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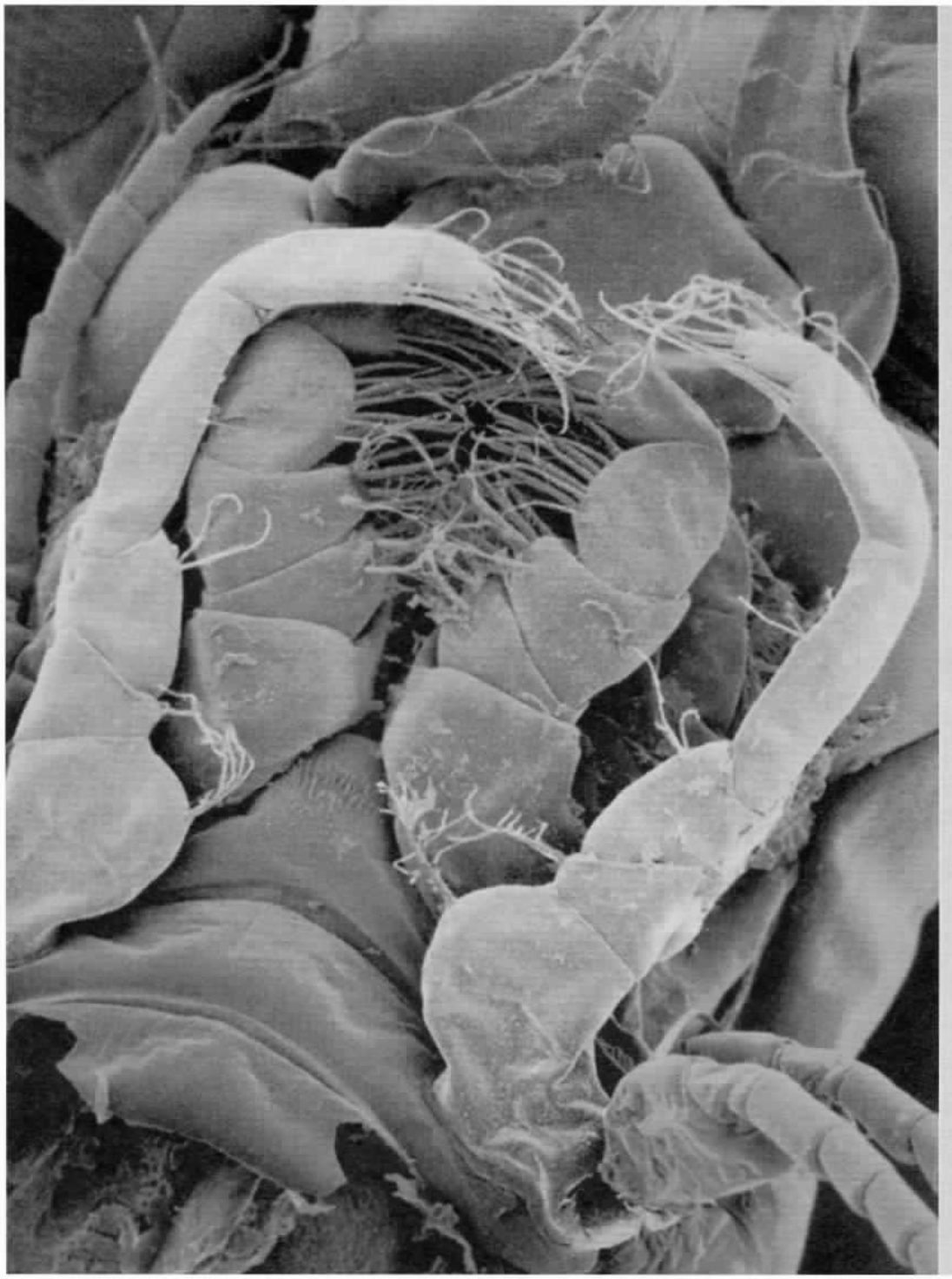

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NCSE REPORTS &
CREATION/EVOLUTION

A Year at NCSE—1997

The Tale of the Whale

Pandas Update—1997

Creationist Geology and Intuition

Members Making a Difference

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FROM THE EDITOR'S DESK

THE FIRST YEAR OF *RNCSE*

RNCSE is now a year old. After the growing pains and the re-orientation to our new form, we will be making a few changes in the publication which we hope will help us provide better service to members and readers. Some of these changes have already appeared, and some are yet to come.

Alert readers will have already noticed changes in the format and layout of the centerfold. This part of *RNCSE* is devoted to the NCSE sales program and features evolution-related resources that members can purchase at a discount (of course, *anyone* can buy these materials from us). During 1997 we began to provide short descriptions of some of the many items that NCSE offers for sale, and we organized each issue's centerfold around a theme. We also experimented with the layout of the centerfold to make the theme and new materials more obvious to our readers. We hope you will provide feedback on whether these changes make the centerfold more useful.

We also responded to reader comments about our feature and news articles. We will keep these articles short (3-5 columns) and uncluttered by lots of references within the text. However, because we believe that identifying the sources of our information is so important, we will include sufficient information in these articles so that readers will be able to find the original sources. These will be included at logical breaks in the text, such as at the ends of sentences or paragraphs, or in a short citation at the end of the article.

There were many other comments—most very constructive and helpful—but none of them formed a consensus of opinion on what would be most helpful. Please be assured that we listened, but that we heard many different opinions on various other aspects of format. Keep those comments rolling in, and we will respond to a consensus that develops. And thanks for caring enough to make your voices heard.

1997 IN REVIEW

This issue contains two items that help us to look back at 1997. Molleen Matsumura reports on the "traffic" through the office as requests for help and information about anti-evolutionary activity roll in from across the nation. Frank Sonleitner has also allowed us to print his annual review of research into evolutionary biology that bears directly on the claims mounted against evolution in *Of People and Pandas*. Frank has presented this as an extended annotated bibliography organized according to the issues raised in *Pandas*. In contrast to the lack of research by the proponents of "intelligent design" which George Gilchrist reported in *RNCSE* 17.3, it is clear that evolutionary biologists are a very active lot.

We have also reprinted three significant articles from 1997. Larry Witham's much acclaimed article from the *Washington Times* describes religious beliefs in the scientific community. We also carry reports on two significant research discoveries. Clive Anderson's report in *New Scientist* describes how complex systems can develop out of simple building blocks in a "selecting" environment. Bill Burton brings us a report from the University of Chicago about how walking limbs and feeding limbs are developed from homologous structures based on the activation and location of a single developmental gene.

REVIEWS

Robert Pennock has a look at Phillip Johnson's latest book *Defeating Darwinism by Opening Minds*. Rob says that this book will be familiar to those who have followed Johnson's writings lately, but there are also a few surprises. We also feature a review by Hans Andersen of a new set of curriculum materials for studying cosmology and origins with young children. We are pleased that Hans recommends this material that was developed in part by an active NCSE member.

CONFRONTING ANTI-EVOLUTIONISM

Who doesn't remember Duane Gish's infamous "bossie-to-blowhole" slide for ridiculing the current state of knowledge on the evolution of whales? Kevin Padian reviews the current status of our knowledge of whale evolution and tells us (again) why Gish was wrong. Karen Bartelt describes her visit to the Institute for Creation Research's Museum of Creation and Earth History in the company of a cohort of skeptics.

AND MUCH, MUCH MORE...

So, what are you waiting for? Go have a look. And thanks for your loyalty and patience this year as we have been getting our legs under us.

Anj Petto

CORRECTION

In "The More Things Change" (*RNCSE* Sept-Oct 1997; 17(5):28) John Cole referred to William Paley's famous work *Natural Theology* of 1699. The correct date for the book is 1802. Paley lived 1743-1805 and did not publish before he was born. John did catch this error prior to publication, but your humbled editor failed to get the correction onto the printed page.

NEWS

A Year at NCSE—1997

Molleen Matsumura
Network Project Director

[Each year NCSE's staff prepares a comprehensive report for the NCSE Board of Directors which summarizes our activities in education, assistance to members and the media, and more. This article has been adapted from part of the NCSE Annual Report so members can have a more complete view of NCSE activities and hear the story behind the stories that appear in RNCSE.]

In 1997, NCSE responded to over 1300 requests for information. These requests included everything from calls by reporters seeking background information on evolution/creation controversies to pleas for help with student research. As a result of such requests, NCSE was consulted or actively involved in 57 incidents in 25 states, two incidents at the national level, and one at the international level. These numbers are comparable to 1995 when we responded to 49 incidents in 22 states, plus 2 national and 1 in Canada; and 1996 with 67 incidents in 28 states, plus 3 at the national level. Of course raw numbers are only part of the story, since solving some problems may require hundreds of staff hours, while others are resolved very quickly.

Overall Trends

Evolution/creation issues seem to be drawing more national attention for numerous reasons. One is that this issue is one of many "science and religion" issues that attract media attention. From the Epic of Evolution conference sponsored by the American Association for the Advancement of Science to the nationally-televised "Firing Line" debate in which NCSE's Eugenie Scott participated, evolution is becoming a part of high-profile discussions about the relationship between scientific and religious perspectives. Another is that evolution-creation controversies are making "bigger" stories.

In 1996 we found that anti-evolution activity had returned to the state level, after having been concentrated at the local level in the years following the 1987 Supreme Court decision in *Edwards v.Aguillard*. However, the arena for state-level battles changed. In 1996 legislative politics were the center of activity, with six legislatures considering anti-evolution bills, and some states party platforms including anti-evolution planks. In 1997, only one state legislature (New Mexico) discussed evolution; in that state, two bills were introduced—one supporting evolution education, one attacking it—and both were defeated.

More recently, conflicts have shifted to boards of education. At the state level, nearly every state is developing science curriculum standards—sometimes mandatory, sometimes advisory—partly as a response to nationwide science reform efforts. In 1997 eight states adopted new content standards. However, while statewide curriculum standards are important, they are not definitive. Where evolution is included in state standards, anti-evolution policies may be still be introduced at the state level or local levels. Attacks on evolution are increasingly aimed at state content standards and the ensuing curriculum development in local districts. What is clear is that the return of state-level anti-evolution activity is definitely continuing and that anti-evolutionists work to consolidate their victories in districts where evolution has already been restricted.

Any single attack on evolution education, particularly when successful, is often one of many related activities in the region. For example in Arizona, regents of the State University approved affiliation with the Institute of Human Origins only after resolving that the university must "come back with a plan that would implement and examine the use of courses to offer alternative theories...." Shortly afterward, the State Board of Education adopted science standards omitting any mention of evolution.

Another trend that continued in 1997 is the growing importance of anti-evolutionists other than those associated with the Institute for Creation Research—many of them "old-earth creationists". These new leaders have expanded their efforts at the college level with some apparent success—we are receiving more information requests from college campuses. References to seemingly sophisticated "intelligent design" claims are commonly advanced as justification for attacks on evolution in local school districts.

National Level

In October 1997, the Board of Directors of the National Association of Biology Teachers (NABT) received a letter urging them to change the wording of an official NABT statement supporting evolution education, eliminating the words "unsupervised" and "impersonal" from a clause describing evolution. NCSE's Executive Director Eugenie Scott, who was a featured speaker at the conference, informally discussed the proposal with NABT Board members and influenced their eventual decision to accept the proposal. Thanks to this revision, which received national coverage, anti-evolutionists can no longer cite the statement as evidence that acceptance of evolution is anti-religious.

State Level

While content standards are very important, especially for shielding teachers from pressures not to teach evolution, adoption of content standards is never the "the whole story". After content standards are adopted, performance standards must be developed and textbooks satisfying these standards must be chosen. These processes may also become targets for anti-evolution activity. In New Mexico, where references to evolution had been omitted from content standards, concerned scientists sought to have it included in student performance standards.

In Illinois, a curriculum revision team added evolution to draft standards in response to expert review

and public comment, but the Superintendent of Public Instruction removed it as "controversial" on the advice of an appointed advisory team dominated by conservative Christians. After content standards that include evolution were adopted in Texas, conservative Board of Education members attempted to exclude textbooks with good coverage of evolution.

NCSE members in some states are opposing efforts to eliminate any mention of evolution from statewide assessment tests.

Local level

While state-level battles make national headlines, activities in local districts and individual classroom have a major impact on evolution education (or its absence!).

As in the past, local incidents covered a broad range. In some cases, such as Melvindale, Michigan and Tippecanoe, Indiana, local school boards considered or adopted anti-evolution policies or disclaimers.

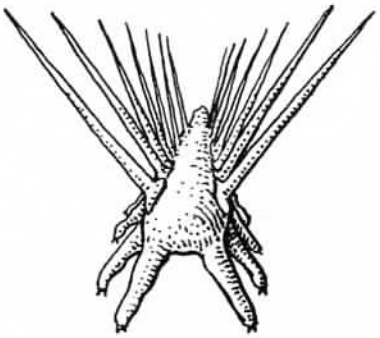
In others, some individual teachers chose to teach "creation science", while others were pressured not to teach evolution. Parental complaints about evolution education, and the use of anti-evolution curriculum materials, such as the videotape, Mysterious Origins of Man, or the "intelligent design" textbook *Of Pandas and People*, also undermined evolution education at the local level.

As in 1996, such incidents were often associated with a nearby creationist organization. For example, in 1996 the Rima Bible Institute was involved in efforts to force the Tulsa Zoo to remove evolution from some signs. In 1997 an English teacher associated with Rima offered to write a curriculum unit on "creation science" for a Tulsa public school.

Looking Ahead to 1998

In 1998, curriculum and textbook adoptions will continue to be the major arena for anti-evolution activity. Some elections will be affected. For example, a resident of one community whose school board is considering a creationist proposal wrote recently to NCSE, "Right now the board has a majority who are opposed to this, but that could change in the next election." In New Mexico a concerned scientist is attempting to replace a State Board of Education member who voted to eliminate evolution from science standards. Still, it is ironic that the commitment of many government and education leaders to improving science education in the 21st century means that attacks on evolution will multiply as state and local boards of education continue to work on improved science curricula. Already, a committee drafting science content standards for the state of California has been asked to give equal time to "creation science".

