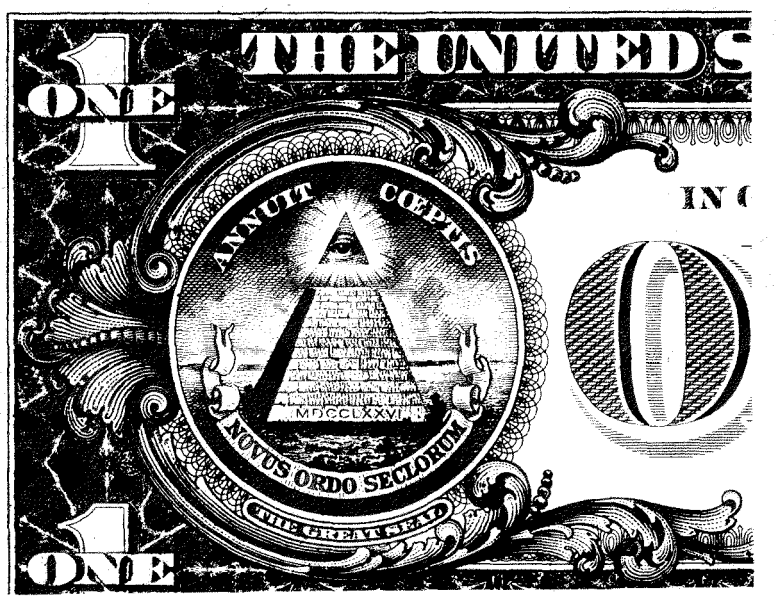
Creation/Evolution



It's a Great Seal, but is it Science?

Issue XXIX CONTENTS Winter 1991-1992

About this issue ...

This issue of *C/E* is the first produced exclusively by the National Center for Science Education after the previous hybrid issue sent out jointly by NCSE and *C/E*'s previous publisher, the American Humanist Association. I helped produce that issue and have been an associate editor for some time and an advisor and kibitzer for a long time previously, so my becoming editor is a sort of gradualistic evolutionary step, not punctuational, as my stylistic critics will probably attest. Succeeding Fred Edwords as editor is a daunting task – I hope I have half his energy and skill. And I certainly lack his appropriate patronym!

This issue inaugurates a partial refocus of priorities which I hope you will welcome. Our focus remains on antievolutionist claims and arguments, but we are also addressing some more positive themes. Articles such as Frank Sonleitner's explanation of "Mitochondrial Eve" will I hope seize the initiative from antievolutionists by accurately discussing positive, interesting aspects of modern evolutionary theory. This article tries to tell "all about Eve" – the evolutionary ancestor of modern humans reconstructed by comparisons of modern variations in mitochondrial DNA. Needless to say, "Eve" has proven to be a poor choice of words, though some researchers now take pains to be more careful in their nomenclature.

Our lead article by Dr. Bernard Ortiz addresses a major issue facing schools today – what I think is the long-overdue attention to multicultural education but the sad misuse of this concept in antievolutionism and the so-called "Afrocentric Science Movement." I expect this article to be controversial and I welcome responses but remind readers that Dr. Ortiz's critique is a defense of objectivity and opposition to antievolutionism, whatever its source. Dr. Ortiz chairs an organization of Chicano and Native American scholars.

Jim Lippard explores the controversy surrounding an Australian critique of creationism which, in his view, exceeds the bounds of propriety and turns counterproductive. He repeats some allegedly slanderous or defamatory charges against Duane Gish *with Gish's explicit permission*. As I read the situation, people may have erred on both sides of the debate, but I honestly do not know. Publication of this article represents our openness to self-criticism, not an endorsement of its charges or the taking of any position on the matters raised.

We have received a few letters about earlier issues and have *not* printed some letters with irate thoughts about old topics. In general, I want to take this opportunity to state that the past is past – I want to move on and not pursue endless debates about old articles. The discussion of topics, of course, continues, but quibbles about the second paragraph in issue 19 seem rather arcane.

Articles and other materials, including proposals, should be sent to the editor with stamped, return envelopes; *guidelines are listed at the end of this issue*. Please retain copies of any submissions, since we can assume no responsibility for them.

John R. Cole, editor

Afrocentric Creationism

Bernard Ortiz de Montellano

The "Afrocentric movement" and its efforts to introduce "multiculturalism" into the schools have received a lot of publicity. One aspect of this movement has had much less scrutiny. An Afrocentric creation myth is being introduced that is based in pseudoscience and which shares many attributes with "scientific" creationism.

The Portland, Oregon School District published the *African-American Baseline Essays* in 1987. These essays were put together under the supervision of Asa Hilliard, a professor at Georgia State University who is a nationally known advocate for Afrocentric education. The essays are supposed to be used by teachers as resources and guides to add material about Africa and African-Americans into the grade school curriculum in order to correct the over-emphasis on European achievements in the usual texts. These essays are being seriously considered or have been adopted by a number of school systems such as Detroit, Buffalo, Newark, Oakland (CA), Baltimore, Atlanta, Washington, D.C., Indianapolis, Ft. Lauderdale, Miami, Camden (NJ), Milwaukee, and Pittsburgh, among others. The following topics are included: Art, written by Michael Harris, an Assistant Professor at Morehouse College; Language Arts, written by Joyce Braden Harris, the Director of the Black Educational Center in Portland, Oregon; Mathematics, written by Beatrice Lumpkin, an Associate Professor of Malcolm X College; Music, written by Charshee L. McIntyre, an Associate Professor at the State University of New York at Old Westbury; Social Studies, written by John Henrik Clarke, Emeritus Professor at Hunter College; the *Science Baseline Essay*, the cause of concern, here was written by Hunter Havelin Adams (1990a).

Adams claims to be a research scientist at Argonne National Laboratory, but is actually an industrial-hygiene technician who does no research at Argonne, and whose highest degree is a high school diploma, according to an Argonne spokesman (Marriot, 1991). The *Science Baseline Essay* claims that

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ancient Egyptians were black, and that they made many extraordinary scientific discoveries. Adams claims that there is a scientific basis for the paranormal, and advocates the use of religion as part of a scientific paradigm. A fuller description and critique of the *Baseline Essay* can be found elsewhere (Ortiz de Montellano, 1991).

Hunter Adams is also a member of a loose grouping called the KM-WR (pronounced Khemware after Kemet, the ancient name for Egypt) Scientific Consortium or the "melanin scholars." These theoreticians provide a "scientific" explanation for many Afrocentric claims. Some of the better-known members of the group are: Leonard Jeffries, Chairman of African-American Studies at CUNY; Wade Nobles, Professor of African Studies at San Francisco State University; Frances Cress Welsing, a Washington, D.C. psychiatrist; and Richard King, a Los Angeles psychiatrist. Their views are primarily spread among the African-American community by broadcasts on "Black" radio stations of talks given at annual Melanin Conferences. They have only recently begun to publish in vanity presses, and to distribute in specialty bookstores in the African-American community. Thus, my main source of information on this group are transcripts of a number of lectures broadcast on the Detroit Public School's educational station, WDTR-FM. Even though Adams does not repeat claims about melanin that he has made at Melanin Conferences or explicitly develop the "melanin" hypothesis in the *Science Baseline Essay*, many of the statements in the *Essay* are based on these theories. The views of "melanin scholars" are thus relevant despite their unorthodox delivery because they are being introduced into the curriculum of the public schools without an acknowledgement of all they imply. See Ortiz de Montellano (1992) for a fuller description of these beliefs.

The fundamental tenet of the "melanin scholars" is that melanin, the very widely distributed pigment found in all humans, has extraordinary properties, and that these properties confer great powers on people with a lot of it. A few of the properties attributed to melanin are: that it is a superconductor, that it absorbs all frequencies of electromagnetic radiation, that it can detect and be influenced by weak magnetic fields, and that granules of melanin can function as microcomputers and process information. Melanin is supposed to regulate all physiological and psychological processes in humans. Accordingly, Black athletes have superior coordination and reflexes because of melanin. Melanin is also responsible for the superior intelligence and the potential extra-sensory ability of Black people. The superior intellect due to melanin provides a "scientific" explanation for the usual Afrocentric assertion of the magnificence of ancient Egyptian civilization. It also explains why, by diffusion, it was the source of Greek civilization and eventually of European civilization (James, 1976). Others make more extreme claims also attributing New World (Van Sertima, 1976), Chinese and Indian civilizations (Van Sertima, 1985) to diffu-

sion from Egypt. The essential argument of the group is that Egyptians were *Black* and the greatness of their civilization was due to the gifts that melanin conferred upon them.

The "melanin scholars" provide the pseudoscientific justification for an Afrocentric creation myth. According to this view, hominids and humans first evolved in Africa (Adams, 1990a:4-6; King, 1991a), and the fossil record is distorted and confused in an effort to give Africa priority in human evolution. This is wasted effort since Africa is generally conceded to be the "cradle of humankind," and this is not racially significant since these hominids are ancestral to all humans. Adams (1990a:4-7) in the *Science Baseline Essay* refers to *Australopithecus afarensis* as human, and states that *Homo Habilius* [*sic*], which he identifies as "Lucy," was the hominid that first dwelt in savannas. ("Lucy" was, in fact, an *Australopithecus afarensis*). *A. afarensis* may actually have been the species that left the forest to walk bipedally, but it was not "human" in a modern sense. Adams attributes well-developed tools, a stable social organization and a high level of cooperation to *Homo habilis*, but most scholars feel that this is much too early for these traits. Adams claims that fire was first discovered in Africa although we have contemporaneous evidence of the use of fire by *Homo erectus* in Java and in Peking. Finally, Adams (1990a: 3) states that Africans first discovered time, fire, tool technology, language, and agriculture. Language is an emergent biological property and cannot be "discovered." Fire as well as agriculture was discovered independently in several locations, and, in fact, Africa does not have priority since animal and plant domestication, *what really counts as agriculture*, apparently began first in Southwest Asia (Iraq, Iran, Syria) with sheep, goats, wheat and barley between 11,000 years to 9000 years ago (Haviland, 1979:233-254).

Other "melanin scholars" make more extreme claims. King (1991a) claims that "truly modern man" (presumably *Homo sapiens sapiens*) existed in Africa from a minimum of 250,000 to a maximum of 900,000 years ago, and that mitochondrial DNA shows that all humans are descended from one African woman of that period. This is a gross exaggeration of the dates involved. The most common dating for *H. sapiens sapiens* is from 50,000 up to a disputed 150,000 years ago. The mitochondrial quote refers to the work of Cann, Stoneking and Wilson (1987), which is somewhat controversial, and which certainly doesn't claim a date of half a million years. These workers, based on the analysis of mitochondrial DNA from a number of populations, postulate the existence of an "Eve" who existed in Africa about 200,000 years ago, from whom the minute amount of DNA in the mitochondria of living humans can be derived. The "Eve hypothesis" does not imply that all modern humans descended from a *single* woman since both men and women contribute *nuclear* DNA, the more abundant and evolutionarily significant DNA. Only the mitochondrial DNA is derived from this one woman. King (1991a) also proposes that *Homo erectus*

could project their conscious minds outside their bodies and communicate directly with angels, certainly a strange scientific claim.

Efforts to heighten the importance of melanin can lead to odd extremes. Stewart (1991) states that "... if melanin was not present in the first single-celled organism, then it would not have survived. Not in this system. Which is why it is strongly suggested that melanin pre-dates DNA, and [it] probably organized DNA." In fact, life began in the oceans and hardly needed melanin as protection from ultraviolet radiation. Early hominids in Africa probably were dark, but this does not justify the extreme claims made for the crucial role of melanin.

The Afrocentric creation myth also explains the origin of races. Stewart (1991) argues that a high level of melanin is biologically normal because humans evolved in Africa. Physical anthropologists would agree that high levels of melanin were maladaptive in Europe, and that white skin with its increased synthesis of vitamin D would be favored genetically. This, however, doesn't make white skin "abnormal." All humans have melanin; even albinos have normal amounts of melanin in the Central Nervous System (Siegel et al., 1989: 755), and whites can increase the melanin concentration in their skin by exposure to the sun. Skin color, like intelligence or height, is controlled by a number of genes, and can exhibit a wide range of colors depending on how many genes are "turned on" to melanin. Afrocentrics, however, distort genetics by claiming that whites are "melanin recessives" or "albinos" (Welsing, 1989; King, 1991a; Finch, 1990:41-44). This would imply that skin color could only be black or white, *that it is controlled by a single gene* with simple Mendelian dominance/recessiveness. This claim is patently false since humans come in variety of colors, but, similarly to "scientific" creationists, Afrocentrics rely on the scientific illiteracy of the general public.

This presumed melanin dominance is then used to explain "scientifically" why white men have conspired to destroy Black men (Welsing, 1989; Kunjufu, 1989). Kunjufu (1989) puts it this way:

> ... because Africans have dominant genes that it is very possible for Africans to annihilate the European population ... Because it is men, specifically African men, that start the reproductive process off. For example, in looking at the four possibilities of sexual relationships. Of looking at those four there is only one possibility to produce a European child.... European men can only produce a child that looks like them when they connect with a European woman. As the result of that, then, European men are very much afraid of African men and the conspiracy is directly centered at them.

