REPORTS OF THE NATIONAL CENTER FOR SCIENCE EDUCATION

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THIS PUBLICATION INCORPORATES *NCSE REPORTS* & *CREATION/EVOLUTION*

Creationists Take Over Dinosaur Dig

Dawkins on Science, Delusion and the Appetite for Wonder

Should Student Belief of Evolution Be a Goal?

An Evening with Dr. Hugh Ross

NABT Unveils New Statement on Teaching Evolution

CONTENTS

3 From the Editor's Desk

NEWS

4 New Mexico: State Legislature Joins the Fray
Molleen Matsumura

5 Scientist Censured for Heresy
Molleen Matsumura

UPDATES

6 Creationists Take over Dinosaur Dig
Molleen Matsumura

14 Calling All Scientists

14 NCSE Members at Work

20 NCSE Discount Books

ARTICLES

8 Science, Delusion and the Appetite for Wonder
Richard Dawkins

15 Should Student Belief of Evolution Be a Goal?
Brian J. Alters

17 Relativist Apologetics: The Future of Creationism
Taner Edis

FEATURES

25 Anti-Evolutionists Form, Fund Think Tank
Eugenie C. Scott

27 Impressions: An Evening with Dr. Hugh Ross
Kenneth E. Nahigian

30 Evolution of the NABT Statement on the Teaching of Evolution *Joseph McInerney*

31 NABT Unveils New Statement on Teaching Evolution

BOOK REVIEW

33 Butterflies of the Neotropical Region, Part VI
reviewed by Arthur Shapiro

34 LETTERS TO THE EDITOR

36 RESOURCES

38 INTERNET LOCATIONS VISITED IN THIS ISSUE

39 INSTRUCTIONS FOR CONTRIBUTORS

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CORRECTION

In a previous issue the contact information for PEARL, the National Coalition for Public Education and Religious Liberty was incorrect. Readers wishing to contact PEARL can do so at PEARL, 165 East 56th Street, NEW YORK, NY 10022; Tel: 212-750-6461.

FROM THE EDITOR'S DESK

Welcome to the premier issue of *Reports of the National Center for Science Education (RNCSE)*. This issue combines for the first time the regular publications of NCSE into a single format that we think will serve our readers and subscribers better. We wish to thank Debra Turner for her assistance in designing the new publication and in the layout and production of this first issue. To guide our readers through this new format, we will follow anthropologist John McCreery's "wedding dress" outline and point out the features of this new publication.

Something Old

Readers familiar with *NCSE Reports* will find our old standby departments still here, but a little streamlined, in our news and information sections. *News* will continue to bring you stories of efforts around the country to improve science education and to keep creationism out of the science classroom. *NCSE News* will be set aside for the NCSE staff to communicate directly with our readers about NCSE operations, events, and services. *Features* will contain reflections, commentaries, and first-person accounts of experiences and events that represent the major mission of NCSE — science literacy and education in general, and teaching evolution in particular. *Resources* will continue to provide recent bibliographies of research and analysis in fields that are important to our knowledge of life's history, to evolutionary theory, or to related sciences. This department will continue to feature new books and other resources available through NCSE. We are also experimenting with a new feature that will list the internet locations of resources mentioned in any of our articles in this issue along with the last time that we successfully connected to them. *Letters* will feature short letters from our readers or anyone responding to ideas in our publications or wishing to communicate with our members.

Something New

This combined publication also adds new departments to our old *NCSE Reports* format. These departments contain more formal pieces that we previously published primarily in *Creation/Evolution*. These articles may include original research, review articles or book reviews, or critical evaluation(s) of anti-evolutionary publications, theories, models, or claims.

Articles may contain original research, review articles, case studies, or formal essays on a topic related to the NCSE mission. *Book Reviews* may contain critical evaluations of books (or other media) that may be important or of interest to our readers. These may include anti-evolutionary books and documents, broadcast programs, or electronic media for teaching and learning.

Something Borrowed

We are always willing to consider reprinting an article that appeared elsewhere — especially if it first appeared in a format or a location that was not easily accessible to most of our readers. An example of this is the article in this issue by Richard Dawkins that was transcribed from a lecture that he gave on BBC television. Keep on the lookout for items that might be valuable for us to reprint and send them to the editors for consideration.

Something Blue(?)

Readers familiar with our old publications will notice a change in the style and format of *RNCSE* compared to *NCSE Reports* and *Creation/Evolution*. We have adopted a new (blue) style manual, *Scientific Style and Format*, that will result in a more efficient use of space on our pages and that will help standardize the abbreviations and special notations of all the scientific fields that bear on the issues of evolutionary biology. Most of this should be transparent to our readers, but potential contributors should examine the "Instructions for Contributors" information in this issue.

And Now, Presenting...

Our first issue of *Reports of the National Center for Science Education*. We bring you news of ongoing legislative efforts to impose creationism in science classrooms in New Mexico and North Carolina. Follow the outcome of elections and school-board decisions in Virginia and Wisconsin. Sit in with Ken Nahigian on a seminar by creationist astronomer Hugh Ross. Read the latest statement by the National Association of Biology Teachers on teaching evolution and the accompanying commentary by Joe McInerney of the Biological Sciences Curriculum Study. Eugenie Scott describes a new antievolutionism based at the college level.

Our *Articles* lead off with the 1996 Richard Dimbleby Lecture, delivered by Richard Dawkins in November, exhorting us to let our students and the public know the awe and wonder that exists in real science and to take back the stage from the pseudoscientists, mentalists, and paranormalists. Brian Alters proposes that we should expect our students to "believe" in evolution (and explains why). Taner Edis explores the possibilities and implications of the use of relativism in education as a political strategy for inserting creationism into the science classroom.

So, please read (and enjoy) our premier issue and help us to develop and improve *RNCSE* as we go along. The phone has voice mail, the fax machine is always on, and the email folders have been emptied so that you can get through as easily as possible - oh, and, yes, the US Postal Service delivers daily. We look forward to hearing from you.

And, have you filled out and returned your questionnaire for the new NCSE Membership Directory?

Anj Petto and Laura McMahon

NEWS

New Mexico: State Legislature Joins the Fray

Molleen Matsumura
Network Project Director

New Mexico has been the scene of stormy public controversy ever since the State Board of Education's August 1996 decision to drop evolution from state science content standards and substitute a requirement for "critical scientific analysis of theories of biological origin" (*NCSE Reports* 1996 Fall; 16[3], p 18; *NCSE Reports* 1996 Summer; 16[2]: pp 4-5) Public statements opposing the Board's action were issued by the University of New Mexico's Faculty Senate and Departments of Physics and Astronomy, Earth and Planetary Science, Biology, and History. Objections to the policy also came from the staff of the National Solar Observatory, Biology Department of New Mexico State University, and the Faculty Council of the New Mexico Institute of Mining and Technology. From outside the state, the president of the Society for Integrative and Comparative Biology, which had recently held a convention in Albuquerque, sent a letter of concern to the Convention and Visitors Center, with copies to the governor and several newspapers, prompting speculation that negative response from the scientific community could affect tourism in the state.

In January 1997, the state legislature became actively involved with the introduction of SB 155 by Senator Pauline Eisenstadt. The bill's text said simply:

> In determining public school curriculum policy or prescribing courses of instruction for public schools, the state board shall adopt curriculum standards for life sciences and earth and space sciences that conform with the National Academy of Sciences' National Science Education Standards for life sciences and earth and space sciences.

The bill was passed on February 17 after three hours of intense floor debate, during which one opponent brandished a stuffed monkey. At press time, it is under consideration by the House committees for Education and for Business and Industry.

On February 21, a rival bill was introduced in the House by Representative Timothy Macko. Macko's bill calls for adding to the Education Code "LEGISLATIVE FINDINGS —Teaching of Various Theories of Biologic Origins". The proposed findings include a partial restatement of the science Content Standards adopted by the Board of Education, and several common creationist "arguments against evolution", for example:

> (3) historic processes such as the origin of the physical universe and biologic life were not observed and have not been repeated; [and]
>
> (5) the theory of evolution posits a pre-biotic soup from which biologic life emanated, ...
>
> (6) no extant fossil evidence exists for this pre-biotic soup, no fossil or any other evidence exists for this common ancestor and noted evolutionists have described the extreme scarcity of transitional forms as the "trade secret of paleontology"; ...
>
> (8) a proposed evolutionary explanation for the transition between reptiles and feathered birds is the mutation of scales, yet the genetic structure of scales and feathers are so different that scales are not the likely source of feathers....

The bill concludes

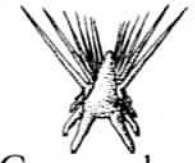
> (14) it is the policy of the state of New Mexico to enhance the self-esteem of students in the classroom, yet the teaching of a theory that indicates that children evolved in a meaningless manner through highly improbable random fluctuations in a pre-biotic soup can result in a particularly negative impact on a student's self-esteem; and
>
> (15) because of these conflicts, and because of the availability of various theories of biologic origins, the legislature affirms and agrees with the position of the state board that various theories of biologic origins be taught in the public school system.
>
> B. In determining public school curriculum policy or prescribing courses of instruction for public schools, the state board shall adopt curriculum standards that teach various theories of biologic origins in the public school system.

If either bill passes, it would require the Governor's signature before it could take effect.

While the legislature deliberates, the Department of Education is continuing to work on developing "performance" standards. The Coalition for Excellence in Science Education (CESE), an organization of scientists, teachers and concerned citizens, has called on the Board of Education to revise their adopted "content" standards. This revision would delete a definition of science written by the board and references to multiple "theories of origin". It would also reinstate references to evolution excerpted from the National Science Education Standards. If the Board adopts CESE's revisions and Representative Macko's bill passes, the state that is home to both the Roswell space alien hoax and one of the

nation's highest concentrations of high-tech industry will become home to another contradiction.

[NCSE thanks Kendrick Frazier, Joe Meert, Dave Thomas, and more members of New Mexicans for Science and Reason than there is room to name, for information used in this story.]



Scientist Censured for Heresy

Molleen Matsumura
Network Project Director

In June, 1996, the 63d General Assembly of the Orthodox Presbyterian Church upheld a heresy charge against Terry M. Gray, Associate Professor of Chemistry at Calvin College in Grand Rapids, Michigan. Gray had appealed a finding by the Harvest Church "that Dr. Terry Gray has committed the public offense of stating that Adam had primate ancestors — contrary to the Word of God (Genesis 2:7, 1:26,27) and the doctrinal standards of the Orthodox Presbyterian Church" (one of several charges adopted by the Committee of Five of Midwest Presbytery on April 4, 1994). Gray was censured, and removed from office as an elder of his church.

According to documents published by Gray, the process began when an Orthodox Presbyterian Church in California questioned the propriety of an article by Gray that had appeared in the April 13, 1992 issue of *The Banner*. "The Mistrial of Darwin" was Gray's comment on *Darwin on Trial*, a critique of evolution by UC-Berkeley law professor Phillip Johnson. Gray wrote, "Johnson serves us well in pointing out the atheistic, naturalistic, and materialistic bias of much of modern science," and expressed his own view that, "God is intimately involved in creation's moment-by-moment workings." He continued, "As long as we recognize God's sovereign control... we can acknowledge that evolutionary theory describes the secondary causes." After a discussion of Johnson's rhetorical strategies and scientific errors, Gray concluded,

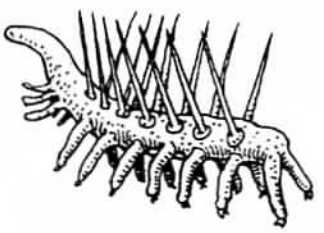
> But [unlike atheistic evolutionists] for Christian scientists who believe in an omnipotent, sovereign Creator, evolution is not a philosophical necessity. For many Christians, however, it is the best explanation of the empirical data.

In February, 1993, *New Horizons*, the magazine of Gray's denomination, published a letter in which he criticized some articles on evolution published in an earlier issue. His comments became evidence supporting the charges against him. The General Assembly's action, which was not unanimous, was based on the majority report of an advisory committee:

> [T]he committee has drawn up charges that are very specific and narrowly focused. Broader issues such as the age of the earth, evolution of animals in general, the 'days' of Genesis, etc., are not in view. Members of presbytery should resist the temptation to make the recommendations of this report an occasion to argue issues that are not in view,... [and] Dr. Gray's character and life are not in question.... [He]has been very cooperative in presenting his views.... [Dr. Gray affirms] the historicity of Adam and his special creation by God in his image.

The decision by the General Assembly hinged on the question of how literally to interpret the scriptural statement that Adam had been made "from the dust of the earth." The action of the Orthodox Presbyterian Church is a reminder that ultimately the evolution/creation controversy is not scientific, but religious.

[This article is based on Church documents and related correspondence that Dr. Gray has posted at <http://mcgraytx.calvin.edu/gray/evolution_trial/index.html>.]



UPDATES

Virginia: In October 1997, controversy erupted in Fairfax County when a parent complained about a few sentences in *Biological Sciences: A Molecular Approach*, a textbook being used at the Thomas Jefferson High School for Science and Technology (*NCSE Reports* 1996 Fall; 16[3], p16). In a section on "Pseudoscience," the authors had written, "'Creation Science' is not science because its working assumptions cannot be examined by scientific methods." The school's principal and a school board member drafted a disclaimer to be inserted in the books, but the district's superintendent withdrew approval in the face of public concern that the disclaimer could inspire a wave of demands for disclaimers in other books containing "offensive" material.

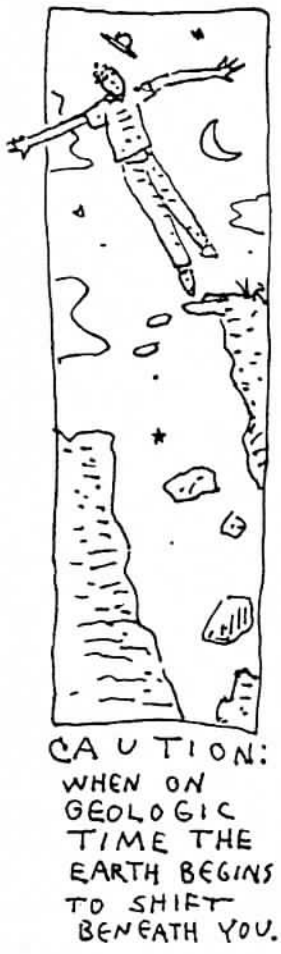
In February 1997, a nine-member committee composed of parents, students, and teachers held two meetings to review the challenge. The complaining parent did not speak at the first meeting; instead, William Nowers, president of the Fairfax County affiliate of the American Family Association argued against the Big Bang and an old earth, as well as the theory of evolution. At the second meeting, a teacher explained that all six teachers in the school wished to continue using the text and why it was useful in the curriculum.

NCSE member Douglas McNeil, who attended both meetings, reports that one of the few questions asked by committee members referred to curriculum standards. Virginia's "Standards of Learning" for the life sciences require that "[t]he student will investigate and understand that organisms change over time. Key concepts include: ... mutation, adaptation, natural selection, and extinction; evidence of evolution of different species in the fossil record; how environmental influences, as well as genetic variation, can lead to diversity."

On February 26, the committee voted unanimously to reject the complaint. They concluded that since creationism cannot be verified scientifically, the textbook's language is correct. Nowers said he will appeal to county school officials.

New Mexico: A regional science fair refused an offer from the Creation

Science Fellowship of New Mexico to donate a prize of up to $1,000. Meeting on January 16, the advisory board of the Northwestern Regional Science Fair accepted awards standards recommended by a separate committee. The advisory board's resolution says the fair will accept "awards from organizations dedicated to promoting science or science education," adding that winning projects must be consistent with scientific methods.



West Virginia: On February 3, the Lincoln County School Board decided not to approve a proposed elective course in genetics, to be taught at Duval High School. The board was responding to a complaint by one parent who said, "It's great to have genetics, but why should we have Darwin's theory? Even if it is scientific theory, I don't think it should be taught" (*Charleston Gazette*, Feb. 5, 1997). Both the principal of Duval High School and the assistant superintendent support teaching the course. Local observers believe the board might reconsider its decision, and NCSE Executive Director Eugenie C. Scott sent the superintendent information on legal and educational aspects of the issue with a letter encouraging re-instatement of the course.

