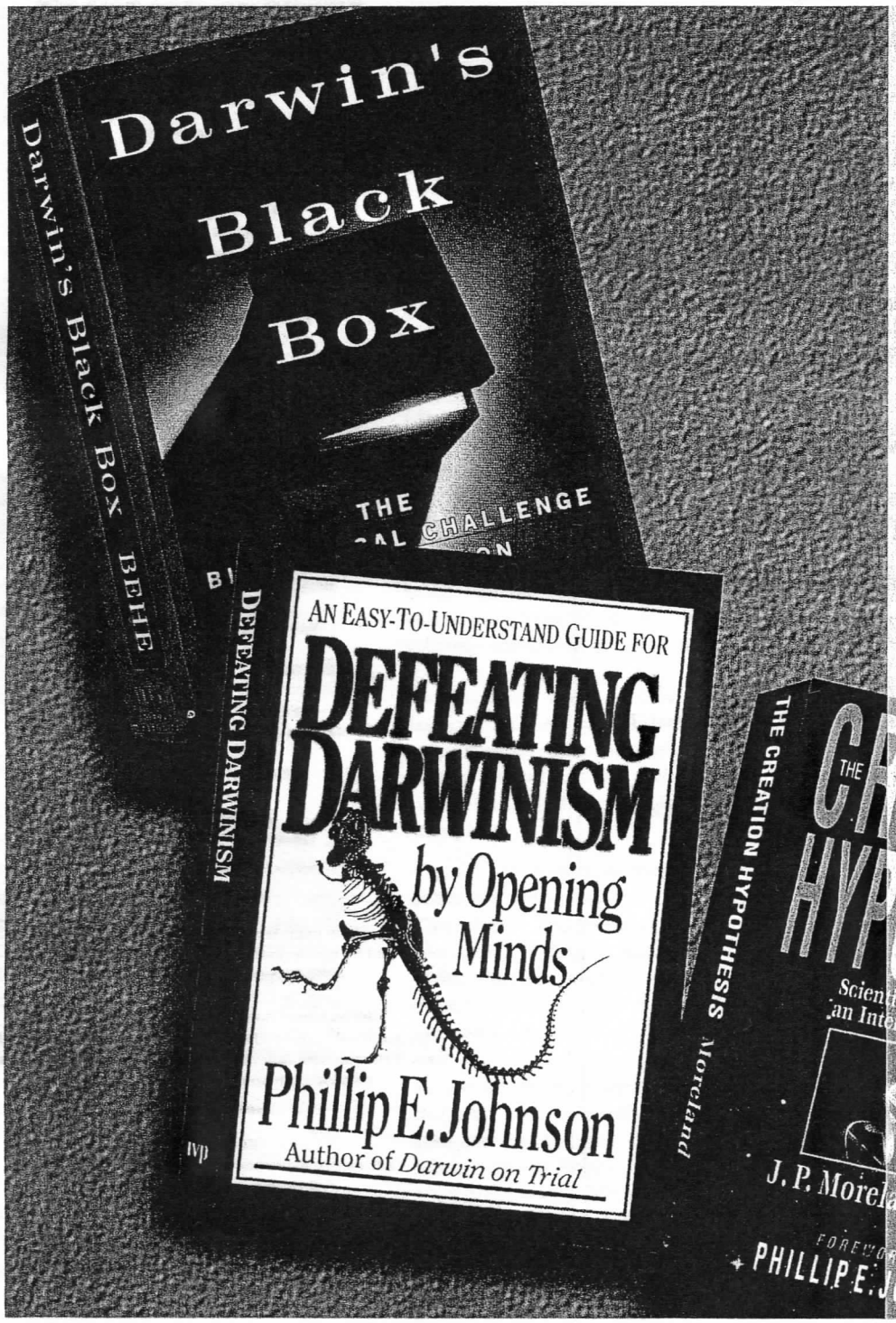
REPORTS OF THE NATIONAL CENTER FOR SCIENCE EDUCATION

Volume 18, Number 6 Nov/Dec, 1998



CONTINUES
NCSE REPORTS & CREATION/EVOLUTION

Of Gods and Gaps: Intelligent Design and Darwinian Evolution

Over the Hump—Taking the AIG Camel Challenge!

Vine Deloria Jr, Creationism, and Ethnic Pseudoscience

Teaching Biological Evolution to Singapore's Teachers

The Trouble With Science

CONTENTS

REPORTS OF THE NATIONAL CENTER FOR SCIENCE EDUCATION
CONTINUES *NCSE REPORTS* & *CREATION/EVOLUTION*

VOLUME 18, NO 6, NOV/DEC 1998
ISSN 1064-2358

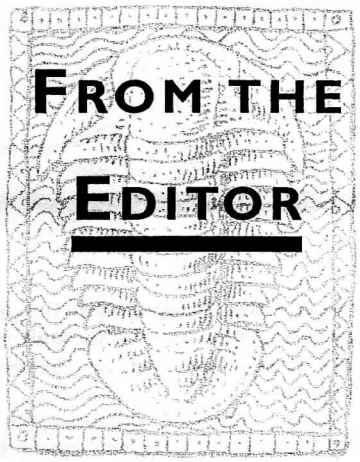
Eugenie C Scott, *Publisher*
National Center for Science Education
PO BOX 9477
BERKELEY CA 94709-0477
510/526-1674
FAX: 510/526-1675
Email: ncse@natcenscied.org
http://www.natcenscied.org

Views expressed are those of their authors and do not necessarily reflect the views of NCSE. *RNCSE* is published six times a year.

Address editorial correspondence to the editor. Style guidelines can be found on the inside back cover of this issue. Write the publisher about address changes, missing issues or back issue purchases, reprint rights, etc.

COVER: COMPOSITE OF 3 MAJOR WORKS PROMOTING "INTELLIGENT DESIGN" THEORY. SEE REVIEWS BY EB DAVIS, P 20.

FROM THE EDITOR



"SAAWOK" sounds like the name of a strange alien creature sprung from the imagination of Hollywood producers. But this anagram stands for "Science as a Way of Knowing"—a way of connecting specific research disciplines and subject matter to a general framework that *all* modern sciences have in common. Increasing the public's understanding of SAAWOK is both one of NCSE's major missions *and* a main focus of the features and reviews in this issue.

Ted Davis provides a group review of 3 important books in the "Intelligent Design" movement. He explores the factual and the philosophical shortcomings of recent offerings by Behe, Johnson, and Moreland. His review shows how these works run afoul of *both* current religious and current scientific thinking on the origin of life on earth.

David Brumble also reviews a recent book, but of a very different kind. He argues that Vine Deloria Jr's exploration and evaluation of modern science falls into a class with other works of "ethnic pseudoscience". Brumble compares the reception of this book to other cases in which sympathy and a wish to make reparation for European cultural hegemony and the repression of the cultural wisdom of ethnic minorities can promote inaadequate scholarship.

The third SAAWOK feature is a book review by NCSE Executive Director Eugenie Scott. Exploring *The Trouble With Science* by Robin Dunbar, Scott tells us that the "trouble" is not in the subject matter or even the immense amount of "stuff" that science knows; rather it is a lack of understanding and appreciation for the *way* that science "knows" what it knows.

News and Updates

The "disclaimer" case in Tangipahoa Parish (LA) continues. Molleen Matsumura reports on the early news from the case now before the Fifth Circuit Court of Appeals. Whatever the decision in the Appeals Court, an appeal to the US Supreme Court seems likely.

Answers in Genesis is pursuing its appeal of a zoning court's rejection of its application for a permit to open a creation museum in Kentucky. Georgia's legislature is considering a bill requiring schools to provide information with "evidence not supporting evolution" in science classes where evolution is taught. The bill in Georgia is similar to an earlier bill introduced in Ohio and is based on a model bill that is being distributed by John Hansen of Operation TEACH.

Draft standards for Science Education are going forward in Pennsylvania and Kansas. In New Jersey, where the standards are already in place, one of our own NCSE members is following the lead of Marshall Berman and running for a seat on the state school board.

A report from the astrobiology program at NASA's Ames Research Lab confirms that the chemical composition of interstellar clouds matches that which scientists have hypothesized made up our own solar system. These chemicals include many precursors to organic molecules necessary for the origin of living things. The precursors represent the debris from older stars and were changed into basic building blocks of organic compounds when exposed to radiation.

Teaching Evolution

We are pleased to present two short notes on teaching evolution. First, Ly and Yeoh report on their study of knowledge about evolution among practicing and pre-service teachers in Singapore. They compared responses of these teachers to those collected by researchers in the US.

In the second report Andrew Petto examines how students with a minimum of training in introductory biology apply their subject knowledge and critical-thinking skills to the interpretation of skeletal remains. This class of nonscientists examined materials prepared by Answers in Genesis meant to convince students that making inferences about behavior and ecology from skeletal remains is unreliable and unscientific.

Feedback

Our first issue in the new format (*RNCSE* 17[1]) is still generating controversy. Ken Nahigian's report of his impressions of a presentation by Dr Hugh Ross of Reasons to Believe prompted a reply by Dr Hubert Yockey, whose work Ross claimed supported the concept of a designer. We carry Yockey's response to the original report and Nahigian's reply. In our next issue, we will carry the responses generated by another feature in that issue — the proposal by Brian Alters that we *should* be trying to get our students to *believe in* evolution.

Anj Petto

RNCSE 18(6) was printed in March 1999.

Subscription Alert!
Got a "time-to-renew" notice in *RNCSE* 18(5)? Check the special notice on page 34.

NEWS

Court Hears Arguments in Louisiana Disclaimer Case

Molleen Matsumura
Network Project Director

In April 1994 the school board of Louisiana's Tangipahoa Parish adopted an evolution disclaimer to be read aloud whenever evolution was taught (*NCSE Reports* 1994 14[2]:8; *see sidebar*). Herb Freiler and other district parents, assisted by the Louisiana ACLU, successfully brought suit against the policy. On August 8, 1997, the US District Court for Eastern Louisiana became the first federal court to include "intelligent design theory" within a definition of "creation science".

The court ruled that the policy violated both state and federal constitutions. Judge Marcel Livaudais explained, "In mandating the disclaimer, the school board is endorsing religion by disclaiming the teaching of evolution in such a manner as to convey the message that evolution is a religious viewpoint that runs counter to ... other religious views" (*RNCSE* 1997; 17[3]:6-7). The school district appealed the decision to the Fifth Circuit Court of Appeal. The case was a milestone for NCSE, which has signed "friend of the court" briefs submitted in other First Amendment cases, but filed its own brief in this case (*RNCSE* 17[5]:4-5).

The Hammond (LA) *Daily Star*, in which the Tangipahoa Parish schools are located, reported on the Court's January 6 deliberations in a front-page article published the following day. One judge, F Pedro "Pete" Benavides, was sympathetic to the disclaimer. He commented "I understand what the motives are, but the kids will not see the motive. A disclaimer seems to be the only way the School Board can teach evolution without destroying religion.... I have a problem with the part of the statement 'his or her own beliefs or maintain the beliefs taught by the parents.'.... Why not say for students 'not to take the facts as the only answer'?"

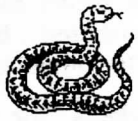
Judge Carolyn Dineen King understood the problems raised by singling out one topic—evolution—for "critical thinking," and "questioned the possibility of the entire teaching staff['s] telling all students before every class... not [t]o let any lessons get in the way of their beliefs." No remarks made by the presiding judge were reported, but it seems clear the Appeals Court's decision will not be unanimous. If either litigant chooses to appeal, the next stop would be the US Supreme Court, which has not heard a creation/evolution case since issuing the 1987 *Edwards v Aguillard* decision. The last time the Court had an opportunity to decide such a case, it refused and left in place a lower court decision in *Peloza v San Juan Capistrano* that requiring teachers to teach evolution does not violate the First Amendment's prohibition against "establishment" of religion.

RESOLUTION ADOPTED BY TANGIPAHOA (LA) PARISH SCHOOL BOARD, APRIL 1994

Whenever, in classes of elementary or high school, the scientific theory of evolution is to be presented, whether from textbook, workbook, pamphlet, other written material, or oral presentation the following statement shall be quoted immediately before the unit of study begins as a disclaimer from endorsement of such theory.

It is hereby recognized by the Tangipahoa Parish Board of Education, that the lesson to be presented, regarding the origin of life and matter, is known as the Scientific Theory of Evolution and should be presented to inform students of the scientific concept and not intended to influence or dissuade the Biblical version of creation or any other concept.

It is further recognized by the Board of Education that it is the basic right and privilege of each student to form his/her own opinion or maintain beliefs taught by parents on this very important matter of the origin of life and matter. Students are urged to exercise critical thinking and gather all information possible and closely examine each alternative toward forming an opinion.



NASA Astrobiologists Find Clues to Origin of Life

In an article published on February 19, 1999 in *Science* a team of scientists from NASA and Stanford University announced that they have created some of the chemicals essential for life in an environment similar to that found in deep space.

The experiments simulated conditions in interstellar clouds of dust and gas. The dust in such clouds plays an important role in the life cycles of solar systems—it is the debris of previous generations of stars and the material from which new stars and solar systems will develop.

A team led by Max Bernstein from the NASA Ames Research Center and Richard Zare of Stanford University re-created the dust clouds of the interstellar medium by freezing and then irradiating the most common carbon-bearing molecules found there. Analysis of the chemical products produced by the experiment confirmed the presence of organic compounds that served as the building blocks for the development of life on earth.

According to Bernstein, "We

wanted to see what chemistry could occur under conditions like those in molecular clouds—the places where solar systems are made. The chemical compounds that resulted are similar to those ubiquitous in living systems today, and play important roles in essential biological processes." Zare added, "The importance of this work is that it increases the odds that carbon-based life may have evolved elsewhere."

The chemicals produced included quinones, aromatic ketones, alcohols and ethers. The researchers think that two types of molecules they created in the lab were biologically important for pre-biotic cells. First, quinones play a crucial part in electron transport in cells—the chemical reactions which allow organisms to extract energy and use or harness it to sustain life. Second, other by-products of the experiment enable cells to harness light energy for photosynthesis. These same classes of compounds have also been extracted from carbon-rich meteors.

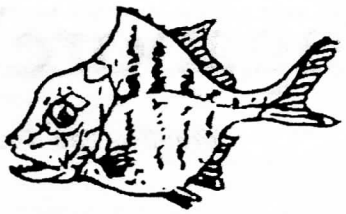
Previous research showed that a family of carbon-containing compounds, common on earth in coal, soot, and automobile exhaust, are typical of the most abundant class of organic molecules in the universe. In space, carbon compounds similar to those the researchers created in the lab are made in the interstellar medium, then brought to earth in interplanetary dust particles (microscopic bits of comets and asteroids) that drift down by the ton every day.

Astrobiology is the multi-disciplinary study of the origin, evolution, distribution and destiny of life in the universe. Ames Research Center is NASA's leading laboratory for astrobiological research and manages the agency's Astrobiology Institute. More information about Ames' Astrochemistry Lab can be found at: <http://web99.arc.nasa.gov/~astrochm/>.

Read more on the story at the ABC news web site: <http://abcnews.com/sections/science/DailyNews/spacecarbon990218.html>; read the original report at *Science Online*: <http://www.sciencemag.org/>; or connect to a summary of the research at NASA's Ames Research Laboratory: <http://web99.arc.nasa.gov/~astrochm/press.html>.

Bernstein MP, Sandford SA, Allamandola LJ, Gillette JS, Clemett SJ, Zare RN. UV irradiation of polycyclic aromatic hydrocarbons in ices: production of alcohols, quinones, and ethers. *Science* 1999 Feb 19; 283: 1135-8.

[*This report is an edited version of a news release written by James Bluck, Information Systems Liaison, NASA Ames Office of External Affairs, distributed on Feb 18, 1999.*]



UPDATES

Georgia: Two anti-evolution bills have been introduced in the state's House of Representatives. One bill, HB 117, is nearly identical to another that was introduced in Ohio in 1996. The bill calls for teaching "evidence not supporting evolution" whenever evolution is taught. The model bill on which this one was based was written by John Hansen, founder of Wisconsin-based Operation TEACH. In his newsletter, Hansen has described his plan to have legislators in every state introduce his bill.

Idaho: On November 13, 1998, the Idaho School Boards Association rejected a resolution stating that, "Mankind appearing on the earth, in his [*sic*] present form, shall not be taught ... as a result of evolution ... as fact....[but] may be presented as theory" (*RNCSE* 1998; 18[4]:6-7). The *Idaho Statesman* reported on November 14, 1999 that "attempts by creationists to influence curriculum are having a chilling effect on how some Idaho science instructors explain the origins of life" (p 1A). The article quotes one teacher as commenting that she omits mention of *human* evolution in some classes, but does describe evolution of other organisms.

Kansas: In February 1999, the State Board of Education held several meetings for public comment on draft science content standards. NCSE members and friends report that early meetings, which were not well-publicized, were dominated by opponents of evolution.

Kentucky: Representatives of the young-earth creationist organization Answers in Genesis express optimism that there will be an out-of-court settlement of a law-suit against Boone County, which has denied a zoning variance for their projected "creation science" museum. Meanwhile, the museum has purchased several exhibits, such as a walk-through model of a cell.

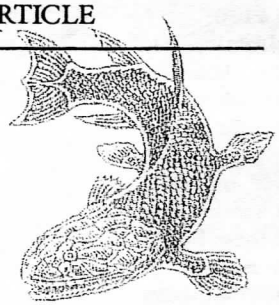
Michigan, Melvindale: On Monday, February 8, the board of this Wayne County area school district voted to place in public school libraries 19 books described as offering "scientific criticisms" of evolution. This vote followed another one which voted not to use these books in classrooms. At the request of school district personnel, the books had been evaluated by NCSE. Although an earlier board resolution had specified that no religious books, including religion "in disguise" could be adopted, NCSE found that many of the books are explicitly religious (*see reviews at <http://www.natcenscied.org/mianal.htm>)*. Others are out of print, out of date, or too technical for middle and high school students. NCSE members and other opponents attended the board meeting and still hope to persuade the board to alter its decision in the future. A spokesman for the state ACLU has said the organization might bring suit.

New Jersey, Metuchen: NCSE member Al Barron has announced his candidacy for the Board of Education. Barron has been actively involved in the introduction of new technology into district classrooms. He decided to increase his participation in the schools partly because he worried about "scientific creationist" sentiments expressed by incumbent members. Barron told NCSE, "I plan to visit every house in the district during my campaign."

Pennsylvania: Pennsylvania's State Board of Education (PDE) is holding roundtable discussions on its proposed academic standards for science education through March 1999. These are divided into two sets—Science & Technology and Environment & Ecology. Curriculum standards relevant to evolution education are in both sets. Participation is by advanced registration only and is limited to 15 people in each of 8 sessions in 4 different locations across the state. The PDE is also accepting written statements from those who are unable to attend any of the roundtables. The draft standards are available on the departments web site at <http://www.pde.psu.edu>.

[*Thanks to Hal Banke, David Caplan, John C English, Karl Fezer, Barbara Forrest, Keith B Miller, Wes McCoy, Arthur Neuburger, Dan Phelps, Charles Reich, JR*

ARTICLE



Teaching Biological Evolution to Singapore's Teachers

Yew-Jin, Lee and Oon-Chye, Yeoh

It is often challenging to teach biological evolution because of the strong emotions and beliefs that influence students' and teachers' conception of reality. Although there has not been much research carried out on students' understanding of evolution in Singapore, it has been the personal experience of the first author as a high school biology teacher for the past 6 years that this topic was rather poorly understood before, and even after, instruction. It was an intriguing question whether poor knowledge of evolution among students, as reported widely in the literature, might be associated with low levels of subject matter knowledge in this topic among teachers. Thus we felt it was worthwhile to examine the teachers of biology and science in Singapore's high schools, and more specifically the levels of content knowledge that they possessed regarding biological evolution in the high school biology curriculum. We also collected data from pre-service biology teachers in Singapore for purposes of comparison in the study. There is a dearth of information about our teachers' understanding of the concepts and principles of biological evolution. There is an urgent need to know and to be able to fill this void with a view to assisting our local biology teachers to teach more meaningfully about evolution in our high schools. It is hard enough for students to reconstruct and assimilate scientifically appropriate knowledge during instruction. This task is certainly made more difficult if students are improperly taught due to poor comprehension of subject matter and low levels of pedagogical competence in teachers.