This is almost a parody of a Ku Klux Klan argument about rapacious Blacks and "racial purity" or pollution.

Others take a racist line claiming that whites are not true or fully human.

Nobles (1989) argues that, after the evolution of the Central Nervous System (CNS), whites stopped evolving, but that blacks went on to develop an Essential Melanic System (EMS). Nobles then proposes an equation CNS + EMS = HB (human being), i.e only blacks are full human beings. Both King (1991a) and Stewart (1991) use the term *hueman* with the implication that only people with *color* are human.

Afrocentrists, like "scientific" creationists, are attempting to get their views into textbooks. The refusal of the Detroit School Board to adopt books if they are not Afrocentric enough was partly responsible for textbook publisher D. C. Heath's hiring Hunter Adams as a consultant for the evolution chapter in *Heath Biology 1991.*

Afrocentrics resemble "scientific" creationists in other ways. Adams (1990a:11-14) claims that, in Egypt, religion was an essential constituent of the "scientific paradigm." The concept of *Maat* which included beliefs such as: 1. Acknowledgement of a Supreme Consciousness or Creative force; 2. Existence via Divine Self-Organization; 3. A Living Universe; 4. Material and Trans-material Cause and Effect; 5. Consciousness Surviving the Dissolution of the Body; and 6. Emphasis on Inner Experiences for Acquiring Knowledge, was the first scientific paradigm and was the basis from which "ancient Egyptians did all types of scientific investigations." Adams clearly admits that *Maat*'s postulates are incompatible with those of modern science, but the implication of the long list of early Egyptian discoveries and successes in science presented in the *Baseline Essay* is that *Maat* is equivalent to or better than the standard scientific method. This claim of scientific standing for *Maat* blurs the fundamental distinction between religion, which can use supernatural explanations, and science where only natural laws can be used to explain observed phenomena. The key question is whether children in public schools are going to be taught religion under the guise of "Egyptian science." Children in the public schools should not be indoctrinated in Christian, ancient Egyptian, or any other religion.

The methods used by "melanin scholars" also resemble those of "scientific" creationists. None of their work is published in refereed journals, and none of them conducts original research on the physiological or physical properties of melanin. Their work consists mostly of searching the literature for snippets of information, which are then often misquoted or misinterpreted into support for their position. For example, Adams (1990a: 8-9) claims that Majno (1975) dates the treatment of wounds and diagnosing of illnesses to 400,000-30,000 years ago, and that

> the stitching of wounds with plant fibers or even shreds of tendon, the pinning together of the lips of a wound with a thorn or a spike used like a skewer with its protruding ends tied together with fibers, and the use of insect mandibles as clips were probably used to some degree by Homo Sapiens [*sic*; he means *Homo sapiens neanderthalensis*].

Adams also says that it was likely that early man performed other forms of medical aid such as eye and dental diagnosis, since chimpanzees in captivity have been known to do so. These statements completely distort Majno's work in an attempt to magnify the importance of early Africans. Majno (1975:9) points out that there is a case of survival of an amputated Neanderthal 46,000 years ago but denies that this represents Neanderthal surgery. "The real lesson of Nandy, I believe, is that nature alone is able to staunch the bleeding and stamp out the infection, even after such major accidental wounds as those of amputation." No mention is made of anything happening 400,000 years ago. Adams' claim that Neanderthals sewed wounds is also a distortion. Majno (1975:14) in fact says that this process took a long time even among modern humans.

> As to wounds, apes make no active attempts to help, such as holding the edges together; but man too has been very slow at that, perhaps because nature proved so fast. Stitching of wounds among primitive people is exceptional. Sometimes the wound is really sewn with fibers or shreds of tendon; sometimes the lips of a wound are pinned together by a thorn or spike used like a skewer, and its protruding ends are wound around with fiber (Fig. 1.10)—a technique that is not wholly obsolete. But we cannot be certain that any of the few examples observed nowadays is truly native or had a prehistoric equivalent.

Majno (1975:12-13) points out that chimpanzees do not treat injuries in the wild and, with one observed exception, apparent care in captivity is a misinterpretation of the usual activity of grooming.

Similarly, Adams (1990a:vi) claims that Luis de Broglie gave scientific status to the paranormal, but actually de Broglie (1955:235-236) criticizes research on the paranormal in the same book:

> Further, a great number of those who write on these subjects give evidence of an insufficient general scientific education, confusing the most clearly expressed ideas and interpreting the theories of modern physics in the most fantastic manner ... From all these investigations, generally pursued in not sufficiently strict conditions by researchers who are often inadequately informed and sometimes not very scrupulous, it does not seem that up to the present we can draw any well-established conclusions. This does not, however, imply, that discoveries substantially confirmed may not some day make known to us, in those realms also, phenomena at present unknown, but nothing yet, it seems, gives us grounds to affirm this.

Like "scientific" creationists, Afrocentrists claim to be persecuted by a scientific establishment which is dogmatic and which refuses to acknowledge the truth about the role of melanin. King (1991a) complains that white scholars

are engaged in a "scandalous cover-up of the great contribution of African science," and ridicules the National Academy of Sciences for calling the KM-WR Science consortium pseudoscience. Later, King (1991b) claims that his paper on the role of the pineal gland as the master controlling gland of the body, and its ability to receive light that penetrates the skull itself, was rejected for publication implying that it was a part of this plot to suppress the truth about melanin. Adams (1990b) complains about the obtuseness of scientists who remain wedded to a Cartesian model of reality, and thus deny the existence of the paranormal and melanin's role in it. Later, Adams (1991) states that you can't separate religion or theology from science because they are all inter-connected and:

> How many believe that scientists are searching for truth? [laughter from the audience] They're searching for something else, but it may not necessarily be truth. So this is just a preface. And I have to give this to you because you probably won't get it anywhere else, because our scientists in the academy, so-to-speak, don't want to touch this because they're afraid they may not get tenure.

There is a pressing need to redress previous curriculum imbalances which underrated the contributions of minorities to civilization and to science in particular. Well-designed accurate multicultural curricula would be a significant improvement in grade schools — particularly those in urban areas with large minority populations. Pseudoscience and religious instruction introduced under the guise of multicultural education, however, will harm this cause. Multicultural instruction in science must first of all be scientifically accurate.

We must also be vigilant against incorporation of this erroneous material into textbooks. As we have seen in the case of evolution, textbook publishers often cave in easily to marketplace demands, with scientific accuracy a secondary priority. Finally, wide adoption by the African-American community of this distorted interpretation of race genetics, and origin myths will contribute to a further polarization of our society and cheat our children out of the equality of opportunity they deserve.

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How Not to Argue with Creationists

Jim Lippard

The scientific method involves a disinterested search for truth. Ideally, scientists apply empirical methods and follow the results wherever they might lead. In reality, however, science is practiced by human beings committed to particular theories. When commitment to a particular theory is greater than commitment to scientific methods, the scientist becomes a true believer who falls back upon irrational modes of defense. This analysis is frequently applied to creationists, but unfortunately there are times when it applies to the opponents of creationism as well. This is particularly unfortunate since, as readers of this journal know, scientific methods are completely adequate to the task of refuting the empirical claims of creationism.

It is with regret that I write this article, but certain opponents of creationism in Australia have engaged in tactics that have led to public apologies to creationists by radio and print media, criticism by other creationism opponents, and even legal action. These events have, until now, gone unnoted in anti-creationist circles. It is my hope that this article will discourage these sorts of tactics in the future, as well as setting an example of self-criticism that creationists would do well to follow. There are legal issues involved, but it is not my intent to judge or evaluate them. Rather, my intent is to advocate a more careful style of debate and dispute.

Australian Debate: Plimer vs. Gish

On March 18, 1988, Duane Gish of the Institute for Creation Research (ICR) took on Ian Plimer, professor of geology at the University of Newcastle (and now chair of the department of geology at the University of Melbourne). Plimer, rather than treating the event as an academic debate, used the occasion to abuse and ridicule Gish – at one point even offering Gish a chance to electrocute himself on bare wires to demonstrate that electricity is "mere theory."[1] The mostly creationist audience was not amused.[2] The ICR (*Acts & Facts*, 1988) characterized Plimer's behavior as "by far the worst behavior ever encountered by Dr. Gish."

Jim Lippard is a graduate student of philosophy at the University of Arizona, Tucson, and a researcher of pseudoscience.

Plimer's opening volley was that, "'Creation science' is a contradiction in terms. I've accused the leaders of fraud, perversity, heresy, fabricating their evidence, and lying about the scientific evidence." He gave as his first example Michael Denton's book, *Evolution: A Theory in Crisis*, which Gish had already mentioned in his own opening statement. "What we were not told," said Plimer, "was that Michael Denton, at this university [the University of New South Wales] last year, said and admitted he was wrong. That was published. He also said that he was unaware of the fossil record when he wrote it."

Plimer explicitly states that Denton was unaware of the fossil record and implies that Denton has retracted his entire book.[3] Neither is the case. Denton's book contains a chapter entitled "The Fossil Record," and what he *has conceded* is only that "the discontinuities in the order of nature might not be as biologically significant" as he implied in his book. His view is that "an objective interpretation of the gaps [is] impossible given the current state of biological knowledge. They could be basically only 'sampling errors' and biologically trivial, [or] they could be determined by fundamental restrictions on what is possible in the realm of organic design and hence of deep significance" (personal communication, October 1, 1991).

Gish, who had lunch with Denton the previous day, responded to Plimer's statement in the debate by saying that "Dr. Denton did not deny or go back on anything he put in his book. This is what he did say: that if he were going to write a book on this subject that he'd take a different approach. The evidence that he discussed in here he said is subjective. ... But from the perspective now in genetic research he believes that possibly its possible to objectively establish that [*sic*] if evolution is possible or not. And certainly from his present state of knowledge he believes it can be objectively proven that its impossible."[4] Here Gish exaggerates as well — according to Denton, Gish's quote is vague but reasonably accurate except for the last statement, about which he says, "I am practically certain I didn't make that statement. Its not true (probably never will be) and I have never made such a claim." (personal communication, October 1, 1991). The truth is that Denton has neither retracted his entire book nor remained entirely unswayed by his critics (though the latter is closer to the truth than the former — he still believes that the neo-Darwinian theory of evolution is "a theory in crisis").

Analysis: Plimer, like Gish, is guilty of exaggeration in his remarks about Denton. His statements about Denton's position were inaccurate and misleading. Plimer is at least partially to blame for the spread of the legend of Denton's "conversion" in the skeptical community.

Fossil Gold Chains Ex Nihilo

In an article in the *Australian Geologist*, Plimer (1986:6-7) criticizes Andrew Snelling, a creationist geologist of the Australian Creation Science

(CSF). Plimer writes that "Other enlightened new data by Snelling are reports in the CSF literature of the occurrence of fossil gold chains and iron anchors in Australian coal seams." In his debate with Gish, Plimer said, "A year ago I challenged someone to give me a gold chain from a coal seam in this country. I offered $20,000. ... I haven't dropped a penny yet." (The publicized offer was $20,000 to charity and $5,000 to the finder; see Plimer, 1987b, where he says, "The CSF alleges that fossilised gold chains are found within the coal seams in the Newcastle area." This challenge, in *The Newcastle Herald*, followed Plimer's (1987a) earlier claim in the same newspaper that "the creationist literature reports fossil gold chains and iron anchors in coal seams at Newcastle" and that "creationists call this science and wish to teach this as part of the school syllabus.")

But Snelling (1988:18) denied ever making such a claim, anywhere, and challenged Plimer to produce evidence of it. David Malcolm (1987) also challenged Plimer to show just where such claims are made in the creationist literature. Plimer has not done so. In correspondence with me (personal communication, April 8, 1991), Plimer stated that claims about fossil gold chains appeared in the CSF's *Ex Nihilo Technical Journal*, which is *edited* by Snelling. "It is this editorial responsibility I refer to," writes Plimer. In the first five volumes of the *Ex Nihilo Technical Journal*, published between 1984 and 1991, there appears only one article dealing with coal (Snelling & Mackay, 1984). This article contains no mention of fossil gold chains or iron anchors in coal seams.

The only thing published by the CSF remotely resembling Plimer's "fossil gold chains and iron anchors" in coal is this sentence: "When Dr. Andrew Snelling and John Mackay were researching the Newcastle coal measures recently, they came across a fossilised bolt from an old shipwreck." (Mackay, 1986:10) This article, which was neither authored by Snelling nor in a publication edited by Snelling, makes it clear that the bolt was not found in coal. The CSF maintains that Plimer has simply fabricated the claim.

In the Gish debate, Plimer spoke of "some marvelous revelations [by creationists] ... one of them is that we find fossilized iron bolts and fossilized gold chains ... within the fossil record," suggesting that this article is indeed the "enlightened new data" he is referring to.