Wisconsin: Madison voters turned down *two* creationist candidates for school board in elections this winter. The first was defeated by a large margin in the primary. After his creationist remarks caused the teachers' union to rescind their support of his candidacy, local media and citizens made a point of asking all candidates their positions on creationism in the science curriculum. The second challenger for a district-wide seat then put in that he, too, supported creationism in the science classroom. Despite his campaign's outspending *all* the other school-board candidates combined, this creationist challenger was also defeated. However, this issue also put the race for Wisconsin Superintendent of Public Instruction in a new perspective. In response to media questions *both* candidates said that they would tolerate creationism in the schools — though the challenger was more adamant than the incumbent. The incumbent, John Benson, was returned to office with over 55% of the vote, and now local NCSE members and friends are pushing the advisory boards that are developing state science education standards to broaden and strengthen the references to and examples of evolution among all the sciences.

[NCSE thanks Douglas McNeil, Martin Wacksman, Duncan Buell, Warren Friedman, Karl Fezer, and Malva Knoll for providing information about these stories.]

Creationists Take Over a Dinosaur Dig

Molleen Matsumura
Network Project Director

"Worst Fears Realized by Evolutionists" reads the headline of a press release at the World Wide Web site of "FACT," the Foundation Advancing Creation Truth. According to the January, 1996 release:

> For the past five years a university professor with a handful of students and other amateurs have been digging in the remains of a vast dinosaur graveyard in Eastern Wyoming. This year, a group of creationists moved in and established a beachhead.

For NCSE readers who wonder what really happened: Creationists have indeed "taken over" the site known to researchers as the "Hanson Bonebed" ("scientific" creationists prefer the nickname "the Dragon's Grave"). The unnamed professor is Dr. Kraig Derstler of the Department of Geology at the University of New Orleans. When NCSE members discovered the FACT press release in January 1997, NCSE contacted Derstler who explained what had happened at the Hanson Bonebed.

The Facts about FACT

Derstler said that for nine years he had been leading expeditions to Eastern Wyoming, several of them funded by the Dinosaur Society. In 1990 he discovered the Hanson Bonebed, a deposit filled with duckbill dinosaur bones. Over the years, he developed a continuing research program for the site, and held many discussions with the landowner about building a small educational and research facility. In the fall of 1993, after lengthy negotiations and after the Dinosaur Society had helped draft a long-term lease, Derstler and the land owner drove some distance into town to have the lease notarized.

While they talked outside the notary's office, the landowner revealed for the first time that he was a creationist. He told Derstler they would need to make one small, handwritten addition to the lease. In this addition, Derstler would agree that his public presentations and exhibits would not mention evolutionary explanations of the site unless he presented creation "science" at the same time. Derstler refused, but he did not "abandon" the site. He continued his research in the hope that a new agreement could be reached.

Negotiation continued in the summer of 1994 and included the participation of the president of the Dinosaur Society. In 1995, Derstler received another research grant on the assumption that a lease might still be arranged. Two days before he and other researchers were scheduled to leave for the field, the land owner called to object to his plans. When Derstler arrived creation "scientists" had already been there, and more were on the way.

Derstler said, "They were already messing up the site and a long-term lease was clearly impossible, so I decided to tidy up my research and leave." He gave the landowner several hundred bones and other fossils that he had already excavated in exchange for the right to conclude his research program. Still, in the summer of 1995 he and some colleagues were given permission to work only in one small area.

FACT offers fiction

According to FACT, the Hanson Bonebed is "potentially the largest dinosaur fossil bed..., [and various fos-

sils] mixed together ...suggests [sic] a sudden catastrophe of great magnitude, far more devastating than a local river could produce." Derstler, who is now working at other sites in the region, explained that the Hanson bonebed *was* formed quickly when there was a break in a nearby natural levee. Sediment and bones were transported a short distance to form the bonebed, but that is was clearly a local and not a global phenomenon. The primary value of the site for scientists was its usefulness for statistical study of variation in duckbill populations. By the time Derstler stopped working at the site, some preliminary identification of materials had been completed but the most scientifically useful information on these had to be abandoned at the site. He told NCSE, "We may have also lost a good chance to test the herd-migration-and-drowning model for monospecific bonebed formation."

According to FACT, "[T]he standard model for paleontological excavations is...this 'Ego-centric' model: One PhD in paleontology, surrounded by a few students, operates the dig and...gets all of the glory and financial reward." Derstler replied that he had financed a considerable portion of the field work personally and had actually gone into debt each summer that he worked at the site. Because of the small scale of the operation, there *was* only one PhD on the site; Derstler explained that most of the collaboration with other professional colleagues occurred in the lab away from the dig. As for "glory", although he did host visiting scientists from professional geological societies, few colleagues had responded to his invitations to participate in this relatively "minor" project.

FACT Slams Science

Besides the discrepancies noted by Derstler, the press release contains some obvious contradictions. First the release asserts that, "The Ego-centric Model used by evolutionists many times is forced to rely on student's [sic] work because of the lack of experienced leadership." Later, FACT's founders invite "students of all ages" to work on the site, offering half-week programs for families. FACT promises to "examine each evolutionary, creationist, or any other explanation... considering all possible explanations." Yet it concludes that when findings are shared, "[T]hinking people will see for themselves why the theory of evolution is false."

Finally, FACT goes beyond attacking an individual scientist, to condemn evolutionary scientists generally. The WWW site urges readers to "include [the release] in your own ministry news letter or submit it to your church, Christian school or local paper." The story they want told is

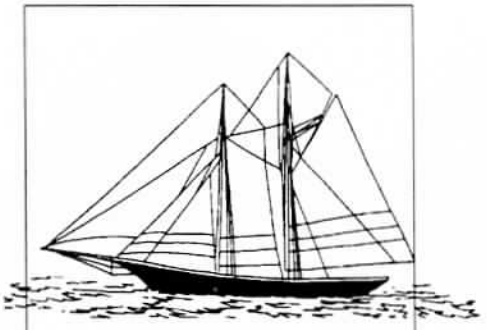
> FACT scientific participants agree that Darwin's fairy tale of evolution has reigned supreme for a hundred years through the control of the press, media, and education. Billions of tax dollars have been wasted promoting this lie....The evolutionists' refusal to consider all data and explanations for it have made evolution a greater hoax than the theory that the earth was flat.

There is more than one unfortunate outcome of the incident at the Hanson Bonebed. Derstler was disturbed when other ranchers in the area brought him examples of creationist literature which, besides using his name without his permission, implied that he had worked with creation "scientists". He also felt deceived and personally hurt by the actions of the landowner, whom he had considered a friend. He told NCSE, "Aside from paleontological information, the one thing that I've learned from this is never trust a creationist. They will tell any lie to accomplish their goals."

The FACT press release never says what "worst fear [was] realized" at the Hanson's Bonebed site, but it is chilling news for us all when the site of serious scientific research is made into a "beachhead" for predetermined conclusions.

Derstler's final concern was to assure our readers that he and his colleagues are continuing their work. After the incident at Hanson Bonebed, a number of other ranchers invited the paleontologists onto their land and offered free access and title to the fossils. Last summer, for example, the crew excavated a wonderful duckbill dinosaur 'mummy' and they have a small *T. rex* waiting in the ground.

[Thanks to Paul Heinrich and Daniel Phelps for bringing this story to NCSE's attention.]



NCSE Goes to the Galapagos Islands

The word from our expedition organizer, NCSE Past President Jack Friedman, is that the NCSE trip to the Galapagos Islands in February 1998 is completely sold out! However, Jack has promised to try to secure a second boat to accommodate all the NCSE members, friends, and families who might want to attend.

This trip will be led by professional naturalist guides and will visit ten of the islands from a base at the Darwin Research Station. The tour will also travel to Pinta Island for the best view in the hemisphere of the last solar eclipse of the millennium.

Details of the trip can be found in *NSCE Reports* 1996 Winter; 16(4):23. To make a reservation or to learn more about the trip, please contact

Jack Friedman
23 Chelsea Drive,
Syosset, NY 11791
or call (516) 921-5522.

Science, Delusion and the Appetite for Wonder

Richard Dawkins

You could give Aristotle a tutorial. And you could thrill him to the core of his being. Aristotle was an encyclopedic polymath — an all time intellect. Yet not only can you know more than he about the world; you also can have a deeper understanding of how everything works. Such is the privilege of living *after* Newton, Darwin, Einstein, Planck, Watson, Crick and their colleagues. I'm not saying that you are more *intelligent* than Aristotle, or wiser. For all I know, Aristotle's the cleverest person who ever lived. That's not the point. The point is only that science is cumulative, and we live later.

Aristotle had a lot to say about astronomy, biology and physics, but his views sound weirdly naive today. Not as soon as we move away from science; Aristotle could walk straight into a modern seminar on ethics, theology, or political or moral philosophy, and contribute. But let him walk into a modern science class and he'd be a lost soul. Not because of the jargon, but because science advances, cumulatively.

Here's a small sample of the things you could tell Aristotle. And surprise and enthrall him, not just with the facts themselves but with how they hang together so elegantly.

Here's a small sample of the things you could tell Aristotle, or any other Greek philosopher, and surprise and enthrall them, not just with the facts themselves but with how they hang together so elegantly.

The earth is not the center of the universe. It orbits the sun — which is just another star. There is no music of the spheres, but the chemical elements, from which all matter is made, arrange themselves cyclically, in something like octaves. There are not four elements but about 100. Earth, air, fire and water are not among them.

Living species are not isolated types with unchanging essences. Instead, over a time scale too long for humans to imagine, they split and diverge into new species, which then go on diverging further and further. For the first half of geological time our ancestors were bacteria. Most creatures still are bacteria, and each one of our trillions of cells is a colony of bacteria. Aristotle was a distant cousin to a squid, a closer cousin to a monkey, a closer cousin still to an ape (strictly speaking, Aristotle was an ape, an African ape, a closer cousin to a chimpanzee than a chimp is to an orang utan).

The brain is not for cooling the blood. It's what you use to do your logic and your metaphysics. It's a three-dimensional maze of a million million nerve cells, each one drawn out like a wire to carry pulsed messages. If you laid all your brain cells end to end, they'd stretch around the world 25 times. There are about 4 million million connections in the tiny brain of a chaffinch, proportionately more in ours.

Now, if you're anything like me, you'll have mixed feelings about that recitation. On the one hand, pride in what Aristotle's species now knows and didn't then. On the other hand an uneasy feeling of, "Isn't it all a bit complacent? What about our descendants, what will they be able to tell us?"

Yes, for sure, the process of accumulation doesn't stop with us. Two thousand years hence, ordinary people who have read a couple of books will be in a position to give a tutorial to today's Aristotles: to Francis Crick, say, or Stephen Hawking. So does this mean that our view of the universe will turn out to be just as wrong?

Let's keep a sense of proportion about this! Yes, there's much that we still don't know. But surely our belief that the earth is round and not flat and that it orbits the sun will never be superseded. That alone is enough to confound those, endowed with a little philosophical learning, who deny the very possibility of objective truth: those so-called relativists who see no reason to prefer scientific views over aboriginal myths about the world.

Our belief that we share ancestors with chimpanzees and more distant ancestors with monkeys will never be superseded, although details of timing may change. Many of our ideas, on the other hand, are still best seen as theories or models whose predic-

Richard Dawkins is professor of zoology at Oxford University, Oxford, England. This text is transcribed from the Richard Dimbleby Lecture broadcast on BBC1 Television, November 12th, 1996.

tions, so far, have survived the test. Physicists disagree over whether they are condemned forever to dig for deeper mysteries, or whether physics itself will come to an end in a final 'theory of everything' — a nirvana of knowledge. Meanwhile, there is so much that we don't yet understand, we should loudly proclaim those things that we do, so as to focus attention on problems that we should be working on.

Far from being over-confident, many scientists believe that science advances only by disproof of its hypotheses. Konrad Lorenz said he hoped to disprove at least one of his own hypotheses every day before breakfast. That was absurd, especially coming from the grand old man of the science of ethology, but it is true that scientists, more than others, impress their peers by admitting their mistakes.

A formative influence on my undergraduate self was the response of a respected elder statesmen of the Oxford Zoology Department when an American visitor had just publicly disproved his favorite theory. The old man strode to the front of the lecture hall, shook the American warmly by the hand and declared in ringing, emotional tones: "My dear fellow, I wish to thank you. I have been wrong these fifteen years."And we clapped our hands red. Can you imagine a government minister's being cheered in the House of Commons for a similar admission? "Resign, Resign" is a much more likely response!

Yet there is hostility towards science — not just from the green ink underlining brigade, but from published novelists and newspaper columnists. Newspaper columns are notoriously ephemeral, but their drip-drip, week-after-week, or day-after-day repetition gives them influence and power, and we have to notice them. A peculiar feature of the British press is the regularity with which some of its leading columnists return to attack science — and not always from a vantage point of knowledge. A few weeks ago, Bernard Levin's effusion in *The Times* was entitled "God, Me and Dr Dawkins"and it had the subtitle: "Scientists don't know and nor do I — but at least I know I don't know".

It is no mean task to plumb the full depths of what Mr Bernard Levin does not know, but here's an illustration of the gusto with which he boasts of it.

> Despite their access to copious research funds, today's scientists have yet to prove that a quark is worth a bag of beans. The quarks are coming! The quarks are coming! Run for your lives...! Yes, I know I shouldn't jeer at science, noble science, which, after all, gave us mobile telephones, collapsible umbrellas and multi-striped toothpaste, but science really does ask for it....Now I must be serious. Can you eat quarks? Can you spread them on your bed when the cold weather comes?

It doesn't deserve a reply, but the distinguished Cambridge scientist, Sir Alan Cottrell, wrote a brief letter to the editor: "Sir: Mr Bernard Levin asks 'Can you eat quarks?' I estimate that he eats 500,000,000,000,000,000,000 quarks a day."

It has become almost a cliché, to remark that nobody boasts of ignorance of literature, but it is socially acceptable to boast ignorance of science and proudly claim incompetence in mathematics. In Britain, that is. I believe the same is not true of our more successful economic competitors, Germany, the United States and Japan.

People certainly blame science for nuclear weapons and similar horrors. It's been said before but needs to be said again: if you want to do evil, science provides the most powerful weapons to do evil; but equally, if you want to do good, science puts into your hands the most powerful tools to do so. The trick is to want the right things, then science will provide you with the most effective methods of achieving them.

[T]here is so much that we don't yet understand, we should loudly proclaim those things that we do, so as to focus attention on problems that we should be working on.... [S]cientists... impress their peers by admitting their mistakes.

An equally common accusation is that science goes beyond its remit. It's accused of a grasping take-over bid for territory that properly belongs to other disciplines such as theology. Listen to the novelist Fay Weldon's hymn of hate against "the scientists" in The Daily Telegraph.

> Don't expect us to like you. You promised us too much and failed to deliver. You never even tried to answer the questions we all asked when we were six. Where did Aunt Maud go when she died? Where was she before she was born?... And who cares about half a second after the Big Bang; what about half a second before? And what about crop circles?

More than some of my colleagues, I am perfectly happy to give a simple and direct answer to both those Aunt Maud questions. But I'd certainly be called arrogant and presumptuous, going beyond the limits of science.

Then there's the view that science is dull and plodding, with rows of pens in its top pocket. Here's another newspaper columnist, AA Gill, writing on science this year in *The Sunday Times*.

> Science is constrained by experiment results and the tedious, plodding stepping stones of empiricism....What appears on television just is more exciting than what goes on in the back of

it....that's art, luvvie: theatre, magic, fairy dust, imagination, lights, music, applause, my public. There are stars and there are stars, darling. Some are dull, repetitive squiggles on paper, and some are fabulous, witty, thought-provoking, incredibly popular.

The 'dull, repetitive squiggles' is a reference to the discovery of pulsars in 1967, by Jocelyn Bell and Anthony Hewish. Jocelyn Bell Burnell had recounted on television the spine-tingling moment when, a young woman on the threshold of a career, she first knew she was in the presence of something hitherto unheard-of in the universe. Not something new under the sun, a whole new *kind* of sun, which rotates so fast that, instead of taking 24 hours like our planet, it takes a quarter of a second.

Far from science's not being useful, my worry is that it is so useful as to overshadow and distract from its inspirational and cultural value.

Could science just be too difficult for some people, and therefore seem threatening? Oddly enough, I wouldn't dare to make such a suggestion, but I am happy to quote a distinguished literary scholar, John Carey, the present Merton Professor of English at Oxford:

> The annual hordes competing for places on arts courses in British universities, and the trickle of science applicants, testify to the abandonment of science among the young. Though most academics are wary of saying it straight out, the general consensus seems to be that arts courses are popular because they are easier, and that most arts students would simply not be up to the intellectual demands of a science course."

