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INTO FOCUS

PALEONTOLOGY: A CANDLE IN THE DARK

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WHY PALEONTOLOGY?

Paleontology is the best of all sciences! At least in the public eye, it seems to be, if media attention means anything. Movies, television programs, newspapers, tabloids, magazines, and books abound with paleontology. Not all of it would meet the approval of every paleontologist, but most likely the exposure is good over the long run. This popularity provides a means of influencing the general public about science in general (Lipps 1998), which is sorely needed. The general scientific illiteracy in the public (National Science Board 1996, 2002) can be countered in part by using paleontology to show how logic, evidence and alternative ideas can be used to make life better.

Just how popular is paleontology? Dale Springer tabulated the number of times that paleontology, among various earth science disciplines, was mentioned from 1994 to 1997 in eleven popular American publications (Springer 1997). These include major magazines in the USA (*Life, Newsweek, Time, U.S. News and World Report, National Geographic Magazine, Discover, Omni, Earth*) and newspapers (*USA Today, The New York Times, The Chronicle of Higher Education*). Paleontology exceeded all the other earth sciences in the number of keyword returns by subdiscipline (e.g., paleontology, volcanology, structural geology, etc.), by practitioners (e.g., paleontologist, volcanologist, structural geologist, etc.), and by topics (e.g., dinosaur, fossil, plate tectonics, volcano, floods, etc.). Floods, earthquakes and other Earth disasters received more citations than paleontology, but these were gratuitous voyeurism rather than true interests (e.g., "thousands killed in earthquake" or "flood cost billions"). An Internet search using "paleontology" and "palaeontology" (on Google in November, 2003) yielded 600,000 pages; far too many to check out individually. Paleontology remains one of the real science topics of greatest interest to the general public for decades, with perhaps only astronomy together with space travel exceeding it in the public's eye. Even politicians of various sorts like paleontology. Thomas Jefferson, third president of the United States, had an abiding interest in fossils (http://earlyamerica.com/review/2000_fall/jefferson_paleon.html), and former USA Speaker of the House Newt Gingrich has a life-long interest in paleontology, expressed some time ago through a fossil-hunting trip with Jack Horner (Gray 1997) and a cast of a dinosaur skull in his Congressional office. Even the Republic of the Maldives in the Indian Ocean, with 1190 tiny coral islands (Quaternary in age) barely poking above sea level, issued dinosaur stamps. Paleontology appeals to just about everyone!

As many of us have said, this great interest in paleontology can be and is used to introduce people to various aspects of science (Lipps 1996; Stucky 1996) from paleontology to physics, from asteroids to zoology, as well as mathematics and

This title was inspired by Carl Sagan's 1995 book title, *The Demon-Haunted World: Science as a Candle in the Dark*. The editorial is an update of Lipps's Presidential Address (which summarized his previous essays) delivered to the Paleontological Society in late 1997. It is published here rather than in the *Journal of Paleontology,* as Presidential Addresses used to be, for the larger, more general audience of this web publication.

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statistics. More importantly, paleontology is among the best of sciences to show how the *process* of science works—ideas and evidence turned into hypotheses, multiple working hypotheses developed, and, finally, hypotheses tested and eliminated or supported. Most people have ideas about dinosaurs, for example, stemming from their childhood interests and the movies, if nothing else. Indeed, movie producers and studios know this too, and have made fortunes for years on those very interests. Like so much of natural history, paleontology is relatively easy to do and to understand in its basics. Paleontologists thus have a great opportunity to use their discipline to educate the general public about how science works—the process, not just the facts.

WHAT'S THE PROBLEM?

People in large parts of the world are inundated daily with paranormal, antiscientific, and nonsensical ideas by the mass media and various charlatans. The general public does not know enough about the processes of science to sort the good from the bad (Ehrlich and Ehrlich 1996; Lederman 1996; National Science Board 1996, 2002; Lipps 1998, 1999). The good reporting and presentation of paleontology and other sciences by these same media are miniscule compared to the junk science they purvey: only about 2% of the programming on USA television can be considered good science (National Science Board 2002), and this includes science in dramas and comedies. This has great impact on all of us everywhere, not just as paleontologists but, far more importantly, as citizens of the world.

Politicians, government agents and citizens decide scientific issues every day without adequate understanding of how science works, how conclusions are derived, how substantial those conclusions might be, and what the consequences of their decisions would really be. Some of these decisions affect us for years (various environmental, global-change, and water issues, and other resource-use policies are a few of many examples), so they should be based soundly in science. Pundits may likewise urge us to behave or vote in certain ways, counter to good scientific evidence or hypotheses, but we should be careful of personalities with big words. Scientific illiteracy cannot be good for you, your country or our world at large.

People need a certain level of scientific literacy just to deal with everyday situations. Some have debated whether scientific literacy for the general public is unnecessary (Greenfield 2003a, 2003b; Nesbit 2003; Turney 2003), and it might be so when scientific literacy is defined as knowledge of certain facts or general issues. Science and scientific literacy can be defined as the possession of knowledge in the first case, and thinking critically, evidentially and logically in the second (Maienschein 1999). Thus the problem of scientific illiteracy cannot be ignored when people themselves use non-scientific methods and processes to make personal decisions or to vote.