METHOD

A 5-option, single-correct answer, multiple-choice questionnaire with 24 questions on evolution and 12 on ecology was devised to assess the teachers' levels of comprehension of biological evolution across a wide area of content. The survey instrument was mailed to a stratified random sample of 56 secondary schools (out of a total of 149) and all 14 junior colleges in Singapore. Secondary schools are equivalent to grades 7-10 while the junior colleges are equivalent to grades 11 and 12 in the United States. We requested participation in the survey of one biology teacher in each secondary school and two in each junior college. Anonymity was guaranteed to all respondents, and all the completed survey forms were returned voluntarily; there was a follow-up mailing to non-responding schools after the second month. After about 5 months, 52 completed survey forms were returned—40 from secondary school and 12 from junior college biology teachers. These teachers were predominantly middle-aged and female, with an average of 13 years of teaching experience (ranging from 8 to 15 years). The sample of 24 Post Graduate Diploma in Education (PGDE) pre-service teachers was drawn from the 1997/98 cohort enrolled in the National Institute of Education. These teachers were administered the same achievement test, with modifications to the section on their current teaching practices. All practicing and pre-service teachers in our sample were university graduates with the exception of one secondary school teacher.

A computer program called QUEST (Adams and Khoo 1996) was used during our analysis of the achievement test. It utilizes item response theory (IRT) which allows a standardized objective combination of item difficulty and respondent's ability on the same linearized scale measured in units called "logits" (This procedure is analogous to converting a score to "z" values in standardized statistical measures). The probability of getting a question right 50% of the time is represented by the point on the scale that is referred to as 0. Those performing above this mark are scored in positive logits; those below receive negative scores. To give an indication of the range of logits obtained in this study, the maximum score that can be obtained (36 items) would be translated to about 4.35 logits while 18 correct answers translates to 0.03 logits and 1 correct to -4.19 logits.

One advantage of IRT is that achievement or ability measures of the respondents will not be inflated with easier tests, nor will they be lowered with more difficult tests. This is because an assumption is made that the probability of getting any question correct is the function of only 2 variables — the ability or knowledge level of the person and the degree of difficulty of that item. A high-scoring person on one test on biological evolution is expected similarly to score well on others. The degree of "objectivity" of the test is reflected in the relative rankings of these teachers which should remain invariant even if the teachers were to take another test later on evolution. Although IRT does

Yew-Jin, Lee is currently teaching biology in a Singapore high school; Oon-Chye, Yeoh is a science teacher educator with the National Institute of Education.

offer clear advantages, its non-intuitive nature and technical difficulty make it less popular than more traditional forms of test measurement (Hambleton and Jones 1993).

Results and Discussion

We will highlight two questions from our larger study. We feel that our data can help provide a window into how practicing and pre-service biology teachers in Singapore perceive the topic of evolution using these two very insightful items. Our results will be compared with answers to similar questions asked by Tatina (1989) and Blank and Andersen (1997) in the United States. The answers marked with an asterisk (*) are those considered the best answer among the choices.

Q1. Do you think that the modern theory of evolution has a valid scientific foundation?

a. Yes, because it is possible to test many predictions of evolutionary science.
b. Yes, even though we can never test many predictions in the past*.
c. No, because we can never be sure about the past.
d. No, because evolutionary science is principally based on speculation and not "hard" scientific fact.
e. No (for other reasons).

This question offered a glimpse into some aspects of the teachers' belief about the validity and reality of evolution. About 17% percent of secondary school teachers adopted a nominalist view in option "b" compared with less than 10% in the other two groups of teachers (see Table 1). It is interesting to note that the popular positivistic view (option "a") was adopted by 35% and 42% of secondary and junior college teachers respectively, though we do not subscribe to a firm positivistic view of science.

On average, options "a" and "b" accounted for about half of the responses by practicing high school biology teachers in Singapore. This is still much lower than the 86% of Texas high school biology teachers who responded that "there is much scientific evidence that indicates evolution has occurred" (Shankar and Skoog 1993). Almost 73% of high school biology teachers in South Dakota claimed to accept the validity or truth of evolution. When asked the same question as in Q1, nearly 75% thought it had a scientific basis (Tatina 1989). In the sample of pre-service secondary science majors studied by Blank and Andersen (1997), options "a" and "b" alone account for 84% of the responses in stark contrast to the 33% in our sample of pre-service teachers.

TABLE 1—Singapore Biology Teachers' Responses to Question Q1

	% of Teacher Responses		
Item	Secondary n=40	Junior College n=12	Pre-Service n=24
a.	35	42	25
b.*	17	8	8
c.	3	0	13
d.	22	23	25
e.	17	23	25
others	6	4	4

Although only 8 junior college biology teachers chose option "b", Table 2 shows that their mean ability in logits was 1.61 (that is, about 27 out of 36 items correct), which indicates higher ability than those choosing the most popular option "a" (with a score of 1.11). For this group of teachers, the mean ability level over all items in our survey was 1.12 logits (SD = 0.97) which translates to about 25 out of 36 items answered correctly. There was low correlation between answering this question "correctly" and the total scores on the test (the point-biserial for this item was only 0.22 [$p<0.05$]). This low correlation may be due to the fact that the question had an element of opinion in it and did not depend entirely on respondents' comprehension of the validity of evolution in the field of science.

In contrast to the results among practicing teachers, pre-service graduate teachers who chose option "b" had the highest mean ability levels of 1.39 logits on this item (Table 2). The ability of the pre-service teachers who choose the other 4 options, however, was only 0.72 logits (SD = 0.67) which was quite a bit lower in comparison to the experienced biology teachers.

A more serious issue is that nearly a quarter of all practicing biology teachers felt that evolution was based on speculation (option "d") and did not have "hard" scientific facts while 19% felt it had no scien-

TABLE 2—Singapore Biology Teachers' Responses to Question Q1

	Practicing Teachers				Pre-Service Teachers		
Item	Number of Answers	Percent of Answers	Mean Ability in Logits	Item	Number of Answers	Percent of Answers	Mean Ability in Logits
a	19	36.5	1.11	a	6	25.0	0.84
b*	8	15.4	1.61	b*	2	8.3	1.39
c	1	1.9	0.18	c	6	12.5	.86
d	12	23.1	0.81	d	9	25.0	.86
e	10	19.2	1.29	e	6	25.0	.26
no answer	2	3.8	0.58	no answer	1	4.2	0.10

On the whole, the results ... showed that ... practicing teachers had ... a satisfactory level of understanding of content knowledge in evolution, *despite* the specific shortcomings in their understanding.

tific foundation for other reasons (option "e"). Intriguingly, the 10 practicing teachers who chose option "e" had a mean ability value of 1.29 logits and 2 of them had a high level of 2.29 logits. A full 63% of pre-service teachers had chosen the last 3 options, indicating that they felt biological evolution had no valid scientific foundation! However, the mean abilities of respondents who chose these options were only slightly higher at 0.86 logits than the mean ability level of the whole sample (at 0.72 logits) while the two respondents who chose option "e" had a low ability level of 0.26 logits (Table 2).

Q2. Which of the following best agrees with your impression of the modern theory of evolution?

a. The phrase "survival of the fittest".

b. Man evolved either from the gorilla or chimpanzee in Africa.

c. Evolution occurred because the strong eventually eliminated the weak.

d. Evolution occurred because different individuals left different numbers of offspring*.

e. Evolution involved a purposeful striving toward higher forms (i.e., steady progress from microbes to man).

TABLE 3—Singapore Biology Teachers' Responses to Question Q2

	% OF TEACHER RESPONSES		
Item	Secondary n=40	Junior College n=12	Pre-Service n=24
a.	75	8	71
b.	0	8	0
c.	8	8	8
d.*	3	58	8
e.	15	17	8
others	0	1	4

Over 70% of all practicing secondary and pre-service biology teachers associated the phrase "survival of the fittest" most closely with the theory of evolution in question 2. This was the second most difficult question (3.05 logits in difficulty). (Ironically, it was Herbert Spencer who had coined this phrase and not Darwin, though Darwin did admit the expression was accurate and convenient.) Tatina (1989) argued that this response leads to a tautology unless "fitness" is equated with differential reproduction.

Of high school biology teachers in South Dakota 37% had similarly associated "survival of the fittest" with evolution. Likewise, only 3% of our secondary and 8% of pre-service teachers answered this question correctly. In South Dakota, the correct answer was chosen least often (7.1%) among teachers (Tatina 1989). Furthermore, about 27% of teachers in South Dakota described evolution as "purposeful striving" in contrast to 15% in secondary and 17% in junior college teachers.

Blank and Andersen (1997) reported that 37% of their pre-service secondary science majors chose the last option in contrast to only 8% among our pre-service teachers. Bloom (1989) reported that 45% of elementary teachers in his sample believed in this kind of anthropocentrism while fewer than 10% included "survival of the fittest" in the descriptions of their conception of biological evolution.

Conclusions and Implications

Although the small sample size limits our ability to generalize, these findings do indicate only about half of *practicing* teachers agreed with statements that biological evolution has a valid scientific basis. About 50% of practicing and 33% of pre-service graduate biology teachers chose this answer. It is clear that this lack of acceptance of the validity of evolution from an all graduate sample, especially among the pre-service teachers, does not augur well for teaching about evolution in Singapore's high schools, even though creationism is never taught in the formal curriculum.

Views of the biological world are summarized as "conceptual ecologies of evolution" (DeMastes, Good, and Peebles 1995). There were some alternative conceptions of biological evolution observed in our study, especially among secondary school teachers. During teacher training or even during in-service courses for practicing teachers, instruction that helps them avoid some of these alternative conceptions could be emphasized (Tatina, 1989). For example, Zuzovsky (1994) required her pre-service teachers to answer 4 open-ended questions on evolution to trace the development of evolutionary thinking by analyzing the teachers' own responses. Any alternative conceptions were then confronted and discussed with the assistance of peers or an instructor.

On the whole, the results of the teachers' achievement test showed that the practicing teachers had achieved a satisfactory level of understanding of content knowledge in evolution, *despite* the specific shortcomings in their understanding as exemplified by question 2. Junior college (grades 11 to 12) biology teachers were most knowledgeable about evolution, followed by secondary (ending at grade 10), and then pre-service teachers. This might be explained by the fact that in junior college the curriculum treats biological evolution to a greater degree than in secondary school. However, we share the same concerns as Blank and Andersen (1997) that, while concentrating on improving understanding of evolution among teachers, we also need to pay greater attention to changing teachers' beliefs about its role in biological disciplines.

Some researchers have made a strong appeal to increase the emphasis on subject matter knowledge during teacher training and to decrease instruction in other areas like pedagogy or classroom management techniques (Abd-El-Khalick and Boujaoude 1997). Prospective teachers should be given time to

reflect, learn or even to relearn content areas in greater depth. The conceptually difficult topic of biological evolution is certainly an excellent candidate for greater reflection and examination during biology teacher education!

The urgency of improving subject matter knowledge, especially in the area of biological evolution, is exacerbated by the reported low emphasis and coverage of evolution experienced by teachers during their past university education. If the instruction received during college or university education was biased or inadequate in terms of subject matter knowledge, then it would be understandable that teachers maintain alternative conceptions that are inappropriate. This might further lead to the perpetuation of these errors among students if this issue is not addressed.

Not related to content *per se*, but of tremendous importance to teaching evolution, would be an improved understanding of the nature of science (Smith, Siegel and McInerey 1995; McComas 1996), of science and religion (Jackson and others 1995), and of constructivist approaches to science teaching. A mandatory course in the nature, philosophy and the history of science might be well advised for both local undergraduates and pre-service teachers in light of their dim view of the validity of evolution!

References

Abd-El-Khalick F, Boujaoude S. An exploratory study of the knowledge base for science teaching. *Journal of Research in Science Teaching* 1997; 42(7): 673-99.

Adams RJ, Khoo ST. *Quest - the interactive test analysis system*. Australian Council of Educational Research, 1996.

Blank LM, Andersen HO. Teaching evolution: Coming to a classroom near you? *Reports of the National Center for Science Education* 1997 May/June; 17(3): 10-3.

Bloom JW. Preservice elementary teachers' conceptions of science: Science, theories and evolution. *International Journal of Science Education* 1989; 11: 401-15.

Demastes SS, Good RG, Peebles P. Students' conceptual ecologies and the process of conceptual change in evolution. *Science Education* 1995; 79(6): 637-66.

Hambleton RK, Jones RW. An NCME instructional module on comparison of classical test theory and item response theory and their applications to test development. *Educational Measurement: Issues and Practice* 1993; 12(3); 38-47.

Jackson DF, Doster EC, Meadows L, Wood T. Hearts and minds in the science classroom: The education of a confirmed evolutionist. *Journal of Research in Science Teaching* 1995; 32(6): 585-611.

McComas WF. Ten myths of science: Re-examining what we think we know about the nature of science. *School Science and Mathematics* 1996; 96(1): 10-6.

Shankar G, Skoog GD. Emphasis given evolution and creationism by Texas high school biology teachers. *Science Education* 1993; 77(2): 221-33.

Smith MU, Siegel H, McInerney JD. Foundational issues in evolution education. *Science and Education* 1995; 4: 23-46.

Tatina R. South Dakota high school biology teachers and the teaching of evolution and creationism. *American Biology Teacher* 1989; 51(5): 275-80.

Zuzovsky R. Conceptualizing a teaching experience on the development of the idea of evolution: an epistemological approach to the education of science teachers. *Journal of Research in Science Teaching* 1994; 31(5): 557-74.

Authors' Addresses:

Mr Yew-Jin, Lee
Victoria School
3 Geylang Bahru Lane
Singapore 339626.
Email: lyj@moe.edu.sg

Dr Oon-Chye, Yeoh
School of Science
National Institute of Education
Nanyang Technological University
469 Bukit Timah Road
Singapore 259756
Email: YEOHOC@nie.edu.sg

The Ages of the Rocks

Samuel A Bowring and Ian S Williams from the Department of Earth, Atmospheric and Planetary Sciences, MIT, Cambridge, Massachusetts, report in the current issue of *Contributions to Mineralogy and Petrology* (Volume 134, issue 1, pp. 3-16) the discovery of rocks in northern Canada that are over 4.03 billion years (Ga) old, making them the oldest known rocks on planet Earth. The rocks come from the same area where rocks 3.96 billion years old were discovered in 1989. The rocks are igneous and granodiorite. The granodiorites were from even older rocks which could be as old as 4.06 Ga. The finding is significant because it closes the gap in the geologic record between formation of the Earth 4.56 billion years ago and the oldest preserved rocks. It also implies that the inferred late bombardment of Earth by large meteorites between 4.6 and 3.8 Ga was not intense enough to destroy all crust on Earth. Surprisingly, these ancient rocks resemble crustal rocks that are currently forming on Earth.

Bowring SA, Williams IA. Priscoan (4.00-4.03 Ga) orthogneisses from northwestern Canada. *Contributions to Mineralogy and Petrology* 1999 Jan; 134(1): 3-16.

See the publisher's news release on this article at <http://www.springer.de/whatsnew/presse/gesteinengl.htm>. An abstract of the research is at <http://link. springer.de/link/service/journals/00410/bibs/9134001/91340003.htm>.

[*Contributed by John R Cole*]

Vine Deloria Jr, Creationism, and Ethnic Pseudoscience

H David Brumble
University of Pittsburgh

Vine Deloria, a Standing Rock Sioux, has been an important advocate for American Indians for more than 25 years. He has defended Indian claims in the courts; he has acted as an Indian spokesman in Washington. Deloria is also a professor of history, law, and religious studies at the University of Colorado.

His books have brought Indian concerns to a broad audience. He burst upon the scene in 1969 with *Custer Died for Your Sins*, and he has continued to write about injustices done the Indians by the government, the schools, the church, anthropologists, and the courts. Most recently, he has taken on the scientists in *Red Earth, White Lies: Native Americans and the Myth of Scientific Fact*. Imagine how Deloria's own people must have felt when this distinguished man returned to the Standing Rock Reservation to talk — no, to consult — with them about science. Deloria describes just such a scene in this book. He returns to the reservation and delivers a speech. In this speech he discusses a problem in paleontology that he is currently working on. Deloria believes that a certain saw-tooth-backed "monster" in one of the Sioux tales is really a stegosaurus:

> After my speech a couple of the traditional people approached me and said that the next time I came, if I had time, they would take me to see the spot where the people last saw this creature, implying that it was still possible to see the animal during the last century before the reservations were established. I gave their knowledge credence (p 243).

Deloria is telling us that he believes that these "traditional people" have helped him to prove that the scientists are wrong — that dinosaurs did not go extinct millions of years ago; a hundred years ago the Sioux saw the stegosaurus walking in the Badlands. He "gave their knowledge credence." Imagine how these "traditional people," these Standing Rock Sioux, must have felt to have Vine Deloria, a university professor and one of their own, talking with them seriously about paleontology—and giving credence to what they were able to tell him about the stegosaurus, what they were able to tell him out of the storehouse of their traditional knowledge. Anyone who knows anything at all about American Indian history must understand what a moment this must have been.

Red Earth, White Lies was written in the spirit of that evening—the book promotes not just the value of American Indian oral traditions, but the *scientific* value of American Indian oral traditions. And the book is also a heady indictment of the white man's science. The only problem, of course, is that Deloria is wrong. He was wrong on that memorable evening—whatever the beast in the tale might be, the Sioux could not have seen a stegosaurus a hundred years ago. And he is just as obviously wrong on almost every page of *Red Earth, White Lies*. Some examples follow.

On the Earth as a Youthful Planet

Deloria doubts that the earth is billions of years old; indeed, he writes, "Most American Indians, I believe, were here 'at the beginning' and have preserved the memory of traumatic continental and planetary catastrophes" (p 251). The geologists are simply wrong in their reading of the geological record. For example, "vulcanism was a onetime event" (p 235).

Dinosaurs and Human Beings

Indians tell stories about a time when there were monsters on the earth. Some of these monsters Deloria recognizes as dinosaurs: "That is to say, humans and some creatures we have classified as dinosaurs were contemporaries" (p 241). Deloria is inclined to credit one western tribe's belief that they have in their possession "an unfossilized dinosaur bone" (p 241). And as we have seen, he believes that the Sioux saw the stegosaurus walking in the Badlands a hundred years ago.

On Noah's Flood

Deloria believes in the historical reality of the biblical flood, because "Indian traditions also spoke of a great flood...and they had their own culture heroes who followed the same procedure as Noah" (p 61-2). In fact, the Old Testament account of Noah's flood "may very well provide evidence of the basic accuracy of the Indian story" (p 207). Just as his forefathers built their encampments in a circle, so Deloria builds his arguments.

On Pilgrims and Mammoths

Deloria argues that "there were mammoths or mastodons still living in the eastern United States at the time the Pilgrims landed" (p 143).

On the Mormon View of the Origin of the American Indians

Deloria gives credence to the Mormon contention that the American Indians came from the Middle East (p 62).

On the Effects of Increased Levels of Carbon Dioxide

Deloria is convinced that increased levels of carbon dioxide lead to gigantism; this explains the size of the mammoths and the giant sloths—just as it explains the increasing size of human beings since the beginnings of the industrial revolution. Indeed, Deloria sees the increase of carbon dioxide (which most of us worry about in

connection with global warming) as one reason for the increased size of football and basketball players since he was in high school (p 172-7).

On the Change in the Coefficient of Gravity

Deloria is inclined to think that the coefficient of gravity has fluctuated so widely as to account (with the increased levels of carbon dioxide) for the gigantism we find in the age of the dinosaurs and again in the age of the mammoths and giant sloths (p 174).

