult and too nakedly sectarian. He contents himself with trying to show that paleoanthropologists are hopelessly biased ninnies. Wells recounts the story of the Piltdown fraud and correctly observes that its success reflects the willingness of scientists to accept bogus evidence for ideas they want to believe. The perennial inconclusive squabbles among the experts about how many species of *Australopithecus* or *Homo* there were, and which is ancestral to what, are duly cataloged. The fact that artists can reconstruct a fossil as either more or less apelike by sticking different-looking ears and hair on it is displayed with a particular air of triumph, as if it were a closely guarded scientific secret. Wells quotes a lot of anthropologists (including me) who have complained that many of the tales scientists tell about human evolution are riddled with mythic elements, which express current cultural values and contain at least as much story-telling as genuine science. The evidence that Wells presents unquestionably proves that people who study evolution are capable of distortion, bias, and even fraud.

So — why *should* you believe anything that paleoanthropologists, or other evolutionary biologists, have to say about anything? The answer may come as something of a shock to Wells. Of course you should not *believe* anything that we say. You should not *believe* anything that any scientist says about anything. "Question authority" is a basic rule underlying the whole scientific method. That is why we are required to publish papers that spell out the materials, methods, and results that led us to our conclusions. You are invited to go get some of the same materials, carry out the same procedures, and see if you get the same results. If the reported phenomena prove to be bogus, let the world know about it. If you have a better interpretation, publish it. If you doubt what scientists say about human evolution, do not just take their word for it; look at the fossils on display in the museums, study the photographs and casts, visit the sites and look at their stratigraphy, learn about the biology of the relevant living animals, and see if you can come up with a better theory. If you can, you will be in for a fight from the partisans of the old theory, but we will all be indebted to you in the long run.

Of course, Wells does not have a better theory of human origins than Darwin's. He does not even want to find one. What he wants is to leave the door open for certain religious beliefs. But if he thought about it a little harder, he would see that that door is already open. Science has no way of closing it, because those beliefs have no testable implications. Conversely, Wells's religious beliefs — even if they are true beliefs — cannot serve as scientific explanations for the facts of biology

Consider those two Darwinian propositions that Wells objects to most strongly: that humans are descended from nonhuman animals and that the change was effected by natural causes. What are the alternative propositions he would prefer to adopt? Evidently, (1) that humans have no animal ancestors, and (2) that our species was brought into being miraculously by supernatural forces. Are these scientific hypotheses?

I guess Alternative Proposition #1 might be one in principle, though not in the way Wells intends. We can imagine evidence that might support it — say, if humans had no detailed molecular or morphological resemblances to other terrestrial creatures and the remains of a million-year-old spaceship were uncovered in Africa. But as Wells admits (p 223), that is not what the evidence looks like. Two centuries of scientific research have documented untold thousands of detailed chemical, anatomical, and behavioral similarities of humans to other animals.

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Scientists have found hundreds of what Wells grudgingly calls "apparently genuine" fossils, ranging in antiquity from around 6 million years down to less than 100 000 years, that are apelike in some respects and humanlike in others — and the older they are, the more apelike they look.

Like any creationist, Wells wants desperately to find an animal-human boundary somewhere in this assemblage. So do a lot of anthropologists, which is why the inconclusive squabbles persist. Should a fossil creature (*Homo habilis*) that had arms longer than ours but shorter than an ape's, and a brain smaller than ours but larger than an ape's, be classified in the long-armed, smaller-brained genus *Australopithecus*, or in our own genus *Homo*? Opinions differ. Since I entered graduate school in the 1960s, the consensus has swung from one opinion to the other, and now it seems to be swinging back again. Similar issues underlie other ongoing arguments over the phylogeny and classification of our fossil relatives — for example, the endless debate over the humanity of the Neandertalers. The perennial nature of these disputes does not imply that paleoanthropologists are dunces. Rather, it suggests that everybody is hunting for boundaries and dividing lines — and not finding them.

