

SURVIVAL OF THE FAKEST

SCIENCE NOW KNOWS THAT MANY OF THE PILLARS OF DARWINIAN THEORY ARE EITHER FALSE OR MISLEADING. YET BIOLOGY TEXTS CONTINUE TO PRESENT THEM AS FACTUAL EVIDENCE OF EVOLUTION. WHAT DOES THIS IMPLY ABOUT THEIR SCIENTIFIC STANDARDS?

-- JONATHAN WELLS

If you had asked me during my years studying science at Berkeley whether or not I believed what I read in my science textbooks, I would have responded much as any of my fellow students: puzzled that such a question would be asked in the first place. One might find tiny errors, of course, typos and misprints. And science is always discovering new things. But I believed – took it as a given – that my science textbooks represented the best scientific knowledge available at that time.

It was only when I was finishing my Ph.D. in cell and development biology, however, that I noticed what at first I took to be a strange anomaly. The textbook I was using prominently featured drawings of vertebrate embryos – fish, chickens, humans, etc. – where similarities were presented as evidence for descent from a common ancestor. Indeed, the drawings did appear very similar. But I'd been studying embryos for some time, looking at them under a microscope. And I knew that the drawings were just plain wrong.

I re-checked all my other textbooks. They all had similar drawings, and they were all obviously wrong. Not only did they distort the embryos they pictured; they omitted earlier stages in which the embryos look very different from one another.

Like most other science students, like most scientists themselves, I let it pass. It didn't immediately affect my work, and I assumed that while the texts had somehow gotten this particular issue wrong, it was the exception to the rule. In 1997, however, my interest in the embryo drawings was revived when British embryologist Michael Richardson and his colleagues published the result of their study comparing the textbook drawings with actual embryos. As

Richardson himself was quoted in the prestigious journal *Science*: “It looks like it’s turning out to be one of the most famous fakes in biology.”

Worse, this was no recent fraud. Nor was its discovery recent. The embryo drawings that appear in most every high school and college textbook are either reproductions of, or based on, a famous series of drawings by the 19th century German biologist and fervent Darwinian, Ernst Haeckel, and they have been known to scholars of Darwin and evolutionary theory to be forgeries for over a hundred years. But none of them, apparently, have seen fit to correct this almost ubiquitous misinformation.

Still thinking this an exceptional circumstance, I became curious to see if I could find other mistakes in the standard biology texts dealing with evolution. My search revealed a startling fact however: Far from being exceptions, such blatant misrepresentations are more often the rule. In my recent book I call them “Icons of Evolution,” because so many of them are represented by classic oft-repeated illustrations which, like the Haeckel drawings, have served their pedagogical purpose only too well – fixing basic misinformation about evolutionary theory in the public’s mind.

We all remember them from biology class: the experiment that created the “building blocks of life” in a tube; the evolutionary “tree,” rooted in the primordial slime and branching out into animal and plant life. Then there were the similar bone structures of, say, a bird’s wing and a man’s hand, the peppered moths, and Darwin’s finches. And, of course, the Haeckel embryos.

As it happens, all of these examples, as well as many others purportedly standing as evidence of evolution,

turn out to be incorrect. Not just slightly off. Not just slightly mistaken. On the subject of Darwinian evolution, the texts contained massive distortions and even some faked evidence. Nor are we only talking about high-school textbooks that some might excuse (but shouldn't) for adhering to a lower standard. Also guilty are some of the most prestigious and widely used college texts, such as Douglas Futuyma's *Evolutionary Biology*, and the latest edition of the graduate-level textbook *Molecular Biology of the Cell*, co-authored by the president of the National Academy of Sciences, Bruce Alberts. In fact, when the false "evidence" is taken away, the case for Darwinian evolution, in the textbooks at least, is so thin it's almost invisible.