My own view is that the sciences can be intellectually demanding, but so can classics, so can history, so can philosophy. On the other hand, nobody should have trouble understanding things like the circulation of the blood and the heart's role in pumping it round. Carey quoted Donne's lines to a class of 30 undergraduates in their final year reading English at Oxford:

> Knows't thou how blood, which to the heart doth flow,
> Doth from one ventricle to the other go?

Carey asked them how, as a matter of fact, the blood does flow. None of the thirty could answer, and one tentatively guessed that it might be 'by osmosis'. The truth — that the blood is pumped from ventricle to ventricle through at least 50 miles of intricately dissected capillary vessels throughout the body — should fascinate any true literary scholar. And unlike, say, quantum theory or relativity, it isn't hard to understand. So I tender a more charitable view than Professor Carey. I wonder whether some of these young people might have been positively turned off science.

Last month I had a letter from a television viewer who poignantly began: "I am a clarinet teacher whose only memory of science at school was a long period of studying the Bunsen burner." Now, you can enjoy the Mozart concerto without being able to play the clarinet. You can be a discerning and informed concert critic without being able to play a note. Of course music would come to a halt if nobody learned to play it. But if everybody left school thinking you had to play an instrument before you could appreciate music, think how impoverished many lives would be.

Couldn't we treat science in the same way? Yes, we must have Bunsen burners and dissecting needles for those drawn to advanced scientific practice. But perhaps the rest of us could have separate classes in science appreciation, the wonder of science, scientific ways of thinking, and the history of scientific ideas, rather than laboratory experience.

It's here that I'd seek rapprochement with another apparent foe of science, Simon Jenkins, former editor of *The Times* and a much more formidable adversary than the other journalists I've quoted, because he has some knowledge of what he is talking about. He resents compulsory science education, and he holds the idiosyncratic view that it isn't useful. But he is thoroughly sound on the uplifting qualities of science. In a recorded conversation with me, he said:

> I can think of very few science books I've read that I've called useful. What they've been is wonderful. They've actually made me feel that the world around me is a much fuller...much more awesome place than I ever realized it was.... I think that science has got a wonderful story to tell. But it isn't useful. It's not useful like a course in business studies or law is useful, or even a course in politics and economics.

Far from science's not being useful, my worry is that it is so useful as to overshadow and distract from its inspirational and cultural value. Usually even its sternest critics concede the *usefulness* of science, while completely missing the wonder. Science is often said to undermine our humanity, or destroy the mystery on which poetry is thought to thrive. Keats berated Newton for destroying the poetry of the rainbow.

> Philosophy will clip an Angel's wings,
> Conquer all mysteries by rule and line,
> Empty the haunted air, and gnomed mine —
> Unweave a rainbow—

Keats was, of course, a very young man.
Blake, too, lamented:

> For Bacon and Newton, sheath'd in dismal steel, their terrors hang
> Like iron scourges over Albion; Reasonings like vast Serpents
> Infold around my limbs....

I wish I could meet Keats or Blake to persuade them that mysteries don't lose their poetry because they are solved. Quite the contrary. The solution often turns out more beautiful than the puzzle, and anyway the solution uncovers deeper mystery. The rainbow's dissection into light of different wavelengths leads on to Maxwell's equations and eventually to special relativity.

Einstein himself was openly ruled by an aesthetic scientific muse: "The most beautiful thing we can experience is the mysterious. It is the source of all true art and science," he said. It's hard to find a modern particle physicist who doesn't own to some such aesthetic motivation. Typical is John Wheeler, one of the distinguished elder statesmen of American physics today:

> [W]e will grasp the central idea of it all as so simple, so beautiful, so compelling that we will all say each to the other, 'Oh, how could it have been otherwise! How could we all have been so blind for so long!'

Wordsworth might have understood this better than his fellow romantics. He looked forward to a time when scientific discoveries would become "proper objects of the poet's art". And, at the painter Benjamin Haydon's dinner of 1817, he endeared himself to scientists, and endured the taunts of Keats and Charles Lamb, by refusing to join in their toast: "Confusion to mathematics and Newton".

Now, here's an apparent confusion: TH Huxley saw science as "nothing but trained and organized common sense," while Professor Lewis Wolpert insists that it's deeply paradoxical and surprising, an affront to common sense rather than an extension of it. Every time you drink a glass of water, you are probably imbibing at least one atom that passed through the bladder of Aristotle. A tantalizingly surprising result, but it follows by Huxley-style organized common sense from Wolpert's observation that "there are many more molecules in a glass of water than there are glasses of water in the sea."

Science runs the gamut from the tantalizingly surprising to the deeply strange, and ideas don't come any stranger than quantum mechanics. More than one physicist has said something like: "If you think you understand quantum theory, you don't understand quantum theory."

There is mystery in the universe, beguiling mystery, but it isn't capricious, whimsical, frivolous in its changeability. The universe is an orderly place and, at a deep level, regions of it behave like other regions, times behave like other times. If you put a brick on a table it stays there unless something lawfully moves it, even if you meanwhile forget it's there. Poltergeists and sprites don't intervene and hurl it about for reasons of mischief or caprice. There is mystery but not magic, strangeness beyond the wildest imagining, but no spells or witchery, no arbitrary miracles.

Even science fiction, though it may tinker with the laws of nature, can't abolish lawfulness itself and remain good science fiction. Young women don't take off their clothes and spontaneously morph themselves into wolves. A recent television drama is fairy tale rather than science fiction for this reason. It falls foul of a theoretical prohibition much deeper than the philosopher's "All swans are white — until a black one turns up" inductive reasoning. We know people can't metamorphose into wolves, not because the phenomenon has never been observed — plenty of things happen for the first time — but because werewolves would violate the equivalent of the second law of thermodynamics. Of this, Sir Arthur Eddington said:

I wish I could meet Keats or Blake to persuade them that mysteries don't lose their poetry because they are solved.... There is mystery but not magic, strangeness beyond the wildest imagining, but no spells or witchery, no arbitrary miracles.

> If someone points out to you that your pet theory of the universe is in disagreement with Maxwell's equations — then so much the worse for Maxwell's equations. If it is found to be contradicted by observation — well, these experimentalists do bungle things sometimes. But if your theory is found to be against the second law of thermodynamics I can give you no hope; there is nothing for it but to collapse in deepest humiliation.

To pursue the relationship between werewolves and entropy would take me too far afield. But, since this lecture commemorates a man whose integrity and honesty as a broadcaster is still an abiding legend 30 years after his death, I'll stay for a moment with the current epidemic of paranormal propaganda on television.

In one popular type of programming, conjurers come on and do routine tricks. But instead of admitting that they are conjurers, these television performers claim genuinely supernatural powers. In this they are abetted by prestigious presenters, people whom we have got into the habit of trusting, broadcasters who have become role models.

In other programs, disturbed people recount their fantasies of ghosts and poltergeists. But instead of sending them off to a kindly psychiatrist, television producers eagerly hire actors to re-create their delusions — with predictable effects on the credulity of large audiences.

Recently, a faith healer was given half an hour of free prime-time television, to advertise his bizarre claim to be a 2000 year-dead physician called Paul of

Judea. Some might call this entertainment, comedy even, though others would find it objectionable entertainment like a fairground freak show. Now I obviously have to return to the arrogance problem. How can I be so sure that this ordinary Englishman with an unlikely foreign accent was not the long dead Paul of Judea? How do I know that astrology doesn't work? How can I be so confident that the television "supernaturalists" are ordinary conjurers, just because ordinary conjurers can replicate their tricks? (Spoon-bending, by the way, is so routine a trick that the American conjurers Penn and Teller have posted instructions for doing it on the Internet! See <http://www.randi.org/jr/ptspoon.html>).

It really comes down to parsimony, economy of explanation. It is possible that your car engine is driven by psychokinetic energy, but if it looks like a gasoline engine, smells like a gasoline engine and performs exactly as well as a gasoline engine, the sensible working hypothesis is that it is a gasoline engine. Telepathy and possession by the spirits of the dead are not ruled out as a matter of principle. There is certainly nothing impossible about abduction by aliens in UFOs. One day it may be happen. But on grounds of probability it should be kept as an explanation of last resort. It is unparsimonious, demanding more than routinely weak evidence before we should believe it. If you hear hooves clip-clopping down a London street, it could be a zebra or even a unicorn, but, before we assume that it's anything other than a horse, we should demand a certain minimal standard of evidence.

The popularity of the paranormal, oddly enough, might even be grounds for encouragement. I think that the appetite for mystery ... is healthy.

It's been suggested that if the supernaturalists really had the powers they claim, they'd win the lottery every week. I prefer to point out that they could also win a Nobel Prize for discovering fundamental physical forces hitherto unknown to science. Either way, why are they wasting their talents doing party turns on television?

By all means let's be open-minded, but not so open-minded that our brains drop out. I'm not asking for all such programs to be suppressed, merely that the audience should be encouraged to be critical. In the case of the psychokineticists and thought-readers, it would be good entertainment to invite studio audiences to suggest critical tests, which only genuine psychics, but not ordinary conjurers, could pass. It would make a good, entertaining form of quiz show.

How do we account for the current paranormal vogue in the popular media? Perhaps it has something to do with the millennium — in which case it's depressing to realize that the millennium is still three years away. Less portentously, it may be an attempt to cash in on the success of "The X-Files", which is fictional and therefore defensible as pure entertainment.

You might think this is a fair defense, but soap-operas, cop series and the like are justly criticized if, week after week, they ram home the same prejudice or bias. Each week "The X-Files" poses a mystery and offers two rival kinds of explanation, the rational theory and the paranormal theory. And, week after week, the rational explanation loses. But it is only fiction, a bit of fun, why get so hot under the collar?

Imagine a crime series in which, every week, there is a white suspect and a black suspect. And every week, lo and behold, the black one turns out to have done it. Unpardonable, of course. And my point is that you could not defend it by saying: "But it's only fiction, only entertainment".

Let's not go back to a dark age of superstition and unreason — a world in which every time you lose your keys you suspect poltergeists, demons or alien abduction. Enough; let me turn to happier matters.

The popularity of the paranormal, oddly enough, might even be grounds for encouragement. I think that the appetite for mystery, the enthusiasm for that which we do not understand, is healthy and to be fostered. It is the same appetite which drives the best of true science, and it is an appetite which true science is best qualified to satisfy. Perhaps it is this appetite that underlies the ratings success of the paranormalists.

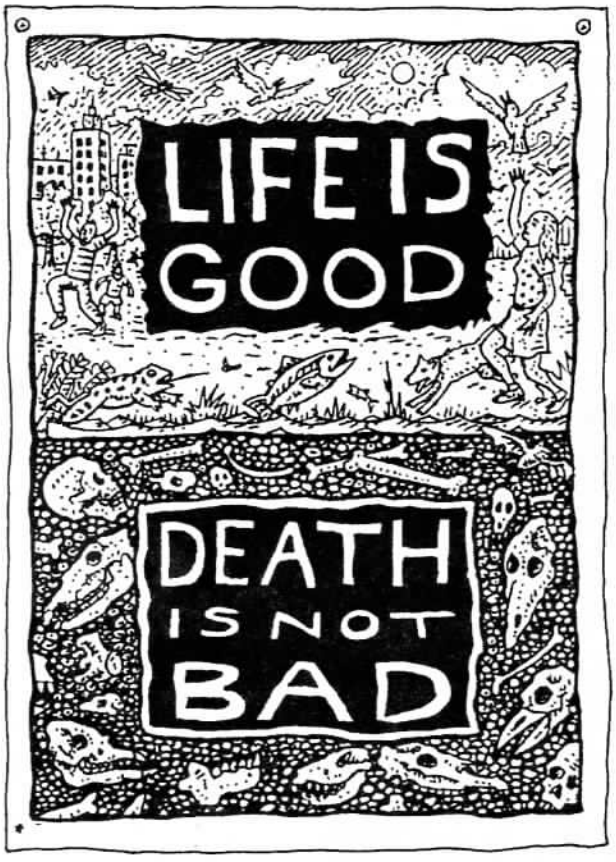
I believe that astrologers, for instance, are playing on — misusing, abusing — our sense of wonder. I mean when they hijack the constellations and employ sub-poetic language like the moon moving into the fifth house of Aquarius. Real astronomy is the rightful proprietor of the stars and their wonder. Astrology gets in the way, even subverts and debauches the wonder.

To show how real astronomical wonder can be presented to children, I'll borrow from a book called Earthsearch by John Cassidy, which I brought back from the US to show my daughter Juliet. Find a large open space and take a soccer ball to represent the sun. Put the ball down and walk ten paces in a straight line. Stick a pin in the ground. The head of the pin stands for the planet Mercury. Take another 9 paces beyond Mercury and put down a peppercorn to represent Venus. Seven paces on, drop another peppercorn for Earth. One inch away from earth, another pinhead represents the Moon, the furthest place, remember, that we've so far reached. Fourteen more paces to little Mars, then 95 paces to giant Jupiter, a ping-pong ball; 112 paces further, Saturn is a marble. No time to deal with the outer planets except to say that the distances are much larger. But, how far would you have to walk to reach the nearest star, Proxima Centauri? Pick up another soccer ball to represent it,

and set off for a walk of 4200 miles. As for the nearest other galaxy, Andromeda, don't even think about it!

Who'd go back to astrology when they've sampled the real thing — astronomy, Yeats's "starry ways", his "lonely, majestical multitude"? The same lovely poem encourages us to "[r]emember the wisdom out of the old days", and I want to end with a little piece of wonder from my own territory of evolution.

You contain a trillion copies of a large, textual document written in a highly accurate, digital code, each copy as voluminous as a substantial book. I'm talking, of course, of the DNA in your cells. Textbooks describe DNA as a blueprint for a body. It's better seen as a recipe for making a body, because it is irreversible. But today I want to present it as something different again, and even more intriguing. The DNA in you is a coded description of ancient worlds in which your ancestors lived. DNA is the wisdom out of the old days, and I mean very old days indeed.



The oldest human documents go back a few thousand years, originally written in pictures. Alphabets seem to have been invented about 35 centuries ago in the Middle East, and they've changed and spawned numerous varieties of alphabet since then. The DNA alphabet arose at least 35 million centuries ago. Since that time, it hasn't changed one jot. Not just the alphabet, the dictionary of 64 basic words and their meanings is the same in modern bacteria and in us. Yet the common ancestor from whom we both inherited this precise and accurate dictionary lived at least 35 million centuries ago.

What changes is the long programs that natural selection has written using those 64 basic words. The messages that have come down to us are the ones that have survived millions, in some cases hundreds of millions, of generations. For every successful message that has reached the present, countless failures have fallen away like the chippings on a sculptor's floor. That's what Darwinian natural selection means. We are the descendants of a tiny élite of successful ancestors. Our DNA has proved itself successful, because it is here. Geological time has carved and sculpted our DNA to survive down to the present.

There are perhaps 30 million distinct species in the world today. So, there are 30 million distinct ways of making a living, ways of working to pass DNA on to the future. Some do it in the sea, some on land. Some up trees, some underground. Some are plants, using solar panels — we call them leaves — to trap energy. Some eat the plants. Some eat the herbivores. Some are big carnivores that eat the small ones. Some live as parasites inside other bodies. Some live in hot springs. One species of small worms is said to live entirely inside German beer mats. All these different ways of making a living are just different tactics for passing on DNA. The differences are in the details.

The DNA of a camel was once in the sea, but it hasn't been there for a good 300 million years. It has spent most of recent geological history in deserts, programming bodies to withstand dust and conserve water. Like sandbluffs carved into fantastic shapes by the desert winds, camel DNA has been sculpted by survival in ancient deserts to yield modern camels.

At every stage of its geological apprenticeship, the DNA of a species has been honed and whittled, carved and rejigged by selection in a succession of environments. If only we could read the language, the DNA of tuna and starfish would have "sea" written into the text. The DNA of moles and earthworms would spell "underground". Of course all the DNA would spell many other things as well. Shark and cheetah DNA would spell "hunt", as well as separate messages about sea and land.

We can't read these messages yet. Maybe we never shall, for their language is indirect, as befits a recipe rather than a reversible blueprint. But it's still true that our DNA is a coded description of the worlds in which our ancestors survived. We are walking archives of the African Pliocene, even of Devonian seas, walking repositories of wisdom out of the old days. You could spend a lifetime reading such messages and die unsated by the wonder of it.

We are going to die, and that makes us the lucky ones. Most people are never going to die because they

are never going to be born. The potential people who could have been standing in my place but who will never see the light of day outnumber the sand grains of Sahara — more, the atoms in the universe. Certainly those unborn ghosts include greater poets than Donne, greater scientists than Newton, greater composers than Beethoven. We know this because the set of possible people allowed by our DNA so massively outnumbers the set of actual people. In the teeth of these stupefying odds it is you and I that are privileged to be here, privileged with eyes to see where we are and brains to wonder why.