On Ecology

By way of dismissing the idea that such animals as the mammoth might have gone extinct because of climate change, Deloria writes that "It hardly seems possible that any animal, living in a more benign region for a change, would promptly expire" (p 164)—as though penguins, for example, would really be better off in San Diego.

On Evolution

Evolution is a failed theory: "[E]ven the most sophisticated of modern scientists, in explaining the fossil remains, finds that species in the rocks are distant relatives to each other, not direct lineages" (p 40). At one point Deloria refers dismissively to "the outmoded sequence of alleged human evolution" (p 217). Once Deloria has considered the evidence he asks, "Where is evolution?" (p 238).

On the Character of Science

Scientists are virtually incapable of independent thinking; they are hobbled by their reverence for orthodoxy (p 42-4, 50-1, 154-5, 180, 202, 231-2). Scientists characteristically persecute those who dare to advance unorthodox views. Science is thus essentially a religion (p 17-8, 41, 87, 178, 251)—and scientists are in the thrall of their scientific myths. In many areas science is nothing more than "a hilarious farce" (p 202).

Most readers will recognize in much of this the lineaments of "creation science". But for those who have (quite reasonably) paid little attention to "creation science", here is a good, brief characterization of the movement:

> The creationists have learned a lot in their long struggle to unseat evolution. Trial and error has shown them what doesn't work: Anti-science doesn't, efforts to ban [the teaching of] evolution don't, and purely religious invective is also a losing proposition.The idea of being open-minded, religiously neutral, and scientific has gained such wide credence (or at least lip service) that creationists can't successfully oppose it, no matter how much they might like to. So, their new tactic is to declare creationism scientific, then join in with the majority and espouse the virtues of the times in their own name. In this way they can pose as latter-day Galileos being persecuted by "orthodox" science (Edwords 1980: 4-5).

Add to this a large measure of standard-issue American Ethnic Invective, and you have Deloria's method exactly.

Ethnic Pseudoscience

Of course Deloria is not the first American ethnic to question mainstream science and scholarship. Deloria's closest pseudoscientific cousins may be in the Afrocentric movement. African-American "melanin scholars", for example Martin Bernal, have as their basic tenet that melanin (the pigment found in all humans) has remarkable properties (Ortiz de Montellano 1991, 1991/1992; Griffin 1996; Lefkowitz and Rogers 1996). So those who have lots of melanin have large powers.

Thus it is melanin that is responsible for the athletic prowess of African-Americans and for the superior intelligence and extra-sensory potential of blacks in general. Melanin also accounts for the achievements of the ancient Egyptians, who were black, according to the melanin scholars. This allows the melanin scholars to provide pseudoscientific underpinnings for an Afrocentric creation myth. According to the melanin scholars, then, it was melanin that allowed Africans to "invent" fire, language, and time.

None of this would matter much if scholars who know better would respond to such arguments on their merits. But educated people of good will recognize in such scholarship the aspirations of disadvantaged peoples for a place at the table of learning. Sympathizing as they do with the yearnings of the dispossessed, educated people of good will often pretend to see real contributions to learning in ethnic pseudoscience and pseudoscholarship.

I was struck, for example, by the dust jacket blurbs for *Red Earth, White Lies*. Leslie Marmon Silko writes that the book "shoots down a whole herd of sacred cows—from Charles Darwin's cow to Samuel Eliot Morison's bull." Goodness; does Silko—who is a university professor, after all—really believe that Deloria has disposed of the theory of evolution? In genuine puzzlement, I wrote to ask her this question, but I received no response. (I am not certain that she received the letter.)

None of this would matter much if scholars who know better would respond to such arguments on their merits. But educated people of good will ... often pretend to see real contributions to learning in ethnic pseudoscience and pseudoscholarship.

Dee Brown, author of *Bury My Heart at Wounded Knee*, one of the best known books on American Indian history, wrote that Deloria is "lambasting scholars and scientists for filling our heads with nonsense while they ignore the traditional knowledge of native tribes." I wrote Brown, again in genuine puzzlement, to ask him if he really meant this: "Deloria even argues," I wrote, "that human beings and dinosaurs were on the earth at the same time."

Brown reminded me that "some of the creation myths tell of green scum heated by the sun being washed ashore to begin terrestrial life." Yes, one might respond, and a Navajo myth tells of four consecutive worlds with the creatures passing from one to the next by ladders. Probably paleontologists and geologists would be as little aided by the one myth as by the other. And of course it is only the work of the scientists which makes the "green scum" myth *seem* more like science than the "ladders" myth. Surely

Brown cannot really think that geologists and paleontologists would be further along if they spent less time looking at rocks and more time interpreting Kwakiutl myths.

But Brown makes another suggestion:

> Deloria has a Siouan sense of black humor, and likes to tease his readers. Unless he has changed in the last few years, he would laugh at the idea of men and dinosaurs living together. But then he might tell you that.

So, Brown is not convinced, really, that dinosaurs and human beings were on the earth at the same time. No, Brown thinks it likely that ol' trickster Deloria is just counting coup in his on-going culture war with the Anglo establishment, just having fun with me—and all the others who might be willing to fork over $23 for a book advertised to dispel "the myth of scientific fact". But if Deloria's book is just a politico-ethnic practical joke, it seems to have taken in another of the blurb writers.

Deloria, the creationists, and the melanin scholars differ importantly from scientists. Deloria and company are ... content with *seeming* scientific arguments to buttress beliefs which they hold independent of evidence.

Father Peter J Powell wrote that this book "is the most important scholarly work" Deloria has written. Powell expresses the hope that the book will "persuade Anglo scholars to accord American Indian elders that respect owed them as repositories of the greatest wisdom concerning the nature of this continent that exists." Powell has written widely on American Indian history, and he has worked for many years among Indians of several tribes. He is a learned man—and so I wrote to him in puzzlement. He wrote back to assure me that, yes, he really does believe that "geologists should take American Indian traditions seriously." He really is "convinced that ultimately geologists will discover the succession of geological events recalled in the tribal traditions to be empirically sound"—but then Father Powell reminds me that he is a priest, that he writes as one for whom "theology is the queen of the sciences." And so we return to creationism.

Political and Legal Consequences

All of this is diverting, but we should remember that when theology or affirmative action drives science, there can be real-world consequences. Most immediately, we should worry that Deloria's affirmative-action science might work its way into public school science curricula. Deloria puts it this way: "All we ask is respect for the other traditions and some of their versions of origins" (p 187). This is, of course, exactly the disingenuous argument of the creationists, as they strive to get "creation science" into the schools and textbooks: "We are only asking that both theories be taught." But well-meaning academics who scorn this argument when it comes from Christian creationists, often encourage ethnic pseudoscience curricula out of a sense of cultural *noblesse oblige*. And so we end up with real science for the nice, white suburbs, and self-affirming pseudoscience for the reservations and inner cities.

Deloria has another motive of ethnic self-interest as well. Deloria must be hoping that *Red Earth, White Lies* will have real legal consequences. For Deloria the lawyer, "proof" of the veracity of Indian oral traditions can be crucial in treaty claims—where Indian tribal memory is sometimes importantly in conflict with written treaties (p 230). Numerous court cases pit Indian understanding of a treaty against the literal wording of the treaty. In many of these cases, this means that Indian tribal memory—oral tradition—is being pitted against what is written.

The Idaho Court of Appeals (*Swim v Bergland* 1983), for example, ruled that agreements between the United States and Indian tribes are to be construed according to the probable understanding of original tribal signatories. The Washington Court of Appeals (*Fry v US* 1981) decided that evidence of tribal custom is a proper basis for judicial conclusions about the present effect of Indian treaty provisions. Such arguments will be easier for Deloria the lawyer to make if he can point to *Red Earth, White Lies* as "proving" that Indian oral traditions have real scientific standing. If academics agree that his book "proves" that oral traditions can help the paleontologists, then oral traditions obviously ought to be accepted as proof in questions of legal ownership dating back a mere century, say.

I would not be misunderstood: I do not mean to deny that oral traditions might be important evidence in a court of law; I certainly do not mean to deny the worth of oral traditions. Indeed, I have devoted a good deal of attention to certain aspects of American Indian oral traditions (see Brumble 1988). And of course a good deal of scientific attention is being paid to oral traditions having to do with plants, to ethnobotany. But Deloria devotes only two pages of *Red Earth, White Lies* to ethnobotany (p 58-59). The book has mainly to do with "geomythology" (60).

Foundations of Competent Scholarship

I do want to point out that Deloria, the creationists, and the melanin scholars differ importantly from scientists. Deloria and company are fundamentally anti-rational — even as they try to wrap the mantle of science about their beliefs. Thus they are content with *seeming* scientific arguments to buttress beliefs which they hold independent of evidence. Deloria, for example, takes up a familiar creationist strain in mocking the evolutionists for lacking any "transitional forms" in the fossil record:

> [E]ven the most sophisticated of modern scientists, in explaining the fossil remains, finds that species in the rocks are distant relatives to each other, not direct lineages.... Apparently somewhere, and at a time unknown, when species were ready to evolve they went offstage, made their changes, and then rushed back into the geologic strata to leave evidence of their existence (p 40).

In fact, by the time Deloria was penning these lines, the paleontological world was already abuzz with the news that transitional

forms had been found. In the January 14, 1994 issue of *Science* Thewissen and Aria described the fossil skeleton of a whale with large, complete, and functional hind legs — legs which would have allowed this early whale to get about on the land! Gould calls this a "bag packer for creationists", the paleontological "smoking gun" (1995: 366-7). This was big news, and *Science* is not exactly an obscure journal. The publication of the article was early enough for Deloria to have read the piece (or even Gould's April, 1994, account of the discovery in *Natural History* reprinted in Gould 1995: 359-76), had he been doing the kind of reading one would have to do in order to write a book responsibly attacking the basic tenets of geology and paleontology.

But even had he read the article, Deloria's thinking would probably have been undisturbed—for the same reason that the melanin scholars are undisturbed by easily available scientific accounts of melanin. They are not doing science really—they are promoting a cause. But one of the many sad things about affirmative-action ethnic pseudoscience is that their cause doesn't really need pseudoscience or pseudoscholarship. It has been the anthropologists, after all, who have been largely responsible for providing the scholarly foundation for cultural relativism. And the weight of scientific research, for another example, now opposes the idea that intelligence is tied to race. Deloria seems to forget this when, in the course of recounting the sins of the scientists, he mentions the notorious case of Cyril Burt:

> Perhaps the epitome of scientific fraud was the work of Sir Cyril Burt on twins. Fearful of criticism of his work, Burt simply performed the peer-review process by himself, writing glowing reviews of his work using pseudonyms. This deceit, and the manipulation of statistical data in his studies was eventually exposed (p 41-2).

Deloria misses much here. Burt's work claimed to find a very high correlation between IQ scores of twins raised apart. This was regarded as important evidence for hereditarian views—evidence which was useful to those who claimed that race could determine intelligence. But ethnic pseudoscience was not necessary to reveal Burt's fraud. Here is the story as Gould tells it:

> I think that the splendid "official" biography of Burt recently published by LS Hearnshaw (1979) has resolved the issue so far as the data permit (Hearnshaw was commissioned to write his book by Burt's sister before any charges had been leveled). Hearnshaw, who began as an unqualified admirer of Burt and who tends to share his intellectual attitudes, eventually concluded that all allegations are true, and worse (1981: 236).

Hearnshaw, then, actually began as an apologist for Burt, but when he found real evidence of fraud, he was forced to change his mind. This is real scholarship. My guess is that Deloria will not change his mind about "transitional forms" (and so about evolution and creationism) just because of the walking whales.

Concluding Parable

In the hope of influencing those who read ethnic pseudoscience with affirmative action in their hearts, I offer in closing this parable:

> A man in tweed stands before an academic audience. He is, let us say, a professor of English (as I am); he has (like me) no scientific training, aside from some amateur reading. He delivers a series of lectures on "creation science". He acknowledges that his religious affiliation is, let us say, Pentecostal, to suggest that he is guided by the spirit.
>
> In his lectures he argues that the scientists have it all wrong, that the earth was created, and not created some unimaginable billions of years ago. He asserts that, while he is not certain of the age of the earth, he is fairly sure that human beings were on earth with the dinosaurs, that human beings were on earth to see the formation of the mountains. And all of the earth's igneous rock poured forth in one great volcanic cataclysm triggered by the impact of a great meteor. He argues that the universal flood of the book of Genesis is probably historical fact.
>
> His scientific breakthrough, he explains, is that he is bringing to bear the testimonies of the people who actually witnessed these events. He presents the testimonies of pre-literate peoples as preserved in their oral traditions of which he is a skilled interpreter; he shows how these oral traditions are very often exactly in keeping with Old Testament accounts. He argues that many scientists actually know the truth of the biblical account of creation (as corroborated by pre-literate peoples)—but they are cowed into dishonest silence by the fear of ostracism from the cozy scientific community. His lectures are applauded by this academic audience and endorsements are written by some rather eminent figures in attendance.

This would, of course, be highly unlikely. Most of the well educated people who praise *Red Earth, White Lies* would be embarrassed even to be found in the audience on such an occasion. Most academics would work hard to prevent such "fundamentalist" notions from intrusion into the science curriculum of their children's school. But change *lecture* to *book published by Scribner's*, change *Pentacostal Christian* to *charismatic Sioux religion*—and this unlikely fantasy is exactly what Vine Deloria has accomplished.

Bibliography

Adams HH. African and African-American contributions to science and technology. *African-American Baseline Essays*. Portland: Multnomah School District, 1990.

Bernal M. *Black Athena: The Afroasiatic Roots of Classical Civilization*, vol 1. New Brunswick: Rutgers U Press, 1987.

Bernal M. *Black Athena: The Afroasiatic Roots of Classical Civilization*, vol 2. New Brunswick: Rutgers U Press, 1992.

Brumble HD. *American Indian Autobiography*. Los Angeles: U California Press, 1988.

Cole JR. It ain't necessarily so: Giants and biblical literalism. *Creation/Evolution* 1985; 5: 48-56.

Deloria V Jr. *Custer Died for Your Sins*. New York: Macmillan, 1969.

Deloria V Jr. *Red Earth, White Lies: Native Americans and the Myth of Scientific Fact*. New York: Scribner, 1995.

Deloria V Sr. The Standing Rock Reservation: A personal reminiscence. *South Dakota Review* 1971; 9: 167-95.

Edwords F. Why creationism should not be taught as science. *Creation/Evolution* 1980; 1: 2-23.

Gould SJ. *The Mismeasure of Man*. New York: Norton, 1981.

Gould SJ. *Dinosaur in a Haystack*. New York: Harmony Books, 1995.

Griffin J. Anxieties of influence. *New York Review of Books* 1996; 43(8): 67-73.

Hearnshaw LS. *Cyril Burt Psychologist*. London: Hodder and Stoughton, 1979.

Lefkowitz MR, Rogers GM. *Black Athena Revisited*. Chapel Hill: U North Carolina Press, 1996.

Nelkin D. *The Creation Controversy: Science or Scripture in the Schools*. Boston: Beacon Press, 1984.

Numbers RL. *The Creationists*. New York: Knopf, 1992.

Ortiz de Montellano BR. Multicultural pseudoscience. Spreading scientific illiteracy among minorities—Part I. *Skeptical Inquirer* 1991; 2.

Ortiz de Montellano BR. Afrocentric creationism. *Creation/Evolution* 1991/92; 19: 2-8.

Patten D. *The Biblical Flood and the Ice Epoch*. Seattle: Pacific Meridian, 1966.

Thewissen JGM, Aria M. Fossil evidence for the origin of aquatic locomotion in archaeocete whales. *Science* 1994; 263: 210-2.

Author's Address

H David Brumble
College of Arts and Sciences
Univ. of Pittsburgh
Pittsburgh PA 15260
email: brumble+@pitt.edu

Correction

Due to last-minute changes in preparation for printing *RNCSE* 18(4), we inadvertently omitted the final reference cited in the feature article by Wilfred Elders on the geology of the Grand Canyon. The missing reference is

Wise DU. Creationism's geologic time scale. *American Scientist* 1998; 86:160-73.

We apologize for the inconvenience.

OFFICE BIZ

Erik Wheaton
Circulation Manager

Gremlins in the Mailbag!

Many of our members were surprised when they received letters inviting them to join NCSE! Many of them wrote to ask, "But I already belong to NCSE! What's this about?" We carried a brief note in *RNCSE* 18.5 just before we went to press. Now here is a chance to give you all a full explanation and to put your minds at ease.

From time to time NCSE seeks new members using mailing lists of other organizations whose memberships may overlap with our own. We ask the mailing house that distributes our large mailings to compare the borrowed lists with NCSE's own membership list. Then we ask them to *eliminate* the addresses of any individuals who already belong to NCSE. In this case, the duplicates were not eliminated. The mailing house is investigating the cause of the problem, and we apologize to any members who were inconvenienced.

To those of you who thought this was *another* fund-raising letter—rest assured that it was not. NCSE sends only two such letters each year—one in the spring and one in the fall.

Email Connections

As more and more of our members "go online", NCSE is finding that often we can respond more effectively to creation/evolution controversies when we communicate through email. If you have acquired or changed an email address since joining NCSE, please write to **ncse@natcenscied.org** so that I can add your email address to our database.

It is also important to keep your email addresses up to date! Our Network Project Director Molleen Matsumura told me that several messages to **Michigan** and **Georgia** members "bounced" recently, which means that we have incorrect addresses for them. If you live in Michigan or Georgia, and *did not* receive Molleen's February email concerning problems in your state, please send email to *ncse@natcenscied.org* so that I can update your file.

Finally, a reminder about contacting NCSE.

To ask about your subscription or notify us of a change, write to:
SUBSCRIPTIONS
NATIONAL CENTER FOR SCIENCE EDUCATION
PO BOX 9477
BERKELEY CA 94709-0477
email: ncse@natcenscied.org

To send a letter to the editor or correspond about writing something for *Reports of NCSE*, write to:
ANDREW J PETTO, EDITOR
DIVISION OF LIBERAL ARTS
UNIVERSITY OF THE ARTS
320 S BROAD ST
PHILADELPHIA PA 19102-4994
email: editor@natcenscied.org

To send a package to our national office, use our street address:
NATIONAL CENTER FOR SCIENCE EDUCATION
925 KEARNEY ST
EL CERRITO CA 94530

Send news clippings and other information about creation/evolution issues in your community to:
NATIONAL CENTER FOR SCIENCE EDUCATION
PO BOX 9477
BERKELEY CA 94709-0477
email:
molleen@natcenscied.org

Over the Hump—Taking the AIG Camel Challenge!

Andrew J Petto
NCSE Editor

Answers in Genesis maintains a web site with resources for teachers, including images that can be downloaded to make into overhead transparencies and suggestions for how to use them. The designers of these materials expect the users to have an uncritical acceptance of a literal interpretation of the Bible, but they are presented using "buzz words" that supposedly promote "critical thinking" among students. In order to show how data can be misinterpreted without the proper "guidance", AIG provided line drawings of a camel's skull and some artists' renditions of the "fleshed-out" head (*see sidebar for the text of the AIG "lesson plan"*). I decided to take the challenge and use the AIG materials in my introductory course in zoology during the 1998 spring semester.

The School and Students

This course fulfilled a basic science requirement for students at Madison (WI) Area Technical College (MATC). There were no prerequisites, and most of the students would not go on to specialize in any area of the sciences. In short, this could be the last or the only science education many of these students would receive. Most of the students were adults returning to school after a number of years or recent high-school graduates whose grades, prior scholastic preparation, or financial situation precluded matriculation at a baccalaureate institution. Most of these students were in the "college-transfer" program, which meant that they hoped to transfer these credits to a school that granted a 4-year degree.

During the one-semester Animal Biology course, we explored the typical zoology topics—basic chemistry, cell biology, genetics, evolution, ecology, and comparative biology (anatomy, physiology, and behavior). Because MATC has a strong program for animal technicians, our teaching lab contained skeletons and mounted specimens of a number of species. We were also fortunate to have access to the University of Wisconsin Geology Museum to supplement our teaching. Although the department had a staff to prepare specimens and schedule laboratory use, the small class size meant that all instruction—classroom, laboratory, field trips, and discussion sections — were led by the course instructor. There were 2 "sections" of the course — 16-17 students in each.