Pseudoscience and antiscience cost people around the world billions of dollars every year through their local, state and federal governments and their own direct payments for various kinds of scientifically unsupportable and irrational schemes, as well as money lost to out-and-out deceit that could be discerned through familiarity with the scientific processes of thinking. For example, Americans have, for years, paid billions of dollars for "alternative" medical remedies that lack any scientific support whatsoever and that often do them harm (Park 2000; Shermer 2003). In 1990, they spent 13.7 billion USD for unconventional or "alternative" medical therapies lacking scientific support and a comparable 12.8 billion USD for regular hospitalizations (Eisenberg et al. 1993). By 1997, the costs rose to an estimated total of 27 billion USD for alternative medicine and about the same for out-of-pocket physician services (Eisenberg et al. 1998). Who knows what additional money is paid to tend to or correct medical conditions that were exacerbated or merely delayed by use of these other untested remedies? These amounts may only be the tip of the iceberg, because of the innumerable psychic, cult, conspiracy, astrologic, and many, many more schemes promoted in earnest by true believers or, less honestly, by charlatans who seek your money.

Unfortunately, not many people know much about science. In 2000 the United States had about 222 million adults (age 15 and over; U. S. Census Bureau 2002). If 95% of them are scientifically illiterate, as estimated[1] (National Science Board 1996), then about 211 million would not understand how science works, what the process is of evidential reasoning, or whose opinions to trust, and only about 11 million people would. Assuming that similar percentages apply to the world's population (U. S. Census Bureau 2003), only about 213 million of more than 4,260 million adults might understand

[1] The National Science Foundation's 2001 survey of adult Americans showed that 70% were ignorant of how science works. This, it noted, may be a low estimate since it's survey was biased by inclusion of more well-educated people than reside in the general population (National Science Board 2002).

how science works. Because these figures are based on estimates of populations and of science illiteracy, they should be considered only an indication of the magnitude of the state of science comprehension for the world. No matter how such estimates are made, the number of scientifically illiterate people worldwide is very large. For self-protection, if no other reason, people need to know the central tenets of science—evidential reasoning, hypothesis development and testing—and who real scientists are and how they work.

What the mass media present in an ostensibly scientific manner is seldom real science (National Science Board 2002). Most of it is pseudoscience, antiscience, superstition, dogma, and sales pitches. Scientific illiteracy is enhanced by such presentations because they confuse fact with fiction, scientific theory with belief, and scientists with non-scientists and charlatans. Why people are fascinated with and will pay good money for pseudoscientific or antiscientific claims is a deep problem, but it involves poor education, personal and mass delusion, various psychoses, indoctrination, hopelessness, fear of other people, apprehension about the world around them, dread of the unfamiliar, and a multitude of other factors (Miller 1987; Eve and Harrold 1990; Shermer 1997). All of these claims add up to an easy target for media moguls—why do anything else when all sorts of pseudoscience, antiscience and weird beliefs are everywhere, from books to universities and colleges? Real science is miniscule in comparison (Shermer 1997), even though most of our society and economy is based on it and technology (Sagan 1996).

WHAT IS SCIENCE?

Real science involves creativity, logic, critical thinking and the use of appropriate evidence, subjects all authority to scrutiny, and allows testing of its claims.These essentials, not a list of facts, are the basis of scientific literacy for the layperson. Looking up facts can be a trivial pursuit, but reasoning scientifically provides a sound basis for comprehending our world. People can feel rewarded when they are able to develop a course in life, make judgments, or solve problems using these methods. They do not need to formalize their thinking to do science or to practice it on a personal basis. Solving a problem, whether it is scientific or not, is a tremendous joy in life, easily equaling or exceeding the thrill of pseudoscience, antiscience or unsupported beliefs.

Three concepts are central to science literacy: critical thinking, evidential reasoning, and evaluation of authority (Lipps 1999). Each includes several steps (Table 1), but these are not hard to learn or apply. Mostly, they involve asking the right questions about a situation, about the evidence, about who is promoting it, and allowing and accepting some uncertainty.

SCIENCE IN THE MASS MEDIA

The mass media's influence is enormous but they seem to deal poorly with science. They are, however, the source for most people's knowledge of the world. The pseudoscience, antiscience and plain lack of common sense that we see on television, read in books, magazines and tabloids, hear on the radio, or view on the Internet distort, confuse, and simply misinform about science, how science is done, and who actually practices science. Many of the media, especially television, the tabloids and the Internet, prey on the ignorance, superstitions and fears of unknowledgeable people who live in a civilization acutely dependent on science and on scientific reasoning. People deserve much, much better! And the media *can* do much better!

The mass media provide very little help, however. Schools, teachers, good books, some excellent Internet sites, and a few informative television programs are overwhelmed by the effluent of pseudoscience and its like. Why do the mass media work against scientific literacy? For money, of course. For example, Tony Tavares, President of Disney's Anaheim Sports, said (*Time Magazine,* August 4, 1997): "Our main goal is to get people to spend their disposable income with properties associated with the company, whether they're our theme parks, videos, movies or our sports teams. *If you've got a dollar, we want it.*" (Italics mine). How pathetic! Responsibility and innovation simply take a back seat to yet another dollar.

