

# REPORTS

OF THE  
NATIONAL CENTER FOR SCIENCE EDUCATION



Volume 18, Number 4

JUL/AUG, 1998

CONTINUES  
NCSE REPORTS &  
CREATION/EVOLUTION



**Bibliolatry in  
the Grand  
Canyon**

**Cruising  
Iguanas  
Demonstrate  
Evolutionary  
Mechanism**

**Evolution as  
a Heuristic**

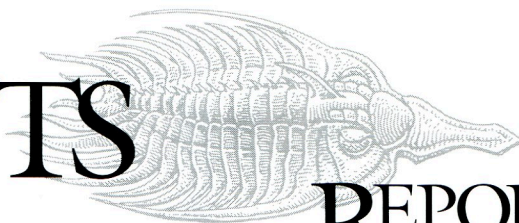
**NCSE  
Creation/  
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**Help for  
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A Review**



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NATIONAL CENTER FOR SCIENCE EDUCATION  
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#### EDITORIAL STAFF

Andrew J Petto, *Editor*  
Division of Liberal Arts  
University of the Arts  
320 S Broad St  
Philadelphia PA 19102-4994  
215/875-1104; FAX: 215/546-2027

email: editor@natcensci.org

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National Center for Science Education  
PO BOX 9477  
BERKELEY CA 94709-0477  
510/526-1674  
FAX: 510/526-1675  
Email: ncse@natcensci.org  
<http://www.natcensci.org>

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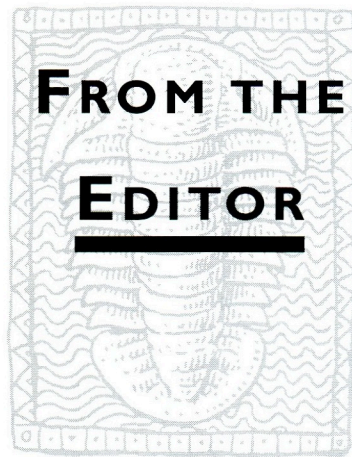
Printed December, 1998



There are few places on the earth as spectacular as the Grand Canyon. Appreciating and understanding the stone formations and their interactions with wind and water would make a visit there a veritable course in geology. We can see the past record of the forces of nature at work and also observe and measure them at work today. It is no wonder, then, that the Grand Canyon is at the foundation of anti-evolutionary activity in the US. If one could demonstrate how the sediments, valleys, uplifts, and intrusions were all generated within a short period of time, then one could hope to invalidate the conclusion that the formation of this feature records the persistent movement of earth, wind, water, and fire over millions of years.

In this issue, our main feature is a review essay by Wilfred Elders exploring creationist claims about the nature of the Grand Canyon, its history, and its geology. Many of you will recognize that Dr Elders will provide the "evolutionist" interpretation of the Grand Canyon in NCSE's upcoming creation/evolution trip to the Grand Canyon, August 7-14, 1999. The book in question is *Grand Canyon: Monument to Catastrophe* edited by Steve Austin of the Institute for Creation Research. Although Elders points out that the errors in fact and interpretation are too numerous to detail even in a book-length review, he focuses on a few of the most dramatic to show how poorly the evidence fits the conclusions of Austin's book. He also points out that all of Austin's book contains references to only 4 pieces of original research conducted by creationists and interpreted as supporting creationist claims about the recent origin of the Grand Canyon after the Noahian Flood.

A second essay by long-time member Robert Siegfried examines the contribution of evolutionary theory from a historical perspective. As a complement to Karen Bartelt's recent article on the Christian origins of evolutionary theory, Bob explores historical documents and correspondence to show us why evolution caught hold and fired the imagination of scientists beginning in the last century. He argues that it is more than just evolution's ability to deliver a cogent explanation. Instead, evolutionary theory has succeeded in great part because it generates *both* cogent explanations *and* productive questions for future research. It is not so



much the answers, he argues, as the questions that make evolution a better scientific theory than the creationism it replaced. Bob challenges us all to share examples with each other and with school boards, political leaders and educators.

In a similar vein, David Kopaska-Merkel reviews *Teaching About Evolution and the Nature of Science* edited by Donald Kennedy and published by the National Academy of Sciences. This book tells why and how we ought to teach evolution. David suggests that there should be a copy in every school library and on every science teacher's shelf. This volume is also useful for anyone who is likely to be discussing the issues with school administrators and school board members.

Another example of how our reviewers go the extra distance is Richard Sherwood's review of Steven Stanley's *Children of the Ice Age: How a Global Catastrophe Allowed Humans to Evolve*. Rich recommends the book to our readers, but also provides us with a table of up-to-date information on human fossil finds in Africa and Asia to keep us abreast of this rapidly changing field.

#### IN THE NEWS

Politics is always a fertile field for anti-evolution activity. Our Updates section follows the "Only a Theory" disclaimers in Idaho and Louisiana and the political fate of one supporter of such disclaimers in Washington. In Michigan a citizens' committee is exploring resources with "non-religious" criticisms of evolution to put in public school libraries. Finally, Answers in Genesis is encouraging students to establish school-based "Creation Clubs" throughout the country. We report on one such effort in Boone County, Kentucky.

In research news, it takes a reptile to prove a biogeographic hypothesis. A recent report in *Nature* demonstrated that land- and tree-living vertebrates *can* survive for extended periods of time at sea and ride "rafts" of storm debris or other flotsam from island to island. This sort of rafting is still considered a rare event, however, *eyewitness* accounts of iguanas from Guadeloupe departing their rafts onto the island of Anguilla provide the sort of "proof" that anti-evolutionists often demand. Yes, someone was there and did see it happen!

And on the home front, there is news from NCSE. In case you need or want to write to us, Erik Wheaton has plumbed the depths of the US Postal System and come up with the proper instructions to assure timely delivery to the NCSE office. And, if you have ever wondered what a board of directors actually does, Molleen Matsumura reports on what some of the members of NCSE's board have been up to over the past year. In a second report, Molleen also points out how numerous volunteers perform many duties vital to NCSE's mission.

Finally, don't miss our Resources section after the centerfold. Frank Sonleitner has provided us with another periodic bibliography of what's new in fields that relate to evolution. We also have a number of short contributions from members and others who share our interests and concerns. This issue also contains a short feature compiled by the NCSE staff containing a variety of resources for teaching about evolution—books, tapes, video, CD, internet, and more. Check it out!

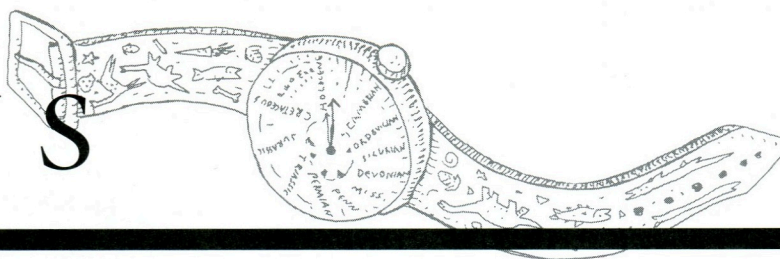
And to show that old dogs can learn new tricks, we thank D Gary Grady of Durham NC for his suggestion that we add this note to each issue—Volume 18, number 4 was printed in December 1998.

Anj Petto

#### Correction

In "Creationism, A Trip to the Dark Side" which appeared on page 22 in issue 2, we incorrectly reported that the Answers in Genesis seminar which Skip Evans attended was held September 15-16, 1997. The seminar at the Roswell Baptist Church in Marietta, Georgia was held on September 15-16, 1996.

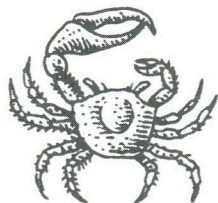




## NCSE Board Members: The Active Type

Molleen Matsumura  
Network Project Director

NCSE has received many offers for books and seminars that promise to help nonprofit organizations get members of their boards of directors to *do* something besides lending their names. We skip all that advice because we don't need it! NCSE is blessed with committed and caring board members who don't wait to be asked before they swing into action. Here's just a bit of what *some* of them have been up to.



### JOHN R COLE

Since retiring as NCSE editor, John has continued to serve as a contributing editor and book reviewer; he even returned as guest editor for our last issue. He has been first to find many of the news items and reprints you see in these pages. He has also

- served as an advisor to many participants of the Internet "anticreationist" listserv who are coping with evolution/creation conflicts or seeking information on "creation science" arguments;
- conducted research on possible investment opportunities as NCSE seeks to build an endowment fund;
- written press releases on the activities of NCSE Board members and others working on NCSE issues;
- continued building a library of evolution-related art from the 19th and early 20th centuries for use in NCSE publications.

### JACK FRIEDMAN

Jack Friedman has a long career as a science educator and for the

past 22 years has been involved with an annual conference for high school students. With a committee of 15 college and high school teachers he arranges a one-day meeting at which approximately 70 "experts" (college professors, physicians, and others) speak on a scientific topic that is of special interest to them. A brochure is prepared and mailed to schools located within an hour of the college campus where the conference will be held. Students pick the sessions they wish to attend and are grouped into classes of 25 which meet during four "periods" on the conference day. This is an enrichment opportunity for above-average high school students. And, he adds, "If any college or high school teacher wishes to put on such a conference, I would be pleased to offer advice and answer any questions that they may have. Our conference was awarded a state 'Program of Excellence'."

### MICHAEL MCILWRATH

McIlwrath, the newest member of NCSE's board (see *RNCSE 1997; 17(5):4-5*), generously makes himself available to answer inquiries about case law affecting evolution and creation controversies. Besides having advised teachers who appealed to NCSE for help with problems arising from their commitment to evolution, he submitted a brief on NCSE's behalf in connection with the Tangipahoa, LA oral disclaimer case. He is still working on this case and will present oral arguments if the appeals court decides to hear further arguments (see *Updates p 7*). Meanwhile, McIlwrath is helping NCSE staff explore the possibility of a special fund-raising event.

### KEVIN PADIAN

Kevin Padian, the current NCSE President, is a professor at the University of California's Berkeley campus, not far from NCSE's office. This proximity is a big help when NCSE staff want input from a board member. He has been taking advan-

tage of a sabbatical this term to try to catch up on a lot of projects. Of these he comments, "Few of them are directly related to the creation-evolution issues at the moment. However, one hopes that by getting some science out to the public, issues can be clarified that are often misinterpreted or miscommunicated by anti-evolutionists. Primary among these, perhaps, is the origin of birds from small carnivorous dinosaurs. I have just finished two papers examining why this is a false controversy."

He has also worked with a colleague to write several papers summarizing and clarifying the evidence about bird origins for the public, including the February 1998 cover story of *Scientific American* and an article in *Biological Reviews*. (This topic is also covered in an entry in *The Encyclopedia of Dinosaurs* [Academic Press, 1997], a comprehensive and well-received book which Padian co-edited with Phil Currie.) He is also making progress on a variety of more technical projects, such as research on theropod dinosaur taxonomy and a paper on Darwin's view of classification which has just been accepted for publication in *Systematic Biology*.

Padian has always taken a strong interest in science education as well, actively contributing to development of science education standards in California. He has recently written chapters on natural selection for a book on evolution for teachers and on the origin of birds for an ornithology textbook. He has also given many public lectures at universities and for other organization, and been named a Distinguished Lecturer for 1999 by Sigma Xi, the Scientific Research Society of North America. Details of Sigma Xi's program selecting scientists, engineers, technologists, and public policy analysts for a special lecture series are available in the November-December issue of *American Scientist*.



Then there are the things that get done for fun. Padian reports: "I also translated a very nice book by Philippe Taquet, who has been Director of the Institute of Paleontology and of the National Museums of Natural History in Paris, recounting over thirty years of his travels around the world in search of dinosaurs and their world. *Dinosaur Impressions* has just been published by Cambridge University Press, and it is a wonderful combination of paleontology, travelogue, history of science, and amusing stories. It provides a nicely Gallic perspective on our field and on science in general, and this is why I thought it would be fun to bring to an anglophonic audience."