Analysis: Plimer somehow managed to turn a claimed fossilized iron bolt into "fossil gold chains and iron anchors," put them into coal seams, and attribute the whole claim to Andrew Snelling. He then made a challenge to the creationists to come up with evidence to support what is in fact a straw man of his own creation. He also used the bogus "gold chains in coal seams" claim in his debate with Gish: since gold was brought to Australia in 1788 and coal discovered there in 1791, if these coal seams were created by the biblical flood, the flood must have occurred between those years. Q.E.D., *reductio ad absurdum*. A solid counterargument to a claim that wasn't made.

Barry Price and The Creation Science Controversy

Another Australian creationism opponent is science teacher and former Religious Education Officer for Sydney's Catholic Education Office (CEO), Barry Price. Price is the author of the ironically titled *The Creation Science Controversy* (Price, 1990), which he produced by revising and expanding an earlier booklet, *The Bumbling, Stumbling, Crumbling Theory of Creation Science.* According to Price, this booklet, published by the CEO, was pulled from publication some two months after its release in response to threat of legal action (Price, 1990:viii).[5]

It looks like a similar fate may be in store for *The Creation Science Controversy*, as he and his publisher are presently in court, charged with defamation (more on this below). The book is polemical – light on science and heavy on *ad hominem* argument. Its goals are apparently more political than scientific; it is written not for the scientist or seasoned creationist observer, but to persuade the layman that creationism is a hoax and a fraud. Its most powerful arguments against creationism may be found elsewhere in more detail and greater precision.

The book has prompted a response from the CSF (1991), titled *A Response to Deception*, now in its third revised edition. The creationist response correctly notes that "Price's attack is largely not concerned with the realm of science," and goes on to say that the book is "full of error, distortion and worse." In a mostly positive review of Price's book, Australian Skeptic Martin Bridgstock (1990) wrote that Price's book "is clear and punchy, occasionally veering into stridency" and is "peppered with errors." (He goes on to say that these errors are "minor – none approaching creationist whoppers.")

While many of *A Response to Deception's* criticisms are quite minor (e.g., typographical errors), others are more serious. For example, Price parrots Ian Plimer's fossil gold chains argument (Price, 1990:39-40). But he insists that there are no major errors in his book (Price, 1991) and has enumerated the CSF charges as follows: 15 typographical errors, 63 differences of opinion, and no serious errors (personal communication, February 11, 1991). An errata sheet has been issued for the book, correcting 34 mistakes.

Analysis: Barry Price has not exercised proper care in authenticating the evidence he presents in his book (more evidence of this will be presented below). In the case of Ian Plimer's "fossil gold chains" claim, Price should have been aware that every time Plimer published the claim, a rebuttal has been issued in the same publication (Malcolm, 1987; Snelling, 1988). Yet Price never mentions these rebuttals and appears to have made no attempt to find the claim in the creationist literature.[6]

Loss of Funds by the CSF

Both Price and Plimer have accused the creationists of financial wrongdoing. In 1986, the Australian Skeptics discovered that the CSF's financial

reports listed a loss of $92,363 (Bridgstock, 1986:70-71). Plimer described this loss in his debate with Gish: "So when we look at the Creation Science Foundation in this country, it is a closed shop. Seven people who control it, have their hand in the till, whatever you want to call it. And theres a not insubstantial amount of money, $92,358 [*sic*], which is unaccounted for. It just disappeared. So you can't trust these people with your children,[7] you can't trust them with your money." Plimer (1989) also wrote of this loss of funds in his article about the Gish debate in the magazine *Media Information Australia* using the term financial fraud (pp. 11-12).

Barry Price (1990:186-191) uses several pages of his book to describe this loss of funds. He notes (p. 187) that the CSFs director and secretary at the time of the loss, John Thallon, was director of a company, Tralil Pty. Ltd., with which the CSF contracted for "management consultancy services" for the period September 1, 1984 to June 30, 1985. Price writes that "This contract with Tralil is presumably a result of investment losses noted in the *Statement of Income and Expenditure for the year ended 31st March 1985*, which records 'Extraordinary Item Loss of Investments, 1984, $47,939 and 1985, $44,424'." It is difficult to see how this contract could be a *result* of the losses, given that it was made before the losses occurred. This contract was, in fact, for accountancy services from Thallon, who had requested that the CSF hire him as an employee of Tralil, his family trust company -- a type of arrangement which has since been legislated against by the Australian government. (An investigation of this arrangement, unrelated to the lost investment, by the Australian Taxation Office, found no impropriety. The CSF's section 23(e) tax exemption was renewed without incident.)

Neither Plimer nor Price has given details on just how the investment loss took place. The lost funds were interest-free loans from CSF members which had been invested in a company on the advice of CSF director Thallon, who also invested a great deal of his own money. This company in turn invested in yet another company, which ended up defrauding its investors, causing losses for both the CSF and Thallon. Since Thallon had recommended this investment, he felt responsible for the loss and resigned from the CSF. The CSF notified its "closest supporters" of the loss, who contributed funds to pay off the interest-free loans (Robert Doolan, personal communication, February 8, 1991). The CSF supporters as a whole, however, were not informed of the loss until it was made public by the Australian Skeptics, after which the CSF circulated an explanation (Rendle-Short, 1988).

Barry Price (1990:187-188) writes of other CSF directors' resignations in the context of this investment loss: David John Denner, Robert Stephen Gustafson, John Mackay, and Ken Ham. Denner resigned because of health problems but is still a member of the CSF, Steve Gustafson continues as a legal adviser to the CSF, John Mackay resigned and formed his own creationist

organization because of a personal conflict with another member of the CSF staff, and Ken Ham did not in fact ever resign (Robert Doolan, personal communication, February 18, 1991).

Analysis: Plimer and Price have insinuated that the loss of funds was due to untrustworthiness of (or, in Plimer's argument, fraud by) the CSF, when in fact the causes of the loss were criminal actions which victimized the CSF. Those responsible for the fraud have been convicted, and there is some possibility that some of the lost funds may yet be recovered. The CSF should have informed all of its supporters of the loss immediately, instead of waiting until the Australian Skeptics discovered it, but their reluctance to do so is understandable. Plimer's published remarks led to an apology to the CSF and Duane Gish by *Media Information Australia* (1990).

Price has also wrongly implied that the resignations of a number of CSF directors was a result of the loss of funds and falsely claimed that Ken Ham resigned.

Gustafson v Price

In Barry Price's summary of the finances of the CSF (Price, 1990:191), he states that Robert Stephen Gustafson's name "disappeared without explanation from company records after a payment of $8,719 was made by the board of directors to a company in which he had an interest." He writes this immediately after stating that the CSF is not accountable to its supporters and bringing up the loss of funds again. But Price's statement is false. On November 30, 1990, Gustafson filed suit against Price, Millenium Books Pty. Ltd., Price's publisher, and Chertsey Fifty-Nine Pty. Ltd., the printer, for making a false and defamatory allegation about Gustafson. Price failed to file a defense within the six weeks allotted, but did file a late defense. (Such tardiness usually requires the defendant to pay the legal costs of the action up to the date the defense is filed.) By August of 1991, Price's lawyers had offered an apology and pulping of all remaining copies of the book as a settlement, which Gustafson rejected. [*Ed: The book has been withdrawn by the publisher, nevertheless, and is now unavailable in the U.S., at least.*]

Analysis: Price made an erroneous remark, in a context which implied that the payment was somehow related to the loss of funds. In fact, the payment was not only unrelated to the loss of funds, the payment was not to Gustafson or to a company in which he had an interest. The payment in question, which was $8,118.75 not $8,719, was payment to Tralil Pty. Ltd. for the accountancy services of John Thallon.

Alleged Missing Financial Reports

On an Australian national radio broadcast on Robyn Williams' "Ockham's Razor" show of January 8, 1989, Ian Plimer stated that the CSF "submitted no

annual report for 1988, no annual report for 1987, and no annual report for 1986" to the Corporate Affairs Commission. Barry Price (1990:190) writes that "Reports for 1986 and 1987 do not seem to be available. Presumably extensions have been granted by the Corporate Affairs Commission because of extenuating circumstances."

In fact, the CSF has filed returns for each of these years, all of which were available at the time Plimer spoke on the radio and by the time Price's book was published. A letter dated March 7, 1989 from J. Kral of the Office of the Commissioner for Corporate Affairs to Carl Wieland, managing director of the CSF, states that, "You are advised that all the Annual Returns mentioned in your letter have been lodged with this office." The letter goes on to give the dates on which the returns for 1986, 1987, and 1988 were filed: August 8, 1986, December 4, 1987, and December 5, 1988, respectively. This evidence was supplied to the Australian Broadcasting Company, which on June 4, 1989 apologized for Plimer's remarks.

Analysis: Plimer and Price both made false statements which they could have easily checked out but didn't. Plimer (personal communication, January 9, 1991) offers no explanation for his remarks, but maintains that the ABC "caved in" by apologizing against his recommendation. He has neither apologized nor admitted any error, and claims that the CSF is using the apologies from ABC and *Media Information Australia* as part of a "propaganda campaign" against him.

The Mysterious Book Vandalism

Price (1990:165-166) and Plimer (1989:10-11, 1991:5) both quote a passage from an article by Ray E. Martin in *Christian School Builder* (April 1983: 205-207) titled "Reviewing and Correcting Encyclopedias," citing Marty (1983), which reprints a section of the Martin article. Plimer (1989:10) writes that "creationists have been instructed to review and correct encyclopedias" by the article, which advocates removing sections on evolution from encyclopedias by using a razor blade or by gluing pages together. Both Plimer and Price follow up their description of this article by reporting that examples of exactly this sort of vandalism were found in the library of the University of Newcastle: "Every reference to evolution had been cut out from books in the paleontology section of the university library," writes Price (1990:166). Plimer (1991) concludes, "At least the Nazis had the common decency to burn books in public!"

But the article does not advocate vandalism at all: it advocates censorship of books in Christian schools by the administrators. This is only slightly less offensive, but, unlike vandalism, is perfectly legal. The CSF condemns not only the vandalism, but book censorship by Christian school administrators (Robert Doolan, personal communication, February 8, 1991).

Price and Plimer both imply that the University of Newcastle vandalism was

performed by creationists, inspired by the Martin article. But the vandalism occurred in 1988 while the article, which does not advocate vandalism, was published a full five years earlier in periodicals not carried by the University of Newcastle's Auchmuty Library. Neither Price nor Plimer point out that this incident is the only one of its kind known to have occurred and was discovered only after the Martin and Marty articles were brought to the attention of the university librarian by Ian Plimer. Plimer (personal communication, April 8, 1991) states that he has heard of four other cases of book vandalism at other institutions, but does not know if those were directed at articles on evolution or were simply "normal vandalism." He also reports that the Newcastle vandalism was brought to his attention by an unnamed paleontology professor. (Neither Plimer nor the University of Newcastle librarian has responded to my further inquiries on this subject.)

Analysis: Plimer and Price misrepresent the content of the Ray Martin article in order to argue that creationists were responsible for a specific incident of vandalism at the University of Newcastle. It may never be known who was responsible for the damage, but it is unlikely that it was done by creationists inspired by the Martin article; certainly there is no evidence to support the claim.

A Smear Letter

Shortly after the Gish-Plimer debate in Sydney, Ian Plimer responded to a letter from a creationist. Plimer's response, on University of Newcastle letterhead, stated that

> In a forthcoming book, further proof will be given with regard to the financial activities of Gish (and two others) in the San Diego-based Institute of Creation Research [*sic*] and a US-based publishing house which operates essentially as a money laundering organisation for the personal enrichment of the leaders of the creationist movement. Furthermore, if you were at the debates in Sydney (18.3.88) or Brisbane (30.3.88), you would surely have noticed an entourage of young people (principally boys) accompanying Gish and who continually touched him. This is commensurate with testimony from elsewhere which throws enlightenment on Gish's personal life and which makes Jimmy Swaggart look like a moral guardian of the faith.

I have a copy of this letter, which Plimer (personal communication, January 9, 1991) acknowledges writing. The letter appears to be a form letter: although it is typed, the name in the salutation is written in. After a description of various correspondence Plimer has received following the debate, the sentence, "Your letter falls into the _____ category," has the blank space filled in with the handwritten word "third."

Plimer claims that no sexual implication is intended by the quoted passage. According to Plimer, the "testimony from elsewhere which throws enlightenment on Gish's personal life" refers to Gish's membership in "a pro-nuclear lobbying group." Price's book (1990:66) points out that Gish is the chairman of the science and technology section of the Coalition on Revival, which Price describes as a group which "supports increased military spending and proclaims that all of science must be based on the Bible." (The Coalition on Revival is part of the Christian Reconstructionist movement. For details, see Hakeem (1991), McIver (1988), Porteous (1991), and Tucker (1989).) While this is an interesting political point about religious right interconnections, it is a different issue entirely.

Plimer further maintains that the letter was intentionally written to be ambiguous and *to look like a form letter*, but was only sent to a single person, in order to find out how far creationist tentacles extended. Plimer makes much of the fact that the creationists have been disseminating this statement about Gish through such publications as the CSF's *A Response to Deception*.

