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The Battle Against Evolution Continues

Introduction:

People who believe that the Bible is literally true in every particular have a hard time with modern science. Their belief that God created the world in six days is at odds with the science-based notion that the world is several billion years old. Beginning with the Scopes trial in the 1920s and into the present time, Fundamentalists have worked diligently to suppress the teaching of scientific ideas that conflict with their religion, especially the evolution of species. Anti-evolution is not a main-line Protestant, Catholic, or Jewish concern. Theologians of these religions have decided that science and religion have different concerns: science tries to work out the mechanisms of the natural world, religion tries to give it meaning.

Despite losing in court in every case since Scopes, anti-evolutionists have been resilient, resourceful, and surprisingly effective. The recent decision in Kansas not to include evolution in state teaching standards is only one of their recent victories. At this time Alabama and Oklahoma have approved disclaimers to be pasted into the fronts of their biology textbooks to warn students of the dangers of evolution, and Fundamentalists are active in every state every year trying to eliminate ideas that are contrary to their religion.

Scientists and science teachers could be more careful in their use of

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language so as not to give the impression that science speaks to religious questions. The more careful use of language and a better-educated public are worthy and important goals, but efforts to this end will have no effect on fundamentalist intolerance. Anti-evolutionists understand the science well enough to think that it challenges their beliefs, and they will continue to fight it.

We spoke with Dr. Eugenie Scott, director of the National Center for Science Education, about anti-evolution activities¹.

ER: Dr. Scott, what is your training?

ES: I'm a physical anthropologist, which is probably the most evolution-ary of all the biological sciences. So

I've been interested in evolution for a long time and have studied it and have taught it and find it an exciting and intellectually stimulating idea. My job as director of National Center for Science Education is a pretty good match for me because I have to deal with a wide variety of topics in this job. I have to deal with science, I have to deal with religion, I have to deal with politics, with education, with the law. It's a very eclectic list of things that we deal with at NCSE.

ER: What is your mission?

ES: NCSE is a clearinghouse for information and advice about the creation and evolution issue. One columnist referred to me as the Dear Abby of the anti-Creationist movement because I give people advice on how to deal with them. At NCSE we also try to help teachers and professors do a better job teaching evolution, because quite honestly the way evolution is sometimes taught just exacerbates the problem of anti-evolutionism, and we have had some experience that may help to avoid that in the future.

ER: Who started NCSE?

ES: The NCSE was founded in the 1970s by a group of scientists and teachers who were appalled that in about twenty state legislatures around the country, legislation was being introduced to require that if evolution were taught Creation Science had to be taught. And because so many state legislatures were actively pursuing these kinds of ideas, they decided to

form a committee that would share information so that if teachers or administrators had gone through a problem in Iowa they could share information with somebody in Michigan who was going through the same problem, so they didn't have to keep reinventing the wheel.

They called themselves the Committees of Correspondence, based on the old Revolutionary War committees which shared information about the British. In the early 1980s they decided that this problem wasn't going to go away and that a more formal national organization should be organized. So the National Center for Science Education was organized by some of these Committees of Correspondence people in January of 1981 at a meeting of the American Academy of Sciences.

Then one of the founders of NCSE went looking for foundation money, and it took him a while, but by 1986 he had gathered together about \$250,000 from private foundations to open an office and hire an executive director and start some projects to try to work on not just short-term putting out of the brush fires but also some long-term solutions to the problem of anti-evolutionism. I was hired in the fall of 1986, and we opened the national office in January of 1987.

ER: What is the background of anti-evolutionism?

ES: Well, the history of the anti-evolutionist movement, like Gaul, is divided into three parts. The first was the effort to ban evolution. The *Scopes* trial in 1925 is the best known example of that, and *Scopes* lost. People forget that.

ER: Anti-evolutionists won that case.