Life in a Bottle

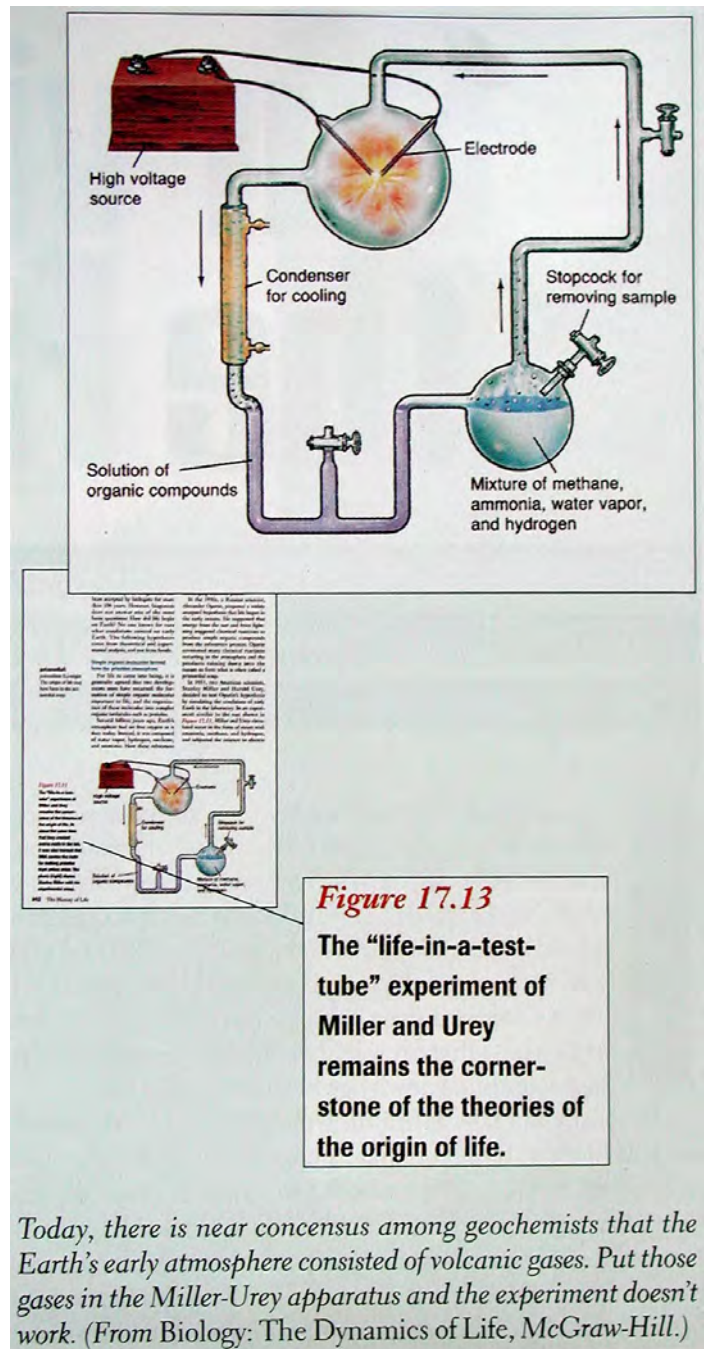
Anyone old enough in 1953 to understand the import of the news remembers how shocking, and to many, exhilarating, it was. Scientists Stanley Miller and Harold Urey had succeeded in creating "the building blocks" of life in a flask. Mimicking what were believed to be the natural conditions of the early Earth's atmosphere, and then sending an electric spark through it, Miller and Urey had formed simple amino acids. As amino acids are the "building blocks" of life, it was thought just a matter of time before scientists could themselves create living organisms.

At the time, it appeared a dramatic confirmation of evolutionary theory. Life wasn't a "miracle." No outside agency or divine intelligence was necessary. Put the right gasses together, add electricity, and life is bound to happen. It's a common event. Carl Sagan could thus confidently predict on PBS that the planets orbiting those "billllions and billllions" of stars out there must be just teeming with life.

There were problems, however. Scientists were never able to get beyond the simplest amino acids in their simulated primordial environment, and the creation of proteins began to seem not a small step or couple of steps, but a great, perhaps impassable, divide.

The telling blow to the Miller-Urey experiment, however, came in the 1970's, when scientists began to conclude that the Earth's early atmosphere was nothing like the mixture of gasses used by Miller and Urey. Instead of being what scientists call a "reducing," or hydrogen-rich environment, the Earth's early atmosphere probably consisted of gasses released by volcanoes. Today there is a near consensus among geochemists on this point. But put those volcanic gasses in the Miller-Urey apparatus, and the experiment doesn't work – in other words, no "building blocks" of life.

What do textbooks do with this inconvenient fact? By and large, they ignore it and continue to use the Miller-



Today, there is near consensus among geochemists that the Earth's early atmosphere consisted of volcanic gases. Put those gases in the Miller-Urey apparatus and the experiment doesn't work. (From *Biology: The Dynamics of Life*, McGraw-Hill.)

Urey experiment to convince students that scientists have demonstrated an important first step in the origin of life. This includes the above-mentioned *Molecular Biology of the Cell*, co-authored by the National Academy of Sciences president, Bruce Alberts. Most textbooks also go on to tell students that origin-of-life researchers have found a wealth of other evidence to explain how life originated spontaneously – but they don't tell students that the researchers themselves now acknowledge that the explanation still eludes them.

