

# The evolution of Darwin's theory Scientist's early insights continue to help us all make sense of the world

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What do the sciences of chemistry, physics, geology, astronomy, biology, paleontology, anthropology and sociology all have in common?

Not only are these diverse fields in broad and detailed agreement with Charles Darwin's theory of evolution, many scientific explanations from these eight disciplines are fundamental to our knowledge of the facts of evolutionary change over time.

For example, astronomy underlies our understanding of the formation of the Earth. Physics provides radiometric and isotopic data for geological timelines and climatic cycles. Geology is the "bedrock" of the evolution of the continents, oceans and atmosphere. And paleontology overwhelms us with an abundance of fossil evidence reconstructing the history of life.

Biology continues to generate an ever-expanding body of molecular, genetic and population data that has only confirmed, in the words of noted evolutionary biologist Theodosius Dobzhansky, that "nothing in biology makes sense, except in the light of evolution." And insights from anthropology and sociology are helping us understand the intersection between our animal heritage, psychological and social behavior, and our human culture.

In fact, when at various historic moments scientific claims have been found to be in disagreement with Darwin's revolutionary insight, it's the theory of evolution that has held the day as scientific evidence accumulated.

Darwin's early insights were amazing especially because while he could observe the implications of his theory, he had no idea of the actual mechanisms of evolution. Today, scientists have a vastly more detailed biochemical understanding of exactly how species change and diverge, not only through natural selection but through other mechanisms such as genetic drift and gene transfer between species.

Thursday is Charles Darwin's 200th birthday, and 2009 brings the 150th anniversary of the publication of his opus "On the Origin of Species." Thus it seems worthwhile to reflect on the significance and impact this man and his theory have had on the sciences, on modern society, and on our view of ourselves on this planet.

For one thing, it's not only the sciences that have benefited from the power of Darwinian explanations. Most of modern medicine and public health would not be possible without an understanding of evolution.

Even the field of engineering has been affected by the principles of the “nonrandom selection of randomly varying characteristics.” Today, engineers routinely use evolutionary methods to calculate optimum wing shapes for fuel efficiency and combustion chambers for maximum rocket thrust.

And even the “dismal science” of economics is now making use of insights from human evolutionary psychology to understand why investors do not always make rational choices based on their own enlightened self-interest, but instead sometimes behave more like panicked herd animals.

But from a national and political perspective, why is evolution important today? Because evolution provides a powerful framework for investigating the planet on which we live.

Without evolution, the astonishing variety and diversity of the natural world is merely a collection of random and disconnected facts. Add evolution, and all of a sudden patterns emerge everywhere. Understanding not only becomes possible, but those insights are constantly used by scientists, doctors and engineers — and, today, increasingly by farmers and public health officials.

Evolution is immediately relevant here and now. It is not just an abstract subject that deals with the age of the planet, or how a fish first flopped onto a riverbank to lay its eggs away from predators.

The increasing effect humankind is having on our planet through habitat loss, pollution and climate change not only concerns frogs, ocean coral and weather patterns. We are affecting thousands of other organisms in this constant process of change and adaptation.

Examples abound, such as the widespread resistance of insects to pesticides, weeds to herbicides and bacteria, tuberculosis and HIV to antibiotics and viral drugs. This is evolution within our lifetimes, happening in real time.

Evolution also provides a scientific basis for understanding our human ancestry and how we connect to the story of life on Earth. Not only are we part of life on this planet, but we are intimately connected to it.

For example, 90 percent of the cells in our bodies by number are nonhuman — that is to say, they contain nonhuman DNA. How is that possible? For the reason that 90 percent of the cells in our bodies are beneficial bacteria upon which we have symbiotically evolved a dependence for our very survival.

Most people by now have learned that mankind shares 96 percent to 98 percent of its genes with the chimpanzee. More recent research now suggests that the genetic similarity is closer to 99.4 percent when only functional genes are counted, and that our last common ancestor lived about 5 million years ago.

Going further back, it turns out we share a common ancestor with all large primates about 13 million years ago. Even further back is found a common ancestor with all placental mammals about 60 million to 80 million years ago.

And 300 million to 350 million years ago, all four-limbed animals shared a common ancestor, while around 1 billion years ago the first animal with a backbone appeared — for which we might all be thankful, except occasionally when our backbones show the effects of overdoing it in the garden.

And speaking of gardening, molecular DNA data also demonstrates that we share a considerable number of genes with our corn and bean plants from which we animals diverged even longer ago.

Some may object to scientific comparisons such as these. But does science serve to flatter our egos or to investigate truth? Evolution is simply one of many scientific theories that challenge our heartfelt intuitions.

There was a time when a belief in evidence that the Earth circled the sun was not just socially controversial, but could get you tortured.

The germ theory of disease was once described as a “ridiculous fiction.” But today, if your surgeon declared that he wasn’t going to wash his hands before performing surgery on you because germs are “just a theory,” you might be wise to get a second opinion.

Indeed, the story of our origins trespasses on some emotionally sensitive territory. But not to teach the science of evolution is to demonstrate contempt for scientific evidence in favor of political and religious ideology.

A society in which ideology supplants evidence is a society where future imagination, innovation and advancement are seriously at risk. Failing to teach our children the facts of evolution leaves them unprepared to critically assess the world around them. This is a great danger to a society where future comfort, progress and economic success depend on continued scientific, medical and technological innovation.

Among industrialized countries in the world, the United States today ranks 33rd — just above Turkey but below Latvia and Bulgaria — in public acceptance of the most fundamentally profound scientific concept we have — evolution. Science is inspiring and beautiful, but science is also a human endeavor essential to our survival as a nation in a globally competitive world.

Perhaps it is worth considering the words of Thomas Huxley, often referred to as “Darwin’s Bulldog” because of his passionate defense of Darwin’s ideas, who said: “Only a scientific people can survive in a scientific future.”

While there exists no scientific controversy about the facts of evolution, nor about the importance of natural selection as the dominant explanatory process of evolution, there undoubtedly remain fascinating details to be worked out regarding additional mechanisms of evolution.

But students who are not given the opportunity to acquire an understanding of evolution, or who are deliberately confused by ideology disingenuously disguised as “teaching the controversy,” cannot achieve a basic level of scientific literacy.

Any society that bases major decisions on ideology and belief rather than reality and evidence is heading for disaster. One has to look only to the tragic episode in the former Soviet Union, when evolutionary genetics were rejected by the Communist Party in favor of the more ideologically compatible and anti-intellectual populist ideas of Trofim Lysenko. The biological sciences in Russia today still bear the scars of that brutal scientific repression.

Last December, Barack Obama’s radio address discussed the essential compatibility of science, truth and democracy by saying: “Promoting science isn’t just about providing resources — it’s about protecting free and open inquiry. It’s about ensuring that facts and evidence are never twisted or obscured by politics or ideology. It’s about listening to what our scientists have to say, even when it’s inconvenient — especially when it’s inconvenient. Because the highest purpose of science is the search for knowledge, truth and a greater understanding of the world around us.”

Let us all support the scientific effort toward greater understanding and appreciation of the beauty, complexity, diversity and interconnectedness of all of us on the good Earth.