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Brown Tree Snakes on Guam

Introduction:

Guam is a 541 square kilometer island in the western South Pacific, equidistant from Japan to the north, the Philippines to the west, and New Guinea to the south. In the 1960s wildlife authorities noticed that birds were entirely absent from the southern one-third of the island; by the 1970s birds were missing from two-thirds of the island; and by 1985 most birds were in isolated pockets at the northern tip of the island, or completely gone. The accidentally introduced brown tree snake, *Boiga irregularis*, was responsible not only for the extinction of the birds but also the decimation of the island's lizards, mammals, and small domestic animals. By October 1996 only three of Guam's twelve native forest bird species still survived in the wild, and most forests of Guam are empty of bird life. Two of the three native bat species have also vanished in the last few years.

Thomas Fritts is a research biologist and chief of the Biological Survey Program with the U.S. Geological Survey. A lifelong student of reptiles, he received a Ph.D. from the University of Kansas with a specialty in tropical herpetology. In a recent paper in *BioScience* he explained the effects of the brown tree snake on the wildlife of Guam. We spoke with Dr. Fritts about how the brown tree snake arrived on Guam and its effects on the wildlife there.

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ER: Dr. Fritts, when did you become involved with the snake problem on Guam?

TF: Having worked in South America with lowland snake populations, when I first heard of the brown tree snake situation in Guam I was tempted at first to say that if there are really that many snakes that are causing the extirpation of birds, then there ought to be more evidence than anybody had found. So I went out there in 1984 as a disbeliever that it was the snake that was killing off all the birds. Julie Savidge went out to Guam to figure out why the birds were disappearing,

and had to wade her way through a lot of experimental work to eliminate exotic diseases or pesticides as the cause before it became apparent to her that it was the snake. But it being apparent and having an argument that would stand up to scientific scrutiny are two different things, and she was in the process of gathering those data when I first arrived on Guam in 1984. I had an advantage because I had a lot of experience with snakes before going to Guam. Dr. Savage — she was a Ph.D. candidate at that time — was an ecologist and did not have that much experience with snakes. So my going helped her build her argument.

My first day on island I had jet lag and got up at six in the morning and walked down the main street of one of the most densely populated areas of Guam and found dead snakes on the road and in urban situations. We had snakes not just out in the woods where the birds were, but downtown; that was an indication that we probably had a fairly dense snake population.

ER: When were the snakes introduced to Guam?

TF: As you know Guam was occupied by the Japanese from the day after Pearl Harbor until the American re-invasion in July 1944. There is no indication that the brown tree snake occurred on the island during the occupation by the Japanese; when the Americans came back to Guam there was no evidence that the brown tree snake or any other snake occurred there. Not until 1952 do we have a



Brown tree snake with bird in belly.

Photo: GH Rodda

bona fide documented case of a brown tree snake being reported on Guam although it had probably been present since the late 1940s. So the snake probably came to Guam in post World War II traffic. A lot of surplus military materiel was shipped back through Guam either for salvage or disposal or for the lend lease program providing military supplies to Taiwan. Tremendous amounts of materiel from the South Pacific where the brown tree snake is native came back through Guam and that provided the opportunity for some snakes that were hiding in that materiel to stow away and arrive on Guam.

ER: Where is the brown tree snake native?

TF: The brown tree snake is native to a very broad geographic area: all the way from Sulawesi in central Indonesia, east through New Guinea and the Solomon Islands, and a narrow coastal band around the northern and eastern coast of Australia as far as Sydney.

range.

The actual point source of snakes that came to Guam may have been the Admiralty Islands which are just a short distance to the north of New Guinea. When we re-invaded Guam the South Pacific command headquarters was on an island called Manus in the Admiralty Islands, and we moved a tremendous amount of materiel from Manus and New Guinea to Guam. On the basis of the snake's morphology we can pinpoint the probable source; the scale patterns of the snakes we have on Guam most closely relate to those on the Admiralty Islands.

ER: Is it normal for snakes to be hitchhiking around the world?

TF: No it is not, although things like that have happened. If you look back in museum collections here in the U.S. you can find a boa constrictor collected out of a grocery store in Chicago or Des Moines, and usually it was because a snake was stowed away

ER: Is Guam the northern limit of its range?

TF: Guam is not part of its native range. Guam is about 1,000 nautical miles north of New Guinea, and so by moving that far north it has extended its

in a bunch of bananas. Occasionally things like that happen. A cobra was found in the wheel well of a bomber that came back from Thailand and landed in Honolulu during the Vietnam era. Usually it doesn't happen with any great frequency because snake populations are usually not that dense, especially not in close contact with man. But the brown tree snake appears to do very well in a disturbed habitat and in close proximity to man. The things that man does to habitats, for example chopping down some of the trees, disturbing the forests, allowing some bird species to become very dense, all those things allow the brown tree snake to take advantage of habitats that are not very suitable for many other snakes. The snake densities that occurred in Manus were probably like the densities we are seeing in Guam today.

Over a million GIs went through the island of Manus during the war and there was a tremendous amount of habitat disruption; stockpiles of materials, food supplies, and garbage dumps were characteristic of our war time effort. So rat populations boomed, and probably brown tree snake populations boomed also in Manus. The same thing is true today in Guam, there are very dense snake

Correction:

In last month's article on the restoration of Mono Lake's watersheds Richard Ridenhour was incorrectly identified as professor emeritus at the University of California, Davis. He is a professor emeritus at Humboldt State University.

populations; they are everywhere, including that air cargo container, that pallet of lumber that is going to another island, and perhaps even in that aircraft that is parked out there on the tarmac.

ER: Does the brown tree snake specialize on birds?