Faked Embryos

Darwin thought "by far the strongest single class

of facts in favor of” his theory came from embryology. Darwin was not an embryologist, however, so he relied on the work of German biologist Ernst Haeckel, who produced drawings of embryos from various classes of vertebrates to show that they are virtually identical in their earliest stages, and become noticeably different only as they develop. It was this pattern that Darwin found so convincing.

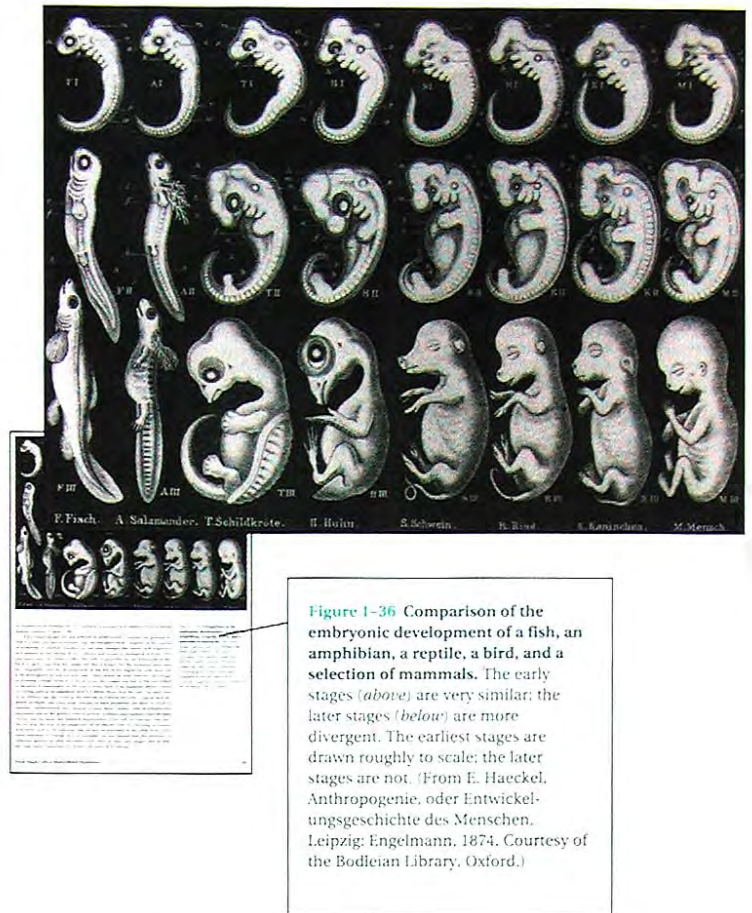
This may be the most egregious of distortions, since biologists have known for over a century that vertebrate embryos never look as similar as Haeckel drew them. In some cases, Haeckel used the same woodcut to print embryos that were supposedly from different classes. In others, he doctored his drawings to make the embryos appear more alike than they really were. Haeckel’s contemporaries repeatedly criticized him for these misrepresentations, and charges of fraud abounded in his lifetime. In 1997, British embryologist Michael Richardson and an international team of experts compared Haeckel’s drawings with photographs of actual vertebrate embryos, demonstrating conclusively that the drawings misrepresent the truth.

The drawings are misleading in another way. Darwin based his inference of common ancestry on the belief that the earliest stages of embryo development are the most similar. Haeckel’s drawings, however, entirely omit the earliest stages, which are much different, and start at a more similar midway point. Embryologist William Ballard wrote in 1976 that it is “only by semantic tricks and subjective selection of evidence,” by “bending the facts of nature,” that one can argue that the early stages of vertebrates “are more alike than their adults.”

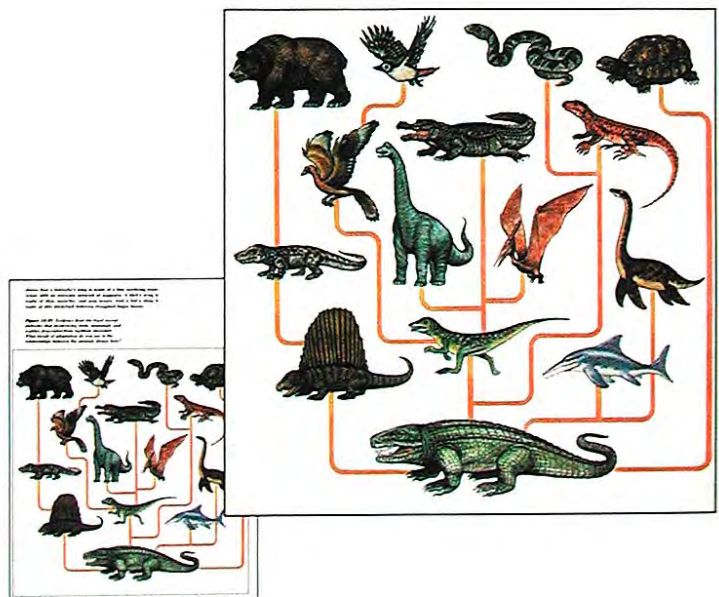
Yet some version of Haeckel’s drawings can be found in most current biology textbooks. Stephen Jay Gould, one of evolutionary theory’s most vocal proponents, recently wrote that we should be “astonished and ashamed by the century of mindless recycling that has led to the persistence of these drawings in a large number, if not a majority, of modern textbooks.” (I will return below to the question of why it is only now that Mr. Gould, who has known of these forgeries for decades, has decided to bring them to widespread attention.)