ES: That's right and those laws stayed on the books in the three states that had passed them until 1968 when a Supreme Court ruling, *Epperson v. Arkansas*, overthrew them. After the *Scopes* trial evolution essentially disappeared from textbooks and from the high school curriculum and didn't reemerge until the mid-1960s when a series of textbooks that had been commissioned by the National Science Foundation were published on geology, biology, chemistry, and physics. These textbooks, which had been written by scientists as opposed to just being written by employees of publishing houses, had a lot of evolution in them.

It was the reappearance of evolution in textbooks and therefore in the high school curriculum in the mid-sixties that generated the next period of anti-evolutionism, which is the Creation Science period. By the late seventies the Creation Science movement was going great guns.

ER: What is Creation Science?

ES: The Creation Science argument is that a literal presentation of the religious doctrine of Special Creation can be supported with scientific evidence. Special Creation is the idea that God created everything all at one time in its present form. So the universe is not billions of years old, new galaxies are not forming, God created everything perfect from the beginning, including galaxies and stars and the Earth and the plants and animals on Earth.

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ER: And all the fossils.

ES: Well, no. The fossils were not created. They died out in the Flood, and the Flood was an actual historical event, and Adam and Eve were historical flesh-and-blood people. This is the doctrine of Special Creation with God creating everything all at one time in its present form.

This is not Catholic or mainline Protestant theology. Catholics and mainline Protestants hold to something

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called Theistic Evolution, which is that God created through the process of evolution. God's in charge, but He brought about the universe gradually through time. Special Creation is the religious doctrine that motivates Creation Science.

ER: Where does Creation Science come from?

ES: Creation Science was the product largely of one charismatic leader and the people that he inspired and brought into his movement. This is Henry R. Morris, recently retired from the Institute for Creation Research. Morris co-wrote a book in 1962 called *The Genesis Flood*, which was the first modern presentation of Creation Science: the idea that you could take the geological evidence of strata and the Grand Canyon and so forth and use those data to support the idea of a literal Genesis flood but of course also the general doctrine of Special Creation.

The effect of Henry Morris has been phenomenal. He has inspired the modern-day Creation Science movement and he is held in enormous respect by the conservative Christian community, and he's also been prolific at writing scores of books and many articles.

ER: Who believes in Creation Science?

ES: I like to use the term conservative Christian rather than Fundamentalist because Fundamentalist in many quarters has a pejorative meaning. Even the word evangelical has many meanings and the two do not necessarily correspond to anti-evolutionism. I

Message from the Oklahoma State Textbook Committee:

This textbook discusses evolution, a controversial theory, which some scientists present as scientific explanation for the origin of living things, such as plants and humans.

No one was present when life first appeared on earth. Therefore, any statement about life's origins should be considered as theory, not fact. The word evolution may refer to many types of change. Evolution describes changes that occur within a species. (White moths, for example, may evolve into gray moths). This process is micro evolution, which can be observed and described as fact. Evolution may also refer to the change of one living thing into another, such as reptiles into birds. This process, called macro evolution, has never been observed and should be considered a theory. Evolution also refers to the unproven belief that random, undirected forces produced a world of living things.

There are many unanswered questions about the origin of life, which are not mentioned in your textbook, including: Why did the major groups of animals suddenly appear in the fossil record, known as the Cambrian Explosion? Why have no new major groups of living things appeared in the fossil record in a long time? Why do major groups of plants and animals have no transitional forms in the fossil record? How did you and all living things come to possess such a complete and complex set of instructions for building a living body? Study hard and keep an open mind. Someday you may contribute to the theories of how living things appeared on earth.

know evangelical Christians who are thorough-going evolutionists. So the term conservative Christian is neutral, and it does describe people whose theology is, shall we say, more Bible-based than that of mainline Protestants and Catholics.

ER: The defining principle would be strict interpretation of the Bible?

ES: Exactly. Inerrancy of the Bible would be a major religious tenet. And of course, the more biblically literalist one is, the more probable it is one is going to be an anti-evolutionist.

ER: How successful have they been?