TF: I would describe the biology of the brown tree snake as a true generalist. It would be tempting to say the brown tree snake is a specialized bird eater if it can wipe out nine of eleven forest species of birds on Guam, but it is not. In its native range — and in Guam — the brown tree snake will eat just about anything that will fit in its mouth which includes rats, and shrews; birds' eggs and birds; lizards, both nocturnal geckos and diurnal skinks; and even garbage. Occasionally it may take one species in preference to another, but after it eliminates that one it switches to something else. That is one of its keys to success: it is able

to take advantage of many prey species. Similarly some people would say the brown tree snake is a fairly specialized arboreal snake, and it does occur in trees. But the snakes spend a great deal of time on the ground and hunt animals that nest on the ground such as Guam rails, which is a flightless rail; some of the lizards it feeds on do not get up in trees. The brown tree snake can take advantage of these resources too, as opposed to a true arboreal snake that would never get down there to hunt those animals.

ER: How big do they get?

TF: Two-point-three meters is the maximum that has ever been sighted in its native range; in Guam we had one snake reported at 3.1 meters.

ER: Because they are eating so well no doubt.

TF: Guam is fat city for a snake. They are growing faster, perhaps living longer because of ideal food condi-



Brown tree snake on Los Negros Island in the Admiralties, 1,000 miles south of Guam.

Photo: GH Rodda

tions. The average snake we find on Guam is about 1.25 meters in length. They get to sexual maturity at about 1.25 meters in total length, so the average brown tree snake we find in Guam is what I call the teenage snake, it is just about to reach sexual maturity.

ER: Is the population still growing or has it stabilized?

TF: We believe the population has reached a dynamic equilibrium; it

oscillates up and down depending on weather and prey base oscillations and so on, but the level of snakes now on Guam is thirty to fifty snakes per hectare in many areas of Guam, which is a lot. The maximum at the peak eruption probably exceeded 100 snakes per hectare. In 1985 there were about 100 snakes per hectare in the northern part of the island where the birds still persisted and the rat populations had not crashed.

ER: So it isn't all bad; the rat population has gone down.

TF: That is the one benefit that we can cite out of this, but it is a little bit like mowing your grass with a blow torch. To lose so much of Guam's fauna constitutes an ecological disaster that cannot be offset by any reduction of rats.

Nine of thirteen species of forest birds have disappeared on Guam due to the snake, and only one species, a megapod, due to other causes. The native starling — it is not our

European starling — has persisted, as has the Mariana's crow. Less than thirty individuals of the latter persist on Guam and it may go extinct in the next few years at least on Guam. Three other species of birds are missing from Guam that have not received a lot of attention because they are seabirds or shorebirds that occur in other places: tropic birds, noddies, fairy terns, have all disappeared from Guam. And they should be there, they are on all the adjacent islands, they nest in profusion on little

offshore islands that don't have the brown tree snake, yet they are gone from Guam. We assume that snake predation wiped those off Guam as well.

We also think that the native fruit bat — the flying fox — on Guam is prevented from recovering its numbers, even though it is enjoying total protection from human poaching or hunting, because the juvenile bats are vulnerable to snake predation. Even though the adult bats are pretty predation proof, there is very little recruitment into the population and eventually we will get a senile bat population that could go extinct just from lack of recruitment. Two other bats on Guam, one a flying fox like the one that persists but smaller, and one an insect-eating bat have disappeared. We can't say whether it was because of snake predation or not, but it is just as good a hypothesis as any other that it was snake predation.

In addition six species of lizard are gone from Guam that we either have historical records that they occurred there, or we would predict they would occur there based on their being present on little offshore islands around Guam. Some of those are probably casualties of the brown tree snake itself, they were abundant as late the late 1960s, early 1970s, and then just disappeared. Or they may have been secondary casualties because of introduced shrew populations that soared as a result of the knockdown of the rats. The brown tree snake knocked down the rats, the shrew was introduced and enjoyed a heyday for a little while and

then it too was knocked down by the snake. So introduced species as well as some native species have been wiped out. One might go so far as to call it an ecological collapse.

ER: Why is the loss of all these animals from the island important?

TF: Those birds and lizards that are gone were the primary vertebrate insect eaters on Guam. So there is no biological control on insects that are already there, and it makes it easier



Brown tree snake on Guam.

Photo: GH Rodda

snake more directly impinge on the human quality of life on Guam, such as electrical power and human health and safety because of snake bite. Oftentimes when a snake comes in contact with an electrical conductor whether it be inside a substation or on a high voltage line or sometimes at a transformer near a distribution line, it can cause not just a short but it oftentimes causes a total meltdown of circuit breakers or cracks insulators or causes transformer explosions. These are all things that have to be fixed by

the power company and can cause outages that last anywhere from a minute to a cascading power outage where the electrical system collapses on itself. In the last few years we have averaged about 100 power outages per year; we had 180 in 1996 caused by brown tree snake.

ER: There have been snake attacks on people?

for any insect that might be introduced. Maybe only a few insects arrive on Guam but if there are no insectivores to eat them then they are much more likely to become established. That is just one example: we have lost our insect eaters.

Another example: both the bats and the birds that are gone were eating fruits and dispersing their seeds, and that changes the ecology of plants, in particular those plants that are adapted to benefit from animals carrying seeds from one place to another.

Other impacts of the brown tree

TF: Occasionally brown tree snakes invade peoples' homes and they are biting people while they are sleeping in their beds at night, apparently because the snakes are finding it harder to find food, at least the bigger snakes, because of the declines of the birds and mammals that were formerly their prey. Small infants are more vulnerable to the venom of the snake because of their small body size and because of the fact that the snake is trying to eat them; that is, trying to inject a lethal dose of venom. When you try to remove a snake from underneath your

kitchen cabinet, it may bite you quickly and then release and try to escape, but these snakes are not doing that, they are repeatedly biting, chewing, and sometimes swallowing either a finger or a whole hand of a person because they don't realize it is attached to a body that they can't eat.

ER: How often does that occur?

