COMMENTARIES

Intelligent Design?

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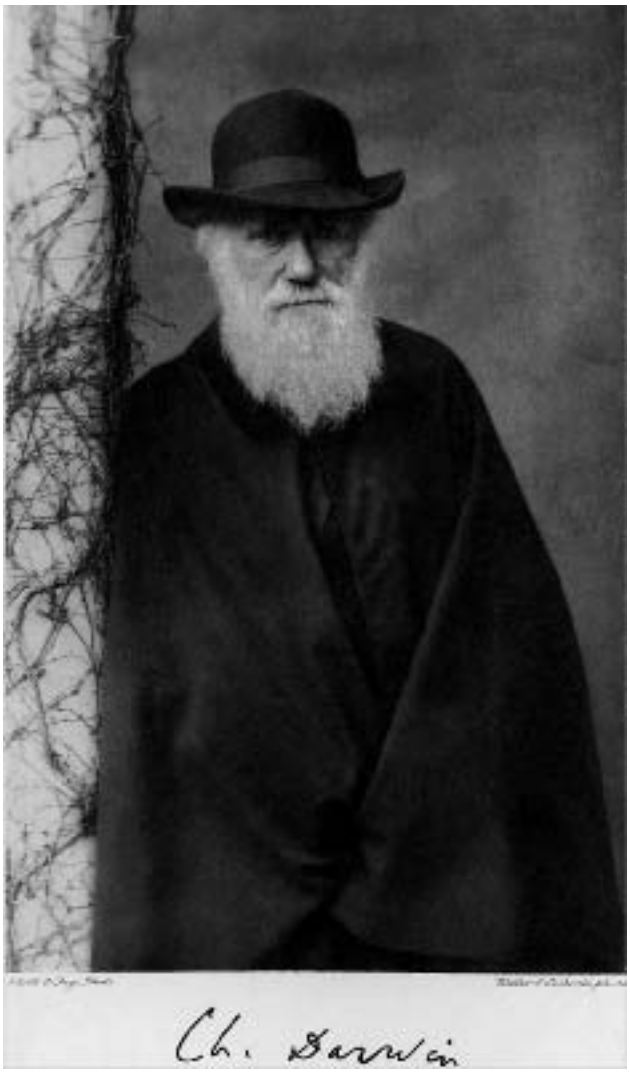
Charles Darwin was not looking for trouble when he set off on the Beagle in 1831. He most definitely could not have imagined that, more than 150 years later and a third of the globe away, judges in one of the world's most advanced nations would still be handing down rulings on his findings. Yet here we are, and, as I write this in late December 2005, a federal judge once again has had to inform the American public that the theory of evolution is the only scientific explanation we have for how life arose on this planet. The case in point involved the school board of Dover, Pennsylvania, which in late 2004 adopted a policy requiring students in science classes to be told about "intelligent design" (ID) as "an explanation of the origin of life" (the text of the statement can be found at http://www.cnn.com/2005/LAW/12/20/intelligent.design.ap/). In striking down this requirement, U.S. District Judge John E. Jones III, a Republican appointed by President Bush, said that the school board's decision was not just unconstitutional but also dishonest: "We find that the secular purposes claimed by the Board amount to a pretext for the Board's real purpose, which was to promote religion in the public school classroom." He also had some strong words for the members of the school board who created the policy, all eight of whom subsequently lost their positions in recent elections and were replaced by board members who promised to eliminate the policy. He called the effort to force ID on the students a "breathtaking inanity" and pointed out that "It is ironic that several of these individuals, who so staunchly and proudly touted their religious convictions in public, would time and again lie to cover their tracks and disguise the real purpose behind the ID policy" (the text of the decision can be found at http://www.pamd.uscourts.gov/kitzmiller/kitzmiller_342.pdf).