As anti-evolution attacks shift from elections and legislatures to boards of education and writing committees, media attention may move from the front page to the back page. The challenge for NCSE and its members will be to remain alert and to keep our friends and neighbors informed of the continuing need to defend good science education.



UPDATES

Arizona: On February 23, 1998, Arizona's Board of Education voted unanimously to revise recently-adopted statewide content and performance standards. Current standards avoid the topic of evolution. The unanimous vote doesn't mean there are no struggles ahead, however. NCSE member John Banister-Marx called NCSE after attending the meeting with many other NCSE members and other supporters of evolution. He reported that the board decided to have new performance standards written and that board members who advocate "creation science" made it clear that they intend to influence the composition of the new writing committee.

Idaho: Some residents of Post Falls (near Coeur d'Alene) are urging their school board to adopt a resolution requiring the teaching of creationism—a move that met strong opposition at the board's March 9 meeting. The resolution includes a "clarification" that says, "This resolution does not require or permit any instruction of religious doctrine or materials," which is explicitly forbidden by the state constitution. Superintendent of Schools Dick Harris says he plans to "improve" the teaching of "origins" and will seek advice from a variety of sources, including local clergy, the state Superintendent of Public Instruction, and the Idaho Attorney General. He also plans to review "legal" curriculum materials. In addition, an editorial writer for the *Spokesman Review* used the usual "fairness" rhetoric to support the idea of teaching "both sides" of the issue. ACLU of Idaho has written to Harris advising him that "creation science" is unconstitutional, and NCSE has sent him information explaining both legal and scientific issues in detail.

National: On March 3, 1998, the House Judiciary Committee approved a proposed "Religious Liberty" constitutional amendment. At press time a House vote on the proposed amendment had not been scheduled. If such a bill passes both houses, it would take effect only if approved by three-quarters of state legislatures. The amendment includes a provision that "people's right to pray and to recognize their religious beliefs, heritage or traditions on public property, including schools, shall not be infringed" and forbids states to "discriminate against religion". Such a drastic change could lead to new court battles and re-interpretations of church-state law in many areas, including evolution-creation controversies.

International: In the Netherlands, creationism has surfaced in a general circulation magazine published out of the Free University in Amsterdam (a Christian university) and which is sold in bookstores and other outlets. There is no creationism in state universities. Even at the Free University it seems that at least some people resist in public this brand of (young-earth) creationism. It is not a hot political issue in Holland, although creationism is present in Christian groups and Christian education centers. However, evangelist Peter Scheele has his own web site, and he recently published a creationist book (in Dutch) which he claims has sold more copies than Darwin's *Origin of Species*.

[Thanks to John Hill and Gert Korthof for some of the information used in the updates.]

ARTICLE

A Visit to the Insitute for Creation Research

Karen Bartelt
Eureka College

On January 9, 1998, a group of about 25 skeptics visited the "Museum of Creation and Earth History" run by the Institute for Creation Research in Santee, California. This tour was a part of a workshop entitled "Creation/Evolution" which was sponsored by the Committee for the Scientific Investigation of Claims of the Paranormal. The ICR staff was made aware that our group would be visiting the museum, and they suggested an introductory lecture followed by a tour of the museum.

The lecture was given by geologist Dr Steve Austin, who showed us a video which he said is also shown at the Mt St Helens visitor center. The Mt St Helens eruption was described in accurate detail, and there was a great emphasis on the velocities of the mudflows and the amounts of material that were removed and deposited elsewhere.

It was Austin's intention to use the Mt St Helens eruption to convince us that catastrophes can cause rapid, large-scale changes on the earth's surface. Austin said that he had once been an evolutionist, but that his observations of the Mt St Helens eruption had converted him to catastrophism and creationism. He set up a "straw man", implying that his "catastrophist" view of geology was something new and revolutionary in the geologic world and that "uniformitarian" (that is, mainstream) geologists ignore the role of volcanoes and other catastrophic events in the shaping the earth. One of our group leaders, PhD paleontologist Jere Lipps, took Austin to task for having such a simplistic view.

Austin continued his presentation by showing us some of his slides of the Mt St Helens area. One slide was simply described as showing "strata 25 feet high deposited by Mt St Helens". He referred to this stratified volcanic ash only as "sedimentary rock" and observed that it took only a few hours to be deposited in layers. What was implied here, of course, was that large-scale sedimentary strata, such as limestones and sandstones found in many parts of the world, could be deposited in a similar, rapid manner. I asked Austin whether he had any evidence that any of the more typical sedimentary rock—limestone, sandstone, or shale—had ever been deposited rapidly, but he provided no such example. Our group's level of geologic expertise was above average, but I wonder how many less-skeptical people have left such presentations thinking that all sedimentary rocks show evidence of rapid deposition.

Young-earth creationists would be interested in a mechanism that allowed for the rapid formation of coal (since coal would have time to form in a young earth *only* if such a mechanism existed). Austin pointed out the post-eruption burial of trees in a nearly vertical, root-down position at the bottom of Spirit Lake (apparently there are some trees in that position) and said that he was sure that coal was forming at Spirit Lake now.

He then referred to the petrified forests found in Yellowstone Park and described them as remnants of similar ancient catastrophes (to be fair, he never came right out and said "Flood of Noah"). The generally-accepted view of the petrified forests of Yellowstone—that the trees represent 27 forests, buried *sequentially* by many volcanic episodes—was not mentioned. Austin also failed to mention why, if these forests in Yellowstone were such good models for catastrophic burial and coal formation, they do not contain *any* coal deposits. Erling Dorf, in his comprehensive article on the petrified Yellowstone forests, reported the presence of conglomerates from stream deposits, breccias from mudflows or landslides, volcanic tuff from the numerous volcanic events, and lava beds—but no coal!

Though Austin described himself as "an age-dating agnostic", he was eager to share with us the fact that he alone had radiometrically dated the Mt St Helens lava dome. Using potassium/argon dating, he determined a lava dome age of 350 000 years. His unstated conclusion was that radiometric methods are unreliable and give all sorts of bogus dates. There are, however, several other explanations of his results.

First, Austin sent young, low-potassium rocks to Geochron Laboratories. Such samples are very low in radiogenic argon, which is the isotope responsible for the radioactive decay that is the basis of the dating techniques. Although Geochron specifically stated that it did not want to deal with young, low-potassium samples, Austin sent them anyway and specifically stated in his paper that he did not reveal the origin of the samples. This "omission" can result in potentially large ranges of error in the results and also opens his research to ethical questions.

Dr Karen Bartelt teaches chemistry and earth science at Eureka College in Eureka, IL.

Second, Austin may have dated some of the solid material that came up with the lava rather than the lava itself. Austin had mentioned that the lava contained xenoliths—pieces of solid rock that came up with the lava. Although Austin stated that he was careful to remove the xenoliths, we have no assurances that he succeeded; and he apparently made no effort to date the xenoliths separately. Although Austin's date was published in a "peer-reviewed" journal (*Creation Ex Nihilo Technical Journal*), this journal is "peer-reviewed" only in the sense that the journal was published by other creationists. The peer-review process of a mainstream geology journal would have demanded that he explain his unusual results more completely. Therefore, contamination by rock that is 350 000 years old or older remains a possibility.

Third, some of Austin's previous forays into the radiometric dating of rocks demonstrate that he is not an expert in this field. Austin is the head of the ICR's "Grand Canyon Dating Project". As such, he is committed to casting doubt on the radiometric ages of the lavas in the Grand Canyon. In a 1992 publication, ICR *Impact* #224: "Excessively Old 'Ages' for Grand Canyon Lava Flows", Austin asserted that he found Cenozoic (relatively recent) lavas that gave radiometric (Sr/Rb) ages of 1.34 billion years.

These assertions are completely debunked in Chris Stassen's "Criticism of the ICR's Grand Canyon Dating Project" at the Talk.Origins Archive (<http://www.talkorigins.org/faqs/icr-science.html#sec2>, last accessed 1-13-98). Stassen points out that Austin's Grand Canyon lavas came from different flows, and the "ages" of the flows may actually represent a minimum age for the mantle that served as source material for the flows. Despite the obvious problems with Austin's methods, *Impact* #224 is alive, well, and available at the ICR museum!

Austin's last point about Mt St Helens was that the rapid erosion of volcanic ash in the Mt St Helens area (which he calls the "Little Grand Canyon") was a good model for catastrophic erosion over much larger areas. He proposed the existence of large pluvial lakes above the current Grand Canyon. According to this scenario the Canyon itself was cut when the lakes drained catastrophically. Again, this presumes that recently-deposited volcanic ash has properties similar to those of lithified limestone, sandstone, and shale—something most mainstream geologists do not accept.

As a young-earth creationist, Austin presumably believes that the sedimentary strata of the Grand Canyon were laid down rapidly and catastrophically during The Great Flood. I was eager to hear Austin's response to what I would consider a general problem for catastrophists, whether we are talking about catastrophic erosion of sedimentary strata or floods depositing these strata. Many of the sedimentary strata in and around the Grand Canyon contain the tracks of animals. The red Kayenta formation, exposed nearer to Glen Canyon Dam, contains the tracks of dinosaurs. I have seen these tracks personally and told Austin so. I asked Austin to comment on the fact that these tracks exist and are difficult to square with a catastrophic formation of the layers of the Grand Canyon. It is inconsistent to have all life on earth obliterated by a flood and then have animal tracks in the layers deposited by the flood. Austin stated that these certainly were animal tracks, laid down by animals walking through mud or sand, but he never satisfactorily explained how animals could happily meander through an area during or so soon after a global catastrophe.

At the end of the presentation Austin was confronted by another member of our group, who asked, "Whatever happened to Stuart Nevins? Does he publish anymore?" Those of you familiar with ICR literature may recognize the name from tracts published in the late 70's. Austin admitted that he had published under that pen name. So much for his recent, Mt St Helens-induced conversion to creationism!

Our group of skeptics was beginning to realize what passed for reality at the ICR, and we had not even set foot in the museum...yet.

[The author thanks Chris Stassen, Andrew MacRae, and Steve Austin for their helpful critiques via email and telephone.]

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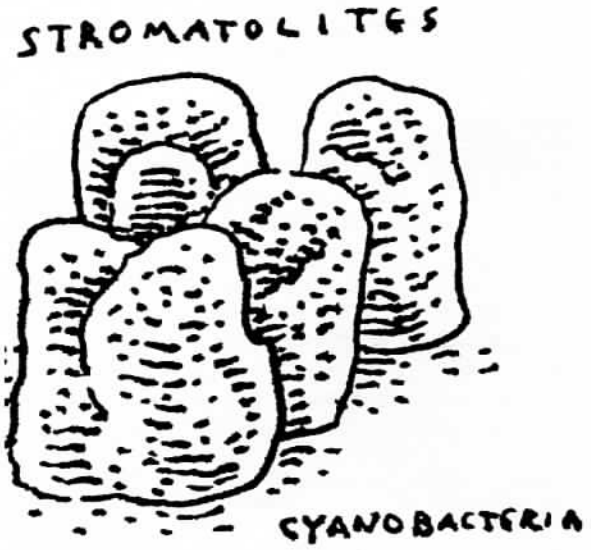

PANDAS UPDATE—1997

Frank J Sonleitner

In 1995, I began to summarize the year-to-year discoveries and advancements of science that have relevance to the subject matter of the "intelligent design theory" book *Of Pandas and People: The Central Question of Origins* by Percival Davis and Dean Kenyon. Surveying all the published literature would have been an impossible task so I have relied heavily on certain weekly publications such as *Nature*, *Science*, *Science News*, and *New Scientist*. I have also explored various general-circulation science magazines such as *Natural History*, *Scientific American*, *American Scientist*, and *Discover*, along with a variety of newly-published books. The new material for the year 1997 (including some early 1998 items that refer to 1997 events) is presented in this article and is organized according to the chapters in *Pandas*.

[A] "missing link" in the evolution of the enzyme ribonucleotide reductase...converts the building blocks of RNA into those of DNA....

In the text, each section represents new research which refutes the supposed "evidence against evolution" that is featured in Davis and Kenyon's book. The reference section also follows the layout of *Pandas*, but is expanded beyond just those items cited in the text. The additional references include relevant scientific review articles, reports from science news organizations, and accounts from some general circulation publications.

CHAPTER 1: THE ORIGIN OF LIFE

A summary of the problems associated with the origin of life is given by Szathmary (1997). Although most origin-of-life researchers subscribe to the RNA world hypothesis, others continue to work on proteins. Researcher Ghadiri of the Scripps Research Institute in La Jolla, CA has assembled miniature ecosystems of a few types of proteins that can self-replicate (Cohen 1997). Lee and others (1997) report on the discovery of a hypercycle consisting of two self-replicating peptides (a hypercycle is a collective of two or more self-replicating molecules linked in a cyclic catalytic network). One problem with the synthesis of peptides from nonliving precursors has been that the usual reactions that link amino acids into proteins barely work in aqueous solutions. Liu and Orgel (1997) report that such reactions can be brought about efficiently under mild conditions in aqueous solution.

Recent research on the origin-of-life examines the idea that early life was based on RNA, not DNA (the "RNA world" hypothesis). Tarasow and others (1997) demonstrate the *in-vitro* evolution of RNA enzymes that can catalyze formation of carbon-carbon bonds. Riera and others (1997; Wu 1997) report the discovery of a "missing link" in the evolution of the enzyme ribonucleotide reductase that converts the building blocks of RNA into those of DNA which helps make plausible the evolution of DNA to specialize as the genetic material. Gao and others (1997) also report the discovery that a change in a single amino acid residue can convert a DNA polymerase into an RNA polymerase.