#### ANDREW J PETTO

Does the name sound familiar? It should! Anj is the editor of *Reports of NCSE*. But that's not all. Anj constantly works for the improvement of evolution education, both in the academic arena and as a citizen. So far in 1998, Anj

- worked with NCSE members and friends in Wisconsin to respond to a visit by Duane Gish and a "seminar" series entitled "Understanding the Times: A Worldview Weekend" and sponsored by Summit Ministries and the American Family Policy Institute;
- worked with NCSE members for final acceptance of the Wisconsin Model Standards in Science (and social science) which contained a firm commitment to evolution in *all* areas of the sciences. (It was in the course of these efforts that Anj heard a supporter of "creation science" decry the influence of evolution on the children's book *Horton Hatches The Egg* (see *RNCSE* 1998; 18[1]:24);
- ran teacher workshops on "science as a way of knowing" (and evolution), including a half-day session on the Afar hominid fossil site with a featured speaker from the University of Wisconsin at Madison;
- worked with a committee from the Society for the Study of Evolution to plan and carry out a workshop on teaching evolution for the SSE meetings in June 1999;
- co-directed an invited workshop at a series of "Communicating

Science" workshops at Hamilton College in upstate New York;

- established a new course on "Science and Pseudoscience at the End of the 20th Century" at Philadelphia's University of the Arts;
- completed an application for a Templeton grant for a new course called "Place in the Universe" which explores indigenous narratives and scientific explanations, discussing both cultural and cosmological implications;
- and last but not least, since his move to Pennsylvania, Anj has begun building a whole new network of evolution supporters.

#### ELIZABETH STAGE

Elizabeth Stage is director of science for New Standards, a partnership of districts and states interested in standards-based reform. Last academic year she worked with a group of science educators from the Chicago Public Schools, led by NCSE member *Melanie Wojtulewicz*, Manager of Science Support. This group drafted programs of study for high school science courses based on the Chicago Academic Standards and Framework for Science, to be used as the basis for city-wide examinations. The Biology Program of Study has four areas of concentration, one of which is biological evolution.

This year Elizabeth is working with educators from New York City to assemble a collection of student work that shows teachers, students, and parents the quality of work that is expected at elementary, middle, and high school levels. Five themes have been selected for the life sciences: interdependence, structure and function, change over time, responding to changes, and reproduction and heredity.

#### ROBERT M WEST

"Mac" West contributes a vital link between NCSE and the world of "informal science" — museums, nature centers, and other science education facilities that are not school based. He reports that one of his most significant recent activities has been work on the "signature" film for the 3-D IMAX theater at the Smithsonian's National Museum of Natural History. The film, to be completed in 1999, features the

Galapagos. West's consulting firm is working on educational materials to accompany the film.

He is also involved in the early stages of planning the Space Science Initiative at the Denver Museum of Natural History, helping both to develop the storyline and to make sure that a full spectrum of educational opportunities are available. He comments, "An item of discussion always is ultimate origins, extraterrestrial life, and the statistical certainty that we are not alone."



## A Little Help from Our Friends

*Molleen Matsumura*  
NCSE Network Project Director

It is always a pleasure to acknowledge the contributions of NCSE's members and friends. Here are some off the wonderful people who help out at NCSE headquarters.

**Yves Barbero and Lee Hartz:** We've mentioned these friends in previous issues, but newer members should hear about them too! Yves Barbero has donated hardware, software and countless hours of his time to maintaining and updating NCSE's computer network. Lee Hartz is indispensable to maintaining our library and resource files.

**Tina Bhargava:** When she volunteered as a student intern for summer, 1998, Tina performed heroic labors developing a subject index for issues 26-39 of *Creation/Evolution*, the journal that was merged into *RNCSE*. We're looking forward to announcing the availability of the completed index, which will make it much easier to locate articles refuting "evidences" against evolution.

**Erica Cande:** You're never too young to help! This Berkeley high school student, daughter of University of California-Berkeley biologist and NCSE member Zac Cande, devoted part of her summer

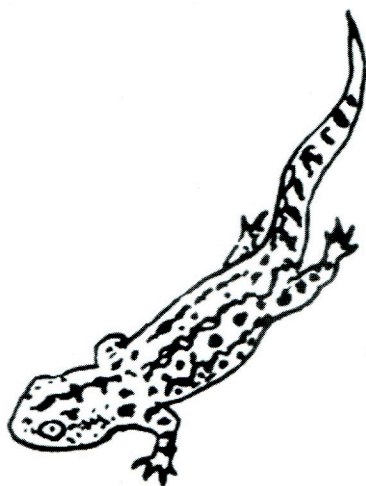


vacation to volunteering at NCSE, updating databases, helping process book orders and more. No task is too menial...for Erica to make a good joke about doing it!

**Letizia Gasparetti:** When our friends at the Institute for Human Origins moved from California to Arizona, they advised one of their volunteers that she could continue to help increase public understanding of evolution by volunteering time at NCSE. Lee has done everything from photocopying to database work cheerfully and efficiently. Thanks to her, we now have a complete database indexing *NCSE Reports*, which helps us better serve members by quickly locating information to share with them.

**Richard Golden:** A science educator with considerable experience in providing resource and professional development materials for his colleagues, Richard seems to be one of those people who is busier than ever after he "retires". Richard has been helping us update our records of evolution/creation controversies around the country and to expand our science textbook database. Richard is also assisting with our Pre-Publication Review Project.

**And a Cast of Thousands...** Thanks to Jack Dohlinow, Gary Glenn, Richard Golden, Kennan Herrick, Bill Lidicker, Peg Marshburn, Katharine Milton, Frank Norick, Carole Segal, Leslie Morris, Stephen Morris, Monroe Strickberger, and John Zalabak for staffing an NCSE booth at a regional fair, and to John H Beyer and Vince Sarich who would have if they could have.



## Cruising Iguanas Demonstrate Evolutionary Mechanism

Andrew Petto  
NCSE Editor

In a report in *Nature* Ellen Censky and colleagues have finally presented *eyewitness* evidence for one mechanism of evolutionary change. Fifteen iguanas rode a "raft" of storm debris on a 320-km trip from Guadeloupe to Anguilla. In September 1995 Hurricanes Luis and Marilyn struck the Caribbean and apparently blew the trees to which the reptiles were clinging into the ocean. A month later fishermen noticed logs washing ashore carrying the iguanas as passengers. Such rafting has been proposed as a *plausible* mechanism for the spread of organisms along island chains and between continents, but this is the first time that humans have witnessed the arrival of the colonizing species.

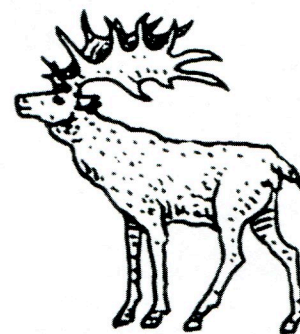
It is fairly easy to explain the movement over the open ocean of swimming and flying animals and of plants and fungi with airborne dispersal of seeds and spores. For primarily terrestrial and arboreal animals—especially vertebrates—extended trips without fresh food and water were considered unlikely.

Iguanas from different islands show physical features and coloration which are characteristic of and limited to specific locales. So, even if there had been no eyewitnesses, the sudden appearance of the immigrants from Guadeloupe would have been noticed. However, to prove that they had rafted over the ocean, scientists would have had to rule out several competing hypotheses—such as introduction by humans via air or sea cargo, as pets or contraband, and so on. It is just all the better that someone *did* see them arrive on a raft of logs, because it demonstrates that rafting can and does account for the spread of some arboreal and terrestrial vertebrates from island to island.

The geographical distribution of the biological and behavioral variations found in living things is one of the most interesting and engaging subjects in scientific research today. Local variations associated with spe-

cific islands, valleys, or even cave environments have served as natural laboratories for the study of evolution—from the Galapagos finches and tortoises to the spread of humans out of Africa to all other continents. Now, thanks to Censky and colleagues, we have an opportunity to examine both the process and the outcome of the spread of a species between islands by rafting.

[The complete citation for the original research report is Censky EJ, Hodge K, Dudley J. Over-water dispersal of lizards due to hurricanes. *Nature* 1998; 395: 556. A news report can also be found in Yoon CK. Hapless iguanas float away and voyage grips biologists. *New York Times* 1998 Oct 8;A1.]



## UPDATES

**Idaho:** While draft state "Exiting Standards" in science still include coverage of evolution, some modifications have been made in response to anti-evolution objections, according to an October 29, 1998 story in the Twin Falls *Times-News*. The changes reflect the misleading "fact vs. theory" strategy often adopted in anti-evolution efforts. The use of "theory" accompanying the word "evolution" is viewed as a compromise and, the article reports, Standards Commissioner Tom Luna said that "it left the door open for creationism by using 'theories of origin' regarding the beginning of the universe." While NCSE members who spoke at public hearings are concerned about the effect of these changes, opponents of evolution education don't believe they go far enough.

**Idaho:** On November 13, 1998, the Executive Board of the Idaho School Boards Association rejected an anti-evolution resolution submitted by the Board of New Plymouth School District. The resolution read



in part: "Whereas, common schools should not teach or promote concepts which tear at the fabric of what is being taught in homes;...Mankind appearing on the Earth, in his present form, shall not be taught...to be a result of evolution, where evolution is accepted as fact. ...This law shall extend to library books and textbooks." In

**RESOLUTION SUBMITTED  
BY THE NEW PLYMOUTH  
(ID) SCHOOL BOARD TO  
THE IDAHO SCHOOL  
BOARD ASSOCIATION,  
1998**

**"CREATION VS. EVOLUTION IN  
THE PUBLIC SCHOOLS"**

Whereas, scientific theories should be presented as theories, not as fact; and  
Whereas, leading scientists who promote evolution recognize it as a theory; and  
Whereas, common schools should not teach or promote concepts which tear at the fabric of what is being taught in homes;

**Now, Therefore be it resolved:**

Mankind appearing on the earth, in his *[sic]* present form, shall not be taught in K-12 public schools to be a result of evolution, where evolution is accepted as fact. Mankind appearing on the earth in his present form as a result of evolution may be presented as theory. This law shall extend to library books and textbooks.

**Statement of Purpose:**

Even though evolution is a theory, some schoolbooks on science present the origin of mankind through a process of evolution as fact. This also happens at times in classrooms.

Public schools are having a hard time hanging onto students whose parents believe in creation, and in keeping tuition tax credits at bay. A resolution such as this, if it became law, would accomplish two purposes: 1) it would be less likely that students would be left with the wrong impression regarding the validity of evolution; and 2) parents believing in Creation will be more comfortable sending their children to COMMON schools.

1997, a disclaimer resolution was rejected by a 4-1 vote. The 1998 resolution was rejected 3-1. Proponents say they will submit another resolution in 1999 and hope that removal of references to library books will improve chances of passage. While some opponents of the resolution framed the issue as one of local control, its backers argue that passage would address many parents' dissatisfaction with public schools (see sidebar, left).

**Kentucky:** Answers in Genesis (AIG), the Kentucky-based "creation science" ministry, announced the launching of its nationwide "Creation Club" campaign. According to a report in the *Kentucky Post*, AIG had already received applications from many would-be founders in Boone County, Kentucky and elsewhere in the Cincinnati area (September 22, 1998). The Boone County School Superintendent told the *Post* that he had not yet received any requests to found such a club, which would have to be school-sponsored and student-initiated. NCSE members and friends in Kentucky are monitoring the situation.

**Louisiana:** An oral disclaimer case that originated in Louisiana's Tangipahoa Parish has been appealed to the Fifth Circuit Court of Appeal. The Court will decide on January 4 whether to hear oral arguments in support of NCSE's *amicus* brief (see RNCSE 17(5):4).

**Michigan, Melvindale:** The "Origins of Man" Science Subcommittee met on December 3, 1998 to consider recommendations of books for possible placement in school libraries as resources providing nonreligious criticisms of evolution. If they produce a final report, it will be presented to the Melvindale Board of Education on December 14. The board's decision will be reported in a future issue. NCSE submitted evaluations of many of the proposed books for school district staff to forward to the sub-committee.

**Washington, election news:** Harold Hochstatter, who introduced an evolution disclaimer bill when he was chair of the state's House Education Committee in 1998, was re-elected to his seat. However, because his party lost the majority, he was replaced as committee chair. Even when he was chair, the bill was defeated in committee (see RNCSE, 17(5):6,7), so without his leadership

it is unlikely that anti-evolution bills will be introduced in this committee during the next session.

[NCSE thanks Garvin Chastain, Taner Edis, Michael McIlwraith, Dan Phelps, and Charles Reich for information used in this report.]

## OFFICE BIZ

### *Writing to the NCSE*

Erik Wheaton  
Office Manager

We have gotten a few letters from members inquiring about our mailing address and business reply mail. When mailing to the NCSE use this address:

NCSE  
PO BOX 9477  
BERKELEY CA 94709-0477

Using the all caps format with no periods and commas helps the USPS direct your mail to our PO box more efficiently.