TF: It varies and I am not sure we have a good handle on it. Our way of measuring attacks on humans is by getting reports from emergency room visits. So people who are bitten but don't go to an emergency room we might not find out about, but it varies from around twenty to thirty a year, maybe as high as fifty per year, snake bites on all kinds of people. Our bite patients range in age from people who are eighty years old to people who are two days old. We have had at least seven children who have suffered respiratory arrest as a result of the venom in them. A couple of other kids have experienced neurological problems, inability to stand, inability to focus their eyes, drooping eyelids, which is an indication of a neurotoxic venom, but there have been no fatalities to our knowledge. We have had some unexplained infant deaths but we do not know that it was the brown tree snake.

ER: Do the snakes hunt at night?

TF: Of late we would have described the brown tree snake as a nocturnally active snake. Up until about 1985, over 90 percent of our power outages were during nighttime hours. Most power outages due to snakes occurred around midnight and then by sunrise they dropped off. In recent times as the animals the brown tree snake was able to prey on in the night have

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disappeared, it has increasingly relied on daytime-active lizards, it has shifted to being a daytime-active snake. Now almost 50 percent of our power outages are in the morning hours after sunrise. So we could be tempted to call the brown tree snake a nocturnal snake, but it is the prey base that is determining whether it is nocturnal or not.

ER: Why are brown tree snakes such a problem on Guam compared to their native range? Is Guam a different situation?

TF: It is a different situation. The most common question I have to answer about the brown tree snake is, What is its predator in its native range, and why don't we introduce it onto Guam? I always rephrase the question and say, What controls its populations in its native range? The answer is starvation, not a predator. So what is different about Guam or about oceanic islands in general is that they have lots of small vulnerable prey species, lots of small lizards, small geckos, small skinks. Many of the island bird species either are small or don't have the anti-predator defense mechanisms that birds in mainland or big island situations have that co-evolved with snakes.

ER: What kinds of defenses are there against tree snakes?

TF: Some birds in Australia nest at the time of the year when the brown tree snake is least active because of cool temperatures. Some cavity nesters may be better able to protect themselves from snakes invading nests as opposed to those that nest in an open cup situation.

In a typical native range situation when the snake egg hatches, the baby snake faces a problem in finding prey that is small enough for it to eat. Once it gets to be a bigger snake it is okay, but in the native range there is a high juvenile mortality. The same thing with many other animal species: they have a high juvenile mortality with a few making it to adults, and that is what determines the density of the species. On these oceanic islands with optimal prey bases most baby snakes that hatch survive to adulthood. The brown tree snake does not produce that many eggs per year, maybe four to six twice a year — that is not a high reproductive output — but if they all survive, they are magnifying the population every time they have a reproductive season.

That is what is different about the island situation and is the red flag as far as expecting the brown tree snake will constitute a problem like it has been on Guam on other oceanic islands if it gets to them, whether it be Oahu, or other islands in the Marianas or elsewhere in Micronesia or Polynesia. A great deal of Oceania

could be affected if we allow the brown tree snake to continue spreading.

ER: There is no prospect of eradication once they get in?

TF: There is no way of eradicating it on Guam that appears reasonable to anyone who is familiar with the situation in Guam. Eradication may be possible on an island where the snake is confined to a small area, inside the port area for instance. If the snake population numbers 100 you might have a chance of wiping out most of them and the others dying of natural causes, but once the snake population is island-wide, once it is in all habitats, eradication is an impossibility, just like we have never been able to eradicate black rats from New York city or cockroaches from Miami. There is no magic disease or poison; you can't just go out and trap snakes from an island that is over 200 square miles.

ER: The Mariana crow is endangered. Does it exist on other islands?

TF: The Mariana crow originally occurred on two islands: Guam where it is almost extinct now, and the island of Rota just to the north of Guam. There may be 500 to 1,000 individuals on the island of Rota, but genetic studies show us that there is less genetic diversity in the Rota population than the Guam population. The Rota population was apparently founded by a small number of crows from Guam. So if we lose the Guam population we have lost a large part of

the genotype of the Mariana crow. Brown tree snakes have shown up in the port of Rota, so we don't know if it will become established on Rota. If it does, we will have twenty years to stop it from wiping out the Mariana crow.

ER: Nine of thirteen forest bird species are gone from Guam. Were they unique to the island?

TF: No, most of them were not endemic, they are also on other islands nearby, but two of them were. One endemic bird is gone, it was a subspecies of the white eye, a relatively small bird that was one of the most numerous birds on Guam prior to the snake. It went extinct first. The other

Nine of thirteen species of forest birds have disappeared on Guam due to the snake.

one is the Guam fly catcher or broadbill; it is gone and never will be recovered. The Guam rail also has been extirpated from the island but is still in captive propagation in zoos and a small captive colony on Guam. So if we ever manage to lower the snakes' density or protect certain types of habitat on Guam it could be re-released back onto Guam, but it is extinct in the wild.

ER: What is left of the bats on the island?

TF: Of the Mariana fruit bat, a species that is endemic to the Mariana islands, there are less than 400 individuals and occasionally it is down as low as 200.

ER: Have you tried to build exclosures to keep the snakes away from the bats?

TF: We have worked a great deal on barriers with the idea that if we cannot eradicate the brown tree snake from Guam maybe we can eradicate the snake from a small island of habitat inside the island somewhere. We are encouraged by the results so far, at least on modest levels of scale. We can keep snakes out of areas or at least keep populations at relatively low numbers. We are not to the point of actually having erected large enough barriers in forested habitats on Guam now to say we have endangered species habitat that is protected. The National Research Council panel on the Mariana crow recently recommended that such exclosures should be built to protect crow nests and crow nesting habitats.

The bat is a particularly problematic animal because the bats tend to nest in complex trees, strangler fig trees, and near cliff lines, and that is the roughest type of topography in which to either trap snakes or to build barriers around roost trees. So we have not been able to erect barriers or to protect the bat extensively so far. That is one of the great challenges for the immediate future.