Duane Gish (personal communication, August 5, 1991) calls these statements "outrageous slanderous falsehood" and challenges Plimer "to produce one iota of evidence" to support his accusations. He states that the money laundering claim is "an outright lie" and that he was accompanied to the Australian debate only by his wife, his host, and his host's wife. (Gish granted permission to publish these scandalous charges against him on the condition that his emphatic denial be included.)

Analysis: Plimer's letter, on university letterhead, is a serious ethical lapse. The statements are unsupported *ad hominem* innuendo, whether Plimer sent the letter to one person or to a thousand.

Conclusions

Ray Hyman (1987), professor of psychology and executive council member of the Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP), has constructed a list of suggestions for proper criticism of paranormal and fringe science claims which should also be taken to heart by critics of creationism. His eight suggestions are:

1. Be prepared.
2. Clarify your objectives.
3. Do your homework.
4. Do not go beyond your level of competence.
5. Let the facts speak for themselves.
6. Be precise.
7. Use the principle of charity.
8. Avoid loaded words and sensationalism.

My criticisms of Price and Plimer have primarily been based on their violations of 3, 5, 7, and 8. What I would like to focus on briefly in my final remarks is number 2, the issue of clear objectives.

In correspondence with me, Ian Plimer and others have defended his style on the grounds that creationism is a political rather than scientific movement. It is my impression that they think it must be stopped at any cost, by almost any means available. This view is not only short-sighted, it doesn't seem to justify the means I've been criticizing. While the heavy-handed style might convince some people that creationism is ridiculous and not worth serious consideration by scientists, misrepresentations are bound to come to light (as they have). When they do, all of the short-term gains and more are lost.

We must not lose sight of the fact that no matter how silly creationism looks from an informed perspective, those who adhere to it are human beings. Most creationists are sincere believers, even if some of the leaders of creationist organizations are not. There is probably no hope of convincing an insincere leader, so why argue rationally with one? Why not just ridicule and abuse such a person? Because sincere people are watching. Ridicule and abuse simply confirm their suspicions about evil conspiratorial evolutionists who are out to suppress the creationist viewpoint. (This does not require us to forego humor or sarcasm which are not abusive and counterproductive.)

It is possible to deal with creationists effectively yet politely — Philip Kitcher's 1985 debate and Ken Saladin's 1988 debate, each with Gish, are prime examples.[8] Presentations like these are probably more likely to persuade people than those like Plimer's. Price and Plimer have engaged in the same sort of tactics we complain about creationists using. The only result of such tactics can be the loss of credibility.

The creation versus evolution debate is already one which tends to generate more heat than light. To attempt to gain converts by means other than reasoned argument supported by evidence is to engage in a war of propaganda, in which the first casualty is truth. It is my hope that this criticism will serve to discourage such counterproductive battles in the future.

Notes

1. All debate quotations have been transcribed by the author from videotape. Plimer's attacks on Gish included: "They are telling lies for Mammon. Here is Satan [gestures towards Gish]. He wants God's blessing for the devil's work." (Plimer, 1989:12 also quotes this.)
2. It wasn't just the creationists who were unamused. In the Australian Skeptics' summary of the debate (Roberts and Mendham, 1988:13), it is reported that "The adjudicator summed up by saying that, rather than a debate, the evening was more like a presentation by Dr. Gish and a series of derogatory replies by Dr. Plimer. He would award poor marks to both speakers, neither of whom had properly expounded his point of view as a science." The same page of the summary states that "Dr. Plimer's style of speaking excited comments and polarised the

passions of quite a few people. Many Skeptics have said they were disappointed in his manner of presentation and his handling of the topic, preferring that he had presented purely the scientific evidence supporting evolution in a sombre and more scientifically respectable manner."

3. A possible source of Plimer's remark (or perhaps they share a common source) is Stan Weinberg's (1986:22) report in the *Creation/Evolution Newsletter* that "According to [paleontologist Michael] Archer, Denton acknowledged that before he wrote his book he had never heard of the mammal-like reptiles. He added that had he known of them beforehand, he would have written his book differently. But there are no indications that a corrected edition is forthcoming." Denton (personal communication, October 1, 1991) says that this is a misrepresentation — his book discusses mammal-like reptiles on pages 180 and 181 (U.S. edition). What he did concede to Archer is what I have noted in this article about the significance of gaps in the fossil record.
4. This remark from Gish was garbled in transcription by Australian Skeptic Steve Roberts, who wrote in his summary of the debate that Gish had agreed with Plimer that Denton had recanted his views on evolution and considered it "possibly now a provable reality." (Roberts and Mendham, 1988:12) This error made its way into the *Creation/Evolution Newsletter* (July/August 1988:17) and was recently corrected by me in *NCSE Reports* (Summer 1991:19). The Australian Skeptics have yet to print a correction of this and other errors in their debate summary, though they have admitted them in private correspondence.

   It should be pointed out that the Summer 1991 *NCSE Reports* correction contained a mistake introduced by the editor — that of referring to Denton as a creationist. He is not. As he wrote to me (personal communication, October 1, 1991), "I am sure that the cause of evolution will turn out to be perfectly natural even though as yet we have no satisfactory naturalistic explanation. However, I am inclined to the view that when the natural explanations are elucidated they will represent deeply embedded laws or tendencies in the nature of things which will largely restrict life forms to designs similar to those actually manifest on earth or in other words that life's design is not contingent as Gould claims but directed in large measure by physics in the most general sense of the term."
5. The CSF says it did not threaten legal action, though CSF managing director Carl Wieland did write a letter to the Catholic hierarchy in Sydney, New South Wales expressing concern about allegedly defamatory statements in the booklet (Robert Doolan, personal communication, April 10, 1991).
6. Snelling (1988:18) points out that Wysong (1976:370) reports a gold chain found in U.S. coal. Wysong describes the June 9, 1891 discovery of a gold chain in coal by a Mrs. S.W. Culp of Morrisonville, Illinois, citing the *Morrisonville Times* of June 11, 1891 as his only source. Walter Brown's 1989 book, *In the Beginning...*, also reports a gold chain found in coal, for which he cites three sources: Noorbergen (1977), pp. 41-42 of which describe and cite the *Morrisonville Times* article; an article in the January 1979 *Bible-Science Newsletter* which I have not obtained; and a letter in the June 1976 *Creation Research Society Quarterly* which is about a spoon allegedly found in coal and says nothing about gold chains. A list of "fossilized technology" claims and their sources, including some involving coal (but no gold chains) may be found in Corliss (1978:651-660).
7. This is a reference to the 1980 case of Emma C. Smith Elementary School in Livermore, Calif., where teacher Ray Baird used materials from the ICR to indoctrinate students with creationism and apparently succeeded in converting some of them to atheism. Plimer had discussed this case earlier in the debate. Price's book gives a good summary (Price, 1990:143-158).
8. I chose these examples not because they are the only ones available but because they are the best ones I am familiar with, having viewed the videotape of the Kitcher debate several times and read a transcript of the Saladin debate.

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ERRATA

Dr. Frank Harrold notes the following errata introduced into his article "Past Imperfect" in Issue 26: On p. 6, line 19, "pre-Pleistocene" got inserted as a modifier of *Homo erectus*, all of which are Pleistocene. On p. 21, line 9, "I'd originally noted that many fossil localities, like Olduvai, are 'equally important' for their archaeological sites." Loyal archaeologist though I am, I wouldn't claim that they are 'even more important' for their archaeological sites, as the published text says. [*This latter was definitely my fault – an unwarranted intrusion of my first-hand observation that their are hundreds of archaeological sites at Olduvai for every fossil site – Ed.*]

For typographic production reasons some umlaut marks and cedillas were omitted, as well; I trust this will not be the case in the future.

Random Protein Formations and the Origin of Life

Matthew Landau and BJ Landau

It has been pointed out elsewhere that discussions with creationists about evolution are commonly routed toward the problem of origins (which is actually a very different subject). This is a form of the old debating technique of casting doubt on the weakest of an opponent's arguments, and thereby through inference all of the arguments an opponent presents. Certainly all theories on the origin of life are highly speculative. Therefore, since we know less about the origin of life than the evolution of higher organisms, we should expect that the problem of origins will continue to rear its head whenever the subject of teaching evolution in public schools is discussed. We will examine here what seems to be one of the stronger creationist arguements.

An often sounded argument by creationists is that life could not have originated by random processes, and creationists often try to "mathematically prove" their point. These "proofs" are often designed to show that the odds against the random formation of macromolecules, such as proteins, are so great that it is against reason to expect that they formed "by accident." Generally the line of reasoning runs something like this:

Proteins are long chains of amino acids, connected by peptide bonds; the amino acids in a protein are called "residues". There are structural proteins and proteins called "enzymes" that regulate the production of all other molecules in the organism. Only twenty different amino acids are normally found in proteins. Without proteins there is no life. If a small protein of 17 amino acids residues is composed of 12 different amino acids, the number of ways those amino acids can randomly combine is 300,000,000,000,000, making the accidental synthesis of that precise molecule very unlikely. But the typical small protein has about 100 amino acids, meaning that the number of random combinations which could be formed is 20^{100}, or 1.27×10^{130}, essentially an impossibility (Gish,

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1972). The question that the creationists then pose for evolutionsts is, "How then can you claim that random processes are responsible for the existence of functional enzyme proteins which have highly specific jobs to do in the organism? It is too unlikely."

To answer this very good question, we must know something about the way proteins work and how they are structured. When chemists talk about the structure of a protein they are talking about several levels of organization. The "primary structure" is that which the creationists allude to and simply refers to the sequence of the amino acids. The "secondary structure" of a protein is a description of the rotation of the amino acids which are linked together by the peptide bonds. Finally, there is the "tertiary structure" which refers to the complete 3-dimensional shape of the protein. (A "quaternary level", which is used to describe aggregates of proteins will not concern us here.) The tertiary structure of the protein is maintained because of interactions of amino acids which are adjacent to each other when the protein folds but which are not connected by peptide bonds. For example, in a hypothetical protein, residue 32 and residue 54 may be separated by 21 residues in terms of the primary structure, but may be side-by-side because of the way the protein folds and bends. Such acid-acid interactions may take the form of hydrogen bonds, electrostatic attractions between ionic portions of the amino acids, disulfide bonds, coordination with metal ions, and hydrophobic interactions among clusters of nonpolar (insoluble in water or saline) portions of the amino acids.

Proteins which are enzymes can be thought of as consisting of four types of amino acid residues: (1) those which are nonessential and can be replaced or in some cases removed without altering the molecule's ability to function; (2) structural residues which contribute to maintaining the tertiary structure of the protein. These can sometimes be substituted for but not removed completely; (3) binding residues which function in the "capture and holding" of the substrate molecule; and (4), catalytic residues, which may also be binding residues, that participate in the chemical transformation of the substrate.

The active binding and catalytic sites are often composed of amino acids that are located a great distance apart (in terms of the primary structure), but which have come together at or near the surface of the molecule because of the way the protein folds (that is, because the structural residues have dictated a particular tertiary structure).

Based on this more explicit knowledge of protein structure and function, it is obvious that the creationists have asked the wrong question. Each protein isn't so specific that some of the residues can't be changed or removed (see, for example, Lim and Sauer, 1989). They should not ask what are the odds of a particular 100 residue enzyme forming randomly, but more properly, what are the odds of a protein, with any number of residues, forming randomly that can

do what that particular enzyme does? Or stated another way, what are the odds that a particular protein will fold into a stable compact form that will allow the defining binding/catalytic sites access to the substrate? Until recently biologists were unable to answer this question. However, the research of Drs. Kit Fun Lau and Ken Dill of the University of California at San Francisco now allows us to begin to address that problem.

Lau and Dill (1989) developed a theory/model that can predict the tertiary structure of proteins based on the sequence of amino acids. In theory, the "native" structure of the protein (a stable, compact conformation, presumably the tertiary structure in which the protein is found in biological systems) can be derived since it is the structure with the smallest energetic restrictions. The Lau and Dill model makes use of only two types of amino acids, P (polar) and H (nonpolar), arranged in a lattice of two dimensions. By simplifying the proteins in this manner, short sequences can be completely explored by computer programs (algorithms) written by the researchers.

Several interesting conclusions were drawn: as the number of H-H attractions increase, certain molecules fold into conformations that are compact, have a core of H residues, and a low free energy. The folding is primarily a function of the ratio of H to P molecules and secondarily the sequence of the residues. Most of the larger molecules tended to fold into only a single native conformation; the longer the chain length, the greater the chance is that there will be only one native state.