If you need to mail something larger than a regular sized envelope or need to use a delivery service other than the USPS, please use our street address:

NCSE  
925 KEARNEY ST  
EL CERRITO CA 94530-2810

Please note that the business reply envelopes we send to members have a different address, it is:

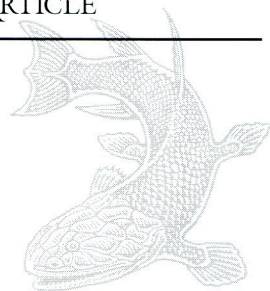
NCSE  
PO BOX 9477  
BERKELEY CA 94709-9953

These last 4 digits signify a code used by the USPS to send reply envelopes to a processing unit so it can charge us for the postage. Please don't use this ZIP + 4 for any mail to the NCSE; it is only for post office use.

### *One Last Point*

At the end of 1998, we mailed several thousand letters to prospective new members, PLUS mailed our fall fund-raising request to all our current members PLUS published two issues of RNCSE, which generated many renewals. I'm delighted to say we are swamped with mail - but because of our small staff, we may not be able to get your thank-you gifts to you as promptly as we usually do. Please have patience! We WILL catch up!





# Bibliolatry in the Grand Canyon

Wilfred A Elders

After his heroic pioneering voyage in 1869 down the Colorado River through the Grand Canyon, John Wesley Powell wrote

[T]he thought grew in to my mind that the canyons of this region would be a Book of Revelations in the rock-leaved bible of geology. The thought fructified and I determined to read the book.

Powell recognized that there are few places on the planet with such awe-inspiring beauty and with such dramatic and continuous vertical exposures, as can be seen in the colorful walls of the Grand

Canyon through which the Colorado River flows for 450 km from Lee's Ferry to Lake Mead. The Canyon is more than 1600 m deep, and ranges from 6 to 30 km wide. Each year more than four million visitors visit Grand Canyon National Park in Arizona. There is perhaps no better place in all the world to appreciate the grandeur of geologic time (Calvin 1986; Redfern 1980).

However, bibliolatry has come to the Grand Canyon. The creationist textbook, *Grand Canyon: Monument to Catastrophe* (MTC), has challenged the accepted interpretations of geologic time and the geology of the Grand Canyon (Austin 1994). Heaton (1995) warns, "Many readers may find this book especially threatening because of its mix of scholarship and creationist dogma, targeted to a natural monument of great popularity." My aims in writing this arti-

cle are to review creationist ideas on the geology of the Grand Canyon and to encourage members of the National Center for Science Education to review the field evidence for themselves by participating in the first NCSE "Creation/Evolution Grand Canyon Raft Trip", a float trip through the spectacular scenery and whitewater rapids of the Grand

Canyon of Arizona, to be held in August 1999.

## STRATIGRAPHY OF THE GRAND CANYON

Today the Grand Canyon is one of the best-known and most spectacular paradigms of stratigraphy. The canyon walls reveal exposures representing a slice of earth-history, spanning 1700 million years (Ma). Figure 1 shows the "classic" geologic section within the Grand Canyon as a block diagram, viewed toward the north-west. The sequence of strata exposed consists broadly of three major packets of rocks, respectively of Early Proterozoic, Late Proterozoic and Paleozoic age (Elston, Billingsley and Young 1989; Beus and Morales 1990). The oldest rocks are an Early Proterozoic (1700 Ma) crystalline basement (Vishnu Schists, intruded by Zoroaster Granites). Above these are Middle- to Late Proterozoic sedimentary and volcanic rocks, known as the Grand Canyon Supergroup, which were tilted and eroded before the deposition of the overlying Tapeats Sandstone of Cambrian age (< 540 Ma). A major angular unconformity, which Powell (1875) termed the "Great Unconformity", separates these two formations.

The Tapeats Sandstone of the Tonto Group is the oldest of the many sub-horizontal Paleozoic sedimentary formations which occur above the Precambrian rocks. Not so easily seen in Figure 1 is another major unconformity occurring between the Upper Cambrian Muav Limestone and the overlying Temple Butte Formation of Devonian age, so that Ordovician and Silurian strata, between 515 Ma and 385 Ma in age, are missing. The youngest rocks shown in Figure 1 are basalts which erupted from volcanoes on the Uinkaret region of the Colorado Plateau and poured down the steep cliffs of the north rim after the Grand Canyon was eroded. During the last 0.7 Ma more than 150 lava flows have cascaded down to form a series of lava dams in the inner gorge of the Grand Canyon which temporarily blocked the flow of the river (Dalrymple and Hamblin 1998).

The broad stratigraphic sequence of Grand Canyon rocks is well-established by numerous field observations in Powell's "bible of geology" (Spamer 1989). Powell was, of course, writing figuratively. His "bible" was the rock outcrops themselves. However, Figure 1 is taken from MTC (Austin 1994). Its contributors regard the King James version of the Bible as the *true* "bible of geology". At first sight, MTC resembles a well-illustrated, geological textbook, replete with maps, technical diagrams,

**Austin has taken on the daunting task of using the spectacular geology of the Grand Canyon as an exemplar of a creationist world-view, despite numerous compelling arguments to the contrary.**



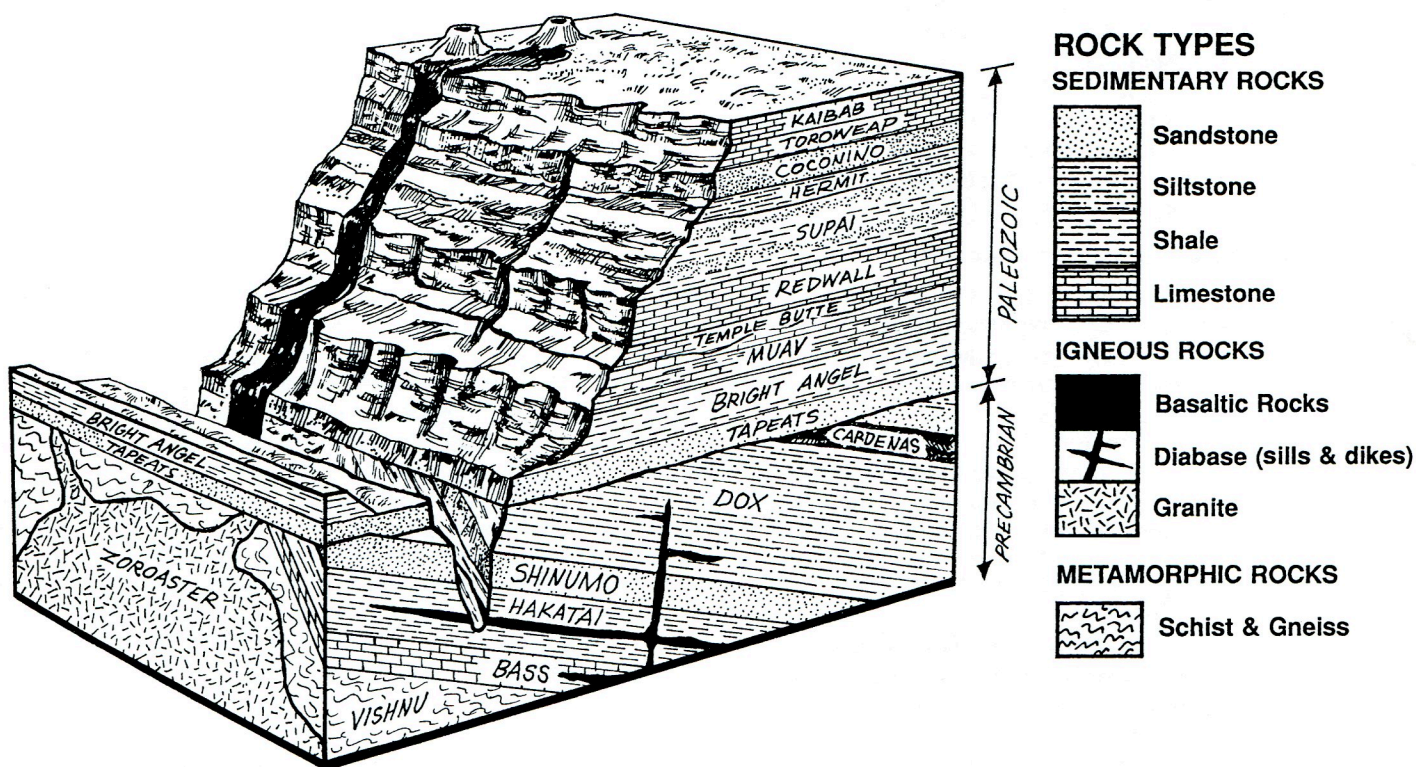


Figure 1. Block diagram showing the sequence of geologic formations and topography below the north rim of the Grand Canyon (Austin 1994: Fig. 2.5).

and references to scientific literature. However its aim is to demonstrate unequivocally that the geology of the Grand Canyon is the product of creation week and Noah's flood, as determined by specific "literal" interpretations of the Book of Genesis.

#### MONUMENT TO NOAH'S FLOOD

The numerous modern scientific arguments against Noah's flood have recently been discussed by Isaak (1998) and Wise (1998) among many others. Austin (1994) has taken on the daunting task of using the spectacular geology of the Grand Canyon as an exemplar of a creationist world-view, despite numerous compelling arguments to the contrary. The result is a detailed and comprehensive text, covering a wide range of phenomena, which demonstrates familiarity with (if not acceptance of) much of the geological literature. The authors of MTC were asked to write a creationist field guidebook to the geology, biology, and human history of "the world's greatest natural wonder" at the undergraduate college level. However, the sections on geology and radiometric dating, written by Austin himself, are at a much more advanced, technical level. On the other hand, the chapter dealing with the atmosphere is very elementary. For example, the explanation of the physics of Noah's flood is so brief and qualitative as to be almost unintelligible to me. Some clue to the anticipated readership of MTC comes from the fact that Austin (1994) provides a lengthy glossary of technical (mostly geological) terms ranging from "abrasion" to "zonation". However explanations of other kinds of specialist "terms of art", with which MTC is replete, such as "sin" and "the fall of Adam", are singularly lacking.

Evidently the authors of MTC anticipated that readers would be better trained in the ICR brand of religion than in their brand of geology.

#### THE GENESIS STORY

To understand the creationist arguments propounded in MTC, it was necessary for me to refer frequently to the first eight chapters of Genesis. I found that the so-called "literal" interpretations at the ICR involve enormous embellishments of the basic story told in that book, involving mountain building, earthquakes, volcanic eruptions, and so on. According to Genesis 1:1-27, a creator-God is said to have formed by fiat the cosmos, the earth, and its biota, in 6 working days. Marine animals and birds appeared on Day 5 (Gen 1:20-1) and land animals, including one male and one female human, on Day 6 (Gen 1:24-7). This initial breeding pair of *Homo sapiens* and its progeny had life spans of several hundreds of years.

After a lapse of 1656 years (Austin, 1994:65) the creator-God re-appeared as a destroyer-God and caused a world-wide flood that extirpated all living things, except for a remnant which took refuge on a boat called "the Ark", built expressly for that pur-

**MTC fails to mention that the creationist time scale violates the first law of thermodynamics....Applying the laws of heat transfer... indicates that... it would take at least 2 million years for these formations to cool to the boiling point of water.**



pose (Gen 6:11-6). The remnant consisted of a 600-year-old human (named Noah) and 7 family members, plus "two of every (other) sort of living thing...male and female", and 7 breeding pairs of "clean beasts" and "fowls of the air" (Gen 6:18-20; 7:1-3). The flood lasted less than a year before the survivors left the ship for dry ground and migrated throughout the world (Gen 8:14-9).

#### CREATIONIST STRATIGRAPHY

The essence of MTC is contained in Chapter 4 which divides the strata of the Colorado Plateau into five major groups, according to the ICR reading of the Genesis story (Austin 1994:57-82). These are

##### Fifth division:

The youngest group of strata includes river gravels, lake sediments, and lava flows, formed after the erosion of the Grand Canyon, which in turn formed as Noah's flood ended.

##### Fourth division:

The Mesozoic strata represent erosion and deposition as floodwaters retreated.

##### Third division:

The Paleozoic strata comprising the Canyon's characteristic, horizontal strata formed in the early part of the flood.

##### Second division:

The Late Proterozoic Grand Canyon Supergroup, the older tilted stratified rocks below the 'Great Unconformity'. They formed during and after Day Three of creation week. The Great Unconformity formed by erosion during the onset of Noah's flood.

##### First division:

The Zoroaster Granite and the Vishnu Group, which formed during the first part of creation week.