Wells stresses the scarcity of likely common ancestors for humans and the living apes in the fossil record between 10 million and 5 million years ago, leading the reader to infer that the "missing link" is still missing. But he carefully avoids pointing out that the fossil record of the human lineage from 5 million years ago onward is vastly richer, and manifests no sharp dividing lines between the ape and the human. The earliest hominid fossils we have are so apelike that specialists argue about whether some of them are on the human or the chimpanzee limb of the ape-human divide.

If there are not any boundaries, does that imply that humans are nothing but animals, as Wells fears? Of course not. A diamond is a chunk of carbon, and nothing else; but that does not mean it has the same market value as a piece of graphite. The way the constituents are put together makes all the difference. Even if human beings are animals, and nothing else, we can still be things that no other animals are. We can be Muslims, or Republicans, or biochemists, or embezzlers, or all four at once. Apes and dolphins and parrots cannot be any of these things. No one questions these facts. Do humans have immortal souls? Do other animals? Nobody knows — not Charles Darwin, not Jonathan Wells, and certainly not me. It is beyond the domain of scientific inquiry.

So is Alternative Proposition #2: the idea that human beings were brought into being by a special divine intervention in the natural order. Wells does not want to believe that people came into being through the uninterrupted workings of the laws of nature, because he thinks that this somehow implies that God had nothing to do with it. I respectfully suggest that Wells ought to read some more theology. From the standpoint of an eternal God who exists outside of time, a natural law is just an invariate pattern pervading a universal tapestry that has Space as its warp strings and Time as its weft. How can the existence of such an unvarying pattern possibly prove that the tapestry was not designed by a Creator — who presumably had that pattern in mind, along with all the details of the fabric, from the very foundation of the world? Some of the devout theists who brought about the scientific revolution in the 17th century argued the reverse, and they pointed to the happy outcomes of unvarying natural laws as proof of an all-wise Providence. The origin of humanity might have been one such foreordained happy outcome. A belief in divine providence does not entail a belief in miracles.

Maybe miracles do happen. Maybe the patterned fabric of the world is punctuated with rare, off-color spots where the patterns no longer obtain. But even if such spots exist, science cannot identify them as miraculous or supernatural. As far as science is concerned, an event that violates a supposed law of nature does not prove the existence of God; it just disproves the law. And since a miracle is by definition not a repeatable event, a science of miracles is a contradiction in terms.

Perhaps the most profound objection to invoking God as an explanation of biology was voiced back in the mid-1700s by David Hume. Hume noted simply that a finite effect can never provide evidence for an infinite Cause. It follows that no natural phenomena (which are necessarily finite) can require such a Cause for their explanation — and so nature cannot provide evidence for the existence of God. We can imagine finding proof of the existence of some sort of being with superhuman powers and intelligence. But we can never find reasons for thinking that such a being is infinite, or eternal, or omniscient. If "intelligent design" arguments of the kind Wells seems to favor held water, they might lead us to conclude tentatively that the earth was visited some 3 billion years ago by a race of skilled genetic engineers, who have come back every few million years since then to tune up their handiwork. Again, we can imagine finding ancient spaceships and other evidence that might support such a conclusion. But nothing we can learn about the observable world can ever demonstrate the presence of the eternal *I Am* of Abraham, Isaac, and Jacob. That does not mean that there is no God. It just means that science has nothing to say about the subject.

I do not find much to object to in Wells's catalog of the shortcomings and frailties of paleoanthropologists. Other and worse sins could be added to the catalog — for example, the racist theories of Ernst Haeckel and Eugen Fischer, which helped to fuel the fires of the Holocaust. We really do sometimes misread evidence, play down or conceal facts that upset our pet theories, fool ourselves into believing things that are not so, and smuggle our cultural, political, and religious biases into our stories about the causes of human evolution. In short, we scientists are fallible, finite, and human. But similar things could be said about the practitioners of any other science. (Consider, for example, the history

of scientific thought about the Martian canals, or the intimate connections between genetics and eugenics throughout much of the 20th century.) And a number of Wells's examples are themselves distorted or deliberately misleading, like the great show he makes of the irrelevant absence of missing links among Miocene apes.