ES: The Creation Science movement culminated in the late seventies and early eighties with attempts to try to get equal time legislation passed in the legislatures around the country. Two attempts did pass, but both of them were challenged legally, and in both cases the courts ruled that equal time for Creation Science is unconstitutional. Creation Science violates the First Amendment's establishment clause that schools need to be religiously neutral. The Court ruled that promoting a basically religious idea

that God created everything all at one time in its present form is sectarian religion, and you cannot advocate that in public schools. You can talk about it. You can describe it, just like you can describe Buddhism or Hinduism, but you can't advocate it as truth.

So when the Supreme Court in 1987 struck down equal time laws, the Creationists morphed yet again. If nothing else evolves, creationism does.

By 1989 we saw the appearance of Intelligent Design Theory. ID took off in the early 1990s when a law professor at the University of California, Phillip Johnson, wrote an anti-evolution book called *Darwin on Trial*. And the fact that a professor at a prestigious secular institution came out as an anti-evolutionist gave anti-evolutionism a credibility that it hadn't had in fifty years, and perhaps never had.

ER: What scientific training did Johnson have?

ES: None. He is a lawyer. Some lawyers do have scientific training, but Phil doesn't, and it shows in his work unfortunately. *Darwin on Trial* was fairly whalloped by scientists who pointed out the inaccuracies and misinterpretations and generally speaking, wrong headedness of the factual content of the book. The next couple of books that Phil wrote have been considerably softer on the science and deal much more with his personal philosophy. But make no bones about it, Intelligent Design Theory is an anti-evolution movement.

ER: What is ID?

ES: Intelligent Design harkens back to William Paley's 1802 argument from design, which is that structural complexity cannot be produced by natural causes, it has to be designed by an intelligence. What William Paley focused on back in the early 19th century was the vertebrate eye and how wonderful the human hand was and similar examples.

The modern-day Intelligent Design theorists focus more on biochemistry and molecular biology, so whereas Paley would say the vertebrate eye is too complex to have occurred naturally, there had to have been a designer, they will say DNA is too complex to have occurred naturally, it had to have a designer; or the blood-clotting cascade, or the bacterial flagellum. They point to molecular

complexity or cellular complexity as something that could not have evolved through the process of natural selection, so therefore the designer must have done it.

The problem with this is it's an argument from ignorance. It's saying, I can't figure out how this could have occurred by natural selection; therefore, God did it. And that's not good enough. Just because you can't figure it out doesn't mean somebody else can't. But the only thing you can do in science is try to figure out how things work and how they came about. Now whether God designed the assembling of all the parts that are involved in the blood-clotting cascade is a matter of

faith. You can't demonstrate pro or con using science. But the fact of the matter is, you can explain the blood-clotting cascade through a natural selection process. The Intelligent Design people claim that you can't and that you have to point to an intelligent being behind it and creating it de novo. ID is a rather more sophisticated version of Special Creation.

The problem with the Intelligent Design approach is that it's a real science stopper. It says, this particular phenomenon has implications for my religious views. Therefore, I'm not going to look for a natural explanation. We won't look for a natural explanation for the Big Bang, we won't look for a natural explanation for the origin of life.

ER: ID was another effort to get religiously repugnant ideas out of the curriculum.

ES: Yes. You know, when Intelligent Design first came on the scene back in the early nineties I thought, Well, hey, this is interesting. Let's take a look at this, maybe they're going to come up with something different. I kept hoping. But I've been disappointed because they don't seem to come up with anything new. They basically have a couple of ideas and seem to be impervious to any modification based on criticism.

One of them is Michael Behe's irreducible complexity, the idea that there are structures, all the parts of which are required at the same time to function and if you take any one part away, it doesn't work. Therefore, it's irreducibly complex and therefore it couldn't have evolved by the step-by-step process of natural selection.

...scientists fight like cats and dogs, but we fight about how evolution took place, we don't fight about whether evolution took place.

Therefore such a structure could not have evolved.

The Intelligent Design people use some lame probability arguments that in a system composed of twenty different enzymes, all those enzymes would have to be together at the same time, and so the probability of that is twenty times twenty times twenty. That's just silly.

ER: Well, improbable events do happen.