The good and bad information the media present is often selected by the media themselves or their advertisers (Bagdikian 1997). In general, those in the media responsible for material they use are as uninformed about science and its processes as the general public (Hartz and Chappell 1997). Newspaper editors in general, for example, are woefully ignorant of science, hence are reluctant to include it in their stories (Hartz and Chappell 1997). Screenwriters, although they would like to do intelligent and funny stories about science, simply do not have the basic knowledge to do so (Steve Allen, personal communication, 1997). As a result, the mass media serve science very poorly.

The mass media can be separated into two intergrading categories: Active and Passive (Lipps 1999). People engage the Active Mass Media with

Table 1. Skills for critical thinking, evidential reasoning and judging authority (Lett 1990; Wade 1990; Lipps 1999).

Critical Thinking	
1. Ask questions: be willing to wonder	Start by asking "Why?"
2. Define the problem	Restate the issue several different ways so it is clear.
3. Examine the evidence	Ask what evidence supports or refutes the claim. Is it reliable?
4. Analyze assumptions and biases	List the evidence on which each part of the argument based, The assumptions and biases will be unsupported..
5. Avoid emotional reasoning	Identify emotional influence and "gut feelings" in the arguments, and exclude them.
6. Don't oversimplify	Do not allow generalization from too little evidence.
7. Consider other interpretations	Make sure alternate views are included in the discussion.
8. Tolerate uncertainty	Be ready to accept tentative answers when evidence is incomplete, and new answers when further evidence warrants them.
Evidential Reasoning	
1. Falsifiability	Conceive of all evidence that would prove the claim false
2. Logic	Argument must be sound
3. Comprehensiveness	Must use all the available evidence
4. Honesty	Evaluate evidence without self-deception
5. Replicability	Evidence must be repeatable
6. Sufficiency	A. Burden of proof rests on the claimant. B. Extraordinary claims require extraordinary evidence. C. Authority and/or testimony is always inadequate
Judging Authority	
1. Does the authority use critical thinking and evidential reasoning?	If not, don't believe her/him.
2. Does the authority have proper credentials?	Degrees or documented experience are required.
3. Does the authority have proper affiliations?	Is he/she attached to an organization that relies on critical thinking and evidential reasoning?
4. Does the authority subject their work to peer review?	If not, be very skeptical.
5. Does the authority demonstrate expertise in the field?	Do other authorities rely on this person's work?
6. Does the authority's organization have an interest in the outcome?	If so, don't believe her/him.

some effort to get the message, whatever it is. The Passive Mass Media require little decision-making, and the information is received passively. Generally, media that require reading are active, whereas those that are viewed or heard are passive.

Active Mass Media. Americans, for example, read a great deal. More than 50,000 books are published in the USA each year, including many excellent, beautiful and interesting science ones. Pseudoscientific books, however, seem to far outnumber science books, suggesting a much larger audience for these topics. They are so popular that some bookstores are dedicated solely to the paranormal. Science books seldom attain "best seller" status, yet anti- or pseudoscience books do rather frequently. Carl Sagan's *Cosmos* (Sagan 1980) may well have been a bestseller, largely thanks to its association with his popular television program of the same name. Books in paleontology, like *T. rex and the Crater of Doom* (Alvarez 1997), *The Dinosaur Heresies* (Bakker 1986), or *Digging Dinosaurs* (Horner and Gorman 1988) perhaps sell tens of thousands of copies, but many others, like *The Hominid Gang* (Willis 1989), appear suddenly and are gone and forgotten. Even Bakker's dinosaur novel *Raptor Red* (Bakker 1995) did not make the bestseller list, in spite of anticipation that it would. On the other hand, *Jurassic Park* (Crichton 1993) did very well, thanks in large part to the movie version of the book. Although the book and the movie had scientific errors (DeSalle and Lindley 1997), together they surely did a wonderful job of promoting paleontology and science in general. The movie thrilled a billion people or more and created an unprecedented interest in paleontology and molecular biology. Museums opened new exhibits, magazines explained the details, Internet sites created special pages to deal with it, and a lot of organizations made good money on good entertainment that challenged people to think a bit about science. Even TV experimented a little with paleontology in the fantastically successful situation comedy *Friends.* One of the principal characters was a professor of paleontology whose science was used occasionally to enhance the program but never with any understanding of how science works, even though it would have added a great deal to both the humor and the story.

Authors who promote antiscientific or pseudoscientific views have considerably larger readerships than those promoting science. Many more books, magazines, and articles are devoted to such views than to science. The radio talk-show host Rush Limbaugh's best selling books sold well over 7 million copies (Limbaugh 1993a, 1993b). He promoted an abundance of antiscientific and pseudoscientific errors and incorrect logic (Perkins 1995) to make his points. These books and his radio program regularly reach around 20 million people. Such numbers are significant.

