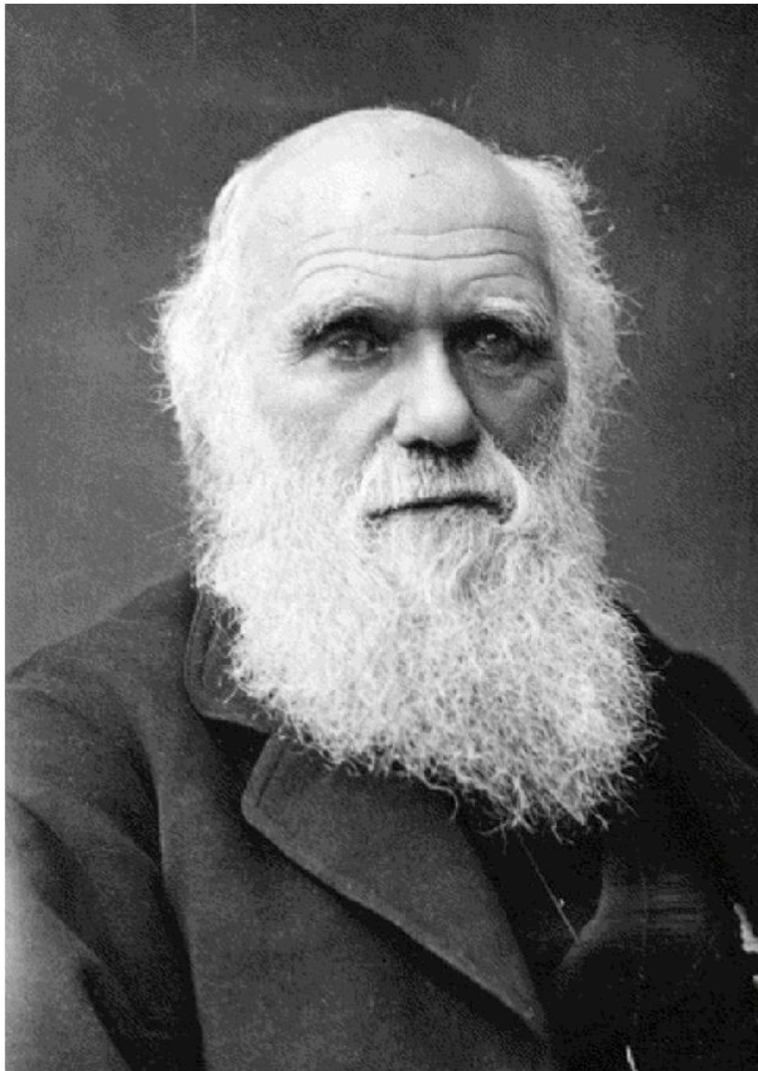


The end of the debate

Evolution is real. It's the foundation of all modern biological and genetic research. And the scientists who are pushing the boundaries of human knowledge are frustrated at having their vast body of work questioned by people still quibbling over the now-ancient words of a single Victorian gentleman.

By Tom Spears, Citizen Special March 7, 2009 1:01 PM [Comments \(5\)](#)



Charles Darwin published *On the Origin of Species* in 1859, but it was not until the 1940s that genetics and evolution 'had come together and and

made sense in light of each other,' says André Lachance of the University of Western Ontario.

Photograph by: Richard Milner Archive, Reuters, Citizen Special

It's over. The whole evolution question -- if it ever was one, in living memory -- is settled. Done. Time to move on. . Evolution works. It's our best way of understanding biology.

Yes, this bicentennial year of Charles Darwin's birth has brought a flurry of letters and speeches and angry calls to radio stations denouncing evolution as a hoax. But we live in a world where scientific theories have to be evaluated by evidence, and with evolution, it's all on one side.

The moon landings were real, doubters notwithstanding.

It's true that cigarettes cause cancer.

Hitler's death camps were real.

So is evolution.

