

BOOKS AND IDEAS PODCAST

with Ginger Campbell, MD

Episode #21

Interview with Dr. Eugenie Scott, Executive Director of the National Center for Science Education

Aired June 30, 2008

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INTRODUCTION

This is *Books and Ideas* and I'm your host, Dr. Ginger Campbell. This is the monthly podcast where I explore topics ranging from science to science fiction and I talk to lots of interesting people. For more information please visit my website at booksandideas.com.

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Welcome back to *Books and Ideas*. This is Episode 21, and today my guest is Dr. Eugenie Scott from the National Center for Science Education. To many people, especially those outside of the United States, it seems ironic that almost 150 years after the publication of Darwin's *On the Origin of Species*, polls consistently show that a majority of Americans still reject the theory of evolution. Dr. Scott has been the Executive Director for the National Center for Science Education for over 20 years, and her work is centered on trying to get evolution taught accurately in the schools, and also on keeping the teaching of creationism and its current version, intelligent design, out of the public school system.

Even if you have doubts about the theory of evolution I hope that you will listen to this interview because I think that you will learn some new ideas. Also, for the sake of my international listeners I asked Dr. Scott to explain the history behind this uniquely American problem. I'll be back after the interview with some closing comments and announcements.

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INTERVIEW

GC: I want to welcome everybody to this episode of *Books and Ideas*. I have a special guest today, Eugenie Scott, who is the Executive Director of the National Center for Science Education. Eugenie, I want to thank you for coming on my show today.

ES: I am delighted to be here. Thanks, Ginger.

GC: Before we start talking about your work with the National Center for Science Education could you tell us a little bit about yourself?

ES: I'm a physical anthropologist by training. I taught at the university level for 10 or 12 years, mostly at the University of Kentucky and the University of Colorado. And I left the academic life in 1986, actually, and was hired by the Board of Directors of the National Center for Science Education the fall of that year. We kind of round up and say that the national office was opened in January of 1987. I guess technically speaking I was hired in November of 1986. But that gets much more complicated than people really need to know.

I've been the Director of NCSE ever since. We started out with one employee—that was me—and went to one-and-a-half employees, and then two full-time employees, and have gradually over the years built up, as funds would allow, to our current staff which is about a dozen—rounding up—full-time and part-time

people. And there is still more to do. If I could add more staff I certainly would, because there's lots to be done in the effort to try to keep and get evolution into the public school science class.

GC: The fact that you have a background in physical anthropology gives me a chance to share a personal aspect on this subject of why I'm interested in it. One of my what I call skeletons in my closet is that in my teenage years and early 20's I was a Jehovah's Witness. And actually the thing that got me out of Jehovah's Witnesses was the issue of creationism. I married a man—who is still my husband; we've been married 31 years now—and he kept saying, 'You need to look at the science about this.'

And so, I started doing that, because I had always told people you shouldn't be afraid to listen to objections to your beliefs. If what you believe is true, you'll just prove that you're right. And I ended up actually taking a class in college on physical anthropology, and that was one of the things that really helped me to get hold of the fact that – now, I don't know, you're probably familiar with the Jehovah's Witnesses' version of creationism, although they don't try to impose it upon the public schools.

ES: No, that's very true.

GC: But I think they probably use some of the same tactics that the bigger organizations use, including quoting scientific sources out of context.

ES: Well, there is a fair amount of material from the Jehovah's Witnesses about anti-evolution and creation, and they pretty much crib it from the traditional Young Earth Creationists. They don't do their own work, so to speak. I mean there's no need for them to. There's, goodness knows, a long list of Young Earth Creationist organizations that can provide them with plenty of information. So, unfortunately the Jehovah's Witnesses tend to repeat that information

uncritically. And so, yes, it's pretty much as you say: they have the same shortcomings in their materials as do the Institute for Creation Research, and Answers in Genesis, and the rest of them.

It's not good science. OK? Certainly there are many Christians who think it's a bad theology. Not being a Christian I don't have a position on that argument; but certainly it is not good science. The fact claims that the Young Earth Creationists make are just simply not supported by the data. Unless you want to go to a totally miraculous type of creation where God created everything as we see it today but just made it look old, you simply cannot argue that creationism is a scientific position. And of course, if you make that purely miraculous statement you are not arguing science anyway, so you're kind of outside of the realm of what science can tell you.

GC: I think this is a good time for us to emphasize a point that I think you always do a good job of when I hear you interviewed by other people, and that is that most Christians don't have a problem with evolution.

ES: Exactly. If you look at the Catholic theology—and Catholics are the single largest group of Christians—and mainstream Protestants like Episcopalians, the United Church of Christ, most Lutherans, most Presbyterians, most Methodists, you'll find that their official, as it were, theology is that, yes of course evolution happened but that's the way God did it. It's not like they're saying God had nothing to do with it, but God does have a lot to do with it. He plans it, He in some cases carries it out, and so forth, depending on the theological view.

But there's not this feeling that science and evolution is the big enemy and that there has to be this barrier between faith and science; and especially between Christian interpretations—some Christian interpretations—of the Bible and evolution. The position is generally called theistic evolution, and it's the idea that God is involved in some ways. And actually one of the things that's been very

interesting about my job is that I have had to learn quite a bit about non-scientific aspects in addition to the science of evolution. And getting to know a number of theologians who have thought very seriously about science, and evolution, and how they can integrate it with their religious beliefs has really been quite interesting to me.