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Creationism's War On Science

Introduction:

Creationists, those who believe in a literal interpretation of the Bible, like scientific theories, such as the big bang hypothesis about the beginning of the Universe, that support their religious beliefs. However when science contradicts their beliefs, for example concerning the age of the Earth or evolution, they have developed alternative theories that agree with the Bible, calling it creation science. Creationists have lost in court when they try to get their beliefs injected into school curricula and law. There are some kinds of questions that science cannot address; that is, questions of value and purpose, and even the Pope has recently tried to downplay any apparent contradiction between science and matters of faith. But scientists and non scientists alike should know that there are organized, dedicated, and well financed groups of creationists who are working to impose their religious beliefs on public institutions under the disguise of creation science. If you want more information about creationism you can visit the Institute for Creation Research website at <http://www.icr.org>.

Robert Pennock, a professor in the department of philosophy at the University of Texas, recently delivered the following address at the University of Washington outlining

creationists beliefs and the the evolution of their strategy to get their beliefs into law and policy. Professor Pennock has written a book on creationism, *Tower of Babel*, due to be published in the fall of 1998 by MIT press.

RP: Creationism is an issue that is in the public's mind, it is getting debated in new arenas including the comic strip page. In Johnny Hart's BC comic strips he regularly brings in these issues in one way or another. "What letter of the alphabet do we use to symbolize education? It's not the three Rs now it is the three Es: Evolution, Ebonics, and Ethnocentrism. What is the message of this cartoon? The message is three bad things, all of which in the view of creationists come out of evolutionary thinking. On the blackboard it has 2 plus 3 equals 4. The implication here is this is part of what is wrong with our education

founded on creation and Christ, and on the other side is evolution, and which is founded on Satan. The balloons indicate all the things the evolutionists are giving rise to: there is the flag of humanism; the balloons include the balloon of euthanasia, divorce, homosexuality, abortion, pornography. Their idea is all of these evils of society are given rise to by evolutionary thinking. As creationists see this, evolution is an all embracing philosophy, a way of seeing the world, and they think that our problems stem from having an evolutionary viewpoint.

I think most people think of creationism as being a very fringe, small, or marginalized group. But fairly recently it has become much more mainstream, up to the level of presidential politics. In Pat Buchanan's presidential campaign this was one of his issues. He explicitly said in his campaign speeches and interviews in magazines and on Larry King, "You may believe you are descended from monkeys; I don't believe it. I think you are a creature of God." Buchanan is not a fundamentalist Baptist

"You may believe you are descended from monkeys; I don't believe it. I think you are a creature of God"

Pat Buchanan

or Evangelical Christian, he is Catholic, and traditionally Catholics have not been creationists. In fact the Pope just last year said in October "Fresh knowledge leads to a recognition of the theory of evolution as more than just a hypothesis."

What do the creationists say to this? A letter that went out to the mailing list of the Institute for Creation Research in response to this said this is what is to be expected, this is just more evidence of the compromising attitude of religious people now, and just another step in the long war

system as well, why Johnny can't read and write. Skool of course is spelled with a K: we can't spell anymore. These are more aspects of the culture of the creationist debate. Here is an example that is not from a newspaper but is from the Website of one of the main creationist organizations, the Institute for Creation Research. The image they are portraying to people is the image of a cultural war with the evolutionists in their castle on one side and the creationists in theirs on the other. The creationists are wearing cleric's collars and waving the flag of Christianity on their turret, which is

or Evangelical Christian, he is Catholic, and traditionally Catholics have not been creationists. In fact the Pope just last year said in October "Fresh knowledge leads to a recognition of the theory of evolution as more than just a hypothesis."

What do the creationists say to this? A letter that went out to the mailing list of the Institute for Creation Research in response to this said this is what is to be expected, this is just more evidence of the compromising attitude of religious people now, and just another step in the long war

against God. The implication is that Catholics are backsliders and evolution is not really a true Christian view. I have here the quote from Pope Pius XII back in the fifties which said there is no conflict between Catholic doctrine and evolution, but apparently it hasn't really sunk in.

What do most people think of when they think of creationism? Young Earth creationism is the classic view. These six points are distilled from the Institute for Creation Research's proposal for legislation.

There have been several attempts to have creationist legislation put in and typically they distill down to these sorts of claims. They are put in a generic way. They don't say Noah's flood, but that is what they mean; they believe in a relatively recent inception of the Earth, even though specifically their view is that recent origin is 6,000 to 10,000 years ago. Where do they get that figure? It is from looking at the generations in the Bible and calculating back. And this young Earth view is what people will typically think of as the stereotype. But although this is by far the most dominant position, within the creationist castle there are a variety of views. There is a battle going on among the creationists as to whether they should

be young Earth creationists or old Earth creationists. Young Earth creationists want to say Genesis days are literally twenty-four hour days. The old Earth creationists say we can think of these not as twenty-four hour days, they can't be days like ours because days have to do with the sun

and the sun wasn't created until the fourth day, so of course they can't be twenty-four hours days. The day-age interpretation says we should interpret day not as being a twenty-four hour day but more in the sense of an epoch. In that sense you think of the days of creation not as being sequential twenty-four hour periods but as being possibly millions of

years old. Sometimes people say this is like God days, millions of years. That is one way of getting geological time into the Genesis account.

Another common old Earth view is called the gap interpretation — in that they say you have to put a huge period of time in between Genesis 1:1 and 1:2 and that is where geological time comes in. This view is called the ruin and restoration because there was an original creation then a destruction and then a recreation. Old Earth creationists will try other methods to fit geological time into the Biblical

account. One is called the visionary day interpretation, that what these days refer to are the days upon which God revealed to Moses elements of creation. So they did occur in six sequential 24-hour days but they don't represent the actual creation, they represent the revelation to Moses of what happened. This is a way of sticking fairly literally to Genesis but getting in geological time.