In spite of a gap between science and journalism (Hartz and Chappell 1997) magazines and newspapers can do very well with science. *Time, U. S. News and World Report,* and *Newsweek* regularly include science stories (paleontology too), although pseudoscience appears regularly in them as well without much critical comment. Millions of people read these magazines, but their influence seems small compared to other media. Newspapers, in some circumstances, do a reasonable job of science reporting, especially when the writers are trained in science or are dedicated only to science writing (Hartz and Chappell 1997). General reporters do not seem to be any better with science than the general public. They ask the wrong questions, probe for preconceived significance, and may well distort science. Some of you may have been disappointed with the news coverage of your own work. Sometimes reporters fail to understand, even if allowances are made for "writing for their audiences", an excuse for poor science coverage.

Among several such disappointments I experienced, one shed light on how the process sometimes works. Some time ago, the National Science Foundation decided to drill a hole through the Ross Ice Shelf in Antarctica to see what was under it. No one knew what might live there. But the drill froze 3/4 of the way through the ice and no sampling could be done. In spite of that, I was able to get some dive gear to Antarctica in time to divert my team to do some diving under the ice pack near McMurdo Sound. We found a new kind of foraminifera (Figure 1) that looked like a little tree, 5 or 6 cm tall with roots, trunk and branches (DeLaca et al. 1980). In spite of the fact that nothing could be found below the ice shelf, a symposium about the results of the Ross Ice Shelf Project was held. Investigator after investigator stood up and said they had no results because the engineers got the drill stuck. When my turn came, I told them about how we diverted and found a new species of protozoan. Big deal, but it was all I had! Two weeks later, the NSF Public Relations person called me up and said, "I hear you discovered a new species of animal in Antarctica". I said: "Well, it wasn't an animal, it was a single-celled protozoan, and besides, scientists find new species of animals every day. It is not newsworthy." He then asked: "Is it good to eat?" I said, "It's a single cell—no one in their right mind would even think of eating one!" He continued: "Well, if you did eat it, what would it taste like?" Wearily, I said I had no idea but since it

Figure 1. The foraminiferan *Notodendroides antarctikos* (DeLaca et al. 1980) was the subject of a misleading news release. The news correspondent asked all the wrong questions, did not listen to the correct explanations, and wrote a story that "a new species of animal was found that is not good to eat because it tastes like sand". Interviews with the news media must be conducted with care and understanding between the scientist and reporter. *N. antarktikos* ranges in size up to about 6 cm tall, fairly large for a foraminiferan. Photograph by T. E. DeLaca.

had a shell made of sand, I supposed it would taste like sand. But I warned, “No one would ever want to eat one!” In a few days his report went out over Reuters International, and I received one reprint request and a clip from a newspaper in Rhode Island sent to me by a colleague. He pasted it to the back of a post card and wrote, “Did you really say this, Jere?” It said: “Professor Jere Lipps of the University of California found a new species of animal in Antarctica that is not good to eat because it tastes like sand!”

Be very careful with the press! Don’t let them ask the questions that make no sense or that are irrelevant or wrong. Instead, just tell them about your work. Help them to formulate correct questions if they must ask them. If they insist on asking wrong questions and you don’t think they are appropriate, don’t answer them. Give them instead the answers to the right questions. Most reporters want their stories to be correct, but they do want to write them themselves. They seldom, for reasons beyond me, allow their stories to be read for correctness by the scientists they interview. Surely a way can be found to have the facts of the story checked by someone knowledgeable besides the writer and his or her editor. It would be in everyone’s best interests. Less significant errors or marginal statements may be present, but hopefully none will be as memorable as my bad-tasting foram.

Tabloids hardly need discussion. Their aim is to make a lot of money, so what little science gets presented may be either bad or good depending on what might sell best. Some of their stories have substance when particularly sensational events take place, because they do assign special writers to those stories. While the events rarely involve science or scientists, these successes increase the apparent veracity of their other stories enormously.

The Internet has turned into a vast pit of sites that must be navigated and used cautiously. Anyone can have a site where they can post nearly anything they like. Just sorting through the results of an on-line search now takes considerable sophistication, because of the need to determine which sites are reliable and which are not. Scientific literacy may help here. Tens of millions of sites now exist on the WWW and purvey a wide range of material. Our own Museum of Paleontology site (http://www.ucmp.berkeley.edu), one of the first on the Web and now containing 4000+ pages of paleontology, geology and evolution, is accessed over 2.5 million times a week (but many of these are multiple hits by the same user). Even so, it is a paltry number compared to some sites on the Web. The Internet can help considerably by providing students with good information, but this usually requires guidance from teachers and the development of appropriate content.

Passive Mass Media. Television, movies and radio reach billions of people worldwide. They could provide very good understanding of science through informative programs, such as those on the Discovery Channel, and entertainment programs that use science themes. However, modern radio is mostly music and talk shows, movies are clearly entertainment, and TV seems unable to develop scientific topics in prime time.

Even though movies are recognized by most people as entertainment and fiction, they nevertheless may have influence. They indicate what scientists do (crazy stuff usually), who scientists are (flakes and bad guys), but provide little indication of the scientific process. They may promote pseudoscientific themes. Much of this is defended as simply entertainment (Crichton 1999), but it nevertheless has greater influence than might be supposed by screenwriters, producers and directors. Some of this may even be quite positive. On the other hand, movies may reinforce pseudoscience or antiscience learned in other media. For example, I took my son to see *Independence Day,* the fantasy film about a massive alien invasion of the world. When an alleged UFO crash and supposed capture of aliens was screened, a woman behind me excitedly told her three children, "That’s true! I saw it on television!!"