And I find that there is quite a range of views that are all called theistic evolution. It's not like there's only one choice out there. And there's a great deal of variance among different Christian theologians as to how much God is involved; from basically a deistic perspective where God set up everything and it's just sort of ticking along; to a very interventionist God who is sort of constantly tweaking the DNA, as it were; to all kinds of varieties in between. But what's interesting, at least among the theologians that we work with at NCSE—and the Christian community respects science and really wants to have children learn science, and understands the importance of science, and embraces evolution—is that the science is really respected.

There doesn't seem among this group of Christians to be the feeling that a literal interpretation of the Bible comes first, and therefore all of the scientific observations and experiments and theoretical conclusions have to be subservient to it. It's sort of, well, here's the science, it's really good science, now how do we bring this together with our theology so that we have a coherent world view. And even though I'm a non-believer, I can certainly respect people who are making that effort to try to have an intellectually coherent, if you will, view of reality.

GC: It always makes me think of when Galileo was forced by the church to say that the sun went around the earth, because at that time that was somehow a threat. It's hard for us now to imagine why that was a threat.

ES: Yes.

GC: But it was seen as a threat to the Christian world view.

ES: At one time, yes.

GC: And it seems like there's this small fringe of Christians now that see evolution as a threat to the Christian world view. But it doesn't seem that most Christians feel that way.

ES: Well, it's interesting, when you look at the polls—the survey data—on what Americans believe about evolution, there's a higher percentage of Americans who reject evolution than there are conservative Christians who come from those traditions of biblical literalism and the idea that the Bible has to be absolutely true—a 10,000-year-old earth, six 24-hour days of creation, and the rest. So, it's clear that there are a lot of mainstream Christians—Catholics and mainstream Protestants—who haven't quite grasped that they don't have to be anti-evolution. You know what I mean?

One of the things that we're trying to do at NCSE—and of course, it's a very difficult thing to do—is to try to encourage the mainstream Christian community to take more of an interest in science and religion issues; particularly in evolution and religion issues. Professional clergy, for example, encouraging them to spend more time with their congregation members talking about science and religion, or explaining to them why in Episcopal theology or Methodist theology it's not necessary to reject evolution to still be a faithful member of that denomination.

Part of the reluctance to do this is that most of the professional clergy does not come from a science background. It comes from a humanities background, social sciences perhaps, and the unfamiliarity with science, the unfamiliarity with the science of evolution tends to be a little discouraging to them. So, one of the things we've done is encourage people of faith—scientists who, for example, work at universities or in industry who themselves belong to a congregation

somewhere; scientists who are people of faith—to go to their ministers, priests, or rabbis and offer to help out.

Offer to teach a Sunday school class, say, for the junior high or high school kids about science and religion, or do an adult Sunday School—many denominations have something like that either before or after the service, where adults can talk about different religious issues—and offer to lead a discussion on what does evolution mean to our faith's tradition. And most ministers where this has been tried, they've been very enthusiastic. It's not that they're against bringing this topic up, they just don't know very much about it. And maybe if scientists who are people of faith can supplement this, this is a way of decreasing some of the anti-evolutionism that's really completely unnecessary.

GC: Some people seem to have a problem separating this from the issue of atheism, and that this is not a way of promoting atheism, but some people seem to think that it is.

ES: Yes, very much so. I think that's one of the real problems that science has in this country. Science, and especially evolution, have been demonized by some members of the conservative Christians who present science and their faith tradition as a dichotomist choice. You're either a good guy Christian creationist or you're a bad guy atheist evolutionist. And of course that is simply a false dichotomy just on empirical evidence alone.

I mean there are many scientists who are people of faith and there are theologians who accept evolution. It's not a stark choice between science and atheism on one side and Christianity and creationism on the other. But that is how it is framed by many conservative Christians—by the anti-evolutionists, the people in these various organizations who are promoting creationism.

And, frankly, that is a choice that some of the more vigorous leaders in the atheist community are presenting as well. I mean that's one thing they agree on. And, frankly, either of these groups of people—either the more militant atheists or the conservative Christians—are just simply empirically wrong. It is not a dichotomist choice. There are intermediate positions, and most people can find themselves somewhere in that intermediate group.

GC: I have some listeners—I'm not sure of the exact percentage—that aren't in the United States, so they may not really be familiar with what's going on in the U.S. on this issue of evolution. Do you get much email or contact from people from other parts of the world? I guess we're sort of spreading this thing, unfortunately, to them aren't we?

ES: Whenever I have an interview with a member of the foreign press it always kind of tends to go the same way. You know we start out speaking and oftentimes if we've not conversed before there tends to be a certain formality because this is how you do this. But as we talk it's obvious I'm a very informal person and everybody will relax a little bit, and by the end of the interview everybody—he and I, or she and I—is feeling quite relaxed and chatting. And then the interview will be completed, and then there'll be this pause at the end. And before long a reporter will come in and say, 'I don't get it. What's wrong with you people?' We just completely mystify them. Here we are, this great industrial technological nation with pretty darned high levels of literacy, and yet we seem to be so clueless about this one topic.