By the time I discovered the AIG materials in March, these students had already studied specimens at the UW Geology Museum and had begun comparative studies of skeletal materials in their laboratory sections. One of the assignments in that exercise was to examine skeletal material, including teeth, to understand the relationship between dental anatomy and behavior (including food sources). The AIG challenge to bring these images directly to these students seemed to me to be the ultimate "authentic assessment" of their learning and my teaching. If they could apply their "book learning" to this "real-life" situation, then they really did grasp the process that we call "science as a way of knowing" (SAAWOK). It was not without a little trepidation that I presented the AIG materials during the 2-hour discussion sections.

The AIG Materials

The first AIG overhead is a line drawing of the skull of a camel (see Figure 1). True to the AIG expectations only one of my students—a young woman from North Africa—knew what sort of animal this was (*see sidebar*). She agreed to sit on the sidelines and fill us in later on camel behavior and ecology and how they relate to the structures we observed. Also true to AIG expectations was the students' initial reaction—they focused immediately on the tall, pointed teeth in the front of the skull as I asked the what sort of food these animals ate. But then things changed.

These students with a minimum of prior instruction in comparative anatomy also noticed the molars—high, flat teeth which are typical of animals eating grasses and tough vegetation. One student remarked that, although the "anterior dentition" is impressive, it is really the back teeth which dominate the

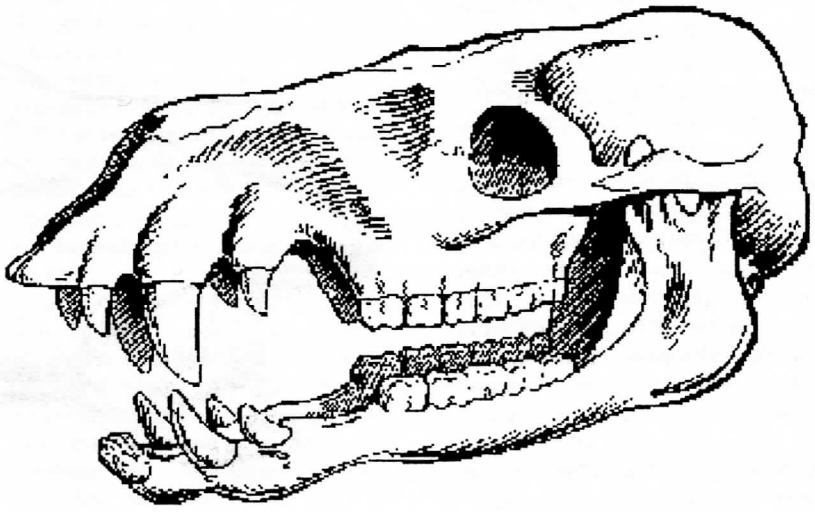


Figure 1: Camel Skull Illustration.

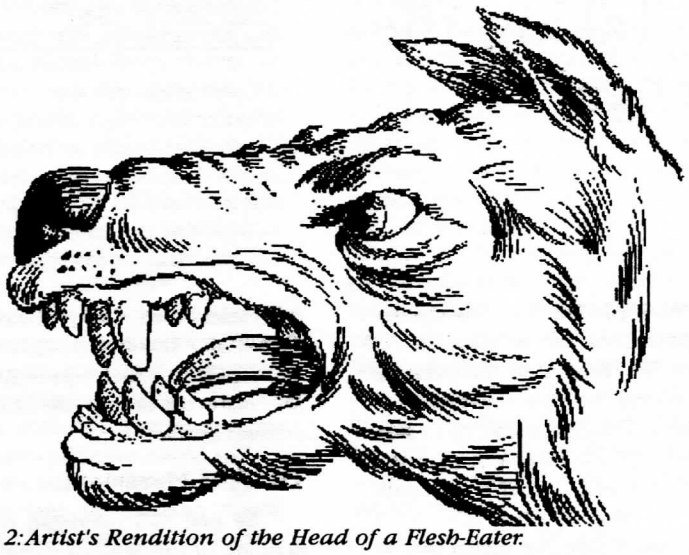


Figure 2: Artist's Rendition of the Head of a Flesh-Eater.

mouth. They seem more "important" to the animal than the few larger pointed teeth in the front.

Because they had already examined the dentition of flesh-eating, plant-eating, and omnivorous reptiles and mammals in the museum and lab, the students were able to see that the "sharp" teeth in the front of the jaw were not really sharp! The teeth were tall and narrow, but even the line drawing showed that they were blunt, not sharp. These students had seen large canines and incisors in plant-eating animals and knew that these were used in a variety of social and antipredator behaviors—not for eating meat. Furthermore, many were familiar with horses and deer and recognized that the combination of lower incisors with a bony "cutting board" in the upper jaw is useful for animals that bite off tough stems or grasses.

The discussion of the qualities of the skull lasted about 20 minutes, and then I introduced the second AIG image (see Figure 2). This artist's rendition of the living animal clearly presents the animal as a flesh-eater. After discussing the rendition in small groups for about 10 minutes, the students came up with 2 reasons to reject this image as inappropriate. The first was the shape of the mouth. One group noticed that the "lips" opened far back into the jaw. This is good for flesh-eaters which need to open wide to kill and tear chunks of flesh from their prey or which use teeth near the back of the jaw as a sort of "bone-cracker". However, for grazing animals, like camels, horses, and deer, that need to chew their food a lot, the "cheeks" help keep the food between the teeth while chewing. The mouth is smaller and the molars almost never show. In this rendition, the students suspected that the half-chewed food would keep falling out of the animal's mouth.

Second, the students noticed that the front teeth were not "sharp" and that the lack of teeth at the front of the upper jaw would cause serious problems for any animal that needed to tear flesh or deliver a deep puncture wound to its prey. This animal had none of the sharp, piercing, slicing teeth needed to be a competent predator.

Then, following the AIG "lesson plan", I showed the students the artist's rendition of the camel's head (see Figure 3). All the students agreed within minutes that *this* head was the more likely fit. They were willing to hedge their bets as to whether the skull had to be a camel, but they clearly saw that the animal had to be a plant-eater and not a flesh-eater. Of course, they had already rejected the flesh-eater as a good fit solely on the basis of anatomical evidence. They had seen skulls of many animals and recognized that the dental anatomy in this animal was that of a plant-eater with special adaptations for "mowing" stems and grinding foods, not piercing and tearing.

At last, our North African student gave us a brief account of camels in her homeland. Once she explained how and what camels eat, their social organization, and their behavior, there was a "chorus" of nods and murmurs.

Reflection

An important part of the "discussion" sections in this class was a period for reflection on ideas and issues raised in the course or on the various learning activities, such as this one, that they engaged in. It is a classic SAAWOK component — what do we know and what makes us sure we know it? The students needed to identify the question(s) they were asking, the data available to them, what else they might need to know to answer the questions(s), and how to present their conclusions persuasively (for example, Stewart and Jungck 1995). An important part of this process is to identify the evidence and the materials used in the process and to explore how they influenced our conclusions (Petto and Petto 1997).

In this activity, the students rec-

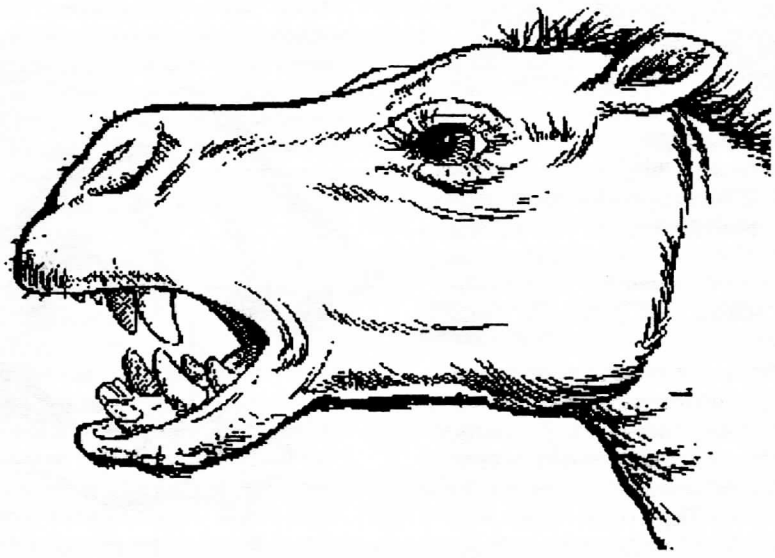


Figure 3: Artist's Rendition of the Head of a Camel.

ognized that the prominent front teeth had tended to attract their attention away from the other evidence and away from a more thorough examination of the anatomical features in the camel skull. This attraction, they agreed, prompted them to jump to conclusions about the nature of the organism before they had a chance to consider all the information available. Perhaps most important, the students recognized that a focus on the large front teeth caused them to put aside—at least temporarily—their previous knowledge and experience which were vital for solving the problem.

The AIG website invites us to "show that our pre-conceived ideas will influence how we see the world around us" without, of course, telling us that the AIG conclusions are derived from Genesis 1:30: "And to every beast of the of the earth, and to every fowl of the air, and to every thing that creepeth upon the earth, wherein there is life, I have given every green herb for meat." This is the passage that AIG Director Ken Ham uses in his lecture to "prove" that *Tyrranosaurus rex* was a plant-eater (*See Skip Evans's "Creationism: A trip to the dark side"* RNCSE *1998 Mar/Apr;18[2]: 22-2*). If abandoning the scientific evidence in favor of a 6000-year-old scriptural account doesn't constitute being influenced by "pre-conceived ideas", I don't know what does.

In the end, however, these students really came through and performed as AIG said they *ought* to—forming their conclusions on the basis of the evidence and not on "pre-conceived ideas". I couldn't have written a more appropriate and challenging final exam.

Acknowledgments

Special thanks to the students in my spring 1998 Animal Biology class at Madison Area Technical College. Without them, this outcome would not have been possible, but most of all, thanks for proving that you were learning something about the process of science as well as the data.

References

AIG Tools for Teachers Website, <http://www.answersingenesis.org/Webman/Article.asp?Old=camskull.html> last accessed Dec 29 1998.

Petto AJ, Petto SG. Portfolio assessment from the fine arts to the sciences:The 'Feldman' 4-part analysis. Uncensored Community College List (UCC-L) Resources Page, <http://www.taft.cc.ca.us/tclists/resources/portfolios.html> last accessed Oct 1998.

Stewart J, Jungck J. Problem-posing, problem-solving, and persuasion in biological investigations. *BioQUEST Library*. Beloit (WI): BioQuest Curriculum Consortium, 1995.

A Camel Skull!!!

How can a camel skull be used in the ministry?

Take a look at the following three overheads. I think you will see how we can use even a camel skull to show that our pre-conceived ideas will influence how we see the world around us. Remember when you use these the audience will not know (usually) that it is a camel skull.

1. First show this graphic and have the audience give you feedback. ... Was this animal a flesh-eater, omnivore etc. Point out the "sharp teeth", what would this animal have used these teeth for?

2.Then show this next graphic. This is a drawing made showing what one person (the artist) thought the animal may have looked like.

3. Lastly, show this graphic of what the animal really was. Even though something has sharp teeth it doesn't necessarily "prove" that it ate meat.

In the same way we have to have all of the information before we can know what happened in the past. Only God was there in the beginning and has told us what has happened. We have to trust Him when it comes to issues such as the origin of man, earth, the universe etc. These issues are outside of the realm of science and cannot be "proven". I hope these help!

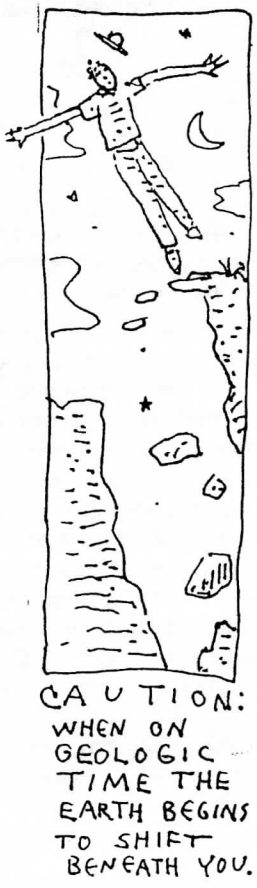
<http://www.answersingenesis.org/Webman/Article.asp?Old=camskull.html>

From the pages of ...

The March-April 1999 issue of *American Scientist* has an article by Ross Hardison (Department of Biochemistry & Molecular Biology, Pennsylvania State U) entitled "The Evolution of Hemoglobin" (p 126-36). Though still very much in its infancy, this sort of research on the evolution of biomolecules continues to progress and to answer Michael Behe's challenge about the supposed irreducible complexity of functional molecules.

The same issue has an interesting article by Michael C Corballis entitled "The Gestural Origins of Language". He makes the case that human language may have evolved from manual gestures. There is also a long review of Dawkins's *Unweaving the Rainbow* and a short review of Werner R Loewenstein's *The Touchstone of Life: Molecular Information, Cell Communication, and the Foundations of Life*.

[*Contributed by Robert Pennock.*]

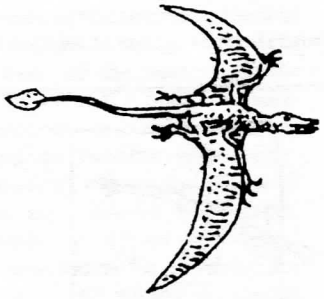


BOOKS FROM NCSE
SPECIAL 30% DISCOUNT

EVERYTHING EVOLUTIONARY!

Last Chance: One-of-a-Kind Specials!

NCSE's close-out of books in stock is in the final stretch. This means that most of the books on our shelves are going out of stock and others are rising in price. We will continue to offer specially selected books on science and evolution with a member discount of 20%, but every book you see listed in this issue is one-of-a-kind, offered on a first-come, first-serve basis ... and at a special 30% discount. Hurry! This is the last time we can offer these tremendous bargains.



Without Miracles: Universal Selection Theory and the Second Darwinian Revolution
by Gary Cziko.

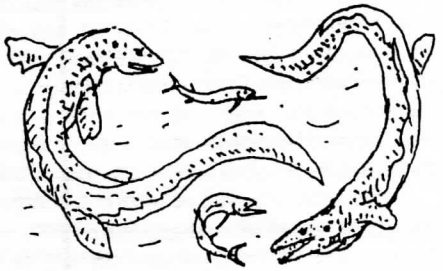
In the same spirit as Daniel Dennett's *Darwin's Dangerous Idea*, Cziko presents a universal selection theory that attempts to account for all novel instances of adapted complexity. He extends the evolutionary process of cumulative blind variation and selection to many areas—not only in biology, but complex ideas and scientific theories as well. See a sample of this most stimulating book at <http://www.ed.uiuc.edu/people/gac/without_miracles>. 385 pages, hardback. *List price $30, special discount price $21.00.*

The Science of Jurassic Park and the Lost World, or How to Build a Dinosaur
by Rob DeSalle and David Lindley.

An American Museum of Natural History curator and a *Science News* editor team up to analyze the accurate and the inaccurate in the two dinosaur blockbusters. How large would a real Jurassic Park have to be, given what we know of the ecological requirements of dinosaurs? What do you need to do to get a dinosaur from an amber-encased mosquito meal? This is a fun book, engagingly written but not skimping on the science. A must for dino fans and nit-pickers everywhere Cloth, 193 pages. *List price $18.00, special discount price $12.00.*

The Miner's Canary: Unraveling the Mysteries of Extinction
by Niles Eldredge.

Eldredge asks, "Can we pinpoint what causes extinction without human intervention, then see what happens when we add humans to the mix?" This book offers some answers in this outline of a "general theory of extinction". Praised by EO Wilson as the "best account to date" comparing the extinctions occurring in the modern world to extinctions of the past. Cloth, 246 pages. *List price $20.00, special discount price $14.00.*



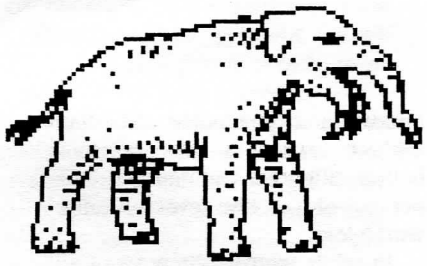
The Creationist Movement in Modern America
by Raymond A Eve and Frances B Harrold.

An illuminating analysis of "scientific creationism" as a social movement—its history, tactics, ideology, and where it's likely to go next. A must-read for anyone who wants to understand why this movement continues to attract followers at the end of the 20th century. Paper, 234 pages. *List price $11.95, special discount price $8.35.*

Getting Here: The Story of Human Evolution
by William Howells.
The "dean of American physical anthropology" reviews the path of human evolution in his usual conversational style. An excellent introduction to the topic, authoritative yet clear and understandable. Paper, illustrated, 261 pages. *List price $19.95, special discount price $14.00.*

Human Evolution: An Introduction
by Roger Lewin.
In this third edition, Lewin presents human evolution in the context of the behavioral ecology of a large-bodied, large-brained mammal. He discusses how developments in the study of life history theory and ecological influences on social structure can help us understand extinct species. Paper, large format, 216 pages. *List price $26.95, special discount price $18.85.*

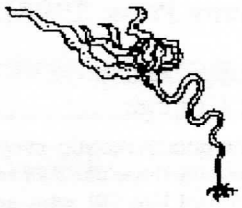
The Meaning of Evolution
by Robert J Richards.
What did *Darwin* mean by the word "evolution"? Richards explores the question as he discusses the evolution of the "meaning of evolution" in the history of ideas and the development of Charles Darwin's thinking. Cloth, 205 pages. *List price $10.95, special discount price $7.65.*



Man and Beast Revisited
Michael H Robinson and Lionel Tiger (editors).
Papers from a Smithsonian-sponsored symposium comparing human and animal behavior, and the relationships between animals and humans. Sections include "The Cosmic Setting for Man and Beast"; "The Evolution of Man and Beast"; "Social Behavior"; "Communication, Consciousness, and Intelligence"; "The Man and Beast Interface: Networking with Animals"; "Have Man and the Beasts a Future?". An introduction by the editors compares changes in substance and theme between this 1995 symposium and the "Man and Beast" symposium of 1969. Paper, 386 pages. *List price $17.95, special discount price $12.55.*

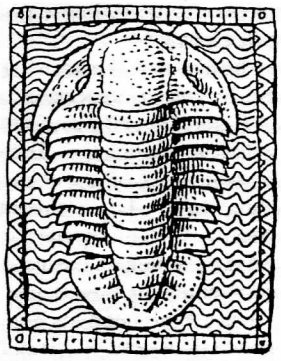
Shadows of Forgotten Ancestors
by Carl Sagan and Ann Druyan.

Sagan and Druyan turn from studying the cosmos to an attempt to understand some of its inhabitants—us! They discuss human evolutionary history and its shaping of "who we are" in an attempt to answer dilemmas facing us in the modern world. Cloth, 505 pages. *List price $23.00, special discount price $16.10.*



The Best of The Journal of Irreproducible Results
by George H Scherr (editor).

Bring down the Ivory Tower in a fit of laughter! Over 90 selections from the journal that parodies academic research journals, with topics like "Golf and the Poo Muscle" and "Prenatal Psychoanalysis." Paper, large format, 194 pages. *List price $12.95, special discount price $9.00.*



The Science Book
by Sara Stein.

Sara Stein says, "This has been the hardest book that I have ever written... because ... every time I thought I had an answer, I found another question.... [N]ow I realize that's the way writing a science book ought to be." The fun is infectious in a book that your child will enjoy for a long time, reading in short spurts and returning to sip and savor discoveries about "Outsides" (pets, pests, people), "Insides" (what we find under the skin and under the microscope), and "Invisibles" (senses, behavior). Just right for grades 5-7, and the young at heart. Paper, illustrated, 285 pages. *List price $9.95, special discount price $6.95.*

The Diversity of Life
by EO Wilson.