In 1990 Lau and Dill applied these algorithms to the problem of protein origins. Their first experiments were designed to ask "what will the substitution of a single H for a P, or a P for an H, do to the folding of a small (13 residue) molecule?" It is assumed that the smaller the molecule, the more sensitive it will be to a single substitution; therefore, a substitution (mutation) in a 13 residue molecule would be relatively consequential. After selecting 251 sequences, each having a single, well-folded native state, they examined the changes in 3263 altered sequences. They found that the molecules were in fact very insensitive to a single substitution, and only substitutions in the core (residues 3-8) were potentially significant. When this experiment was repeated using two mutations per 13 residue molecule, the mutation was again usually neutral (although, not surprisingly, less often than was the case for the single mutation). There were even cases where the first mutation changed the structure of the molecule and the second mutation changed the molecule back to its original unmutated native tertiary structure. As Lau and Dill point out, this is in agreement with a large body of experimental evidence which suggests that proteins are relatively insensitive to single or double mutations. They go on to state that "it is hard to imagine how biological evolution could succeed otherwise."

This brings us back to the creationist's original question. If the chances of any particular 100 residue protein forming by accident are 1 in 1.27×10^{130} (that

is a probability of about 7.89×10^{-131}, essentially a zero probability) how can we ever imagine that these, or any larger proteins, could have formed by random events? The answer, as we now can see, is that not all residues are essential, and can be substituted for or removed. Lau and Dill go on to state that "evolution 'cares' only about the biological function, and therefore the native conformation of the molecule, no matter what sequence is required to achieve it."

If this is true, how many different sequences will result in functional structures? Lau and Dill set up several mathematical models to predict the number of highly folded, energy stable forms that might exist in our 100 residue molecule. The number of different sequences that would yield a single compact native conformation is approximately 5.4×10^{121} of the possible 1.27×10^{130}. Of these, only a small fraction (10^{-2} to 10^{-7}) might have a particular set of three residues coming together in a position suitable to form an active binding/ catalytic site. Even so, the probability of getting a functional 100 residue enzyme is at worst about 4.25×10^{-16}, and not the 7.89×10^{-131} predicted by the creationists. Again, to quote Lau and Dill (1990), "there is a significantly nonzero probability of the origin of an enzyme from a random sequence of amino acids."

Finally, there is one other point to consider. We have shown that the chances of a particular protein forming are far from nonzero, but we must also point out that life can probably exist without any particular special enzyme to do a single special job. How many ways could life have evolved with a different basic blueprint? Can cells find different pathways to solve similar problems? Can different materials be used to build cell parts, thus requiring different building modes? For example, can DNA be replaced with something else to guide the synthesis of proteins, or could glycolysis be carried out without a pyruvate intermediate? The set of probabilities that needs to explored is the total set of conditions that would allow for selforganizing and replication, which hold must be a very large set of probablities indeed.

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A Survey of Pseudoscientific Sentiments of Elected Officials: A Comparison of Federal and State Legislators

Michael Zimmerman

ABSTRACT. *The present paper presents the results of a 32-item questionnaire distributed to all members of the U.S. Congress and to all members of the Ohio House and Senate. The results suggest that there is widespread acceptance of many pseudoscientific concepts by lawmakers. Significant differences exist between federal and local legislators, with local officials demonstrating far less scientific sophistication.*

Introduction

In 1959, C. P. Snow eloquently explored the gulf between the sciences and the humanities. Since that time, although scientific and technological breakthroughs have become commonplace, and although science and technology affect our daily lives more than at any other time in history, we have, as a society, allowed that gulf to widen even further. Miller (1983) does an admirable job of summarizing many of the studies demonstrating the pervasive ignorance of scientific facts and methodology present in many segments of American society.

But as science becomes ever more complex, it is, perhaps, not such a terrible thing that large numbers of citizens are incapable of explaining the science that affects their lives. A much more problematic situation arises when large numbers of individuals are incapable of differentiating between scientific and pseudoscientific explanations of everyday phenomena. When pseudoscience is placed on an equal footing with science, literally anything appears possible, while rational public discourse and decision-making become all but impossible. Unfortunately, a number of recent studies have shown that popular acceptance of pseudoscience is quite common (e.g., Feder, 1984, 1987; Fuerst

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1984; Eve and Harrold, 1986; Zimmerman, 1986, 1987, 1990; Gray, 1987; Harrold and Eve, 1987; Hudson, 1987). Gray (1987), for example, using a scale that permitted respondents to rate the quality of evidence supporting various phenomena, has shown that almost 80% of the university students responding to his survey thought that the evidence for ESP is "good" or better, with approximately 97% indicating that there is at least some evidence supporting the phenomenon. Similarly, almost one-half of Gray's respondents felt that the evidence supporting both astrology and reincarnation was "good" or better. More than 80% of his respondents indicated that there was some evidence to support astrology while more than 60% felt similarly about reincarnation.

"Creation science," with its dogmatic insistence that the Earth is only approximately 6,000 years old, that dinosaurs and humans coexisted as recently as 4,500 years ago, and that the stratification found in the fossil record is due to various animals having differential success at outrunning the rising waters of Noah's flood, is, perhaps, the archetypal example of pseudoscience. "Creation science" is antithetical to modern science on methodological grounds because its proponents demand uncritical acceptance of a whole host of postulates and refuse to accept the fact that any of these might be open to refutation via the standard scientific method. Since the 1960s, when the term "creation science" was coined (Numbers, 1982), the creationists have struggled mightily to wrap their ideas in a veneer of science (e.g., Morris, 1974; Morris and Parker, 1982). This scientific veneer has served "creation science" quite well; the subject is currently being favorably taught in at least 15% of the high school biology courses in Ohio (Zimmerman, 1987) and 9.5% of the high school biology courses in South Dakota (Tatina, 1989).

With such significant pseudoscientific inroads being made in the public schools, it cannot be surprising that we are educating a scientifically illiterate public. The consequences of such illiteracy can be staggering. Public policy-makers who are ill-prepared to deal with scientific issues can, under certain circumstances, bring a complete halt to modern science, as happened in Soviet biology and genetics under the 30-year scientific rule of T. D. Lysenko, President of the Lenin All-Union Academy of Agricultural Sciences and Director of the Institute of Genetics (e.g., Medvedev, 1969). Even under much more benign circumstances, lawmakers misunderstanding the basic premises of the scientific method can have a significant effect on the scientific community. In response to criticism by religious fundamentalist groups of an elementary school science program (MACOS: Man: A Course of Study), the U.S. Congress, in 1981, slashed the budget of the education arm of the National Science Foundation virtually to zero (Nelkin, 1982).

The present research is an attempt to assess the degree of acceptance of pseudoscientific ideas by elected officials in Washington and throughout my own state of Ohio. Because of the impact that these groups might have on

shaping our scientific and technological future, it is clearly important to understand the views held by individuals comprising these groups. Because of the volatility associated with the "creation science" movement, because it is such a good example of pseudoscience, and because a fair amount of research has already examined the degree to which individuals accept the premises of this particular pseudoscience (e.g., Bergman, 1979; Fuerst, 1984; Ellis, 1986; Zimmerman, 1986, 1987, 1990; Tatina, 1989), the present research focused on creationism most heavily. A questionnaire dealing with associated issues was sent to all members of the U.S. Congress and to all members of the Ohio House and Senate, allowing direct comparisons to be made between federal and local officials. Such comparisons seem particularly relevant with respect to this issue because, as Larson (1985) points out, the battles to include "creation science" in the curriculum of public schools are increasingly being waged at the local rather than the national level.

Methods

On 10 August 1988, a copy of a 32-item questionnaire (Appendix) was sent to all 533 members of the U.S. Congress (two seats were vacant) and to each of the 131 Ohio House and Senate members (one seat was vacant). In addition to the questionnaire, a postage-paid, business reply envelope and a covering letter were included. The letter briefly explained the study, requested participation and guaranteed anonymity if requested. A follow-up letter, another copy of the questionnaire and a return envelope were mailed out to all non-respondents on 10 October 1988.

Nonparametric statistics (Siegel, 1956) were used throughout the paper.

Results

Responses were received from 62 of the 533 (11.6%) federal officials. Of those, 19 declined to fill out the questionnaire. Responses were received from 34 of the 131 (26%) Ohio officials. Of those, three declined to fill out the questionnaire. Of those responding, 65.1% of the federal officials were Democrats and 34.9% were Republicans. At the state level, 71% of the respondents were Democrats and 29% were Republicans.

To facilitate data analysis, the first 30 items on the questionnaire were grouped into five broad categories: principles of creation "science" (Figures 1 and 2); acceptance of creation "science" (Figures 3-5); acceptance of evolution (Figures 6 and 7); general policy affecting the interaction between science and religion (Figure 8); and acceptance of pseudoscientific issues (Figure 9).

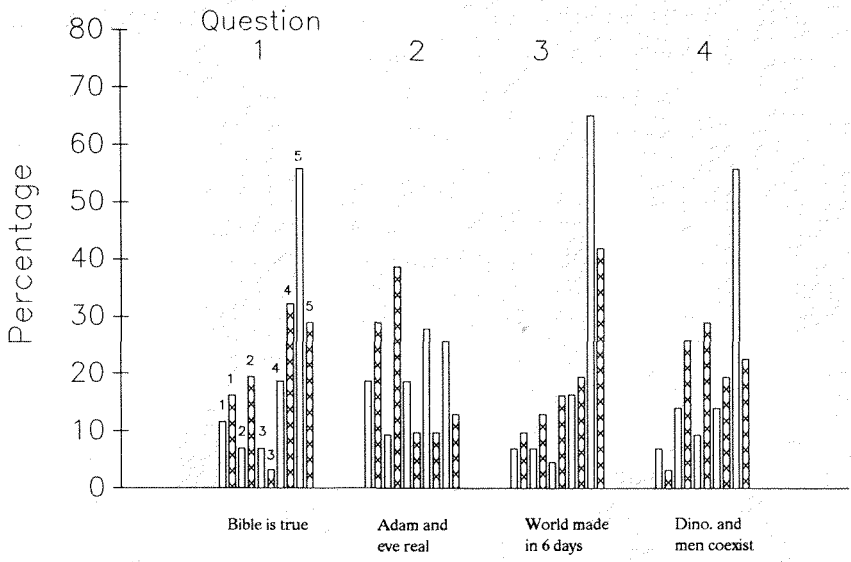

Figure 1 Responses to four questions relating to the principles of "creation science." The responses to each question are arranged in the following order: (1) strongly agree; (2) mildly agree; (3) no opinion; (4) mildly disagree; (5) strongly disagree. Open bars refer to federal respondents and cross-hatched bars refer to Ohio respondents.

All seven of the questions comprising the "principles of creation 'science'" category relate to some of the basic premises of creation "science" (Figures 1 and 2). The results indicate that large numbers of respondents were unwilling to disagree strongly with some of the clearly erroneous tenets of creation "science." Only 29% of the Ohio officials and 55.8% of the federal officials, for example, disagreed strongly with the statement, "Every word in the Bible is true" (question 1). Similarly only 12.9% and 25.6% of the two groups, respectively, strongly disagreed with, "Adam and Eve were actual people" (question 2); only 41.9% and 65.1%, respectively, disagreed strongly with, "The world was created in six 24-hour days" (question 3); and only 19.4% and 41.9%, respectively, strongly disagreed with, "Various kinds of plants and animals have changed slightly, but basic 'kinds' have remained the same since their origin (for example, reptiles did not evolve into mammals or birds)" (question 27). The respondents fared no better when various statements relating to Earth chrono- logy were presented. Only 22.6% of the Ohio legislators and 55.8% of the federal legislators disagreed strongly with the statement, "Dinosaurs and humans lived contemporaneously" (question 4), while only 38.7% and 72.1%, respectively, strongly disagreed with, "The Earth is approximately 6-20 thou-

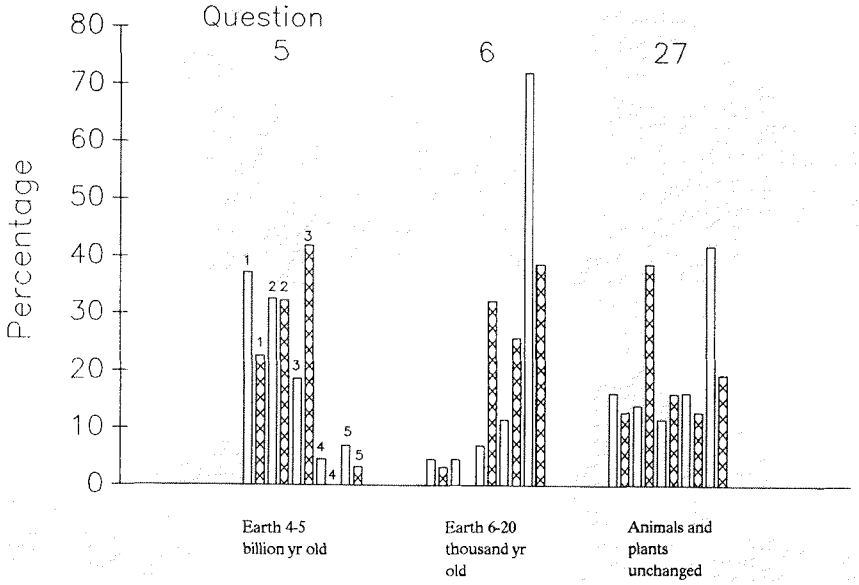

Figure 2 Responses to three questions relating to the principles of "creation science." The responses to each question are arranged in the following order: (1) strongly agree; (2) mildly agree; (3) no opinion; (4) mildly disagree; (5) strongly disagree. Open bars refer to federal respondents and cross-hatched bars refer to Ohio respondents.

sand years old" (question 6). Few respondents were able to deal appropriately with the obverse statement ("The Earth is approximately 4-5 billion years old" (question 5)); only 22.6% of the Ohio officials and 37.2% of the federal officials agreed strongly with this statement.