In terms of political intervention, the young Earth position has been the most active. In 1981 Arkansas put in place Act 590 which required "balanced treatment" specifically using the young Earth model. The six points were all included in the Act. Those six points I quoted typically go under the name of creation-science, and they contrasted that with evolution-science. They said here are these two models, and the bill required balanced treatment of them in the schools. That Act was ruled unconstitutional for violating the establishment clause. Much of the court case involved not just the testimony of biologists — Stephen Jay Gould and others were expert witnesses — but also philosophers, in particular Michael Ruse who talked about what it is for something to be science, and theologians talking about what it is for something to be religion. Much of the Court's ruling hung on that point, that creationism is religious not scientific. You can't just say creation science is bad science; there is nothing in the constitution that says you can't teach bad science.

There have been other cases since, the Edwards v Aguillard 1987 Supreme Court case, for instance. This is one where the state, Louisiana, tries something a little different: they don't require balanced treatment but they said you cannot teach evolution unless you also teach creation science. Again

Creationist Legislative Agenda:

- 1) Sudden creation of the universe, energy, and life from nothing.
- 2) The insufficiency of mutation and natural selection in bringing about the development of all living kinds from a single organism.
- 3) Changes only within fixed limits of originally created kinds of plants and animals.
- 4) Separate ancestry of man and apes.
- 5) Explanation of the Earth's geology by catastrophism, including the occurrence of a worldwide flood.

that was ruled unconstitutional for the same sets of reasons. But Justice Scalia in his dissenting opinion brought up this one point: “The people of Louisiana, including those who are Christian fundamentalists, are quite entitled, as a secular matter, to have whatever scientific evidence there might be against evolution presented in their schools.” Creationists now will cite *Edwards v Aguillard* to say this is the Supreme Court telling us that we can now teach creation science in schools. That is not right of course because a minority dissenting opinion does not have the force of law. But it does set a possible precedent because you can refer to minority opinions of the Court in future cases.

There are now attempts at local levels to make use of the Scalia minority opinion to set up new possible laws that could then be contested. Here is one from two years ago in the Ohio House of Representatives. These are the so-called evidence against evolution bills — there is one here from Georgia as well. The Ohio bill states, “Whenever a theory of the origin of humans or other living things might commonly be referred to as evolution is included in the instructional program provided by any school district, both [scientific] evidence and arguments supporting or consistent with the theory, and [scientific] evidence and related arguments problematic for, inconsistent with, or not supporting the theory shall be included.” The attempt here is to use the language of the Scalia minority opinion to be able to introduce creationist ideas indirectly; the Georgia legislation was very similar. This was defeated in Ohio, but only by twelve to eight. Legislators were

shamed into voting against this law because they thought if their state supports this law they would be a laughing stock and people would not set up their companies there. Many of the swing voters specifically said, but don’t interpret this vote to mean I don’t believe in God. There is a lot of pressure on them to not be seen as being atheistic, since that is associated with evolution.

Here is the another attempt to get creationism into the schools. This is from Tennessee 1996, and it is called the “just a theory” approach. I quote,

Creationism itself is evolving, their terminology has changed its expressed traits in response to court rulings.

“No teacher or administrator in a local educational system shall teach evolution except as a scientific theory.” Now you might say, How else am I going to teach it? It is a scientific theory. But it goes on to say, “Any teacher or administrator teaching such theory as fact commits insubordination and may be dismissed or suspended.” The contrast they want to draw is that evolution is just a theory, not a fact. If they can get that into legislation then they are going to be able to undermine evolution in that indirect way.

Question: How clearly have the courts drawn the line between science and religion in these court cases?

RP: The courts have attempted to set some criteria. In *McLean v Arkansas* they have four or five different criteria. That is critical because if you cannot draw some sort of a line — and creationists will try to fuzzy up

the lines — then we lose the legal argument of separation of church and state. So it is important to distinguish science from religion as clearly as possible.

Creationists had some code words — creationism as origin science — but now there are some new ones. For example people will say, I am not a creation scientist, I hold the abrupt appearance theory, or the initial complexity theory, or the intelligent design theory. Creationism itself is evolving, their terminology has changed its expressed traits in response to court rulings. Their attempt is now to modify their views and slip them through the cracks of the court rulings. Each of these new terms moves back away from some of the explicit claims that the earlier ones were making. Before it was very simple, you could see that the six statements are a disguised version of Genesis but it is not very subtle. Anyone who saw that could immediately tell that this was just Genesis, so it was obviously religion. Some of these new terms, by moving away from explicit commitments and talking very generally — we believe things started abruptly, or we believe things had complexity from the beginning, or we believe that things were intelligently designed, — they are generic enough so that their religious basis is much better disguised.

Creationism is becoming mainstream. In the elections it wasn’t just Pat Buchanan, several states had explicit creationist planks in their Republican party platforms: Iowa, Oklahoma, Texas, Missouri, Kansas, Alaska. They are talking about explicitly having creationist resources in all tax funded public school libraries. This is a sign creationism is

penetrating into the mainstream in a way it wasn't before.

One of the main ways it is penetrating is at the local level. Creationists are extremely active at the local level and at the state level. Just a couple months ago I testified in Texas at State Board of Education hearings for the Texas Essential Knowledge and Skills curriculum for the Texas schools. Texas and California are the two main textbook buyers so the curriculum standards that they adopt wind up being what publishers will write their books for, and the rest of the country winds up getting the books that follow those standards. I was amazed at the systematic testimony of the creationists at these hearings to try to water down in one way or the other and to eliminate as much as possible any reference to evolution.

New Tactics of Creationists:

- 1) Stealth Candidates
- 2) Change curricula and standards.
- 3) Adopt Creationist materials.