And actually I was involved in an article: Miller, Scott, and Okamoto, published in *Science* magazine a couple summers ago. It was all Jon Miller's data—I can't take any credit for that—he did all the heavy work, I just helped with some of the interpretation. But Jon Miller's data on public understanding of science internationally asks a series of questions about the understanding of science, and do you know how science works, and the facts and concepts of science. And he

has conducted these in developed countries, and developing countries, and of course the United States.

And he has asked for many years a question about acceptance of evolution. And I have a slide from that article—which I think was August in 2006, if anybody wants to look it up—and I've got a slide from a diagram from that article showing the United States and something like 34 other nations. So, it's a fairly complicated diagram. But way, way down, second from the bottom is the United States in its acceptance. We beat Turkey. So, yes, foreigners are just mystified by this. They just can't figure it out.

And frankly, Ginger, the question that I tend to get asked the most frequently in public lectures, or even if I go on a radio talk show, is why do we have this problem here. And is this as big a problem elsewhere? And, no, it isn't as big a problem elsewhere. And kind of the short answer for why we have this problem here is, obviously, culture and history. Right? I mean if you want to know why things are like they are, look at how they evolved.

And in the United States we have two things that they don't have in Europe, and Great Britain, and Japan, and other places where you don't have this problem, one of which is a very decentralized education system. Foreign reporters are regularly shocked when I explain to them that we do not have a national curriculum. They cannot understand why any country would do it that way. I mean why would students in Nebraska learn long division at a different grade than students in Iowa, across the border? This doesn't make any sense to them. But that's the way we've done it because that was kind of the frontier history of the United States. Everything is decentralized here, and of course the state vs. federal government kind of relationship and everything else.

So, we have a school system that's composed of something like 15,000 independent school districts, each of which has the authority to make decisions

about what's going to be taught. And if you have a conservative community where it's small and more homogeneous, and religious conservatism is very high in frequency, then there's not going to be much enthusiasm for teaching evolution. And there might actually be opposition to it.

The second reason why we have so much anti-evolutionism here and not in, you know, France or Germany, is that we've had a rather unique religious history in the United States. Because the founding fathers, having seen what happened in Europe when you do have a state religion, they decided that there would be a real hands-off policy; that the state would not try to control religion or try to establish religion. And the First Amendment of the Constitution is an absolutely brilliant piece of work which has saved us enormous amounts of problems.

But what that has meant then is that there has been a real, you know, let a thousand flowers bloom kind of attitude toward religion in this country. Because there is no privileged religious view, the United States has been the source of all kinds of native grown religions. Jehovah's Witnesses are an example. The Mormons, the Shakers, the Quakers, the Millerites, the Owenites—groups that don't even exist anymore—Christian Science. We can go on and on. These all kind of sprouted up here and some of them, like the Mormons, have become world religions.

But what that has meant is that we've had a rather different religious history. And in the early part of the 20th century during a period of about 1913 to 1918 there was a movement of American Protestantism which came to be called Fundamentalism, based on a series of booklets called "The 12 Fundamentals." And Fundamentalism was a back-to-basics kind of Protestant Christianity with reliance on the inerrancy of the Bible—which fairly quickly became biblical literalism—occurring at a time just before the First World War when there was a lot of social turmoil anyway. This religious view became very, very popular in North America, but it never really caught on anywhere else. And so, the biblical

literalist strain in American Christianity is not something that you find in most other Christian denominations in other parts of the world. But it's a very strong part of our Christianity and a major reason why we have so much anti-evolutionism here.

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GC: I guess people sometimes think of your organization as the organization that fights creationism, but you really also want for evolution to be taught. I mean I think it's probably more common to have evolution just be failed to be taught. I grew up in Alabama and I don't remember having it in high school, although I think I was aware of it. Last year I went to this beautiful aquarium in Gatlinburg, Tennessee, which is an area that was once under the ocean. And there's all this wonderful stuff. And one of the things that I noticed was the word 'evolution' appears nowhere in that museum.

ES: Yes.

GC: It's not that they're talking about creationism, they're just avoiding pointing out all the evidence for evolution.

ES: You're absolutely correct. Yes, we have problems in various school districts around the country with people trying to bring creationism in, or intelligent design—which is just a type of creationism after all—but we have a much bigger problem with evolution just being skipped. Teachers tend not to be fighters, and if they perceive—not always accurately, by the way—if they perceive that there is an anti-evolution sentiment in the community or that some of the parents might complain, they just somehow don't get around to teaching evolution this semester.

And this, of course, is a real shame for the kids because they are getting a greatly inadequate science education. Yes, we're very concerned with evolution being

taught, and being properly taught in the public schools; and, of course, in keeping creationism out. But, yes, you're right, the former is a much bigger problem.

GC: Would you like to talk a little bit about why learning evolution in school really is important to our children's education?

ES: To the extent that we want our students to understand the biological sciences—and I think we do; biology, after all, is so basic to medicine, and horticulture, and agriculture, and lots of very practical fields—a student simply does not understand biology if a student doesn't understand the relationship of evolution to biology. You know sometimes it's nice to use an analogy. And everybody knows the periodic table in chemistry. Right? And the periodic table is this framework, as it were, that organizes the data of chemistry—the elements, the protons, neutrons, electrons, all that kind of stuff.