Darwin’s Tree of Life

Darwin wrote in *The Origin of Species*: “I view all beings not as special creations, but as the lineal descendants of some few beings” that lived



Haeckel’s faked embryos, presented as evidence of evolution in Molecular Biology of the Cell, 3rd Edition, by Bruce Alberts, president of the National Academy of Sciences, et al. (Garland Publishing)



Darwin’s branching “Tree of Life” has been seriously undermined by the fossil record and modern molecular biology. (From Biology, by Miller and Levine, published by Prentice Hall.)

in the distant past. He believed that the differences among modern species arose primarily through natural selection, or survival of the fittest, and he described the whole process as “descent with modification.”

No one doubts, of course, that a certain amount of descent with modification occurs within species. But Darwin’s theory claims to account for the origin of new species – in fact, for every species since the first cells emerged from the primordial ooze.

This theory does have the virtue of making a prediction: If all living things are gradually modified descendants of one or a few original forms, then the history of life should resemble a branching tree. Unfortunately, despite official pronouncements, this prediction has in some important respects turned out to be wrong.

The fossil record shows the major groups of animals appearing fully formed at about the same time in a “Cambrian explosion,” rather than diverging from a common ancestor. Darwin knew this, and considered it a serious objection to his theory. But he attributed it to the imperfection of the fossil record, and he thought that future research would supply the missing ancestors.

But a century and a half of continued fossil collecting has only aggravated the problem. Instead of slight differences appearing first, then greater differences emerging later, the greatest differences appear right at the start. Some fossil experts describe this as “top-down evolution,” and note that it contradicts the “bottom-up” pattern predicted by Darwin’s theory. Yet most current biology textbooks don’t even mention the Cambrian explosion, much less point out the challenge it poses for Darwinian evolution.

Then came the evidence from molecular biology. Biologists in the 1970’s began testing Darwin’s branching-tree pattern by comparing molecules in various species. The more similar the molecules in two different species are, the more closely related they are presumed to be. At first this approach seemed to confirm Darwin’s tree of life. But as scientists compared more and more molecules, they found that different molecules yield conflicting results. The branching-tree pattern inferred from one molecule often contradicts the pattern obtained from another.

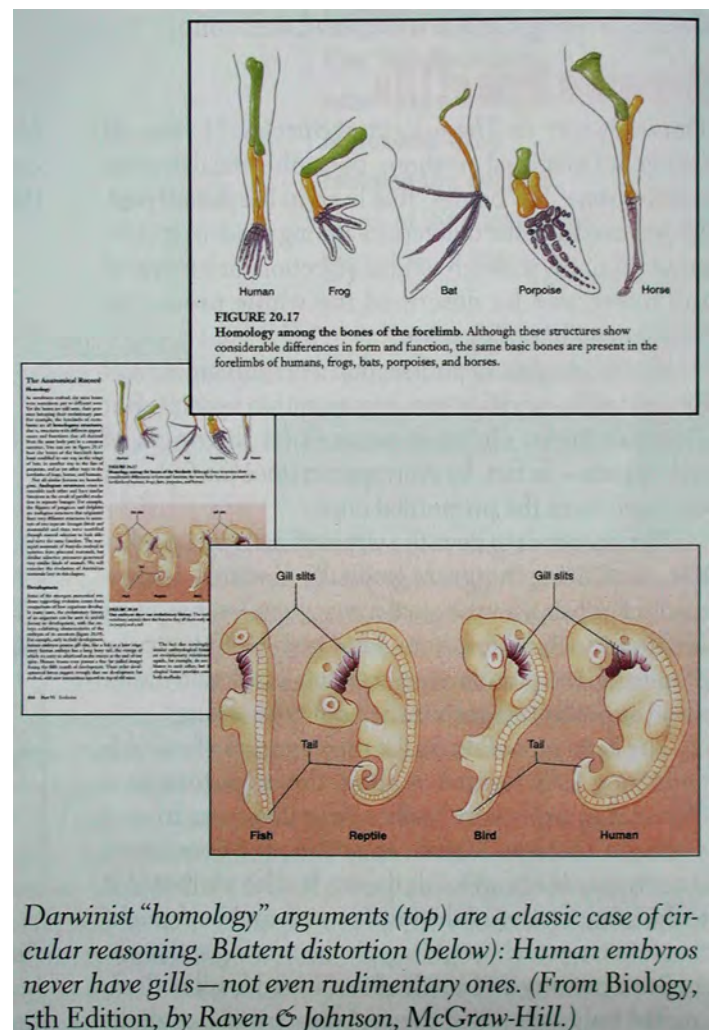
Canadian molecular biologist W. Ford Doolittle doesn’t think the problem will go away. Maybe scientists “have failed to find the ‘true tree,’” he wrote in 1999, “not because their methods are inadequate or because they have chosen the wrong genes, but because the history of life cannot properly be represented as a tree.” Nevertheless, biology textbooks continue to assure students that Darwin’s Tree of Life is a scientific fact overwhelmingly confirmed by evidence. Judging from the real fossil and molecular