There is an appetite for wonder, and isn't true science well qualified to feed it? It's often said that people "need" something more in their lives than just the material world. There is a gap that must be filled. People need to feel a sense of purpose. Well, not a BAD purpose would be to find out what is already here, in the material world, before concluding that you need something more. How much more do you want? Just study what is, and you'll find that it already is far more uplifting than anything you could imagine needing.

You don't have to be a scientist — you don't have to play the Bunsen burner — in order to understand enough science to overtake your imagined need and fill that fancied gap. Science needs to be released from the lab into the culture.

Calling All Scientists

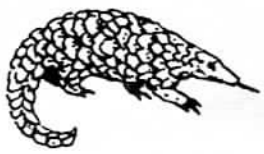
NCSE member John Banister-Marx, a science teacher who is always on the lookout for opportunities to inform his colleagues about evolution education, is seeking scientists to collaborate in an exciting project. Banister-Marx is one of 300 teachers from around the nation involved in developing the Access Excellence website into a resource for biology teachers. The site offers article summaries, lab activites, on-line discussion groups, and special seminars conducted by scientific experts.

Banister-Marx is working to develop a series of on-line seminars regarding evolution. He hopes to find a number of university/college professors willing to conduct one-week internet seminars, and also to act as resources for teachers' questions on such subjects as paleontology, biogeography, plate tectonics, molecular biology, radiometric dating, and comparative cytogenetics. During the month-long series, each weekly seminar would focus on one or two discussion topics.

Banister-Marx, who believes that it is important to link the average teacher to the university community, says, "What I'm hoping for in the long run is a long-lived, drop-in-and-ask clearing house for information on evolution, *and* a national forum for presenting to teachers the work of scientists involved in evolutionary research."

Ideally, the series will feature experts in the fields of biogeography, paleontology, human evolution, geochronology, archaeology, molecular biology (origin of life; genetic homologies), cladistics/ phylogenetics, astronomy/ cosmogeny (age of the cosmos; origin of the universe), nature of science, and the American Creationist movement.

Scientists — and teachers! — who would like to know more about Access Excellence can visit the site at <http://www.gene. com/ae>. To participate in the seminar series, write directly to John Banister-Marx at <aejbmarx@sedona.net>.



NCSE Members At Work

Indiana State University at Terre Haute now has a permanent exhibit on human evolution thanks to an NCSE member in the Department of Life Sciences. George S. Bakken arranged for the display because there are no similar exhibits in the area. Located in the west hall on the second floor of the science building, it includes 15 casts or models of crania from several species important to the study of human evolution. The collection contains specimens of chimpanzee, *Australopithecus afarensis*, *A. africanus* (Ms. Ples), *Paranthropus robustus/zeuxus*, *P. boisei* (OH 5), "Peking Man", Steinheim woman, Neanderthal, and modern humans. There are also important individual specimens from southern and eastern Africa (KNM-ER 1813, KNM-ER 1470, KNM-ER 3733, Kabwe [Broken Hill]), the Middle East (Tabun es Skuhl), and Europe (Predmosti). Rounding out the collection are a few tools, some text, and the Harvard wall poster of the Nariokotome *Homo erectus* boy.

For more information contact George Bakken at <gb@scifac.indstate.edu>.

Should Student Belief of Evolution Be a Goal?

Brian J. Alters
Philosophy of Education Research Center, Harvard University

Imagine a freshman college student named Dave — a very cordial, high achieving student. In high school he took algebra through calculus and almost all the sciences offered at the school. During the first semester of college a friend of his told him about an interesting course in the Philosophy Department. Dave, needing to take some requisite courses outside of his civil engineering major, decided to take the course. So he registered for PHIL 304: Philosophy of Science. The instructor delved deeply into the philosophy of physics, especially concentrating on various theories of causality and quantum mechanics. Dave, while not doing as well as the philosophy majors in the class, passed with a satisfactory grade.

After leaving college with a bachelor's degree in civil engineering, Dave was hired by a firm that specialized in building bridges over water for automobiles. His first assignment was to make some calculations that were vital with regard to supporting a suspension bridge to be built in his home town. After some time went by, he turned in the calculations to his manager and was given another task. A couple of days later the manager called Dave into his office. "You seem to have made some serious errors in your calculations," rebuked Dave's boss. After closely reexamining his work, Dave replied, "No, I contend these are correct." The manager retorted, "I have passed these by some of our veteran engineers, and they say that if we go with your figures the bridge will collapse when a heavy load of cars drives on it."

Dave explained his calculations step by step to his manager and fellow engineers. They were shocked and wondered how he ever passed his physics and engineering classes with such unorthodox ideas. Dave explained: "In college, I wrote what the instructors wanted me to write in order to pass the classes. But here I'm working on a real bridge that might carry my loved ones; I have to do what I believe is correct." (Dave had developed some highly unorthodox theoretical ideas during his freshman philosophy of science class days that affected how he looked at physics from then forward.) The manager, even though he had grown to like Dave, was forced to let him go.

When Dave was in college, some of his physics instructors had been aware of his rejection of some aspects of the physics that were taught. However, they never looked into Dave's rationales for his rejection; their goal was only to have students understand the material, not believe it. As Dave's plight illustrates, teaching students to just understand the material is not a sufficient goal; the teachers must also attempt to have students believe that what is being taught is correct.

At this point it seems appropriate to discuss briefly the messy issue of defining *believe* and *accept*. Some well-meaning educators have attempted to delineate the two — belief as being based on little more than personal convictions while acceptance is based more on empirical evidence. But I argue that any attempt to delineate the two is mistaken. I understand that *believe* might be more associated in the vernacular with nonscientific uses than *accept*, however, for all practical purposes they are synonymous. Both are ways to express concisely the degree of confidence one has in something no matter what may be the basis for that confidence. For example, Protestant ministers commonly use accept in their rhetoric and scientists commonly use believe in theirs.

The latter was recently demonstrated by NASA scientist David McKay when speaking at the Mars' meteorite press conference: "There is not any one finding that leads us to *believe* that this is evidence of life on Mars. Rather, it is a combination of many things that we have found" (*Chronicle of Higher Education*, 1996 Aug 16, p 10; italics added). McKay, the lead scientist and first author of the Mars meteorite study, obviously did not mean that his confidence level with respect to evidence of life on Mars was based on little more than personal convictions — no empirical evidence. It certainly was based on empirical evidence; that was the whole point of his comments. He simply uses *believe* as others may use *accept*, both meaning the same thing — a particular level of confidence. What is of importance is on which data and arguments one bases a particular belief or acceptance.

Back to schools... What would occur if the public schools graduated classes in which 50% of the students believed the following: George Washington was the eighteenth US President; 1 + 1 = 3; arsenic is healthy to ingest; and whales live in deserts? Most cer-

tainly Americans would be calling for answers to why their high school graduates believe such things; after all, no rational adult believes these statements.

However, what if the students instead believed that the Holocaust never happened, UFOs landed on Earth and temporarily took humans for examination; astronauts never walked on the moon; and fortune tellers can accurately tell one's future. Again, the general public would be appalled — but not all of them this time. There are rational adults who contend that these are correct conceptions.

Nevertheless, the reason that the most of the public does not want students to accept such ideas is that the overwhelming majority of experts in the respective fields report differently. After all, the reason we believe that brushing our teeth is good for our health is that dentists — experts in their field — report it to be so. We teach what the overwhelming majority of experts in a field report, whether or not there are some people who believe differently. Therefore, both public and private schools have always had belief as a goal of instruction whether implicitly or explicitly expressed.

The majority of material presented at both types of schools is similar, even when it comes to literalist Protestant schools. However, the similarities end between public and private religious schools when it comes to teaching that specific supernatural entities or actions existed or occurred in the past, are existing or occurring in the present, and/or will exist or occur in the future. These teachings are clearly an advancement of religion and are therefore ruled unconstitutional to present in public schools. The literalist schools make belief in a religion an explicit goal, if not the major explicit goal of their schools; public schools have no such goal.

So if the majority of material taught at both public and private schools is similar and both have a goal of belief in that material, why do so many educators contend that public schools should teach evolution for only understanding and not belief? I would argue that it has to do primarily with misconceptions these educators hold:

(1) "belief" means little more than personal convictions — no empirical evidence;

(2) "belief" is never a goal in public education;

(3) evolution has little empirical evidence;

(4) belief cannot be assessed, therefore it does not belong as an educational goal;

(5) teaching evolution with belief as a goal is tantamount to proselytizing students.

I discussed the first and second of these misconceptions previously. The third misconception is generally held by non-biology majors who simply have not been introduced to the voluminous amount of data that support evolution, and/or do not themselves believe evolution occurred themselves (both significant problems in their own right that will not be addressed here).

With regard to the fourth misconception, the inability to assess accurately students' progress concerning a specific educational goal does not mean that the goal should not be sought in schools. By the logic of this misconception we would have to eliminate many important public school goals such as having students believe that AIDS can be transferred through unprotected sexual intercourse. Whether the students understand the biochemical pathways involved with AIDS or not, we have an important additional educational goal — that students believe that the virus can be transferred through unprotected sexual intercourse, as experts in that field have reported.

Teaching evolution with belief as a goal has been equated with proselytizing students — misconception four. Usually *proselytize* is used to mean the act of attempting to convert a person from one religious faith to another; this should never be a goal of public school teachers and cannot be a goal legally. In this commonly used sense of the word, teachers are not proselytizing students when they attempt to change students' belief from "arsenic is healthy to ingest" to "arsenic is dangerous to ingest." Likewise, teachers are not proselytizing when they attempt to have students believe the scientific fact of evolution. The problem for many educators is that evolution is in conflict with some students' religious beliefs and therefore, by teaching evolution with a goal of belief, the educator is attempting in fact to change the students' religious beliefs.

I respond with a question: What would happen if teaching that arsenic is poisonous was against someone's religious beliefs? It is not the job of public schools to become experts on religious convictions and then craft curricula that would be religiously inert. Besides, with all the personal and organizational religious beliefs that exist in America, that would be an impossible task. The US Supreme Court reviewed and allowed to stand as constitutional the language and decision of the US Court of Appeals in *Florey v. Sioux Falls School District,* 619 F.2d 1311, 1317 (1980).

> It would literally be impossible to develop a public school curriculum that did not in some way affect the religious or nonreligious sensibilities of some of the students or their parents. School administrators should, of course, be sensitive to the religious beliefs or disbeliefs of their constituents and should attempt to avoid conflict, but they need not and should not sacrifice the quality of the students' education.

So no matter what our public schools teach, we could easily be offending someone. The offense taken by students and parents is certainly not intended; it is just unavoidable.

In summary, I argue that a goal of belief with regard to biological evolution be given the same rational evaluation as the goal of belief concerning other subjects that are taught in our schools. Given this equality we will teach for understanding and belief of all

Relativist Apologetics: The Future of Creationism

Taner Edis

Creation "science" is, it seems, an intellectual embarrassment. Creationists mostly rely on unsophisticated polemics and appeals to sectarian religious beliefs. The scientific community no longer considers special creation to be a worthwhile hypothesis, even though creationists claim "there are today *thousands* of recognized, qualified scientists who have become creationists, in spite of the evolutionist intimidation which they now face in organized intellectualism" (Morris 1985, p16). With few exceptions (e.g. Moreland 1989), even theologically conservative philosophers stay away from creationism. So when we oppose creationism in the science classroom, we start from a very strong position. If scientists — indeed, most people with a decent intellectual background — do not take creationism seriously, why should it appear in a science course?

Creationism may be outside the pale, but others besides conservative monotheists are uncomfortable with Darwinian evolution. The trouble with Darwinism is that it refuses to be confined to biology. After all, evolution is all about obtaining complex organization by purely natural means; so even fields as diverse as cosmology and artificial intelligence can benefit from Darwinian ideas (Dennett 1995). Evolution begins to encroach on the human sciences. Though "pop-sociobiology" was overly ambitious and thus failed to invade much social science turf (Kitcher 1985), Darwinism still threatens to help explain humans in naturalistic terms, denying the existence of irreducible realms of mind or meaning. Not everyone is happy with this prospect.

If natural science was getting too imperialist, some philosophers and human scientists were busy erecting the perfect defense. Science, after all, is a social activity, and scientific knowledge is the product of a distinct community. Perhaps, then, science is only the expression of the values and way of life of a particular community, with no more claim to a better grasp of reality than witchcraft. Our very notions of evidence and logic are culture-bound, not subject to trans-cultural criteria of rationality (Winch 1970). This cognitive relativism was also echoed in the philosophy of science. Scientists, it seemed, worked within frameworks which included standards of rationality. These frameworks, or paradigms, were not comparable in any paradigm-independent sense, hence major changes in science came about like a "conversion experience" based on faith (Kuhn 1970).

At present, relativism is intellectually respectable. It tends to explain the cognitive authority of science not by science's ability to approximate truth, but by political power. It tends to valorize the "ways of knowing" of different communities. It impresses people with ugly postmodern buzzwords like "valorize." In other words, it is just what creationism needs to construct a sophisticated argument. Protestant theology is already full of presuppositional apologetics and leaps of faith between world views — much like paradigms. And as part of the world view constructed by a distinct community, creationism must be no worse than orthodox biology. Surely it must get equal time, at least. We have to be concerned about more than the standard creationist arguments. I would like to suggest that

- Evolutionists cannot count on a continuing lack of sophistication on the part of extreme anti-evolutionary views.
- There is a natural affinity between conservative Protestant apologetics and cognitive relativism; this connection may be exploited in the future.
- Common anticreationist arguments are not only inadequate in responding to relativism, but are often deficient in ways relativist challenges highlight.

If creationists adopt relativist apologetics, they will acquire a shinier intellectual veneer. The primary battleground, however, is science education. Teaching only evolution privileges evolution over creationist beliefs. And if evolution is ultimately an expression of faith, similar to biblical creation in its world-view-dependence, it becomes easier to portray teaching evolution alone as a one-sided imposition of a cultural belief not shared by everyone. Some educators have already been responsive to "multicultural" arguments for teaching pseudosciences comparable to creationism (Ortiz de Montellano 1992); relativism can serve creationists as well.

A Tale of Two Sciences

To highlight the force of relativist apologetics, consider a science-fiction scenario for our future.

To begin, let us imagine a stronger and more self-confident creation "science" community. Religious cultures, far from becoming secularized, seem resurgent across the globe (Greeley 1995; Bruce [1996] identifies a shift to an individualist style of religion, but creationism can probably flourish either way). Conservative Christianity and creationism provide community, guidance, and a perception of clear-cut meaning in history and the natural universe for many believers. *If* conservative religion is socially successful, it *might* be able to sustain an alternative quasi-scientific community.

A confident conservatism could support the institutions required for an effective creation "science" community. Phillip Johnson (1991, 1995) considers evolution to be bad science driven by naturalistic metaphysical assumptions, and suggests that committed Christian scientists could reconstitute science along lines explicitly acknowledging creation. Such a project needs new "scientific" institutions more sophisticated than Bible colleges; the ICR's graduate school is a small step in this direction. Now imagine that such efforts succeed beyond ICR's wildest imaginings, and creationists begin to develop a network of alternative institutions of higher learning.

[W]hat if creation and evolution both end up supported by sophisticated communities and institutions?

The creation "science" practiced in these fundamentalist universities would not be divorced from mundane reality. Creationists think science should be a Baconian activity, observing "facts" and fitting them into a biblical picture (Marsden 1984). They probably would emphasize engineering, going along with the popular equation of science with technological progress.

Meanwhile, evolutionary sciences would not stand still. We can easily imagine how developments in genetics, artificial life, and the physics of complexity will deepen our understanding of evolution. But at the same time, trust in science may erode in our culture. Already all too many people see science as no more than a collection of facts with the stamp of Authority on them. Modern science is supported largely through its services to economic and military competition—other social contexts may not be as favorable. Many are disillusioned with the secular social options in our modern world (e.g. Lasch 1995, chap 13); it is conceivable that the prestige of modern science will decline as well. Creation "science", in contrast, will have hitched its wagon to more comfortable social ideals.

Our tale of two sciences is perhaps far-fetched; it is not a prediction but a device to remove some of the social background we take for granted while arguing for evolution. We would like to believe evolution is the best explanation for the relevant evidence, even in a social climate less favorable to science as we understand it. But what if creation and evolution both end up supported by sophisticated communities and institutions? Relativists will say the rival communities defend not only different claims, but different assumptions about knowledge and proper method. The "creation-science" and "evolution-science" communities embody different fundamental commitments, and we have no neutral, commitment-free ground from which to judge between the two. In education, a future philosopher might argue, all we can do is present both creation and evolution and let the student decide. Anything else would be arbitrarily favoring one community over another.