A recent publication (Ilg and others 1996) used detailed mapping and radiometric dating to divide the older Proterozoic rocks of the Grand Canyon into three mappable units—the Rama, Brahma, and Vishnu Schists, collectively named the "Granite Gorge Metamorphic Suite". This suite was intruded by two distinct series of Paleoproterozoic gabbro to granite intrusions, each of which is now given an individual name, rather than using the general name Zoroaster Granite. Temperatures of gabbro and granite magmas (molten rocks) exceed 1000°C and 750°C,

#### BRINGING YELLOWSTONE TO GRAND CANYON

To evaluate and rebut the numerous specific creationist claims Austin presents, would require a book many times longer than MTC. Because Austin (1994:136) repeats the tired, erroneous argument that evolution violates the *second* law of thermodynamics, my book would begin with *thermodynamics* — a word frequently used by creationists to impress untrained people. MTC fails to mention that the creationist time scale violates the first *and* second laws of thermodynamics (Wise 1998). Austin (1994:69) indicates that on Day 3 of creation week,

molten Zoroaster Granite was intruded into Vishnu Schist.

Ilg and others (1996:1160) estimate that the

peak temperatures, associated with the emplacement of granites into the Granite Gorge Metamorphic Suite reached 650-725°C. Applying the laws of heat transfer to the cooling of igneous intrusions indicates that these features cool at rates varying between 30 and 250°C per *million* years, depending on the size and depth of the intrusion. This means it would take at least 2 million years for these igneous rocks to cool to the boiling point of water.

Even if these intrusions were too deep to present thermal problems during creation week, they are widely exposed in the inner gorge of Grand Canyon, only a "few thousand" ICR years later. Austin (1994) provides no clue to what thermal insulation, if any, organisms were using on Day 6 of creation which allowed them to survive the heat. Will our NCSE *Creation/Evolution Grand Canyon Raft Trip* encounter geysers or similar intense, explosive hydrothermal activity where the river enters the Upper Granite Gorge? Has bibliolatry brought Yellowstone National Park to Grand Canyon?

#### ATTACKING UNIFORMITARIANISM

A recurrent tactic in MTC is to state opposing arguments in such a way that they are more easily defeated. According to MTC, evolution depends on "the extreme generalization that only known, modern processes, *operating at modern rates*, formed strata (uniformitarianism)..." (Austin 1994:24, emphasis in the original). However, few geologists today would accept that only those geological processes observed happening today have operated in the past, and that they only did so at the rates currently observed. I believe that uniformitarianism, certainly in the extreme version formulated in MTC, is just like creationism; they are both concepts of respectable ancestry which have been superseded.

Perhaps the most blatant example of a straw man in MTC occurs in a discussion of the fate of the sediment removed from the Colorado Plateau when the Grand Canyon was eroded. Austin (1994:84) makes the valid points that the Colorado River in the Grand Canyon flows through the uplifted Colorado Plateau, rather than around it. Initiation of this uplift began in the eastern (Kaibab) part of the plateau due to flexing during the Laramide Orogeny (mountain-building episode) which geologists infer to have happened between 80 and 64 Ma ago. Austin (1994:87) cites data that the Colorado River carried approximately 153 million tons of sediment per year between 1926 and 1950. He then calculates that, at this rate, since the initiation of uplift in the last 70 Ma, the river should have transported a volume 1500 times greater than the volume of the Grand Canyon. Why, he asks, have geologists failed to locate anywhere near this amount of sediment downstream on the delta of the Colorado River?

To the uninitiated this argument might seem plausible, but a closer look reveals its flaws. First, even the most ardent uniformitarian should have qualms about extrapolating data from 25 years to 70 Ma. During this 70 Ma, there have been major realignments of the interactions between the North American and the Pacific tectonic plates, and dra-



matic changes in topography, climate and sea level. Second, this calculation is an inappropriate act because neither the Colorado River Delta nor the Grand Canyon, has been in existence for 70 Ma; both are no older than 4.5 Ma.

The Colorado River Delta partially fills the depression known as the Salton Trough, an extension of the tectonic regime of the Gulf of California (Elders and others 1972). It was formerly filled by the waters of the gulf, as shown by the widespread occurrence of the marine sediments of the Imperial Formation (Lonsdale 1989). Drilling for geothermal resources confirms that, along the axis of the trough, these marine rocks are covered by younger deltaic sediments more than 4 km thick. This scenario is consistent with the dating of the onset of erosion by the Colorado River in the western part of the Grand Canyon. Luchitta (1990) shows that this occurred in Pliocene times, 5 to 3.8 Ma ago. Prior to that time the lower Colorado River system, as we know it today, did not exist. Both the ages and the volumes of the canyon and the delta are quite consistent. The Delta contains roughly 270 000 cubic kilometers of Pliocene to Recent sediments, equivalent to a canyon measuring 450 X 37.5 X 1.6 km deep—a volume somewhat larger than the Grand Canyon proper.

#### IGNORING THE GEOLOGIC TIME SCALE

A major omission in MTC is any discussion of the great synthesis of worldwide geologic observations known as the Geologic Time Scale. Wise (1998) pointed out that the creationist time scale ignores the countless worldwide geological studies which show that, on all continents, the same general sequence of sedimentary rocks occurs, and that the major and minor divisions in this sequence are characterized by the specific assemblages of fossils they contain. This overall scheme was essentially completed before 1859 when Darwin published his *On the Origin of Species by Means of Natural Selection*. No assumptions of organic evolution were made in deriving the geologic column or in using fossils for correlation of strata from continent to continent. However, the eras and periods of the geologic time scale, with which we divide geologic time, reflect the dramatic changes which have occurred in the history of life on earth recorded in the rocks (Gould 1994). Because of these changes, the fossil assemblages found in each geologic system are distinct, permitting us to make worldwide stratigraphic correlations. Today such correlations are also made using non-paleontological criteria, such as radiometric dating, and sequences of magnetic reversals and of light stable isotope ratios, particularly carbon isotopes (Bowring and Erwin 1998).

Sequences of strata occur everywhere in the same order, with minor exceptions due to tectonic disturbances. However, in many places (the Grand Canyon is an example), parts of the sequence are missing, due either to non-deposition, or to erosion subsequent to deposition. However, in more than a dozen deep sedimentary basins throughout the world, the whole sequence of sedimentary rocks bearing fossils is essentially complete. During the

last twenty years, stratigraphic correlation of these sedimentary rocks has been buttressed by the use of "sequence-stratigraphy", developed largely by major oil companies. The presence of major "unconformities" or ancient erosional surfaces can be used to correlate rock units over wide areas. Many of these erosional surfaces are of global extent because they were formed during periods of worldwide lowering of sea level due to extensive glaciations. The remarkable concordance obtained between these independent methods gives powerful support to the thesis that the Geologic Time Scale records 3.8 billion years of earth history (the age of the oldest dated crustal rocks) and that the sequence of fossils these rocks contain is the record of organic evolution.

Discussion of these issues is omitted in MTC. For example Chapter 7, entitled "Fossils of Grand Canyon", presents some of the weakest arguments for the creationist position. The authors make the astounding claim that "[i]t is not clear whether the order of appearance of organisms in Grand Canyon, or anywhere on Earth, for that matter, is necessarily any different than a random order which a flood might produce" (Austin 1994:147). Before creationists recommend that oil companies shut down their Departments of Stratigraphic Paleontology, they should decide whether they prefer to walk or to drive.

#### THE PROBLEM OF SPACE FOR FOSSILS

Another problem in MTC is where to put all the organisms living in the world before the flood. Geologists infer that the organisms in the fossil record accumulated during a period longer than 500 Ma, but according to MTC, all these organisms were alive during the 1656 years between the creation and the Noachian flood. If we take the total biomass represented by fossils when alive, and divide by the number of years during which that biomass is believed to have accumulated, the amount of living matter would have to be over 30 000 times greater in the creationist's pre-flood world than in the geologist's evolutionary world. Not only would the flora and fauna have to be incredibly more abundant in the pre-flood world but it also would have to be incredibly more diverse than at present; *all* extinct organisms would have to have been present at roughly the same time. Were there no limits to the carrying capacity of the ecological niches available to these organisms in the pre-flood world?

To have accumulated in that time from the origi-

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**The authors make the astounding claim that "[i]t is not clear whether the order of appearance of organisms in Grand Canyon, or anywhere on Earth, for that matter, is necessarily any different than a random order which a flood might produce."**

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There are about 20 sites in the world where the geological column is preserved in its entirety. You can find a list of these at <http://www.isource.net/~grmorton/geo.htm>.



nal breeding pairs would require an enormous reproductive success and survival rate by the founding stock. If the human population before the flood world grew at the same rate, there would have to have been  $1.8 \times 10^{15}$  people in Noah's time—about 300 000 times the world population of 5.9 billion humans alive today. After 1656 years

of the inevitable environmental degradation which would accompany such a prodigious human population explosion, I wonder that there was enough wood left for Noah to build an ark!

Another point not explained in MTC is the paucity of fossils in the Proterozoic sedimentary rocks. Austin (1994:57) claims that the uppermost strata of the Proterozoic Grand Canyon Supergroup "represent normal sedimentation in the post-Creation, but pre-flood ocean". Considering the hyper-productivity of the pre-flood biosphere required by the creationists' model, one would expect that these rocks would be the most highly fossiliferous on the planet and that the

Proterozoic flora and fauna would be rich and diverse, including representatives of both extinct and extant taxa. Instead we see a very low abundance of fossils consisting only of unicellular organisms, cyanobacteria and stromatolites (algal mats). There are no remains of coral reefs, trilobites, ichthyosaurs, whales, nor shipwrecks in Proterozoic marine sedimentary rocks.

#### ORIGINAL CREATIONIST RESEARCH

The scientific data and observations presented in MTC are almost entirely re-interpretation and attempted rebuttal of published main-stream science. But what of original creationist research? The appendix of MTC lists 18 "Questions for Discussion and Study". The last of these reads, "What are four research projects creationists have conducted on Grand Canyon?" A careful reading of MTC reveals that the author of this question expects students to be diligent. In fact, I was able to find *only* four examples of creationist research which could be cited, plus one which the authors of MTC admit is dubious.

#### Precambrian Pollen

This latter example is instructive because it shows that even when "creation science" is refuted there is an urge to cling to "evidence" favorable to the cause (Austin 1994:137). Burdick (1966) claimed to have isolated pollens of pine, juniper and Mormon tea in samples of the Proterozoic Hakatai Shales in the Grand Canyon, rocks much older than the first appearance of vascular plants in the geologic record. When later, more comprehensive and careful studies failed to reproduce these

results, it was concluded that Burdick's work was simply a case of contamination by modern pollens (Chadwick 1981). MTC still leaves the door open by concluding, "The possibility of pollen in Precambrian rocks, no doubt, will remain controversial among creationists."

#### Nautiloids

Original research by a creationist in Grand Canyon first appears in MTC on page 26 where Austin (1994) reports actual new data. In some places in the Mississippian Redwall Limestone, fossils of orthocone, chambered nautiloids (marine mollusks differing from modern nautilus by having straight, rather than coiled, shells) are abundant. Austin measured the orientation of 12 examples of these nautiloids in a single outcrop and showed that 10 of them are aligned with their long axes within an arc spanning  $90^\circ$ . He concludes that this preferred orientation indicates that the nautiloids received their alignments when dead, as lime mud was moved by water currents. He concludes that this is consistent with the flood hypothesis rather than "the uniformitarian notion that fine-grained limestone beds of Grand Canyon usually accumulated...in a calm and placid sea" (Austin 1994:28).

#### Modern Squirrels

A second example in MTC of original data by a creationist concerns modern populations of tassel-eared squirrels (*Sciurus aberti*; Austin 1994:174). Earlier work had suggested that two distinct races of these squirrels have evolved on the plateaus north and south of the Grand Canyon due to geographic isolation. However, after examining 94 museum specimens, Meyer (1988) concluded that the two groups contain individuals showing close enough resemblance so that, for all practical purposes they form one continuous population. Thus, in Meyer's opinion, although the two groups are geographically isolated, divergent evolution is not demonstrated by *Sciurus aberti*.

#### DESERT DUNES AND FOSSIL FOOTPRINTS

The argument for a flood origin for Grand Canyon rocks is particularly weak in the case of the Permian Coconino Sandstone Formation which consists of very pure sandstones with prominent sets of cross-stratification dipping at high angles. This formation is regarded as being the product of extensive, Sahara-like sand dunes (McKee 1979). The sandstone consists of fine-grained, well-sorted, well-rounded, frosted and pitted grains, composed almost entirely of quartz—features that are characteristic of the effects of grain-to-grain impacts and of winnowing during wind-borne sediment transport. Other evidence which indicates that the Coconino Sandstone was not formed in a catastrophic flood is the presence of raindrop impressions and of abundant, well-preserved animal tracks (McKee 1979). Of course, MTC does not accept the view that the Coconino is an extensive desert dune deposit and claims that the dunes are actually submarine sand waves (Austin 1994:33).