Significant differences were found between the two respondent groups for a number of questions when responses were subdivided into those strongly disagreeing (or, for question 5, strongly agreeing) and those preferring any other option. Chi square (X^2) tests showed that Ohio officials were significantly less likely than federal officials to disagree strongly with statement 1 ($X^2 = 4.20$, $p < .05$)*, statement 4 ($X^2 = 6.86$, $p < .01$) and statement 6 ($X^2 = 6.93$, $p < .01$). Additionally, the degree to which Ohio respondents were less likely than federal respondents to disagree strongly with statement 3 ($X^2 = 3.04$, $p < .10$) and statement 27 ($X^2 = 3.20$, $p < .10$) approached statistical significance.

The nine questionnaire items grouped together to form the acceptance of "creation science" section were designed to assess the respondents' feelings

* The p values refer to the likelihood that a result is accidental; $p < .05$ means there is a less than 5% chance that results are random.

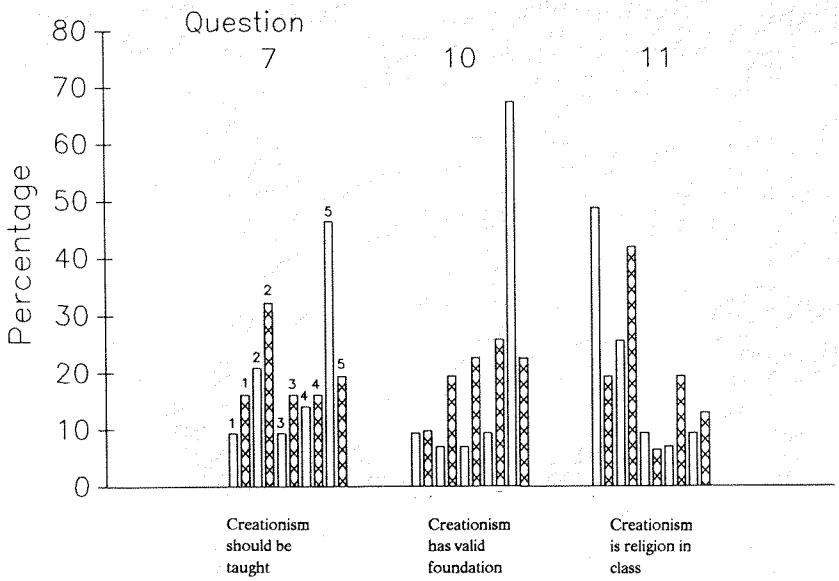

Figure 3 Responses to three questions relating to the respondents' acceptance of "creation science." The responses to each question are arranged in the following order: (1) strongly agree; (2) mildly agree; (3) no opinion; (4) mildly disagree; (5) strongly disagree. Open bars refer to federal respondents and cross-hatched bars refer to Ohio respondents.

rather than their actual knowledge about creation "science" (Figures 3-5). Almost half (48.4%) of the Ohio officials and almost one-third (30.2%) of the federal officials felt (either strongly or mildly) that creation "science" should be impartially taught in public schools (question 7), but many fewer (32.3% from Ohio and 16.3% from Washington) favored state laws mandating equal time for creation "science" and evolution (question 18). Table 1 shows the specific subjects in which respondents felt creation "science" should be presented. A fairly constant percentage of the federal respondents agreed (either mildly or strongly) that "Creation science has a valid scientific foundation" (16.3%, question 10), that "Bringing creation science into the public school science classroom means bringing religion there as well" (11.6%, question 11), and that they "accept the premises of creation science" (16.3%, question 14). Many more *Ohio* respondents indicated that they accepted the premises of creation "science" (54.8%) than thought either that it has a valid scientific foundation (29.1%) or that it could not be taught in public school science classes without the introduction of religion (25.2%). For all five of these questions, responses from the two groups were significantly different. Ohio legislators were significantly less likely to disagree strongly with statement 7 ($X^2 = 4.70$, $p < .05$),

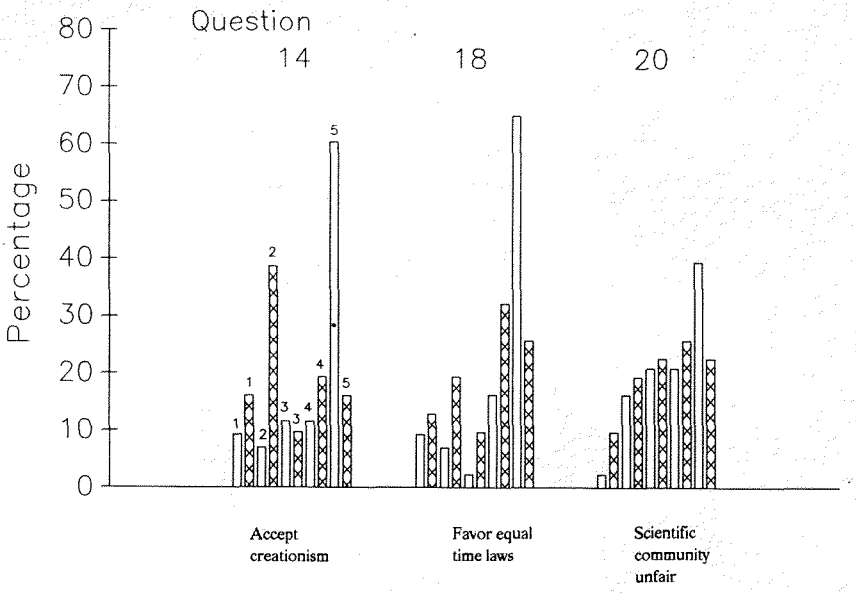

Figure 4 Responses to three questions relating to the respondents' acceptance of "creation science." The responses to each question are arranged in the following order: (1) strongly agree; (2) mildly agree; (3) no opinion; (4) mildly disagree; (5) strongly disagree. Open bars refer to federal respondents and cross-hatched bars refer to Ohio respondents.

statement 10 ($X^2 = 12.77$, $p < .001$), statement 14 ($X^2 = 12.78$, $p < .001$) and statement 18 ($X^2 = 9.62$, $p < .01$) and significantly more likely to strongly agree with statement 11 ($X^2 = 5.54$, $p < .02$) than were federal legislators. Approximately one of every three (29.1%) Ohio lawmakers and one of every five (18.6%) federal lawmakers agreed (mildly or strongly) that "The mainstream scientific community is unfairly close-minded with respect to creation science" (question 20), while a slightly lower percentage of Ohio respondents (25.8%) and a slightly greater percentage of federal respondents (23.2%) agreed that "Creationists are unfairly treated in our society" (question 22). Although relatively few Ohio and federal legislators (9.7% and 9.3%, respectively) agreed that "The teaching of evolution is an important cause of major social and political problems" (question 29), only 74.3% and 76.7% of the respondents, respectively, *disagreed* strongly with this premise. Respondents from the two groups did not differ significantly with respect to their answers to any of the above three questions. Ohio officials were, however, significantly less likely to agree strongly that "Creation science represents an anti-intellectual movement" than were federal officials ($X^2 = 4.10$, $p < .05$, question 21). Only 19.3% of the former agreed (mildly or strongly) with the statement, while 51.2% of the latter did so.

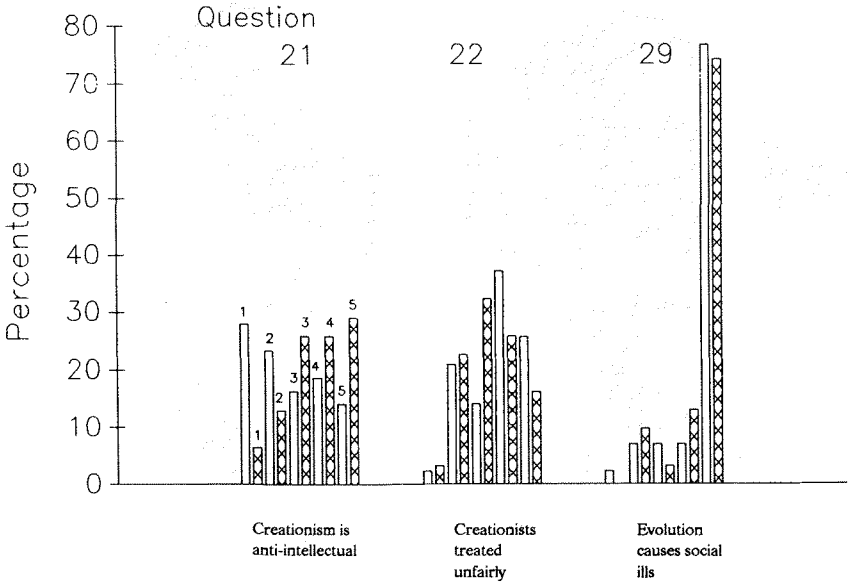

Figure 5 Responses to three questions relating to the respondents' acceptance of "creation science." The responses to each question are arranged in the following order: (1) strongly agree; (2) mildly agree; (3) no opinion; (4) mildly disagree; (5) strongly disagree. Open bars refer to federal respondents and cross-hatched bars refer to Ohio respondents.

Respondents who agreed (either strongly or mildly) that creation "science" should be taught in the public schools quite often appeared to have little conception of what it actually involves (Table 2). Appre- ciable percentages of those individuals disagreed (either strongly or mildly) with various of its tenets even though they felt the subject should be taught.

Like the nine questions just discussed, the six comprising the "acceptance of evolution" section were designed to assess respondents' feelings rather than their actual knowledge about evolution (Figures 6 and 7). Although overwhelming percentages of both Ohio and federal lawmakers (87.1% and 95.4%, respectively) agreed (strongly or mildly) that "Evolution should be impartially taught in the public schools" (question 8), only 29% of the Ohio officials and 55.8% of the federal officials strongly disagreed that "Bringing evolution into the public school science classroom means bringing religion there as well" (question 12). Significantly fewer Ohio officials agreed strongly with the former question ($X^2 = 4.41$, $p < .05$) and disagreed strongly with the latter question ($X^2 = 4.20$, $p < .05$) than did federal officials. Table 1 presents the specific public school subjects in which respondents felt evolution should be introduced.

Appreciable percentages of both Ohio (74.2%) and federal (88.4%) law-

Subject	"Creation Science" Federal	"Creation Science" Ohio	Evolution Federal	Evolution Ohio
Science	2	10	16	17
Biology	5	2	18	4
Religion	4	1	0	0
History	3	1	3	0
Social Studies	1	1	0	2
Literature	1	0	1	0
Humanities	1	0	1	0
Philosophy	1	0	0	0
Creation Science	0	1	0	0
Anthropology	0	0	2	0
Evolution	0	0	0	1
Geology	0	0	1	1
Health	0	0	0	1
Natural History	0	0	1	0

Table 1 Frequency with which elected officials suggested that evolution and "creation science" should be taught in particular public school subjects. A number of respondents listed multiple subjects.

Statement	Federal	Ohio
Every word in the Bible is true	46.2%	33.3%
Adam and Eve were actual people	23.1%	0.0%
The world was created in six 24-hour days	61.5%	33.3%
Dinosaurs and humans lived contemporaneously	61.5%	13.3%
The Earth is approximately 6-20 thousand years old	69.2%	53.3%
Basic kinds of plants and animals remain unchanged	46.2%	13.3%

Table 2 Percentage of respondents who agreed (either strongly or mildly) that "creation science" should be impartially taught in the public schools who also **disagreed** (either strongly or mildly) with each of six other statements.

makers agreed (mildly and strongly) that "Modern evolutionary theory has a valid scientific foundation" (question 9). The same percentage of Ohio respondents (74.2%) agreed that "Most scientists accept the modern theory of evolution" (question 15) while slightly fewer federal respondents (81.4%) did so. More than half (61.3%) of the state respondents and more than three-quarters (81.4%) of the federal respondents indicated that they personally "Accept the modern theory of evolution" (question 13). Ohio lawmakers were significantly

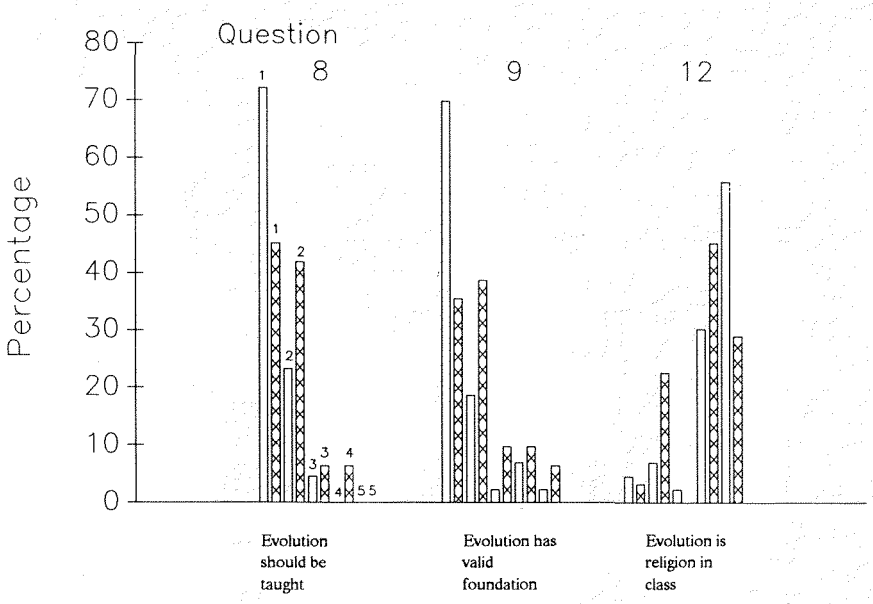

Figure 6 Responses to three questions relating to the respondents' acceptance of evolution. The responses to each question are arranged in the following order: (1) strongly agree; (2) mildly agree; (3) no opinion; (4) mildly disagree; (5) strongly disagree. Open bars refer to federal respondents and cross-hatched bars refer to Ohio respondents.

less likely to agree strongly with each of these three statements than were their federal counterparts ($X^2 = 7.24$, $p < .01$; $X^2 = 6.92$, $p < .01$; $X^2 = 10.16$, $p < .01$; respectively). The two groups of lawmakers did not differ significantly from one another with respect to their responses to the statement, "One must choose between accepting evolution or God" (question 19), with 9.7% of the state and 4.6% of the federal group agreeing.