For all the questions over dinosaur fossils and quibbles over Darwin's precise words from the 1850s, modern evidence is an outpouring of testing and re-testing evolutionary theory.

Evolution keeps passing those tests. And one of the places where it passes them is in the glass dishes and the striped images of DNA in Sarah Otto's lab.

Otto teaches biology at the University of British Columbia. The native New Yorker is a leading light in Canada on the topic of evolution.

"What is very cool and probably not widely appreciated in the public is that evolution is studied in the here and now," she says.

"It's not just about looking at the fossil record or imagining what might happen. It's actually watching populations as they change over time."

"My research group uses yeast, and we see them evolving over the course of a day."

Yeast, as all bakers know, reproduces extremely quickly -- many times in a single day -- if you feed it and keep it warm.

Otto's lab exposes ordinary yeast cells to antibiotics -- enough to kill some, but not all, of the cells. The ones that have the best defences against antibiotics survive, produce more yeast cells, and the circle starts again.

"At the beginning of the day they are sensitive to antibiotics; at the end of the day they are not. And that's after dozens of generations of evolution. We can track that down to the genetic level," she says.

"It just then becomes quite silly to talk about evolution as a theory when it's happening right before our very eyes and we can track it."

Flu viruses evolve the same way, which is why this year's flu bug laughs at last year's vaccine. So do all kinds of microbes from tuberculosis germs to useful bacteria in soil.

"At a large scale, too, we're seeing organisms adapting to changing environments," she notes. "And if we ignore that process then we're not going to be able to predict how tree populations will shift in their ranges in response to global climate changes. Some species will go extinct and others won't."

Like all new theories, evolution took its time winning acceptance since Darwin published *On the Origin of Species* (1859) and *The Descent of Man* (1871).

Final agreement among biologists emerged in something blandly titled the "modern synthesis."

"Call it 1940 or so," says André Lachance of the University of Western Ontario.

"All biologists who were interested in the topic more or less stated that genetics, as it was beginning to be understood, and evolution as described by Darwin ... had come together and made sense in light of each other."

Darwin had observed what happens. Genetics introduced the cell machinery that makes it happen.

"Now, every now and then someone introduces a variation or a new idea that's complementary. They'll say, 'Oh, I've disproved Darwin,' when in fact they're advancing the science and it all integrates together," Lachance notes.

That happens in all sciences, all the time.

"The things that the early astronomers told us are, for the most part, true: The idea that the Earth is not the centre of the universe, and the Earth turns around the sun, and the sun is part of a galaxy.

"Now in the last 20 years we've had the Hubble telescope tell us a whole bunch of things about the shape of the universe. This is not invalidating what Galileo or Kepler or any of those people said. It's the same idea."

Want to toss out Galileo's core beliefs? You have to throw out all modern astronomy.

To drop evolution from biology would be just as central. So, the evidence:

"For me, the strongest support for evolution, and I mean for common descent, is that ... all species are related like members of a family. The evidence for that is coming out by the truckload, constantly, whenever someone or some consortium sequences another genome."

All plants and animals share a common ancestor, and the similarity between genes is tremendous. An example: The genes governing the ribosome, a piece of cell machinery that assembles protein molecules. They are not identical, but are similar across the vast array of animals, plants and the two branches of bacteria.

Francis Collins summed up the importance of this in a TV interview. (Collins was head of the Human Genome Project and was director of one of the U.S. National Institutes of Health. He is also a fundamentalist Christian who sees no conflict in this.) "Yes, evolution by descent from a common ancestor is clearly true. If there was any lingering doubt about the evidence from the fossil record, the study of DNA provides the strongest possible proof of our relatedness to all other living things ...

"I take the view that God, in His wisdom, used evolution as His creative scheme. I don't see why that's such a bad idea. That's pretty amazingly creative on His part."

This similarity among species supports the idea that life is the result of constant adjusting, not an intentional design, Lachance explains. This is why some animals have genes with no function, while their distant relatives have the same gene in a working form.