Alas, that is not likely to be the end of the ongoing battle to remove the teaching of evolution from the nation's science curricula, preferably to be replaced by material perceived to be more compatible with Christian views of a particular flavor. Proponents of ID correctly point out that evolutionary theory does not explain everything. The struck-down Dover statement, for example, says: "Gaps in the theory exist for which there is no evidence." In as much as our knowledge of anything is incomplete, they are absolutely correct. However, the underlying problem appears to be that many religious people in the U.S. believe that accepting evolution somehow requires them to give up their faith. The theory of evolution does make statements about how life evolved once it appeared on Earth, and these statements now have extensive support from biology, geology, and other fields of science. They are not consistent with a literal interpretation of the biblical creation story, but neither are parts of physics, astronomy, geology, and other sciences. Nonetheless, science has nothing to say about whether or not any particular deity exists, and evolutionary theory does not make claims about the ultimate source of life. As stated by the recently-deceased Pope John Paul II, one can be a Christian and accept evolution: No inherent contradiction exists between the two. In fact, many believers see no problem accepting evolution, and many scientists are religious.



Charles Darwin is often villified by those claiming evolution cannot be true, and his theories are often disparaged by critics who pejoratively call them "Darwinism," suggesting that an acceptance of evolution is comparable to a personality cult.

"As a Christian, a trained engineer and scientist, and a professor at Emory University, I am embarrassed by … [attempts] to censor and distort the education of Georgia's students," said former President Jimmy Carter, a Baptist and Nobel prize winner, in 2004 in response to suggestions that the word "evolution" should be banned from the state's curriculum. Additional information can be found at the White House web site (http://www.whitehouse.gov/history/presidents/jc39.html).

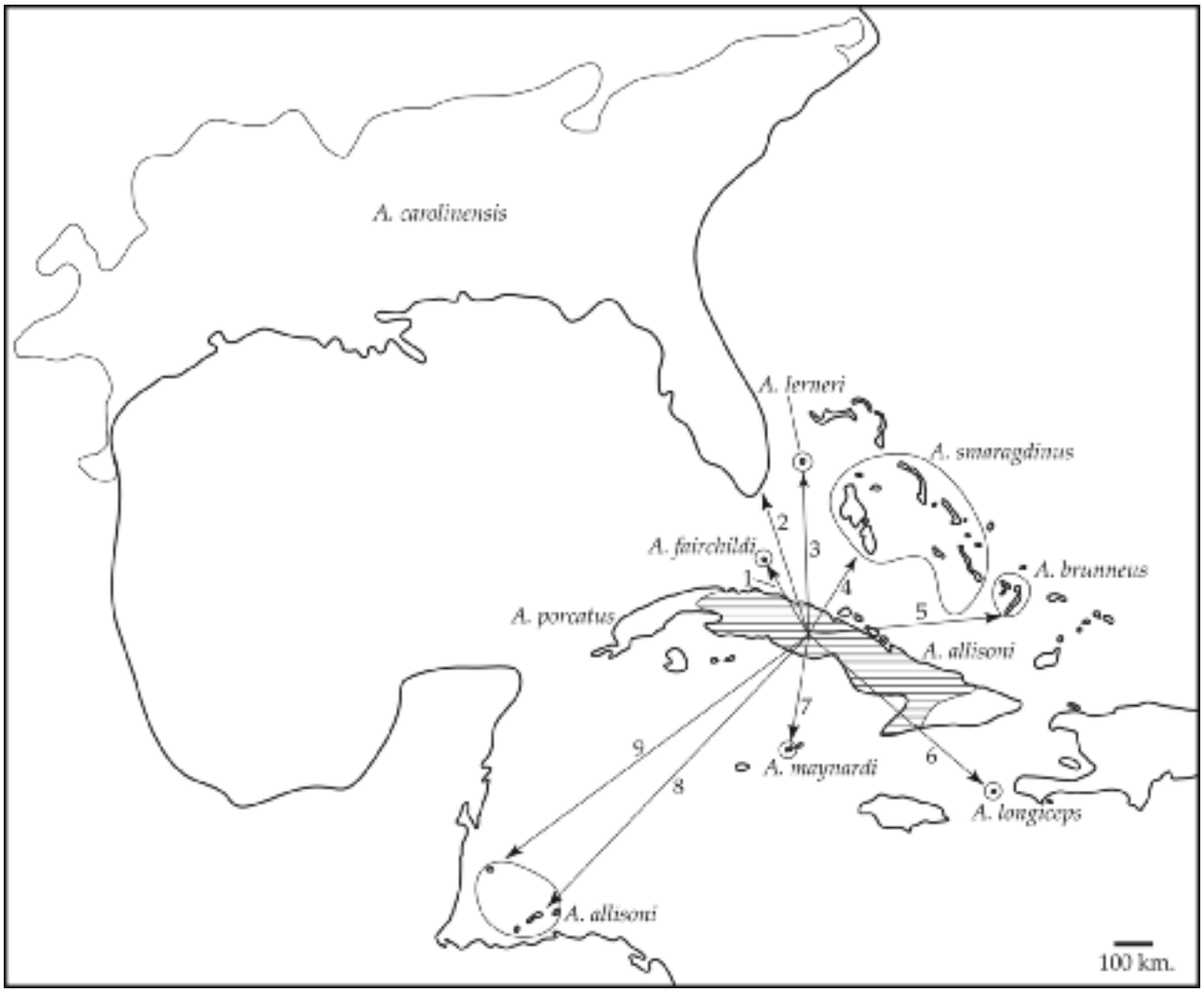
Michelangelo's Sistine Chapel illustrates the negative consequences of curiosity. The church in Michelangelo's time, like many authoritarian regimes, very actively stifled any free-thinking, believing that curiosity would foster doubts and lead to inquiries, all of which are threatening to the status-quo.