evidence, however, it is an unsubstantiated hypothesis masquerading as a fact.

They All Look Alike: Homology in Vertebrate Limbs

Most introductory biology textbooks carry drawings of vertebrate limbs showing similarities in their bone structures. Biologists before Darwin had noticed this sort of similarity and called it “homology,” and they attributed it to construction on a common archetype or design. In *The Origin of Species*, however, Darwin argued that the best explanation for homology is descent with modification, and he considered it evidence for his theory.

Darwin’s followers rely on homologies to arrange fossils in branching trees that supposedly show ancestor-descendant relationships. In his 1990 book, *Evolution and the Myth of Creationism*, biologist Tim Berra compared the fossil record to a series of Corvette models: “If you compare a 1953 and a 1954 Corvette, side by side, then a 1954 and a 1955 model, and so on, the descent with modification is overwhelmingly obvious.”



But Berra forgot to consider a crucial, and obvious, point: Corvettes, so far as anyone has yet been able to determine, don't give birth to little Corvettes. They, like all automobiles, are designed by people working for auto companies. In other words, an outside intelligence. So although Berra believed he was supporting Darwinian evolution rather than the pre-Darwinian explanation, he unwittingly showed that the fossil evidence is compatible with either. Law professor (and critic of Darwinism) Phillip E. Johnson dubbed this: "Berra's Blunder."

The lesson of Berra's Blunder is that we need to specify a natural mechanism before we can scientifically exclude designed construction as the cause of homology. Darwinian biologists have proposed two mechanisms: developmental pathways and genetic programs. According to the first, homologous features arise from similar cells and processes in the embryo; according to the second, homologous features are programmed by similar genes.

But biologists have known for a hundred years that homologous structures are often not produced by similar developmental pathways. And they have known for thirty years that they are often not produced by similar genes, either. So there is no empirically demonstrated mechanism to establish that homologies are due to common ancestry rather than common design.

Without a mechanism, modern Darwinists have simply defined homology to mean similarity due to common ancestry. According to Ernst Mayr, one of the principal architects of modern neo-Darwinism: "After 1859 there has been only one definition of homologous that makes biological sense: Attributes of two organisms are homologous when they are derived from an equivalent characteristic of the common ancestor."

This is a classic case of circular reasoning. Darwin saw evolution as a theory, and homology as its evidence. Darwin's followers assume evolution is independently established, and homology is its result. But you can't then use homology as evidence for evolution except by reasoning in a circle: Similarity due to common ancestry demonstrates common ancestry.

Philosophers of biology have been criticizing this approach for decades. As Ronald Brady wrote in 1985: "By making our explanation into the definition of the condition to be explained, we express not scientific hypothesis but belief. We are so convinced that our explanation is true that we no longer see any need to distinguish it from the situation we were trying to explain. Dogmatic endeavors of this kind must eventually leave the realm of science."