The animal tracks in the Coconino Sandstone are

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**In other locations there are tens of thousands of radio-metric dates which are consistent with the relative stratigraphic positions of the rocks dated. Why should Grand Canyon be different?**

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consistently preserved on steep, upwind, slopes of the fossil dunes rather than on the lee sides, where they would be destroyed by avalanching of dry sand. They are interpreted as being produced by invertebrates (similar to modern isopods, scorpions, millipedes, or spiders) and by diverse four- or five-toed vertebrates (Middleton and others 1990). The nature of the animals responsible can only be inferred from the trackways, as body fossils have not been recognized in the Coconino Sandstone. This leads us to the third example of original creationist research, a study which re-interprets these trackways from the creationist viewpoint.

This study by Brand and Tang (1991) included experiments on the track-making abilities of western newts walking on sand under 4 cm of flowing water in an aquarium tank. They report that some unusual tracks in the Coconino start and end abruptly and have individual prints oriented obliquely to the general trend of the trackway. By analogy with their tank experiments, they infer that such tracks were formed by amphibians buoyantly supported in flowing water. They conclude that these features, "point to the subaqueous deposition for at least part of the Coconino Sandstone" (Brand and Tang 1991:1204).

On the other hand, as part of an extensive review of animal trackways, Lockley and Hunt (1995) decided that the vertebrate trackways in the Coconino Sandstone were made by mammal-like reptiles (called caseids) rather than by amphibians. Furthermore they record trackways made by animals moving with loping, trotting, or galloping gaits, most often up slope, but occasionally horizontally or obliquely to the slope. They also point to the problem of the many invertebrate traces. It is difficult to imagine millipedes, scorpions and spiders making prolific underwater tracks. Besides, the geological evidence for the eolian origin of the Coconino Sandstone is compelling.

#### RADIOISOTOPE DATING

The fourth example of original creationist research is important enough to have been awarded a chapter to itself in MTC (Austin 1994, Chapter 6). It takes head-on one of the most difficult issues for young-earth creationists—the problem of radiometric age measurements. The chapter begins with an explanation of how radioactive isotope ratios are used in dating and of the assumptions inherent in the technique. This makes it all the more puzzling when Austin perversely proceeds to misapply the method by violating these assumptions. To help understand the nature of this perversity, a short review of radioactive isotope dating methods might be helpful for some readers (*see sidebar right*).

In Chapter 6 of MTC, Austin describes what he claims was a systematic research project to test isochron radiometric dating using rubidium and strontium isotopes. The rubidium isotope  $^{87}\text{Rb}$  decays to its daughter strontium  $^{87}\text{Sr}$ , whereas  $^{86}\text{Sr}$  is the common non-radiogenic isotope of strontium. Austin reports Rb/Sr data from whole-rock samples of the Pleistocene volcanoes on the Uinkaret Plateau, collected from five different basalt flows.

The 5 data points fall on a reasonably straight line which he claims defines an isochron giving a common age of 1300 Ma years (Austin 1994:124). For Proterozoic rocks, he plotted an isochron giving a common age of 1070 Ma (Austin 1994:122). He triumphantly points out that it is impossible for these rocks, which are clearly older than the formation of the Grand Canyon, to be 270 Ma years younger than the Pleistocene basalts, which certainly formed after the canyon was eroded. This leads him to challenge the basic assumptions of the radioactive dating by asking, "Has any Grand Canyon rock been successfully dated?" (Austin 1994:129).

In other locations there are tens of thousands of radiometric dates which are consistent with the relative stratigraphic positions of the rocks dated (Dalrymple 1991). Why should Grand Canyon be different? In answer to Austin's rhetorical question we can point to two recent studies. In their work on the oldest rocks of the Grand Canyon, Ilg and others (1996) used  $^{238}\text{U}/^{206}\text{Pb}$  ratios in individual crystals of zircon and monazite to derive a detailed chronology for the Early Proterozoic metamorphic and igneous crystalline rocks. Two different units of the Granite Gorge Metamorphic Suite gave ages of 1750 and 1742 Ma. Two different members of the Zoroaster Plutonic Complex, which *intrude* the Metamorphic Suite, gave ages of 1740-1710 Ma and 1700-1660 Ma. These ages are completely consistent with the stratigraphic positions and cross-cutting relations of these rocks. The Late Proterozoic Rb/Sr isochron age of 1070 Ma for the Cardenas Basalt reported in Austin is also consistent with its stratigraphic position.

The 1300 Ma age for the Pleistocene basalts determined by Austin from his data is clearly inconsistent with more recent work of Dalrymple and Hamblin (1998). These workers measured  $^{40}\text{K}/^{40}\text{Ar}$  isotopic ratios in 65 whole rock samples from the lavas which flowed into the canyon and temporarily dammed the Colorado River at least 13 different times. The ages obtained lie in the range 0.684 Ma to 0.443 Ma. With few exceptions, the relative ages of the 65 samples analyzed are in the same order as

Radiometric dating of rocks and minerals works by modeling the time elapsed since the formation of a sample by measuring the ratio of the abundance of a parent isotope to the abundance of its daughter isotope produced by radioactive decay. The rate at which a radioactive parent isotope decays to its daughter isotope is well known. To correct for the ratio of this isotope pair present at the time of formation of the sample, we use the so-called "isochron" method (Dalrymple 1991). This requires that we analyze a number of samples that geologic criteria indicate were cogenetic (that is, they formed at the same time) and from a medium which had a common, uniform ratio of the two isotopes. A typical example would be a sample of rocks and minerals extracted from a single volcanic extrusion with a common initial isotope ratio acquired from that lava. For samples which are cogenetic, the isotope ratios of parent to daughter, normalized to a non-radiogenic isotope of the daughter element, plot on a straight line, termed an isochron. This is because, in each sample, the parent isotope decreases and the daughter isotope increases at the same fixed rate due to radioactive decay. Having obtained an isochron we can determine the initial parent to daughter isotope ratio and correct for it in calculating the time elapsed since the formation of the rock.



**The crux of the book is a lengthy and detailed, but ultimately failed, attempt to rebut published accounts of the geology, paleontology, and dating of the strata of Grand Canyon and to present re-interpretations consistent with the Genesis story.**

that in which the lavas erupted, determined by superposition. These exceptions appear to have been caused either by the presence of carbonate, which interferes with the clean-up process during Ar extraction, or by the presence of "dunite xenoliths" which contribute unknown and varying amounts of inherited  $^{40}\text{Ar}$  (Dalrymple and Hamblin 1998). Dunite xenoliths are remnants of unmelted older parent material from which the basalt magma (melt) was originally formed and so are much older than the lava flows.

Austin's "test" of Rb/Sr isochron dating of these same Pleistocene basalts has been examined and thoroughly refuted by Stassen

(1997). In an earlier publication Austin (1988) used data selectively from Leeman (1975) to plot a seemingly reliable Rb/Sr isochron which gave an apparent age of 1500 Ma for these Pleistocene lavas. In a section of his paper headed "Fictitious Isochron Ages", Austin (1988) noted that such "false Rb/Sr isochrons" have been well documented in the scientific literature. Citing this literature, Austin (1988) explained that false isochrons are caused by isotopes such as  $^{87}\text{Sr}$  being "inherited from the molten material's source at great depth in the earth". Stassen (1997b) points out that this statement indicates that Austin knew he would get a false isochron long before collecting his own samples from the Western Grand Canyon for Rb/Sr analysis. The study of Pleistocene basalts described by Austin in MTC, rather than being a true test of Rb/Sr isochron dating, was an exercise in reproducing a previously-determined false isochron.

## CONCLUSIONS

My copy of Webster's dictionary defines bibliolatry as, "absolute dependence on a group of sacred writings as infallible". Where others have read the "rock-leaved bible of geology", the authors of *GTC* bring a different bibliolatry to the Grand Canyon. The book presents a more detailed argument than any previous creationist publication on geology. The crux of the book is a lengthy and detailed, but ultimately failed, attempt to rebut published accounts of the geology, paleontology, and dating of the strata of Grand Canyon and to present re-interpretations consistent with the Genesis story. Such re-interpretations are buttressed by some original creationist research. However, a case of contamination of pollen samples, 12 oriented nautiloids, the tale of 94 squirrel skins, some experiments with tracks made by newts in an aquarium, and wilful misinterpretation of radiometric dates based on five Rb/Sr isotopic ratios scarcely constitute a deluge of new

compelling evidence for the flood of Noah.

In yet another sense I found it difficult to understand for whom the book is intended. Creationists relying on unquestioning faith do not need physical evidence; the rest of us, particularly those more technically trained, are likely to find that the close examination of the evidence presented in MTC leads us even further away from bibliolatry. In presenting their strict, religiously-based, interpretation of such a well-studied and spectacular region as the Grand Canyon—an interpretation which is in stark contrast to that of main-stream geologists—the authors apparently willingly accept the risk of bringing their fundamentalist religion into disrepute. Presumably their expectations were otherwise. Decide for yourself by joining us in the Grand Canyon on the first NCSE *Creation/Evolution Grand Canyon Raft Trip!* (See p. 25 for details!)

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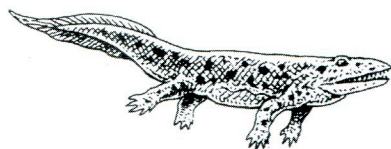
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## APPENDIX I

### THE LAWS OF THERMODYNAMICS

The laws of thermodynamics describe the internal energy in a system and how that energy may be exchanged between the system and its surroundings. The variables that describe the internal state of a system concern the total energy of molecules making up that system in terms of temperature, gas pressure, and volume. The first law of thermodynamics describes how work and heat *change* the internal state of the system. The internal energy of a system can be lowered by converting heat to work, just as the internal energy can be raised by converting work to heat. The "conservation" of energy refers to the fact that internal energy *can and does* change, and we can use the relationship between heat and work to estimate the speed and intensity of the change.

The second law of thermodynamics describes a preferred direction in the transfer of energy—from a state of higher to lower internal energy. This means that, if the energy of the surroundings is lower than that within a system, then that system will gradually exchange energy with its surroundings until the energy states match. The second law also tells us that the conversion of heat to work is not absolute; there is always some heat that dissipates in the process, and this causes the total energy available to the system to decrease. The second law also tells us that the "tendency to entropy" (or disorder) that seems to be inevitable can be reversed simply by adding energy to the system from another source; volcanic eruptions or solar radiation are two of the more common sources of this added energy on earth.

[From BW Tillery. *Physical Science*, 4th edition. New York: WCB/McGraw-Hill. 1999; compiled by AJ Petto.]

## GLOSSARY

### GETTING TO KNOW ROCKS AND MINERALS

**Mineral.** A mineral is generally a solid, inorganic compound. The atomic structures, chemical compositions, and physical properties vary somewhat, but, for example, all quartz crystals have the same properties whether in sandstone or in granite or in lava.

**Rock.** A rock is a collection or aggregation of a number of different minerals fused together in certain combinations. Rock is classified into 1 of 3 groups depending on how it is formed.

**igneous.** Igneous rock is formed as magma cools. This type of rock may be produced as lava flows cool on the surface (or the ocean floor) or as the molten rock forces itself between other rock in the earth's crust.

**sedimentary.** Sedimentary rock is formed as mineral particles are deposited in layers in lakes, river deltas, dunes, or seabeds. The particles can be transported by glaciers, wind, or water.

**metamorphic.** Metamorphic rock is formed as igneous or sedimentary rocks are subjected to intense pressure and/or heat. This causes the structure and the properties of the rock to be changed. If enough heat and pressure are applied, the rock melts to become magma again.

**The Rock Cycle.** The rock cycle describes the various stages in the building and remodeling of the rocks which make up the earth. For convenience the cycle starts with molten magma below the earth's crust. The magma slowly rises to the surface on currents like those we can see in boiling water. When it invades the solid crust or reaches the surface, the magma cools and forms solid rock. Movements in the earth's crust and erosion by ice, wind, and water cause minerals to be worn out of the rock and cause deeper rock to be exposed to the surface. These minerals are transported and deposited in layered sediments which solidify into rock. The intense pressure and/or temperature applied to sedimentary and igneous rock by geological processes transforms it into metamorphic rock. Higher pressure and temperature can transform any solid rock back into molten magma to complete the cycle.