Future biologists will naturally be incensed. After all, the independent evidence in favor of evolution is overwhelming. Not only biology, but most of natural science, hangs together very well in the light of evolution. And we are supposed to treat this incredibly successful theory on a par with an overgrown fairy tale? Our postmodern philosopher will not be impressed. She will agree that evolution is more successful *on its own terms*: it is open to correction by empirical tests, its theories and evidence fit together nicely, and so on. But creation "science" is also successful by its own criteria: it is corrected by biblical tests, it nicely fits a firm moral vision together with its description of nature, it affirms spiritual truths manifested in human needs, and so forth. Evolutionists and creationists both claim truth, but we cannot decide between them except by arbitrarily accepting a package deal which includes criteria for truth.

Could we not find a deeper principle of rationality which could firmly ground our confidence in evolution? Our philosopher will tell us no—after all, any such principle we propose will fall within yet another paradigm, a broader one perhaps, but still a paradigm with no external justification for its principles. Evolutionists and creationists accuse each other of irrationality, but this means nothing more than that they disapprove of one another (see Latour 1987, p 192). There are no secure foundations; we choose through faith and commitment.

Now relativist apologetics can really get in gear. We can accept or reject creation, but face a crisis since reason demands neither. Conservative Christians, however, recognize the necessity for faith. Modernists are handicapped by the chimera of a universal truth accessible to impartial inquiry; creationists understand one must believe in order to see. Faith is the province of biblical religion; from traditional apologetics to reliance on conversion experiences, it has

the equipment to handle the relativist predicament.

It might be surprising for creationists to use relativist rhetoric, since Christian conservatives usually condemn modern culture for its relativism and hold themselves up as defenders of biblical Absolutes. But they need not defend cognitive paralysis; relativism is useful only to induce a crisis to be resolved by a leap of faith. God and Creation provide a way out of the relativism a sterile Reason leads to. In fact, the biblical God is the only possible savior of an otherwise self-destructing Reason. Just as creation by a self-existent God is supposed to tell us why there is something rather than nothing, a God we can trust in provides the foundation for Reason. Rationality emerges from relativism, but under the authority of the Word of God, which is its only sanction. We do not reach this Creator without an act of faith, even an act against the wanton Reason which produces idols like evolution. But once we take that step, creationists might say, our reasoning faculty has reached salvation as well as our souls.

Back to the Present

While creationists lean on relativist apologetics only in science fiction, the groundwork is already present. Some Calvinist-style arguments are similar to a relativist approach; for example, presuppositional apologetics, which insists the Bible is the unprovable foundation of all legitimate thought (Van Til 1967). Creationists themselves use quasi-relativist language to prepare the way for faith, declaring that

> [A] philosophy of origins can only be achieved by faith, not by sight. That is no argument against it, however. Every step we take in life is a step of faith. Even the pragmatist who insists he will only believe what he can see, *believes* that his pragmatism is the best philosophy, though he can't prove it! (Morris 1985, p 4).

These are not, of course, the most academically reputable sources. But contemporary philosophers often use arguments with a relativist flavor to deflect evidential objections to religious fact claims, even to reconstruct our idea of rationality in a religious image (see Loades & Rue 1991, particularly selections from A. Plantinga and T. Penelhum). If one were to throw a brick at a gathering of religion scholars; chances are that it would hit someone who has made use of the relativism so prevalent in philosophy and the human sciences. Indeed, some religious evolutionists look favorably on an intellectual climate which can limit reason to make room for faith (e.g. Shapiro 1993).

Relativists are occasionally sympathetic to creationist struggles against the bugbear of Enlightenment science, even when they consider creationism absurd (Aronowitz 1988, p 12). However, there is a potential for more. Consider the following quotes from Bruce B. Lawrence's study of fundamentalism (1989).

> Evolution prevailed not on its intrinsic merits but because Darwin benefited from the general prestige conferred on science as an independent inquiry that heralded progress but lacked firm criteria for correlating truth with success.
>
> Once evolution has been understood as dubious science seeking acceptance as a universal ideology, it becomes possible to make sense of the entanglement of Darwin with religious issues. The natural selection of the species precluded any divine agent or ulterior purpose in the genesis of human life (p 175).
>
> Even contemporary exponents of evolution must admit that the arguments for its validity rely as much on ideology as facts. The pretense to scientific objectivity needs to be unmasked, the claim to universal validity scaled down (p 184).
>
> Creationists fail to realize the extent that they have not invoked true scientific principles because they are not trying to identify new, testable hypotheses but rather to cast doubt on those hypotheses that already exist. Yet at the same time positivists [including evolutionists] falter in not recognizing the ideological and nonuniversal character of their claims on behalf of science. Facts and values are enmeshed in all human activity, including science, and the desideratum is not to eliminate prejudice but only to clue the lay reader and listener, as also the scientific practitioner, to its existence.
>
> Even as a public spectacle, the debate on creation is less an objective inquiry into knowable facts from value-free perspectives than it is a testing of constituencies who advocate two variant world views (p 188).

[C]ontemporary philosophers often use arguments with a relativist flavor to deflect evidential objections to religious fact claims.

Lawrence does not exactly defend creationism, but his views are not congenial to evolutionists. He is also a well-respected scholar of religion, and his arguments are not considered eccentric.

Relativists usually subscribe to a "symmetry principle," demanding "that true and false knowledge claims are to be explained by means of the same set of explanatory notions." In contrast, rationalists take true knowledge to be forced upon us by proper procedures and reality checks, while social explanations are

continued on page 22

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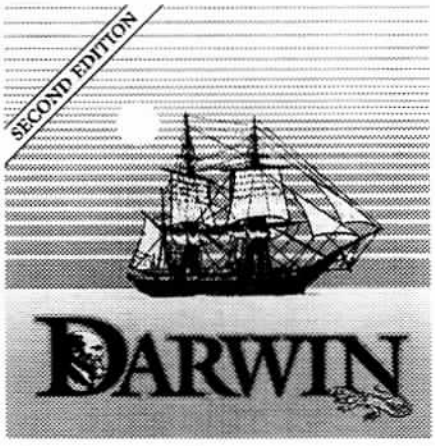

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appropriate for irrational beliefs (Raven and others 1992, pp xxii—xxiii). This asymmetry bothers sociologists of knowledge. If scientists say they accept evolution because of reasons like the fossil evidence, creationists are as capable of producing reasons from their own perspective. And if creationism is largely a product of social circumstances, prior religious beliefs, and so forth, perhaps belief in evolution is also explained by social factors.

Social conditions did affect the 19th-century debate over evolution. Adrian Desmond, for example, argues that the acceptance of evolution was delayed until Darwin produced a theory congenial to conservative Victorian elites, while previous ideas of evolution were closely associated with radical politics (Desmond 1989). Departing from such arguments, scholars like Lawrence play up the social context so much that the biological issues fade to insignificance. Interestingly, Lawrence's views find a crude echo in creationist charges that the driving force behind evolution was an ideological need to explain life without a God (Morris 1989). This is not to say historians of science have all decided to explain Darwin by social ideologies. There are good defenses of Darwin's originality, denying, for example, that he merely reflected the competitive Victorian ethos (Bowler 1988, chap 2). Still, relativist accounts are a serious part of the current debate.

...scientific is not a mere extension of everyday reasoning or trial and error — there is a deep and perplexing discontinuity...

Many scientists react to relativism with exasperation. Some suggest it is mainly an intellectual failure of nerve, or an intrusion of pseudo-left politics into scholarship (Gross & Levitt 1994). Natural science seems too *successful* to be undermined by philosophical handwaving. Physicists, for example, think their theories and experiments often converge onto very solid explanations, and that the physics community is coerced by such reality tests rather than external social influences (Weinberg 1992, chap 7; Mermin 1996). One has to be isolated from reality by a philosophy or sociology department in order to doubt our ability to explain electricity or projectile motion. Or the origin of species, for that matter. Evolutionists are also inclined to dismiss relativism as a "fashionable salon philosophy," easily refuted by the successes of science (Dawkins 1995, pp 31-3). Furthermore, while science succeeds, a runaway relativism would undermine even the most trivial everyday reasoning. Our confidence in being able to shop for groceries comes into doubt, never mind evolution. Relativists also buy groceries.

Unfortunately, acknowledging common-sense reality is not enough. As critics of relativism like Ernest Gellner observe (1985, pp 51-55), scientific reasoning is not a mere extension of everyday reasoning or trial-and-error—there is a deep and perplexing discontinuity involved. Everyday reasoning depends on "folk theories," while scientific theories like quantum mechanics or Darwinian evolution regularly offend common sense (Churchland 1989). Ideas like special creation or vital essences are closer to our folk theories than the counterintuitive concepts of theoretical biology.

How scientists come up with general theories extrapolating from experimental evidence is also unclear. A relativist could agree that evolution is not the naive uniformitarian generalization described by creationist diatribes, but also point out that the possible ways of extrapolating from finite data are literally endless. Microevolution does not strictly entail macroevolution; so how do we get there? The procedures favored by the scientific community are not self-evident; indeed, exactly how science proceeds is hard to describe. There are other communities which manage to cope with everyday reality, but which build wider theoretical pictures in very different ways. We need not rely only on exotic anthropology here—modern Western society contains many groups which adopt non-scientific procedures of extrapolation. New Agers put trust in occult correspondences in their accounts of reality. Creationists note that we cannot directly observe evolution in the past and prefer to trust biblical testimony.

Relativists may need to weaken their position and acknowledge common-sense reality to avoid talking nonsense. However, this does not bring them to trust science, but to seek cognitive security in custom and community. Creationism is rooted in a strong religious community, and is *closer* to the folk-theories of common sense. So creation "science", especially a creation "science" which collects Baconian facts and emphasizes engineering, is still poised to benefit from a weaker relativism.

Defending Science

Relativists can make a case that evolution is permeated by ideology, even that the perspective of a creationist community is no less valid than that of scientists. Still, defenders of science can find plenty to criticize in their arguments.

First of all, relativists make fact claims about science. Take, for example, the idea that we operate within closed sets of presuppositions which are not rationally comparable to one another. But if we are always trapped in the circle of our presuppositions, what objective reason do we have to believe we are so trapped? Or, if a sociologist claims scientists operate within paradigms which reflect social ideologies, why is sociology exempt from such a description? The extreme forms of relativism risk contradicting them-

selves (Harris 1992), and these extremes are what prepares the way for creationist leaps of faith.

Relativists derive philosophical support from the impasse we reach when we ask for the justification of a claim, the justification of that justification, and so on. Science, it appears, does not rest on absolutely certain foundations. So be it. We do not build on certainties but construct a network of beliefs which support one another. Anything within this network is open to question; though of course we cannot question all of it at once. We may start from our folk theories, but we find that by doing science, we converge on different theories which do a much better job explaining things. In this case, since we do not set aside any unchallengeable foundations, we can ask if our philosophies are supported by science as well as the other way around. Emphasizing foundational principles seems to lead to a relativism where creation is as good as evolution, and the moon might as well be made of green cheese. But if this is so, so much the worse for foundations (see Nielsen 1989).

Relativists also make much of the social nature of science, and the fact that it is not strictly value-free. But unless truth is available through magic, science *must* be organized as a community expressing certain values. Indeed, far from compromising inquiry, the structure of the scientific community is precisely what enables us to learn about nature (Grim 1982; Kitcher 1993, p 305). The social nature of science is no argument against its theories; no more than the fact that all that happens in our brains is neurons firing means humans cannot learn about the world.

Of course, all this is only a small taste of a complex debate. But it is clear there is no easy way to defend science against relativism. Relativism has force precisely because it fits our prejudices. We too often think there is a hierarchy of knowledge with the eternal principles of philosophy at the top, theoretical science next, and downwards as we get our hands more dirty. We believe philosophical foundations are terribly important, so uncertainty becomes a reason to panic. We like our science ethereal as well, so any hint that the communities that actually *do* science are imperfect taints the results. Now, none of this is really true; indeed, relativists do us a service by emphasizing that our legend of an ethereally perfect science is not the reality. We do perfectly well without absolute certainty, and with jury-rigged social arrangements which nevertheless help us learn about the world. But this is a counterintuitive idea, almost as difficult as the notion that jury-rigged but functional organisms can evolve without supernatural design.

So if creationists adopt relativist apologetics, evolutionists may have a hard time responding. A religiously pluralist culture is already somewhat relativist in attitude (Bruce 1996). Presenting a case for equal time in the classroom based on science being just another way of knowing and creationism being the belief of a legitimate community is fairly straightforward, especially if done in plain language and not the jargon of postmodern academics. And if postmodern academics can be found to support creationist demands for fairness, even better. Evolutionists want to say modern science is more reliable—not certain, but the best we can do at present. But declaring modern science superior to creation "science" at a school board debate will work only if the wider culture already affirms this as obvious. Otherwise, explaining why we think science is better will be about as easy as a quantum mechanics lecture.

Perhaps we can defend evolution by relying on comforting myths. Moderate Christianity has reason to adapt to evolution, since modernist culture endorses scientific truths as valid for everyone. And evolutionists want to enlist broad public support for evolution. So we usually claim evolution is compatible with our traditional religions. In fact, we try to stop the argument before it starts by ruling creation scientifically inadmissible. Special creation, we say, is an unfalsifiable claim, or it is unscientific because it relies on supernatural explanations. Science, the story goes, is characterized by *methodological* naturalism, while possible conflicts with religion concern *philosophical* naturalism (Scott 1993, Fezer 1996). Religious authorities join in, calling creationism bad religion as well as non-science (Frye 1983). We hope that once we understand the proper spheres and limits of science and religion, we will see there is no need for creationism.

This happy compatibility is suspiciously convenient. Indeed, the falsificationist critique of creationism is a failure (Kitcher 1982, pp 42-44), and philosophers have all but given up on distinguishing between science and non-science based on the content of fact claims. Even the "supernatural" can be examined as a scientific hypothesis, as parapsychologists in effect do. Science does not exclude the supernatural by design, it just happens to be that such explanations have not been very successful. And since religions almost always include fact claims beyond moral exhortation or mystic feeling, the potential for friction between science and religion is always present. This does not mean science and religion are eternal enemies—another myth—but that, as history indicates (Brooke 1991), there is a complex and ambiguous relationship between the two.

Our myth of compatibility works fine, defects and all, when our society has a strong consensus in favor of modern science. But if this consensus weakens, the disagreements the myth papers over will surface. As scholars like Bruce Lawrence recognize, the burning issue with evolution has always been its implications for the Abrahamic religions. Darwinism goes a long way towards making a designer-God superfluous, and while it does not strictly entail atheism, it *undermines* God in favor of a thoroughgoing naturalism (Rachels

1990, chap 3). For this and other reasons, our secular science education does in fact reflect a bias against anti-evolution Christians. Warren A. Nord has already argued education should become more "balanced" regarding conservative religious views (1995, pp 282-296), in light of how some philosophers and human scientists have presented a weakened, somewhat relativist picture of science and rationality. One of these days we are bound to encounter a similar argument specifically about creationism.

Relativism, then, can help creationists. It can be adopted to give creationism intellectual respectability, but it also creates a climate where evolutionist arguments for an educational monopoly ring hollow. Of course, no one can say if creationists will ever develop a full-blown relativist apologetic strategy. But if this happens, there will be interesting times ahead of us in the creation/evolution debate.

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ANTI-EVOLUTIONISTS FORM, FUND THINK TANK

Old-Earth Moderates Poised to Spread Design Theory

Eugenie C. Scott, NCSE Executive Director

A press release dated August 10, 1996, announced that two private foundations have granted the Seattle-based Discovery Institute nearly a million dollars to establish the Center for the Renewal of Science and Culture. The Center will sponsor conferences, disseminate research and support postdoctoral students.

Individuals associated with the Center include some familiar old-earth anti-evolutionists employed at secular colleges and universities: Stephen Meyer (philosophy, Whitworth College), John West (political science, Seattle Pacific University), Phillip Johnson (law, University of California-Berkeley), and Michael Behe (biology, Lehigh University). The current research fellows include William Dembski (mathematics, formerly at Princeton), Paul Nelson (philosopher, former editor of the *Bible-Science Newsletter* and recent University of Chicago Ph.D.), and Jonathan Wells (molecular and cell biology Ph.D. from UC-Berkeley.)