So how do the textbooks treat this controversy? Once again, they ignore it. In fact, they give students the



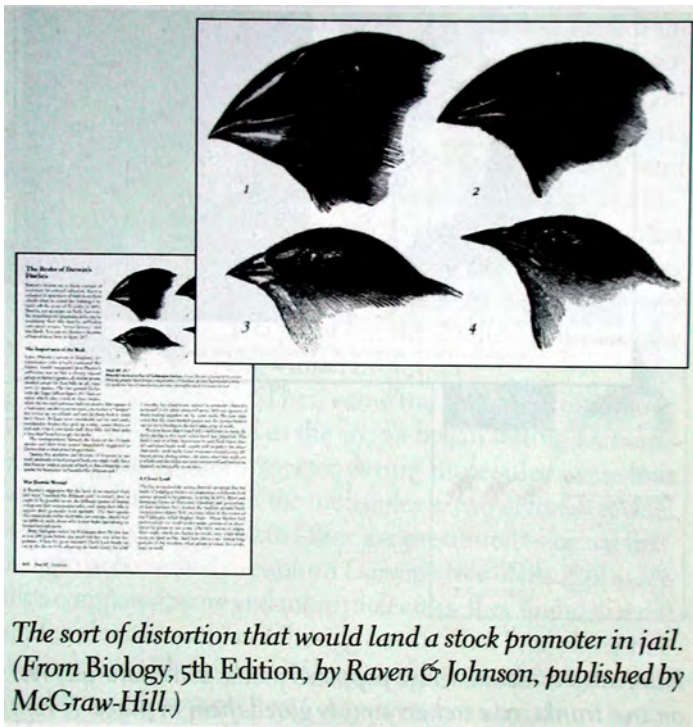
impression that it makes sense to define homology in terms of common ancestry and then turn around and use it as evidence for common ancestry. And they call this "science."

Nothing a Little Glue Can't Fix: The Peppered Moths

Darwin was convinced that in the course of evolution, "Natural Selection has been the most important, but not the exclusive means of modification," but he had no direct evidence of this. The best he could do in *The Origin of Species* was give "one or two imaginary illustrations."

In the 1950's, however, British physician Bernard Kettlewell provided what seemed to be conclusive evidence of natural selection. During the previous century, peppered moths in England had gone from being predominantly light-colored to being predominantly dark-colored. It was thought that the change occurred because dark moths are better camouflaged on pollution-darkened tree trunks, and thus less likely to be eaten by predatory birds.

To test this hypothesis experimentally, Kettlewell released light and dark moths onto nearby tree trunks in polluted and unpolluted woodlands, then watched as birds ate the more conspicuous moths. As expected, birds ate more light moths in the polluted woodland, and more dark moths in the unpolluted one. In an article written for *Scientific American*, Kettlewell called this "Darwin's missing evidence." Peppered moths soon became the classic example



Apparently, the “later” can be much later. When University of Chicago Professor Jerry Coyne learned the truth in 1998, he was well into his career as an evolutionary biologist. His experience illustrates how insidious the icons of evolution really are, since they mislead experts as well as novices.

Beaks and Birds: Darwin’s Finches

A quarter of a century before Darwin published *The Origin of Species*, he was formulating his ideas as a naturalist aboard the British survey ship H.M.S. Beagle. When the Beagle visited the Galapagos Islands in 1835, Darwin collected specimens of the local wildlife, including some finches.

Though the finches had little in fact to do with Darwin’s development of evolutionary theory, they have attracted considerable attention from modern evolutionary biologists as further evidence of natural selection. In the 1970’s, Peter and Rosemary Grant and their colleagues noted a 5 percent increase in beak size after a severe drought, because the finches were left with only hard-to-crack seeds. The change, though significant, was small; yet some Darwinists claim it explains how finch species originated in the first place.

A 1999 booklet published by the U.S. National Academy of Sciences describes Darwin’s finches as “a particularly compelling example” of the origin of species. The booklet cites the Grants’ work, and explains how “a single year of drought on the islands can drive evolutionary changes in the finches.” The booklet also calculates that “if droughts occur about once every 10 years on the islands, a new species of finch might arise in only about 200 years.”

But the booklet fails to point out that the finches’ beaks returned to normal after the rains returned. No net evolution occurred. In fact, several finch species now appear to be merging through hybridization, rather than diverging through natural selection as Darwin’s theory requires.

Withholding evidence in order to give the impression that Darwin’s finches confirm evolutionary theory borders on scientific misconduct. According to Harvard biologist Louis Guenin (writing in *Nature* in 1999), U.S. securities laws provide “our richest source of experiential guidance” in defining what constitutes scientific misconduct. But a stock promoter who tells his clients that a particular stock can be expected to double in value in twenty years because it went up 5 percent in 1998, while concealing the fact that the same stock declined 5 percent in 1999,

of natural selection in action, and the story is still retold in most introductory biology textbooks, accompanied by photographs of the moths on tree trunks.