The "dean of biodiversity studies" takes us through the 5 great extinctions of the last 600 million years. Then he presents evidence that the 6th, human-made one, is taking place right now. Written in Wilson's usual beautiful style. Cloth, 424 pages. *List price $29.95, special discount price $21.00.*

The NCSE book catalog is online at <http://www.natcenscied.org/dbooks.htm>. Order books or request copies of the catalog by calling (800)290-6006.

ORDER FORM NCSE PO Box 9477, Berkeley CA 94709-0477

Name

Address

City State Zip

Home Phone Work Phone

METHOD OF PAYMENT

☐ Check (U.S. Dollars) Made payable to NCSE

Charge to ☐ VISA ☐ Mastercard Name as it appears on card

Credit Card Number Exp Date Signature

QUANTITY	DESCRIPTION			PRICE
			SUBTOTAL	
SHIPPING				
Books		each	$2.00	
Cassettes, transcripts, diskettes		1-3	$1.25	
		4-5	$1.75	
		6+	$2.00	
CA residents add 8.25% tax				
Foreign Orders: We will invoice shipping costs			SUBTOTAL	
			TOTAL	

FEATURE

Of Gods and Gaps: Intelligent Design and Darwinian Evolution

Review Essay of Darwin's Black Box: The Biochemical Challenge to Evolution, by Michael J Behe (The Free Press, 1996); *Defeating Darwinism by Opening Minds* by Phillip E Johnson (InterVarsity Press, 1997); and *The Creation Hypothesis: Scientific Evidence for an Intelligent Designer*. JP Moreland, ed. (InterVarsity Press, 1993).

Edward B Davis
Messiah College

"The time has come," the lawyer said,
"To talk of many things,
Of Gods, and gaps, and miracles,
Of lots of missing links,
And why we can't be Darwinists,
And whether matter thinks."
—with apologies to Lewis Carroll

In 1874, 15 years after Charles Darwin published *On the Origin of Species*, the great Princeton theologian Charles Hodge replied with his own book, *What Is Darwinism?* An astute critic of the theory as Darwin himself defined it, Hodge went right to the heart of the matter. Darwin had proposed that a blind, purposeless process—natural selection, operating on random variations—had produced the myriad forms of life that now inhabit our planet. "The denial of design in nature," Hodge concluded, "is virtually the denial of God." Although Hodge noted that Darwin might personally believe in a creator, who had in the distant past "called matter and a living germ into existence," God had "then abandoned the universe to itself to be controlled by chance and necessity, without any purpose on his part as to the result, or any intervention or guidance." Such a God was "virtually consigned, so far as we are concerned, to non-existence." Thus Darwinism was "virtually atheistical."

In the century and a quarter since Hodge leveled his pen at the offending theory, plenty of Christians have come to terms with evolution by placing it within a different metaphysical framework. There are multiple ways in which the settlement has been negotiated.

Edward B Davis is professor of the history of science at Messiah College in Grantham, Pennsylvania.

Many contemporary theistic evolutionists, especially those like Richard Bube or Howard Van Till who are theologically moderate to conservative, have endorsed either the separation model of science and theology or a more nuanced version of it called the complementarity model. On either view, science deals with mechanism and material reality ("how") and is complete in its own domain or at its own level, while theology deals with meaning and spiritual reality ("why"), which are in another domain or on another level. This approach is best summed up in the famous phrase that Galileo borrowed from Cardinal Baronio, "The Bible tells how to go to heaven, not how the heavens go."

More integrative models are employed by others, including a number of more liberal Protestants such as Ian Barbour and Arthur Peacocke. Adherents of these models typically decry the intellectual schizophrenia of the separation model and the theological insulation of the complementarity model, proclaiming instead the need for a genuine conversation between theology and modern science that shapes both enterprises. But much of the conversation is dominated by one side: many leading advocates of integration are process theologians or panentheists who call for doctrinal reformulation in light of modern scientific knowledge, but do not intend to call on scientists to reformulate their theories in light of theology. Indeed, none of these views proposes what we might call a *Christian* science, in which Christian beliefs influence the actual content of scientific theories, so that the rules of science might be different for Christians than for non-Christians. Rather they represent various Christian *views* of science in which the rules of science *qua* science are assumed to be the same for all scientists in a particular discipline without regard to their religious beliefs; differences among positions occur only at the level of one's worldview.

In other words, adherents of all of these views accept methodological naturalism (MN)—the tenet that scientific explanations of phenomena always ought to involve natural causes which are usually understood as mechanistic causes operating without any intelligence or purpose apparent within the phenomena themselves. Whether or not any intelligence or purpose has been imposed upon natural processes from the outside is a separate question that science alone is not competent to answer, though scientific knowledge may have some influence on the kinds of answers one might offer. Science is seen as religiously neutral; evidence for or against theism has to be found elsewhere. From this perspective, Hodge's response to Darwin's theory was mistaken because it failed to distinguish between the purposelessness of scientific mechanisms which by assumption have no minds of their own, and ultimate purposelessness at the level of worldview.

The three books reviewed here represent a strong dissenting voice from the terms of this settlement. The authors understand Darwinism just as Hodge did: a God who is not involved in obvious, highly visible, scientifically detectable ways with the creation of the world and human beings is no God at all. Rejecting the assumption that naturalistic science is religiously neutral, they seek to construct an evidentialist apologetic for the truth of Christian theism, based partly on the perceived deficiencies of Darwinian evolution. Although certain elements of their position may warrant further consideration, on

the whole I find it neither very convincing nor particularly original.

The Dissenters

Leading the prosecution of evolution is Phillip Johnson, professor of law at the University of California and author of *Darwin on Trial* (1991) — a lawyer's brief arguing that the evidence for full-blown evolution from non-living matter to human beings is greatly overstated. Although I don't accept this conclusion, it is a clearly argued, stimulating book that has elicited grudging admiration from a number of evolutionists, including Cornell biologist William A Provine, an atheist who has debated Johnson and invited him into his classroom to argue the case against Darwin. The fact that Provine and Johnson agree that evolution is atheism cannot be overlooked, and I will return to this point later. For the moment, however, I want to focus our attention on the main idea presented in these three books—a highly sophisticated form of anti-evolutionism called "intelligent design" theory (ID).

The essence of ID and the motivation behind it are clearly explained in Johnson's latest book, *Defeating Darwinism*. Theistic evolution, he argues, is a "much-too-easy solution" that "rests on a misunderstanding of what contemporary scientists mean by the word *evolution*" (emphasis in the original). Following scientists like Provine and Cambridge biologist Richard Dawkins, Johnson defines evolution as "an unguided and mindless process" that admits no possibility of being a divine work, implying that "our existence is therefore a fluke rather than a planned outcome." To prevent students from being indoctrinated with this type of irreligion, Johnson offers his readers a primer on thinking critically about evolution and a brief account of ID. The latter is essentially the opposite of the strong biological reductionism associated with Dawkins, according to which (in Johnson's accurate description) "everything, including our minds, can be 'reduced' to its material base." For Johnson, matter is preceded both ontologically and chronologically by intelligence, in the form of the information necessary to organize it into living things, and this is "an entirely different kind of stuff from the physical medium (for example, DNA) in which it may temporarily be recorded."

A principal goal of the ID movement is to convince working scientists that information cannot and does not spring from matter which they understand as brute and inert. This is essentially the same dualistic conception of matter that was shared by the founders of mechanistic science in the 17th century, such as René Descartes, Robert Boyle, and Isaac Newton. However, although the mind/matter distinction remains philosophically problematic and some types of dualism may be possible to defend, most contemporary scientists (including most Christian scientists) no longer hold to this type of dualism even if they retain the mechanistic science to which it was once linked. The same is true of many contemporary theologians—especially those committed to panentheism and/or process theology. They generally hold a more active view of matter and its capabilities—either that matter itself can think or at least that cognition arises out of it in some naturalistic manner yet to be determined. This is one important reason why adherents of the ID program are facing an uphill climb. They don't really confront the fact that the philosophical landscape has changed, and they fail to engage those Christian thinkers who recognize this.

Irreducible Complexity

Hardly one to be discouraged by steep slopes, however, Johnson bases his case substantially on Michael Behe's notion of "irreducible complexity"—the idea that certain parts of living organisms are so complex and composed of so many separate parts that cannot function properly on their own that we cannot account for them in a reductionistic fashion, as merely the products of blind selection. Rather we are forced to invoke a *deus ex machina* who assembled the parts supernaturally according to a preconceived design. Johnson uses this strong form of the teleological argument to challenge both materialism and naturalism. He calls his strategy "the wedge" and sees his own books as its "sharp edge" opening a crack in scientific materialism that can be widened by others, especially Behe.

A biochemist at Lehigh University, Behe is not a creationist in the sense in which that word is most often (ab)used today. For example, he believes the earth is billions of years old, which self-styled "scientific creationists" deny, and that natural selection (NS) can account for much of life's diversity, which even an old-earth creationist like Johnson probably does not accept (if so, he is awfully quiet about it). What NS cannot explain, in Behe's opinion, is how the original building blocks of living things were formed. *Darwin's Black Box* is a detailed study of certain biochemical machines in humans and other organisms, aimed at realizing one of Darwin's worst nightmares.

In *On the Origin of Species* Darwin had worried that the origin of complex organs, such as the eye, would prove very difficult to explain using the gradual, stepwise process required by his theory. The best he could do was to speculate that complex eyes might have developed somehow from simple, light-sensitive cells that could give a competitive advantage to an organism that possessed them. But the molecular biology of vision, as Behe notes, was a "black box" to Darwin.

Darwin and his contemporaries took the simplicity of cells for granted, treating them as black boxes that needed no further explanation. Now that we know how complex even the "simplest" cells actually are, Behe argues, we can no longer ignore the question of how they originated, nor can we deny the lack of progress in answering that question scientifically within a Darwinian paradigm. Examining every issue of the *Journal of Molecular Evolution* (a top journal in its field) since it began in 1971, Behe could not find even one article that "has ever proposed a detailed model by which a complex biochemical system might have been produced in a gradual, step-by-step Darwinian fashion." This he takes as "a very strong indication that Darwinism is an inadequate framework for understanding the origin of complex biochemical systems."

Although reviewers in scientific journals have generally been highly critical of Behe, they have not agreed with one another on the accuracy of his assessment of the state of the literature. While some critics deny his claim, others, such as biochemist James Shapiro of the University of Chicago, think that Behe has his finger on a real unsolved problem in evolutionary theory—a problem that invites novel approaches, but certainly not the invocation of an intelligent designer which would be to give up hope of a "scientific" (read, "naturalistic") solution. Still others, such as Notre Dame philosopher of science Ernan McMullin, argue perceptively that Behe's proposed solution is itself just another "black box", for the appeal to ID slams the door on further inquiry at the level of secondary causes, denying in principle

our ability to learn how irreducibly complex structures were assembled. Van Till takes this point further, noting that we should be careful to distinguish between the claim that the world is a product of creative intelligence (a belief he shares with the ID camp) and the additional claim, implicit within the ID position, that certain products of that intelligence could not have been assembled naturalistically.

Behe realizes that it will be difficult for most scientists to give ID fair consideration, mainly for philosophical (rather than purely scientific) reasons. The scientific community, he notes, is not only committed to MN, which rules out *a priori* any appeal to design, but in addition "many important and well-respected scientists, just don't want there to be anything beyond nature." He is right about the convictions of many scientists and the way in which this can bias their response to ID—one cannot challenge the operative rule of MN without simultaneously challenging the worldview of philosophical materialism—but this point can be stressed only by overlooking many other scientists (including most Christian scientists) who accept MN while rejecting its extrapolation into a larger worldview.

Theistic Science

In the highly charged atmosphere that results from excluding the middle ground, the ID challenge will inevitably be perceived as ideologically motivated with the unfortunate result that often more heat than light will be generated. This can only be encouraged by the highly apologetic thrust of certain essays in *The Creation Hypothesis* edited by Biola University philosopher JP Moreland. Consider for example just the title of the essay by Canadian astrophysicist Hugh Ross, head of Reasons to Believe, a Pasadena-based ministry specializing in apologetics: "Astronomical Evidences for a Personal, Transcendent God"; or the title of Moreland's own essay: "Theistic Science & Methodological Naturalism" which he posits as competing alternatives. The latter distinction has elsewhere been drawn even more starkly by Johnson who likes to refer to MN as "methodological atheism" and to label Christian scientists who defend it as "mushy accommodationists". This can hardly be described as a helpful approach — a fact that a rhetorician of Johnson's stature ought to appreciate.

Theistic science, as Moreland defines it, claims that God "has through direct, primary agent causation and indirect, secondary causation created and designed the world for a purpose and has directly intervened in the course of its development at various times" including "history prior to the arrival of human beings". Primary causes are further defined as "God's unusual way of operating; they involve his direct, discontinuous, miraculous actions," whereas "secondary causes are God's normal way of operating". Either way, Moreland stresses, "God is constantly active in the world, but his activity takes on different forms". In spite of this clear affirmation that God is never absent or inactive in the creation (and similar statements by others), the ID program is widely viewed as being committed to a "God-of-the-gaps" (GG) in which (as Dietrich Bonhoeffer noted with objections) God is invoked only when natural explanations fail and God disappears from view when previously unexplained phenomena are given natural explanations. This is a serious charge that warrants a fuller examination than I can provide here, but something at least needs to be said to prevent a misunderstanding.

It is important to distinguish between a GG theology and a GG strategy. As we noted above, advocates of ID believe that God is active always and everywhere in a variety of ways, including (for the most part) working through natural processes. It is both inaccurate and unfair to call this a GG theology—which is in my view a form of deism — simply because they believe that God sometimes acts in ways that cannot be described naturalistically. On the other hand, they believe that such extraordinary divine activity must be postulated as a scientific explanation to account for certain phenomena when MN fails, and that the failure of MN itself provides one of the strongest arguments available for the existence of God. This is, in my opinion, properly described as a GG strategy, though it is not based on a GG theology.

Johnson and Behe also employ a GG strategy, since they argue apologetically from gaps in our knowledge of nature to gaps in the actual processes of nature from which the necessity to invoke an agent outside of nature is inferred. However—and this is not a trivial point—it is not a simple form of the GG argument; as with other ID arguments, it is quite sophisticated (which sharply distinguishes their approach, in my view, from that of garden variety creationism). To justify an appeal to divine causation of a particular complex entity, the argument goes, one needs to show not only the *absence* of any plausible naturalistic explanation, but also the *presence* of irreducible complexity, which suggests that no naturalistic explanation can be found. Many complex features are not classified as *irreducibly* complex, but some are, including several of those discussed in Behe's book.

A weak form of the ID program, without the strong apologetic component, has been suggested by others, such as Messiah College philosopher Robin Collins. On this view, the ID hypothesis warrants due consideration, not for what it denies (the adequacy of Darwinism)—although pointing out the inadequacies of a received theory is a necessary part of an argument for an alternative—but for what it affirms—that some real causes might not be purely mechanistic—and for the possibility that a research program that looks in non-mechanistic directions might ultimately be successful. It is true that some very interesting and fruitful science has been done by great scientists who did not assume that all causes must be mechanistic. For example, Leibniz called Newtonian gravitation a "perpetual miracle" because Newton offered no mechanical explanation for it; and Kepler hypothesized that the orbital radii of the planets could be found from the assumption that God used the 5 Platonic solids as "archetypal causes" in laying out the dimensions of the solar system.

For ID to fit this category, however, it will be necessary for its advocates to spell out much more clearly just what an ID account of the origin of biological diversity would look like, and how this would actually further scientific inquiry rather than hinder it. I remain skeptical that this will happen, but the movement is still in its infancy and some of the very bright people associated with it may in time prove me wrong; certainly they will try to.

Intelligent Design as Special Creationism

Despite the desire by some in the ID movement to have potentially enlightening discussions of very interesting philosophical and scientific questions, thus far ID appears to be little more than a highly sophisticated form of special creationism, usually accompanied by strong

apologetic overtones that tend to keep the debate at the ideological level. All too frequently science becomes a weapon in culture wars, denying in practice the clean theoretical distinction between science and religion that is otherwise widely proclaimed. As Provine put it in a recent public statement, "evolution is the greatest engine of atheism ever invented".

Johnson's audience would be much smaller if scientists like Provine and Dawkins did not make it so easy for him to equate evolution and MN with atheism. But in fact they do speak for a good number of scientists (not to mention other academics) who like to project the public image of science as a highly secular, rational enterprise that challenges or flatly contradicts religious interpretations of reality. Because this image flies in the face of a highly religious American public, anti-evolutionism will not go away any time soon, whether or not Johnson and his associates convince many scientists to adopt their program.

No single solution is likely to satisfy all parties. My own view is that we could go a long way toward correcting the excesses of the Johnsons and the Provines if public education were more genuinely pluralistic, that is, pluralistic in a philosophical and religious sense in addition to other types of pluralism. As long as public education essentially ignores the religious values of many families and pretends to remain neutral toward religion while actually promoting secularism, many religious people will feel disenfranchised.

Johnson is keenly aware of this; indeed, he is at his best when he decries what he elsewhere calls "scientific fundamentalism"—the tendency of scientific materialists to monopolize the conversation about science in public schools. A key chapter in *Defeating Darwinism* analyzes the Hollywood classic Inherit the Wind—a profoundly unhistorical film based on a McCarthy-era play that depicts the Scopes trial as the triumph of academic freedom (personified by Spencer Tracy as Clarence Darrow) over an ignorant, intolerant fundamentalism (personified by Frederic March as William Jennings Bryan). Johnson calls attention to the moment when Tracy warns March not to deny others freedom of thought, supposing for March's consideration that there may come a time when a law would be passed "that only Darwin should be taught in the schools!"

But this, as Johnson tells us with considerable accuracy,

> is exactly what happened later. The real story of the Scopes trial is that the stereotype it promoted helped the Darwinists capture the power of the law, and they have since used the law to prevent other people from thinking independently. By labeling any fundamental dissent from Darwinism as "religion" Darwinists are able to ban criticism of the official evolution story from public education far more effectively than the teaching of evolution was banned from Tennessee schools in the 1920s.

What Johnson wants most is for Americans to think more critically about evolution—and also about tough religious questions such as the problem of evil. He is right to link these issues. The teaching of evolution should be coupled with serious discussions both of its perceived religious implications and of various ways in which religious thinkers have responded to it—highly inclusive, controversial conversations that public schools seem unable to undertake, given the prevailing interpretation of the anti-establishment clause of the First Amendment. All told, the efforts of an accomplished legal theorist like Johnson might be better directed toward persuading his colleagues to reconsider their interpretation of the Constitution, rather than toward criticizing the basic tenets of what most scientists rightly regard as a well-supported theory of the origin of biological diversity.

[*A shorter version of this essay was published in* The Christian Century *1998 July 15-22; 115(20): 678-81. Portions reprinted with permission of The Christian Century Foundation, Inc. All rights reserved.*]

BOOKREVIEW

Cataclysm! Compelling Evidence of a Cosmic Catastrophe in 9500 BC

by DS Allan and JB Delair. Santa FE (NM): Bear and Company Publishing, 1997. 372 pages, $20 Paperback.

Reviewed by Dan Phelps, Kentucky Paleontological Society, Lexington KY.

Cataclysm! is advertised in *Geotimes* and elsewhere as a book which "calls into question many current geological theories." My curiosity piqued, I decided to obtain a copy of this book to see if it was a book of scientific merit. Unfortunately this volume turned out to be one of a genre of literature that mimics science but ignores the scientific method to draw exciting but untenable conclusions. These books are often wonderfully crafted; capable of tricking very intelligent people. *Cataclysm!* is riddled with flawed logic and pseudoscience. It is impossible to mention all the ignored data, incorrect information, and outright deception in a short review, but a brief summary will provide an adequate characterization.