ES: Sure, but the point is, you don't have to have all twenty of these enzymes together at the same time in order to have this system evolve. Maybe a couple enzymes get together for one purpose and are selected for and then along in the evolutionary history of a species, four or five of them get together for some other purpose and get along just fine. And it's only at the end when different components are brought together that what looks like an irreducibly complex system is composed of modifications of systems that were already extant or were used for different purposes in the cell or in the organism.

ER: Tubulin has a long history in dividing the chromosomes and providing internal structure for cells. Then all of a sudden it shows up as part of the motor in flagella. *[An appendage used for swimming by microscopic organisms such as sperm and algae. Ed]*

ES: Yes. Co-optation is a good concept to keep in mind when you're thinking about evolution.

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ER: Are there any credible scientists who take Creation Science seriously?

ES: They don't have very many biologists, but the best biologist among the ID people is Michael Behe. He has real publications, he's a protein folding scientist and does real research and has a reasonable resume; and he is a left winger among the ID folks. I had a commentary in *Science* magazine in the May 5th issue, and Mike took umbrage and wrote in to the online debate section of *Science* magazine and he identified himself as a theistic evolutionist. He said, "I would fit with that group of scientists that Scott says think evolution happened but it was brought about by God." My thought here is, Okay, Mike, why are you hanging out with these people?

He also agreed in a debate he had with Ken Miller a number of years ago that humans and apes shared a common ancestor. Now that's about as evolutionary as you can get. So the best biologist in the whole stable of Intelligent Design folks is the one who accepts evolution. It's just that he has this thing about irreducibly complex structures, that God needs to reach in and do things periodically, which may

be the case, but you don't change how you teach high school biology based on an idea like that. And, of course, the rest of the ID people would not agree with Mike at all that evolution took place.

One of the frustrations of dealing with Intelligent Design Theory is that they never tell you what happened. You can search long and hard in the ID literature before you get any a model of how things came to be. Let's take biological evolution. How is it that we have the present diversity of species? At least the Young Earthers will tell you that God created a set of basic kinds, and then you have variation with the kinds. So you've got a cat kind that God created and then from that you've got lions and tigers and pumas and house cats. And the Young Earthers will tell you that the Grand Canyon was cut by Noah's Flood. They'll at least give you something you can talk about.

ER: Are Young Earthers a new sub species? I'm confused.

ES: No, they're the Henry Morris followers.

ER: Okay. So we're going back to

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Creation Science.

ES: Well, they're still around. They're doing great, in fact. They're far better known than the ID people. It's just the ID people are more interesting. But at least the special creationist, young Earth, Henry Morris followers will tell you what they think happened and you can go after them. The ID people never tell you what happened. And Phil Johnson is very explicit about directing his followers not to get into the details. His feeling is that we should all just link arms against the foe of evolution, and after we defeat evolution we can then decide among ourselves what happened.

ER: What is the latest version of anti-evolution?

ES: The Supreme Court decision in 1986 that struck down equal time laws, that was effectively the end of the Creation Science era. This has ushered in the current period, which I and some others have called Neo-creationism. Neo-creationism reflects the post-Creation Science era where because of court decisions, avoiding the word creation is very important. The Supreme Court said you can't teach creationism. Okay, we won't teach creationism. We won't teach anything that sounds like creation or Creator. Instead we'll teach Intelligent Design Theory. Instead of arguing that we should teach both evolution and Creation Science to balance it; we'll teach evolution and the evidence against evolution to balance it.

So Neo-creationism is the equivalent of the let a thousand flowers bloom period of anti-evolutionism, because

science instructors are now being faced with a whole variety of post-Creation Science approaches, which all draw heavily from Creation Science in content. The arguments are the same: the Intelligent Design people recycle the probability arguments that Henry Morris used, as well as some other arguments. But we are also finding more subtle forms of anti-evolutionism being promoted, ideas which they hope will avoid problems with the First Amendment.

ER: The language scientists use is so specialized the people can't sort this out.