In the final analysis, then, Wells's book is dishonest. If he had contented himself with complaining that evolutionists of an atheistic bent have unfairly tried to recruit their science to the service of their religious beliefs, I would be among the first to applaud. But he cannot assail the atheists' illogic at its roots, because he himself hopes to refashion biology to serve his own religious beliefs. If he had tried to put up some new, non-evolutionary explanation of the facts of biology, or to array novel evidence for discerning the hand of God in prehistory, I would at least listen to him politely. But he has not got any new theories or evidence to go up against Darwin. All he has is an *ad hominem* stick for beating the dogs of Darwinism. It will not do the job. And if he and his readers will look at all these arguments a little more carefully, they will realize that the job does not need to be done.

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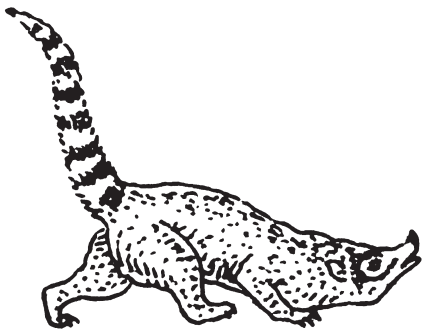

Evolution 101: Finding a Solid Introduction

The Complete Idiot's Guide to Evolution

by Leslie Alan Horvitz
Indianapolis (IN): Alpha Books, 2002. 310 pages

Evolution: A Very Short Introduction

by Brian and Deborah Charlesworth
Oxford: Oxford University Press, 2003. 135 pages

Reviewed by Andrew J Petto, University of Wisconsin, Milwaukee

As we travel around the country talking with people about evolution education, one questions comes up over and over: "What would you suggest as a good way to get the basics of evolution so we know what we are talking about?" There ought to be an easy answer, but there are very few books available that are suitable for a general audience. There are, however, two books that we always carry to these public events: *The Complete Idiot's Guide to Evolution* and *Evolution: A Very Short Introduction.* Ideally, *the* book written for a general audience would combine the best aspects of these two … and eliminate the worst.

The Complete Idiot's Guide is the more "user-friendly" because of its design and format. It is brightly colored and the cover has that distinct bright orange border that marks it as one of a series of *Complete Idiot's Guides,* making it stand out among the books on the shelf. The text is accessible and broken up by a number of boxes, sidebars, highlights, and special features. One of the best of these is a bulleted list at the end of every chapter entitled "The Least You Need to Know". This book is easy to read, and it is easy to pick up again after a few days without having to go back and re-read several pages or sections. The book is also strong on the historical and cultural contexts of both evolutionary thinking and of anti-evolutionism.

The main problem with *The Complete Idiot's Guide to Evolution* is that it is full of errors. Some of these are terms that are misused throughout. For example, Horvitz uses "development" as a synonym for "evolution" — an error we keep trying to prevent people from making. He defines a mutation as "differences in offspring of an organism" (p 101) — something most biologists refer to as biological variation. On page 215, he asks which of two *Australopithecines* "truly represented early hominids?" The correct answer, of course, is "both", but Horvitz seems to be more interested in which of these taxa is the *direct ancestor* of modern humans, in which case the correct answer is most likely "neither". And on page 287, he conflates hybridization ("cross-breeding") with selective breeding.

For every concept clearly described and explained, there seems to be one of these serious, fundamental errors. Because of these problems, it is difficult to recommend this book, despite its general ease of use and attractiveness to the general public. At least it should not be used without proper supervision.

Evolution: A Very Short Introduction is everything that *The Complete Idiot's Guide to Evolution* is not. The contents are thorough, well-organized, and up-

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to-date. There are eight very succinct chapters with writing that is clear and to the point. The format is not user-friendly, however. The text is densely packed and there are few illustrations and other "diversions" from the text.

The writing is excellent, as one would expect from these authors, and the contents, of course, are accurate. The authors give a clear explanation of the current state of evolutionary theory and research, as well as exploring some unanswered questions and some disagreements among scientists regarding particular models or research issues.

For all that *Evolution: A Very Short Introduction* has to offer, it is not a book that would be picked up off the shelf at the local bookseller's or library. We often recommend it to general audiences, but make it clear that it has to be read carefully, because there is so much "coverage" of important information in a very few words. The reading level is not difficult, but it does require that the reader be conscientious and attentive to the text. This is not for the casual reader.