Another creationist tactic is stealth candidates — elected on back to basics platforms: reading, writing, and arithmetic — who end up after they are elected trying to bring in their religious views.

An example of changing the curriculum is this is from Phyllis Schafly's group, Eagle Forum, a proposed amendment. The way the curriculum standard had been written originally was "Explain how fossils provide evidence that life has changed over time." They suggested to change that to "examine fossil evidence for change." That is a very subtle change; others are more explicit.

As an example of adopting creationist teaching materials, there was an attempt in Plano, Texas to adopt a textbook called *Of Pandas and People*, which is a very nicely written, very slick textbook from the people who are intelligent design theorists. In the introduction to the book you can see what they have in mind: "We present data that bear on the question of biological origins. We will present interpretations of the data proposed by those who today hold *the two* alternative concepts ... those with the Darwinian frame of reference as well as those who adhere to intelligent

The governor of the state of Tennessee personally bought copies of *Darwin on Trial* to distribute to every biology teacher in the state.

design." "We will do what others do not do; give the scientific rationale. Our intention has been to give you presentations that will balance the curriculum. For what might be a refreshing change, you are asked to form your own opinions. If you understand the information presented here you are fairly capable of drawing your own conclusions." So it is never explicitly said that evolution is wrong or Darwinism is wrong, but anyone with half a brain is of course going to draw their own conclusion that intelligent design is the right way. This was one of the things that got me interested in creationism, when one of my students from Plano came into my office and said, "Do you know what's going on in my home town?" She was just finishing her degree and had been accepted into a Ph.D.-M.D. program and she had said when she had gone to highschool they had taught biology really well and now she is wondering,

what is happening in my school.

Another thing that is very common is textbook disclaimers; they will put a little sticker into the front of biology books that will say watch out for what is presented. These proposals have gone through. This example is from the Alabama Board. This is what you would see if you were a student opening up your textbook, "A message from the Alabama State Board of Education: This textbook discusses evolution, a controversial theory some scientists present as a scientific explanation for the origin of living things. No humans were present when life first appeared on Earth, therefore any statement about life's origins should be considered as theory not fact."

In the next part they say evolution can refer to small changes and they say this is just microevolution, that is okay, that you can observe, there is no problem with that, but it can also refer to the change from one living thing to another like reptiles into birds, this is macroevolution, has never been observed, and should be considered a theory. "There are many unanswered questions about the origin of life that are not mentioned in your textbook. Here are some of these things: What is the explanation for the Cambrian

Editor's Note:

In January 1998 legislation mandating textbook inserts with language identical to the Alabama State Board disclaimer was introduced into the Washington State Senate. It is under consideration by the education committee, which is chaired by the senator who introduced the bill.

explosion? Why have no new major groups of living things appeared in the fossil record for a long time? Why do major groups of plants and animals have no transitional forms? 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, keep an open mind, someday you may be able to contribute to the debate.” What is the message you are getting here from the State Board of Education?

Don't pay attention to what is in this textbook, the authors are trying to pull the wool over your eyes.

Scientists who are teaching evolution are finding that students are coming in with a mindset against what they are being taught; students are being prepped. Many people I talk to in Texas and many people I have talked to here in Seattle have the same experience: some students come in ready, they know the arguments that will be given, they know the professors are going to try to indoctrinate them, and they are prepared often with responses, and prepared not to pay attention. I had one student walk out of my class the moment I started talking about evolution. This is something I find more prevalent in Texas than elsewhere, but today some fundamentalist students are primed to think of this as something they will encounter and something they will prepare for and that they should not believe.

The creationists have people now who are trained and who can give them more credibility. Some of their new champions are Kurt Wise, who was a graduate student of Stephen Jay Gould. Walter Bradley is at Texas A&M; Dean Kenyon at San Francisco

State University. He was one of the early researchers on the origin of life and he gave up on there being any explanation and now thinks that intelligent design is the right answer to the origin of life. Michael Behe is at Lehigh University, and Phillip Johnson — he is the one that really got me interested in this — is at Berkeley. So the new creationists have institutional affiliations, they have credentials, they have academic

whole system does not work. He concludes that such complex mechanisms could not have evolved because if they didn't have any of their pieces, they wouldn't function. The explanation for that however, is that hardly anyone has even started to work on these problems at that level.

[Editor's note: Behe's complexity argument ignores what is already known by biologists: highly ordered biomechanical systems are not perfect machines, and their evolution can be traced genetically.]

Richard Dawkins was asked to debate him and said, No I am not an expert

in this area. This the case with many people, not many people are competent to deal with the specifics at this level. The new creationists have researched their arguments at a detailed level to which few people will be able to respond. Even if you are an expert in this for the most part you are not going to be able to give an answer because there is no answer. It may be decades before we answer some of these questions.

Phillip Johnson is the leader I would say, of this new creationist movement. He is at University of California, Berkeley in the law school. He appeared suddenly on the scene in 1991 with his book *Darwin on Trial*, and many people have coalesced around him. Since then he has published two other books, *Reason in the Balance* in 1995, which focuses on evolutionism, and a book in 1997 called *Defeating Darwinism by Opening Minds*, which is written for high school students. It goes through to say here are the things you will hear in college, here are the things to watch out for, and it is extremely well

New creationists like the big bang cosmology because it goes along with the idea that God created something out of nothing.

backing, they are coming forward and saying this is a credible academic position and they have their Ph.D.s in hand and they say you cannot dismiss us.