"The only way to explain that is that the common ancestor of both species had the ancestral gene," while one line of descendants changed in ways that no longer made that gene necessary.

"Evolution did not get rid of the gene; it just turns it off."

Blind fish living in dark caves have remnants of eyes. Humans and other great apes (chimps, gorillas, orangutans) have a tail bone, with no tail -- mostly.

"We have all the genes required to grow a tail, and in fact every once in a while someone is born with a tail. And surgeons discreetly chop it off.

"The genes are there and they are suppressed by other genes that determine what goes on in the body. If the human body had been designed from scratch, why on Earth include genes that will wag a tail, when there's not going to be a tail?"

Yet time and again, political movements try to ban the teaching of evolution, or to water it down by ordering that creationist beliefs must be taught along with it.

A key element lies in a quirk of the English language. Evolution, its opponents say, "is only a theory."

That's what science calls it. The theory of evolution. But "theory" can mean two things.

In common language, it can mean someone's wild idea. You can have a theory about the best way to win the lottery.

In the science world, a theory is something really big, and well-supported.

"It's really used in a very misleading way, I think, to the public," says UBC's Otto. "They think of theories as including crackpot ideas, right? Whereas really evolution is just like the theory of gravity -- our understanding of how biological systems on Earth are, and change over time."

"Only a theory!" Western's Lachance says with a deep sigh.

"Well, first of all, a theory is a body of knowledge that has gone beyond being just a collection of facts but instead represents an integrated explanation for many phenomena.

"(It is) a body of knowledge that is able to make predictions, and a body of knowledge that grows, that gets refined -- and that is susceptible to being falsified eventually.

"The way things are going for evolution, evolution is getting refined all the time, but there are certainly no indications whatsoever that it will be falsified in the near future."

This business of prediction is key. It doesn't mean predicting the future; it means saying, "If this theory is true, then we should be able to go out and find the following new facts, not just the facts we already know."

Finding new facts is how a theory is tested, and re-tested.

Take Einstein. When he advanced his general theory of relativity in 1915, the world was at war. But in 1919, after peace came, the world's scientists were able to join and test his theory.

Einstein believed that a massive object like our sun has enough gravity to bend light passing close to it. His theory predicted that if one looked at a star on the far side of the sun, it should appear slightly out of its true position, because its light bends near the sun on its way to us.

Normally, you can't look at stars on the far side of the sun. But the year 1919 brought a total solar eclipse, and scientists gathered in West Africa to photograph a star which appeared where the new theory said it would.

That didn't end it. There were arguments about the accuracy of the measurements, and astronomers are still testing Einstein today. His theory keeps passing.

"To become a theory is (an) achievement," Lachance says. "If the things you work on are boring and trivial, they're not going to constitute a theory. They'll be a hypothesis. So maybe people confuse the word theory with hypothesis.

"Once a hypothesis has been confirmed and verified and supported by evidence over and over again, it ceases to be a hypothesis and it becomes a theory.

"So to say evolution is just a theory is to say what you won was just the Nobel Prize. Well, where do you go beyond that? There's nowhere to go."

"Gravity is just a theory," says Dan Graur of the University of Houston. "And heliocentricity (the idea that the Earth goes around the sun) is just a theory, and the atomic structure" is a theory.

Still, Darwin keeps coming under attack from people who say that he got some details wrong, and so the whole theory must be hooey -- putting the entire burden of modern biology on the narrow shoulders of a single Victorian gentleman.

"That's stupid," Graur says.

"They (Darwin and other evolutionary theorists) may have said whatever they like. Science is not a record of the written word. We don't care.

"The ultimate reference is the world, reality."

It tires him to hear people arguing on and on about Darwin's supposed misunderstanding, while he's out in the forefront working on the mathematics of biology. (Example: "Regions of unusual statistical properties as tools in the search for horizontally transferred genes in *Escherichia coli*.")

"We don't regard the Origin of Species as a holy book, or The Descent of Man. So what he said, we don't care about it."