**Basalt.** A fine-grained igneous rock—the most abundant type of lava.

**Dikes.** Small intrusions by molten rock.

**Gabbro.** A coarse-grained rock common in plutonic intrusions poor in quartz and silica.

**Gneiss.** A banded metamorphic rock rich in quartz and feldspar and formed under high temperature and pressure.

**Intrusions.** Cooled molten rock which has forced itself between other cooled rocks in the earth's crust.

**Plutons.** Intrusions by molten rock which form large masses.

**Schists.** A metamorphic rock rich in feldspar, quartz, and mica formed under moderate pressure and low to moderate temperature.

**Shale.** A fine-grained sedimentary rock rich in clay minerals and often containing fossils.

[From C Pellant. *Rocks and Minerals*. New York: Dorling Kindersley, Inc. 1992; compiled by AJ Petto.]

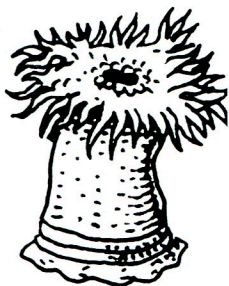


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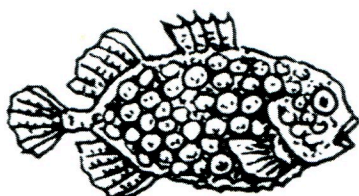
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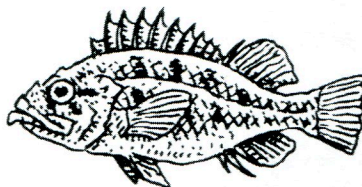
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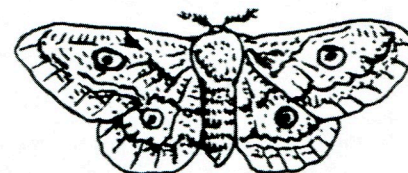
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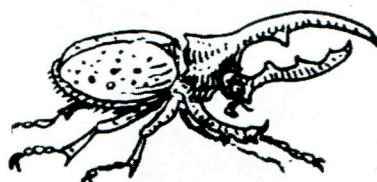
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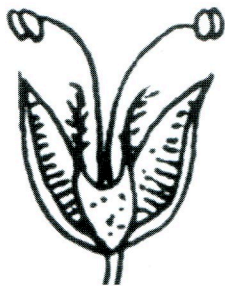
# HELP FOR TEACHING EVOLUTION

NCSE Staff

We get a lot of calls and letters from teachers looking for resources for teaching evolution. Here are some suggestions from the Web and other sources we have found helpful.

## BOOKS

On the NCSE website, you can find annotated bibliographies at <<http://www.natcensci.org/heenbib.htm>> and <<http://www.natcensci.org/dbooks.htm>> The latter is also our discount book catalog, and if you need to arrange bulk purchases just call us at 1 (800) 290-6006.



## MULTIMEDIA

The California Instructional Technology Clearinghouse lists instructional resources at its web site. Point your browser to <<http://clearinghouse.k12.ca.us>>. The mission of the Clearinghouse is to recommend to California teachers high quality software and video programs. Every recommended program has been evaluated by at least two classroom teachers using the Clearinghouse's evaluation rubrics.

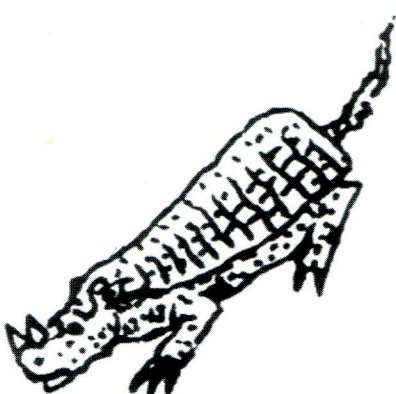
You'll also find some multimedia materials, including an excellent CD-ROM about Darwin, in NCSE's book catalog.

The University of California Extension Media Center, 2176 Shattuck Avenue, Berkeley CA

94704, supplies two videos for teaching evolution. "How Scientists Know about Human Evolution" (Catalog #38102) is an 18-minute color video for middle school and high school students. "How Scientists Know about Punctuated Equilibria" is a 20-minute color video for high school and college students. For rental or preview information, call (510) 642-0460. For purchase information, call (510) 642-5578. NCSE can provide a descriptive flyer.

In the summer 1995 issue of *NCSE Reports* John Rebers from Northern Michigan University recommended two videotapes that "give a good overview of evolutionary ideas coupled with a visually appealing presentation...suitable for the general public, high school, or introductory college audiences." Both can be previewed before rental or purchase.

Order "The Evidence for Evolution", produced by Carolina Biological/BBC, from CLEARVUE/eav at 1 (800) 253-2788. Order "Evolution" from Hawkhill Associates at 1 (800) 422-4295. To request a copy of Rebers' complete review (about 1 page), send a self-addressed, stamped envelope to NCSE, 925 Kearney St, El Cerrito CA 94530-2810, or email your postal address to us at <[ncse@natcensci.org](mailto:ncse@natcensci.org)>.



## WEB LINKS TO SCIENCE AND EDUCATION RESOURCES

Check links to educational resources listed at <<http://www.natcensci.org/edures.htm>> and to scientific organizations and publications listed at <<http://www.natcensci.org/links.htm>>. We'll soon be updating and expanding these lists. You can also check out the sites reviewed by Leslie Chan in a 2-part series in *NCSE Reports* 16, numbers 1 and 2. One of the more interesting sites that Leslie described is the "Tree of Life" website at <<http://phylogeny.arizona.edu/tree/phylogeny.html>>.

The National Association of Biology Teachers maintains a listing of on-line resources on their website at <[http://www.nabt.org/resources\\_online.html](http://www.nabt.org/resources_online.html)>. You can also check out the resources at the National Science Teachers' Association <<http://www.nsta.org/onlineresources/>>. There are some pre-college materials available from the National Science Foundation <<http://www.nsf.gov/home/students/start.htm>>, and you should definitely visit the National Institutes of Health Office for Science Education home page <<http://science-education.nih.gov/homepage.nsf>>.

The National Institute for Science Education, a collaboration between the National Science Foundation and the University of Wisconsin in Madison, sponsors "The Why Files" at <<http://whyfiles.news.wisc.edu/>>. The perfect antidote to the "X Files" perhaps? WGBH in Boston (producer of NOVA) maintains a website for teacher resources at <<http://www.wgbh.org/wgbh/learn/index.html#classroom>>.

Finally, there are science "corners" and links in websites of many state departments of education or public instruction. These and the websites of the



regional educational laboratories affiliated with the US Department of Education can be reached through <<http://www.nwrel.org/national/>>. You will also find links to the Eisenhower National Clearinghouse for Mathematics and Science Education at <<http://enc.org/>>.

Meanwhile, be sure to check the very rich list of resources offered by the Association for Supervision and Curriculum Development (ASCD) at <<http://www.ascd.org>>. On their top page, click on "Educational Links" and then click on links to "science" and other keywords that seem appropriate. It was there that we discovered the California resources site described above.

If you enjoy web-surfing, a rich but changing resource can be the sites of university anthropology departments. Instructors frequently use them to post bibliographies, photos of primates

or of rare fossils, and other materials for use by their students. You can select material that will be useful and enjoyable for secondary students. For the adventurous at heart there is the wide net cast by search engines such as Yahoo and Altavista.

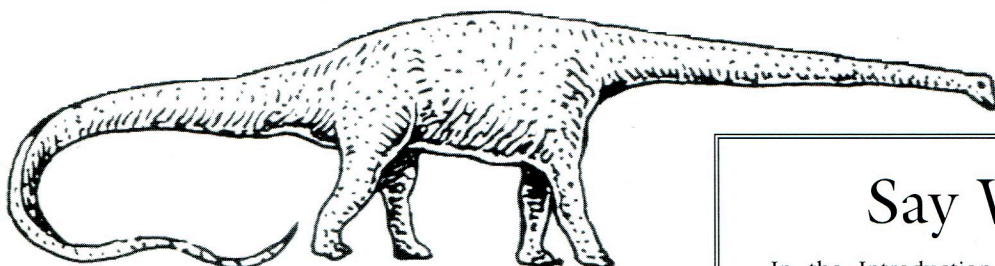
#### NETWORKING WITH OTHER TEACHERS

Besides using the resources of your professional associations, and continuing education, consider exploring Internet newsgroups and other on-line discussion sites. Explore discussion fora offered by your service provider, and be sure to follow the link from NCSE's site to the Access Excellence site where science teachers exchange ideas. The ASCD website mentioned above also hosts some teacher forums. The "Secondary Biology Teacher Enhancement PI"—BIOPI-L—is a "listserve" which brings a discussion forum to your email box.

When you send a note to the listserver, it is mailed to all members, and their discussions are emailed to you. To subscribe, send email to this address: <[LISTSERV@LISTSERV.KSU.EDU](mailto:LISTSERV@LISTSERV.KSU.EDU)>; in the body of your message, write "subscribe BIOPI-L [your name]".

#### WHAT ABOUT CHALLENGES TO EVOLUTION EDUCATION?

NCSE has a large library of information on this issue; if you have additional questions after exploring our site, feel free to ask! (Be sure to check our lecture schedule at <<http://www.natcensci.org/coming.htm>> for opportunities to attend public lectures or workshops; also check for answers to commonly raised issues at <<http://www.natcensci.org/broclist.htm>>.



The Institute for Creation Research has released a position statement on science education written by Steve Deckard. It was published in Impact number 306 and is also available on the web at <<http://www.icr.org/pubs/imp/imp-306.htm>>.

Deckard writes that this statement is "...an effort to...establish a firm Biblical base for the discipline of science education...."

The "Game of the Year", according to the Dec 1998 *Games* magazine, is "Fossil" (by Rio Grande, about \$30). Aside from the artwork on the game pieces, it doesn't seem to have much to do with paleontology; instead, it involves collecting and trading pieces trying to form sets.

[Contributed by Mark Isaak.]

## Say What?

In the Introduction to his book *Neglect of Geologic Data*, DA Wonderly says the following relative to evolution:

A great many evangelicals now rely on the published works of prominent young-earth leaders who are aware of only minor amounts of data relating to some of the subjects with which they deal. ... The immense amount of non-radiometric data which indicates long periods of time prior to the creation of man is almost totally neglected by these creationist authors. They suppose that most geologic research reports contain attempts to support evolutionary theory, and thus avoid them. However, there are many, many geologic publications, both old and new, which show no detectable evolutionary purpose.... The creationist leaders also frequently say that those of us who recognize the evidences [*sic*] for long periods of time which are found in the earth's strata do so by relying on a stereotyped form of uniformitarianism left over from the 18th and early 20th centuries. This is not at all the case.

Wonderly DA. *Neglect of Geologic Data: Sedimentary Strata Compared with Young Earth*. Hatfield (PA): Interdisciplinary Biblical Research Institute, 1987.

[Contributed by Jim Moore]





# Evolution as a Heuristic

Robert Siegfried

**"**If you will not let me treat the Art of Discovery as a kind of Logic, I must make a new name for it. Heuristic, for example" (William Whewell, quoted in Todhunter, 1970).

Creationists continue to claim scientific validity for their version of "scientific creationism" and to demand its admission to the science classrooms of the nation's public schools. If both "models" are fairly presented, they say, students would overwhelmingly prefer the creation model over the evolutionary view.

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**One of the major factors in this rapid transformation was the recognition that evolution provided a more rational way of organizing natural history than the traditional view of providential design.**

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This may be good propaganda, but the claim ignores the historical fact that we had just such a choice once before, and we chose evolution. What the creationists overlook is that before the publication of *Origin of Species* nearly everyone was a creationist—scientist and layman alike—and that a few years later, nearly

everyone, scientist and layman alike, had become an evolutionist.

One of the major factors in this rapid transformation was the recognition that evolution provided a more rational way of organizing natural history than the tradi-

tional view of providential design. In particular, as a whole new way of looking at nature, it generated vast new areas for investigation not previously perceived. This heuristic, or exploratory, advantage of evolution has been little used in current debates, yet evolution continues to be an excellent heuristic, while creationism has no exploratory consequences at all. It is my purpose in outlining the heuristic argument at Darwin's time to provide additional perspective on today's debates.

The doctrine of special creation that dominated biological thinking in the century before Darwin was not basically different from so-called "scientific creationism" today. Both were derivatives of the faith in the absolute validity of the Genesis account of creation. But if one has belief in a final truth, then there is no need for further investigation, and this is the end of science. Darwin and his colleagues recognized this barrier to the search for the enlargement of human understanding of nature.

The capacity of evolutionary thinking to elucidate the facts is nowhere more effectively demonstrated than in the *Origin* itself where page after page is filled with observations demonstrating patterns and interrelationships of facts that could hardly have been noted without the guiding hypothesis of evolution. In the final chapter Darwin makes clear the heuristic function of his theory which will give a new sense of order to what it already known, and open vast prospects for new understanding.