THINK TANKS AND UNIVERSITY ANTI-EVOLUTIONISM

The funding and deployment of the Center for the Renewal of Science and Culture is a major step towards scholarly respectability for a relatively new group of anti-evolutionists: religious conservatives based at secular universities. They are organizing (or have organized) Internet list serves and web pages, conferences, new journals *(see NCSE Reports* 1996 Fall; 16[4], pp 4-5) and, now, think tanks.

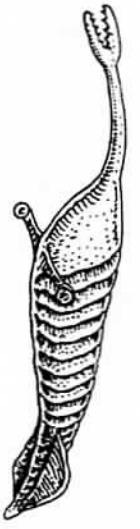
We are witnessing the embryogenesis of what I shall call "university-based anti-evolutionism". This term, though imperfect, reflects the fact that the newer crop of old-earth, mostly "design theory" anti-evolutionists are disproportionately located in secular institutions of higher learning, rather than at the more familiar independent, not-for-profit centers such as the Institute for Creation Research, Answers in Genesis, and so on. Because most of them are not, in fact, in science departments, it would be inaccurate to refer to them as creation "scientists".

Historically, the leading anti-evolution activists have been such "young-earth" creationists as Henry Morris of the Institute for Creation Research. However, the publication of Phillip Johnson's *Darwin on Trial* in 1991 encouraged the growth of a more moderate, "old-earth" anti-evolutionism which, because it accepts that the earth is ancient, is perceived by the public as being less on the fringes of science than other creationist models. Although they disagree on the age of the earth, neither old-earthers nor young-earthers accept biological evolution (descent with modification) as the basis for the emergence of new species from ancestral forms. Most will accept mechanisms and processes of evolution such as natural selection, but they balk at a natural origin of new "kinds" and "basic body plans".

Phillip Johnson, a nationally-known scholar at a major secular university (Boalt School of Law at UC-Berkeley) articulated the concerns of conservative Christians that their views were being systematically excluded from the secular institutions in which they worked. Johnson and others supporting university-based anti-evolutionism have challenged academe by arguing that if it is acceptable in academia to teach and do research from the perspective of an "ism" such as Marxism or feminism, why is it not also acceptable to argue from the perspective of Christianity? A concern of university-based conservative Christians is the increasing secularization of society and what they see as the abandonment of faith. Their own universities, they believe, are mainsprings of this tendency, and they don't like it. They believe society is locked in a struggle between materialism and theism.

MATERIALISM AND THEISM

Materialism is the view that the natural world can be explained in terms of matter, energy and their interactions. It may be expressed as a methodological rule — "science is restricted to explaining the natural world through natural means", or as a broader, philosophical conclusion that, "therefore, there is no God." *Theism* is the belief in a supreme God, and for conservative Christians, this God must be an active participant in the running of the universe and in the affairs of humankind. But instead of arguing philosophically about the values



of theism vs. materialism, the university-based anti-evolutionists use evolution as a stalking-horse. Evolution is a symbol of these conservative Christian professors' discontent with secularism in academia and in society at large. NCSE objects to books by Johnson (Pennock 1996; Fezer 1996) and Michael Behe's recent *Darwin's Black Box* (see review by Miller 1996) not because they promote a philosophy, but because they unjustifiably attack a science.

The focus on theism vs. materialism is well exemplified by "intelligent design" (ID), the argument that some aspects of nature are "too complex" to have occurred through evolution, and thus a place must be left in science for supernatural intervention. But the practice of modern science is overwhelmingly (methodologically) materialistic: supernatural explanations are dead ends that do not lead to further understanding. University-based anti-evolutionists object to the current primacy of methodological materialism in science and request that we scrap a methodology that has worked very successfully for over a hundred years. I have frequently run into a, "but-if-it-is-the-truth, why-can't-we-teach-it?" argument for allowing supernatural explanations into science classes. Members of the public who feel this way can now claim support from an impressive source: scholars based not just at Bible colleges, but at secular universities.

[T]he newer crop of old-earth, mostly "design theory" anti-evolutionists are disproportionately located in secular institutions of higher learning.

The rise of university anti-evolutionism is relatively new, and the promised hard-hitting critiques of the science of evolution have not yet appeared. ID has not influenced evolutionary biology or any other mainstream science, for example. However, although it has been inconsequential in science, university anti-evolutionism appears to be seeping into philosophy, history, "science studies", and social studies classes, in which works by Johnson, Behe, and others are being assigned and read. As valuable as it may be for understanding the social context of late 20th-century science to read these modern critiques, the question arises as to whether a philosopher or a sociologist has sufficient *scientific* background to see and to articulate to students how these books and articles fail as science.

What will be the future influence of university-based anti-evolutionism? How will its rise affect the current struggle to keep evolution in the schools? Currently, the resources and influence of the Center for Renewal of Science and Culture pale next to the vigorous proselytizing of the Institute for Creation Research, the Bible Science Association, or Answers in Genesis. But there is another, more long-term way that university anti-evolutionism may affect the creation/evolution controversy: To the extent that anti-evolutionism spreads throughout the secular university community, its major influence is likely to be in training the next generation of teachers (and school board members and state legislators) to be suspicious of evolution. It does not matter that university-based anti-evolutionism is not rooted in science departments: most students take few courses in these departments anyway. If university-based anti-evolutionism expands, there will be ample opportunity for them to learn erroneous science in non-science courses.

University scientists should watch for opportunities to open channels of communication when colleagues in other disciplines assign readings that distort or misrepresent science, such as Johnson's *Darwin on Trial* or Behe's *Darwin's Black Box*. The point that should be made is that although the philosophical issues raised in these books are legitimate subjects for debate, the science is often substandard, and if the books are used, scientific errors should be noted for the student.

As an example, if a history teacher wanted to discuss the historical issue of the divine right of kings, he would be unlikely to use a source that claimed that ancient Egyptians ruled 15th-century France — the historical issue could be discussed, but the historical example itself is just bad history. Similarly, Johnson brings up issues of philosophical interest, but *Darwin on Trial* is not a source one should use to learn the science of evolution (*see* Scott and Sager 1992, Scott, 1993).

Ironically, from the standpoint of evolution education, it is far preferable to have anti-evolutionary ideas expressed and debated at the university than in the local school board meeting. At least at the college level, individuals can be found who can show the scientific flaws in anti-evolutionist arguments, as has been done with Behe's and Johnson's books.

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IMPRESSIONS:

An Evening with Dr. Hugh Ross

Kenneth E. Nahigian

Creationist astrophysicist Dr. Hugh Ross spoke at the Fremont Presbyterian Church in Sacramento, February 16, 1996, on "New Scientific Evidence for God". A smoother speaker I have not heard in years. Jubilant believers nearly filled the large church hall — mostly affluent-looking couples, but a fair-sized coterie of college students were also present, taking notes and asking intelligent, if uncritical, questions. (Fremont Presbyterian is just outside the front gate of California State University Sacramento.) For an old evolutionist like me, it was humbling.

Ross is a proponent of Anthropic Design, trimmed heavily with evangelical Christianity. In his view the benevolent design of the universe in general, and Earth in particular, is evidence of the Christian Creator. A progressive creationist, he also promotes the model of an ancient earth (billions of years) but a recent humanity (tens of thousands), with nudgings and fine-tunings by God along the way. He flatly denies a common ancestry for man and ape but seems equivocal about non-simian species. All this puts him in a fairly liberal camp, by creationist standards.

As a speaker, Ross is warm, affable, soft-spoken, good-humored, entertaining. He defused angry questions from a few young-earthers in the audience, taking wind from their sails with careful biblical exegesis and no hint of impatience or sarcasm, and, most importantly, making no enemies. (To this extent some evolutionist debaters could well take a leaf from his book.)

He spoke quickly, in a lively montage style, often outracing my note-taking skills. Much of his science seemed passably accurate, even cutting edge. Some points were oddly slanted or false; these ranged from the merely quirky to the occasional howler. The highlights of his presentation, drawn from memory and my notes scribbled during the evening, are shown in italics. My impressions and responses as I listened to Ross follow.

Ross began with definitions: Science is the interpretation of nature; theology is the interpretation of the Bible.

Right at the start, Ross defined non-Christian theologies (such as Moslem and Hindu and much of Judaic thinking) out of existence.

Science and theology are not independent disciplines; they overlap, because the Bible speaks about nature. True science must thus conform to true theological findings.

Why not put it the other way, I wonder?

Even Einstein, as a result of his findings, came to believe in a personal God that directly influences the world.

Certainly not! According to Einstein: "It was of course a lie what you read about my religious convictions, a lie which is being systematically repeated. I do not believe in a personal God and I have never denied this but have expressed it clearly" (Dukas and Hoffman, 1979) And: "The idea of a personal God is an anthropological concept which I cannot take seriously" (Hoffman, 1973). For what it's worth, Einstein was on the board of advisors of Charles Francis Potter's First (secular) Humanist Society of New York.

The Bible is unique, in that it alone teaches that God created time and space. Only the Bible teaches that God is uncreated.

That dull roar in the background is the sound of Brahmaists and Moslems, howling.

String and Inflation Theory tell us that the universe had ten dimensions at creation. A "trillionth of a trillionth of a trillionth" of a second later, it split into two worlds of four and six dimensions.

This somewhat misrepresents String Theory, wherein the universe did start with from ten to twelve dimensions, and still has them; the extra dimensions are now "rolled up" or compressed into loops tinier than a proton. Inflation Theory does suggest a sort of splitting, but into many "bubble universes" each with the same dimensionality as the original.

The Bible teaches that God moves in six dimensions.

My curiosity is killing me. Where? But of course no theologian or Bible scholar said such a thing until String Theory came along. It would have astonished Aquinas! And if String Theory had postulated fifteen dimensions, I suspect somehow Ross would have found verses proving God moves in eleven. Theological retrofitting, it's called.

Life would be flatly impossible if the fine structure constants (gravitation, electromagnetism, speed of light, etc.) were even slightly altered. The universe is designed for life!

Score a half point for Ross. If I were an evangelical theist, this is where I'd bet the farm. Consider lowly carbon. Only carbon (and just possibly boron, but boron is rare) can form the long peptide and phosophoribose chains needed for life. (Silicon was a contender once, but recent research has ruled it out.) And if electromagnetism or the strong nuclear force were re-tuned, even slightly, carbon would lose its special resonance and fecundity. It would not exist, or would be rare, or would not bond easily with other elements. But this argument conceals some shifty assumptions. If we slip those constants, wouldn't the properties of other elements slip also? Then perhaps silicon would form long chains, and ....

Most of Ross's examples were like that. When evaluating how things "might" have been, he'd adjust *one* property in a complex of interrelated properties and assume that all else would remain the same. And of course things aren't so simple. Changing just one physical law, as

Larry Niven observed, is like trying to eat one peanut. Close the door on one possibility, and others fly open

Ross also downplayed the ferocious tenacity of life. We don't have to re-adjust any fine structure constants to find some pretty alien environments right in this world. And we've already discovered life in places such as the thermal vents 2550 meters deep along the Galapagos Rift. These creatures thrive in 350° C water kept from vaporizing by 265 atmospheres of pressure. Such examples show how life is highly adaptable, not nearly so fragile as Ross's example might suggest.

Finally, all of Ross's alternative-world scenarios seemed geared toward showing the utter incompatability of those worlds with Life-As-We-Know-It. But of course Life-As-We-Know-It is pretty well attuned to this world, since it evolved here! Ross also cheerfully piled hundreds of 0's after a 1 to impress on us the unlikelihood of our universe's turning out *exactly this way* by *blind chance*. I recalled Robert L. Forward's splendid book, *The Dragon's Egg*, which postulates life on the surface of a collapsed star, working out its neutronic "biochemistry" in considerable detail. And I remembered an essay, the author and title forgotten, which proposed a hypothetical universe of magnetic monopoles and electrons whirling in linked chains, forming highly exotic "atoms" — and perhaps, life. What if our own world had developed along those lines? Fantastically alien lifeforms might now be sitting in a hall somewhere, or in something like a hall, congratulating themselves that the Laws of Physics were made just for *them*, and no one else. Beware of backward reasoning.

In all fairness, Ross did outline key weaknesses in our knowledge of abiogenesis...and... the existence of ... fundamental questions that science has yet to answer.

Earth's moon is unusually large for its host, which represents an astonishing astronomical coincidence. Without it, Earth would have an atmosphere much like Venus, and life would be impossible.

Hard to generalize from such a limited sample, but an amateur astronomer friend tells me that atmospheric CO_2 levels have something to do with it.

The extreme chemical distinction between the Earth and Moon shows that the moon probably resulted from a rare collision with a Mars-sized object.

Another half point for Ross, but "Mars-sized" and "collision" seem like slight exaggerations. "Our moon, once thought to have been a part of earth that broke away owing to centrifugal effects, is now thought almost certainly to have formed as a result of the fusion of a planetoid or, considering its size, protoplanetary material" (Ronan 1991). "Planetesimals...would have been plentiful in the early solar system; on passing very close to the Earth these would have been disrupted, their lighter surface materials being captured and their heavier materials continuing in solar orbit. This captured material in orbit around the earth would eventually coalesce to form the moon" (Ridpath 1979, p 136).

Advanced life appeared about 5 million years ago, meteoric bombardment being too intense until then.

I had to readjust my jaw here. 5M years ago, all major groups were already thriving, and *Australopithecus afarenis* was well-established in South and East Africa. I thought perhaps Ross had confused millions with billions, but 5 billion years ago, the Earth was still forming.

Hubert P. Yockey, an atheist scientist, has admitted that odds are astronomical against chance formation of even "simple" proteins. Intelligent design is needed.

As biochemist Russell F. Doolittle pointed out in 1983, Yockey started with the goal of filling one specific biochemical protein "niche" — that of the ubiquitous cytochrome c enzyme, then assumed, in effect, that only one polypeptide sequence could perform the function. This is like calculating the odds against a golf ball's landing on a specific blade of grass, then concluding: "Golf is impossible."

It's absurdly easy to play the "low probability" game — looking back at an event that has already transpired and computing outrageous odds against its happening exactly as it did. What are the odds against *you*, just as you are now, with your exact genetic blueprint and those clothes and your hair combed just so? Life is chock full of such post-facto surprises. Everybody knows *someone* will win the lottery; yet to the winner it seems a miracle.

Yockey (and Ross) also ignored the effects of cumulative natural selection in protein development. In fact nature does not form a complex protein all at once, but starts with simpler forms and then refines them. The ancestor of cyctochrome c was probably only 20—30 amino acids long; its catalytic power was surely pathetically low, but it did the job. Once it existed, nature could duplicate and modify it. This tips the odds.

How long do you think it would take a monkey to type the first 13 letters of Hamlet's soliloquy by "pure chance"? It would require 26^{13} trials (about 2.5 million trillion). But if *correct* letters are preserved, and incorrect eliminated, it goes faster. How much faster? A programmer named Richard Hardison ran a program which used probabilities to "select for" and "against" certain letters, and it took only 335 trials to produce "TOBEORNOTTOBE". The computer did it in less than 90 seconds. Recreating the entire play takes about 4.5 days.

We have never observed the emergence of a new species.

What about corn from maize from teosinte, British eel grass, triticale, a new North American goatsbeard wildflower, new species of tobacco, canine parvovirus emerging from feline parvovirus in the 1970's, bacteria that eat only nylon by-products, a new species of native Hawaiian wallabies (appearing several years after an Aussie pair escaped an Oahu zoo in 1916), five new species of *Hedylepta* moths (also in Hawaii), HIV, and so on.

The Mormon Church (Latter Day Saints or LDS) teaches that Earth had humanoid visitors from the center of the Galaxy —

obviously an impossibility, since the galactic core is a thermal and radioactive hellhole. Thus, science not only confirms the Bible, but refutes LDS doctrine.

I confess I'm not up on Mormon theology. The comment of a Mormon friend was, "Sounds wacky to me." [*Ed. Interested readers may explore Mormon ideas about evolution and other scientific matters at <http://www.frii.com/~allsop/eyring-l/faq/>.*]

The number of known human fossils would barely fill an average-sized coffin.

A simple falsehood with thermonuclear force. Creationist Michael J. Ord, in his book review of *Bones Of Contention:A Creationist Assessment Of Human Fossils* had this admission: "I was surprised to find that instead of enough fossils barely to fit into a coffin [as an evolutionist had stated long ago], there were over 4000 hominid fossils as of 1976. Over 200 specimens have been classified as Neanderthal and about one hundred as *Homo erectus*. More of these fossils have been found since 1976"(Ord 1994, p 222).