Well, evolution similarly provides a framework for organizing the facts of biology, because what evolution says is that living things—plants and animals—share common ancestors. They have descended with modification from common ancestors. And the idea of common ancestry really does make all of these facts and observations that we see in biology make sense. It tells us why things are like they are rather than some other way.

A very familiar example I think that people can understand fairly quickly is the fact that all land vertebrates all have four legs—you know, two arms, two legs—and the bones in these limbs are the same from one group of vertebrates to another whether you're talking about mammals, or reptiles, or amphibians, or birds. You have one large bone close to the body—the femur or the humerus—you have two smaller bones—the radius and ulna in the arms or the tibia and fibula in the legs—and then you have a bunch of little bones—ankles or wrists—and then you have the spray of longer bones—foot bones, tarsals, metatarsals, and then a bunch of fingers or toes.

And this is the case in all land vertebrates. Well, you know, why is there this particular structure? Well, it's because all land vertebrates are descended from forms that had this particular type of limb structure. And so, the idea of common ancestry really makes sense of so much biology. Why are things like they are rather than some other way?

And so, it really helps students to understand a lot of things about biology that might not otherwise make sense. And just like the periodic table, it provides a framework that you can use to organize a huge amount of information that we have about biology. And, of course, that's true not just about anatomical structures but it's also true about biochemistry; it's true about various molecules and other cellular structures that typify living things as well.

GC: I'll give an example from my own field of interest which is neuroscience, and the fact that the way that nerve cells work in a human is exactly the same way as they work in an *Aplysia*, which is just a snail.

ES: Yes. Yes, you've seen one nerve cell, you've seen them all, so to speak.

GC: Which was actually an amazing discovery when they first figured it out, because they thought that somehow there must be something fundamentally different. But it hasn't been found.

ES: Nope. Nope. That's because those characteristics of living things evolved very, very early and they're very, very basic. And if it ain't broke, don't fix it. Getting electrical impulses from one structure to another is going to pretty much be the same, because it got selected for very, very early as an efficient way of getting that information around. I mean evolution is just such a cool way of looking at biology, and it really does help students understand this so much more.

There are, of course, more practical applications as well. If you have any plans to go into medicine or health-related fields you jolly well better understand evolution, because so much of medical research and so many medical discoveries do rely upon this idea of common ancestry. And, of course, the mechanisms of natural selection are very clearly expressed in modern medicine today. That's why you don't take antibiotics if you've got a cold. Antibiotics don't work against viruses, and why you don't want to abuse antibiotics is because the bacteria and other microorganisms that antibiotics do work on can evolve very quickly to no longer be affected by a specific antibiotic. So, there are a lot of things that evolution helps us with in a very practical sense as well.

GC: What about learning how to think scientifically? How do you think that applies in the area of evolution?

ES: I don't think evolution is unusual in that regard. The issue of thinking like a scientist, of science as a way of knowing, is a very important one. We all want our fellow citizens and our children to be critical thinkers. Sometimes I think Americans don't exercise nearly as much critical thinking as they ought to on all kinds of issues. But when you think about it, science is a particularly good way to learn critical thinking. I mean you can learn critical thinking in history, you can learn it in literature, you can learn it in any number of fields. But science works really well for teaching people how to think critically, because how we answer questions using science is really the epitome of critical thinking.

In science what we do is we start with a question. We want to answer a question, we're curious about something in the natural world, so how do we explain something? Well, you come up with a tentative explanation and then you test it. The testing is the all-important thing in science. You test your explanation against the natural world. And the way you test your explanation is you hold constant certain components of the environment so that you can really look to see whether your explanation is the one that makes this whole thing work. If it

doesn't, well you start all over again. If it does, well then you accept it tentatively, and you think about, well how can I test it some more, because somebody else will come in and try to test it some more.

And you work with more than one possible explanation. Asking if there is another explanation is one of the most important aspects of thinking critically, and it's absolutely critical in science as well. We're always asking ourselves, is there another explanation. This explanation works pretty well, but can I improve it? What am I missing?

And it's this iterative back and forth hammering away at an explanation that really gives science its power; and the fact that we don't assume that we've named it and nailed it. We don't assume that we have the explanation after a couple of tests. We always keep this idea that all of our explanations are tentative. They could all be improved, they could all be modified in some way. That in itself makes science very unusual. It makes it very different from more dogmatic ways of knowing—mere opinion, for example.

GC: Yes, I think that the whole idea that we're talking about ideas that are testable, and that we might change if the evidence changes, is very important. So, we come to intelligent design and its claim that it's a science.

ES: Yes. Not a very good claim. Not a very accurate claim, I must say. We've looked at intelligent design very closely. I mean we started studying intelligent design when it first appeared on the horizon and that was in the late 80's. Intelligent design actually got its start a long time ago—much less recently than most people realize. The first stirrings of intelligent design were really in the mid 80's, but it appeared, at least on our radar, in 1989 with the publication of a high school textbook called *Of Pandas and People*. And this introduced the phrase 'intelligent design' the first time into the anti-evolution literature.