Television has done very little with science. It reaches so many homes and is so easily absorbed passively, that it is very, very influential. As such it may serve science well, if it can develop the scripts and programs that people would likely be interested in. Because most children and adults uncritically watch many hours of television weekly, it is particularly unfortunate that science is so sparsely represented. People learn a good deal from television, and their views and behavior are commonly shaped by what they see (Postman 1985). Commercial television executives claim that their programs do not influence people, yet they sell billions of dollars worth of advertising based on just the opposite claim. It can’t be both ways! The sales of advertising and changes in people’s buying patterns demonstrate that TV is tremendously influential (Bagdikian 1997). It decides our cultural norms, our interests, our politics, and our learning habits, as well as what we want to buy. It could also positively influence scientific understanding around the world.

Television is particularly good at promoting visual images rather than serious discussion or information about the issues. Unfortunately, this usually results in the trivialization of the important things in our lives, our nation and our world. Besides the production of this kind of "junk", television distorts and misinforms by mixing programming. Entertainment programs look like news programs, and news programs look like entertainment. Documentaries are designed to be entertaining, not necessarily factual. People cannot easily distinguish between reality and fantasy on TV.

Furthermore, television companies have two major problems: they have to keep the viewers from quickly switching channels with their remote controllers and they have to fill 24 hours a day with programs. The first need forces stations and networks to switch topics within programs every 45 or so seconds and to show spectacular items and sensational programs in attempts to keep people from channel jumping. The second need forces them to uncritically accept and buy some programs that distort, lie and cheat about science (and other issues as well), and promote pseudoscience. Yet even in reruns, these programs reach millions of people, and many more than that in the first showing (Emery 1997). My favorite example is *The Mysterious Origins of Man,* a program purchased and twice shown in prime time by NBC. It showed mostly factual errors, a couple of self-proclaimed authorities claiming "scientific cover-ups", and presentations of distorted and erroneous theories. Curiously the Public Broadcasting System sold a video of it through their online store. This program was criticized by scientists, me included, on the basis of the errors and silly theories it presented. The program, derived in large part from a book "Forbidden Archeology" (Cremo and Thompson 1993), relied on statements that 55-million-year-old human remains were found under Table Mountain in California and that trackways preserved in Cretaceous mudstones in Texas proved that humans walked with dinosaurs. It also claimed that scientists "covered up" such facts in a gigantic conspiracy. Far from it—science long ago dismissed the alleged high age of the California remains because they came from a near-modern overhanging shelter (Blake 1899), and the so-called Cretaceous human footprints were made by other kinds of dinosaurs or were carved fakes (Hastings 1987). Demonstrably erroneous theories were presented, such as the crust of the earth slipping 2000 miles sometime in the last million years or less, from temperate places to new positions in the Arctic, so fast that mammoths could not swallow or spit out the buttercups they had been eating at the time. These things were dredged up, packaged in an entertaining fashion, and moderated by Charlton Heston who sounded very authoritative. Alternative hypotheses (such as: buttercups did live in the Arctic when the mammoths died) were never presented—a complete distortion of the process of science. Scientists did not cover anything up; they did their job and long ago disproved those very ideas. The cover-up is on the other side, as its proponents pushed errors and fraudulent ideas as real science by omitting whatever data and theory that countered their own viewpoints. The book sold several hundred thousand copies, and the authors make even more money on lecture tours. This looks more like a business scheme than science. The program should have been labeled fiction or entertainment instead of science, but the networks seem to have no way to evaluate the validity of its programs. When NBC was done with this program, it was shown on the "Learning Channel" a number of times. Is this really a Learning Channel?? A number of scientists sent messages to NBC, the sponsors of the program, and the Federal Communications Commission to point out the errors of fact and theory and to object to the promotion of the program as real science. The producers and authors of the program used this commentary as further evidence of a conspiracy of scientists, and even wrote more books that sold more copies.

Sadly, many other programs, some of which are regular features, continue to convey these distorted and false messages about science on television. Sometimes television produces a whole series of such pseudoscientific programs. For example, the week of March 24, 1997, was declared "Alien Invasion Week" on the Learning Channel. During this week, packaged pseudoscientific programs were shown each night concerning UFOs, alien abductions, alien autopsies, and similar topics. While most programs included a sprinkling of terms like "might have been", "could have been", "alleged", these terms were surrounded by images of flying saucers, big-eyed aliens, and impressive sounding pro-UFO people all accompanied by dramatic music. In a few cases, a skeptic or scientist noted why these things were unacceptable, but the music, images, and general tenor of the segment changed from the dramatic ones used when UFO phenomena were shown. These kinds of presentations significantly influence the viewers to believe the general message about UFOs and not the more rational one (Sparks et al. 1995, 1997). While alien space crafts may well exist somewhere in the Universe, lights in the sky, Biblical tales, fuzzy recollections, blurry photos, and outright fakes are hardly the kind of evidence that such claims require. This is not learning in any sense of the word, but indoctrination. Such programs have enormous influence because they reach millions of people, and many people believe, in the absence of other sources of information, that television tells the truth. These programs should carry a disclaimer that they are dramatizations based on unreliable evidence and beliefs, and that they do not meet acceptable scientific criteria for acceptance. Producing such programs is more than a prescription for disaster, it is a great waste of time, effort and money, and an opportunity for international and local charlatans to foist who-knows-what on people everywhere. It is truly “the dumbing of the world”.