Michael Behe was hired by Lehigh University, he is a biochemist and just published a book, *Darwin's Black Box*, which has gotten reviews in major journals. He is now doing speaking tours and being interviewed regularly. His general approach is to say, "I am a biochemist, I know molecular mechanisms, and his book goes through a series of molecular mechanisms — the visual cascade, blood clotting, cilia motion — and he says we see complexity now at the molecular level which before we could not see. It used to be a black box. Now we have opened the box and we see it is every bit as complex at the molecular level as it was up at the higher level, and Darwinians have no explanation. He says not only are these biological mechanisms complex, but irreducibly complex. His claim is these molecular mechanisms are such that if you lose any component, the

written. He quotes Carl Sagan on how to look out for baloney and turns it around and he says turn your baloney detector on those evolutionists. Here are the things they will tell you and here are the problems they have that they won't tell you. He is extremely persuasive, very articulate. This is another one of the things that got me interested in creationism: going to a talk and hearing him speak to a room of hundreds of students at the University of Texas who were just rapt. He is very persuasive, very congenial, he doesn't come across as a zealot, he says I just want you to be open minded about this.

His main argument is a philosophical one: he says, "Sure, evolution by natural selection is a plausible story, if that is the only thing you are considering, if you are only considering natural mechanisms." But he asks, Why do scientists only consider natural mechanisms? Because they have a naturalistic philosophy and that rules out any divine intervention. Most of his argument is pushing forward his criticism of scientific naturalism. He says many times, naturalism is the scientists' religion; scientists are a priesthood which is guarding the door to knowledge and they have this naturalistic world view which prevents them from even considering this supernatural alternative. Most scientists who hear this argument and try to respond are not prepared to be reflective about the methodology, the rationale for naturalism, and Johnson is getting not just national but international attention.

The governor of the state of Tennessee was at a local school board and was mocking the people who were trying to promote evolution in the curriculum. It was reported that at the hearings he did a mime of the evolu-

tion of human beings from apes to mock this idea and said, Why do people believe this? Then he personally bought copies of *Darwin on Trial* to distribute to every biology teacher in the state. Several supporters of Johnson among my colleagues in the philosophy department sponsored a conference on his views and most of the people who support the intelligent design theory came. All of them are saying, he's right, this scientific naturalism is just a dogmatic philosophy and without that, evolution would collapse.

Johnson recommends that we drop naturalism and allow the possibility of theism as an explanatory hypothesis. He says he wants to talk about a new science, not a naturalistic science but a theistic science. My challenge to him however is if you propose a theistic science, you have to tell us something about the conception of God that you have. It is not so clear how to evaluate theistic science until you know what that conception is. I remind you that everyone is an atheist of some sort; that is, for everyone there is some god they don't believe in, so you have to tell me what notion of God you have in mind. I think part of the reason this issue gets so confusing is because people have different notions of God, different notions of what theism implies, different notions of what naturalism implies. It is easy to think that Johnson has an argument, that intelligent design folks have an argument because these concepts get muddy. If you think of God supernaturally — What does it mean to be supernatural? It means to be outside the realm of natural law, above the law of cause and effect, above the natural realm — then I would say theistic science cannot be scientific. But if you have a naturalized idea of a

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creator — that is to say a creator that is like other natural beings operating in the natural world by lawful mechanisms — then it is not really theistic.

He wants to redefine creationism in a generic way. "A creationist is any person who believes that God creates." Well over 90 percent of Americans would agree with a statement like that. If you redefine creationism in this generic way, many people would say they were creationists, and that is the first step to broadening its appeal from being a fringe fundamentalist position to a generic Christian one.

Many of the new creationists say they believe that the Earth is millions of years old. They actually like the big bang cosmology because it goes along with the idea that God created something out of nothing. They cite the anthropic principle; that is, the idea that the fine tuning of the laws of nature allow life, and if things had been a little bit different, life could not have occurred, while others still hold on to

the young Earth view. So the creationists like those aspects of science that support their views. The belief that unites them is the argument from design. The design argument is the one people know from Paley's *Natural Theology*, the argument from the watch: If you found a watch on the heath, you wouldn't think it just happened by accident, there must have been a watchmaker. Then Paley goes through examples from the biological world, he concludes these are like watches and there must have been a watchmaker who designed the biological world as well. Johnson and others are switching this argument to say that God is broadcasting or sending us messages through different aspects of creation. That, they say, is what the SETI project is doing, the Search for Extraterrestrial Intelligence, it is searching for an information-bearing signal that would indicate there is some civilization out there broadcasting. So Johnson's claim is that science can find out and explore intelligent design, and that we are doing that now. Then they say, What if you had your telescope trained on a pulsar and it started sending out a message? Think of that as scientific evidence of the existence of God. They have different messages in their stories: sometimes they have it pulsing out the Old Testament in Morse Code. Then they say, Look at DNA. What is DNA? This is an information-bearing signal, this is just that sort of complex information that indicates a designer. So they draw an analogy to the SETI project, searching for the information-bearing signal and say that is what DNA is, and we are just overlooking the right explanation.

Behe says biologists are ignoring the elephant in the room. His analogy is that we see a body lying bloody on the floor and we ask, what was the

cause of death? Behe says if you don't notice there is a big elephant with bloody feet standing in the room and don't think that is the obvious explanation, you are fooling yourself. His claim is intelligent design is the elephant in the room, that it is the explanation for the origin of life, the origin for the information in DNA. He says the only reason scientists don't recognize this is because they are worried that the elephant is God, and naturalized philosophy means that you can't consider that possibility.

Sometimes people say the right answer to give to creationists is to say that science does not explain anything, science just describes. There are types of explanations; and science can answer explanations of what exists but it cannot answer the question of why something exists. Science can answer how

things came to be, but cannot answer what are thing's purposes. Why did this happen? Why did you go to the store? I went to buy some bread. That is a teleological notion, the explaining of purposes. Then there is the how come question. How did it come to be? That is explaining in terms of the origins and causes, and that is most of what science is doing, it is figuring out causal mechanisms.