Question 31 allowed lawmakers to indicate which phrase they felt best described the modern theory of evolution. The correct answer is the one referring to differential reproductive rates (B). The remaining options deviate to varying degrees from the correct description. Answers A and E both have to do with survival, and thus are related to the concept of differential reproduction: dead organisms cannot reproduce. Neither C nor D can be considered accurate descriptions of modern evolutionary theory. The most common answer selected by Ohio respondents, that "evolution involved a purposeful striving toward 'higher' forms" (Table 3), was one of those two responses that are not even partially correct. The most common answer selected by federal respondents, "Survival of the Fittest" (Table 3), while incorrect, may at least be considered to be one of the answers referring to natural selection. None of the

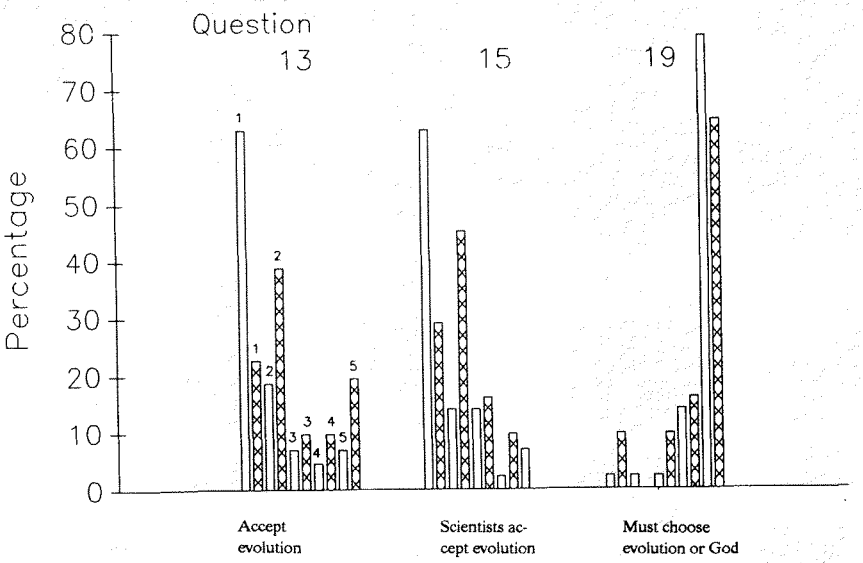

Figure 7 Responses to three questions relating to the respondents' acceptance of evolution. The responses to each question are arranged in the following order: (1) strongly agree; (2) mildly agree; (3) no opinion; (4) mildly disagree; (5) strongly disagree. Open bars refer to federal respondents and cross-hatched bars refer to Ohio respondents.

Statement		Federal	Ohio
A.	The phrase "Survival of the Fittest"	37.2%	16.1%
B.	Evolution occurred because different individuals left different numbers of offspring	4.6%	0.0%
C.	Humans evolved from either the gorilla or chimpanzee in Africa	4.6%	0.0%
D.	Evolution involved a purposeful striving towards "higher" forms (that is, a steady progress from microbes to humans)	34.9%	64.5%
E.	Evolution occurred because the strong eliminated the weak	0.0%	6.4%
	No opinion or multiple answers	18.6%	12.9%

Table 3 Percentage with which respondents selected the following statements as the best definition of the modern theory of evolution.

Ohio legislators and only 4.6% of the federal legislators selected the correct answer. A total of 22.6% of the Ohio group selected one of the three natural selection responses, while 41.9% of the federal group made a similar choice.

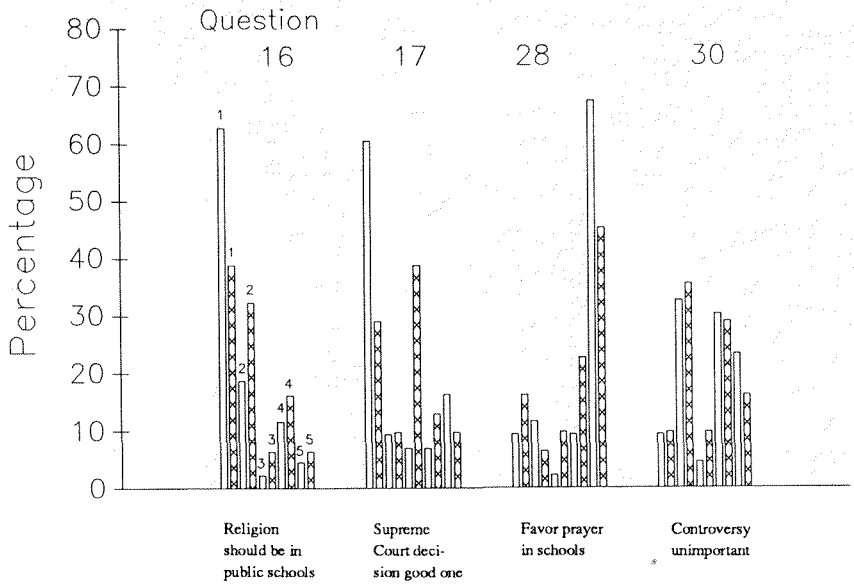

Figure 8 Responses to four questions relating to general policy affecting the interaction between science and religion. The responses to each question are arranged in the following order: (1) strongly agree; (2) mildly agree; (3) no opinion; (4) mildly disagree; (5) strongly disagree. Open bars refer to federal respondents and cross-hatched bars refer to Ohio respondents.

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a The four questions comprising the section dealing with general policy affecting the interaction between science and religion (Figure 8) focus on the respondents' willingness to allow religion into the public schools and on their views on the importance of the evolution creation controversy. Although relatively small percentages of state and federal legislators (6.4% and 4.6%, respectively) strongly disagreed with the statement suggesting that "religion should not be introduced into public schools" (question 16), appreciably larger percentages (16.1% and 9.3%) strongly supported the contention favoring "organized prayer in the public schools" (question 28). While the differences between the two respondent groups were not significant for these two questions, the results did approach statistical significance (X^2=3.28, p<.10; X^2=2.82, p<.10; respectively). While slightly more than one-third (38.7%) of the Ohio officials agreed (mildly or strongly) that the "Supreme Court decision overturning the Louisiana 'equal treatment of creation science' law was a good one" (question 17), more than two-thirds (69.8%) of the federal officials held similar views. The former were significantly (X^2=5.94, p<.02) less likely to agree strongly with the statement than were the latter. Approximately equal percentages of the two groups (45.2% and 41.9%, respectively) agreed (strongly or

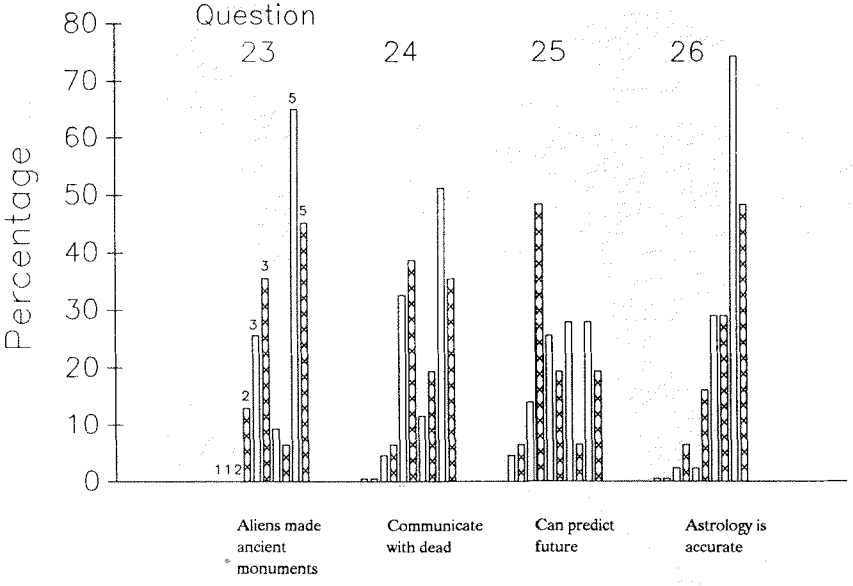

Figure 9 Responses to four questions relating to the respondents' acceptance of pseudoscientific issues. The responses to each question are arranged in the following order: (1) strongly agree; (2) mildly agree; (3) no opinion; (4) mildly disagree; (5) strongly disagree. Open bars refer to federal respondents and cross-hatched bars refer to Ohio respondents.

mildly) that "The controversy between evolution and creation science is not particularly important" (question 30).

Analysis of responses to the final group of four questions gauged the respondents' "acceptance of pseudoscientific beliefs" (Figure 9). Given the absurdity of the statements posed in these four questions, a surprisingly small percentage of respondents disagreed strongly. Only 45.2% of the Ohio lawmakers and 65.1% of their federal counterparts strongly disagreed that "Aliens from other worlds are responsible for the construction of some ancient monuments" (question 23); 35.5% and 51.2%, respectively, strongly disagreed that "It is possible to communicate with the dead" (question 24); 19.4% and 27.9%, respectively, strongly disagreed that "Some people can accurately predict future events with psychic power" (question 25); and 48.4% and 74.4%, respectively, strongly disagreed that "Astrology is an accurate predictor of future events" (question 26). The difference between the two groups with respect to their answers to the last question was significant ($X^2 = 4.20$, $p < .05$) with the Ohio legislators being less likely to disagree with the statement than the federal lawmakers.

Of the first 30 items on the questionnaire, Ohio legislators provided significantly more extreme answers in 16 cases ($p < .05$). In an additional four cases,

the differences, again with the local officials responding in the more extreme fashion, approached statistical significance ($p < .10$). Although the patterns in none of the remaining 10 cases were significant, in every one of those cases the Ohio respondents provided the more extreme answers. Similarly, while in only one of six cases (Table 2) did a significantly greater number of the federal lawmakers who favored the teaching of "creation science" disagree with specific premises of the subject than did their local counterparts ($p = 0.022$, Fisher exact probability), in each of the other five cases the trend, although not statistically significant ($p < 0.05$), was in the same direction.

Discussion

Two conclusions are immediately obvious. First, a large percentage of elected officials showed surprising sympathy for many of the premises of creation "science" as well as a range of other pseudoscientific beliefs. Second, the pseudoscientific sentiments of the state officials were significantly greater than those of their federal counterparts.

While many questionnaire items asked for the opinions of the respondents, a number concerned matters of actual scientific fact. The responses to this latter type of question are not encouraging. Although there is absolutely no doubt among the scientific community that dinosaurs and humans missed each other by millions of years, not even one-quarter (22.6%) of the state lawmakers were confident enough of their knowledge on this point to disagree strongly with the statement that the two lived contemporaneously. The Ohio lawmakers' responses to this question were virtually identical to a 1984 sample of University of Texas at Arlington students (Eve and Harrold, 1986). Although the federal officials provided a slightly more creditable response to this question, their response could hardly be called encouraging. They fared only slightly better (55% to 51%) with respect to this point than did the managing editors of the nation's daily newspapers (Zimmerman, 1990), suggesting that even highly educated and successful segments of modern society have a terribly distorted view of terrestrial chronology. The responses offered to the questions dealing with the age of the Earth support this claim. Appreciable percentages of lawmakers appear unaware of the fact that the scientific community has agreed, based on a whole host of independent evidence, that the Earth is approximately 4.6 billion years old.