[W]hen we regard every production of nature as one which has had a history; when we contemplate every complex structure and instinct as the summing up of many contrivances, and each useful to the posses-

sor...when we thus view each organic being, how far more interesting...will the study of natural history become!

A grand and almost untrod-den field of inquiry will be opened, on the causes and laws of variation, on correlation of growth, on the effects of use and disuse, on the direct action of external condition, and so forth. The study of domestic productions will rise immensely in value. A new variety raised by man will be a far more important and interesting subject for study than one more species added to the infinitude of already recorded species. Our classifications will come to be, as far as they can be so made, genealogies; and will then truly give what may be called the plan of creation (C Darwin, p 486).

Rules of classification, he added, will become simpler, embryology will reveal structure, geographical distribution will be illuminated by increased geological knowledge, changes of climate, and so on. All these and many more areas of human curiosity will be freshly perceived through the perspective of descent with modification.

In addition to listing the benefits of his evolutionary perspective, Darwin also noted the negative effects of the prevailing doctrine of special creation. For too many years, naturalists had viewed species as specially created to occupy the niches into which they are clearly adapted. But this traditional view could now be seen for what it was, a way "to hide our ignorance under such expressions as the 'plan of creation', 'unity of design', &c., and to think that we give an explanation when we only

*Robert Siegfried is a long-time member of NCSE and Professor Emeritus of the History of Science from the University of Wisconsin, Madison. He has been active in supporting evolution education and confronting creationism nationally and throughout the upper midwest for over 20 years.*



restate a fact." And the sterility of such views is further disguised by assuming a "reverent silence" instead of seeking causal explanations (C Darwin, p 482-3). It is, after all, the office of science to investigate nature, not merely to admire it.

Darwin's earliest confidant, botanist Joseph Hooker, resisted for 14 years Darwin's arguments for descent with modification. It was only while Darwin was rapidly writing *Origin* that Hooker indicated that he was going to organize his "Essay on Australian Flora" according to the new views. Darwin was delighted and wrote to Hooker, July 13, 1838 emphasizing the opportunities the theory created.

You cannot imagine how pleased I am that the notion of Natural Selection has acted as a purgative on your bowels of immutability. Whenever naturalists can look on species changing as certain, what a magnificent field will be open—on all the lines of variation—on the genealogy of all living being—in their lines of migration, &c., &c. (F Darwin 1837: 485).

And Hooker in turn expresses the heuristic advantages of evolution when explaining his intentions to his botanical colleague William H Harvey.

What I shall try to do is, to harmonize the facts with the newest doctrines, not because they are the truest, but because they do give you room to reason and reflect at present, and hopes for the future, whereas the old stick-in-the-mud doctrines of absolute creations, multiple creations...are all used up, they are so many stops to further enquiry; if they are admitted as truths, why there is an end of the whole matter, and It is no use hoping ever to get to any rational explanation of origin or dispersion of species—so I hate them (Huxley 1918:481-2).

The deadening effects of a strong commitment to special creation is nowhere more clearly illustrated than by Adam Sedgwick In his 1860 review of *Origin*.

Change the conditions of life, he admits, and old species would die out, and new species *might* have room to come in and flourish. But how, and by what causation? I say by *creation*. But, what do I mean by creation? I reply, the operation of a power quite beyond the powers of a pigeon fancier, a cross-breeder, or hybridizer; a power I cannot imitate or comprehend; but in which I can believe. (Quoted by Hull 1973:161).

By declaring his faith in a "power I cannot imitate or comprehend", Sedgwick has set the problem of species outside the scope of human inquiry, and in Hooker's words, "there is an end of the whole matter."

In contrast to the stultifying effects of creationism, Thomas Huxley saw in Darwin's work the fulfillment of the highest aims of science and humanity itself.

The known is finite, the unknown infinite; intellectually we stand on an islet in the midst of an illimitable ocean of inexplicability. Our business in every generation is to reclaim a little more land, to add something to the extent and the solidity of our possessions. And even a cursory glance at the history of the biological sciences during the last quarter of a century is sufficient to justify the assertion, that the most potent instrument for the extension of the realm of natural knowledge which had come into men's hands, since the publication of Newton's "Principia," is Darwin's "Origin of Species" (F Darwin 1887: 557).

An additional century has not altered the validity of Huxley's assessment, and the creationism so vigorously rejected then still has no

place in the intellectual toolbox of science today.

## SUMMARY

A good scientific theory provides not only a rational organization of factual information, essential for effective pedagogy, but also stimulates questions that lead to further investigations, new factual knowledge of nature, and modification and expansion of the theory. Evolution continues to do this even as it has been modified. Creationism has NO exploratory consequence and thus has no justifiable place in science classrooms.

## CHALLENGE

If this heuristic function of evolution and all scientific theories can be conveyed to the general public, surely evolution will be generally supported as good science, and creationism recognized as not science at all. To meet this challenge we need to develop and present a series of specific examples of how evolutionary thought has led directly to the discovery of valuable knowledge in the biological sciences. Examples from agriculture and medicine would perhaps be most persuasive to those who determine classroom curricula: school boards, school administrators, teachers, and parents. All of us who support evolution in science education should take up this challenge.

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## AUTHOR'S ADDRESS:

Dr Robert Siegfried  
2206 West Lawn Ave  
Madison WI 53711-1952



# BOOKREVIEW

*Children of the Ice Age: How a Global Catastrophe Allowed Humans to Evolve*

by: Steven M. Stanley, 1998.  
New York: WH Freeman and  
Company. 277 p.

Reviewed by Richard Sberwood,  
Department of Anthropology,  
University of Wisconsin,  
Madison, [rjsberwood@fac-staff.wisc.edu](mailto:rjsberwood@fac-staff.wisc.edu).

As an anthropologist currently working on issues concerning the origin of our genus, I was immediately intrigued when Steven Stanley's *Children of the Ice Age* arrived in my office. While the title caught my eye, it was the subtitle *How a Global Catastrophe Allowed Humans to Evolve* that caught my attention. In recent years the paleontological community has been replete with descriptions of global climatic changes brought on by asteroid impacts, volcanic eruptions, or other such phenomena. While climatic changes have been discussed with regard to human evolution for many years, no one had really suggested a catastrophic origin for these changes. I was curious to find out if Stanley had identified such an event.

The book begins by identifying three mysteries: 1) Why had the earliest hominids — the *Australopithecines* — existed for a million and a half years relatively unchanged? 2) Why did the *Australopithecines* disappear rather rapidly? and 3) What was the reason for the rather abrupt appearance of early members of our own genus, the genus *Homo*?

Those familiar with Stanley's work know that he is one of the major proponents of the model of punctuated equilibria which

states that species will endure long periods of stasis "punctuated" by short periods of rapid, often dramatic, change. By looking at the three mysteries proposed it is obvious that punctuated equilibria will play a major role in this investigation. As it is fairly easy to explain why a species would not change under somewhat stable conditions, it is the periods of punctuation which require the most attention. In the introductory chapter Stanley identifies a global climatic change, specifically the beginning of an ice age, which serves as the answer to all three mysteries.

After setting the scene with historical background and discussions of current interpretations of early hominids, Stanley gets to the meat of his argument that involves the mechanism for onset of the ice age in question—the uplift of the Isthmus of Panama and the resulting shift in oceanic currents. For an event of such importance it is interesting to note that discussion of this event receives only 1 figure and 5 pages of discussion in a book that is 277 pages long. I have to admit it left me wanting.

If the discussion of the pivotal event in human evolution is reduced to only five pages, what is covered in the rest of the book? A great deal of time is spent discussing the fossil evidence, and this is where I begin to have problems. The first problem is that historical information is presented out of context. For instance, the anthropological community is criticized for having accepted the single-species hypothesis. According to this view, only one species of early

human could exist at any one time because competition would be too great for multiple species to co-exist. The single-species hypothesis was most popular prior to 1970, but the subsequent, rapid increase in the number of fossil specimens, resulting from the work of Richard Leakey at Koobi Fora, put it to rest. In the 1960s it was not unreasonable to believe in the single-species hypothesis given the available material.

The representation of the fossil record is also a little biased. Stanley presents *Australopithecus* as a genus that underwent little change for most of its existence. In table 1, I provide a list of currently accepted hominid species and their chronology. There are currently 4 species of *Australopithecus* recognized. While some species appear to have existed for a considerable period of time, it is apparent Stanley's characterization of this genus as "stable" may not be warranted.

Another issue is that Stanley continually focuses on early hominids at the generic level, that is *Australopithecus*. If we take a step back and look at the next higher taxonomic category, the subfamily Australopithecinae, the genera *Paranthropus* and *Australopithecus* are now included. This gives us a very different picture than the one Stanley paints. We see a highly variable lineage with multiple speciation events. One part of the lineage, species of the genus *Paranthropus*, even arises after the global event said to have decimated *Australopithecus*. *Paranthropus* demonstrates many of the defining characters



TABLE 1

TAXON	COUNTRIES	TIME
<i>Ardipithecus ramidus</i>	Ethiopia	4.5 mya
<b>Early australopithecines</b>		
<i>Australopithecus anamensis</i>	Kenya	4.2-3.9 mya
<i>Australopithecus afarensis</i>	Ethiopia, Tanzania, Kenya	4.0-3.0 mya
<i>Australopithecus africanus</i>	South Africa	2.8-2.2 mya
<i>Australopithecus bahrelgazali</i>	Chad	~3.0-3.4 mya
<b>Robust Australopithecines</b>		
<i>Paranthropus aethiopicus</i>	Kenya, Ethiopia	2.7-2.3 mya
<i>Paranthropus robustus</i>	South Africa	2-1.5 mya
<i>Paranthropus boisei</i>	Kenya, Tanzania, Ethiopia	2.0-1.0 mya
<b>Early Homo</b>		
<i>Homo habilis</i>	Kenya, Tanzania, South Africa	2.0-1.6 mya
<i>Homo rudolfensis</i>	Kenya, Ethiopia	2.5-1.6 mya
<i>Homo ergaster</i>	Kenya, Tanzania	2.0-1.6 mya
<i>Homo erectus</i>	Kenya, Tanzania, South Africa, China, Java	1.8-0.5 mya

Mya=million years ago

Stanley uses for *Australopithecus* (small brain and primitive limb structure), yet discussion of this group, and why they may have survived this catastrophe, is extremely limited.

Continuing towards our own genus, Stanley claims that punctuated equilibrium is obvious because of the lack of intermediate fossils between *Australopithecus* and *Homo*. This is largely because he dismisses *Homo habilis* from the possible inclusion in either genus because of its enigmatic anatomy. He admits these specimens display traits that may have been more *Australopithecus*-like, but ignores the dental, basicranial, and facial features linking these specimens to the genus *Homo*. In this light, *Homo habilis* may serve as good evidence of an intermediate form.

Do these differences affect the thesis presented in the book? The question becomes, "How do we want to interpret the fossil record?" Most anthropologists will agree that hominid evolution took a new turn 2.5 million years ago resulting in a novel animal which eventually led to humans. Was this change the result of a rapid catastrophic change in climate, or simply the inertia of a continuing evolutionary trajectory? The purpose of a book like this is to initiate such discussions not only among researchers but

among all interested parties.

While disagreements between researchers are not unexpected in a work such as this, there is an aspect of this book that is indisputably problematic. I believe that one of the most dramatic pictures available is the striking visual image of these fossils. On a scientific level the appearance of fossils is obviously important to me, but I also believe there is an aesthetic beauty to these specimens. Anyone familiar with the photographs in *National Geographic*, or in a number of coffee-table books currently available, is aware of this. Figures are very rare in *Children of the Ice Age* and, when present, are always simple line drawings. These do little to assist in understanding the arguments presented and are of no aesthetic value.

In the end I feel I should recommend the book. It is true there are better historical accounts, and certainly better graphics, available. Ultimately, though, this book is interesting and important because it addresses an issue of great consequence to us all—why are we here? It covers a large number of issues ranging from aspects of evolutionary theory to determinants of global climate. All of this is synthesized into a novel conclusion that leads us a step closer to understanding a crucial period in our evolutionary history.

#### RECOMMENDED READING

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#### THE ESTHETICS OF FOSSIL CRANIA

Just as we were finishing the layout of this issue, Phillip Walker at the University of California, Santa Barbara emailed us with this offer:

NCSE members might be interested in our web site with 3D images of the fossil evidence for human evolution located at <<http://www.sscf.ucsb.edu/~hagen/crania/>>.