In the 1980’s, however, researchers discovered evidence that the official story was flawed – including the pertinent fact that peppered moths don’t normally rest on tree trunks. Instead, they fly by night and apparently hide under upper branches during the day. By releasing moths onto nearby tree trunks in daylight, Kettlewell had created an artificial situation that does not exist in nature. Many biologists now consider his results invalid, and some even question whether natural selection was responsible for the observed changes.

So where did all those textbook photos of peppered moths on tree trunks come from? They were all staged. To expedite things, some photographers even glued dead moths to trees. Of course, the people who staged them before the 1980’s thought they were accurately representing the true situation, but we now know they were mistaken. Yet a glance at almost any current biology textbook reveals that they are all still being used as evidence for natural selection.

In 1999, a Canadian textbook-writer justified the practice: “You have to look at the audience. How convoluted do you want to make it for a first time learner?” Bob Ritter was quoted as saying in the April 1999 *Alberta Report Newsmagazine*. High school students “are still very concrete in the way they learn,” continued Ritter. “We want to get across the idea of selective adaptation. Later on, they can look at the work critically.”

might well be charged with fraud. As Berkeley law professor Phillip E. Johnson wrote in *The Wall Street Journal* in 1999: “When our leading scientists have to resort to the sort of distortion that would land a stock promoter in jail, you know they are in trouble.”

From Apes to Humans

Darwin’s theory really comes into its own when it is applied to human origins. While he scarcely mentioned the topic in *The Origin of Species*, Darwin later wrote extensively about it in *The Descent of Man*. “My object,” he explained, “is to show that there is no fundamental difference between man and the higher animals in their mental faculties” - even morality and religion. According to Darwin, a dog’s tendency to imagine hidden agency in things moved by the wind “would easily pass into the belief in the existence of one or more gods.”

Of course, the awareness that the human body is part of nature was around long before Darwin. But Darwin was claiming much more. Like materialistic philosophers since ancient Greece, Darwin believed that human beings are nothing more than animals.

Darwin, however, needed evidence to confirm his conjecture. Although Neanderthals had already been found, they were not then considered ancestral to humans, so Darwin had no fossil evidence for his view. It wasn’t until 1912 that amateur paleontologist Charles Dawson announced that he had found what Darwinists were looking for, in a gravel pit at Piltdown, England.

Dawson had found part of a human skull and part of an apelike lower jaw with two teeth. It wasn’t until forty years later that a team of scientists proved that the Piltdown skull, though perhaps thousands of years old, belonged to a modern human, while the jaw fragment was more recent, and belonged to a modern orangutan. The jaw had been chemically treated to make it look like a fossil, and its teeth had been deliberately filed down to make them look human. Piltdown Man was a forgery.

Most modern biology textbooks do not even mention Piltdown. When critics of Darwinism bring it up, they are usually told that the incident merely proves that science is self-correcting. And so it was, in this case - though the correction took over forty years. But the more interesting lesson to be learned from Piltdown is that scientists, like everyone else, can be fooled into seeing what they want to see.

The same subjectivity that prepared the way for Piltdown continues to plague human-origins research. According to paleoanthropologist Misia Landau, theories of human

origins “far exceed what can be inferred from the study of fossils alone and in fact place a heavy burden of interpretation on the fossil record – a burden which is relieved by placing fossils into pre-existing narrative structures.” In 1996, American Museum of Natural History Curator Ian Tattersall acknowledged that “in paleoanthropology, the patterns we perceive are as likely to result from our unconscious mindsets as from the evidence itself.” Arizona State University anthropologist Geoffrey Clark echoed this view in 1997 when he wrote: “We select among alternative sets of research conclusions in accordance with our biases and preconceptions.” Clark suggested that “paleoanthropology has the form but not the substance of science.”

Biology students and the general public are rarely informed of the deep-seated uncertainty about human origins that is reflected in these statements by scientific experts. Instead, they are simply fed the latest speculation as though it were a fact. And the speculation is typically illustrated with fanciful drawings of cave men, or pictures of human actors wearing heavy make-up.

What’s Going on Here?

Most of us assume that what we hear from scientists is comparatively trustworthy. Politicians might distort or shave the truth to support a preconceived agenda, but scientists, we are told, deal with facts. Sure they might sometimes get it wrong, but the beauty of science is that it’s empirically testable. If a theory is wrong, this will be discovered by other scientists performing independent experiments either to replicate or disprove their results. In this way the data are constantly reviewed and hypotheses become widely accepted theories. So how do we explain such a pervasive and long-standing distortion of the specific facts used to support evolutionary theory?

Perhaps Darwinian evolution has taken on a significance in our culture that has little to do with its scientific value, whatever that may be. An indication of this was seen in the nearly universal and censorious reaction to the Kansas School Board’s decision to allow room for dissent in the standard teaching of evolution (much of which, as we have just seen, is plain wrong).