Yet television is also the solution, for it reaches everybody! TV could present entertaining and newsworthy programming and readings that properly convey science, so people gain rather than lose something of value in their daily lives. The sense of discovery, excitement and the checks and balances operating in science, especially a science like paleontology, make for interesting stories.

There are good science programs presented in the passive media once in a while. *National Geographic Specials, Nova,* and similar TV programs are good examples. The Jacques Cousteau programs showed how science was done, and they did it in an entertaining manner. Usually, a problem was identified, a hypothesis proposed, and then his divers went out to solve the problem. The programs were a bit dramatic and took poetic license at times, but they were widely viewed around the world and very influential in educating people about various scientific issues. Other programs, shown especially on PBS or other “educational channels”, often thought to represent science fairly, fail to provide an antidote to the TV trash science. They are merely films of scientific subjects, most commonly animals and plants, with voice-overs describing the scenes. Rarely is the scientific process part of the program. The thrill of discovery, the sorting of hypotheses, evidential reasoning, critical thinking, and the joy of successful problem solving—few of these are seen on television even though they could be made dramatic, humorous or interesting.

This should not be acceptable today. Science should become as familiar on television to people as the sex, violence and pseudoscience that are learned in great detail from TV (Postman 1985; Sapolsky and Tabarlet 1991; Paik and Comstock 1994; Sege and Dietz 1994; Signorielli et al. 1995). If these things can be learned from television, the workings of science can be learned as well, if only television will take some initiative and show some real science in their programming.

HOW CAN PALEONTOLOGY HELP?

As scientists, educators and parents, and especially as paleontologists, we can do lots of things. We should ask that the media present a fair representation of the process of science. I made these suggestions before (Lipps 1999), but here I repeat them with comments on what has been done. We still need lots of creative thinking and energy, and we need to present our criticisms constructively and in a way that will enhance the mass media corporations, at least monetarily. They need to know that real science sells well, that it is dramatic, funny and tragic, and that good stories can be written for showing in prime time, and that it makes excellent reading. We have much hope and, indeed, quite a future in selling literacy in science, if we so choose. We have so much good material in science. If the media can so effectively peddle trash science, it can capitalize on good science just as easily.

1. Join the battle, in spirit if not in action. For years, scientists did not want to be involved with the public, leaving the interpretation of their work to professional writers. They were afraid they might not get promoted, win awards, gain membership in prestigious organizations, and not get grants. These attitudes have changed somewhat in recent years, as more and more scientists speak out and get involved with writing or speaking about science. The best known scientist to do this was Carl Sagan. He was enormously successful in the publishing, television and movie industries, yet during most of his life as a popularizor he was disparaged by fellow scientists. Sagan is now admired by scientists and laypeople alike as a great scientist and an even greater popularizer of science, and some realized too late that he had not been treated well concerning his public efforts (Gould 1997). Not every scientist needs to be active, but some must and the rest should not criticize. Certainly paleontologists have many opportunities to do so because of the interest in our subject. Not only that, but few of us confirm the public’s view that scientists are weird or nerds. Especially when we work in the field, where adventure and danger may lurk.

2. Scientists should work with television writers and producers to get good, exciting science on television and in the movies. They want to do this for the most part, but do not often know how. The late television celebrity Steve Allen enthusiastically embraced the idea of holding a workshop for screen-writers and scientists, but he passed away before it materialized. The idea was not to have one group lecture to the other authoritatively, but to

somehow work together to develop exciting science-based plots for television. Paleontology is an obvious subject because it is a proven commodity. We might reinvigorate Allen's hopes for workshops with local and network television people and with the screenwriters and producers who develop programs.

The process and activities of science and scientists are often dramatic and hilarious, and, since scientists are people, they get themselves into the same situations that most people do. In other words, this is the fodder of TV programs, as we know them anyway. Science could be incorporated into regular prime time programs, including situation comedies. If the polls showing 70% of Americans to be sincerely interested in science are correct, then the television writers, producers, directors, stations, and networks are missing a significant potential market, and one likely to have disposable income.

TV and the rest of the media need not present only factual programs about science. Entertainment has been a very important part of all cultures for much of human history, and television is merely the latest manifestation of that tradition, albeit much more powerful and influential. Television, in particular, specializes in junk of all sorts because people need junk to balance their high-paced, worrisome lives (Bagdikian 1997). Preaching about science would merely add to their burden, but the incorporation of science into entertaining programs might well enhance their comprehension of how to use it in their own lives. In any case, the media have a responsibility to identify junk and separate entertainment from factual documentaries. What is at stake is the well being of our culture and traditions, especially when it comes to what is and is not science, for our modern world's foundation is now manifestly scientific.