Why is it so important that lawmakers in particular know these facts? There are at least two compelling reasons why it is imperative that those dealing directly with public policy have an appreciation for the full stretch of Earth's history. First, as technology has advanced over the years, it has become clear that humans have developed the ability to alter the functioning of entire ecosystems in significant ways. From acidification of many fresh water lakes to

destruction of the ozone layer, some of our technology has had strikingly dramatic negative effects on the environment in which we live. Our elected public officials are the ones who are going to have to make the many critical decisions that will determine the environmental future that we shall face. The seriousness with which people assess and address our current environmental problems has to be shaped by their perspective on the frequency and magnitude of natural environmental change. It seems extremely unlikely that someone who believes that 4,500 years ago the Earth was completely covered with water and the continents united in a single land mass upon which humans and dinosaurs lived in harmony, is going to be particularly upset by the prospect of a 1 - 4 °C increase in worldwide temperature occurring over a relatively short period. Pseudoscientific belief can thus greatly color the perception of the world.

The second reason why it is important for lawmakers to be more conversant with the types of scientific facts probed by the questionnaire is because issues of terrestrial chronology are at the core of creationism. That creation "science" is well outside the bounds of science becomes obvious when some of the statements of its major proponents are examined. For example, Henry Morris, the head of the Institute for Creation Research, has written (Morris, 1978):

> We are limited exclusively to divine revelation as to the date of creation, the duration of creation, the method of creation, and every other question concerning creation .... Further, God in grace has even revealed much concerning the true age of the creation, in His written Word, but men have simply refused to accept it.

Similarly, "creation scientists" abdicate the right to call themselves scientists when they join the Creation Research Society, one of the country's largest creationist organizations, because they must sign an oath dictating what they will and will not believe. Science, by definition (e.g., Ruse, 1983), must be falsifiable, and scientists must be skeptical. Signing a declaration of the sort demanded by the Creation Research Society forces members to commit themselves to a particular interpretation of the world regardless of what any data might ultimately show. By making such a commitment, adherents voluntarily remove themselves from the scientific community. When apparently well-educated citizens, like the lawmakers who responded to the questionnaire, are so misinformed about basic scientific issues, they provide credibility to, and are more likely to embrace, those groups who would like to bring various forms of pseudoscience into the public school science classroom.

In spite of the appreciable degree of ignorance displayed by the respondents, there is a bit of good news as well. Of all groups surveyed to date, federal lawmakers were the least likely to indicate that they wanted "creation science" taught in the public schools. Approximately 30% of that group were in favor of such an introduction while 37% of the managing editors of the nation's daily

newspapers (Zimmerman, 1990), 37% of Ohio high school biology teachers (Zimmerman, 1987), 39% of South Dakota high school teachers (Tatina, 1989), and between 56 and 94% of college students (Bergman, 1979; Fuerst, 1984; Zimmerman, 1986) felt similarly. Unfortunately, approximately 48% of the Ohio legislators favored bringing creationism into the public schools. As with other groups (e.g., newspaper editors), the legislators in favor of "creation science" were not always aware of what they were supporting (Table 2). Many of those in favor of having the subject taught in the public schools actually disagreed with many of the subject's basic premises. Such a coupling of ignorance and support is representative of a common pattern that is recognized and encouraged by the major creation groups (Edwords, 1980; Zimmerman, 1986). When the pseudoscience of "creation science" or that of astrology is equated with science in school, students cannot possibly be learning anything substantial about real scientific methodology. Without a solid understanding of such methodology, however, people are susceptible to further scientific misunderstandings. When those misunderstandings influence public policy decisions, the problem is very serious indeed.

The fact that the present results demonstrated that local officials were significantly less scientifically sophisticated than were federal officials is quite troubling because virtually all educational decisions in this country are made at the state level or lower. The lack of scientific sophistication present at the state level has apparently not gone unnoticed by the creationists who are increasingly targeting the lowest administrative level possible for lobbying (Larson, 1985).

The present results point out some very serious and some very broad problems with science education. When such a large percentage of a successful and presumably educated group is unwilling to discount the possibility of communicating with the dead or using psychic power to predict the future, it is obvious that less well educated groups are likely to hold even more extreme views. Because the percentage of officials surveyed who actually responded to the questionnaire is small, particularly among federal legislators, it might be easy to dismiss the present results as not fully representative. To do so, however, would, I believe, be a serious mistake. The views held by some of the respondents are so far from that of the scientific mainstream and demonstrate such a gross misunderstanding of scientific methodology that even if all of the elected officials who chose not to respond to the questionnaire held views that were considerably more sophisticated, I would still argue that a considerable scientific literacy problem exists. This problem is not going to be an easy one to resolve, and it is clear that steps must be taken at a variety of levels. Elementary and secondary education must be refocused, both to include significantly more science and to direct more attention on methodology rather than on fact. Similarly, university and college scientists need to be encouraged to undertake more public outreach initiatives.

Appendix

Questionnaire sent to all federal legislators and to all state legislators in Ohio.

Use the following scale to rate your opinions of the statements that follow
1 - Strongly Agree 2 - Mildly Agree 3 - No Opinion 4 - Mildly Disagree
5 - Strongly Disagree

_____1. Every word in the Bible is true.

_____2. Adam and Eve were actual people.

_____3. The world was created in six 24-hour days.

_____4. Dinosaurs and humans lived contemporaneously.

_____5. The Earth is approximately 4-5 billion years old.

_____6. The Earth is approximately 6-20 thousand years old.

_____7. Creation science should be impartially taught in public schools.
If you answered with a 1 or 2, in what subject?_____

_____8. Evolution should be impartially taught in the public schools.
If you answered with a 1 or 2, in what subject?_____

_____9. Modern evolutionary theory has a valid scientific foundation.

_____10. Creation science has a valid scientific foundation.

_____11. Bringing creation science into the public school science classroom means bringing religion there as well.

_____12. Bringing evolution into the public school science classroom means bringing religion there as well.

_____13. I accept the modern theory of evolution.

_____14. I accept the premises of creation science.

_____15. Most scientists accept the modern theory of evolution.

_____16. Aside from comparative religion and allied subjects, religion should not be introduced into public schools.

_____17. Last year's U.S. Supreme Court decision overturning the Louisiana "equal treatment of creation science" law was a good one.

_____18. I favor state laws dictating equal time for creation science and evolution.

_____19. One must choose between accepting evolution or God.

_____20. The mainstream scientific community is unfairly close-minded with respect to creation science.

_____21. Creation science represents an anti-intellectual movement.

_____22. Creationists are unfairly treated in our society.

_____23. Aliens from other worlds are responsible for the construction of some ancient monuments.

_____24. It is possible to communicate with the dead.

_____25. Some people can accurately predict future events with psychic power.

_____26. Astrology is an accurate predictor of future events.

_____27. Various kinds of plants and animals have changed slightly, but basic "kinds" have remained the same since their origins (for example, reptiles did not evolve into mammals or birds).

_____28. I favor organized prayer in the public schools.

_____29. The teaching of evolution is an important cause of major social and political problems such as war, family instability, communism, drug usage, etc.

_____30. The controversy between evolution and creation science is not particularly important.

Please answer the following multiple choice question by circling the one letter with which you are most comfortable

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

a. the phrase "Survival of the Fittest"
b. evolution occurred because different individuals left different numbers of offspring
c. humans evolved from either the gorilla or chimpanzee in Africa
d. evolution involved a purposeful striving towards "higher" forms (that is, a steady progress from microbes to humans)
e. evolution occurred because the strong eliminated the weak

32. I prefer that my responses remain anonymous. _____Yes _____No

33. I am a _____Democrat _____Republican

32. Additional comments:

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The Real Mitochondrial Eve

Frank J. Sonleitner

A new study (Vigilant et al., 1991) corroborates the hypothesis put forth by Cann et al. (1987) that our mitochondrial genes can all be traced back to a single female living in Africa about 200,000 years ago. Mitochondria are tiny organelles in the cytoplasm of a cell that function in energy metabolism. They have their own extranuclear DNA. Because sperm normally contribute only a nucleus to a zygote, mitochondria and their genes can only be transmitted to the next generation by females; the mitochondrial genes of a woman who only produces sons will be lost to the population. One result of this is that over many generations, just by chance, all the mitochondrial lines but one present in an

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ancestral population can be expected to become extinct (Gould, 1987; Rowell and King, 1991).

Our earlier ancestor, *Homo erectus*, appeared in Africa about 1.7 million years ago and subsequently spread to other parts of the world, ranging over most of Europe and Asia by 700,000 years ago (Waters, 1990). Fossil evidence seems to indicate that many of these erectus populations evolved into "archaic" *Homo sapiens* types. Some anthropologists claim that the fossil evidence indicates that modern humans originated in Africa about 100,000 years ago and subsequently spread to Europe and Asia, replacing the earlier resident archaic *sapiens* peoples (Stringer, 1990; Stringer and Andrews, 1988; Cavalli-Sforza, 1991). The mitochondrial data seem to support this hypothesis. Other anthropologists favor a multiregional evolution of modern man directly from the various archaic sapiens peoples in Africa, Europe and Asia, citing fossil evidence for locally occurring transitional forms (Wolpoff and Thorne, 1991; Shreve, 1990) and reject either the interpretation of the mitochondrial data or the dating of "Eve."

Because of the strict haploid, clonal maternal inheritance of mitochondria one must interpret the data carefully. Although all of our mitochondria may have come from a single female about 200,000 years ago, she may have been a member of a population including thousands of other females (and males) who contributed nuclear DNA to modern humanity. It is also likely that this "Eve" was not a modern human but anatomically an archaic *sapiens* type. Thus she was an "Eve" only in a very restricted and special sense (Lewin, 1987; Brown, 1990:108). Because of this, Vigilant et al. refrain from using the term "Eve." Also, depending on the extent to which the decendents of this African population migrated to other areas and how marriage customs might have allowed them to interbreed with resident populations, those older resident populations could possibly have contributed much nuclear DNA to modern populations, producing the local fossil continuity that some anthropologists claim to observe (Paul, 1990; Rowell and King, 1991). Finally, there has been a great deal of gene flow and migration between human populations. Thus a genealogical tree of the human races would look more like a web than a tree. This is not reflected in the mitochondrial gene trees produced by these studies because mitochondria do not take part in sexual recombination as do nuclear genes. Instead the people included in these studies who come from same geographical region show up at widely different places on the mitochondrial gene tree. Cann et al. illustrate this multiple origin of many of the non-African races with the New Guineans in their sample.

Given the above cautions, it is not surprising that much misinformation regarding the interpretation of these data has appeared in the popular press. The creationists are no exception. Mehlert (1987) interperts the mitochondrial research to mean that all human genes come from a solitary "Eve" and that all alleged ancestors of mankind older than 280,000 years (Australopithecines,

etc.) are excluded from human ancestry! This is incorrect. Only populations of *H. erectus* that migrated from Africa earlier than the time of "Eve" did not contribute to the modern human mitochondria. Obviously "Eve" must have descended from older populations of *erectus* that remained in Africa.

The creationists also claim that these results are remarkably like the Genesis story. But how would creationists really explain the mitochondrial data? Did neutral mutations occur and become fixed in human populations at a fantastic rate in the few thousand years since the Flood? It is creationist dogma that all mutations are deleterious and that all the species or species populations that may have separated out from an original created kind simply display variation that was present in the original. Would they instead believe that the biblical Eve (actually Adam) was highly polymorphic in her mitochondria? Why should God have put so much functionally neutral variation into the mitochondria? (The hypervariable segments of mitochondrial DNA used by Vigilant et al. are thought to represent non-coding "junk" DNA). If so, how did these mitochondrial morphs get sorted out in the various geographical populations of humans in subsequent generations? Apparently another whole suite of miracles is called for!

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Book Review

Milner, Richard. 1990. *The Encyclopedia of Evolution; Humanity's Search for Its Origins*. Forward by Stephen Jay Gould. NY: Facts on File. Paperback and hardcover. xii + 481 pp., illustrated, large format. *Review by John R. Cole*

This is a DELIGHTFUL volume which should be in every library and school and in the personal library of people interested in the topic of evolution.

It is the product of an individual (albeit with help) and is not an encyclopedia in the usual sense, therefore. It's quirky, like Dr. Johnson's Dictionary, but it covers an incredible range of topics with researched wit and erudition. It notes antievolutionist arguments and dismisses them (with evidence and references, not snideness), and it surveys an amazing range of issues in evolution, historical figures, details about DNA, etc. Almost anyone put off by a particular argument will be mollified by directions to a lot of basic references and sources discussing controversial or complex matters in depth.

The well-dressed evolutionist will hesitate to appear in public without this volume at hand along with Arthur Strahler's *Science and Earth History; The Evolution/Creation Debate*. Buffalo: Prometheus Books (available from NCSE at discount). The Milner book is vastly more attractively produced, but Strahler is more pointedly critical of creationist claims – Milner emphasizes evolution while taking dumb alternatives into account, you might say.

Buy Milner and browse! The book is arranged alphabetically by big topic, but there's also an excellent detailed index.

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