STEREOISOMERS

Many biological molecules such as DNA and proteins, are chiral—that is, they consist exclusively of either left-handed or right-handed forms. Much research has been done on the origin of this chirality. Recently it has been discovered that polarized UV light, such as might have come from a neutron star, can affect the chirality of molecules producing an excess of one stereoisomer (right- or left-handed form of the same compound) in compounds formed in space (Bradley 1997). Evidence from the Murchison meteorite shows that the amino acids it contains are of extraterrestrial origin (Engel and Macko 1997) and that they contain an excess of left-handed forms (Cronin and Pizzarello 1997). This research suggests an asymmetric influence on organic chemical evolution before the origin of life. Davin and others (1997) have also discovered that enzymes that construct molecules from phenols—organic alcohols that are linked to rings of 6-carbon atoms—such as plant lignins and lignans, utilize "guiding" proteins to orient the phenols so that they will combine in the proper orientation. This research indicates *both* a prebiotic bias for left-handed forms and a tendency for active realignment of forms during the synthesis of organic molecules.

Frank Sonleitner is a long-time supporter and director of NCSE. He teaches zoology at the University of Oklahoma in Norman

Early appearance of life

Evidence has accumulated that life came into being very early in the earth's history. Holland (1997) comments on last year's evidence based on carbon isotopes that life existed as early as 3.98 billion years ago. The early earth suffered from repeated impacts of meteorites and comets. Experimental evidence suggests that the energy released from such impacts could have helped synthesize prebiotic organic chemicals (McKay and Borucki 1997). Sagan and Chyba (1997) report that small amounts of ammonia in the atmosphere would have produced a greenhouse effect that would have kept the early earth warm in spite of the fact that the energy radiated from the sun was significantly lower 4 billion years ago. Sylvester and others (1997) also give evidence for the early formation of continental crust.

Extremophiles and subterranean life

Quite recently much evidence has accumulated that there are diverse microorganisms that normally live in extreme conditions of temperature, salinity, and so on, including many with unusual metabolisms that live inside rocks, sometimes deep under the ground. These discoveries have had a great impact on our ideas of how and where life originated on earth and where it might be found elsewhere in the solar system. Several articles (Hively 1997; Madigan and Marrs 1997; Pennisi 1997) summarize our knowledge of these "extremophiles" and their possible use in industry. The occurrence of life deep in the earth's crust is summarized by Ghiorse (1997), Gold (1997), Monastersky (1997a, 1997b), and Kerr (1997). Krumholtz and others (1997) have discovered microbial communities in subsurface Cretaceous rocks, and Swedish researchers have found microbial fossils 207 meters down in fissures in granite (Hecht 1997). Recently strange new species of annelid worms have been found inhabiting deposits of methane hydrates at the bottom of the Gulf of Mexico (Leutwyler 1997).

The space connection

An accessible and readable account of all phases of the discovery of life traces in a Martian meteorite last year is given by Gibson and others (1997). Other shorter reviews are given by Kerr (1997) and McCoy (1997). McDonald (1997) describes meteorite hunting in Antarctica. Gould (1997) recounts the history of our knowledge of Mars and suggests that microbes may still live in its subsurface rocks. Although Mars is too cold for surface water and life today, it might have been warmer in the past as a result of the greenhouse effect of carbon dioxide ice clouds (Forget and Pierrehumbert 1997). Chown (1997) reports the find of possible microbe fossils in the Murchison meteorite. There is still controversy over the nature of the "nanofossils" found in the Martian meteorite (Bradley and others 1997). There is also controversy over whether the carbonates in the meteorite were formed at high or low temperatures. Scott and others (1997) believe they were formed at high temperatures while Kirschvink and others (1997) and Valley and others (1997) present two lines of evidence that would indicate they were formed at low temperatures.

Observations of Europa—one of Jupiter's moons—by the Galileo space probe suggest that there is a liquid water ocean below its ice-covered surface which possibly could harbor life (Powell 1997; Carr and others 1998). Galileo has also found signs of organic molecules on the surfaces of two other moons of Jupiter: Callisto and Ganymede (McCord and others 1997). The Cassini space probe, which has recently been launched, will orbit Saturn and send the Huygens lander through the atmosphere of the moon Titan which is known to contain much organic matter (Lorenz 1997).

CHAPTER 2: GENETICS AND EVOLUTION

The origin of genes from exons—noncontiguous regions of DNA that combine to compose the sequences that we recognize as "genes"— is discussed by Gilbert and others (1997) and Rzhetsky and others (1997). Common misconceptions about evolution by natural selection are discussed by McComas (1997). Bardell (1997) discusses biological misfits (imperfect adaptations) as evidence of evolution (What would such imperfect designs tell us about an "intelligent designer"?). Nowak and others (1997) propose a model for the stability of redundant genes (genes that exist in many copies in a genome).

Mutation

Hypermutation (increased mutation rate in stressed cells) may explain observations of apparent directed mutation (Bridges 1997). Evidence for the role of mutator genes in evolution is given by Taddel and others (1997). Peck and Eyre-Walker (1997) report on new efforts to measure the rate and magnitude of deleterious mutations. Morell (1997) reports on the use of fast-mutating RNA viruses to test models of evolution. Elena and Lenski (1997) looked for synergistic interactions among deleterious bacterial mutations. Transposable elements are discussed by Kidwell and Lisch (1997). Horizontal transfer of a transposable element between species was demonstrated by Gueiros-Filho and Beverley (1997). Wedemayer and others (1997) document the role of mutation in the development of a more efficient antibody combining site.

These discoveries have had a great impact on our ideas of how and where life originated on earth and where it might be found elsewhere in the solar system.

Natural selection

Wright and Joyce (1997) report on *in-vitro* (test tube) evolution improving both the catalytic rate and amplification rate of a ribozyme. Test tube evolution is reviewed by Conrad and others (1997). Selection and gene flow between populations affect the evolution of inland water snakes (King and Lawson 1997). Losos and others (1997) report on the role of natural selection in the evolution of experimental island populations of anolid lizards in

the Greater Antilles. Reznick and others (1997) investigate evolution in a natural populations of guppies. Gould (1997) summarizes some of these studies.

Sex

Theories about the evolution of sex are summarized by Lyons (1997). Competition between the sexes is discussed by Brookes (1997). A mutant gene alters sexual behavior in fruit flies (Horgan 1997). Morell (1997) says that sexual recombination allows RNA viruses to repair harmful mutations. Zeyl and Bell (1997) say the same for yeast.

Domesticated species

The origin of corn is discussed by Dold (1997). The site of einkorn wheat domestication is identified by Heun and others (1997), while Vila and others (1997) discuss the multiple and ancient origins of the domestic dog.

Evolution on computers

The development of Field Programmable Gate Arrays (Villasenor and Magnione-Smith 1997) allows for the evolutionary programming of computer hardware (Davidson 1997). A specific case of a silicon version of natural selection generating a new circuit design is reported by Taubes (1997).

Genomes

Although the Human Genome Project is not due to be finished until around 2005, other genome projects—mostly dealing with microbes—have already been completed. Blattner and others (1997) have completed sequencing of the *E coli* genome. At the time of that publication, eleven other microbial genomes and one eukaryote genome (yeast) had been sequenced. These include the Lyme disease spirochaete *Borrelia burgdorferi* (Fraser and others 1997), the hyperthermophilic sulphate-reducing archaeon *Archaeoglobus fulgidus* (Klenk and others 1997), the Gram-positive bacterium *Bacillus subtilis* (Kunst and others 1997), and the gastric pathogen *Helicobacter pylori* (Tomb and others 1997). All these genomes have only up to about 4000 genes; the human genome contains as many as 100 000 genes or as few as 60 000 (Cohen 1997). The free-living organism with the smallest known genome, *Mycoplasma genitalium*, has 468 genes. Wells (1997) speculates on the minimum number of genes to make a bacterium (about 256).

[V]arious organisms share the same genes which interact in different ways to produce different body plans...

The completely sequenced yeast genome (a eukaryote or nucleated cell with about 6000 genes) is discussed by Clayton and others (1997) and Das and others (1997). Wolf and Shields (1997) present evidence that the yeast genome had doubled some time in the past. Work on sequencing invertebrates such as *Drosophila* and the nematode *Caenorhabditis* (each with an estimated 10 000 genes) continues. With regard to vertebrates, several authors (Elgar and others 1997; Brenner and others 1997) suggest sequencing the pufferfish *Fugu rubripes*. Its genome is about 7.5 times smaller than the human genome, apparently because it has eliminated most of its introns—the noncoding or "nonsense" segments of DNA that interrupt the exons in eukaryotic organisms.

Margulis and Dolan (1997) review the endosymbiont hypothesis of the origin of eukaryotic cells—the view that organelles such as mitochondria in these cells represent once-free-living organisms that took up residence inside other cells. Recently a protozoan has been found with mitochondria that contain many more genes than usual, including some very similar to those in modern bacteria supporting the bacterial origin of mitochondria (Lang and others 1997). Embley and others (1997) also report evidence that hydrogenosomes, found in anaerobic microbial eukaryotes, are derived from mitochondria. Other eukaryotes have eukaryote cells as endosymbionts. Kohler and others (1997) give an example of a parasitic protozoan having acquired an algal endosymbiont. Such endosymbionts have very reduced nuclear genomes which researchers now plan to sequence (McFadden and others 1997).

Newly discovered species of marine Archaea from north-east Atlantic waters reveal a degree of genetic diversity that may require an increase in the number of subkingdoms within the Archaea (McInerney and others 1997). Several new Archaea have been found in a hot spring in Yellowstone National Park (Burggraf and others 1997). The modern research that resulted in the discovery of the wide variety of prokaryotes is summarized by Service (1997) and Morell (1997).

CHAPTER 3: THE ORIGIN OF SPECIES

Ayala and Fitch (1997) give a general introduction to a series of papers on speciation in the July issue of the *Proceedings of the National Academy of Sciences*. The special volume includes Avise and Wollenberg (1997) on speciation and classification, Grant and Grant (1997) on speciation in birds, and Wake (1997) on speciation in salamanders.

Klicka and Zink (1997) review the role of the ice ages in the speciation of North American birds. Vulic and others (1997) investigate the effect of DNA polymorphism on genetic exchange in bacteria. Cross-breeding experiments are used by Monti and others (1997) to try to identify the genetic basis for several premating isolation mechanisms in two species of South American moths. An example of sexual selection's reinforcing premating isolation in flycatchers is reported by Saetre and others (1997), while Boake and others (1997) discuss sexual selection and species recognition in the stalk-eyed fly.

Roush (1997) reports that the rusty crayfish is invading new areas in North America and producing hybrids with other species it encounters. Turner (1997) reviews speciation among cichlid fishes in East African Rift Valley lakes, while Martens (1997) reviews speciation in lakes in general. Smith and others (1997) investigate the role of rainforest mar-

gins in speciation, while Morell (1997) reviews studies on the role of uplifted ridges in past geologic time separating populations and initiating speciation in the Amazon basin. Miya and Nishida (1997) have found genetic differences within a circumglobal deep-sea fish species indicating that new lineages have originated in the open ocean without any discernible geographic barriers.

CHAPTER 4: THE FOSSIL RECORD

The Cambrian Explosion

New Precambrian fossils include the earliest sponges (Brasier and others 1997), and 1.1-billion-year-old worm burrows in India (Monastersky 1997a). Monastersky (1997b) also reports on a new Ediacaran oddity *Swartpuntia* which apparently consisted of several vertical sheets attached to a central stalk and may represent a new kingdom. New specimens of *Kimberella* reveal it to be a mollusc-like bilaterian (Fedonkin and Waggoner 1997). Wright (1997) provides a general review of Ediacaran fauna.

The plethora of new invertebrates in the Cambrian period is correlated with the invention of homeobox-like regulatory genes which allowed for the evolution of diverse body plans (Erwin and others 1997; Edgar 1997; Holmes 1997). Well-preserved fossils of metazoan embryos are reported by Bengtson and Zhao (1997).

New evidence for Precambrian ice sheets on land is given by Evans and others (1997). Early Cambrian biogeography is discussed by Lieberman (1997). Evidence that the continents shifted positions more quickly than usual at the beginning of the Cambrian is presented by Kirschvink and others (1997). This could have produced large-scale environmental changes, which might have contributed to the burst of Cambrian evolution.

New Fossils

Benton (1997) investigates the patterns of diversification of families displayed in the fossil record. Little and others (1997) describe a Silurian hydrothermal vent community. Kenrick and Crane (1997) review the origin of terrestrial plants; Feist and Feist (1997) report on the earliest bisexual plant. Mlot (1997) reports on an ancient flowering tree found still living in Madagascar; and da Silva (1997) reports on an ancient species of pine in Australia. Long (1997) reviews several books on fishes including *Air-breathing Fishes: Evolution, Diversity and Adaptation* by JB Graham. DNA data indicate that the lungfish is more closely related to tetrapods than to coelocanths (Roush 1997). Grescoe (1997) describes the Devonian formation of eastern Canada from which many fishes and early amphibians have been recovered. Lebedev (1997) reviews the features of *Acanthostega*, the most primitive known tetrapod.

Reptiles

Recent fossils of giant crocodiles that could attack dinosaurs have been uncovered (Anonymous 1997). An ancestral snake with legs is reported from the marine Cretaceous (Caldwell and Lee 1997). Frey and others (1997) report a late Permian reptile with unusual lateral gliding membranes, and Hecht (1997) describes new dinosaur fossils from the Jurassic. New discoveries also include a Jurassic-era dinosaur embryo (Holden 1997) and a nest and egg clutches of the Cretaceous *Troodon* (Varricchio and others 1997). The controversy over the ancestry of turtles is discussed by Lee (1997), while Miller (1997) discusses whether pterosaurs were bipedal or quadrupedal.

Kirkland (1997) reviews the diversity of horned dinosaurs. New theropods larger than *T rex* have been found (Monastersky 1997a). During the evolution of dinosaurs, their lung capacity increased (deduced from the joint between the ribs and the backbone which indicated how much the chest could expand; Monastersky 1997b). Seife (1997) reports the idea that male sauropods may have wooed lovers and intimidated rivals by cracking their tails like whips. Zimmer (1997) reports on computer simulations based on dinosaur skeletal measurements that reveal how dinosaurs moved. Thomas and Farlow (1997) report on an analysis of a Paluxy River trackway that may record the attack of a carnivorous dinosaur on a sauropod.