Allan and Delair ignore much of the geomorphologic evidence for ice ages. Entire fields of study such as lake sediment cores and deep sea floor drilling are left out of consideration or barely mentioned. Ice core drilling in the major ice caps is ignored except to claim that cores from Greenland go back only 10 000 years. The famous Vostok core of Eastern Antarctica, which shows a continuous record of the last

160 000 years of the earth's climatic history, is not mentioned at all. Drilling was completed on this core in the early 1980s, and it is one of the most discussed pieces of evidence for the earth's climatic history in the Late Pleistocene. Since *Cataclysm!* was published in 1997, one would think there would be some reference to this important location. Other important evidence for ice ages such as glacial rebound are also ignored. Perhaps most amazing is that glacial features such as fjords are attributed to faulting (p 35).

Throughout the book Allan and Delair provide numerous references for their claims, but many of their references date to the turn of the century or even earlier. The reader is not told of much more recent writings on the subjects under consideration. Similar treatment is given to plate tectonics and continental drift. The authors only mention papers published before the mid-1970s, when the idea was still being debated. More recent works on tectonics—a large field of geology in which thousands of articles are published yearly — are ignored by Allan and Delair.

Questionable data are often presented as if factual. For example the Cleavers skull hoax is presented as factual, even though its fraudulent nature is well known. Figure 6.3 illustrates what is purported to be a metal chain preserved in sedimentary rock. Most geologists would consider this object to be a concretion that only superficially resembles a chain.

However there are even more disturbing examples of outright lying in *Cataclysm!* The authors deny that polishing and striations on rocks are evidence of glaciating, claiming that similar striations exist on rocks blasted by volcanic ash from Mt Pele. They do not explain or even acknowledge that most examples of rock with glacial striations and polishing show no evidence of volcanic activity. The most outrageous case of outright deception is the claim that the glacial grooves from Peru are "fault-grooves". Similar glacial grooves can be found in the vicinity of the Great Lakes, a long distance from any major faulting.

Allan and Delair misrepresent both the age and the preservation of the frozen mammoths of Siberia and Alaska. They claim that all the carcasses are about 11 500 years old and display "virtually unimpaired" flesh. The reality is that the frozen mammoths date to two periods of time, one ranging from 45 000 to 30 000 years ago and another from 14 000 to 11 000 years ago (Sutcliffe 1985; Guthrie 1990). The flesh on frozen mammoths has undergone a desiccation process similar to freezer burn; the term "frozen mummies" is more appropriate (Guthrie 1990; Lister and Bahn 1994).

Other examples of egregious "science" used by Allan and Delair include a sudden detachment and shifting of the earth's crust — and the sudden relocation of tropical and arctic habitats—which they confuse with the precession of the earth's axis (Chapter 9). Again using older literature, Allan and Delair claim that cave deposits show a mixing of tropical and glacial animal and plant remains. More recent science reveals that these deposits are not mixed, but represent both glacial and warm interglacial periods in distinct layers.

Large portions of *Cataclysm!* are devoted to symbolically interpreting ancient myths and legends as evidence of extraterrestrial catastrophes. Such claims can only be subjective, and thus are not really evidence for anything but the authors' fertile imaginations. Besides picking and choosing evidence from geology and paleontology to support their dubious thesis, Allan and Delair apply similar methods to astronomy.

Cataclysm! assigns the origin of asteroids and meteorites to an exploded planet between Mars and Jupiter. This idea has not been widely accepted since the 1960s. Predictably, Allan and Delair only cite the older literature, ignoring the last 30 years of research. Their thesis seems to be that the Vela supernova of 11 500 years ago shot a planet-size body into our solar system creating various catastrophes and accounting for almost every anomaly of planetary astronomy. Since the remnants of the Vela supernova are about 1300 light years away, to arrive so soon after the supernova this planet-sized object would have had to travel at incredible speed (about one-ninth the speed of light or more than 7.5 million miles or 12 million kilometers per hour). Allan and Delair fail to ask how much energy would be required to accomplish this voyage.

Amusingly, Allan and Delair illustrate an ancient Babylonian cylinder seal (p 220) and interpret the various dots on it as different planets and the asteroid Chiron. One of the dots is claimed to be Uranus (almost invisible without binoculars). Another is claimed to be Neptune (invisible without a telescope). Chiron is extremely faint; it was discovered by astronomers using photographs in 1977. Apparently the Babylonians had excellent eyesight.

Figure 4.13 (p 228) summarizes Allan and Delair's odd thesis. The entire solar system is shown, but unfortunately not to its true scale. The figure depicts planetary pinball as the authors envision the story with most of the planets lined up on one side of the sun so the planetary body from Vela can do its damage. A diagram of the solar system at its true scale would impress upon the reader how unlikely this tale of cosmic catastrophism would be.

Modern geology is willing to accept catastrophic events when the evidence is good. Efforts such as this appalling book are not taken seriously because the authors take a pick-and-choose attitude to the data, playing fast and loose with evidence. *Caveat emptor!*

References Cited

Allan DS Delair JB. *Cataclysm! Compelling Evidence of a Cosmic Catastrophe in 9500 BC.* Santa Fe (NM): Bear and Co, 1997.

Guthrie RD. *Frozen Fauna of the Mammoth Steppe: The Story of Blue Babe.* Chicago: University of Chicago Press, 1990.

Lister A, Bahn P. *Mammoths.* New York: Macmillan, 1994.

Sutcliffe A. *On the Track of Ice Age Mammals.* Cambridge (MA): Harvard University Press, 1985.

[This review is a modified version of a review in the Newsletter of the Kentucky Paleontological Society *1998 Mar; 6[3]. It is reprinted with permission.]*

BOOKREVIEW

The Trouble with Science

by Robin Dunbar. Cambridge: Harvard University Press, 1997.

Reviewed by Eugenie C Scott, NCSE Executive Director, PO Box 9477, Berkeley CA 94709-0477.

Try this: There are 4 cards on a table, one with a letter "A", one with a letter "D", one with numeral "3", and one with numeral "6". The rule says that all vowels have an even number on their backs. What card(s) would you have to turn over to see if this rule is true?

If you're like me (and the family members I asked, and the majority of the thousands who have been tested with this standard test over the years), you did *not* answer correctly, which would be to turn over the "A" and the "3".

Now try this: There are 4 people drinking at a bar. One is drinking beer, one is drinking soda, one is 16, and one is 24. The rule is that only people over 21 can drink alcohol. What would you have to do to test this rule? If you're like me, (and those same thousands of others) you correctly answered "ask the beer drinker how old he is, and check the drink of the 16-year old." And if you are like the rest of us, you answered this question much more quickly than you answered the structurally-identical card question.

The reason we did better on this question, according to Robin Dunbar, is part of *The Trouble with Science*: we have been naturally selected as social primates for the ability to solve social problems quickly and correctly, whereas there has not been any great need during most of our evolution for us to be able to solve problems in symbolic logic. Unfortunately, science, among other things, requires an ability to use logic and think systematically about the natural world—something we are not especially well-wired to do. As a result, many people find science too difficult, and/or incomprehensible, while in academia, there exists an anti-science movement among postmodernists that views science as negative and even "corrosive". On top of it all, science education is failing to produce either a sufficient number of future scientists or a scientifically-literate general public. Not an encouraging situation.

There is a huge gap between scientists and laypeople, and yet Dunbar argues that the *method* of science is a modification of simple learning, a systematization of trial and error and a natural propensity that we (and primates and even some nonprimate mammals) possess to categorize and order experience to make sense of the natural world in which we live. In an engaging chapter, "The Roots of Science", Dunbar argues that there is evidence that rats and other mammals store knowledge as simple causal hypotheses, which allows for the formation of simple inference. But even if the process of science is ultimately graspable, many times the explanations or theories of science are nonintuitive and far from the experiences of average individuals. This is particularly true of scientific disciplines as they become more mathematized (and consequently more rigorous.) Physics after Newton's *Principia* became incomprehensible to the lay reader, as was evolutionary biology after Fisher. When one is dealing with matters for which everyday experience and language do not prepare us, one is almost forced to resort to metaphor. Dunbar insightfully points out that the two scientific fields that seem to specialize in communicating by metaphor are the two that are farthest removed from everyday experience: particle physics and evolutionary biology. So we have the playfulness of "flavors" of "quarks" such as "charm", or "Red Queen Effects" and "Selfish Genes".

I think that every science class should provide for a discussion of the nature of science, and *The Trouble with Science* would be an excellent choice for a short textbook on this subject. In conversational, well-illustrated prose, Dunbar takes the reader through a discussion of what science is (as opposed to what the public thinks it is) and how it works, weaving in just enough history of the philosophy of science to be illustrative without bogging down.

We get a clear treatment of Popperian falsification, and Dunbar is especially good at explaining why anti-rationalists like Kuhn and Feyerabend are off track. He describes with ethnographic examples how empirical science in its basic form is universal among all human societies and also the features that make science a successful way of knowing. But part of the "trouble with science" is that the public thinks science is something other than what scientists think it is. In addition, science is also "unnatural": more developed, logical, and mathematical elements of explanatory science (as opposed to "cookbook" empirical science) are hard to grasp. And it doesn't help that nonscientists, eager for the latest cure and/or technological fix, find frustrating and inexplicable scientists' willingness to suspend judgment before concluding that something has been explained.

Dunbar is especially good at defending science from its postmodern critics and writes with feeling for the potential of science to solve precisely the problems of the environment, sex, race, and class that critics of science often lay at its feet. He approvingly quotes Andrew Collier: "To vote for relinquishing human power over nature through science is to vote for the permanent oppression of some people by others." He argues that science succeeds partly because it is unfettered—not because it is a tool of oppression wielded by masters of society, as postmodernists claim. In two cases when science was indeed restricted by societal/power requirements, it foundered: the tragedy of Soviet Lysenkoist genetics and the death of 12th century Arabic science. In the latter case, the progress in learning achieved by Arab astronomers and mathematicians ground to a halt when the necessary ability to seek where the data led conflicted with strictures of Islam that anything important was already available in the Koran. His concluding comments on the need for revamping science education are more appropriate to the British system than the current American situation except for the mutual need to have well-trained, highly-motivated, inspiring teachers. That's a universal!

[*This review appeared originally in* Isis 89:(3):585-586 *and is reprinted with permission.*]

BOOKREVIEW

Survival of the Fittest

by Jonathan Kellerman. NY: Bantam, 1998. 519p, Paper.

Esau

by Philip Kerr. NY: Pocket Books, 1997. 403p, paper.

Reviewed by John R Cole, Contributing Editor.

Evolution and related issues have been grist for novelists since Darwin first wrote. Two recent best sellers are notable in their continuation of the tradition of pop/pulp Darwin fiction, and each illustrates a different species of pitfall. Kellerman's book is the better read, although Kerr is considered by many to be the better author based on his earlier books.

Esau stars a Berkeley physical anthropologist who is up for tenure in the coming spring and needs to publish something. Therefore, she mounts an expedition to the Himalayas to search for "Abominable Snowmen" where her mountain-climber boyfriend found a skull he brought her as a souvenir. With secret help from the CIA she gets a National Geographic Society grant, and skullduggery ensues, including much academic infighting.

Survival of the Fittest is a murder mystery starring amateur sleuth Alex Delaware, an LA child psychologist, who discovers a series of apparently random killings linked by the fact that the victims are variously disabled. With help from a Mossad detective and a gay LA cop, he infiltrates a high-IQ club devoted to eugenics which he suspects may be behind the murders.

Kellerman includes a chapter outlining what his protagonist discovers about how IQ testing is linked to the early eugenics movement. (One review I read said to skip this boring chapter, but it is the heart of the book!) He also finds that there is a mysterious foundation endowed by funds from an old agricultural fortune behind modern racist eugenics—a thinly disguised portrait of the real Pioneer Foundation, funded by Pioneer Hybrid Seed Company. This fictional funder supports books which sound exactly like *The Bell Curve,* and, apparently, murder as well. (The real Pioneer Foundation did not fund the real book or any murders.)

It seems very odd that a supposedly eminent psychologist would know nothing about the history of IQ testing, but I suppose his "discovering" it brings out the information less pedantically than would pure exposition.The author is not really arguing that murder is justified by evolutionary theory, although the bad guys use "survival of the fittest" to justify homicide and genocide. And conversely, one can be both a critic of IQ testing and a card-carrying evolutionist.

Kellerman leaves it up to the reader to know this, however, because, far from having an expository chapter explaining how evolution—or Darwinism—does not justify murder or eugenics, the book has a frequent tinge of the false dichotomy of "caring humanism vs cold, cruel science". Still, it's one of the better entries in Kellerman's series of Alex Delaware mystery/thrillers.

Kerr's book is harder to summarize or critique because it is so gaudy in its errors. It is very "pro-evolution" and has a creationist villain, not just an evolutionist heroine; it even suggests further readings such as Roger Lewin's *Bones of Contention* and books by Leakey, Johanson, Ian Tattersall, Dian Fossey, Carl Sagan, Jared Diamond, and so on. Unfortunately, although Kerr learned all sorts of facts to give his tale touches of realism, he imbedded them in various howlingly unrealistic scenes and subplots.

What could be a good, if farfetched, science fiction novel about the discovery of living *Gigantopithecus*-like Yetis is constantly subverted by a nearly complete ignorance of the *nature* of the paleontological issues and how scholars approach them. He drops in a funny line about Berkeley anthropology's not being the same since (NCSE member) Vince Sarich took early retirement or dialogue about the Johanson-Leakey rivalry/feud which he has borrowed from Roger Lewin—but his heroine's world is completely unreal.

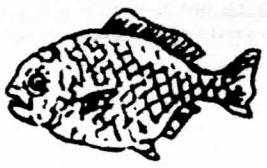
A professor does not get a grant at Christmas for research to justify a favorable tenure decision in the following May; a many-year pattern of scholarship is evaluated, not a sort of vacation project. And grant-writing, let alone *getting* a grant, takes many months, not a weekend. The National Geographic Society does not secretly funnel Pentagon or CIA money to researchers; a radiocarbon lab does not date a sample in an afternoon (nor would radiocarbon be the dating technique for the average hominid fossil); it takes time to acquire and prepare statistical samples (which would be submitted to multiple labs if the bone was considered revolutionary); and other techniques would be employed for anything suspected of being over 40 000 years in age. And surely even a very dull physical

anthropologist handed a fresh *Gigantopithecus* skull would be able to draw a few immediate conclusions (I'll note that, so far, only teeth have been found for this extinct ape).

The quick expedition to find what no one else ever has would be hopeless, as depicted, and I doubt if a major co-investigator would be an advocate of the notion that aboriginal Australians have evolved separately from the rest of humanity. And so it goes with so many of the details that were added for the sake of realism making the tale more and more unrealistic. Anthropology just is not depicted at all accurately when the "realistic" bits are added together.

As is so often the case, actually knowing something about a novel's subject can sour one's appreciation of the book. Why do so many authors seem compelled to get it wrong in order to sell the book? Look at Agatha Christie's archeology-themed books, which give us little clue that she spent her life married to a renowned archeologist; or the current mysteries by Sharyn McCrumb which dumb down her real training in anthropology. The *practice* of science nearly always comes off poorly in popular fiction, even when writers get specific facts right, even when they themselves are or were scholars. The general world of scholarship seems even more elusive, which is all the more depressing when one recalls that nearly all writers have attended college! Novelists seem never to have attended college—or noticed what professors actually do. Police have similar complaints about mystery and crime fiction, I know, but fewer writers have ever been cops than have been college students!

So, in this case, a slightly anti-evolution murder mystery comes across much better than an even better-researched "evolution thriller". Both incorporate a lot of real science, but both create a very unrealistic picture of the nature of evolution and its students.



Letter to the Editor

I am afraid I must disagree with Dr Eugenie Scott's assessment (*RNCSE* 18[2]: 24) that the questions in a Gallup poll about Americans' belief in evolution "are quite straightforward, well-designed to reveal people's attitudes towards evolution." Personally, I would not want to have to choose between Gallup's questions 2 and 3: that "God guided the process" of evolution, or that "God had no part in this process." To gain any real insight into people's beliefs, pollsters (and those who interpret their results) will have to develop a much more sophisticated grasp of the nuances of the philosophical and theological positions they are trying to study.

Specifically, the statement that God "guided" evolution could mean a range of things, from constant direct tinkering with the process to a more subtle and mysterious technique of "attracting", "inviting", or "persuading" creatures to evolve to more derived states (these terms have in fact been used by various writers). "Intelligent-design" quasi-creationists like Michael Behe would embrace the former position. However, the latter view is sufficiently vague and nonempirical that it would not necessarily be unacceptable (on a theological level) even to some strictly Darwinian theistic evolutionists, as long as it was not used to explain specific observable phenomena.

Likewise, to say that "God had no part" in evolution could be construed to rule out even the minimal divine roles of initial creation and immanent sustaining of the physical universe. Except for this, I might be most comfortable with this answer as expressing my belief that God does not micromanage the evolutionary process. But if I did choose answer 3, I would be tallied incorrectly as a nontheistic evolutionist. On the other hand, answer 2 would lump me with Behe and others whom NCSE rightly regards as outside the orthodox evolutionist fold.

My point is that nontheistic evolutionists tend to underestimate the diversity, complexity, and sophistication of the religious views that people actually hold. The Gallup poll's crude categories are not adequate to meaningfully analyze this spectrum of belief. The best contemporary theologians, in a variety of faith traditions, are far more knowledgeable about science today than most scientists are about current theological thinking. It's the latter who need to do some catching up in order to contribute to the dialog!

Daryl P Domning
Professor of Anatomy
Howard University
Washington DC

RECAPITULATIONS

[*In the inaugural issue of* RNCSE's *new format we published Ken Nahigian's impressions of a lecure presented by Dr Hugh Ross. In that note, Nahigian mentioned Ross's inclusion of research done by Dr Hubert Yockey. In this issue we present Yockey's response to the article and the issues raised in it followed by Nahigian's reply.*]

Hubert Yockey Responds

It is a favorite tactic of creationists to tilt, edit, and distort scientific evidence in support of evolution to give the false impression that there are serious scientific difficulties. This tactic is rare in *RNCSE* but Nahigian's recent article on Dr Hugh Ross seems to counter this trend. (Nahigian 1997). On page 28, he made the following remarks:

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

Although close reading shows that Nahigian is quoting Ross, this is not obvious to the speed reader. My religious beliefs are none of anyone's business. I have never identified myself with regard to religion. I made my views on the relationship between science and religion clear in *Information Theory and Molecular Biology* (Yockey 1992, p 29, 288, 336, 340). I have never suggested that "[i]ntelligent design is needed." May I point out that *Creation/Evolution* published a piece in which I discussed my views on the origin of life (Yockey 1986). At the bottom of page 44 I wrote: "Reference to divine intervention lies outside the domain of science." Furthermore, I did not *admit* anything. My conclusions on the origin of life were the result of sophisticated calculations based on information theory in molecular biology. In science we must accept the result of our investigations whether we like them or not.

Nahigian follows this discussion with a distorted summary of my work based on an equally distorted chapter by Russell F Doolittle in *Scientists Confront Creationism*. Among the blunders in this piece, which Nahigian attributes to Doolittle, is:

> Yockey started with the goal of filling one specific biochemical "niche"—that of the ubiquitous cytochrome c enzyme, then assumed, in effect, that only one polypeptide sequence could perform that function. This is like calculating the odds against a golf ball's landing on a specific blade of grass, then concluding: "Golf is impossible"." I don't know the "odds" [*sic*] of a golf ball's landing on a specific blade of grass but I suggest that it is much more than 10^{93}. Professional golfers and even duffers occasionally score a hole-in-one.

I did not "assume" anything. In fact I showed that there are not one, but 2.316×10^{93} possible cytochrome c sequences that differ by at least one amino acid residue. All such cytochrome c sequences play the same role in the metabolism of the cell. Other important enzymes have many forms that differ at some sites in the sequence without changing the specificity of the enzyme. Some changes in the amino acid at a given site may reduce the effectiveness of the protein. For example, sickle cell anemia is caused by the replacement of glutamic acid by valine at site 6 on the beta chain of hemoglobin. Of course, at the conserved sites an enzyme loses all activity by any change.