What is ID? At heart, it claims that biological complexity — proponents often cite processes such as blood clotting, which rely on multiple biochemical pathways — shows that life could not have evolved, but must rather have been formed by an unnamed intelligent designer. In Pennsylvania, Judge Jones complained about the "striking ignorance" of the education board regarding the underpinnings of ID, but that does not necessarily discredit the concept. However, Judge Jones also had some clear words about the underlying scientific merit. ID is "not science," and "the fact that a scientific theory cannot yet render an explanation on every point should not be used as a pretext to thrust an untestable alternative hypothesis grounded in religion into the science classroom or to misrepresent well-established scientific propositions." In fact, he ruled that ID is "creationism relabeled." ID cannot be science primarily because it does not provide any means for scientists to test it. The few scientists who advocate ID have been unable to provide scientifically valid ways to evaluate their idea, and have consequently yet to receive external support for such work or publish anything in the peer-reviewed scientific literature. Moreover, let's assume for a moment that ID proponents are correct and evolutionary theory is too weak to hold water. The scientific method would require us to seek an alternative, but the Judge pointed out that the argument made by ID proponents is "at bottom premised upon a false dichotomy, namely, that to the extent evolutionary theory is discredited, ID is confirmed."

OK, ID is not science. Why have scientists throughout the world long accepted evolution as the cornerstone of all biological sciences? To appeal to scientists, an explanation has to have predictive value. One must be able to make statements such as: "*If* I am correct about the nature of gravity *then* this pen will drop as soon as I let go of it." Only a single case in which the pen drifts up to the ceiling disproves our hypothesis, but no matter how many times it falls, the possibility always remains that *next* time, it will do something different. That is why scientists should never claim to have proven anything. Still, we have now dropped enough items and watched them crash to the floor that no sane person will step off the roof with the hope of floating up. Gravity has so much predictive power that we now call it a theory and take it for granted, even though physicists still do not understand *why* it works.