Birds

Over the past few years a number of new early Cretaceous bird fossils have been found in Spain and China. The Chinese fossils are exquisitely preserved in lake beds of siltstone from Liaoning Province (Hecht 1997a). They include the turkey-sized *Protarchaeopteryx* intermediate between a theropod and *Archaeopteryx* (Hecht 1997b); *Liaoningornis*, the earliest ornithurine bird (Anonymous 1997), and the enantiornithine bird *Cathayornis* (Martin and Zhou 1997). From Patagonia comes a very bird-like theropod *Unenlagia* (Novas and Puerta 1997). From Spain comes a lower Cretaceous fossil of an enantiornithine nestling (Sanz and others 1997) which reveals that the evolution of cranial characters lagged behind those involved in flight. A *Velociraptor* "wishbone" is reported by Norell and others (1997). Further observations on *Sinosauropteryx* seem to indicate that its "feathers" are more likely part of a frill on the back or possibly some sort of protofeather (Gibbons 1997).

Poore and others (1997) studied the mechanism of the wing upstroke. Using this new information they conclude that *Archaeopteryx* was a very poor flyer at best. Several authors review the modern data on the origin of birds (DeSilvestro 1997; Shipman 1997). The debate about the origin of birds is discussed by Horgan (1997) and Monastersky (1997). Although most paleontologists believe that the birds evolved from theropod dinosaurs, two ornithologists, Martin and Feduccia claim that they evolved from dinosaur ancestors—the thecodonts—diverging *before* the branch that led to *Archaeopteryrx*. Burke and Feduccia (1997) claim that the digits in the bird wing are not the same as those in the theropod hand. Rubin and others (1997) claim that dinosaurs breathed with piston-driven diaphragms

(based on preserved soft parts of the Chinese *Sinosauropteryx*) that could not have evolved into the air sac breathing apparatus of birds.

Although the fossils suggest that there was a great turnover in birds at the K-T boundary, DNA molecular clocks seem to indicate that many lineages survived that great extinction (Cooper and Penny 1997). All the new fossils from the Spanish and Chinese formations have increased interest in the origin of birds and inspired the production of three new books. Dingus and Rowe (1998) discuss dinosaurs, birds and the K-T extinction. They consider birds to be modern dinosaurs. Chatterjee (1997) also considers the birds to be dinosaurs, but extends their origin back to the Triassic to accommodate the controversial *Protoavis*. Shipman (1998) reviews both the dinosaur and thecodont views on the origin of birds. Witmer (1997) reviews Feduccia's 1996 book *The Origin and Evolution of Birds*. Zimmer's (1997b) article reviews the giant dinosaur-like birds of the early Tertiary.

Mammals

Several discoveries have shed more light on the Mesozoic prototherian mammals which previously were known only from skull and tooth fragments. Hu and others (1997) report on a full skeleton of a symmetrodont mammal from China. New skeletal material reveals the unique and specialized nature of the early Mesozoic haramyids (Jenkins and others 1997). Meng and Wyss (1997) report on the discovery of multituberculate mammal hair, lending support for the presence of this feature in the most recent ancestor of the multituberculates, therians and monotremes. Novacek and others (1997) report on the first epipubic bones found in eutherians. They may have had a function in locomotion and in supporting the weight of attached nursing offspring. Rich and others (1997) report on the discovery of a possible placental mammal from the early Cretaceous of Australia. Krause and others (1997) report on the finding of multituberculate-like Gandwanatherians from the late Cretaceous of Madagascar and India.

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New skulls and skeletons shed light on the relationships of the dog-like borhyaenoid marsupials of the Tertiary of South America (de Mulzon and others 1997). Molecular evidence for the relationship of whales to even-toed ungulates is given by Shimamura and others (1997). A shift to cooler, drier and more variable climates affected the flora and mammalian fauna of the Pliocene period (Behrensmeyer and others 1997; Cerling and others 1997).

Extinction

Ideas about what happened at the end of the Cretaceous are reviewed by Jablonski (1997, Anonymous 1997a). Ward (1997) reviews three books on the K-T extinction: *Cretaceous-Tertiary Mass Extinctions: Biotic and Environmental Changes* edited by N MacLeod and G Keller, *Dinosaur Extinction and the End of an Era: What the Fossils Say* by JD Archibald, and *The Great Dinosaur Extinction Controversy* by C Officer and J Page. Morgan and others (1997) report on an impact site (the Chicxulub structure) that has a multi-ring basin morphology. Debris from the K-T impact is discovered in a 2000 foot deep borehole into marine sediments in New Jersey and off the coast of Florida (Kerr 1997). This K-T impact possibly produced a searing hot vapor cloud that swept over North America (Zimmer 1997). Other views about the demise of the dinosaurs refer to the lowering of sea-level (Hecht 1997b) or the earth's encountering clouds of dark matter (Kanipe 1997). Other cratering events include a late Pliocene impact (Gersonde and others (1997), a Jurassic-Cretaceous impact (Hecht (1997a) and 35.7-million-year-old craters in Siberia and Chesapeake Bay (Zimmer 1998).

Isozaki (1997) provides geological evidence for world-wide deep sea depletion of oxygen coinciding with the end-Permian extinction. The role of plants and forest soils on weathering and atmospheric carbon dioxide in the Devonian is discussed by Retallack (1997). Trilobites may have gone extinct because of their inefficient molting processes (Anonymous 1997b). Sole and others (1997) suggest that the apparent periodicity in mass extinctions may be due not to meteorite impacts, but to nonlinear responses of the biosphere to minor perturbations. Humans have been blamed for the extinction of the North American Pleistocene megafauna. Now Pain (1997) reviews the idea that humans did the same for the Australian marsupial megafauna as well.

Human evolution

Some general accounts of human evolution include Cartmill (1997), Fullick and Fullick (1997), Gould (1997), Kay and others (1997), Leakey and Walker (1997), and Tattersall (1997). Theime (1997) reports on the discovery of palaeolithic hunting spears suggesting that humans of 400 000 years ago were sophisticated big-game hunters. Semaw and others (1997) report on 2.5-million-year-old tools from Ethiopia. These tools from the Hadar region are the oldest known tools. Gibbons (1997a) reviews the hand morphology necessary for tool-making.

Bower (1997) reports that most Neandertals were right-handed as are we. Neandertal noses also have a unique morphology (Menon 1997). Body mass in Pleistocene *Homo* was about 10% larger than in modern humans (Ruff and others 1997), but size differences between the sexes were about the same as today (Arsuaga and others 1997). Suwa and others (1997) report on the first cranium of *Australopithecus boisei*.

A new ancient human, *Homo antecessor*, 650 000 years old and possible ancestor to both Neandertals and modern humans, is discovered in

Spain (Bermudez de Castro and others 1997). More details are given by Kunzig (1997). A near-modern human cranium (270 000-300 000 years old) is found in Kenya (Brauer and others 1997). Modern human footprints 117 000 years old are found near Cape Town, South Africa (Menon 1998). Lewin (1997) discusses views on the origin of modern Europeans

Chaimanee and others (1997) report on a new late Eocene ape *Siamopithecus* from Thailand, providing evidence for a southeast Asian evolutionary center for anthropoids. Another late Eocene ape *Proteopithecus* is reported from Egypt (Simons 1997). Gebo and others (1997) report a new Miocene ape *Morotopithecus* from Uganda which may be the earliest form related to hominoids. New studies indicate that the Miocene ape *Oreopithecus bambolii* had an upright posture (Kohler and Mola-Sola 1997).

Mitochondrial DNA (mtDNA) sequence data from a Neandertal fossil bone seems to indicate that they and modern humans evolved independently (Kahn and Gibbons 1997). Mitochondrial sequence data also support a single and early migration for the peopling of the Americas (33 000–43 000 years ago; Bonatto and Salzano 1997). Data on autosomal DNA sequences indicate that the human ancestral line diverged from the New World monkeys 57.5 million years ago (MYA); from the Old World monkeys 31 MYA, from the gorilla 8 MYA and from the chimpanzee 4.5 MYA (Takahata and Satta 1997).

Analysis of Y chromosome sequences support the "Out-of-Africa" hypothesis of the origin of modern humans. They also suggest some populations returned to Africa (Gibbons 1997b and 1997c, Wood 1997). Radetsky (1997) discusses the evolution of the Y chromosome. Data on DNA microsatellite diversity also support the Out-of-Africa hypothesis (Jorde and others 1997) as do some short repeated DNA sequences (Wood 1997). Criticisms of the mitochondrial mutation rates used in mitochondrial Eve studies are summarized by Loewe and Sherer (1997). Travis (1997) reports that sometimes sperm mtDNA gets into the zygote, thus mtDNA is not inherited exclusively in a maternal manner. Criticisms about the mutation rates for the Y chromosome are discussed by Brookfield (1997).

Origin of Insect flight

Kramer and Marden (1997) report on stub winged stone flies using their wings to sail or skim over the water surface, a behavior that may well represent an intermediate function in the evolution of insect flight. The recent hypothesis that insect wings evolved from gills is supported by the work of Averof and Cohen (1997) who found that genes in the crustacean *Artemia* which are homologues of the wing genes *pdm* (nubbin) and *apterous* exhibit expression patterns in the gill-bearing epipod of the leg.

Miscellaneous

Austin and others (1997a, 1997b) have thrown doubt on the authenticity of ancient DNA from amber and fossils. Yet, other researchers are claiming to find proteins and heme compounds from dinosaur bones (Hecht 1997) and a Japanese researcher plans to recreate a mammoth from 40 000–year-old frozen mammoth sperm (Coughlan 1997). Other researchers have found cell structures and even color-producing structures called chromatophores in fossils which could indicate the color of the animals in life (da Silva 1997).

CHAPTER 5: HOMOLOGY

General

The concept of homology always had to be considered hierarchically. Thus, all vertebrate forelimbs are homologous, but their modification into wings (pterosaurs, birds and bats) are not. All the new information on gene homologies among phyla confirms that they share the same homologous genes. However the interrelationships of these genes in networks that produce, say, eyes, are not homologous (Abouheif 1997; Harris 1997) This new idea, that various organisms share the same genes which interact in different ways to produce different body plans, is reviewed by Pennisi and Roush 1997). For example, genes which make arthropod structures in fruit flies make echinoderm structures in starfish; the genes involved in the formation of the bilaterally symmetrical echinoderm larva also cause the formation of the radial adult (Lowe and Wray 1997). Further relations between the larvae and adults of starfish are discussed by Palumbi (1997). An example of ancient regulatory genes being co-opted for additional functions is given by Carroll (1997). Gould (1997) reviews the idea that vertebrates are upside-down invertebrates. A recent book that covers these latest findings in embryology (Gerhart and Kirschner 1997) is reviewed by Mahowald and others (1997). Valentine (1997) reports on the evolution of embryonic cleavage patterns. Jeffrey (1997) reports the latest findings on ascidian (protochordate) development.

[T]he apparent periodicity in mass extinctions may be due not to meteorite impacts, but to nonlinear responses of the biosphere to minor perturbations.

Development and Homeobox (*Hox*) genes

The study of the genes that control the expression of developmental potential is also a very active field of research, and the papers cited below represent only a small sample of the literature of 1997 on these. Angiosperms, metazoa and fungi share homeodomain proteins which apparently duplicated at least once before the origin of those groups (Bharathan and others 1997). Within the vertebrates, the *Hox* clusters duplicated by a three-step sequential process (Bailey and others 1997). The structure of *Hox* genes is reviewed by Sharkey and others (1997).

Several articles discuss the zebrafish as a model organism for the study of vertebrate development (Gordon 1997; Postlewaite and Talbot 1997) while several others discuss work on nematode worms

(Emmons 1997; Kaletta and others 1997). Homeotic transformations in *Drosophila* are reviewed by Emerald and Roy (1997). The genetic determination of embryonic axes (left-right and top-bottom) are discussed by Supp and others (1997), Isaac and others (1997), and Schulte-Merker and others (1997). The control of body segmentation is discussed by De Robertis (1997) and Roush (1997). Further patterning in vertebrates is discussed by Thomsen (1997) and Graff (1997). A number of papers deal with *Hox* genes and the development of limbs (Kondo and others 1997; Averof and Patel 1997; Cohn and others 1997; Desilvestro 1997; Panganiban and others 1997; Lecuit and Cohen 1997; Shubin, and others 1997; Tabin and Carol 1997; Zakany and others 1997). Other articles treat eye development and the ubiquitous *Pax* gene (Balczarek and others 1997; Tomarov and others 1997; Travis 1997; Glardon and others 1997; Sun and others 1997; Mathers and others 1997). Other workers report new categories of homeobox genes (Papaioannou 1997; Simon and others 1997; Joly and others 1997; and Munoz-Marmol and others 1997). Additional homologies are reported by Rice and others (1997), Munster and others (1997), and Hammerschmidt and others (1997). Regulation of homeobox genes is discussed by Manzanares and others (1997) and Goodrich and others (1997).

Recapitulations

The charge that Ernst Haeckel "faked" many of his drawings of embryos that illustrated recapitulation has been raised again (Richardson and others 1997). This has been known for many years (see Bolsche 1906:267-9). Creationists then (and now) interpret the "faking" as meaning that early embryos have no features in common. Yet even von Baer in the early 19th century, a staunch opponent of recapitulation, based his laws of embryology on the extensive similarities among early vertebrate embryos. Creationists also claim that Haeckel was the exclusive proponent of recapitulation when in fact he was the *last* of a long line of biologists extending back into the 18th century, both creationist and evolutionist, who accepted the idea of recapitulation (see de Beer 1958, Gould 1977). Recently Richardson and his coworkers (1998) criticized the creationists for their denial of the embryological evidence and pointed out that, although "Haeckel was overzealous" with his illustrations, he was basically right!