Nahigian then further compounds his errors in molecular biology by carrying on with a wild speculation about how "The ancestor of cytochrome c probably was only 20-30 amino acids long." For this to be the case, extant cytochrome c would have had to increase its size. If this occurred by duplication then there should be structural similarities in the molecule. The structure of cytochrome c (and many other proteins) is known by X-ray diffraction. Like most proteins, cytochrome c is modular with more than one domain, however, there is no resemblance between the domains of cytochrome c to indicate that they occurred by duplication.

RNCSE is not the proper venue to discuss the mathematics of probability theory or molecular biology. Those who wish to pursue those subjects may wish to read my book *Information Theory and Molecular Biology* where I discussed my calculations on cytochrome c and other proteins. The point of my papers is to show that, however life appeared on earth, it did not appear by chance polymerization of amino acids to make proteins in a primeval soup. I do not draw the conclusion that "intelligent design is needed".

Technical issues and Nahigian's ignorance of this subject aside, the issue bearing on Nahigian's paper is the distortion of the material in my original publications that he undoubtedly has never read.

References Cited

Doolittle RF. Probability and the origin of life. In: Godfrey LR, ed. *Scientists Confront Creationism*. New York, WW Norton & Company, 1983. pp 85-97.

Nahigian K. An evening with Hugh Ross. *Reports of the National Center for Science Education* 1997 Jan/Feb; 17 (1): 27-9.

Yockey HP. Materialist origin of life scenarios and creationism. *Creation/Evolution* 1986 nr 18; 6(1): 43-5.

Yockey HP. *Information Theory and Molecular Biology*. Cambridge (UK): Cambridge University Press, 1992.

Hubert P Yockey
1507 Balmoral Drive
Bel Air MD 21014-5638

KEN NAHIGIAN REPLIES

Hubert P Yockey's kind letter has cleared up some misunderstandings and raised up others. I'm grateful for the former. Yes, the bit about his being an atheist was from Dr Ross, not me—though I disagree that it took much close reading to see that. That the italicized paragraphs were impressions culled from Ross's talk was, I thought, fairly clear.

And, yes, Yockey's private religious sentiments are none of my business. We agree that the concept of God is quite outside the boundaries of science. So good, so far. Since Yockey feels maligned by a mischaracterization of his religious sentiments, I encourage him to redirect the issue to Ross, who certainly has much wider venues than the NCSE. I think we would both like to see him correct this factoid in future talks.

Yockey poked some fun at my quick-and-dirty golf game analogy, and again he was right—the odds against a ball's landing on one particular blade of grass are dwarfed by his computed odds of 10^{-91} of the "from-scratch" formation of a modern cytrochrome c enzyme. But most golf games don't consist of a single stroke. More like a hundred, (a lot more if you play the way I do). So count the blades on your favorite course, and raise that number to the hundredth power. Now we have an idea of the odds against a particular game's turning out exactly the way it does. I'll bet they leave Yockey's odds in the dust.

Are golf games impossible? Of course not. The reason is that a golf game allows considerable variation in just where the ball lands at each stroke. Likewise, in the suspect sentences of my very informal "Impressions" piece, my point was that there might have been a bit more variation in the ancestral amino residues than Yockey allows (at least as Ross represented him as allowing). The presentation placed an arbitrary constraint on our hypothetical ancestor enzyme by requiring it to be in the same catalytic league as modern forms. Relax that constraint, I suggested, and the probability shifts just a bit in evolution's favor.

Carried away by the analogy, I quipped that Yockey had "assumed *in effect* that only one polypeptide sequence could perform the function" of ancestral cytochrome c (emphasis added). This hyperbole obviously left a bad taste with him, and I apologize. Yes, he does allow some variation—a lot, in fact—but many orders of magnitude less than what is possible if we loosen the constraint, and over 90 orders of magnitude less than the probability space of all possible sequences!

But if I understand Yockey (let me underscore the *if* because some of his reasoning is murky to this layman), cytochrome c could not possibly have had humbler, less catalytic roots, because its unique structure rules out the possibility of domain duplication. However, other forms of variation/selection seem possible.

For example, it could have evolved from a more primitive heme-carrying protein that diversified into the cytochromes, the globins (myo- and hemo-) and the chlorophylls. The characteristic domain structure could have arisen later as a result of mutations in the genome. But what about the heme group itself? This simple heart of the enzyme contains a single atom of iron surrounded by pyrrole rings, acting as an electron donor/acceptor in oxidative processes in the cell. Obviously cytochrome c would not do much for the cell without it. And in fact, there is remarkable consistency among species in the residues of this region of the enzyme, suggesting that any variation might be lethal.

Is this "irreducible complexity", proving at last that some structures are beyond evolutionary development? Actually, no. Look to creatures such as protozoa and photosynthetic bacteria, and you'll find significant residue variance even here, showing some paths are still open to selection and change. For that matter, nor is cytochrome c, in any form, *essential* to life. Many anaerobic bacteria (the *Clostridia*) get on quite well without it. So a robust web of life could have developed without cytochrome c about 2 billion years ago, affording it the opportunity to evolve at leisure, by whatever means. Of course it is nearly impossible to retrace exactly the evolutionary path taken by cytochrome c or any enzyme—in part because enzymes do not fossilize.

But let us not assume we need to know everything before we can know anything. A mere century ago, scientists had not reproduced a single biochemical reaction. Now we observe weak enzymatic activity in the laboratory, created by reproducing pre-biotic structures (Sidney Fox's protocells, for example); and even weak catalytic ability might give a lipid globule a competitive edge in the primeval "soup". So it seems hasty to dismiss *out of hand* the possibility that cumulative selection, a tremendously powerful process, might eventually produce more complex, effective enzymes—which was what Ross seemed to do in his original talk.

That was my point. If this is "wild speculation", it is just the kind of speculation that is intrinsic to hypothesis formation and part of the background music of science. With due respect, I would like better reasons before closing the door on all possibility of naturalistic origins, for cytochrome c, or for life itself.

[*Many thanks to Kevin O'Brien of Colorado State University and Dr Russ Doolittle of UC/San Diego for help with technical details above.*]

Kenneth E Nahigian
2411 Tyrolean Way
SACRAMENTO CA 95821-4809

nahigian.ken@email.mcclellan.af.mil

ODDS AND PROBABILITIES

Odds and *Probabilities* are often used interchangeably in discussions of the likelihood that some event will occur. This is because they are different ways to express similar concepts and because one can be calculated from the other. However, the *probability* of an event's occurring is expressed as the proportion of all events which will produce the desired result. On the other hand, *odds* are expressed as a ratio of the desired result compared to some undesirable event. In a flip of a coin, the *probability* of tossing "heads" is 0.5, and the *odds* are 1:1.

[*Excerpted from a discussion in Phillips LD.* Bayesian Statistics for Social Scientists. *London: Thomas Nelson and Sons LTD, 1973.*]

RESOURCES

[In this issue we begin listing the bibliographic resources provided by NCSE Supporter Frank Sonleitner under 4 broad categories to help our readers locate items of interest more readily. We hope that this presentation makes this resource more useful. Ed.]

GEOLOGY AND PALEONTOLOGY

Agnew N, Demas M. Preserving the Laetoli footprints. *Scientific American* 1998 Sep; 279(3): 44-55.

Anonymous. These butts were made for walking. *Discover* 1998 Nov; 19(11): 32. Role of the *gluteus maximus* in human walking.

Anonymous. A bellyful of jaws. *Discover* 1998; 19(11): 36.

See also: Sato T, Tanabe K. Cretaceous plesiosaurs ate ammonites. *Nature* 1998 Aug 13; 394: 629-30. Discovery of new plesiosaur fossil with stomach full of ammonites.

Anonymous. A million-year-old relative. *Discover* 1998 Sep; 19(9): 26. A new 1-million-year-old human skull from Eritrea with a blend of *Homo erectus* and *H sapiens* features.

Anonymous. Saurian sore. *Discover* 1998 Oct; 19(10): 26. Evidence of bone tumors in dinosaur skeleton.

Anonymous. Ordure of magnitude *Discover* 1998 Oct; 19(10): 32. The discovery of a large dinosaur coprolite.

Anonymous. Fossil flies. *Discover* 1998 Aug; 19(8): 33. 145-million-year-old flies from China may indicate earlier evolution of flowering plants.

Anonymous. Turtle tears. *Discover* 1998 Aug; 19(8): 28. The oldest known sea turtle is found in 110-million-year-old strata.

Anonymous. A new *T rex* cousin. *Discover* 1998 Aug; 19(8): 22. A 70-million-year-old carnivorous dinosaur from Madagascar.

Anonymous. A billion years of stability. *Discover* 1998 Sep; 19(9): 19. Discovery of a long stable period in the Precambrian before the evolution of eukaryotes.

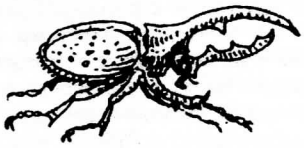
Anonymous. Old Gobi bird. *Discover* 1998 Sep; 19(9): 20. A new Cretaceous bird from Asia.

Bower B. Ancient fire use flickers inside cave. *Science News* 1998 Jul 11; 154(2): 22.

See also: Weiner S, Xu Q, Goldberg P, Liu J, Bar-Yosef O. Evidence for the use of fire at Zhoukoudian, China. *Science* 1998 Jul 10; 281: 251-3; Wuethrich B. Geological analysis damps ancient Chinese fires. *Science* 1998 Jul 10; 281: 165-6; Wheeler DL. 'Earliest campfire' now placed in doubt. *The Chronicle of Higher Education* 1998 Jul 17; XLIV(45): A22. No controlled use of fire found at a prominent *Homo erectus* site.

Brainard J. Giving Neandertals their due. *Science News* 1998 Aug 1; 154(5): 72-4.

See also: Bahn PG. Neanderthals emancipated. *Nature* 1998 Aug 20; 394: 719-21. *Current Anthropology* 1998 Jun; 39: Supplement. A special issue on the Neanderthal problem. dealing with modern human-like features of Neandertals.



Brown KS. Tracking vanishing mammals and elusive Nitrogen. *Science* 1998 Aug 28; 281: 1274-5. Explaining Miocene mammal extinctions through vegetation changes.

Chiappe LM. Wings over Spain. *Natural History* 1998 Sep; 107(7): 30-3. Early Cretaceous bird fossils from Spain.

Copley J. Nearly out of Africa. *New Scientist* 1998 Oct 10; 160 (2155): 12.

See also: Anonymous. The ancient tomb of a young child. *Discover* 1998 Nov; 19(11): 28; Bower B. Ancient child's burial on the Nile. *Science News* 1998 Oct 10; 154(15): 235. A child's skeleton 80 000 years old found in the Nile valley of southern Egypt.

Erdmann MV, Caldwell RL, Moosa MK. Indonesian 'king of the sea' discovered. *Nature* 1998 Sep 24; 395: 335.

See also: Forey P. A home away from home for coelacanths. *Nature* 1998 Sep 24; 395: 319-20; Milius S. Second group of living fossils reported. *Science News* 1998 Sep 26; 154(13): 196; McDonald KA. 'Living fossil' found in Indonesian waters. *The Chronicle of Higher Education* 1998 Oct 2; XLV(6): A21. Coelacanths have been reported in Indonesia.

Gibbons A. New study points to Eurasian ape as great ape ancestor. *Science* 1998 Jul 31; 281: 622-3.

Johnson KR. Moon over Chicxulub: Will night finally fall on the dinosaur-extinction debate? *American Scientist* 1998 Nov-Dec; 86(6): 568-71. Book review of: Powell JL. *Night Comes to the Cretaceous: Dinosaur Extinction and the Transformation of Modern Geology*. Freeman, 1998.

Kerr RA. Did an ancient deep freeze nearly doom life? *Science* 1998 Aug 28; 281: 1259-61.

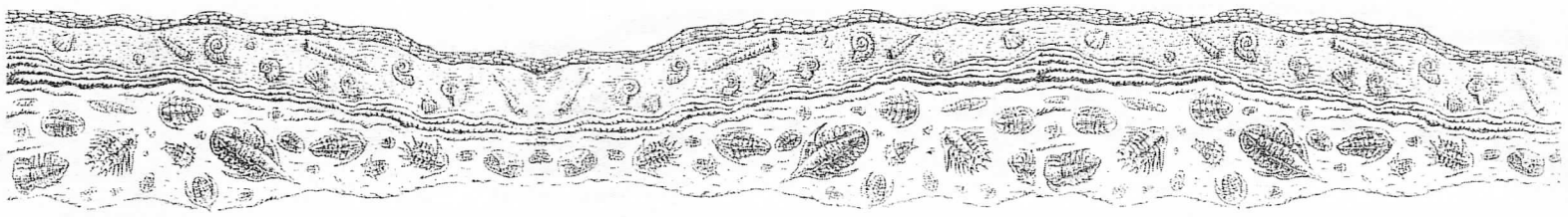
See also: Monastersky R. Popsicle planet. *Science News* 1998 Aug 29; 154(9): 137-9; Hoffman PF, Kaufman AJ, Halverson GP, Schrag DP. A neoproterozoic snowball earth. *Science* 1998 Aug 28; 281: 1342-6. Evidence for global glaciation.

Lincoln T. Lucy takes a stroll. *Nature* 1998 Jul 23; 394: 325.

See also: Anonymous. Ambling Australopithecine. *Discover* 1998 Nov; 19(11): 32. Computer simulations indicate that *Australopithecus afarensis* walked erect like modern humans.

Lincoln T. Ancient Australian arthropods. *Nature* 1998 Jul 9; 394: 127.

See also: Edgecombe GD. Devonian terrestrial arthropods from Gondwana. *Nature* 1998 Jul 9; 394: 172-5.



McMenamin MAS. *The Garden of Ediacara. Discovering the First Complex Life*. New York: Columbia University Press, 1998. Detailed review of our knowledge and interpretations of the Precambrian Ediacaran fossils.

Moldowan JM, Talyzina NM. Biogeochemical evidence for dinoflagellate ancestors in the early Cambrian. *Science* 1998 Aug 21; 281: 1168-70. Dinoflagellate fossils earlier than common finds in the Triassic.

Monastersky R. Climate did in giant Mongolian mammals. *Science News* 1998 Aug 1; 154(6): 95.

See also: Meng J, McKenna MC. Faunal turnovers of Palaeogene mammals from the Mongolian Plateau. *Nature* 1998 Jul 23; 394: 364-7; Hartenberger J-L. An Asian Grande Coupure. *Nature* 1998 Jul 23; 394: 321.

Monastersky R. Attacking an enigma with engineering. *Science News* 1998 Aug 8; 154(6): 95. Models of Ediacaran *Dickinsonia* indicate it must have been denser than worms or protoplasm.

Monastersky R. Wyoming wonder: Tiniest mammal ever? *Science News* 1998 Oct 17; 154(16): 255. Mammal jaw from Eocene belonged to individual weighing only 1.3 grams.

Monastersky R. Paleoscatology: Prying DNA from dated dung. *Science News* 1998 Jul 18; 154(3): 38.

See also: Poinar HN, Hofreiter M, Spaulding WG, Martin PS, Stankiewicz BA, Bland H, Evershed RP, Possnert G, Pääbo S. Molecular Coproscopy: Dung and diet of the extinct ground sloth *Nothrotheriops shastensis*. *Science* 1998 Jul 17; 281: 402-6; Stokstad E. A fruitful scoop for ancient DNA. *Science* 1998 Jul 17; 281: 319-20; DNA from this excrement is used to identify the plants eaten by the sloth.

Morris SC. *The Crucible of Creation. The Burgess Shale and the Rise of Animals*. Oxford: Oxford University Press, 1988. Morris's latest interpretations of this unique faunal assemblage.

Normile D. New views of the origins of mammals. *Science* 1998 Aug 7; 281: 774-5. Report of a July symposium on the Tertiary radiation and the evolution of whales.

See also Monastersky R. Fossil jaw tells tale of whale evolution. *Science News* 1998 Oct 10; 154(15): 229. Perhaps older than *Pachycetus*, this animal was marine.

Orr PJ, Briggs DEG, Kearns SL. Cambrian Burgess Shale animals replicated in clay minerals. *Science* 1998 Aug 21; 281: 1173-5. How these animals came to be preserved as fossils.

Seilacher A, Bose PK, Pfluger F. Triploblastic animals more than 1 billion tears ago: Trace fossil evidence from India. *Science* 1998 Oct 2; 282: 80-3.

See also: Kerr RA. Track of billion-year old animals? *Science* 1998; 282 Oct 2: 19-21; Azmi RJ. Fossil discoveries in India [letter]. *Science* 1998 Oct 23; 282: 627; Kerr RA. Fossils challenge age of billion-year-old animals. *Science* 1998 Oct 23; 282: 601; Monastersky R. Questions raised about oldest animal. *Science News* 1998 Oct 17; 154(16): 255; Hecht J. Worms dig holes in evolutionary ideas. *New Scientist* 1998 Oct 10; 160(2155): 6; Kerr RA. Earliest animals old once more? *Science* 1998 Nov 6; 282: 1020; Gould SJ. On embryos and ancestors. *Natural History* 1998 Jul/Aug; 107(6): 20-2, 58-65. Comments on the recent discovery of triploblastic embryo fossils from the Precambrian and controversy over very old worm burrows from the Precambrian.

Stokstad E. Young dinos grew up fast. *Science* 1998 Oct 23; 282: 603-4. Microscopic studies of dinosaur bone indicate sauropods grew to maturity in 8 to 11 years.

Swartz S. Into Jurassic air. *Science* 1998; 281: 355-356. (17 July.) Review of Shipman P. *Taking Wing: Archaeopteryx and the Evolution of Bird Flight*. New York: Simon and Schuster, 1998.

Ward PD. The Greenhouse extinction. *Discover* 1998 Aug; 19(8): 54-8. Evidence of the Permian extinction in the mammal-like reptiles of the Karoo.

Life Science and Ecology

Anonymous. The Ur-plant. *Discover* 1998 Nov; 19(11): 26.

See also: Qiu Y-L, Cho Y, Cox JC, Palmer JD. The gain of three mitochondrial introns identifies liverworts as the earliest land plants. *Nature* 1998 Aug 13; 394: 671-4. Evidence from molecular biology points to the liverworts as the ancestors of land plants.

Bower B. Asian DNA enters human origins fray. *Science News* 1998 Oct 3; 154: 212.

See also: Chu JY, Huang W, Kuang SQ, Want JM, Xu JJ, Chu ZT, Yang QY, Lin KQ, Li P, Wu M, Geng ZC, Tan CC, Du RF, Jin L. Genetic relationship of populations in China. *Proceedings of the National Academy of Sciences* 1998 Sep 29; 95(20): 11763-8; Cavalli-Sforza LL. The Chinese Human Genome Diversity Project. *Proceedings of the National Academy of Sciences* 1998 Sep 29; 95(20): 11501-3. A genetic analysis of a large sample of Chinese citizens indicates that modern humans originating in Africa migrated across Asia in a SE direction before heading north into China.

Cartmill M. The gift of gab. *Discover* 1998 Nov; 19(11): 56-64. The origin of language in humans.

Gibbons A. Which of our genes make us human? *Science* 1998 Sep 4; 281: 1432-4.

See also: Leigh SR. Chimp research [letter]. *Science* 1998 Oct 2; 282: 47; Chou H-H, Takematsu H, Diaz S, Iber J, Nickerson E, Wright KL, Muchmore EA, Nelson DL, Warren ST, Varki A. A mutation in human CMP-sialic acid hydroxylase occurred after the *Homo-Pan* divergence. *Proceedings of the National Academy of Sciences* 1998 Sep 29; 95(20): 11751-6.

Martini FH. Secrets of the slime hag. *Scientific American* 1998 Oct; 279(3): 70-5. Biology of the deep-sea hagfish, a primitive jawless vertebrate.

Meinke DW, Cherry JM, Dean C, Rounsley SD, Koornneef M. *Arabidopsis thaliana*: A model plant for genome analysis. *Science* 1998 Oct 23; 282: 662-81. A report on the progress in sequencing the *Arabidopsis* genome.