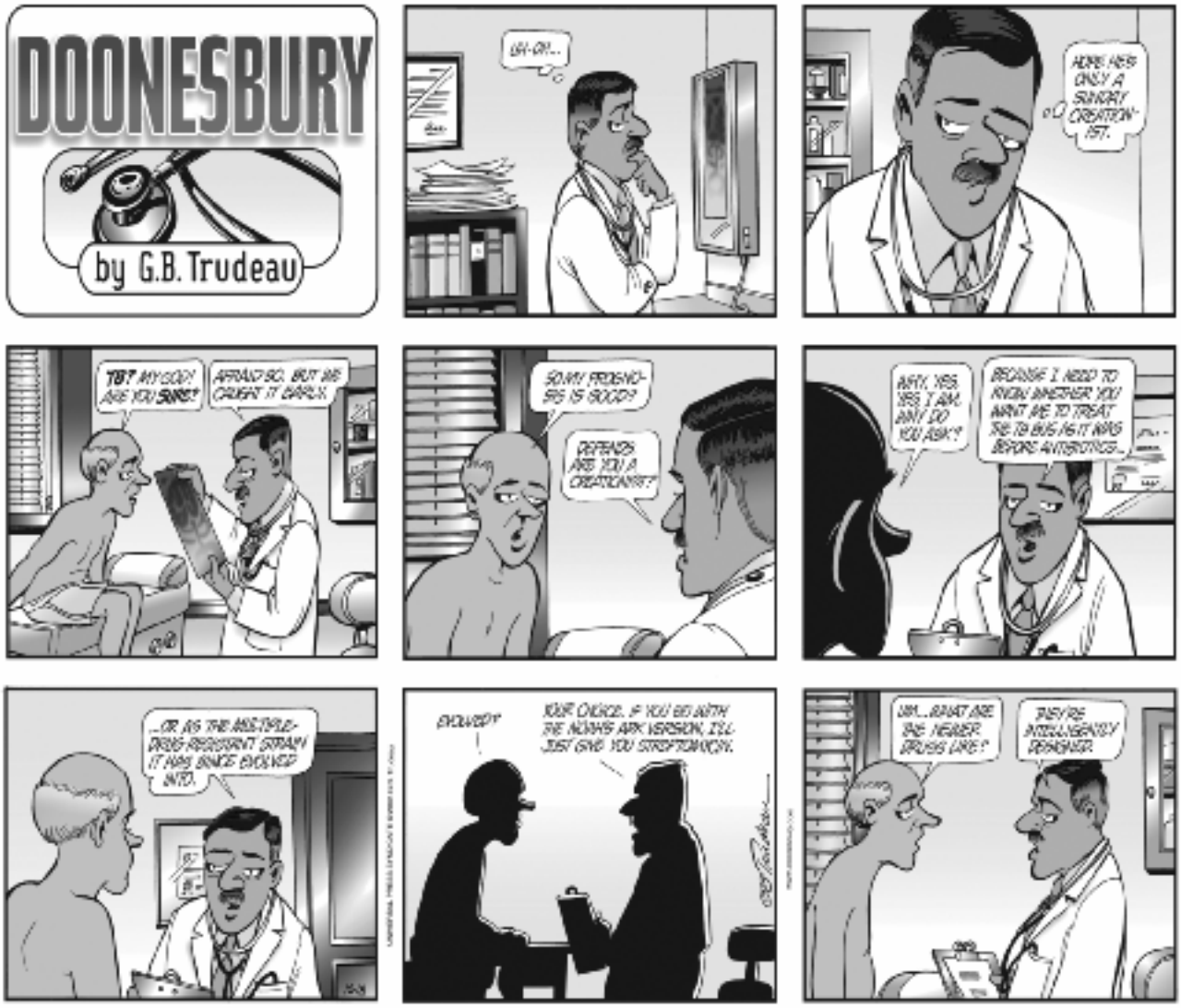
Our understanding of evolution also allows us to make testable predictions about the world around us. For example, a single solid case in which a fossil of a mammal is found in a layer preceding the evolution of fish would refute our understanding of the process, because fish are thought to be ancestral to mam-

This series of "family trees" shows how natural selection has affected anoles on the islands of the Greater Antilles. **A.** When only physical characteristics are considered, species cluster according to ecomorph class (a descriptive suite of characters that reflects an animal's lifestyle or niche) regardless of geographic affinities. Letters indicate the islands on which a species is found (C = Cuba; H = Hispaniola; J = Jamaica; P = Puerto Rico). **B.** In sharp contrast with A., this tree, which was generated using molecular data (DNA sequences), indicates frequent transitions among ecomorph classes and a much stronger correlation between close relationships and geographic affinities. In other words, species found on the same island are much more likely to be closely related than species on different islands that might share very similar appearances as a consequence of being in the same ecomorph class. This example of how evolutionary methods can shed insights on ecological relationships was adapted from Losos et al. (1998. *Science* 279: 2115–2118).