CHAPTER 6: BIOCHEMICAL SIMILARITIES

DNA and RNA sequences have provided a wealth of data upon which to construct classifications. Such molecular data have provided information on the origin of slime molds (Baldauf and Doolittle 1997). They have also been used to explore the origins of echiurans and pogonophorans (McHugh 1997) and of red algae (Stiller and Hall 1997). Sequence similarities reveal the relationships among the arthropod classes (Regier and Shultz 1997; Staton and others 1997) and the relationships of arthropods to other phyla (Aguinaldo and others 1997). They also help understand the relationship of the marsupials to the monotremes (Janke and others 1997) and the position of the marsupial Tasmanian wolf to the other marsupials (Krajewski and others 1997), which *Pandas* had questioned. Other DNA analyses indicate that insectivores are a complex group that contains many ancestral lineages; golden moles are related to other African mammals and indicate an extensive African radiation in the Cretaceous (Springer and others 1997).

A general discussion of building phylogenies from DNA sequences is given by Purvis and Quicke (1997). Some shortcomings of molecular classifications were revealed when they were tested against data from structural biology (Naylor and Brown 1997). The related topic of molecular clocks and their possible shortcomings are discussed by Ayala (1997) and Feng and others (1997). The reader should also see the section on human evolution in this paper for articles concerned with the mitochondrial clock. Molecular phylogenies depend on variation in DNA sequences. Experimental evidence (Clothia, and Gerstein 1997) indicates that proteins can withstand many amino acid substitutions without losing their function.

New genes are thought to have arisen by duplication, divergence and exon shuffling of old genes. Such genes and their protein products should retain similarities to their ancestral forms. Tatusov and others (1997) and Henikoff and others (1997) examine the protein families and their homologues in various organisms based on the data coming from recent genome sequencing work. Chen and others (1997) demonstrate how the antifreeze protein of certain Antarctic fishes has evolved from pancreatic trypsinogen. Bailey and others (1997) report on the molecular origins of primate alpha-globin units while Messier and Stewart (1997) describe the evolution of primate lysozymes. Kasahara and others (1997) discuss the possibility of genome duplication in the evolution of the major histocompatibility complex.

Differences between the mitochondrial genetic code and the nuclear genetic code are known. Now Keeling and Doolittle (1997) report on differences between the nuclear genetic code of diplomonads (primitive flagellated protozoa) and the "universal" genetic code. Researchers have found that only five amino acids are necessary to make most of a working protein (Wu 1997).

Noji and others (1997) report that the enzyme F1-ATPase actually rotates like a motor as it functions! Might something like this be a precursor to the bacterial flagellar motor? Nemecek (1997) reports on research that demonstrates that protein structures (in this case beta-sheets and alpha-helices) are determined by a few key animo acids in the polypeptide sequence. Related work (Dahiyat and Mayo 1997) has shown how to choose an amino acid sequence that will produce a desired three-dimensional structure. Protein folding *in vivo* is a complicated process. Strauss (1997) reports on research that reveals "chaperon" molecules that assist newly synthesized proteins in folding into their correct shapes.

SUMMARY

The discovery of extremophiles and deep underground communities of microbes, along with the discovery of possible fossils of Martian organisms, has greatly affected ideas about the origin of life and its possible occurrence on other planets. The continuing compilation of complete genome sequences, along with our rapidly expanding knowledge of regulatory genes (*Hox* and many other types), continues to reinforce the idea that organisms share most of their genomes and that all invertebrates have essentially the same genes. The different body plans result from the evolution of different relations and interactions among these genes. Vertebrates appear to have the same genes as invertebrates, except that the vertebrate genome has greatly expanded as a result of several duplications of the genome and subsequent specialization of the extra copies. Our knowledge of genes and the proteins they produce reveals that proteins are not a collection of unique molecules but can be classified hierarchically as are organisms, reinforcing the idea that they have arisen as modifications of "ancestral" proteins. More and more new fossils are closing the gaps in the fossil record. All of these discoveries lend credence to evolution. If evolution is not true, then the intelligent designer had a very peculiar way of doing things.

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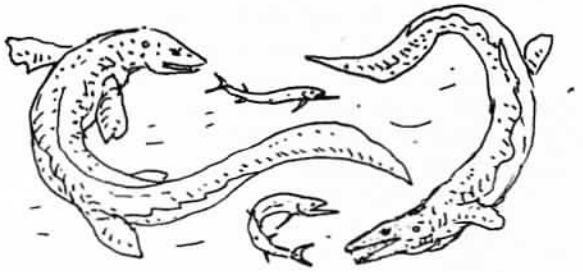
In an article titled, "Falwell fights 'heresy' on campus", Skipp Porteous reported:

> "We don't have tenure," Falwell said. "Where tenure is practiced, eventually theistic evolution is taught. And pretty soon that kind of heresy leads to another level, and to another level, and then suddenly you look around you and you've got to look real hard to find one of those inerrantists who believe the Bible from cover to cover." The faculty at Liberty [University] has one-year contracts.

Source: *Freedom Writer*, November/December 1997, p 1, 4.

[*thanks to Paul Heinrich for locating this note.*]



The Tale of the Whale

Kevin Padian
Museum of Paleontology, UC-Berkeley and
President, NCSE

The Winter 1996 issue of *Pacific Discovery*, published by the California Academy of Sciences, was devoted to whales. Among the nice articles and beautiful pictures is a particularly interesting article about the origins and early evolution of whales by Elizabeth Culotta, a writer for *Science* who covers evolution and ecology. Culotta is collaborating on a book on whale origins with Hans Thewissen, one of the scientists intimately involved in studying whale evolution. Her interviews with noted specialists underscore what tremendous progress in understanding whale origins has occurred just in the last few years. At least three new forms—*Pakicetus*, *Ambulocetus*, and *Rodhocetus*—have been found to fill in some of the gaps between the whales we know and their terrestrial ancestors, a group of mesonychid carnivores that lived in the Eocene epoch, some 60 million years ago. Along the way, paleontologists have learned a lot more about the evolution and relative timing of the adaptation of skulls, ears, jaws, backbones, and limbs for life in the open sea.

The problem of the origin of whales, of course, has long been one in which anti-evolutionists have been particularly interested. "Creation scientist" and former biochemist Dr Duane Gish liked to mock the traditional paleontological assertion that whales evolved from an ungulate ancestor. In his lectures, Gish would explain to his audiences that an ungulate was a hoofed mammal, like a cow. Then he would show a cartoon of Jersey cows with bells around their necks and mermaid-like tails, asking his audience if they thought such an evolutionary transition were possible. No paleontologist, of course, suggested that whales evolved from cows, but this seemed to make little difference to Gish.

Culotta's article points out that the fossil relatives of living whale groups are recognized not primarily by the great size and specialized swimming adaptations that generally describe today's whales, but instead by features of their skulls and teeth that are shared only with living whales. However, what interests most people is how whales came to take up an aquatic existence.

The first steps in whale evolution included a reduction of the pelvis and hindlimbs even while these structures still remained fully functional for locomotion and bearing weight. By the evolutionary stage represented by *Ambulocetus*, we find elongated hands and feet, a longer skull, and larger teeth. But the tail is still long and lacks a fluke, and the toes still end in little hooves. Thewissen and his co-workers suggest that this animal swam by vertical undulations and was amphibious (lived both on land and in water).

Rodhocetus, which occurs a bit later in time, has a shortened neck and more reduced hindlimbs. It appears to have been a more open-water swimmer, while still retaining many terrestrial features. These animals are still in the 5- to 8-foot range and lived about 50 million years ago. However, *Basilosaurus* shows that by 40 million years ago, whales had become much larger and more like the living groups.

As its name suggests, *Basilosaurus* was thought to be a dinosaur or marine reptile when it was first discovered in the early 19th century, but its mammalian affinities were soon recognized. *NCSE Reports* reported that Duane Gish dismissed it as a reptile (Anonymous, 1990), however, to my knowledge he has not published a peer-reviewed scientific paper documenting his evidence. Meanwhile, the rest of us may find interesting some recent scientific efforts on early whales, many of which are summarized in a couple of nice (and short) pieces by Dr Michael Novacek, a pre-eminent mammalian paleontologist and Vice President of the American Museum of Natural History in New York (*Nature* 1993, 361:298-299; and 1994, 368:807; Other relatively accessible pieces are listed at the end of this article.)

A more recent creationist postscript to the whale saga began not long after the recent "Firing Line" television program on evolution. Science teacher Larry Flammer wrote to law professor and self-proclaimed Darwin expert Philip Johnson, asking about his comment that a "recent article in *Science*" refuted what biologist Dr Ken Miller said on the show about whale evolution. Johnson referred Flammer to microbiologist Dr Michael Behe, who responded by citing a single sentence in Novacek's 1994 article (listed above): "*Ambulocetus*, *Rodhocetus* and other more aquatically specialized archaeocetes cannot be strung in procession from ancestor to descendant in a *scala naturae*." Flammer checked with NCSE as to

whether Johnson's interpretation was an accurate statement of Novacek's views.

The excerpted sentence, which begins the last paragraph of a nearly full-page commentary, is classically taken out of context. Novacek spends the entire article explaining the traditional problem of the lack of fossil intermediates between land mammals and whales, then shows how recent discoveries are morphologically, functionally, and stratigraphically intermediate. Novacek's quoted sentence means only to say that we do not regard these things as successive direct ancestors.This is because *Ambulocetus*, *Rhodhocetus*, *Pakicetus*, and other forms each have their own "autapomorphies" or distinguishing characteristics, which they would have to lose in order to be considered direct ancestors of other known forms. (For general information, modern evolutionary biologists do not search for ancestors, but for relationships among organisms based on the new appearances of heritable features, which are represented in the form of cladograms.)

Here's the important part. Any modern paleontologist or evolutionary biologist knows that the chances of finding an *actual lineal ancestor* to a later form are very small. Imagine your own chances if you returned to where you think your 6th-century ancestors are buried and started to dig looking for them. Even if you found a graveyard from that period, what are the chances that any of the bones would belong to your *direct* ancestors? A distant cousin, maybe. But couldn't you tell a lot about those people and how they lived, the stage of cultural development in their society, their possessions and features? Would it be unreasonable to suppose that your *direct lineal* ancestors had the same features and lived in more or less the same ways?

This is exactly the approach that Novacek is taking to the whale fossils. He is clearly saying that these fossils show progressive specialization of features common to whales today, even if they are not the direct lineal ancestors of whale species that survive in modern oceans.This is what he means when he writes: "Nonetheless, these fossils are real data on the early evolutionary experiments of whales." In previous paragraphs he pointed out that archaic whales first evolved cetacean features of the middle ear, muzzle, skull roof and teeth; then an amphibious habit with front-to-back flexion of the body for providing locomotion in the water aided by paddle-like hind feet (*Ambulocetus*); then shorter neck vertebrae, unfused hip vertebrae, and the reduced femur (*Rodhocetus*); and so on. Finally, Novacek writes, "They powerfully demonstrate transitions beyond the reach of data, whether molecular or morphological, derived from living organisms alone."

Readers may judge for themselves, based on what Novacek actually said, but in my view it is not responsible scholarship, nor accurate representation, to tell someone that Novacek's article refuted what Miller said about whale evolution. Novacek, Gingerich, Thewissen, and other scientists are understandably upset about the distortion of their work and publications, but it seems to make little difference. Sadly, as long as creationists can pretend to hold scientists to a semantically strict and epistemologically unreasonable definition of ancestry, they will continue to try to fool the public. Readers who are not professional scientists might be interested to know, however, that if someone tried this sort of misrepresentation in the scientific literature, they would be sat down hard by reviewers and by the authors themselves. Understanding what someone actually said and meant in his work is the first precept of scholarship.

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Creationist Geology and Intuition: Isn't science just common sense?

Kevin Padian
NCSE President

The dismay expressed about "The Mysterious Origins of Man," a pseudoscientific jumble of Bible distortion, garbled geology, warped paleontology, and gonzo archeology that aired on NBC-TV in February 1996, burned up phone and fax lines, tied up modems, and sent postal workers scurrying around with stacks of letters to editors and broadcasting executives. Jere Lipps, then Director of Berkeley's Museum of Paleontology and President of the Paleontological Society, led the charge on behalf of science and was recently rewarded with NCSE's "Friend of Darwin" award for these and other efforts.

The uproar about the program reached the pages of scientific journals such as *Science*, mass-market magazines such as *Time* and a bunch of internet talkgroups and bulletin boards. The network responded, "Hey! It's not our fault. We do entertainment!"; the producers responded, "We don't know what you're getting all upset about. It's *true*, isn't it?"; and the NBC executive responded, "Oh, come on. *everyone* knew it was just opinion."

Perhaps Kris Krishtalka, a vertebrate paleontologist who directs the Natural History Museum at the University of Kansas, said it best when he was quoted in *Science* (March 8, 1996): "I'm sure in a few months [NBC News anchor]Tom Brokaw will have a special on the deplorable state of science knowledge among American school children." Unfortunately, we now know better; NBC rebroadcast "The Mysterious Origins of Man" several months later.

It is well known by now that the "Mysterious Origins" people are Hare Krishna people, not biblical fundamentalists, and they think that all the life forms on earth are hundreds of millions of years old, not a few thousand. However, there are instructive comparisons between the two groups, and their approaches to the distortion of science and the selective presentation of often apocryphal evidence are in many ways similar.

What makes this strategy successful, and why should we care?

The answer is that their line is persuasive to the poorly educated in science—which happens to include the majority of American adults and adolescents. But people like to be persuaded. They especially *like* to be persuaded that their views are right, and that they are intelligent people capable of figuring out things for themselves. What the so-called experts know is just their opinion, after all. It may not be right. Look how many times the "experts" have gotten the rest of us into trouble!

I was reminded of this in re-reading Tom McIver's revealing article, "A Creationist Walk through the Grand Canyon" (*Creation/Evolution* Issue 20, 1987). Tom signed up for a field course, as something of an undercover anthropologist, at the Institute for Creation Research. In this course, participants were led through the Grand Canyon, and its geology was explained through the window of "creation science." So, for example, participants were told that the Coconino Sandstone, a Permian deposit with a great many nice footprints of amphibians and reptiles, could not be formed from desert dunes because the angles of these beds are supposedly inconsistent with the bedded layers in the Canyon. Instead, of course, they were all formed in the Noachian Flood. Participants were taught to distinguish "creation" rock (pre-Cambrian) from "Flood" rock (Cambrian and later).