3. Scientists could connect with journalists. An easy way to do this is to rely on public relations officers that so many universities, scientific institutions and societies employ. The Geological Society of America has made efforts recently to provide news releases to the press, and they have proven successful. Other societies might consider similar strategies. News media appreciate such leads, and they trust them, so use them, when received from a trusted source. Some major societies, such as the American Association for the Advancement of Science, commonly host science writers at their meetings and involve them and scientists in workshops or discussion groups. These also work well in breaking down the walls between science and the media. Remember, paleontology is always newsworthy!

4. Scientists can give good public lectures. Many paleontologists do this well, and it helps to explain how science works if alternative interpretations can be set as opposing hypotheses. This adds interest for the audience and keeps them intrigued to know the final outcome. Paleontology presents ample opportunities for this approach. Amateur paleontologists could also help here by giving their own accounts of collecting trips and showing fossils, especially in schools where direct contact with science is limited. This would expose the children to the excitement of discovery.

5. Write good science for TV, movies, magazines, and newspapers. Steve Gould did a masterly job of this, of course, but others can take part as well. We need more good stories at all levels of the science. Newspapers welcome a column or story from a scientist because it looks good, fills the newspaper, and costs them little. Paleontology ought to be very popular.

6. Tell your local TV, movie, book, or radio reviewer what is good and what is bad. Let them know what real science is and what pseudoscience is in programs, films, books, and the Internet.

7. I suggested that we ask the TV Academy of Arts and Sciences to institute a "best science" category in the Emmy Awards. After all, lighting and a number of different kinds of music each have an award category. Why not one for science? So I wrote to the President of the Academy with that suggestion. He replied that it was a good idea but that they already did it in the documentary or special-programs category. This also includes stories about rock stars, fashion designers, novelists, and a host of other special programs. But science is not a special category, because it is so pervasive in our culture and everyday lives. I'll try again.

8. Write letters and commentary to newspapers and magazines on pseudoscientific programs, events, books and articles. Write letters to sponsors of bad programs. The television industry pays attention to these kinds of objections, even if they do not act immediately.

9. Lastly, we must keep supporting science education. Many scientists and their organizations have taken this very seriously, in hands-on teachers training and especially in the development of web sites. The US National Science Foundation supports a variety of educational projects with sizeable grants. They usually require collaborations between teachers and scientists, as well as evaluators, but truly innovative programs are in short supply.

PALEONTOLOGY, TRULY A CANDLE IN THE DARK

Paleontology is truly a candle in the dark, to change Carl Sagan's words just a little. We stand together with few other sciences in the level of interest the public takes in our subject. Thus, paleontologists that practice one of the most difficult, yet seemingly easiest, of the sciences, could help people understand issues of significant consequences to them as well as the processes by which those consequences were evaluated. Paleontology can do this for us—we have a natural entrée into this problem, and we understand change through time in a way few others do. We are well positioned to develop creative ways through the mass media to deal with the public perception of the scientific process. This can only be beneficial, for everyone needs to know the fundamentals of critical thinking, evidential reasoning and judging authority in the modern world. And what field more easily brings each to the people than paleontology?

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REFERENCES

Alvarez, W. 1997. *T. rex and the crater of doom.* Princeton University Press, Princeton, N.J.

Bagdikian, B.H. 1997. *The media monopoly.* Beacon Press, Boston.

Bakker, R.T. 1986. The dinosaur heresies: new theories unlocking the mystery of the dinosaurs and their extinction. Morrow, New York.

Bakker, R.T. 1995. *Raptor Red.* Bantam Books, New York.

Blake, W.P. 1899. The Pliocene skull of California and the flint implements of Table Mountain. *Journal of Geology,* 7:631-637.

Cremo, M.A., and Thompson, R.L. 1993. *Forbidden Archaeology: The Hidden History of the Human Race.* Bhaktivedanta Institute, San Diego.

Crichton, M. 1993. Jurassic Park. *Bio-Technology,* 11(8):860-860.

Crichton, M. 1999. Ritual abuse, hot air, and missed opportunities. *Science*, 283(5407):1461-1463.

DeLaca, T.E., Lipps, J.H., and Hessler, R.R. 1980. The morphology and ecology of a new large agglutinated antarctic foraminifer (Textulariina: *Notodendrodidae* fam. nov.). *Zoological Journal of the Linnean Society,* 69:205-224.

DeSalle, R., and Lindley, D. 1997. *The science of Jurassic Park and the lost world, or, How to build a dinosaur.* BasicBooks, New York.

Ehrlich, P.R., and Ehrlich, A.H. 1996. *Betrayal of science and reason: how anti-environmental rhetoric threatens our future.* Island Press, Washington, D.C.

Eisenberg, D.M., Davis, R.B., Ettner, S.L., Appel, S., Wilkey, S., Rompay, M.V., and Kessler, R.C. 1998. Trends in alternative medicine use in the United States, 1990-1997: results of a follow-up national survey. *Journal of the American Medical Association,* 280:1569-1575.

Eisenberg, D.M., Kessler, R.C., Foster, C., Norlock, F.E., Calkins, D.R., and Delbanco, T.L. 1993. Unconventional medicine in the United States. Prevalence, costs, and patterns of use. *New England Journal of Medicine,* 328:246-252.

Emery, C.E. 1997. How do TV's pseudoscience specials rate? And the case of the Quadro Tracker. *Skeptical Inquirer,* 21:20-21.