In the end, the book we would like to see is one that combines the best aspects of these two: one that is accurate and up-to-date, but also "user friendly". To be useful to a general readership, the many checkpoints, sidebars, marginalia, and end-of-chapter lists help to reinforce what can be complex content. On the other hand, these reference points for the reader can improve understanding of evolution *only* if they contain accurate information.

Even though neither one of these alone completely meets the need for a good, clear account of the basics of evolution, together they contain valuable resources. Neither, however, should be used as the sole source of information for a general audience.

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Evolution - Why Bother?

A film produced by the Biological Sciences Curriculum Study, the American Institute for Biological Sciences, and Why Bother Films. Available in VHS and DVD formats. 27 minutes

Reviewed by Karen Mesmer

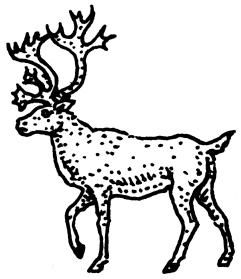
Students often ask, "Why do we need to know this?" With a topic such as evolution, this question may be asked even more frequently, since they think that evolution happened only in the past and has no bearing on their lives. The Biological Sciences Curriculum Study (BSCS) and the American Institute of Biological Sciences (AIBS) have produced a 27-minute film called *Evolution — Why Bother?* to answer this question for high school students. The National Association of Biology Teachers (NABT) endorses this program.

The film is divided into eight self-contained chapters on the various topics of drugs, crime, food, education, disease, ecology, invasive species, and endangered species. Each chapter can be watched separately or the film can be watched as a whole. The chapters start with background given by prominent biologists or science educators and then include explanations of how evolution relates to the topic.

An explanation of why evolution is important to biology begins the program. Joel Cracraft of the American Museum of Natural History explains how it can be tied to all aspects of biology while Jerry Waldvogel of Clemson University expresses the idea that evolution is the unifying idea in biology and that it allows us to ask and answer questions that cannot be answered any other way. Specific examples are described that enable students to see the types of questions that can be answered using evolution. Ken Miller explains that evolution connects to everyday life and is the central organizing principle in biology. Then evolution is presented in the context of eight contemporary examples.

Evolution and drugs is the first example. This section highlights the biochemical similarities of life on earth that exist because of evolution. We can identify mechanisms of disease and potential treatments found in other organisms because of this relationship. Two examples are offered, that of *Aspergillus terreus* and the development of cholesterol-lowering medications, and *Arabidopsis thaliana* and the $BRCA_2$ gene associated with increased risk of breast cancer. The narration is sometimes rapid, so stopping the film after each section for discussion is beneficial.

DNA and crime is the next topic to relate to evolution. The narrator says that DNA analysis is based on common descent with modification and different rates of evolutionary change, but these relationships could be made more explicit for students. Some sections could leave students with questions about specifics on how the topic was related to evolution. This criticism also applies to the next section on **Evolution and foods** where higher yields of crops, disease resistance, and pest resistance are discussed. For example, pentachlorophenol is discussed, but not enough information is given for students to understand exactly how it ties in with natural selection. Students either need to take the narrator's word for it, discuss it with their teachers, or research it themselves.



Evolution and ecology is the fourth area. Understanding that endangered species evolved in a certain environment is essential for formulating policies to protect these species. A specific example would be useful here. The fifth example, **Evolution and endangered species,** is directly related to the previous topic. Evolution provides insight into the genetic viability of endangered species and ecological factors that can help

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keep them from going extinct. More of an explanation of how this works would be beneficial in this section.

The last two sections on **Invasive species** and **Disease** offer the best examples and explanations of the relationship between evolution and the topic at hand. Kudzu, zebra mussels, and West Nile virus are the familiar examples used in this section. Students are told that these invasive species evolved in one habitat and then were transported to another where they exploit their niche and out-compete the native species. Evolutionary biology can suggest ways to control or eliminate these non-native species. This is presented in a way that I think enables high school students to grasp the relationship between evolution and their everyday lives. The section on disease does an excellent job of discussing herpes, HIV, flu, SARS, and vaccines. There are diagrams of how bacteria become resistant to antibiotics and a discussion on how the predictive power of evolutionary biology can provide us with strategies to prevent antibiotic resistance, design new vaccines and describe where new epidemics might occur.