McIver reported that none of the participants expressed any doubts whatever about the veracity of this kind of explanation; in fact, they were incredulous that anyone could accept the traditional geologic story. "How could this whole enormous canyon have been formed by such a small river, as the evolutionists claim? Where is the necessary downstream deposition of eroded canyon sediment? What about all the alleged missing layers? We shook our heads in wonder and genuine pity at the ability of evolutionists to accept such utter absurdity."

There are abundant clues as to why this teaching strategy is successful. It makes people who know very little about a complex subject feel confident about their ignorance. McIver writes: "Our opinions were solicited, although most of us had no previous geological training." This is consistent with the creation-science tradition of amateur nature-watching. "Creation science" relies upon a naive empiricist philosophy of science:

- science is built up of common-sense observations;
- nature (like Scripture) is perspicuous;
- ordinary folk, if not blinded by theoretical speculations and materialist, evolutionist idols, can participate in this enterprise of understanding God's creation.

In other words, traditional "creation science", like Krishna pseudoscience and "Intelligent Design"

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panaceas, provides people with validation of what they want to believe. There is no need for fancy theories, complex instruments, or laborious testing of hypotheses. It's American populism—your view is just as good as anyone else's. People love to be asked, "What do *you* think?"

There is a subtle flattery to this approach. How much harder it is for a scientist to remonstrate, "Well, we have to see where the facts lead us. We have to form hypotheses and test them. We have to examine many different lines of evidence. We may not have enough information to get to the right answer." Hmph. That doesn't make me feel as good as that fellow over there did. At least he thought my ideas were important.

It is a seductive idea that ordinary people can understand the natural world with only the most superficial training, and that it is as likely to be correct as the views of that fellow over there with the PhD. But it also has a parallel in religion. In most faiths, there is a hierarchy of clergy and a standard system of tenets. This does not simply mean a holy book, like the Bible, the Torah, or the Tao; rather, it means an orthodox interpretation of these views, developed through history by scholars and clerics (and invested with all the institutional prejudices of that history).

The tradition of American fundamentalism is outside this institutional scholasticism because it has no hierarchy, it does not particularly value academic scholarship, and it places the validity of religious interpretation squarely on the individual preacher (See Ronald Numbers's masterful book, *The Creationists*). If you have witnessed, if you believe, if you understand, then you can pretty much preach and interpret however you like, as long as you can get people to listen. This is not to say that fundamentalist clergy cannot be scholars or cannot interpret the Bible accurately, any more than one would assert that anyone with a PhD degree in a scientific field is widely read in science, let alone inerrant about scientific matters. But this is why the absurd literalisms of many fundamentalist preachers, pointed out by historians, theologians, biblical scholars, and scientists, make no impression on their beliefs or teaching. One man's view of the Bible is just as good as that pointy-headed theologian's over there; after all, he probably doesn't share my Faith, so why should anything he says be trusted?

If anyone can receive the Word, if they believe, and can interpret the Bible correctly, then certainly anyone can interpret the phenomena of the natural world, which is of course the handiwork of the Creator. Hence the parallel between the "commonsense" or "populist" view of religion, and that of nature.

McIver continues: "Yet, despite this tradition of obsolete commonsense empiricism, with its harsh criticism of evolution and other modern scientific theories for being nothing but biased, abstract speculations, creationists indulge in hypothesis-spinning of the most reckless sort. We were encouraged in this: what scenarios could we devise which would account for the observed data—fossil footprints, various strata, faults and unconformities, or whatever—and still preserve the absolutely required literal interpretation of Genesis? No discrepancy is perceived, because creationists know that the Bible is totally inerrant."

Here, the two components of this world view are combined. Anyone can figure out the science; and the Bible tells us all we need to know. It may seem odd that a person would reject a secular scientific view of natural phenomena on the grounds that it is authoritarian and a belief system, but would accept with ease an authoritarian view of natural phenomena based on religious knowledge that has little or nothing to do with the proximal evidence of the natural world. But it is just as odd to think that a person could reject a secular scientific view of natural phenomena with nothing whatever in its place, able to be swayed by the flimsiest *prima-facie* case for human and dinosaur footprints together, human artifacts 55 million years old, or continents slipping halfway around the earth suddenly every 41 000 years. The uncertainties of science, and its philosophical methods of forming hypotheses and testing them, are not congenial to you if you like things simple, and accept that the average person can come up with explanations as good as those of the most highly trained scientist, just by sitting down and thinking a little. After all, science is supposed to be an open-minded process, isn't it?

The best answer to this, perhaps, is the well-known aphorism that "science is open-minded but not empty-headed." It builds on itself, it is continually self-correcting, it has expectations, and if these are not met by the evidence then it looks for other evidence in the system that would explain why. People from all religions and cultures can participate in this community endeavor as long as they follow the precepts of scholarship and hypothesis-testing. But don't be disappointed if the "populist science" folks don't seem overly impressed by this. And you won't just find them in the pews. They'll be on the bus next to you, reading the astrology column; they'll be listening to the salesman in the jewelry store at the mall talking about the healing powers of crystals; and they'll be perusing the offerings in the New Age section of the bookstore.

Ohio member Brad Lepper informed us about a review by Stephen Bostock in the 19 February issue of *Nature* of a book called ***Spectacular nature: Corporate culture and the Sea World experience*** by Susan Davis (University of California Press). The reviewer wrote that at Sea World "mention of evolution is now banned too, as presumably too controversial, and this in an institution that seeks increasingly not only to encourage school parties but also to provide biological instruction to schools on a vast scale through television and the Internet."

Self-Organizing Systems from a Primordial Silicon "Soup"

In the Nov 15 1997 issue of *New Scientist*, Clive Davidson reported an astounding development. Adrian Thompson developed a microprocessor that distinguishes between the spoken words "Stop" and "Go", but Thompson did *not* program the chip to do so. Davidson writes, "Even though the circuit consists of only a small number of basic components, Thompson does not know how it works. He can't ask the designer because there wasn't one. Instead, the circuit evolved from a 'primordial soup' of silicon components guided by the principles of genetic variation and survival of the fittest."

To kick off the experiment, Thompson created a population of 50 configuration programs on a computer, each consisting of a random string of 1s and 0s. The computer downloaded each program in turn to the microprocessor to create its circuit. The genetic algorithm tested the fitness of each circuit by checking how well it discriminated between tones. It looked for some characteristic that might prove useful in evolving a solution. At first, this was just an indication that the circuit's output was not completely random. In the first generation, the fittest individual was one with a steady 5-volt output no matter which audiotone it heard.

After testing the initial population, the genetic algorithm killed off the least fit individuals by deleting them and let the most fit produce copies of themselves—offspring. It mated some individuals, swapping sections of their code. Finally, the algorithm introduced a small number of mutations by randomly switching 1s and 0s within individual programs. It then downloaded the new population one at a time onto the processor and ran the fitness tests once more.

By generation 4100, the circuits in the microprocessor could distinguish consistently between the two tones. From that point on, the evolutionary process continued to refine the performance of the chip the spoken words "go" and "stop" became distinguishable.

"So how did evolution do it?" Davidson asks. "When he looked at the final circuit, Thompson found the signal routed through a complex assortment of feedback loops." The signals passing through these loops also appeared to interact with the original test signal so that the circuit can distinguish it from the alternative signal. The best evidence of this is that the processor did not produce the two-state outputs that are typical of digital technology.

In addition, of the 100 "cells" in the chip, Thompson found that only 32 were essential for the operation of the circuit. Most other cells could be bypassed without affecting the output; however, if Thompson disconnected a certain 5 of these cells that seemed to have no purpose in the logic of the program, the chip would not work.

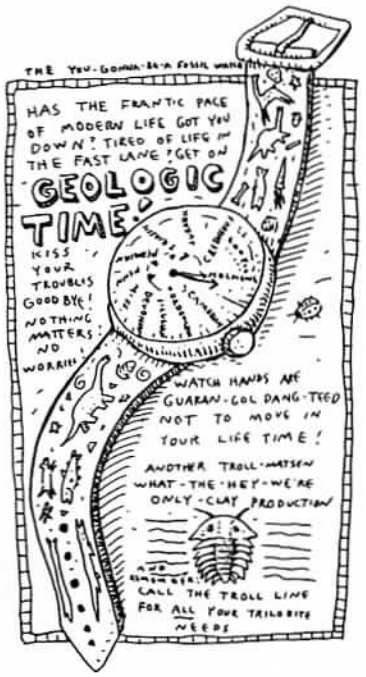
At this point, neither the microprocessor's "creators" nor anyone who has tested them can explain how they work or how they organized themselves from the "primordial" elements—a particular type of circuit component in an array on a silicon chip. It surely does appear that a self-organizing system has evolved in Adrian Thompson's laboratory.

[*Excerpted from Davidson C. Creatures from the primordial silicon.* New Scientist *1997 Nov 15; 156 (2108): 30-4. Full text available at <http://www.newscientist.*

For the Journal of Irreproducible Results, try <http://gort.ucsd.edu/newjour/m/msg00403.html>

Or, for a tasty alternative, try the Annals of Improbable Research at <http://www.improb.com/>

[*Contributed by John R Cole.*]



In *Christianity Today's* annual book issue (April 27, 1998), the 1997 Book of the Year was Billy Graham's autobiography, *Just As I Am*. Not far down the list at number 5 was Phillip E Johnson's *Defeating Darwinism by Opening Minds*. A panel of writers, scholars, pastors and other church leaders chose the books on the list. See review by Robert Pennock of Johnson's book on p 36.

Friend of Darwin Award Given to Barbara Forrest

Molleen Matsumura
Network Project Director

Each year, NCSE's Board of Directors confers one or more "Friend of Darwin" awards for significant efforts to advance evolution education, and service to NCSE. At its February 1998 meeting the board voted to honor Barbara Forrest for years of hard work.

Forrest teaches at Southeastern Louisiana University, which is located in Tangipahoa Parish. When Tangipahoa's Board of Education began considering a "Model Origins Curriculum" and then adopted an anti-evolution disclaimer, Forrest joined NCSE members Bob and Nicole Okazaki and other citizens in publicly opposing the move. In time, when the Board of Education appealed a court ruling against the disclaimer, she spent long hours (at the same time as she was grading finals!) finding local organizations willing to sign onto the PEARL and NCSE briefs (*see* RNSCE *1997 Sept/Oct; 17[5]:4, 5-6*).

While the Tangipahoa disclaimer was under challenge, the same "creation science" curriculum was proffered to neighboring Livingston Parish, whose schools Forrest's children attend. In this case she was a leading opponent. Barbara wrote opinion pieces, encouraged others to speak out, maintained a constant flow of information to NCSE, wrote a detailed critique of the proposed curriculum, and collected extensive information about evolution education. She even obtained a letter from Nobelist Ilya Prigogine decrying misrepresentation of his work as providing "evidence against evolution".

Forrest avails herself of every opportunity to inform colleagues of the need to support evolution education—just one example is a presentation on the issue to her state chapter of American Women in Science. She participates in internet listserves discussing the issue, and informs NCSE when she hears of new problems. She can be counted on to respond to calls for help from other states, and was one of the first to write to Arizona's superintendent of education about the need to include evolution in their curriculum standards (*see Updates, p 5*).

Forrest's most recent effort was in early March 1998, when she arranged an evolution symposium at her university. The symposium was open to the public as well as the academic community, and Forrest made a point of inviting teachers. With characteristic thoroughness, she not only invited the speakers, designed posters and arranged publicity, but collected information and resources for teachers to bring back to their classrooms. The NCSE staff was delighted when one of the speakers agreed to present the Friend of Darwin award in person.

As the letter of presentation said: "This isn't the last time NCSE will thank Dr. Forrest, but it is an honor to thank her again."

Office Biz:

Address Updates
Erik Wheaton
NCSE Circulation Manager

The US Postal Service (USPS) has instituted new standards for "standard" (formerly known as "bulk" mail) and second class mail. These new standards requires us to have virtually all of our addresses certified as to accuracy and to include the ZIP+4 code before we can mail at the lower non-profit rate.

Usually this is not a problem. We use a mailing service that verifies our addresses using a nationwide database of USPS-certified addresses. The difficulty we have recently been having is with college and university addresses. For some reason the USPS does not include college or university addresses in its database at this time, unless your department address includes a post office box number or a number and street in addition to your unit or departmental name and the name of your institution.

As a result, we must do two mailings. One goes out at the lower non-profit rate to all members for whom we have accurate ZIP+4 codes, and the other goes at a higher mailing rate for those for whom we do not have a ZIP+4—mostly college and university addresses. This means that if you are receiving *Reports of the National Center for Science Education* at your university address, it is probably not being sent with the ZIP+4 code.

How can you help?

Check your address label for *Reports of the National Center for Science Education*. If there is no ZIP+4 code please check with your institution's mail department and find out the exact street address (if any) and ZIP+4 code for your location.

The correct USPS format for college and university addresses is:

NAME
DEPARTMENT or UNIT
UNIVERSITY OR COLLEGE NAME
BUILDING OR OTHER IDENTIFYING NAME
STREET ADDRESS
CITY STATE ZIP+4

All words are capitalized and there is no punctuation.

Once you confirm your proper ZIP+4 address, please use it in your renewals and changes of address that you send to NCSE. If you are on-line, please e-mail me your corrected address at ncse@natcenscied.org.

How to Make a Foot Into a Mouth: Developmental Genetics and Evolution

A recent report in *Nature* described how changes in genes controlling animal development can lead to novel structures that differ in form and function from those of recent ancestors. According to a University of Chicago press release, Nipam Patel, assistant professor of organismal biology and anatomy in the University of Chicago's Howard Hughes Medical Institute, and Michalis Averof, currently at the European Molecular Biology Laboratory in Heidelberg, "showed that changes in the pattern of activity of two *Hox* genes in crustaceans are linked to the relatively sudden evolutionary development of useful, distinctive feeding limbs called maxillipeds (literally 'jaw-feet') where swimming or walking legs once were."