He adds, referring to the powerful religious pressures to twist science: "It's OK. If the United States wants to become the new Taliban, that's its business... What can I tell you? I feel sometimes that I live in the 12th century."

Outsiders watch in amazement as biology comes under repeated attack.

David Sinclair of Carleton University, a world leader in particle research, was asked what would happen if his field came under the same pressure to throw away its core body of knowledge.

"We wouldn't get anywhere, actually. It does happen in biology. We're just fortunate it doesn't happen as much in physics," he said.

"We do get a few crazy cases of people who think we're going to destroy the world with our experiments." (The European physics lab in Switzerland is accused by some of building a machine that will create a black hole big enough to swallow the Earth.)

"Yes, it's frustrating on the one hand," says Western's André Lachance. "On the other hand, it's understandable that people should have very strong opinions about the nature of human life, and things having to do with morals and spirituality.

"These are much less relevant when you're dealing with pure math or string theory (in physics) or the orbit of planets. But certainly when you're talking about how human life appears, everyone has some kind of innate interest in the matter."

Last week he gave a public lecture on Darwin. He explained how evolution predicts facts that can be tested, and explained how the fossil record shows many examples of "transitional" life forms that pre-date modern ones.

"At the end a guy came to see me and said in a whisper, 'What about the lack of transitional forms?' And I just said to myself, Well, I just talked for an hour about the transitional forms and their overwhelming abundance. And I guess for this person who has a preconceived idea, whatever I say, he's going to find flaws," Lachance says.

"People who oppose evolution usually oppose the same things, and they are based on things that Darwin himself said."

n Worry No. 1: The lack of fossils showing intermediate forms between one modern species and another. Yet the years since then have produced many fossils unknown in Darwin's time, when fossil-hunting was in its infancy.

n Worry No. 2: Darwin's contemporaries set the age of Earth at some 200 million years -- too short, the biologist felt, for such a huge explosion of life. The current estimate, using modern knowledge of radioactive decay, is 4.6 billion years.

"They're not weak points any more."

The opposition isn't going away, but it also doesn't add any scientific evidence. There's a field called creation science, but it never publishes in the crucial research journals where ideas can be tested.

A current popular book in the field (*In the Beginning: Compelling Evidence for Creation and the Flood*) proposes a series of catastrophic movements that shaped our planet in a short time, to fit the idea that Earth is only a few thousand years old. For instance, ferocious rains carved out the Grand Canyon (maximum depth: About 1.6 kilometres) in a few weeks. Mountain ranges grew up with cataclysmic speed, too. Dinosaurs did live -- but not very long ago.

But this doesn't rely on evidence. Rather than asking what happened, this approach asks how one can reconcile the way our planet looks with a strictly literal Biblical world-view. And most importantly, none of it can be tested, which is the acid test for scientific work.

Meanwhile, evidence supporting evolution piles up each time another lab unveils another genome.

This is not just a matter of tracking dinosaurs for the sake of novelty. Understanding evolution is crucial to medical research based on analysis of genes.

"Geneticists use that as a tool constantly," Lachance says. "Even if they don't say so, the assumption they make ... is that the difference between two molecules (eg. two genes) is due to divergence from a common ancestor."

For example, huge amounts of cancer research involves learning how genes go bad and create cancer cells, and hunting for ways to stop this change. In the lab, this usually involves working with mice: searching their genes, and testing drugs on them. The mouse's genes aren't a perfect match for ours, but they often come very close -- because mice are mammals, and therefore close relatives.

Medical research labs couldn't function without mice. That's why.

Having to prove and re-prove what science has known for a very long time is tiring to some in the field, but Sarah Otto calls her own attitude "philosophical."

"There are people who believe there are ghosts," she says. "There are people who believe that psychics can tell you how to live your life."

When Science and Faith Clash

The scientists Tom Spears interviewed for this article make a convincing case that evolution is beyond debate, but there are those who can't reconcile Darwin's ideas with their faith. Tell us what you think.

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