One of the things that most gets creationists' goat is the notion of purpose. In Johnson's definition creationists want there to be a purpose in life. In fact if you look carefully at

much of creationist literature you see that is their real worry, meaningfulness. They want there to be a purpose to life and they fear that evolution takes away any sort of meaning to life. And I think it is only fair to say there are a few cases where scientists bring on the problems themselves by making claims that go beyond what science as science can state. And you do get biologists who speak in terms of biological purposes, but stated in such a way that it sounds like a philosophical conclusion, which goes too far. G.G. Simpson wrote, "Man is the result of a purposeless and natural process that did not have him in mind." When you read this as a scientist you focus on the part that is clearly right from the scientific point

of view, but to say that there is no purpose globally, overall, is beyond what science can say.

There is a global notion of purpose that can still be in place even if you were to agree that evolution is a physical process. There is nothing

science can say as to whether or not God had that in mind; that is not a scientific conclusion. So I think that scientists sometimes bring trouble upon themselves by drawing philosophical conclusions that go beyond merely the scientific conclusions that are reasonable. If one reins in that a bit it will irritate at least some people less.

If you are interested in doing something more to watch what creationists are doing, you should be a member of the National Center for Science Education. This is the one scientific watch dog group that looks

Johnson argues that naturalism is the scientists religion; scientists are a priesthood which is guarding the door to knowledge and this naturalistic worldview prevents them from even considering a supernatural alternative.

out for creationists political activities and tries to be a counter to it. It is a good organization, they have a good Website. Anyone who does biology should support this because it is one group that is systematically trying to get good science education on this issue¹.

Question: If we really believe in natural selection in the clash of ideas, why should we worry about the creationists?

RP: Why should we worry about the new creationists? I find that ideas have changed, they have responded to some ideas in the intellectual landscape that died out or at least are fading. Even the young Earth creationists are absorbing much of the intelligent design theory point of view. Now we have to see how it plays out in the wider intellectual landscape. The people who will be deciding this are not necessarily the people in this room; it is going to be people generally who are voting on issues, and it is not so clear that unless we do a better job of educating people about creationism that the evolutionary view will win out in the intellectual landscape. You might say in the real intellectual landscape of course it is not going to die out, the evidence is so overwhelming, but there is a sense in which the debate is being now played out much more strongly in the public arena and there I think biologists have done a poor job of educating people to respond.

Eugenie Scott is the director of the National Center for Science Education, she is a physical anthropologist, and she says we are bringing difficulties upon ourselves. We are not explicitly teaching evolution carefully

to our graduate students and undergraduates, so they are not prepared to teach this to the highschool teachers and highschool students. There is no wonder that people are coming up with prejudice against evolution, they just don't know. We assume everyone knows the evolutionary basis of biology, but she thinks we are going to be hit by a big wave without being prepared because we have not educated people well enough.

Question: Are there cases where people have stood up in public to creationists? I haven't heard of any.

RP: The 1982 trial in Arkansas was such a case. But to be able to answer all the types of criticism that come from creationists you have to know

There are a few cases where scientists bring on the problems themselves by making claims that go beyond what science can state.

not just biology, not just geology, you have to know radiometric dating, paleontology; there is not any one scientist who is an expert in all of these fields. At the trial there was a series of expert witnesses who could talk about what they did know, and in that case it was obvious to everyone that creationists had nothing to respond to this broad defense. That is the one time you could say there was a clear win.

In any sort of individual debate it is probably the case that a scientist comes off poorly because no particular scientist is prepared to answer the whole range of arguments they would face, and they would be on the defensive right away because of not being able to answer something. Scott

has said that typically after any debate there is always an upsurge in creationist activity when people are saying, Oh, it looks like the creationists won, even though they didn't. After my book comes out I will probably be asked to debate, but I am not sure it would be a good idea to do so considering how long it takes in class to get across some of these evolutionary concepts or philosophical concepts — it takes a whole semester — how can you possibly explain this in a two-hour debate, even on a specific point? So in a way I think debates are not a very effective way of communicating.

Question: Many of the creationist arguments come out of scriptural semantics. Aren't those only as valid as the translation they are based on? If you use the Hebrew instead of the Greek, the meaning of a passage can be shifted.

RP: Right. Historically Christians took a while to accept the fact that there

were extinctions; they thought God would never have allowed it, so when they discovered fossils of dinosaurs they finally had to confront that. What do the young Earth creationists say now about dinosaurs? They say there are dinosaurs in the Bible; they talk about the leviathan and the behemoth. They quote this passage from Job about God created the behemoth and this one passage that makes them say it is a dinosaur, "his legs are like iron, he moveth his tail like a cedar." A cedar-like tail, what is that but a brontosaurus or some creature like that? Well the translation they used for that passage is the King James version, which did not want to talk too explicitly about some things in the original and so it used euphemisms.

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Tail was a euphemism for a penis, so the more literal translation is, "His penis stiffens like a pine."

Question: How much of the debate hinges on the level of ideological precommitments: theistic interpretations versus the scientists.

RP: This is one of the changes that has occurred: the young Earth creationists would go into the details; that is one of the things Johnson very much avoids. He goes about it in a very broad-brush way, and his main argument is this quasi-philosophical one about scientific method and naturalist presuppositions that blind scientists to intelligent design. That is one of the key things that is new about creationism. Johnson talks about his strategy as being a wedge. He says I am your point man to get these possibilities accepted. This is why he talks in such a generic way. If you ask him, What is your view about the age of the Earth? He would say he is not interested in that. What is your view about whether animals evolved? He says he is not interested in that. He focuses on this one thing. His plan is

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to open up the possibility of theistic science. Once that is in place then you can get it into schools, this would now be a science, not religion. Then they can start looking at details that at this point they are being silent about. The book *Of Pandas and People* looks at

the details in terms of the origin of life, that is most of what that book does. That is the next stage. And then you find they do have specific commitments and then it gets more like the young Earth view. It is one step at a time and they are very careful now about the way they are being portrayed to get the wedge in, to get it started.

¹ The Website address for the National Center for Science Education is <http://www.natcensci.org/>



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