ES: There's something even more basic going on. There's a great confu-

sion in the public's mind, exacerbated by the Creationists of course, about how scientists view evolution. And as you said, we fight like cats and dogs, but we fight about how evolution took place, we don't fight over whether evolution took place. And a lot of the anti-evolution literature will take arguments among scientists about the how and twist them so they are expressed as non-existent arguments over whether. So if you get Steven J. Gould and others arguing about the rate of evolution, whether it's gradual or punctuated, that comes out in the anti-evolutionist literature as, Scientist Steven J. Gould says the fossil record is the trade secret of evolution.

ER: Gould has been criticized for giving comfort to the Creationists and I'm sure he didn't intend to.

ES: Oh, no. I think almost all scientists could do with a little consciousness raising about how they phrase things. If you say that evolution has no purpose, you're going to be confusing the public.

If you say that the evolution of humans was a colossal set of contingencies and that if we were to re-roll the tape, evolution would never happen again, well if you mean that if we re-roll the tape a five fingered, featherless biped would not emerge, this is entirely possible. But I think God would love us if we had four fingers; God would love us if we had scales.

There's this confusion because most Americans are religious and they want to believe that God is concerned about them and concerned about humanity. But that's a different question from how human beings got to be the pentadactile featherless bipeds that we are. All science can tell us is the latter; it can't tell us anything about the former.

ER: Where are we now?

ES: In the Neo-creationist era, we are at a point where anti-evolutionists have become a great deal more clever in coming up with ways to avoid legal challenges. The First Amendment says that the school or other public institutions should be religiously neutral. If you advocate a religious idea as truth, you are not being neutral. So therefore, in order to either get creationism into the schools or keep evolution out, you have to somehow package your message in a way that doesn't appear religious.

... in order to either get Creationism into the schools or keep evolution out, Creationists have to package their message in a way that doesn't appear religious.

Intelligent Design theory tries to do this by pretending that all they're talking about is an Intelligent Designer or the results of intelligence. And you say, Well, is there a noun associated with this? Is there an agent? And they say, No, no. We're just talking about intelligence. Well, you mean God, don't you? Well, of course I believe in God, but it could also be astronauts from Alpha Centari. There's this wink-wink, nudge-nudge approach to we all know what we mean, but we're just packaging it this way because we want to be sure we can duck under the First Amendment.

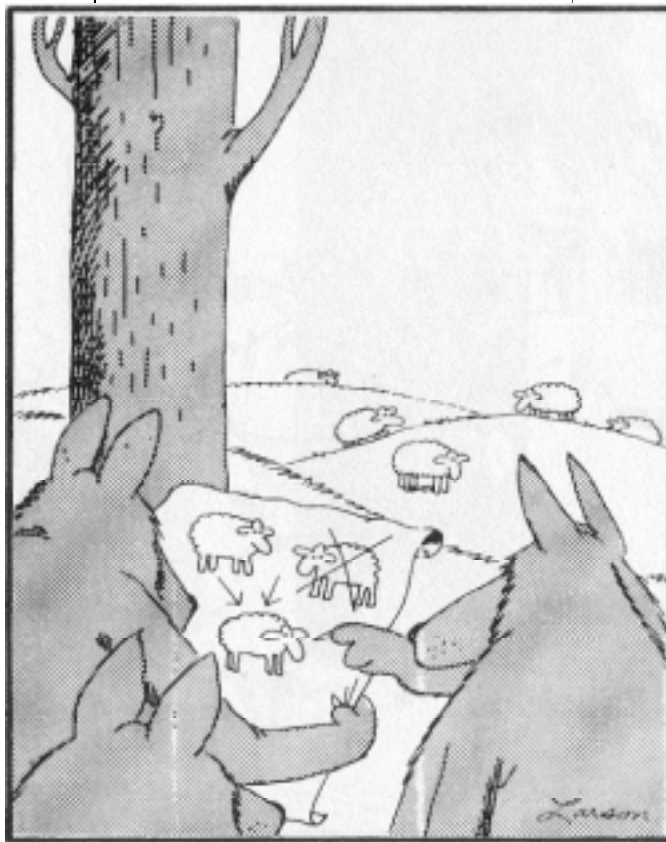
We also have a real popularity these days of disclaimers being proposed to be put into textbooks or to be read to students before the "E" word is mentioned. And disclaimers, of course, are very intimidating. Teachers don't like them. Teachers, unfortunately don't usually know very much about evolution, and so when they're challenged by some of these off-the-wall arguments that Creationists can come up with, the tendency is to say Well, we're not going to be getting around to evolution this year, Johnny. Save your questions for later.