Marvin L. Lubenow, the author of *Bones Of Contention*, wrote to the editor of the same creationist journal: "The current figures are even more impressive: over 220 *Homo erectus* fossil individuals to date and well over 300 Neanderthal fossil individuals discovered to date" (1994, p.70).

I'd have been happier if Ross had taken the tack of these more honest creationists, criticizing the integrity of the fossil finds and their interpretation, rather than hauling out the weary urban fable about a lack of them.

God, being outside of (our) time line, is not subject to laws of casualty, therefore does not require an origin

A respectable theological opinion, first advanced by St. Augustine. One could likewise argue that the time-symmetry of certain basic physical laws puts them outside of time — they are *about* time, but not *in* it. Therefore these are also exempt from requirements of causality...and origins.

Evidence from mitochrodrial DNA points to a common female human ancestor, the "Mitochrondrial Eve", between ten and twenty thousand years ago. Likewise, stretches of nearly homogeneous DNA found in Y-chromosomes the world over point to a common male ancestor, a sort of Y-DNA [sic] *"Adam".*

The Mitochrondrial Eve theory is highly speculative and hotly contested, but even proponents place her no less than 150 thousand years ago. We do have a pretty good idea of how fast mitochondrial DNA mutates, so Ross's estimate was way out in right field.

The business about an "Y-DNA" Adam was new to me. Richard Dawkins, in *River Out Of Eden*, writes that the Y-chromosome contains too little information for establishing common ancestry (Dawkins 1995, p 48).

Ross concluded his lecture with a lengthy question-and-answer session. On the good side, he eschewed most of the fetishistic slogans of creationism; he offered no homilies about the evils of evolution and did not once raise thermodynamics as a problem for it. When audience members inquired about UFO sightings and the putative face on Mars, Ross debunked these with clarity and polish. (He added, knowingly, that almost all UFO reports are from folk with an "open door to the occult" — something hard to dispute). But the occasional descents into wackiness and the whopper-telling discouraged me and made me wary of his other claims.

His response to every mystery or alleged mystery was to invoke a miracle. Scientifically, of course, this is no explanation at all; as if someone "explained" how a television works by telling you there are magic elves inside. But of course his talk was never meant as a scientific lecture, despite the title, and the audience of believers accepted it all with good cheer.

Theologically, the implications are rather worse. I wondered if he had thought them through. By repeatedly appealing to gaps in and alleged failures of naturalistic science, Ross made God into a "God of the Gaps" — a God that hides beyond the limits of current knowledge. Such a God must ever retreat as science advances. History has shown, many times, how orthodox theology has shipwrecked itself on such thinking.

In all fairness, Ross *did* outline key weaknesses in our knowledge of abiogenesis (the origin of life) and underscored the existence of legitimate, indeed fundamental, questions that science has yet to answer. As we are well aware (or should be), there is no dearth of these. When and how did the "three-letter" code for translating nucleotide sequences into amino acid chains develop? How were nucleotides formed and assembled into long strings under prebiotic conditions? Did RNA predate DNA? How did the first protocells develop phosphatide membranes? Why did "left-handed" amino acids win out over right-handed?

I don't know. But as Richard P. Feynman said, I'd rather have no answer than the wrong one.

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Evolution of the NABT Statement on the Teaching of Evolution

Joseph McInerney, Executive Director, Biological Sciences Curriculum Study

In Ireland, the Irish say, there is no future, only the past happening over and over – a sorrowful statement of resignation and frustration that reflects centuries of near-intractable sectarian and political strife. I sometimes feel the same way about the evolution/creation conflict: One hundred and fifteen years after Darwin's death there is no future, only the same, tired creationist arguments repeated over and over and the continuing expenditure of precious time and money to combat creationist nonsense — resources that could be applied to other problems.

Perhaps historian Gary Wills (1990) was correct when he wrote that the evolution/creation debate will never subside because "the Bible will never stop being the central book of Western culture." Richard Lewontin (1996) may also be right when he asserts that the scientific community has made little progress in convincing the public to embrace a scientific world view — including evolution — because hubris has blinded scientists to the fundamental distinctions between "elite" and "popular" culture. I suspect, however, that the cultural and philosophical reasons for the staying power of creationism and the intransigence of its proponents matter little to the average high school biology teacher when he or she is attacked for teaching evolution and unwittingly becomes a central player in a political struggle for control of the curriculum.

Unlike those of us who generally work behind the lines, as it were, dealing with the more global (read "safe") aspects of the evolution/creation conflict, teachers are at the front, dealing with direct challenges to their teaching from real students and real parents who have immediate questions and immediate demands. Some typical examples include:

- "If you're going to teach your religion [evolution], you should teach mine [the Genesis story], too."
- "Are you a Christian, or do you believe in evolution?"
- "My parents say I don't have to listen to this stuff."
- "It's only fair to have a creationist come to class to present the other side of the argument."
- "There are lots of questions about evolution, and lots of scientists don't believe in evolution any more."

Discussions with teachers across the country confirm that challenges to the teaching of evolution are commonplace. There is evidence of correlation between such challenges and student attendance at events such as "Back to Genesis," a week-long seminar sponsored by the Institute for Creation Research and devoted to evolution-bashing and "creation science". For example, Danny Phillips, the Jefferson County, Colorado, high school student who challenged the use of the video *The Miracle of Life* and the BSCS textbook *Biological Science: An Ecological Approach* , attended a "Back to Genesis" seminar in Manitou Springs, just west of Colorado Springs (Matsumura 1996a, 1996b). There also is evidence that challenges to evolution increase in any given community following evolution/creation debates, a good reason to heed Eugenie Scott's advice that scientists inexperienced in such events should decline invitations to participate (Scott, 1996).

Three unfortunate facts conspire to put most high school biology teachers at a severe disadvantage when challenges to evolution arise. First, few teachers are acquainted with the ever-evolving range of creationist arguments. Second, most teachers do not have enough background and training in the range of subjects and disciplines pertinent to evolution to respond effectively when parents or students confront them with those arguments. Third, teachers get little help from their administrators when creationists begin to make noise, because most administrators themselves do not understand evolution or its importance to biology, and because they do not like controversy. Most administrators are more likely to compromise, or even capitulate completely to creationist demands, than they are to support their teachers or to protect the integrity of science. Many teachers, for example, have told me that their principals suggest that "it would be okay not to get to evolution" during the course of the school year, and others have told me that they simply avoid evolution because they do not want the controversy themselves, especially when their administrators fail to support them. It is, in fact, quite easy for teachers to avoid evolution, because most biology textbooks relegate the topic to one or two chapters, often near the end of the book, and do not integrate evolutionary perspectives throughout the program.

Against this distressing backdrop, the board of directors of the National Association of Biology Teachers (NABT) appointed an *ad hoc* committee to prepare a new statement on the teaching of evolution. During the fall of 1994, the six-person committee, chaired by Dr. Richard Storey, chairman of biology at Colorado College, produced a document intended to:

- provide support for biology teachers when they are confronted with challenges to the teaching of evolution;
- reinforce the centrality of evolution to biology and to biology teaching;

NABT Unveils New Statement on Teaching Evolution

As stated in *The American Biology Teacher* by the eminent scientist Theodosius Dobzhansky, "Nothing in biology makes sense except in the light of evolution." This often quoted assertion accurately illuminates the central, unifying role of evolution in nature, and therefore in biology. Teaching biology in an effective and scientifically honest manner requires classroom discussions and laboratory experiences on evolution. Modern biologists constantly study, ponder and deliberate the patterns, mechanisms and pace of evolution, but they do not debate evolution's occurrence. The fossil record and the diversity of extant organisms, combined with modern techniques of molecular biology, taxonomy and geology, provide exhaustive examples and powerful evidence for genetic variation, natural selection, speciation, extinction and other well-established components of current evolutionary theory.

Scientific deliberations and modifications of these components clearly demonstrate the vitality and scientific integrity of evolution and the theory that explains it. This same examination, pondering and possible revision have firmly established evolution as an important natural process explained by valid scientific principles, and clearly differentiate and separate science from various kinds of nonscientific ways of knowing, including those with a supernatural basis such as creationism. Whether called "creation science," "scientific creationism," "intelligent-design theory," "young-earth theory" or some other synonym, creation beliefs have no place in the science classroom. Explanations employing nonnaturalistic or supernatural events, whether or not explicit reference is made to a supernatural being, are outside the realm of science and not part of a valid science curriculum. Evolutionary theory, indeed all of science, is necessarily silent on religion and neither refutes nor supports the existence of a deity or deities. Accordingly, the National Association of Biology Teachers, an organization of science teachers, endorses the following tenets of science, evolution and biology education:

- The diversity of life on earth is the outcome of evolution: an unsupervised, impersonal, unpredictable and natural process of temporal descent with genetic modification that is affected by natural selection, chance, historical contingencies and changing environments.
- Evolutionary theory is significant in biology, among other reasons, for its unifying properties and predictive features, the clear empirical testability of its integral models and the richness of new scientific research it fosters.
- The fossil record, which includes abundant transitional forms in diverse taxonomic groups, establishes extensive and comprehensive evidence for organic evolution.
- Natural selection, the primary mechanism for evolutionary changes, can be demonstrated with numerous, convincing examples, both extant and extinct.
- Natural selection — differential, greater survival and reproduction of some genetic variants within a population under an existing environmental state — has no specific direction or goal, including survival of a species.
- Adaptations do not always provide an obvious selective advan-

- summarize some of the most frequent creationist challenges to evolution theory and provide concise refutations thereof; and
- summarize the major legal decisions related to the teaching of evolution to ensure biology teachers that the law is solidly in their corner.

Following approval by the NABT board in March, 1995, the statement appeared in January, 1996, in the Association's journal (*The American Biology Teacher* 1996 Jan; 58 [1]; pp 61-2) and in the second edition of *Voices for Evolution* published by NCSE in 1995.

NABT — comprising approximately 8,000 professionals who teach at the middle school, high school, and college levels — is the only professional society devoted exclusively to the teaching of biology. It is appropriate, therefore, that the society be on record with an unequivocal statement about the importance of teaching evolution, and it is imperative that the scientific and educational communities embrace the statement and support those teachers who put themselves on the line to defend the integrity of biology. The immediate future of the evolution/creation conflict likely holds few surprises, but the nation's biology teachers — and creationists — need to know that someone will be watching and responding as the past repeats itself over and over.

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tage. Furthermore, there is no indication that adaptations — molecular to organismal — must be perfect: adaptations providing a selective advantage must simply be good enough for survival and increased reproductive fitness.

- The model of punctuated equilibri[a] provides another account of the tempo of speciation in the fossil record of many lineages: it does not refute or overturn evolutionary theory, but instead adds to its scientific richness.
- Evolution does not violate the second law of thermodynamics: producing order from disorder is possible with the addition of energy, such as from the sun.
- Although comprehending deep time is difficult, the earth is about 4.5 billion years old. *Homo sapiens* has occupied only a minuscule moment of that immense duration of time.
- When compared with earlier periods, the Cambrian explosion evident in the fossil record reflects at least three phenomena: the evolution of animals with readily-fossilized hard body parts; Cambrian environment (sedimentary rock) more conducive to preserving fossils; and the evolution from pre-Cambrian forms of an increased diversity of body patterns in animals.
- Radiometric and other dating techniques, when used properly, are highly accurate means of establishing dates in the history of the planet and in the history of life.
- In science, a theory is not a guess or an approximation but an extensive explanation developed from well-documented, reproducible sets of experimentally-derived data from repeated observations of natural processes.
- The models and the subsequent outcomes of a scientific theory are not decided in advance, but can be, and often are, modified and improved as new empirical evidence is uncovered. Thus, science is a constantly self-correcting endeavor to understand nature and natural phenomena.
- Science is not teleological: the accepted processes do not start with a conclusion, then refuse to change it, or acknowledge as valid only those data that support an unyielding conclusion. Science does not base theories on an untestable collection of dogmatic proposals. Instead, the processes of science are characterized by asking questions, proposing hypotheses, and designing empirical models and conceptual frameworks for research about natural events.
- Providing a rational, coherent and scientific account of the taxonomic history and diversity of organisms requires inclusion of the mechanisms and principles of evolution.
- Similarly, effective teaching of cellular and molecular biology requires inclusion of evolution.
- Specific textbook chapters on evolution should be included in biology curricula, and evolution should be a recurrent theme throughout biology textbooks and courses.
- Students can maintain their religious beliefs and learn the scientific foundations of evolution.
- Teachers should respect diverse beliefs, but contrasting science with religion, such as belief in creationism, is not a role of science. Science teachers can, and often do, hold devout religious beliefs, accept evolution as a valid scientific theory, and teach the theory's mechanisms and principles.
- Science and religion differ in significant ways that make it inappropriate to teach any of the different religious beliefs in the science classroom.

Opposition to teaching evolution reflects confusion about the nature and processes of science. Teachers can, and should, stand firm and teach good science with the acknowledged support of the courts. In *Epperson v. Arkansas* (1968), the US Supreme Court struck down a 1928 Arkansas law prohibiting the teaching of evolution in state schools. In *McLean v. Arkansas* (1982), the federal district court invalidated a state statute requiring equal classroom time for evolution and creationism. *Edwards v. Aguillard* (1987) led to another Supreme Court ruling against so-called "balanced treatment" of creation science and evolution in public schools. In this landmark case, the Court called the Louisiana equal-time statute "facially invalid as violative of the Establishment Clause of the First Amendment, because it lacks a clear secular purpose."

This decision — "the Edwards restriction" — is now the controlling legal position on attempts to mandate the teaching of creationism: the nation's highest court has said that such mandates are unconstitutional. Subsequent district court decisions in Illinois and California have applied "the Edwards restriction" to teachers who advocate creation science, and to the right of a district to prohibit an individual teacher from promoting creation science in the classroom. Courts have thus restricted school districts from requiring creation science in the science curriculum and have restricted individual instructors from teaching it. All teachers and administrators should be mindful of these court cases, remembering that the law, science and NABT support them as they appropriately include the teaching of evolution in the science curriculum.

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BOOKREVIEW

Butterflies of the Neotropical Region, Part VI

by Bernard D'Abrera, 1994, Hill House, Victoria, Australia, 219 pp., $235.

Reviewed by Arthur Shapiro, Center for Population Biology, University of California, Davis

> Every flower of the field, every fiber of a plant, every particle of an insect carries with it the impress of its Maker, and can, if duly considered, read us lectures of Ethics or Divinity (Sir Thomas Blount, *A Natural History*, 1693).

Is Bernard D'Abrera familiar with Sir Thomas? He certainly thinks like him — a magnificent example of a 17th-century natural theologian! D'Abrera is an entomologist and science writer based in Australia who has published numerous lavishly illustrated, large-format picture books of the butterflies of the world (as represented in the British Museum). These books are very expensive, but are also immensely useful insofar as there are no identification guides for the butterflies of most of the world. The primary literature is scattered, polyglot, and largely inaccessible to amateurs. Outside of global centers like the Smithsonian or the British Museum, one is hard-pressed to know what museums have what holdings.

The last time that anyone attempted a synoptic illustrated global butterfly catalog was in the first quarter of this century, when Adalbert Seitz published *The Macrolepidoptera of the World* in many volumes. The illustrations were quality German lithographs, but still inferior to photos, and the set is rare and decades out of date taxonomically.

D'Abrera has many previous volumes on butterflies. The first that I reviewed, *Butterflies of South America*, was poorly thought out, arbitrary and loaded with errors, but I also noted creationist fulminations within the text (Shapiro 1985). In that review, for example, I cited this example of creationist content and execrable writing in which D'Abrera referred to the family Riodinidae as:

> so extravagantly and outrageously shaped and decorated as to be almost parodies of the whole Order of Lepidoptera, as if the Creator [were] having some deeply private Divine joke at his own expense.

Later, in *Butterflies of the Holarctic Region, Part I* (Shapiro 1990), D'Abrera went to unusual pains to ridicule evolutionary research in the *Pieris napi* species group — a name used as an umbrella for a large complex of related butterflies from the cooler parts of all of the Northern Hemisphere and known commonly as the "green-veined white". This group has been studied intensively since the earliest days of Darwinism by biogeographers, ecologists, and geneticists, with virtually everything published on the group being informed by evolutionary theory. In this book D'Abrera ridiculed all this work and characterized it as hopeless and misguided because of its evolutionary "bias".

Now D'Abrera is back with his Riodinid book *Butterflies of the Neotropical Region, Part VI* and in an absolute dither. The ratio of creationism to biology in this volume is the worst of any he has produced. For example, in his discussion of the many mimicry associations observed in this family of small, brilliantly-colored butterflies, D'Abrera takes umbrage at the suggestion that evolutionary theory has any potent explanation for these associations.