Then, of course, in 1991 a law professor from the University of California School of Law, named Phillip Johnson, published a very surprising book from a professor at a secular university. It was an anti-evolution book called *Darwin on Trial*. And this was quite a surprise. So, you know, one of these man bites dog stories, so that the press covered *Darwin on Trial* in a way that they didn't cover *Of Pandas and People*, since *Pandas* was produced by a Christian ministry. It didn't cause the ripple that *Darwin on Trial* did.

And then in the mid 1990's—'96 and '97—the two most important science books of intelligent design were produced by Michael Behe in *Darwin's Black Box*, and William Dembski in *The Design Inference*. And basically everything that intelligent design claims, or is composed of, can be found in those three books: *Darwin on Trial*, and *The Design Inference*, and *Darwin's Black Box*. If you read those three books you know everything you need to know about intelligent design, because there has not been anything new added to the canon, as it were, since basically 1997 and *The Design Inference*.

Which, of course, tells you right there this isn't much of a science because just like you and I were talking about, Ginger, one of the characteristics of science is that science changes, it builds, it grows, it revises, it corrects, it reinterprets, it gets closer and closer to a more accurate understanding of nature. Intelligent design does none of this. It basically made a proclamation, and the proclamation itself is largely unscientific.

The main principle of intelligent design is that there are really, really complex things out there in nature that cannot be explained through natural causes, so therefore only an intelligent cause—and, of course, it's a supernatural intelligent cause, right?—only an intelligent cause is capable of producing these incredibly complex things. So, whereas science is the effort to understand nature through testing and building theory, intelligent design starts off with the idea that we can't

explain this through nature. So, in one sense intelligent design isn't even science, because its basic premise is we can't explain these phenomena through science.

GC: They don't have any testable hypotheses.

ES: None that I've found, anyway. Basically it's very difficult to come up with a testable hypothesis if your organizing principle is we can't study this through science. It's not a big surprise. The vast majority of the "research"—and there are only a couple of papers, really—that is done from the intelligent design perspective, as they would put it, are just efforts to try to come up with things that evolution supposedly can't explain. And probably the only real intelligent design paper published in a refereed journal is an article by Michael Behe and a mathematician colleague, published in *Protein Science*, in which they tried to calculate the probability of getting six mutations in a two-enzyme system. And they really stacked the deck in favor of their hypothesis, and they still failed.

But that seems an odd kind of research to support intelligent design. You're saying a natural cause could not have produced X, therefore we win by default. This is more of that dichotomous way of looking at things that creationism is so famous for. If evolution can't explain it, then special creation explains it. Well, in the case of intelligent design they're saying if evolution can't explain it, then the intelligent agent explains it. And it's the same argument really, just with a little bit more hand waving about probability theory and information theory. But it's still the same old stuff that the creation science people were promoting 40 years ago.

GC: And they still keep pulling out the same old things; like the evolution of the eye, I think, is my favorite one.

ES: Gaps in the fossil record. Ho hum, been there, done that. Yes. I mean there's nothing new in their arguments, either. In fact the vertebrate eye

argument—that it is just so incredibly complex it could not have been produced by a natural cause—when Charles Darwin was writing *On the Origin of Species* he specifically used the vertebrate eye as an example of something that could evolve by his process of natural selection, because he knew that everybody reading his book in the 1850's would know William Paley's argument about the special creation of the eye. If he could persuade people with the eye he'd have them, so to speak. Basically the intelligent design argument of the bacteria flagellum is just Paley's argument of the eye moved to the molecular level. Not a whole lot of new stuff going on here.

GC: And I would just mention for the sake of my listeners, on a recent episode of the *Brain Science Podcast* I did an anatomy episode based on a book from a British writer, David Bainbridge, called *Beyond the Zonules of Zinn*. And one of the things he pointed out in his book was not only can the eye evolve, but the evidence is that it evolved possibly hundreds of times.

ES: There certainly have been a number of pathways by which you can get a light-collecting organ on the head. What's kind of interesting is that mollusks—the cephalopod group which includes things like octopi—mollusks and vertebrates tend to have ended up with a fairly similar structure, although the genetic pathways for getting from A to Z, so to speak, are quite different.

But, yes, there are compound eyes in insects. That's a completely different design than something like we have as vertebrates. And there are a lot of other ways of getting light to the brain, getting images to the brain. The study of how animals have evolved vision is really quite fascinating.

GC: But somehow the ID people seem to ignore all that evidence, don't they.

ES: Well, what they're very, very good at ignoring is the structures in nature which have the same quality that they claim bacteria flagellum or the vertebrate

eye have, but for which we have a very good natural explanation. And the quality that I'm speaking of is what Michael Behe has called irreducible complexity. That's kind of the big idea in ID. Irreducible complexity is the idea that all of the components of a structure have to be together for the structure to work. If you take away even one component, that bacterium just sort of lies there in the water. The rotor motor of the bacteria flagellum doesn't work, you've got an immobile bacterium.

So, the bacteria flagellum that runs the little tail there is irreducibly complex and therefore, says Behe, it could not have been put together piece by piece, which he says natural selection requires. Now there are lots of things that are wrong with that. Behe really doesn't understand how natural selection works. And there have been many, many, many critiques of this position and it's quite easily available.