> *Hox*, or homeotic, genes identify the segments along the embryo's body and regulate the formation of major structures in every animal studied. But because laboratory mutations in these genes can cause monstrosities—such as a fly with legs where its antennae should be—many scientists doubted that natural variation of homeotic genes could underlie the incremental, survivable changes that accrued over eons as animals gradually evolved improved body parts. Today's finding marks the first time that changes in the control of homeotic genes have been shown to underlie an evolutionary trend leading to novel body structures.

Patel and Averof based their report on specimens from 13 separate species of crustaceans distributed in 9 different orders. From this large sample from a number of evolutionary lineages

> the researchers used an antibody that labels the proteins made by 2 closely linked homeotic genes, *Ubx* and *abdA*, to show in which segments of the embryo the genes are turned on. In crustaceans, if *Ubx-abdA* is turned on in a segment, it tells the limb buds they lie in the part of the thorax that should grow locomotory legs. The researchers found variation in the pattern of segments in which *Ubx-abdA* is turned on, and that this pattern corresponded with anatomic changes that traced ancestral relationships and evolution.

"In primitive kinds of crustaceans, we found *Ubx-abdA* is turned on in the first thoracic segment and is 'on' from there back to the tail," Patel said. "In these animals, there's a marked difference between the appendages of the head and the thorax—the head has tiny appendages used for pushing food into the mouth, and the thoracic appendages are long and feathery for swimming."

> But in more advanced crustaceans, the first segment in which *Ubx-abdA* is turned on lies farther back along the body. In these animals, the first few thoracic segments have appendages that look like those of the head. These maxillipeds are not just misplaced jaw parts but have new capabilities because they are attached to the powerful muscles and the nervous system of the thorax. Crustaceans that have them include the decapods—shrimp and lobsters and their relatives.
>
> According to Patel, animals with maxillipeds feed in a different way. "They can walk and hold and move their food at the same time. This has clear implications for the organism and can be an advantage, depending on environment."

Patel said the finding legitimizes the use of comparative genetics of early development as a tool for studying evolution. "This variation is what everyone had hoped to find for this class of genes," he said. "Changes in morphology should mirror what was happening with respect to expression of the gene. In crustaceans we show a very striking example of this correlation."

[*The research was funded by the Howard Hughes Medical Institute and the Carnegie Institute. Reprinted with permission. This article was excerpted with permission from the University of Chicago. The full text with electron micrographs is available at <http://www.ucmc.uchicago.edu/news/1997/evodevo.html>.*]

Donald Wise from Franklin and Marshall College has written an excellent illustrated article entitled: "Creationism's geologic time scale," which was published by *American Scientist* [1998; 86:160-173]. He addresses the issue: "Should the scientific community continue to fight rear-guard skirmishes with creationists, or insist that 'young earthers' defend their model *in toto*?"

One part of this article deals with the creationist idea that late-flood granite masses were formed at 1000 degrees F and cooled to present low temperatures at rates in violation of all laws of physics.

He has given permission to have the article reposted on the world-wide web site maintained by Lorence Collins which is concerned with opposition to creationism. See article number 7 at <http://www.csun/~vcgeo005/creation.html>.

The web-site version is a third longer, has about twice as many references, uses a different organization, and adds other items which debunk the pseudo-science of the creationists.

[*Contributed by Lorence Collins.*]

Many Scientists See God's Hand in Evolution

Larry Witham

While most US scientists think humans are simply smarter apes, at least 4 in 10 believe a creator "guided" evolution so that *Homo sapiens* are ruled by a soul or consciousness, a new survey shows. Scientists almost unanimously accept Darwinian evolution over millions of years as the source of human origins. But 40% of biologists, mathematicians, physicians, and astronomers include God in the process.

"I believe God could work through evolution," a South Carolina mathematician wrote in a marginal note on the survey. "Bell shaped curves describe how characteristics are distributed...so I think that God uses what we perceive to be 'random processes.'" Despite such affirmations, however, 55% of scientists hold a naturalistic and atheistic position on the origins of man, according to the random survey of 1000 persons listed in the 1995 *American Men and Women of Science.*

"I am surprised to find that so many are theistic evolutionists" Duncan Porter, a Virginia Tech botanist and Darwin scholar, said in an interview. "As an Episcopalian, I don't compartmentalize those things," he said of God and evolution, "I put them together in an overall view." Rick Potts, director of human origins at the Smithsonian's National Museum of Natural History, said it is not unusual to find religious beliefs in any community, including scientists.

But "I'm happy to see that 55% are taking a naturalistic approach," he said. "Most anthropologists would draw the line heavily toward the naturalistic side. We want to explain our phenomenon without recourse to things we can't observe or measure." The survey, which had a 60% response rate, asked scientists the same Gallup Poll question posed to the public in 1982 and 1991. In the 1991 round, 40 percent of Americans said God "guided" evolution to create humans.

While this 40% is a middle ground of agreement between scientists and the public, there is a sharp polarization between the groups taking purely naturalistic or biblical views. While most scientists are atheistic about human origins, nearly half of Americans adhere to the biblical view that God created humans "pretty much in their present form at one time within the last 10 000 years." Forty-six percent of Americans agreed with this view of human origins in the 1991 Gallup poll. Only 5 percent of the scientists agreed.

Because only a quarter to a third of Americans are Protestant evangelicals or fundamentalists, the 1991 Gallup Poll showed that many mainline Protestants, Catholics and Jews believe in a "last 10 000 years human creation." The 1991 poll also showed that college-educated Americans were far more likely to accept evolution, underscoring their closer affinity to the views of scientists.

The standard view in science is that modern-day *Homo sapiens* emerged 40 000 years ago and began to organize societies 10 000 years ago. The oldest humanlike ape is called *Australopithecus*, or "southern ape." It was found in Africa and is believed to date back 4 million years. *Homo erectus* developed 1.8 million years ago. Neanderthals roamed Europe and Asia beginning 100 000 years ago.

The survey was a separate but parallel study to one reported in *Nature* (1997 Apr 3; 386:435-6) in which 40 percent of the same scientists reported a belief in a God who answers prayers and in immortality. Both surveys were conducted by a reporter for the *Washington Times* and Edward J Larson, a historian of science at the University of Georgia. The report in *Nature* was based on a replication of a 1916 survey that scandalized Americans by finding that 45 percent of scientists were atheists and 15 percent were agnostics. Before the 1859 publication of Charles Darwin's *On the Origin of Species*, scientists and the Western public agreed that God designed human life. Afterward, they became sharply divided.

The belief that God creates through evolution has been called "theistic evolution" though there are different views on how much God intervenes in the process.A physicist from New Mexico wrote on the survey that God created man "within the last 10 000 years, but the universe is billions of years old." Two biologists from Ohio refined the question about God and evolution. One said, "God created the universe and principles of energy and matter, which then guided subsequent evolution." The other said God did not guide the process "but did create the conditions that allowed the process to take place." "Creation science," most visible in school board debates and court rulings, is only one brand of creationism. It holds that the earth is about as young as human creation. But many Bible believers combine an ancient earth and some evolution with a recent human creation.

[*This article appeared in the* Washington Times *on April 11, 1997, p A8. It is reprinted here with permission.*]

Members Making a Difference

Molleen Matsumura
Network Project Director

NCSE members are a creative crew, always finding new ways to support evolution education and good science education generally. From time to time we report what they've been up to, not only to say "Bravo!" for work well done, but to inspire other members looking for ideas. Here's just a small sampling:

•New Mexico's *Coalition for Excellence in Science Education* (CESE) was founded by NCSE members who work both to assure that evolution is included in science education and, as their name says, to promote excellence in science education generally. CESE President **Marshall Berman** just informed NCSE that he is planning to run for his district's seat on the State Board of Education. Berman, **Kim Johnson**, and others give assistance to individual school districts when they are pressured to adopt "creation science" or "intelligent design". **Steve Getty** was a member of the committee that developed statewide science Performance Standards.

•**Mitchell Cruzan** and **Andrew Kramer** are among the founders of the "Tennessee Darwin Coalition" at the University of Tennessee, Knoxville. As part of their work to promote evolution education in Tennessee, the Coalition has initiated a series of "Darwin Day" conferences and invited NCSE's Eugenie C Scott to conduct a teacher workshop at the 1998 conference. Their World Wide Web site has archived conference papers and other resources at <http://fp.bio.utk.edu/darwin/frmain.html>.

•**Wesley R Elsberry, Robert T Pennock, Steven D Schafersman, Jeffrey P Schloss**, and **Mark I Vuletic** presented papers at the "Naturalism, Theism, and the Scientific Enterprise" conference held in February, 1997 at the University of Texas, Austin. Their cogent discussions of the nature of scientific inquiry have been published on the World Wide Web at <http://www.dla.utexas.edu/depts/philosophy/faculty/koons/ntse/papers.html>.

•**Frank Fire, Mark Gilbert, Thomas Moore**, and **Brett Vickers** are helping in a big way with the NCSE website. Tom Moore has compiled and coded a complete listing of articles published in *Creation/Evolution*, and Frank, Mark, and Brett are doing the time-intensive work of scanning and proof-reading articles from early issues. Mark Gilbert started helping from the moment he discovered NCSE. When he found our site on the World Wide Web, he created the 3-D color logo you'll find there now.

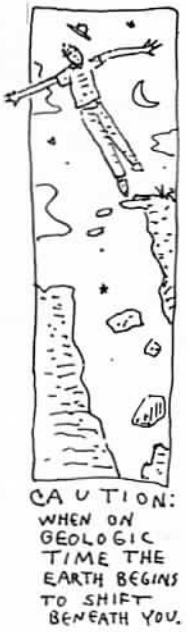
•**Ken Marsalek** sent NCSE a mailing list of potential members.

•**Michelle Petrofes** sought election to her local board of education.

•**Steve Rocchi** serves on the Oroville, California Board of Education.

We'd also like to thank those members who responded to our invitation to join the **Pre-Publication Review Project** ("NCSE's Pre-Publication Review Project Set to Expand" *RNCSE* Jul-Aug 1997; 17[4]). If you are a scientist interested in reviewing textbooks for scientific accuracy, write to Erik Wheaton at NCSE, or send him email at <ncse@natcenscied.org>, and he will send you an application form.

For more suggestions of ways *you* can support evolution education, read "25 Ways to Support Evolution Education." You can find a copy in your 1997 Members' Directory, request a copy by sending a self-addressed envelope to NCSE, or visit our web-site at <www.natcenscied.org/whatcando.htm>.



Daniele Pinti wrote to tell us of a new web site of interest. Connect to <http://psmac5.ess.sci.osaka-u.ac.jp/Homepage/Journal.html> for links to journals that publish articles in the earth sciences. Most of these links are to the publishers' journal pages and tell about the scope of the journals, but not the contents. However, Pinti does provide a topical classification to help indicate journals that tend to carry articles in certain areas.

Topics include:
- Geoarchaeology
- (Bio)Geochemistry
- Geology
- Geophysics
- Geoscience Editing & Popular Geology
- Hydrology & Limnology
- Oceanography
- Paleontology
- Planetary Science
- Sedimentology
- Vulcanology & Geothermics
- Zink

BOOKREVIEW

How we happened: The beginning of everything

by: Gaye Gronlund and Dr Adrian Melott with illustrations by Margaret Shelby. Indianapolis: ECE Consulting, Inc. 35 p. $95.

Reviewed by Hans O Andersen. School of Education. Indiana University, Bloomington. Email: <andersen@indiana.edu>

"How did I happen?" is one of the most common, often unanswered, formally unasked, and deeply interesting questions of primate school-aged children. The authors of this book had as their objective answering this question in a manner that young minds could process and understand. This beautifully illustrated book begins with a question and ends with the idea that there are many more questions to ask and many more discoveries to be made if we put in the effort to do so. The book's initial question, "How do things in the world begin?" is set in a view that seems to be a synthesis of known and unknown with a relatively bright sun-like object, a dark sky containing nebulous colored spheres, and a request to *think really hard about something beginning*. Try it, imagine trying it, or imagine being in a class with young people who have been given the challenge to talk about *something beginning*. This think about *something beginning* establishes the questioning tone for the entire book.

The next pages illustrate plants, kittens, a baby, and the beginning of a day, and they include brief statements designed to lead the reader to the conclusion that everything has a beginning, including the earth, the sun, and the universe, which began with a big bang that happened a very long time ago. After briefly examining what a long, long time might mean, the authors return to the big bang and the idea that the universe has been and continues to expand in spite of the pull called gravity that tends to pull everything together. The universe at the time of the big bang is illustrated as a smooth area with lumps which, because of the pull of gravity, become larger and larger, forming clouds and, eventually, suns and planets. As this process continues, the authors point out that *evolution* means *to change slowly*.

The next stages illustrated are the slow steps of biological evolution which eventually lead to the evolution of people, and even later to scientists, including the cosmologists who study the stars. They, like other great thinkers, use every part of their minds and numerous other resources in their quest for explanation.

The text of the book flows smoothly from the beginning, and the transitions should be easy for teachers and young students to follow. The book then closes by telling the readers that cosmologists use tools, are not always right, and have questions to which they are still seeking answers. Finally, the authors invite the readers to join them in seeking those answers.

The teacher's guide which accompanies the book contains suggestions for 18 45-minute lessons for 1st-3rd graders and 21 45-minute lessons for 4th-5th graders. These lesson suggestions will be particularly useful for beginning teachers and somewhat useful for practicing teachers. The teacher's guide also contains the words to the songs suggested, lists of resources, a star chart, a do-it-yourself starfinder, and suggestions to teachers for communicating with parents concerning what is being taught in school. One might question whether spending 20 days on this one book is appropriate, but as the authors suggest there are numerous additional resources that are available, and the idea is certainly worth the time.