> What has evolutionary science told us about *Stalachtis*? Absolutely nothing —but what it has told us about itself is that it is entirely inadequate, incompetent and ignorant of the great truth of Cause and Effect. It has demonstrated beyond a shadow of a doubt that without the help of genuine philosophical thought — it is a sterile mass of pagan beliefs and incantations terrified of the light of reason illuminated by Faith, and content to grovel in the dark of tribal rituals of superstitious savages fatally obsessed only with the tactile and the sensual. It has become blinded by its own malice. Modern science was given its genesis at the French Revolution, as the principle [sic]means of humanistic social engineering by depriving mankind of its spiritual inheritance. *Stalachtis* (and all of the created Universe) not only belie the mumbo-jumbo of evolutionary science, but also cry out to the humbly intelligent mind that, as St. Thomas Aquinas has demonstrated, we may know God by His great act of love — the act of Creation of *everything, Ex Nihilo*.

After giving a brief historical caricature of mimicry theory, in which he connects Darwin to Marx to Julian Huxley to his cataloguer-forebear Adalbert Seitz in an unbroken chain of villainy, D'Abrera outdoes himself:

> The truth, dear reader...is that these forms are the wondrous product of the most infinitely imaginative creative will. This infinite will has created a 'home' for mankind and filled it with 'good things.' This home [Earth], being only a temporary place of trial, is replete with responsibilities, duties, and puzzles...a challenge to the unfolding and imperfect intellects of men who lack angelic intuition and must needs work from beginnings to conclusions through reason and experience, trial and error, but always humbly acknowledging the Omnipotent Will of the Creator... [Butterflies] never evolved from anything — they were simply CREATED like that, in an instant, *fully programmed* to continue unchanging through the end of time (p 1015; capitalization and italics as in original).

On page 1036 he finally explains why he has put so much creationist soliloquizing in what is ostensibly a butterfly book:

> I regret having to labour the point, but now close to the end of my own studies, my patience with the shibboleths and "infallible" dogmas of the Church of Evolutionism has

Letters to the Editor

Mystery Spheres

After much effort both on my part and others', I have obtained four nodules of the type discussed as possible 2.8 billion year old artifacts in the NBC-broadcast feature "Mysterious Origins of Man". Dr Sue Webb at University of Witwatersrand, South Africa and a geologist who has studied the pyrophyllite quarries, obtained for me samples of the mystery spheres for analysis. However, I will be engaged in some field work for the next three to four months, so careful analysis of the spheres, including taking and posting pictures, will take time.

From the specimens and observations made by friends in South Africa, one significant fact has come to light. The spheres shown on the "Mysterious Origins of Man" and figured in *Forbidden Archaeology* are atypical of the so-called "mystery spheres". In fact, the vast majority of nodules come in a wide variety of shapes and sizes that range from the spheres to flattened spheres to things that look like miniature Texas cow patties (also called "Utah meadow wafers"). One of the so-called spheres that I have actually consists of four spheres that have intergrown together to form a single nodule. Although they are a minor part of the variety of shapes these nodules come in, the spheres tend to be preferentially collected and the other shapes ignored. Thus, despite being a minor part of the wide range of variation in size and shape of that nodules exhibit, the bias of collectors for sphere-shaped nodules creates the false impression that all of the nodules are spherical. I would be willing to hypothesize that the less perfect a spherical shape that a nodule has, the less likely it is to be collected.

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[*Ed. Readers interested in the television program "Mysterious Origins of Man" can check back issues of* NCSE Reports *1995 Winter; 15(4):1,9 and 1996 Spring; 16(1):7 for feature stories and also find a review of the program in* Creation/Evolution *1995 Winter; 15(2) nr 37: 30-2. For a review of* Forbidden Archaeology *look in* Creation/Evolution *1994 Summer; 14(1) nr 34, pp 13-25*].

Let's Drop the 'Darwinian' Name-tag

Isn't it about time that evolutionists grew up and stopped referring to themselves and their theories as "Darwinian"? Of course, the modern evolutionary approach *derives* from Darwin. And Darwin was a magnificent scientist and a fascinating human being, and I love reading about him. Indeed, many of my favorite books on natural selection and human affairs build themselves around the biography of Darwin (Helena Cronin's *The Ant and the Peacock*; Robert Wright's *The Moral Animal*; Daniel Dennet's *Darwin's Dangerous Idea* for example — all exceptionally fine books). But sooner or later, this has got to stop. The pre-occupation with Darwin, the sheer number of books on him, the way evolutionary theory is always introduced by means of an exposition of his ideas — all this is getworn thin. One does get weary of the relentless propaganda, the ceaseless parade of woolly thinking, and conspicuous lack of philosophical principle and the shameless absences of genuine unbiased scientific method. There is such a wall of error and prejudice, and no public means of fighting back, that I have little choice but to use this avenue of my own works to plead with my colleagues to stop, take a deep breath and go back to Linnaeus and his principles. Linnaeus (by the grace of God) was a Taxonomist, not an Evolutionist/Phylogeneticist. He was educated in the 'tried and true' ancient Philosophy. He understood Order, Systems, and the principle of a Single Source for and of everything.... The religion of Evolutionism is like that of Protestantism, with each Theorist being his own infallible Pope. It is fissiparous, blindly irrational and pathologically disordered and finally destructive of Christian Order and of Western Civilization itself.

Bernard D'Abrera is a deeply unhappy man.

Butterfly study has been going through unhappy times, too. Increasing government regulation and restrictions on collecting, and pressures from animal-rights activists have made many lepidopterists wonder why they are suddenly seen as villains. Butterfly watching (as in bird watching) and butterfly photography are being promoted as non-consumptive "green" alternatives to collecting. Meanwhile, taxonomic instabilities caused by fads and trends in the systematics community are driving amateurs crazy (they don't know the "correct" scientific names of even common, backyard species), and professional societies are attempting to standardize and regulate common names. Does lepidopterology need a creation-evolution crisis, too?

Yet, in retrospect, it seems surprising that there hasn't already been one. The major North American lepidopterology journals are solidly in an evolutionary tradition and have been since their beginnings. Butterflies and moths have been very important organisms for evolutionary studies and ecological genetics in both the field and the laboratory, being among the first species studied with a Darwinian perspective. However, many amateur lepidopterists in America are

ting obsessional and pathological.

History and biography are one thing, and science is another. Both are wonderful, but distinct. Today's scientific theories of natural selection must and should stand or fall on the basis of current evidence and arguments; and what Darwin said and thought must take a very secondary place. Otherwise, as all too commonly happens, debate which purports to be about natural selection ends up being a kind of historical, biographical — even theological — exegesis about what Darwin "really" said, or meant, or thought, or would think were he alive today. Rival sects emerge. Both claim Darwin as the one true prophet. One sect asserts that Darwin was primarily interested in complex adaptations, the other that he was primarily interested in explaining the origin of species. Each claims the coveted title *Darwinian*; each tries to be more Darwinian-than-thou.

Some scholars assert Darwin's originality, bravery, or rigor; others present him as a revisionist, intellectual thief, or coward. Revolutionary or reactionary; political radical or conservative; patriarch or liberator? Even anti-evolutionists think that by critiquing Darwin, or by contrasting Darwin's views with modern views, they have been engaged in a scientific debate.

Give it a rest! "Darwinism" is too reminiscent of the excesses of Marxism and Freudianism — obsessed with authority, lineage and the cult of a great man. All "isms" are intellectually second rate. For instance, as a worker in the field of "Darwinian Medicine" I am dismayed at being saddled with the name. Surely it would be better to drop the "Darwinian" as soon as possible in favor of "Evolutionary" or of something else neutral?

Anyway, Darwinian Medicine — in so far as it is valid — isn't "Darwinian" any more than Physics is "Einsteinian" (or Bohrian, or Feynmanian). Many people have contributed to modern evolutionary theory. We learn current science from current debate and current papers, not from ancient authority. The concepts involved are essentially modern (whether or not they may be present in embryo in the Darwinian corpus is, for this purpose, irrelevant).

Natural selection, like any other theoretical concept (such as "atom" or "gene") has a definition that evolves as the science progresses. Democritus invented the "atom" — but we don't call atomic theory *Democritic*. Words used to label scientific concepts should not prejudge the debate, nor should they introduce misleading considerations. It doesn't matter (biologically speaking) what natural selection meant to Darwin; what matters is what it means now to us, and how we use it.

Darwinian should become a taboo label among evolutionary biologists - we should leave it to biographers, historians and sociologists who are engaged in tracing intellectual lineages. Presumably we are interested in evolution by natural selection, in adaptation, in speciation? Then those are the terms that should be used. It is profoundly unhealthy for evolutionary biology to be tied to the ghost of a dead man.

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fundamentalist Christians and creationists who, to date, have been willing to look the other way when the "E-word" appears in their journals. With D'Abrera cheering them on, one wonders how long this is likely to continue.

If D'Abrera's books are full of errors, provide little entree to the literature and hardly *any* biological information, and cannot hope to penetrate the complexities of taxonomically difficult groups (where all the species "look alike"), they are still almost indispensable to anyone trying to label a collection of exotic butterflies. It is a pity, then, that the users of this volume will be subjected to seemingly random outbursts of undisciplined creationist rhetoric scattered throughout the text.

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ON-LINE GENETIC TOOLKIT?

John R. Cole
Contributing Editor

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Human genome mapping will be complete within a decade and the database will be online and essentially free to anyone with internet access. Then what? Will there be a temptation to end "somatic" therapy in favor of genetic manipulation? Will parents be able to customize their offspring? Will there be limits? Will there be "infomorphs" or clones of people reproduced in a computer without the messy biological shell? Will "virtual people" mutate? All this any more at<http://www.wired.com/5.01/genome/>.

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FAQ FOR BIOLOGY EDUCATION SOFTWARE

For the past year Eli Meir at the University of Washington Zoology Department has been writing and maintaining an FAQ (Frequently Asked Questions) on computer software for education in biology at the undergraduate level. It contains descriptions and reviews of many PC and Macintosh programs written for teaching different aspects of biology. It is now available in http format on a new web site. If you are interested, point your browser to: <http://www.zoology.washington.edu/biosoft/>. Meir welcomes feedback and questions via email: meir@zoology.washington.edu.

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Richard Wakefield's article dealing with the Geology of [Robert] Gentry's "Tiny Mystery" is now available on the internet. This article was originally published in the *Journal of Geological Education* and dealt with Gentry's supernatural explanation for the origin of polonium (Po) halos and the instaneous formation of granite on Day 3 of the Genesis Week. He has excellent color illustrations of the Po halos and geologic maps and shows why Gentry's arguments are fallacious. See article 6 at <http://www.csun.edu/~vcgeo005/creation.htm>.

[*Contributed by Lorence G. Collins whose article on Po halos appears in* Creation/Evolution *1996 Fall;* 16(2):10-15.]

EDITORIAL POLICY ON WORLD-WIDE WEB RESOURCES

Andrew J. Petto and Laura L. McMahon

More and more of the articles and other items submitted to *Reports of the National Center for Science Education (RNCSE)* contain references to sites or pages on the World-Wide Web (WWW). The web is in a constant state of flux,so it is sometimes a challenge to be as confident about the internet locations as we are about print citations in our Resources department. Furthermore,since editorial style manuals are still deciding how to standardize references to internet resources, the formats may be inconsistent at best or confusing at worst.

In order to provide better access to these internet resources for our readers,the editors and the editorial board members have adopted the following policies.

- All WWW locations (universal resource locators or URLs) will be printed inside angle brackets (for example,<http://www.natcensci.org> is the URL for the NCSE home page). Angle brackets are used in the hyptertext mark-up langauge (HMTL) within web pages and as a general convention in electronic media. So, readers can assume that they should enter all the text between the angle brackets to connect to the web page that is being discussed.
- All WWW locations (URLs) will be verified before publication by the editorial staff. We will only print those locations that we have successfully located in these tests. This will assure that they are accurate at the time of publication.
- All URLs cited in any article in an issue will be extracted from the article and included in a table in the Resources section of that issue.

We hope that these policies will improve our readers' abilities to get access to WWW resources. As always, we welcome your suggestions about valuable URLs to visit, and we want to know if and when URLs for the internet resources that are important to our readers change, evolve, or go extinct.

INTERNET LOCATIONS VISITED IN THIS ISSUE

TOPIC Access Excellence Home Page
LOCATION <http://www.gene.com/ae>
LAST VISIT 1997 Mar 28

TOPIC Biology Computer Software
LOCATION <http://www.zoology.washington.edu/biosoft/>
OWNER Eli Meir, Department of Zoology, U Washington
LAST VISIT 1997 Mar 28

TOPIC Creationist Geology
LOCATION <http://www.csun.edu/~vcgeo005/creation.htm>.
OWNER Lorence Collins, Department of Geology, Cal State U - Northridge
LAST VISIT 1997 Feb 15

TOPIC Darwin Multimedia CD-ROM
LOCATION <http://lbin.com/darwin/>
OWNER Lightbinders, Inc.
LAST VISIT 1997 Mar 28

TOPIC Eye Evolution
LOCATION <http://www.pnas.org/cgi/content/full/94/6/2421#SEC0>.
OWNER National Academy of Sciences
LAST VISIT 1997 Mar 28

TOPIC Hanson Bonebed Dinosaur Site "Takeover"
LOCATION <http://earth.nettrek.net.au/~rik/cyber/dino.htm>
OWNER Foundation Advancing Creation Truth
LAST VISIT 1997 Mar 28

TOPIC Human Genome Project
LOCATION <http://www.wired.com/5.01/genome/>.
OWNER Wired Magazine
LAST VISIT 1997 Apr 14

TOPIC Mormon Views on Science
LOCATION <http://www.frii.com/~allsop/eyring-l/faq
OWNER Brent Allsop for EYRING-L
LAST VISIT 1997 April 14

TOPIC *Origins and Design* Home Page
LOCATION <http://www.mrccos.com/arn/odesign/odesign.htm>
OWNER Access Research Network
LAST VISIT 1997 Mar 28

TOPIC Orthodox Presbyterian Church Censure of Dr TM Gray
LOCATION <http://mcgraytx.calvin.edu/gray/evolution_trial/index.html>
OWNER Terry M Gray, Department of Chemistry, Calvin College
LAST VISIT 1997 Mar 28

TOPIC Hugh Ross
LOCATION <http://www.origins.org/menus/hross.html>
OWNER Leadership University
LAST VISIT 1997 Mar 28

TOPIC Spoon Bending
LOCATION <http://www.randi.org/jr/ptspoon.html>
OWNER James Randi Educational Foundation
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Origins and Design Web Site Changes

In our last issue we reported a WWW location for the journal *Origins and Design*, published by the Access Research Network. Since that issue was printed, *Origins and Design* has acquired a new location. To see the web version of this publication connect to <http://www.mrccos.com/arn/odesign/odesign.htm>.

INSTRUCTIONS FOR CONTRIBUTORS

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.

News, commentaries, and features describe events or experiences that we wish to relate to our readers and members. These may include reports of school-board elections or local organizing by parent and teacher groups, political or governmental decisions and policies, first-person accounts of experiences with anti-evolutionist speakers, curriculum, or organizations, other reports of information related to our primary concerns of promoting good science in education and public life, *and*, of course, humor related to creation/evolution issues.

Articles include book reviews, scholarly articles, and formal essays. These may explore specific arguments raised by anti-evolutionist scholars, relate new information that may be helpful in promoting evolution, or original research related to the public understanding of evolution. We also welcome case reports and classroom action research that assess the outcome(s) of strategies for strengthening the understanding of evolution in educational practice.

All articles should be written for a general audience, and authors should provide definitions or descriptions for technical terms and concepts whose meanings might not be evident to the nonspecialist. All feature manuscripts are submitted to reviewers for comments on the technical content and the suitability for a general audience. Acceptance for publication does not take into account the author's formal academic background or profession. We encourage query letters from any prospective author.

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5. Reference sections are alphabetical and should conform to the citation-sequence format in *Scientific Style and Format: The CBE Manual for Authors, Editors, and Publishers*, illustrated in the following example for books and periodicals.

Chan L. Exciting potential of scholarly electronic journals. *Canadian Association of University Teachers Bulletin* 1996; 43(7):9. <http://www.caut.ca/bull/ejournal.html> Accessed April 17, 1997.

Kehoe AB. Modern anti-evolutionism: The scientific creationists. In: Godfrey LR, ed. *What Darwin began*. Boston: Allyn and Bacon; 1985. pp 165-85.

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

Zubrow E. *Archaeoastronomy*. Orlando, FL: Academic Press, 1985.

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