But the point is there are other structures in nature which are just as irreducibly complex as the flagellum, for which we have a very good fossil or developmental biology record. The middle ear of mammals: some of the bones of the middle ear started out as parts of the jaw and then evolved gradually into the sound-transmitting structures that we use them for as mammals. We happen to have a very good fossil record showing intermediate stages between these small bones of the jaw that got incorporated into the middle ear. So, here's an irreducibly complex structure, but we know that it did evolve. It didn't need to be poofed into existence at the end by some intelligent agent.

But the ID folks completely ignore examples like that. Or the bird wrists are another structure which is irreducibly complex, but which we have a good fossil record for. They just never mention those. It's kind of ironic. They deal with the structures we haven't yet explained, and of course that's a win-win situation for them. Because, let's say some investigators come up with a very plausible sequence of events which take us from some simple precursors to something like

the bacteria flagellum rotor engine. And everybody looks at it and says, ‘Yeah, that really works. I can understand how that could happen.’

This would not disprove intelligent design. They would just say, ‘Well, guess we were wrong about the bacteria flagellum. How about the blood clotting cascade?’ And so, basically there’s always something we don’t understand. And if your theory depends upon ‘we haven’t explained it yet’ you always win, because there’s always something out there. But, of course, that makes you profoundly unscientific.

GC: Yes, it won’t make your reputation as a scientist, that’s for sure.

ES: Indeed.

GC: So, do you want to before we close tell my listeners about your latest project?

ES: Oh, yes, I will tell you actually about two websites. Our regular website is ncseweb.org, and there is lots and lots of information on the creation and evolution controversy, and about evolution education, and science, and faith, and good stuff. But then we have another site that we constructed just in the last several months which is a site that specifically looks at the Ben Stein movie, “Expelled: No Intelligence Allowed.” Our site is easy to remember. It’s called expelledexposed.com. And if your listeners go to expelledexposed.com they will find lots of information on the inaccuracies that are rampant in the movie “Expelled.”

And also we have posted four new videos—little short YouTube couple-minute videos—that deal with some issues that we think are important for people to understand about the creation and evolution controversy. They’re not specific to “Expelled” but the videos do deal with issues that are brought up in “Expelled.”

And actually we have one on the eye. Maybe your listeners might like to go and take a look at some ideas about how the vertebrate eye evolved as well.

GC: I'll put a link in the Show Notes with this episode.

ES: Links work.

[music]

GC: Now, I would like you to—if you don't mind; I know you've probably told this story thousands of times—but what about your personal experience with the making of “Expelled”?

ES: Oh, yes. I was asked—as were several other scientists who are involved in the creation and evolution issue—I was asked to participate in a movie that was going to be called “Crossroads.” And this was a very generic creation and evolution movie to be made by a company called Rampant Films. I do that fairly frequently—I mean that's part of my job. There are a lot of documentaries that start to get made and never finish, so it's fairly common; you know I get two or three calls a year probably for requests of this sort.

And so, fine, they came out and taped me and all that. And it was only a couple of months later that I discovered that in fact I had been lied to. The movie was not called “Crossroads,” the movie was called, “Expelled: No Intelligence Allowed.” The company was not Rampant Films, the company was a Christian-oriented movie company in Canada called Premise Media. It wasn't a generic creationism and evolution film, it was an anti science, pro intelligent design film.

You know, frankly, I would have appeared in it anyway because I consider that's part of my job. I would expect a creationist filmmaker to present my point of view accurately and honestly. But I also expect you to be honest with me. I tend to be pretty careful about what I say on tape or in public, and because I'm not

anti-religious I don't go making anti-religious statements, which is of course what they were looking for among the scientists that they interviewed.

When confronted with the accusation that a number of scientists had been lied to the maker of the movie—the person who interviewed us, a man named Mark Mathis, who is something of a TV personality down in New Mexico—Mark Mathis claimed that “Crossroads” was just a working title; that they decided to change it to “Expelled” at a later time. Now, certainly there is such a thing as a working title. That is a plausible explanation. Except for the fact that the domain name expelledthemovie.com—which is the name for the website for “Expelled”—was acquired a full month before I was interviewed.

I suspect—I'll tell you my hypothesis, Ginger—I think that I, and Michael Shermer, and PZ Myers, and Will Provine, etc., I think all of us were lied to in order for the movie makers to get the cooperation of Richard Dawkins. Richard does not cooperate with creationists. He's been burned a couple of times by creationist movie makers and he just refuses to have anything to do with them.

If the word had gotten out that there was a creationist movie being made Richard would not have cooperated. So, the fact that a generic kind of crossroads movie was being made would have seemed plausible to Richard, and none of us would have tipped him off, so to speak. I think that we were all lied to in order for them to get Richard, because he was their real prize. He was the one they really, really wanted to showcase; and, of course, did in the movie.

GC: Did they take what you said out of context in the movie?

ES: Well, no, I wasn't treated poorly, but then I didn't give them anything that they could – they taped for a long time and they didn't show very much of me. Which I am rather happy for. You know I just answered some very straightforward questions about NCSE. The way NCSE and I are presented in

the movie is this kind of evil nerve center that is waiting to pounce upon the slightest indication of faith and grind it into the ground with our jackbooted heels. I mean it's really quite silly. We were thinking we might even do a little parody, but we just were too busy.