Evolutionary studies have confirmed Cuba as the origin of all species in the *Anolis carolinensis* group (top); adapted from Glor et al. (2005. *Molecular Ecology* 14: 2419–2432). Most dispersal routes follow prevailing winds and currents; a notable exception is *A. longiceps* on Navassa Island (left; no. 6 on the map), which is to the southeast of Cuba. Over-water dispersal of the ancestors of *A. longiceps* was presumably facilitated by the counter-clockwise winds associated with hurricanes (Powell. 1999. *Caribbean Journal of Science* 35: 1–13).

mals. In fact, evolutionary biologists predicted the evolution of drug-resistant germs and pesticide-resistant insects. Both are large and well-publicized problems now, especially with the prevalence of drug-resistant diseases such as tuberculosis being on the rise. Evolutionary biologists also were the first to point out that a disease such as avian flu, that currently attacks birds in Asia, could easily evolve into a pandemic killing many millions of people all over the world — a contingency many countries, including the U.S., are investing billions of dollars to address. Evolutionary biologists made predictions about the mechanisms by which evolution proceeds long before the tools for studying evolutionary developmental biology were available to test them. Cutting-edge research from recent years has shown how different-looking morphological structures could evolve from similar underlying genetic building blocks. Scientists used to think that eyes had evolved many times, giving rise to the different structures shown by insects and mammals, for example. Recent discoveries have identified a single gene, called Pax-6, which is involved in the formation of eyes in creatures as diverse as fruit flies, squid, and humans. Apparently, all modern eyes, no matter how different-looking, have evolved from a primitive



Understanding evolution can have important practical applications. Doonesbury © 2005 G.B. Trudeau. Reprinted with permission of Universal Press Syndicate. All rights reserved.

organ found in a shared ancestor. As one final demonstration of its utility, an understanding of evolutionary processes allows us to use DNA to determine paternity, identify bodies, and assign blame in criminal cases.

For those of us engaged in conservation, an understanding of evolution is especially important. "Everybody knows" small populations are at risk, but evolutionary biology explains why, and further predicts how fast they might decline. We all recognize that habitat fragmentation is undesirable, but only because evolutionary theory allows us to analyze the potential genetic consequences. Without the concept of coevolution, how would we understand the strong dependence some plants have on particular pollinators, or why closely related species of parasites often infect closely related hosts? Evolutionary theory also tells us that invasive species are going to adapt to their novel environments and become even more problematic, something managers have to know when designing responses to that problem. Finally, evolution is responsible for the many species of iguanas and other insular species in the Caribbean, and an understanding of DNA and the varying rates at which different kinds of DNA evolve allows us to identify unique populations deserving of extra protection.

The now-defeated Dover board defined a theory as "a well-tested explanation that unifies a broad range of observations." By every measure available to us, evolution is not "just a theory" — as one so often hears it disparagingly called — but is instead an extremely robust and successful theory whose predictive value has repeatedly been demonstrated. Of course, there are many things we do not yet know. As a leading proponent of ID pointed out after the Pennsylvania ruling, "A thousand opinions by a court that a particular scientific theory is invalid will not make that scientific theory invalid … It is going to be up to the scientists who are going to continue to do research in their labs that will ultimately determine that." Some details of evolutionary theory will doubtlessly need to be reformulated as more information comes in — for that's how science works. The time has come for religious zealots to leave their beliefs outside the science classroom, which is properly devoted to studying natural explanations of the phenomena that rule our lives. Evolutionary theory is unlikely to be replaced any time soon.