You will need to download a plug-in to take full advantage of the site, but it is well worth the effort.



# BOOKREVIEW

## *Teaching About Evolution and the Nature of Science*

edited by Donald Kennedy, 1998. Washington, DC: National Academy Press, 140 p. ISBN 0-309-06364-7, perfect-bound 8 by 11 inch paperback. \$19.95 from National Academy Press, 2101 Constitution Ave. NW, Lockbox 285, Washington DC 20055. 1-800-624-6242; <<http://www.nap.edu/bookstore>>.

*Reviewed by David Kopaska-Merkel, Geological Survey of Alabama, PO Box 0, Tuscaloosa AL 35486. Email: <davidkm@ogb.gsa.tuscaloosa.al.us>.*

This attractive volume explains why teachers should teach about evolution, gives 8 sample activities that teach evolutionary principles, and answers frequently asked questions. The book was written as a resource for science teachers and also as a primer for those required to teach science who know little of evolution. It succeeds admirably. Every school library should have a copy, and every science teacher should read it. The book will also be valuable for scientists who wish to help teachers teach evolution or who will be speaking about evolution to non-scientists. Scientists can use the book as a resource to teach themselves how to explain evolutionary and scientific concepts so that teachers and students can understand. The book provides explanations in clear and simple terms of important concepts including the nature of science and scientific theories, and more specific topics such as natural selection and molecular evolution. Examples are elegant and apt. For instance, one example shows how more than one hypothesis can be con-

sistent with a set of facts.

The explanations of the nature of science and of scientific inquiry may be some of the most valuable parts of this book. In an excerpt from Ernst Mayr's 1997 book *This is Biology: The Science of the Living World*, science is distinguished from theology by the following characteristics of science:

- (1) scientists do not invoke the supernatural to explain "the natural world";
- (2) science is constantly open to new ideas; and
- (3) science employs first principles very different from those of religion.

The first principles of science include the assumption that there is a real world independent of our perceptions, that the world is structured and we can understand most or all aspects of that structure using scientific inquiry, and "that there is historical and causal continuity among all phenomena in the material universe." The domain of science includes "everything known to exist or to happen in [the material] universe," but does not include supernatural constructions such as spirits, angels, or gods. The openness of science to new ideas, and the testing of those ideas to determine their validity, is the essence of scientific inquiry.

The book contains 7 chapters, 5 appendices, and 3 fictional dialogs that illustrate some of the problems science teachers face in teaching evolution and how those problems might be solved. Chapter 1 is entitled "Why teach evolution?" and it is followed by a dialog that illustrates problems that can arise when teaching evolution and science. Chapter 2,

"Major themes in evolution", is followed by a dialog about how to teach the nature of science. Chapter 3, "Evolution and the nature of science", is followed by a dialog about how to teach evolution. Chapter 4 concerns evolution and the National Science Education Standards, Chapter 5 is a list of frequently-asked questions and answers, Chapter 6 is a set of 8 evolution and science activities, and Chapter 7 concerns how to select instructional materials. Appendices include court decisions, statements about the law and about why evolution should be taught, references, and a list of the book's pre-publication reviewers.

The book doesn't mince words. The true status of evolutionary science, as well as the scientific meanings of "fact", "theory", and other words that have colloquial meanings different from their scientific ones, are explained clearly and unequivocally. *Teaching about Evolution* brings up many of the arguments creationists often use and shows how to defuse them. The chapter on frequently asked questions is particularly useful because it provides concise, cogent answers that ought to find good homes in children's minds. I think teachers will also find useful the eight classroom activities presented in Chapter 6, and the criteria for selecting good instructional materials presented in Chapter 7. In particular, Chapter 7 discusses how to analyze instructional materials to determine whether they truly further the aims of the National Science Education Standards and how well they do this. Worksheets are provided to assist teachers in systematically and efficiently evaluating instructional materials.

There are places where the



book may be hard to follow. For instance, a chart on page 4 explains the history of atmospheric oxygen levels without explaining how oxygen was sequestered by reduced iron after the first photosynthesizers evolved. The breadth of the book's subject requires that many important details be omitted. However, in the case of this chart, one or two sentences might have helped science teachers with no geological training (all too common). This is also true of the fascinating missing-link story presented by EO Wilson, discoverer of a 90-million-year old insect linking ants and wasps. There is a beautiful photograph, but what should also be there is a line drawing comparing wasps, ants, and the so-called wasp ants.

I was impressed with how well this book is written. Whoever wrote most of the prose fluently translates science into plain English without sacrificing technical points. *Teaching about Evolution* is accurate and to the point, and I believe any science teacher will be able to understand it. Teachers who teach science but who have essentially no training in science (and there are many of these!) should be able to use this book with a little effort.

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## NCSE "Creation/Evolution" Grand Canyon Trip Challenge!

*Eugenie C Scott*  
NCSE Executive Director

**A**s readers of this issue of *RNCSE* have already discovered, a major challenge has been hurled at me by Dr Wilfred Elders (see pp 8-15). He's clearly well-prepared to rebut my arguments for a "young-earth creationist" view of Grand Canyon history on NCSE's "Creation/Evolution" tour of the Grand Canyon. After reading his article, you can see that he has made my job tougher.

But I remain undaunted! To provide NCSE members with a unique "Creation/Evolution" experience, Wilf and I are leading a tour down the Grand Canyon August 7-14, 1999. My job will be to explain how the layers of the Canyon were formed during the year of Noah's Flood and how the Canyon itself was cut during a few weeks by an enormous surge of water—and many other insights unfamiliar to geological science. Now, even though I will be presenting a "creation science" view of the history of the Canyon, there are major differ-

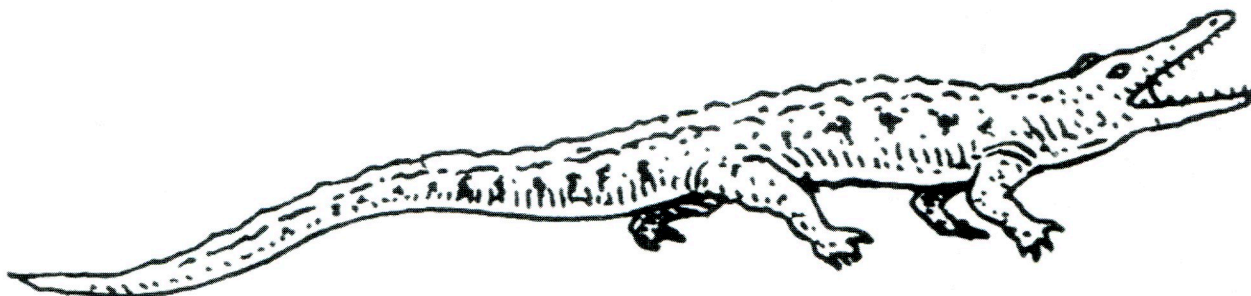
ences between NCSE's tour and those led by the Institute for Creation Research.

For one thing, these lucky 22 members will receive a solid, accurate, scientifically-sound depiction of the geological history of the Canyon by my good friend Dr Elders.

Of course, the rafters will also get *my* version..., but I think they will be able to exercise their critical thinking skills to choose between us. We NCSE members are keen on critical thinking, right?!

I know *I* am going to have a lot of fun on this trip (and Wilf is going to have even more fun showing why "my" view can't hold water).

Join us! Call NCSE for more information or to reserve a place (the first boat is already full, so don't wait too long!) By February 1, 1999, we will need a \$500 deposit to hold your reservation. You can reach us at 1-800-290-6006, or [scott@natcensci.org](mailto:scott@natcensci.org).



"Creationist beliefs, on the other hand, can never increase our understanding of the physical world because what is not already known is the unknowable hand of God moving in his creation. People repeated the Genesis story to each other for 3000 years and at the end of the day knew no more about biology than when they started. In about 200 years of a scientific approach we have learned most of what we know about how living things work."

Comments by Rick Littrell on TalkOrigins available at <http://www.talkorigins/feedback/oct98.html>



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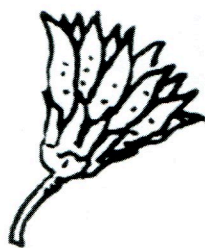
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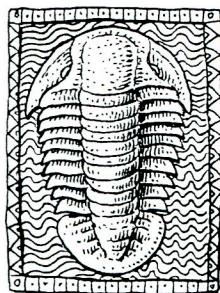
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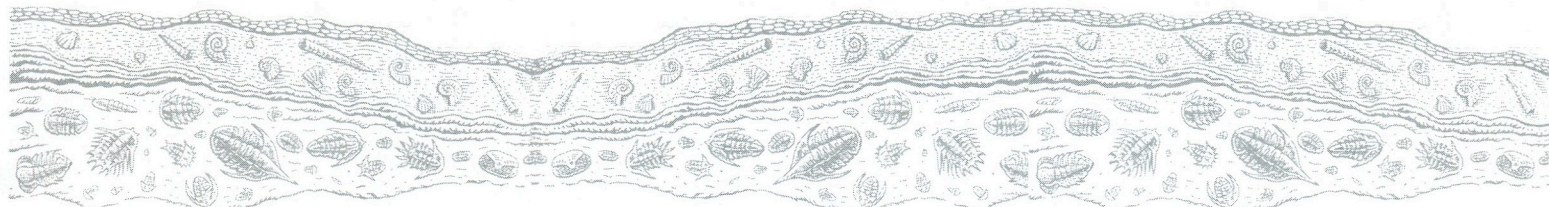
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## TRACE FOSSILS AND PRE-CAMBRIAN LIFE

Researchers working in India reported what appear to be trace fossils in pre-Cambrian sandstone. Adolf Seilacher and colleagues reported in *Science* that they found burrows left from the movement of worms under an algal mat in sediments about 1 billion years old. These predate the Cambrian "explosion" by about 540 million years and are in better agreement with molecular data about the origin of animals than fossils found in later strata. The authors also propose that it was the development of the hardened skeleton which made the rapid evolution of later taxa possible.

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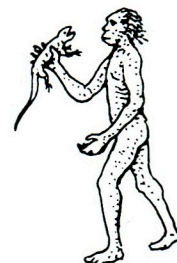
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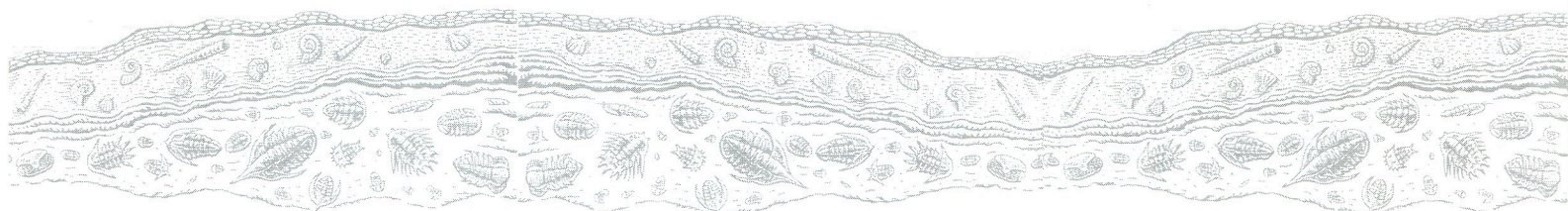
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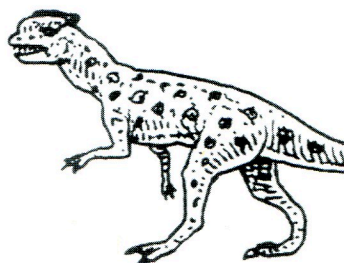
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## ENSIWEB: Lessons for Teaching Evolution and the Nature of Science.

On 9 October 1998, ENSIWEB, a new web site for teachers of biology, was announced to science educators. The site opened with 16 lessons on the site and with immediate plans to add another two or three dozen more over the next several months. The URL is <<http://www.indiana.edu/~ensiweb>>.

These lessons were gathered, created, developed, and classroom-tested by many biology teachers from across the nation during nine years of NSF-funded summer institutes. They were designed to help teach basic concepts in the areas of evolution and the nature of science (ENSI) more realistically. These concepts are treated as central to the teaching of biology and, therefore, do a much better job at communicating the fundamental character of the biological sciences.

For more information, contact Larry Flammer, ENSI webmaster, via email at <[flammer2@pacbell.net](mailto:flammer2@pacbell.net)>.

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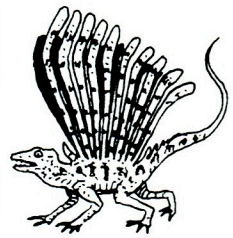
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