There's one scene in "Expelled" where Ben Stein is wandering around the streets of Seattle looking for the Discovery Center and he's asking, 'Do you know where the Discovery Center is?' 'No, I never heard of it.' He's wandering around, and finally he finds it. It's in a big office building down there. And so, he goes up and he finds that it's merely this one floor of an office building. And he expected it to be this big hegemonic huge edifice, etc., etc. Indeed he goes to the office in downtown Seattle—in the high rent district, we might add—but he doesn't mention that that's only one of their offices; that they outgrew the office in downtown and they also have a satellite office out in the suburbs.

They didn't go to that one—or they didn't tell the listeners about it. Whereas NCSE is in this kind of scrappy little office, which you will see if you see any of our videos, with the pipes showing in the roof, and in a, shall we say, low rent area of Oakland, California. I mean we were thinking we could do a nice little parody of that scene with the guy with his shopping cart. Anyway, I digress. We like our little funky office. We're really happy. And we've got a super wonderful landlord who really appreciates what we're doing.

GC: Is your organization non-profit?

ES: Very. Yes, we are a 50123, tax deductible deductions, etc. Our money comes from our memberships. We have about 3700 to 3900 members, depending on renewals. So, their memberships and donations are much appreciated. Your members can join at ncseweb.org. And we also get some money from private foundations. And that's how we support ourselves.

GC: Great. And you were on the *Science* podcast also, weren't you? Or, I know you were on *Science Talk*. Were you on the *Science* podcast?

ES: From *Science* magazine?

GC: Yes. Have you been interviewed by them too?

ES: Yes, probably.

GC: I think that I remember there being a conversation about how some of the mainstream science organizations didn't want to give "Expelled" any air time, but somebody has got to confront them. I just got done reading this book by Drew Westen called *The Political Brain*, and he talks about how just letting the other guys frame the story gives it away to them, and so, I think that the *Expelled Exposed* site is really important.

ES: Yes. We thought very, very carefully about this. I mean we've been working on "Expelled" basically since last August. And we conferred with some of our allies—Americans United for Separation of Church and State, and the ACLU, and the like; People for the American Way, and of course our science organization allies and our education organization allies—after we figured out what this movie was about. One of the big themes in the movie is the claim that big science is out to get ID, and that there are all these poor martyrs like Richard Sternberg and Caroline Crocker, and so forth, who have been cruelly mistreated by the establishment. On *Expelled Exposed* you get a little bit more accurate presentations of their stories—with documentation, I might add.

But that is the theme of this movie nonetheless. And again, you don't want your opponents to frame the issue, but you also don't want to draw attention to a movie if it's going to be a dud. We didn't know back in September. We didn't know whether this movie was going to be a dud or not. So, what we decided to do was to produce a website, but also to encourage the science associations to not

come out and vigorously beat up on this movie, because that would just play right into this frame that big science is out to get us. Right?

On the other hand it was perfectly appropriate for the civil liberties organizations and even for the educational organizations, because they really needed to provide information for teachers—for their clients. But that's what *Expelled Exposed* does. I mean that provides information for anybody who wants to know about this movie. But you know it was more appropriate to treat this as a culture wars issue rather than a science issue, because there's precious little science in the movie. It doesn't make a lot of sense for the National Academy of Sciences, say, to come out against "Expelled" because there's no science in the movie. It makes a lot of sense for the Anti-Defamation League to come out against "Expelled." So, we worked more with the civil liberties and social organizations, and of course, just the general public as well.

Well, we were very fortunate that they made such a lousy movie. What happened was when the movie was released—I mean, yes, right, *Huffington Post* and the liberal blogs in *Washington Post* and *The New York Times*, their reviewers panned it. But, even just the sort of non-political or non-science local newspaper reviewers—you know, the *Lexington Herald*, the *Orlando Sentinel*—these people whose job is not to promote a particular political view or to promote a science view, their job is just to review a movie and tell people about it, they thought it was a terrible movie.

The distribution of reviews is bimodal. The Christian press thought it was just wonderful and went on and on about it. Well, actually not the whole Christian press, the conservative Christian press. And then the mainstream press just panned it. I mean just criticized it on any number of reasons. And what I said is not the entire Christian press. It was interesting that there were criticisms of the movie from some places that you wouldn't necessarily have expected it. There's

an Old Earth Creationist ministry called Reasons to Believe, and they were critical of the movie.

The largest and most respected group of evangelical science and religion organizations, a group called the American Scientific Affiliation—which is an interesting site to go to; it's asa3.org—asa3.org has like a 30-page analysis of “Expelled” by an evangelical Christian who really felt that this movie was doing a great disservice to helping evangelical Christians understand science and its power and its importance. And even Beliefnet panned it pretty thoroughly. So, there are lots of places where religiously-oriented websites have also criticized “Expelled.” So, our job was certainly made easier by the fact that the movie was crappy. But we also did a really good job in *Expelled Exposed*.

GC: Well, yes, I think it's a great website. And it's going to be such a wonderful resource to have out there because “Expelled” is not going to be going away.