ER: Is that what caught all the attention with Kansas?

ES: Kansas didn't have a disclaimer. A couple of years ago Alabama passed a disclaimer, which is stuck into each of the biology textbooks in Alabama, and it's metastasized to a number of communities, although another state didn't pass it until this last spring when the Okla-

homa Textbook Committee declared that disclaimer stickers would be put into the biology books, but it's been put on hold by the Attorney General who ruled that the textbook committee did not have authority to do that. So they're wrestling back and forth about what to do about that. But yes, disclaimers are

The Far Side by Gary Larson



Natural selection at work

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quite popular because they sound reasonable.

ER: They take my breath away when I read them.

ES: Oh, the Alabama disclaimer is just nonsense. It's hard to imagine as much misunderstanding being packed into a few paragraphs as you find with that.

Perhaps the cleverest approach is to argue the teaching of evolution balanced by evidence against evolution. From a scientific standpoint that's nonsense because there isn't any scientific evidence against evolution occurring. We have evidence for and against different arguments about how evolution occurred, like whether birds evolved from dinosaurs, and what happened with the Cambrian explosion, and how are Cambrian fossils related to pre-Cambrian fossils. We have arguments about questions like that, but we don't have any arguments about whether evolution happened. And that of course, is the thrust of the anti-evolutionist argument.

So evidence against evolution is confusing to a scientist. When you ask proponents of this view what is it that you intend to teach, you find that basically they're teaching what used to be called Creation Science but they're teaching it without the word creation so it may not be unconstitutional; of course it's a sham.

ER: How do scientists make it easier for anti-evolutionists? Is it taught poorly?

ES: It's more complicated than that. Many college-level professors don't realize that the terms that we use in science and evolution are not always

heard in the way that they are delivered. Anybody who has ever taught appreciates that what students hear is more important than what you say. In the case of evolution what tends to happen is that specific terms are given existential meanings by students. So if a professor says that evolution has no purpose, by that the professor means that there is no evidence to show that there is any step-by-step direction toward any particular evolutionary end. There is nothing about the range of genetic variation of horses in the Miocene where you have three toes and two toes and grazers and browsers that would lead you to conclude that by the Pleistocene, 1.8 million years later, you will have only one kind of horse, one-toed grazers. Even though that's what happened, you can't say it was pre ordained. But what most students hear when they hear a scientist say, evolution has no purpose, is Oh, evolution means I can't believe in God.

The four main problem concepts are: cause, purpose, design, and chance. Scientists need to be careful about

how they use those words to avoid confusing students with the idea that evolution somehow means that they cannot retain a belief in God. When scientists talk about cause, they generally have a couple of meanings in mind. They can refer to the immediate cause of something: the reason why the meadow flooded is because upstream the beavers built a dam. You can also talk about a more distant or unobservable cause: the reason why beavers build dams is that through the process of natural selection those that have a strong tendency to cut trees down and stick them in the mud tend to survive and leave more offspring than others. That's not an observable proximate

cause, that is an indirect or an inferential cause. We tend to use the same word for both of those, and usually it's possible to distinguish what kind you're talking about and it's not a problem.

Outside of science, people tend to use the same kinds of divisions. I used as an example the shooting at Columbine. Children died at Columbine High School because they were shot by a classmate. That is a proximate cause, but we spent an awful lot of time as a society trying to deal with the unobservable causes. Is it because we have too many guns in our society? Is it because there's too much violence? So we have that same division outside of science as well.