Science education is the last area identified. It is important to understand evolution to develop a "big picture" of the living world. It is a powerful tool in our lives in the areas of biotechnology, medicine, and farming; as Ken Miller states, we "ignore evolution at our own peril." It helps us make sense of our lives.

Overall, the program does a good job of identifying the areas of students' lives related to evolution, but not as good of a job of explaining how evolution specifically connects. Teachers can take this further to help students understand exactly how and why each topic links to evolution. One way to use the DVD is as an introduction to various case studies in evolution and then have students research a particular case in detail.

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The Plausibility of Life: Resolving Darwin's Dilemma

by Marc W Kirschner and John C Gerhardt
New Haven (CT): Yale University Press, 2005. 301 pages

Reviewed by Andrew J Petto, University of Wisconsin, Milwaukee

The diversity of life forms throughout the history of life on earth is so engaging and impressive that it is easy to overlook the other side of the coin: the continuity that connects all organisms to an array of common ancestors. In fact, any evolutionary model that used only data on divergence and none on conserved traits would fail to make any sense of the emergence of new species from ancestral ones. In *The Plausibility of Life,* Kirschner and Gerhardt focus on a number of conserved "core cellular processes" shared by all living things. Their thesis is that these core processes represent successful innovations that are inherited by evolutionary descendants. However, they argue that the success of these processes lies not in their highly specified functions, but in their abilities to produce quite variable outcomes under different environmental conditions.

In essence, this is the negation of the "irreducible complexity" argument of "intelligent design" proponents. The authors show how a single molecule with a highly specified function can perform a different one under different environmental conditions. In other words, the molecular imperative for the cell is flexibility, not specificity. The apparent specificity that we observe is so reliably produced, they argue, because the genome is selected for adaptability. How else could such complex organisms so full of complex biochemical and developmental pathways be produced with so few genes?

Kirschner and Gerhardt explore several specific examples in the text that illustrate their points quite effectively. They give examples of metabolic processes, body-plan evolution, developmental and regulatory change, and morphological specialization (for example, adaptations for flight). Two of the key concepts are weak linkage and exploratory behavior.

The first of these is based on the observation that there are many steps between the DNA sequence for a particular protein and the outcome of the process in which that protein will participate. In a number of well-documented cases, a protein produces a weak signal that produces a particular effect only under specific conditions. The "linkages" between the form and function are "weak" or "easily forged and broken" without any significant genetic change in the organism (p 110–1). This allows new pathways and new linkages to be formed to produce new pathways and products while retaining substantially the same DNA sequence.

Exploratory behavior is viewed from both organismal and cellular perspectives as the basis for the appearance of complex organization from simple actions. In the case of ant foraging, it is clear that the brains of ants do not encode territorial or resource "maps" but build a successful complex foraging strategy based on the accumulation of the results of random foraging behaviors. In the case of the development of blood vessels and nerves, the authors show how these structures emerge in response to signals generated by the target tissues so that they grow in the "right" directions and connect to the "right" cells. This exploratory behavior — whether cellular or organismal — produces complex outcomes from simple conditions, and, as the authors point out using the examples of the pattern of blood vessels that we all can see in the skin of our arms and hands, highly variable ones even within the same individual.

These two examples capture only a bit of the flavor of this book,

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which extracts the results from contemporary research and presents them in a format for nonspecialists. The authors succeed in illustrating their points from the biochemical to the behavioral levels of the organismal hierarchy with examples from each of the levels in between. They are frank about what is known and what is still to be learned, but they present a strong case for the conservation of core processes that allow for the evolution of complex, highly specific functions, but that also allow organisms to adapt these structure-function complexes to a variety of conditions with a variety of outcomes depending on the environment in which the organisms operates. Indeed, in their view of the evolution of complex structures, what is now a mousetrap could easily have started out as a starting gate or a spring latch. The conserved core process is geared to producing components, but the assembly and final configuration are anything but foreordained.