ES: No, and the thing is the martyrs—I think that's maybe one of the most useful parts of *Expelled Exposed*—the various martyrs that claim to have lost jobs, or have been discriminated against, or whatever; we have pretty carefully documented explanations of what really happened to these people, and it's considerably less horrendous than what you find in “Expelled.” But I think one of the real benefits of *Expelled Exposed* is that all that information is in one place. And it used to be that you would have to go to several different sites in order to find out, well what happened to Sternberg, or what happened to Gonzalez, or what happened to this person or that person? And now it's all in one place. And so, that was a real service that we've done for people.

“Expelled” is going to be out of the theaters pretty soon, but it's going to have a long future in church basements. I mean I'm sure this movie will be shown for years—once they resolve the problem with Yoko Ono, of course, and are allowed to make DVDs out of it. Well, we'll have to see what happens.

GC: I noticed when I was researching for this interview that you wrote a book called *Evolution vs. Creationism*.

ES: Yes.

GC: Would you consider that book to still be fairly current?

ES: Oh, absolutely. Yes, absolutely. Actually I was very pleased; I just got an email today from a professor I know at Stanford who was asking me to speak in a course that he and colleagues are organizing, kind of preparatory to the big Darwin Year coming up in 2009. And he mentioned that he was assigning it to his class, which I thought was great. It has been used, actually, in a number of classes.

My thought in writing the book was—again, one-stop shopping—to give people an introduction to all of the different areas that are involved in this controversy. So, the first chapter is on science. What is the nature of science and why is science different from other ways of knowing? The second one is on religion, because you really can't understand this controversy unless you know something about all the various kinds of creationism. There are quite a few chapters on history, because you need to know the history of this controversy. And then I also talk about legal aspects, educational aspects, I've got another chapter on religion, and different science-related chapters as well.

One of the things that the publisher wanted me to do in this book was to have selections from the literature. So, I have a selection on, say, creationist geology. But then it's countered by a selection from the real science literature that tells you why that claim about, say, radioactive dating is inaccurate. So, it's a useful book, I think, because it does let the creationists speak in their own words, and that I think is always useful for people.

GC: Great. Well, I have already added that book to my – I have one of those little Amazon storefronts for my podcast, which I get about 3¢ credit toward books.

ES: Great.

GC: But, anyway, it makes it an easy place for people to find the books, so I'll link to that too. Eugenie I really appreciate you taking the time to talk with me today. I've enjoyed it very much.

ES: I have too. Thank you for asking me to be on your program.

GC: Well, I will let you know as soon as this comes out. I will send you links and everything so that if you want to link to it you can.

ES: I will. Thank you.

GC: Thank you. I'll talk to you soon, I hope.

ES: Bye now.

[music]

I want to thank Dr. Scott again for taking the time to come on *Books and Ideas*. There are two main ideas that I want to emphasize, one of which came up in our conversation and one of which really didn't. The important idea that came up in the conversation is the principle that accepting the theory of evolution does not mean one must become an atheist. I think that this is very important because I think it is a false choice that the religious right has convinced many Christians that choosing evolution is an anti-Christian position. And, as Dr. Scott pointed out, this is not really true.

Secondly—and this is the idea that didn't really come up in our conversation—is the other thing that goes on is the attack on evolution because it's only a theory and therefore they try to get intelligent design taught, because they say that if it's only a theory then alternatives ought to be covered. This is the position that has been espoused by President Bush at certain times. This position represents a complete misunderstanding about how the term 'theory' is used in science. It's not like in day-to-day conversation when you say, 'I have a theory,' which just sort of means you have a guess about what might be going on.

In science the word 'theory' is used to describe any explanatory model for which one is seeking evidence, and if the evidence builds up in favor of a theory, then that theory is accepted; which is where we stand with the theory of evolution. But, of course, since it's an explanatory model and not a religious dogma, there are going to be controversies about the details and even the possibility that parts of the theory may need to be changed at some time in the future when there is more evidence. So, in biology the basic concept of natural selection—which is the idea that species change over time based on various selection pressures—is considered a fundamental principle in modern biology, even if there are controversies about exactly how this goes on.

To my mind the big problem is that a lot of people don't understand the scientific method, which involves looking at the data, proposing a theory to explain it, and then testing that theory. One of the biggest problems with intelligent design is it does not give us any testable hypothesis. That's the reason why the Dover court case was such a clear-cut case of intelligent design is not science, because the principle of science is to create testable hypotheses that can even be falsified.

So, to me the whole thing gets down to—as Dr. Scott and I talked about in this episode—the problems of the deficient science education in the United States at the present time, which have implications that go way beyond whether people believe in evolution. That's the reason why I think this is so important, because

to me it is about the importance of the principles of science being recognized as being different from those of pseudoscience and those of religion. A scientific theory does not represent an opinion or a dogma. It represents a testable hypothesis for which some experimental data has been accumulated. This may be obvious to most of you, but given the sorry state of science education and knowledge in the United States compared to the rest of the world, I don't think it can be emphasized too often.

[music]

So, I'm going to close for today and remind you to check out my other podcast, the *Brain Science Podcast* at brainsciencepodcast.com. And don't forget to go to the new website at sciencepodcasters.org where you can find some more good science podcasts. Finally, don't forget to go to the website at booksandideas.com to find the links to the websites that we talked about in this episode and a link to Dr. Scott's book.

Thanks again for listening. I look forward to talking to you again next month.

[music]

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