In the general public there's also another use of the word cause that has to do with truly ultimate kinds of issues: that God causes things or that

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there's some ultimate reason why things happen. This kind of causation is completely outside the scope of science. Any supernatural causation is just outside of our job description. By definition we don't have the tools to test supernatural hypotheses. So when a scientist says in an evolution class that human evolution is caused by natural selection, oftentimes a student will hear that and say, Oh, he's saying God had nothing to do with it, even though that's not the intent. The problem is not being explicit about the different uses of the word cause, because those are three quite different meanings.

ER: These concepts seem so obvious to me that I have a hard time seeing how they can be confused.

ES: I have talked about these problem concepts before a number of university audiences now, and a lot of people have said, Oh, I never thought about that.

Chance is another problem word. When scientists use the word chance, generally speaking they are referring to probability, and they're not talking about randomness in the popular sense of the term. Chance and random are two terms that are used quite differently by scientists and the general population. If you say the chance of producing a blue-eyed child from two brown-eyed parents who are heterozygous is one in four, you're giving a probability and that's predictable. Of all the children of heterozygous, brown-eyed parents, you can very safely predict that a quarter of them will be blue-eyed.

That's a prediction, even though the word chance in the general public means undirected or unpredictable. The terms chance and random have much

more of an existential meaning to the general public.

We talk about random violence and that means meaningless violence. There's this sense of the word chance or random as connoting meaninglessness in the general public and that's what students bring into a class. So when a teacher talks about evolution being a chance process — by which he means that the sources of genetic variation are random with respect to the needs of the organism — a student may very likely hear, Oh, meaningless, purposeless, therefore God had nothing to do with it. So the word chance can

get you into trouble too if you use it carelessly. It bears spending a little bit of time before you teach evolution, thinking about how these words are used and more importantly, how they are heard by non specialists, of which students qualify.

Purpose is another problem concept. Again, purpose is used in science in two ways. One is as an informal sense of something that is constructed to get something done. The purpose of long legs on a horse is to make it a fast runner, and so long legs have a purpose to allow the creature to escape predation.

That is a way that we use the term purpose in science. One does not imply that there is a force that directed the accom-

plishment of that purpose. We can certainly say the purpose of an egg shell is to prevent drying of the developing embryo, and that's perfectly reasonable. But again, outside of science the term purpose has existential meanings that go beyond the informal way that we use it in the context of science.

If you're a religious person, the purpose of human beings is to worship God. Scientists can be sloppy about their use of the word purpose, and they certainly should not be saying such things as evolution is a purposeless process because of the existential meanings that the word purpose connotes to members of the general public.

The last problem concept is design. Design is similar to purpose in the sense that you can talk about a horse's long legs being designed for running, or only moderately gas-permeable shells accomplish the purpose of

keeping the chick embryo from drying out, and they're designed for this function, without implying that there is a designer. In general in science we don't imply a designer, we just use the term design as a way of understanding or explaining structure and function relationships. But in the public there's this more existential meaning of, if there is design there must be an agent of design.

And students can be confused about what science can and cannot say about agency. Science can't say anything about whether there is or is

The best biologist in the whole stable of Intelligent Design folks is the one who accepts evolution.

not a designer, whether the designer or an intelligent agent or a supreme being is involved or is not involved in forming the universe as we see it today and producing the living things on the planet. All science can say is, How does it work and what is it's history?

ER: Does anti-evolutionism occur in other countries or cultures? It seems to be an American thing.

ES: It's almost uniquely American. Where you find Creation Science especially or other types of anti-evolutionism examples is the countries around the world where there has been an active evangelical Christian missionary movement. So you do find it in Australia and Korea and Turkey, believe it or not, although their spin is a little bit different. And you find it in Eastern Europe and in Russia, where there has been an influx of Christian missionaries. But mostly where you find it is in North America, and I think that is a result of a couple of things: our

education history and our religious history. We have a decentralized education system where the local school board is supreme. Other countries usually have a national curriculum, so if you're in France and you're in fourth grade, you're going to learn how to multiply fractions with two numbers in the denominator whether you're going to school in Lyon or Paris; if you move, you'll just pick up where you left off. In the United States you may learn that in third grade in one state and fourth grade in another state, and if you move you may never learn to multiply fractions with two denominators. So we have this quite extraordinary decentralization of education.