According to the news media, only religious fundamentalists question Darwinian evolution. People who criticize Darwinism, we are told, want to bomb science back to the Stone Age and replace it with the Bible. The growing body of scientific evidence contradicting Darwinian claims is steadfastly ignored. When biochemist Michael Behe pointed out in *The New York Times* last year that the embryo “evidence” for evolution was faked, Harvard Dar-

winist Stephen Jay Gould admitted that he had known this for decades (as noted above) – but accused Behe of being a “creationist” for pointing it out.

Now, although Behe supports the idea that some features of living things are best explained by intelligent design, he is not a “creationist” as that word is normally used. Behe is a molecular biologist whose scientific work has convinced him that Darwinian theory doesn’t conform to observation and experimental evidence. Why does Gould, who knows Haeckel’s drawings were faked, dismiss Behe as a creationist for criticizing them?

I suspect that there’s an agenda other than pure science at work here. My evidence is the more or less explicit materialist message woven into many textbook accounts. Futuyma’s *Evolutionary Biology* is characteristic of this, informing students that “it was Darwin’s theory of evolution,” together with Marx’s theory of history and Freud’s theory of human nature, “that provided a crucial plank to the platform of mechanism and materialism” that has since been “the stage of most Western thought.” One textbook quotes Gould, who openly declares that humans are not created, but are merely fortuitous twigs on a “contingent” (i.e. accidental) tree of life. Oxford Darwinist Richard Dawkins,

though not writing in a textbook, puts it even more bluntly: “Darwin made it possible to be an intellectually fulfilled atheist.”

These are obviously philosophical rather than scientific views. Futuyma, Gould, and Dawkins have a right to their philosophy. But they do not have the right to teach it as though it were science. In science, all theories – including Darwinian evolution – must be tested against the evidence.

Since Gould knows that the real embryological evidence contradicts the faked drawings in biology textbooks, why doesn’t he take a more active role in cleaning up science education? The misrepresentations and omissions I’ve examined here are just a small sampling. There are many more. For too long the debate about evolution has assumed “facts” that aren’t true. It’s time to clear away the lies that obstruct popular discussion of evolution, and insist that theories conform to the evidence. In other words, it’s time to do science as it’s supposed to be done.

Permission is granted to copy this article for non-commercial purposes provided credit is given to Discovery Institute

Are Your Children Using These Textbooks?

Jonathan Wells analyzed ten popular high school biology textbooks. The texts were evaluated on how well they dealt with the evolutionary “evidence” of the Miller-Urey experiment, Haeckel’s embryos, Darwin’s Tree of Life, vertebrate limb homology, peppered moths, and Darwin’s finches.

An “A” grade signifies the book had full disclosure of the truth, discussion of relevant scientific controversies, and a recognition that Darwin’s theory—like all scientific theories—might have to be revised or discarded if it doesn’t fit the facts. An “F” indicates that the textbook uncritically relies on logical fallacy, dogmatically treats a theory as an unquestionable fact, or blatantly misrepresents published scientific evidence. The overall grades are below.

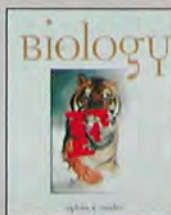
D- *Biology: The Dynamics of Life* by Alton Biggs, Chris Kapicka & Linda Lundgren (Glencoe/McGraw-Hill, 1998)

D+ *Biology (Fifth Edition)* by Neil A. Campbell, Jane B. Reece & Lawrence G. Mitchell (Benjamin/Cummings Publishing Co., 1999)

D- *Evolutionary Biology (Third Edition)* by Douglas J. Futuyma (Sinauer Associates, 1998)

F *Biology: The Unity and Diversity of Life (Eighth Edition)* by Cecie Starr & Ralph Taggart (Wadsworth Publishing Co., 1998)

F *Biology (Sixth Edition)* by Sylvia Mader (WBC/McGraw-Hill, 1998)



F *Biology (Fifth Edition)* by Peter H. Raven & George B. Johnson (WBC/McGraw-Hill, 1999)

F *Biology* by Burton S. Guttman (WBC/McGraw-Hill, 1999)

F *Biology: Visualizing Life, Annotated Teacher’s Edition* by George B. Johnson (Holt, Rinehart & Winston, 1998)

F *Biology (Fifth Edition)* by Kenneth R. Miller & Joseph Levine (Prentice Hall, 2000)

F *Biology: The Study of Life (Seventh Edition)* by William D. Schraer & Herbert J. Stoltz (Prentice Hall, 1999)