Eve, R.A., and Harrold, F.B. 1990. *The creationist movement in modern America. Social movements past and present.* Twayne Publishers, Boston.

Gould, S.J. 1997. Bright Star Among Billions. *Science,* 275(599).

Gray, J. 1997. Speaker Gingrich mixes politics and paleontology. *The New York Times,* pp. A8.

Greenfield, S. 2003a. A new kind of literacy. *The Guardian,* Manchester, UK.

Greenfield, S. 2003b. Why working together is the only way forward. *The Guardian,* Manchester, UK.

Hartz, J., and Chappell, R. 1997. Worlds apart. How the distance between science and journalism threatens America's future. *First Amendment Center,* Nashville, Tennessee.

Hastings, R.J. 1987. New observations on Paluxy tracks confirm their dinosaurian origin. *Journal of Geological Education,* 35:4-15.

Horner, J.R., and Gorman, J. 1988. *Digging dinosaurs.* Workman Pub, New York.

Lederman, L.M. 1996. A strategy for saving science. *Skeptical Inquirer,* 20:23-28.

Lett, J. 1990. A field guide to critical thinking. *Skeptical Inquirer,* 14:153-160.

Limbaugh, R.H. 1993a. *See, I told you so.* Pocket Books, New York.

Limbaugh, R.H. 1993b. *The way things ought to be.* Pocket Star Books, New York.

Lipps, J.H. 1996. The decline of reason?, p. 3-10. In Scotchmoor, J., and McKinney, F. K. (ed.), *Learning from the Fossil Record.* Paleontological Society.

Lipps, J.H. 1998. The media, trash science and paleontology. *Palaeontologia Electronica* 1(2).

Lipps, J.H. 1999. Beyond reason: Science in the mass media, p. 71-90. In Schopf, J.W. (ed.), *Evolution! Facts and Fallacies.* Academic Press, San Diego.

Maienschein, J. 1999. Commentary: To the future argument for scientific literacy. *Science Communication,* 21(1):75-87.

Miller, J.D. 1987. The scientifically illiterate. *American Demographics,* 9:26-31.

National Science Board 1996. Science and Engineering Indicators—1996. *NSB 96-21.* U.S. Government Printing Office, Washington, D.C.

National Science Board 2002. Science and Engineering Indicators—2002. *NSB 02.* U.S. Government Printing Office, Washington, D.C.

Nesbit, M. 2003. *Who's getting it right and who's getting it wrong in the debate about science literacy?* Committee for the Scientific Investigations of the Paranormal.

Paik, H., and Comstock, G. 1994. The effects of television violence on antisocial behavior—a meta-analysis. *Communication Research,* 21(4):516-546.

Park, R. 2000. *Voodoo Science: The Road from Foolishness to Fraud.* Oxford University Press, New York.

Perkins, R. 1995. *Logic and Mr. Limbaugh : a dittohead's guide to fallacious reasoning.* Open Court, Chicago, Ill.

Postman, N. 1985. *Amusing ourselves to death : public discourse in the age of show business.* Viking, New York.

Sagan, C. 1980. *Cosmos*. Random House, New York.

Sagan, C. 1996. *The demon-haunted world: science as a candle in the dark.* Random House, New York.

Sapolsky, B.S., and Tabarlet, J.O. 1991. Sex in primetime television—1979 versus 1989. *Journal of Broadcasting & Electronic Media,* 35(4):505-516.

Sege, R., and Dietz, W. 1994. Television viewing and violence in children—the pediatrician as agent for change. *Pediatrics,* 94(4):600-607.

Shermer, M. 1997. *Why people believe weird things : pseudoscience, superstition, and other confusions of our time.* W.H. Freeman, New York.

Shermer, M. 2003. What's the harm? *Scientific American,* 289(6):50.

Signorielli, N., Gerbner, G., and Morgan, M. 1995. Violence on television - the cultural indicators project. *Journal of Broadcasting & Electronic Media,* 39(2):278-283.

Sparks, G.G., Nelson, C.L., and Campbell, R.G. 1997. The relationship between exposure to televised messages about paranormal phenomena and paranormal beliefs. *Journal of Broadcasting & Electronic Media*, 41:345-359.

Sparks, G.G., Sparks, C.W., and Gray, K. 1995. Media impact on fright reactions and belief in UFOs—the potential role of mental imagery. *Communication Research,* 22:3-23.

Springer, D.A. 1997. Geology in the popular press: Paleontology's greatest hits. *Geotimes*, 42(3):20-23.

Stucky, R. 1996. Paleontology: Window to science education, p. 11-14. In Scotchmoor, J., and McKinney, F. K. (ed.), *Learning from the Fossil Record.* Paleontological Society

Turney, J. 2003. How Greenfield got it wrong, *The Guardian,* Manchester, UK.

U.S. Census Bureau 2002. Population by age and sex of the United States—2000.

U.S. Census Bureau 2003. International Programs Center.

Wade, C., and Travis, C. 1990. Thinking creatively and critically. *Skeptical Inquirer,* 14:372-377.

Willis, D. 1989. *The hominid gang: Behind the scenes in the search for human origins.* Viking, New York.