We also have a decentralization of religion. After all, the U.S. was founded by religious dissidents, and we're also the home of an extraordinary range of sects and beliefs that sprung up through charismatic leaders and have continued or died out as the case may be. The Millerites died out; the Seventh Day Adventists hung in there. So we're quite used to individualized kinds of theology.

Maybe even more important, it was in the United States that a particular back-to-basics Protestant Christianity developed around the first decades of the 20th century; and that was the rise of the doctrine of Fundamentalism with the writing of the twelve fundamentals in 1915. So fundamentalism as a biblically based theology never caught on in Europe and Great Britain but it was very popular here and continues to be quite popular.

¹ The Website for the National Center for Science Education is www.natcensci.org



What Does Forest Conservation Cost?

Introduction:

The economics of forest conservation can be different depending on your perspective. Based on years of work that resulted in the establishment of Masoala National Park in Madagascar, Claire Kremen and others have found that from the viewpoint of a subsistence farmer, forest conservation can be a good deal; they can continue to farm and to use forest products to make a living. From the perspective of the international community, not cutting a forest provides valuable services: the prevention of greenhouse gases being released, and the removal of greenhouse gases from the air by the living forest. However, from the viewpoint of the national government, where most decisions are made, not cutting a forest means giving up substantial amounts of money, enough money to outweigh the apparent economic benefits of saving the forest¹.

ER: Professor Kremen, what is your training?

CK: I got my Ph.D. at Duke University Zoology in developmental biology, but when I finished my Ph.D. I decided to switch into conservation biology. That led me to Madagascar because Duke University has several research projects there, and at the time they were working on a conservation project as well.

I went to Madagascar first in 1988 and along with a number of other Duke scientists led by Patricia Wright, was working on a project to establish a new national park. Several years later I branched out on my own and I started a number of different studies in Madagascar, different kinds of work with local people at different levels, from people that we met in the forest, to villagers who lived around the forest, to university students, to government officials. This led eventually to me working on designing and establishing a new national park in Madagascar's largest remaining area of rainforest, the Masoala National Park; I worked on that from 1993 to 1997.

ER: What is the Center for Conservation Biology?

CK: The Center for Conservation Biology is one of the foremost organizations in the world that is working on the evaluation of ecosystem services and bringing their values to the attention of the world.

The other organization I'd like to mention is the Wildlife Conservation

rice, which is the staple crop and is important both economically and culturally for Madagascar.

We looked at sustainable forestry as one possible way of getting forest to have cash value for people so that they would see forests as more than something that was simply there to be cut down and serve as fertilizer for a few rice harvests. Later, after we got the park set up, I returned to Stanford where I've been a research scientist for the past four years.

One of the big interests among a large group of interdisciplinary scientists here at Stanford is the concept of ecosystem services and how they do not tend to enter into business plans, into markets, into economic evaluation. Because we do not include them we generally do not allow these environmental aspects to come into the calculations of how humans carry out business. So in that climate of interest here at Stanford, I realized that we were sitting on a lot of information from this national park project in Madagascar that could perhaps be used to try to ground the issue using a case study. We used it to see what is the

bottom line when we talk about conservation. Is conservation economically good or is it economically bad? That was the initial question that myself along with a

number of other people here decided to work on. We started with the idea that we would calculate the economic value of conserving a forest, and then compare it against the opportunity cost.

ER: What is the opportunity cost?

CK: The opportunity cost is the highest value that the land could have. So if a government or an individual is considering, Should I conserve or

Ecosystem services tend not to enter into business plans, into markets, into economic evaluation.

Society, which together with partners in Madagascar has been a major player in setting up the Masoala Park in Madagascar. When we worked on the park we were working closely with different organizations and with local people to try to come up with some sustainable alternatives to deforestation, given that most deforestation in Madagascar is caused by local people conducting slash and burn agriculture as their traditional means of growing