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Letters to the Editor

In "Why teach evolution?" (*RNCSE* 2005 Jan–Apr; 25 [1–2]: 27), Andrew J Petto failed to cite the most important reason for learning the truth of evolution. All human beings must understand how evolution has shaped their very (human) nature. Each of us has brain structures that are residual from our reptilian and proto-mammalian evolutionary past. Our drive to do whatever it takes to survive originated in the earliest forms of life, and has been passed down via the genes through all our predecessor species.

Our territorial imperative and the tendency to conform to hierarchy come from the reptile-derived, subcortical part of our brain. Our emotions are generated in the evolutionarily more recent limbic system of the brain, harking back to the offspring-nurturing characteristics of the earliest mammals. Our reasoning capability (such as it is) is very, very recent (deep-time speaking), and subject to an emotion-driven self-deception that masks the cause of most of our actions.

Plato proposed the dictum "Know thyself." Until each of us accepts what we are and why we act as we do, we humans will continue to follow irrational paths to the ultimate destruction of our species. There can be no more important reason for studying and learning the significance of evolution. Unfortunately, our extreme capacity for delusion and self-deception — a culturally (religiously) acquired trait — will probably preclude the "average" person from learning the most important lesson of evolution. When is NCSE going to learn and promote this truth?

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[*I appreciate Richard Neavel's comments, and, of course, understanding the evolutionary roots of our biology and behavior is absolutely fundamental to many critical human endeavors. It is important to note, however, that the list was not meant to be a comprehensive position statement so much as a succinct summary of issues that were being faced by parents and concerned citizens in both Dover, Pennsylvania, and Grantsburg, Wisconsin, at the end of 2004. The content and format of the brochure were shaped by the needs of evolution supporters in those places at those times, and by the space available on standard 8 x 11 inch paper. —Andrew J Petto*]

I was stationed in Turkey for a year in 1971–72 with the US Army and developed a liking for the country and its people, and an admiration for their accomplishments. After World War I they overthrew the Ottoman Empire, possibly the most corrupt and inept government in history, successfully resisted plans by the Allies to dismember their country, then deliberately realigned themselves with the West. The stakes in Turkey could not be higher. As one State Department analyst put it, "If you're looking for an Islamic country that is moderate, democratic, and pro-Western, Turkey isn't just the best game in town, it's the *only* game in town."

Despite my deep affection for Turkey and sympathy for the problems it faces, I must sadly note that Turkey is a country where key policies are often rooted in pseudoscience. Harun Yahya and his Islamic creationists are only part of it. Turkish schools teach crank anthropology, that the Turks are descended from a "Turanian" race that also gave rise to all the European peoples. The Turanian race is thus — shades of Afrocentrism — the fountainhead of Western civilization. Until recently there was no such thing in Turkey as a Kurd. To build a sense of nation-

hood, the fledgling Turkish Republic adopted the fiction that everyone in Turkey was a Turk, and that there were no indigenous non-Turkish peoples. The Kurds were called "mountain Turks" despite speaking an Indo-European language. There is, of course, widespread denial of the genocide of the Armenians. A final ironic ingredient in this witches' brew is that often the Armenians were not massacred directly, but simply driven onto the roads, and they were often stripped and robbed of their means of survival by Kurds.

Unlike the Third Reich, the Khmer Rouge, or the Taliban, the government of Turkey is not made up of malevolent lunatics. Despite a blemished human rights record, Turkey is sincerely trying to create a modern, democratic and enlightened society. Unfortunately an insecure sense of identity has caused the Turkish government to embrace pseudoscientific theories in the service of nationalism. Despite a horrific past, modern Turkey has much to be proud of, and its official pseudoscience serves no useful purpose except to prepare the way for cranks like Harun Yahya.

Steven I Dutch
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As a charter member of the Skeptics Society I have the privilege of periodically spending a Sunday afternoon hearing very erudite and accomplished speakers lecture an audience of like-minded colleagues and interested lay people on their attempts to introduce science or new scientific methods to an audience lacking a critical approach. We chortle at tales of mystics, bunco artists, snake oil salesmen and religious fanatics, often shaking our heads at the gullibility of their "victims". Many of the members and speakers write books on the subject of evolution-versus-creationism. They are well-written and line my bookshelves.