Elementary teachers interested in teaching about evolution should find this text and accompanying resource guide to be very useful and will be pleased with the engagement in this issue that the book stimulates among students. The book is excellent—beautifully illustrated, accurate, and motivating. I recommend its use with elementary school children, and I highly recommend this book and the accompanying resources to all elementary teachers who want to engage their students in exploring the big ideas of science.

BOOKREVIEW

Defeating Darwinism by Opening Minds

by Phillip E Johnson, 1997. Downer's Grove, IL: InterVarsity Press, 131 p.

Reviewed by Robert T Pennock, Dept of Philosophy, The University of Texas at Austin.

Those who have read Phillip Johnson's *Darwin on Trial* (1991) and *Reason in the Balance* (1995) will immediately recognize the argument as well as the rhetoric in his latest book. Johnson again brings up the Cambrian explosion and other features of the fossil record that he says biologists can't explain, but he opposes evolutionary theory primarily by way of an attack on scientific naturalism. He speaks of how the young need protection against "indoctrination" (p 10) from "the ruling naturalists" (p 22) who make students memorize "naturalistic doctrine" (p 34). He continues to insinuate a conspiracy of atheist Darwinian elites who control the airwaves—"the microphone-owners of the media [who] get to decide who plays the heroes and who plays the villains" (p 33).

Though his arguments against evolution are broadly philosophical rather than scientific, he ignores most of the history of philosophy, and still perversely insists, for instance, that taking God as a supernatural foundation is the only way to avoid relativism of both knowledge and morality. When we "declared our independence from God" (in the 1960s of course, on the heels of the 1959 Darwin Centennial), we lost the assumption that "the law was based on a set of underlying moral principles that came ultimately from the Bible," and this, Johnson opines, resulted first in the divorce revolution, then the sexual revolution, the feminist revolution, and inevitably abortion rights and homosexual liberation (p 103-4). These themes, as well as Johnson's characteristic shrill notes, are by now tiresomely familiar. There are, however, a few important developments in the book.

The most significant new point in Johnson's attack on evolution is that for the first time he comes out explicitly against the core thesis of common descent. In many previous writings Johnson blithely ignored the basic textbook meaning of *evolution* and used his own idiosyncratic definition that made no mention of descent with modification. One always suspected that Johnson was more of a traditional creationist than he let on, but he refused to be pinned down on any specifics and mostly confined his objections to the Darwinian mechanism (what he called "the blind watchmaker thesis") and to the purported "dogmatic philosophy" of naturalism that he claimed was part of its definition.

He proffered "intelligent design" as the correct alternative account, but refused to say anything about that "theory" beyond the vague claim that God's intentional design was the true explanation of biological complexity, leaving open the possibility that God did not create biological kinds *ex nihilo*, but by guiding the process of descent. However, as he previously claimed that the Darwinian mechanism was a false doctrine propped up by naturalism, he now says the same of descent with modification: "Put aside the materialism," he concludes, "and the common ancestry thesis is as dubious as the Darwinian mechanism" (p 95). Perhaps in a future book he will finally tell us what intelligent design theory has to say about stratigraphy and Noah's Flood.

A second significant addition here is an indication of how "intelligent design" theorists hope to update the old creationist argument from the information content of biological molecules. Johnson suggests (incorrectly) that information is a radically anti-materialist concept. He claims that information is primary and prior to the material, noting that the Gospel of John says that "in the beginning was the Word," not matter. This is admittedly a clever interpretive idea and, given the real importance of information theoretic issues in biology, we can expect creationists to run with it. Johnson first broached his idea in a 1996 article in *Biology and Philosophy*, picking up on a few statements of biologist George C Williams who was discussing (far too loosely, I would say) biological information. Williams had said that information was "not physical objective reality" and was a "more or less incommensurable domain" from matter, and Johnson proposed that this was a recognition of an ontological *dualism* of matter and information, and that matter could therefore never explain the origin of information.

Williams and Richard Dawkins each wrote pithy, scathing replies, but in *Defeating Darwinism* Johnson oversimplifies their objections. He admits that it is easy to account for the origin of information if its content is low, but he claims that there is no accounting naturally for the "highly specified information" of complex organisms. Expect this to be where the new creationists will try to make their next pitch for intelligent design. As they do, watch for those subtly question-begging words like "specified" which lead one to think of an "intelligent agent" (a specifier), where "specific" would be more precise.

The next time Johnson says that "The Word (information) is not reducible to matter, and even precedes matter" (p 71), be sure to ask for an example of information that is prior to matter (or anything physical)—he won't have one because information is a relational property that can't exist in a "disembodied" form. And don't be put off by facile claims about irreducibility, for that is a difficult and controversial philosophical concept. While it is true that, in one simple sense of reduction, information is not reducible to matter (that is, the same information can appear in any number of different material forms), this is not a sense that would lead to any spooky dualism or would necessarily require an intelligent author.

A less substantive, but perhaps more important, change in this new book is an explicit shift in Johnson's target audience. In a 1993 interview Johnson had said that he was not interested in discussing how the cre-

ationism debate should be conducted in the schools. "[T]he public school system isn't really my venue," he explained, "it isn't where I want it argued. It's in the universities and scientific community that I really start the argument" (Barbero 1993). Now Johnson is ready to switch venues and writes that the aim of this new book is to give "a good high-school education in how to think about evolution" (p 11). His audience consists of "late teens–high-school juniors and seniors and beginning college undergraduates" (p 9) and their parents and teachers. He even tells us how he would design a curriculum in evolution for these students. Apparently Johnson now does want the issue argued in the schools, for he says that the biology curriculum should be built around principles of critical thinking. He wants to turn the table on scientific skeptics and have students learn to train what Carl Sagan called their *baloney detectors* upon evolutionary theory.

Johnson goes through Sagan's baloney detection list of fallacious appeals to authority, selective use of evidence, begging the question, *ad hominem* arguments, and so on, but illustrating these with ways that he claims evolutionary biologists are dishing out the baloney. For example, he says students should be taught to watch for evolutionists' bait-and-switch strategy of starting with what they call "the fact" of evolution and then surreptitiously inflating it to include the mechanism as well. (Gould and some other evolutionary biologists speak of common descent with modification as "the fact" of evolution to distinguish that from "the theory" of the mechanism[s] by which it occurred. In Johnson's section on the curriculum he misleadingly defines and dismisses it as being just the uncontroversial point that "organisms have certain similarities like the DNA genetic code, and are grouped in patterns" [p 58], though he later uses it in Gould's sense to refer to common descent when he rejects that thesis [p 94].)

Incredibly, Johnson claims that this important distinction between product and process is "just a debating gimmick" (p 59) to hide problems with the Darwinian mechanism. He warns teachers that if they want to try to teach about the evolutionary "snow job" they may have trouble avoiding the attention of "so-called civil liberties lawyers" (p 116) and offers his services and those of his colleagues to help. He directs teachers to the Access Research Network Web site <http://www.arn.org> which has become the outlet store for "intelligent design" creationism, where their materials will be posted.

We should applaud Johnson's call for teaching critical thinking, but his seven-point program for applying this as the framework for a biology curriculum is ludicrous. Imagine suggesting that the proper way to teach geology is to tell students that the subject is little more than "philosophical dogma" and that geologists are "bluffers" who intentionally "dodge the hard questions" and who should be "viewed with suspicion." Teaching an academic discipline in this manner would be intellectually irresponsible and morally reprehensible. Even parents who are creationists and would like to see this critical approach to evolution in the schools may be less than pleased to hear that Johnson also recommends that students learn in biology class to turn their baloney detectors upon their own religious beliefs. He argues that to believe in God simply on faith rather than reason is either a "mistake" or a "rational defensive strategy born of desperation" (p 20), and that students must confront the theological problems that result from taking on evolution.

Believe it or not, critical thinking about such theological matters also comes under one or other of the seven points Johnson would include in his biology curriculum. Johnson wants to to blame everything on scientific naturalism, but that is no more or less an "assumption" of every other theoretical and applied science than it is of Darwinism; if Johnson's curriculum is justified in biology classes, then why doesn't he consistently recommend that it be applied in like manner in physics class and auto shop?

Johnson tells high-schoolers that they need to "learn to use terms precisely and consistently" (p 57) but that biologists are intentionally slippery in their use of the term *evolution*, so that when they hear it "the indicator screens on their baloney detectors should display 'Snow Job Alert'" (p 116). Students reading his book will profit from turning their baloney detectors upon it, for Johnson's own use of terminology is no model of the virtues he rightly praises. In addition to the terminological laxity noted above, one finds that Johnson is similarly loose with other evolutionary concepts when it is to his advantage. One instance involves what he calls "Berra's Blunder".

In *Evolution and the Myth of Creationism* (1990), zoologist Tim Berra illustrated a point about the nature of an evolutionary sequence using a series of photographs that show the development of the Corvette over several decades. Johnson says Berra has blundered here because "[t]he Corvette sequence...does not illustrate naturalistic evolution at all. It illustrates how intelligent designers will typically achieve their purposes by adding variations to a basic design plan" (p 63). But it is Johnson who is being misleadingly ambiguous here, for Berra never claims that this is an example of natural selection but says *explicitly* that this is an illustration of a kind of descent with modification. He uses the example to illustrate how small changes, where the relatedness of intermediate forms is easily recognizable, can add up to differences such that the endpoint is nearly unrecognizably distinct from the starting point. For this purpose the Corvette example, using artificial rather than natural selection, works perfectly well.

Furthermore, it is an important, basic point to make with a familiar example, since many creationists continue to cling to the immutability of species and insist that cumulative selection of small variations in a species (microeveolution) can't add up to form new species from old (macroevolution). Johnson misleadingly defines microevolution as "cyclical variation within the type" [p 57] so that it looks like it fits with the creationist idea of fixity of kinds. Johnson claims that these small changes can't add up to form new species from old (macroevolution). It is an important, basic point to make with a familiar example. It is thus Johnson, not Berra, who has blundered. Moreover, are we really supposed to take seriously his implicit suggestion about discovering the divine Designer's purposes on analogy with that of automotive designers? If so, what should we conclude about God's purposes for human beings, chimps, gorillas and the various extinct fossil hominids given that we are all but a minor variation on the primate "design plan?" It looks like *Homo sapiens* is just the latest of a line of mostly failed production models.

Johnson's imprecision and inconsistency are even more pronounced when it comes to the philosophical

concepts he tries to make so much of. For instance, with no regard for the basic distinction between ontological naturalism and methodological naturalism,Johnson continues to speak generically of "naturalism" as a dogmatic metaphysics (see Pennock 1996). His evidence that biologists are committed to the ontological view that there is no God and that nature is "all there is" comes from the 1995 Position Statement of the American National Association of Biology Teachers (NABT) that said that evolution was an "unsupervised" and "impersonal" process. The fact that NABT recently dropped these two terms from its statement to remain properly agnostic about God's role (as methodological naturalism requires) repudiates Johnson's charge.

Compounding the above prevarication, Johnson also confuses scientific naturalism and materialism. Mechanistic materialism became the dominant naturalist ontology in the 17th century, but scientific naturalism allows other explanatory categories of being, provided that they do not violate natural law. Indeed, it is more common in philosophy of science today to speak of *physicalism* rather than materialism, so as not to over-emphasize matter over space-time, forces, fields and other basic categories that have been added to physics in the intervening centuries, and so as *not* to beg ultimate philosophical questions about metaphysics.

Johnson does (temporarily) correct one serious philosophical error he had made in *Reason in the Balance*. There his main target was "modernism," but he incorrectly described modernists as being ethical and epistemic relativists, and attributed to modernism characteristics that actually belong to *postmodernism*. In *Defeating Darwinism* he does better, writing: "Modernists believe in a universal rationality founded on science; postmodernists believe in a multitude of different rationalities and consider science to be only one way of interpreting the world. In other words modernists are rationalists; postmodernists are relativists" (p 90). But after admitting this difference he goes back to lumping the two together and criticizes modernism generically as the subjectivist "established religion" of the West (p 97).

Interestingly, Johnson's own view is clearly postmodernist in many of its key elements. His writings are rife with postmodern language about the "construction" of knowledge by those in the "establishment" who are acting to protect their "power and wealth" by "indoctrinating" the masses with an oppressive "ideology". I was not surprised to learn recently that Johnson's original title for *Darwin on Trial* had been *Darwinism Deconstructed*. Like postmodernist philosophers, Johnson seems to think that what is called knowledge is nothing more than the fashionable cultural narratives held by the ruling elite. One way this view is exemplified in *Defeating Darwinism* is the emphasis he places on the play Inherit the Wind—a fictionalization of the Scopes trial, which he calls a "masterpiece of propaganda" (p 25). Spinning his own masterpiece of deconstruction Johnson tries to argue that the play actually achieves its effect by borrowing from the Gospels and essentially giving Bert Cates (the character representing the evolution teacher Scopes) the moral role of Jesus.

Well, maybe so, but what does that have to do with whether the scientific evidence tells us that evolution is true? The answer, of course, is that although Johnson is like postmodernists in opposing scientific methods as having any special evidential merit for discovering truths about the empirical world, he is at heart really a premodernist in holding (though never quite forthrightly admitting) that the only warrant for truth is God's Word. Johnson wants to defeat Darwinism by having students "open their minds" to supernatural possibilities in the ways he suggests and ignore standards of evidence. As an antidote to Johnson's postmodernist call to carelessly throw out scientific methods, it behooves us to remember Bertrand Russell's wise recommendation that it is good to keep an open mind, but not so open that one's brain falls out.

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Topic: 1998 Tennessee "Darwin Day" conference resources
Owner: Tennessee Darwin Coalition
Location: http://fp.bio.utk.edu/darwin/frmain.html
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Topic: "Naturalism, Theism, and the Scientific Enterprise" conference papers
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Topic: "Creatures from Primordial Silicon"
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Topic: Evo-Devo—How to Make a Foot into a Mouth
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   Kehoe AB. Modern anti-evolutionism: The scientific creationists. In: Godfrey LR, ed. *What Darwin began*. Boston: Allyn and Bacon; 1985. pp 165-85.

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

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

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