Milius S. Why guys get fancy. *Science News* 1998 Aug 29; 154(9): 140-1.

See also: Arnqvist G. Comparative evidence for the evolution of genitalia by sexual selection. *Nature* 1998 Jun 25; 393: 784-6; Gwynne DT. Genitally does it. *Nature* 1998 Jun 25; 393: 734-5.

Morell V. Earth's unbounded beetlemania explained. *Science* 1998 Jul 24; 281: 501-2.

See also: Farrell BD. "Inordinate fondness" explained: Why are there so many beetles? *Science* 1998 Jul 24; 281: 555-9. Investigates the role of angiosperms in the diversification of phytophagous beetles.

Pennisi E. How the genome readies itself for evolution. *Science* 1998 Aug 21; 281: 1131-4. New evidence for how genomes can change.

Seppa N. Researchers solve syphilis genome. *Science News* 1998 Aug 1; 154(5): 79.

See also: Fraser CM, Norris SJ, Weinstock GM, White O, Sutton GG, Dodson R, Gwinn M, Hickey EK, and others. Complete genome sequence of *Treponema pallidum*, the syphilis spirochaete. *Science* 1998 Jul 17; 281: 375-88; Pennisi E. Genome reveals wiles and weak points of syphilis. *Science* 1998 Jul 17; 281: 324-5; Vogel G. Tracking the history of the genetic code. *Science* 1998 Jul 17; 281: 329-31. Computer analyses and RNA experiments offer new insight into the forces that shaped the genetic code.

Stokes MD, Holland ND. The lancet. *American Scientist* 1998 Nov-Dec; 86(6): 552-60. The role of *Amphioxus* in vertebrate phylogeny.

Svitil KA. Life on ice. *Discover* 1998 Oct; 19(10): 38.

See also: Milius S. Looking for life in all the worst places. *Science News* 1998 Jul 11; 154(2): 27. Details of microbes living in Antarctic ice.

Travis J. Dialing up an embryo. *Science News* 1998 Aug 15; 154(7): 106-7.

See also: Dreyer WJ. The area code hypothesis revisited: Olfactory receptors and other related transmembrane receptors may function as the last digits in a cell surface code for assembling embryos. *Proceedings of the National Academy of Sciences* 1998; 95(16): 9072-7. Olfactory proteins also have role in organizing embryonic cells.

Turilli M. The causes of Haldane's Rule. *Science* 1998 Oct 30; 282: 889-91.

See also: Presgraves DC, Orr HA. Haldane's Rule in taxa lacking a hemizygous X. *Science* 1998 Oct 30; 282: 952-3. Investigating the causes of Haldane's Rule which says that in a species-hybrid cross, if one sex is absent, rare or sterile, it is the sex with two different sex chromosomes.

Vogel G. Doubled genes may explain fish diversity. *Science* 1998 Aug 21; 281: 1119-21. The zebrafish apparently has 7 *Hox* gene clusters.

Zimmer C. Into the night. *Discover* 1998 Nov; 19(11): 102-15. Bats and their evolution.

Space and Planetary Science

Anonymous. Other worlds, other oceans. *Discover* 1998 Sep; 19(9): 20. Evidence that Callisto, another Jovian moon, may harbor an ocean beneath its ice.

Irion R. Did twisty starlight set stage for life? *Science* 1998 July 31; 281: 626-7.

See also: Bailey J, Chrysostomou A, Hough JH, Gledhill TM, McCall A, Clark S, Ménard F, Tamura M. Circular polarization in star-formation regions: Implications for biomolecular homochirality. *Science* 1998 Jul 31; 281: 672-4; Schneider D. Polarized life. *Scientific American* 1998 Oct; 279(3): 24; Cowen R. Starlight shows life the right path. *Science News* 1998 Aug 1; 154(5): 68; McDonald KA. Mystery of left-handed amino acids is probed. *The Chronicle of Higher Education* 1998 Aug 14; XLIV(49): A17; Hecht J. Inner circles. *New Scientist* 1998 Aug 8; 159(2146): 11; Green MM, Selinger JV. Cosmic chirality (letter.) *Science* 1998 Oct 30; 282: 880-1. Polarized light in space may affect the directional orientation (chirality) of organic compounds.

Kent DV. Impacts on earth in the late Triassic. *Nature* 1998 Sept 10; 395: 126.

See also: Spray JG, Kelley SP, Rowley DB. Evidence for a late Triassic multiple impact event on earth. *Nature* 1998 Mar 12; 393: 171-3; Anonymous. Chain of craters. *Discover* 1998 Aug; 19(8): 29; Melosh HJ. Craters unchained. *Nature* 1998 Jul 16; 394: 221-3. A chain of craters 214 million years old may have caused the end-Triassic mass extinction.

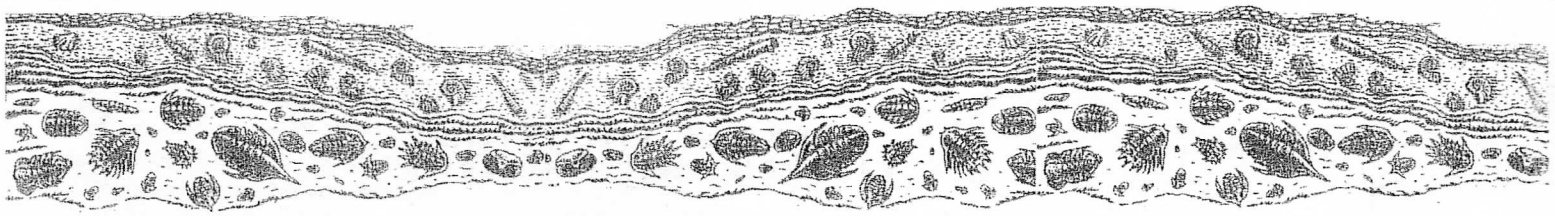
Leutwyler K. New planet. *Scientific American* 1998 Aug; 279(2): 22.

See also: Anonymous. Planet poseur? *Discover* 1998 Aug; 19(8): 24. First image of a planet outside our solar system.

Musser G. The flip side of the universe. *Scientific American* 1998 Sep; 279(3): 22. New cosmological observations confirm inflation.

Other Related Topics

Arthur W. *The Origin of Animal Body Plans. A Study in Evolutionary Developmental Biology*. Cambridge: The Cambridge University Press, 1997. An up-to-date review of how changes in developmental systems produced the many animal body plans.



Bardeen MG, Lederman LM. Coherence in science education. *Science* 1998 Jul 10; 281: 178-9.

See also: Kennedy D. Helping schools to teach evolution. *The Chronicle of Higher Education* 1998 Aug 7; XLIV(48): A48; Letters. *The Chronicle of Higher Education* 1998 Sep 18; XLV(4): B3, B12; Mervis J. US tried variations on high school curriculum. *Science* 1998 July 10; 281: 161-3. A proposal to improve science education.

Behe MJ, Sander K, Bender R. Embryology and evolution [letters]. *Science* 1998 Jul 17; 281: 348-9.

See also: Richardson MK. Haeckel's embryos, continued [letter]. *Science* 1998 Aug 28; 281: 1289. More letters concerning MK Richardson's study of Haeckel's "fraud".

Brainard J. What was life's first sunblock? *Science News* 1998 Jul 11; 154(2): 31.

See also: Cleaves HJ, Miller SL. Oceanic protection of prebiotic organic compounds from UV radiation. *Proceedings of the National Academy of Sciences* 1998 Jun 23; 95(13): 7260-3. Tar-like compounds in primeval ocean could screen out UV light.

Bull J, Wichman H. A revolution in evolution. *Science* 1998 Sep 25; 281: 1959. Editorial on the importance of evolutionary biology today.

Davis EB. A God who does not itemize versus a Science of the sacred. *American Scientist* 1998 Nov-Dec; 86(6): 572-4.

See also: Richardson WM. A skeptic's sense of wonder. *Science* 1998 Sep 25; 281: 1969-70. Book reviews of Polkinghorne J. *Belief in God in an Age of Science*, Yale University Press, 1998, and Raymo C. *Skeptics and True Believers: The Exhilarating Connection between Science and Religion*, Walker and Co, 1998.

Denton MJ. *Nature's Destiny. How the laws of biology reveal purpose in the universe*. New York: The Free Press, 1998. The author of *Evolution: A Theory in Crisis* explores the thesis that the universe is uniquely fit for life as it exists on earth and that this life was produced by evolution governed by basic natural laws leading to an inevitable outcome. In contrast to Gould, who would argue that the course of evolution is heavily contingent, Denton says that contingency plays a minor role. Even if life exists on other planets in the galaxy, it will be carbon-based life, and given the opportunity, will eventually produce intelligent humanoid forms (*see review in* RNCSE *1998; 18[2]: 10)* .

Gibbs WW. Beyond physics. *Scientific American* 1998 Aug; 279(2): 20-2. Report on a conference at the University of California at Berkeley on God and Science.

Hines P, Culotta E. The evolution of sex. *Science* 1998 Sep 25; 281: 1979. An article introducing a special section containing eight articles on sex in evolution.

See also: Barton NH, Charlesworth B. Why sex and recombination? *Science* 1998 Sep 25; 281: 1986-90; Wuethrich B. Why sex? Putting theory to the test. *Science* 1998 Sep 25; 281: 1980-2.

Lee MSY. Similarity, parsimony and conjecture of homology: The chelonian shoulder girdle revisited. *Journal of Evolutionary Biology* 1998 May; 11: 379-87. An example of how a homology is recognized.

Pinker S. Still stimulating after all these years. *Science* 1998 Jul 24; 281: 522-3. Review of Darwin C. *The Expressions of the Emotions in Man and Animals*. New York: Oxford University Press, 1998.

Schimmel P, Alexander R. All you need is RNA. *Science* 1998 Jul 31; 281: 658-9.

See also: Nitta I, Kamada Y, Noda H, Ueda T, Watanabe K. Reconstitution of peptide bond formation with *Escherischia coli* 23S ribosomal RNA domains. *Science* 1998 Jul 31; 281: 666-9. Peptide bond formation with RNA only.

Stephens RS, Kalman S, Lammel C, Fan J, Marathe R, Aravind L, Mitchell W, Olinger L, Tatusov RL, Zhao Q, Koonin EV, Davisthers RW. Genome sequence of an obligate intracellular pathogen of humans, *Chlamydia trachomatis*. *Science* 1998 Oct 23; 282: 754-9.

See also: Hatch T. *Chlamydia*: Old ideas crushed, new mysteries bared. *Science* 1998 Oct 23; 282: 638-9.

Strauss E. How embryos shape up. *Science* 1998 Jul 10; 281: 166-7. Report on a developmental biology conference held at Stanford University in June.

Travis J. The bacteria in the stone. *Science News* 1998 Aug 1; 154(5): 75-7.

See also: Kajander EO, Ciftcioglu N. Nanobacteria: An alternative mechanism for pathogenic intra- and extracellular calcification and stone formation. *Proceedings of the National Academy of Sciences* 1998 Jul 7; 95(14): 8274-9; Folk RL. Life in miniature [letter]. *Science News* 1998 Sep 12; 154(11): 163, 169. Observations on nanobacteria (about the size of the putative ones in the Martian meteorite).

Vogel G. A Sulfurous start for protein synthesis? *Science* 1998 Jul 31; 281: 627-9.

See also: Huber C, Wachtershauser G. Peptides by activation of amino acids with CO on (Ni,Fe)S surfaces: Implications for the origin of life. *Science* 1998 Jul 31; 281: 670-2. Amino acids can be activated under geochemically relevant conditions.

Vogel G. A two-piece protein assembles itself. *Science* 1998 Aug 7; 281: 763. A bacterial protein assembles another from two separate pieces.

Weiss P. Another face of entropy. *Science News* 1998 Aug 1; 154(7): 108-9.

See also: Adams M, Dogic Z, Keller SL, Fradfen S. Entropically driven microphase transitions in mixtures of colloidal rods and spheres. *Nature* 1998 May 28; 393: 349-52; Lekkerkerker HNW, Stroobants A. Ordering entropy. *Nature* 1998 May 28; 393: 305-7; Letters. *Science News* 1998 Oct 3; 154(14): 211, 217. Production of complexity through entropy.

INTERNET LOCATIONS VISITED IN THIS ISSUE

News and Updates

Topic: Ames Research Center Astrochemistry Laboratory (p 5)
Owner: NASA
Location: http://web99.arc.nasa.gov/~astrochm/press.html
Last visit: Feb 1999

Topic: Astrobiology Research (p 5)
Owner: ABC News
Location: http://abcnews.com/sections/science/DailyNews/spacecarbon990218.html
Last visit: Feb 1999

Topic: Reviews of "Evidence Against Evolution" Books (p 5)
Owner: NCSE
Location: http://ww.natcenscied.org/mianal.htm
Last visit: Mar 1999

Topic: Pennsylvania Draft Standards for Science Education (p 5)
Owner: PA Department of Education
Location: http://www.pde.psu.edu/standard/science.pdf
Last visit: Feb 1999

Features and Articles

Topic: Tools for Teachers—Camel Skull (p 17)
Owner: Answers in Genesis
Location: http://www.answersingenesis.org/Webman/Article.asp?Old=camskull.html
Last visit: Dec 1998

Topic: Classroom Assessment (p 17)
Owner: Uncensored Community College List
Location: <http://www.taft.cc.ca.us/jbuddell/tclists/resources/portfolios.html>
Last visit: Oct 1998

Resources

Topic: Press Release: Oldest Rocks on Earth Found in Canada (p 9)
Owner: Springer Journals
Location: http://www.springer.de/whatsnew/presse/gesteinengl.htm
Last visit: Feb 1999

Topic: Abstract: Oldest Rocks on Earth Found in Canada (p 9)
Owner: Springer Journals
Location: http://www.springer.de/link/service/journals/bibs/91340003.htm
Last visit: Feb 1999

Subscription Alert!

Many NCSE members who renewed subscriptions between August and November 1998 received a notice with *Reports of the National Center for Science Education* volume 18, number 5 indicating that it was time to resubscribe. If you received a "one-issue-remaining" or "last-issue" notice with the issue previous to this one, it means that you have nearly received the entire set of 6 issues of *RNCSE* making up an annual membership. Subscriptions (and memberships) are based on the receipt of 6 issues of *RNCSE*, not on the calendar year. Because we had fallen behind in our publication schedule, we have been producing *RNCSE* with shorter-than-normal intervals in order to catch up to the publication dates listed on the title page. As a result, you may receive your 6 issues in less than a calendar year. So, if you get a reminder to renew before a full year has gone by, please be assured that you are still receiving your full membership benefit of 6 issues of *RNCSE*.

As always, please check with NCSE if you have questions or concerns about your subscription. We thank you for your patience, understanding, and continued support of NCSE.

Writing for *RNCSE*

Reports of the National Center for Science Education (*RNCSE*) welcomes contributions from its readers or 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 perceptions 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-evolutionists, relate new information that may be helpful in promoting evolution, or present original research related to the public understanding of evolution. We also welcome case reports and classroom action research assessing strategies for strengthening the understanding of evolution in educational practice.

What to Send

If you wish to contribute a note about events in your community, a letter to the editor, a report or reflection on encounters with anti-evolutionism, a success story or a tale of woe, then just send it. We don't submit most features to outside review, so we need only one copy. We prefer typed, double-spaced text on a diskette. However, you need not worry about style and format guidelines which apply to those submitting formal articles. We are also happy to receive your items via email at the editor's mailbox: <editor@natcenscied.org>.

Submitting Articles For Review

All articles should be written for a general audience. Authors should provide definitions or descriptions for terms and concepts whose meanings might not be evident to the nonspecialist. All article 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.

Style and Format

1. Manuscripts should not exceed 20 manuscript pages and must be typed double-spaced, including inset quotations and references. Margins must be adequate for editorial notation. Authors should include a brief biographical statement and an address where interested readers may contact the author(s).

2. Authors should supply a diskette containing the manuscript and/or a printed original and 2 copies for evaluation by outside. We accept files on 3.5-inch or 100MB Zip disks in WordPerfect®, MS-Word®, Claris Works®, RTF, or ASCII formats in DOS/Windows or Macintosh versions. Please contact the editorial office for information about other file formats and options that might be acceptable.

3. All submissions are subject to editorial correction of grammar, spelling, punctuation, and consistency as per *Scientific Style and Format: The CBE Manual for Authors, Editors, and Publishers*. Reference sections are alphabetical and should use the name-year format illustrated in the following examples.

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.

Waters IC, Rivers HI, Flood NO, Deep C, 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.

Do not abbreviate names of publications. Include location of book publishers, and use the abbreviation "nd" for undated material. Multiple entries by the same author are listed in the bibliography in chronological order; multiple articles in same year are 1982a, 1982b, and so on according to their order of citation in the text.

4. Citations within text referring to reference section should be limited to author, date and (when appropriate) page, for example (Smith 1982, p 21). Multiple references within text appear in chronological order, for example, (Thomas, Peters, and others 1925; Smith 1943, 1947; Smith and Jones 1983a, 1983b, 1984). Citations of electronic resources should include author(s) and date accessed and internet locations should be enclosed in angle brackets, for example <http://www.natcenscied.org>.

5. Text abbreviations based on non-English terms should be translated into the appropriate English equivalent. For example, e.g. should be rendered as *for example*.

6. All measurements reported in scholarly and scientific articles are to be expressed in SI or "metric" units.

7. Figures, plates, diagrams, or photographs should be camera-ready or in electronic form. Submission of these materials or of quotations by writers presumes that authors have obtained permission to use these potentially copyrighted materials. These should be accompanied by "permissions" when appropriate. Authors should retain copies of all manuscripts, photographs, and figures submitted; NCSE assumes no responsibility for these materials.

Authors' queries are welcome. The editor is available via mail, phone, fax, or email as indicated inside the front cover.

NATIONAL CENTER FOR SCIENCE EDUCATION
PO BOX 9477
BERKELEY CA 94709-0477

Address Service Requested

Non-Profit Org.
U.S. Postage
PAID
Berkeley CA
Permit No. 1197

18(6)

Membership in the National Center for Science Education brings you

- One year's subscription to *Reports of the National Center for Science Education* (6 issues)
- 15-20% discount on selected books
- Participation in NCSE's diverse efforts to promote and defend the integrity of science education

MEMBERSHIP / SUBSCRIPTION / DONATION

Name

Address City State Zip

Home Phone Work Phone

Occupation

☐ Check here if you object to our sharing your name with other nonprofit organizations

NCSE MEMBERSHIP **ONE YEAR** US:$30 Foreign: $37 Foreign Air: $39 **LIFETIME** $600	$
TAX DEDUCTIBLE CONTRIBUTION TO NCSE	$
BACK ISSUES *NCSE REPORTS / C/E Newsletter* (Vol 1-18, $3 per issue; $18 per volume; all 18 vols, $300) *C/E Journal* (1-9 copies, $6 each; 10 or more, $5 each; full set, nos. 1-39, $150)	$
SHIPPING $1 for 1 issue; add $.75 for each additional issue; maximum of $10 — even for all 39 back issues.	$
TOTAL ☐ Check (US dollars) Charge to: ☐ VISA ☐ Master Card	$

Credit Card Number Exp. Date

Name as it appears on card

Signature

SUBSCRIBER INFORMATION

Subscriptions are fully tax deductible. NCSE is tax exempt under Federal IRS Code 501(c)(3) and the corresponding provisions of the California law. Amounts paid to NCSE are tax-deductible to the extent permitted by law.

MISSING ISSUES

If your issue fails to arrive or is badly damaged in transit, send us the date of issue and we will rush you a replacement.

MOVING TO A NEW ADDRESS?

Let us know your new address as early as possible and we will update our records of your subscription accordingly. Please allow 4 weeks for an address change.

Please mail all correspondence about your subscription to:

NCSE
PO BOX 9477
BERKELEY CA 94709-0477
(510) 526-1674
(800) 290-6006

Printed on recycled paper.