None of this has the importance or impact of the reports by William J Gonzalez and Jason Wiles in the Jan–Apr 2005 *RNCSE*. The people they describe as members of the communities that abhor evolution will never see or even want to see anything written by a member of the Skeptics Society. The only hope for penetration is the NCSE. That is why you have my financial support. I am sorry it is nowhere near Bill Gates's charity in magnitude. He has taken on a noble effort to cure disease in third world countries, so I cannot begrudge his commitment. Unfortunately, our job is no less difficult. We are fighting a very old and pervasive "disease": fear.

To a way of thinking common among some religious communities, evolution challenges a faith position built on the uniqueness of each human and intimately linked to the salvation of the soul. To these people, evolution threatens their salvation. The fear generated by such a prospect cannot be dismissed. It is at the very core of a resistance to an acceptance of modern science, not only of evolution.

Our goal has to be to convince people of faith not to be afraid of evolution. Pope John Paul II gave us a constructive approach of which we should take advantage. Working against this approach is an army of politicians and fanatics that have a vested interest in maintaining the fear. Often it is hard to tell the manipulators from the true believers. How do we accomplish our goal? We have to find a way to have a dialogue with the millions (probably) of local pastors who have direct contact with fearful congregations. We have to convince them that the science that leads to recognizing the evidence for evolution is a viable path to fulfilling the aphorism: "God helps those who help themselves." Science leads to understandings that help us survive and the evolution models are key to these understandings. Personally, I think a great dialogue subject would be the rapid evolution of infectious microorganisms; perhaps the current avian flu situation would be a good example. I'd like to see the matter explored more by NCSE.

I know engineers, surgeons and molecular biologists who are creationists. Some were taught no evolution. Others have an erroneous concept of it. In a recent letter to the magazine *The Scientist*, one senior scientist proposed we drop the teaching of evolution from training most biological scientists because they will never "use" it in their occupations. The message here is that our own house is not in order. We need to test the knowledge of students entering college for a minimum understanding of evolution. Compared to the efforts of NCSE, mine are small change. But if all we little guys at the periphery do our jobs it may produce a significant number of students with more sense.

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It seems to me, as a long-time reader and supporter, that your articles many times conflate the origin of life and evolution. Evidence for the origin of life is lost in the mists of time, making it entirely speculative. One can speculate that naturalistic processes, extraterrestrials, or the hand of God was causative with equal legitimacy. Evolution, on the other hand, is evidence-based science, and should be treated separately as such.

It may be understandable that many evolutionists believe in a naturalistic origin of life, but they should not be allowed to insert this belief into otherwise cogent arguments for evolution.

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[*While we agree that evolution is equally compatible with practically all of the proposed models for the origin of life, we feel it is necessary to refer readers to the special edition of* RNCSE *(2003 May–Aug; 23 [3–4]) discussing contemporary research into the emergence of the first life on earth. There are significant methodological and data problems, to be sure, but the work of researchers reported in that special issue show that it is substantive research and quite a distance from "entirely speculative". However, we will be careful in the future to be sure that our authors make clear the appropriate distinctions in this area.*]

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Reports of the National Center for Science Education (RNCSE) welcomes contributions from its readers and from anyone interested in issues related to evolution as the foundation for the biological sciences, to the place of evolution in the science curriculum, or to the public perception of scientific method and practice. These contributions may be submitted in one of two forms.

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   Smith FZ. 1985. Geocentrism re-examined. *Journal of Nice Things* 21 (3): 19–35.

   Waters IC, Rivers HI, and others. 2995. Swept away in a flood of enthusiasm [editorial]. *Reports of the National Center for Science Education* Jan–Feb; 1015 (1): 22–9.

   Zubrow E. 1985. *Archaeoastronomy* Orlando (FL): Academic Press.

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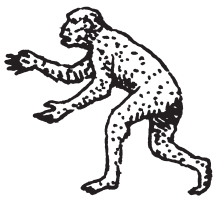

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