Review of *Darwin's Dangerous Idea* by Daniel C. Dennett

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No idea in science has been more threatening to humans' conceptions about themselves than Darwin's theory of evolution; it arguably has been the most controversial idea in the history of science. To most scientifically minded people today, the tenets of evolution—that species had a common ancestor, that they changed adaptively over time, and that the cause of such adaptive change was natural selection on heritable traits with variation—may seem obvious and even self-evident. How can we look at the biological world and not see that, say, humans and chimps are closely related? How could anyone have thought otherwise? But even at the end of the 20th century, this strong feeling among some that evolution must have happened, that the history of life could not have taken any other form, is mirrored by an equally strong feeling among others—for the most part, fundamentalist Christians—that evolution is dangerously wrong: that it takes away all that is special about humans and that school children must be protected (increasingly by legislation and controls on teachers) from what the detractors believe to be its pernicious influence.

Daniel Dennett's book, *Darwin's Dangerous Idea*, is an eloquent and insightful exposition and defense of Darwin's theory of evolution by natural selection, expressing awe for its grandeur and range and detailing some of its philosophical implications, ranging from biology to human cognition and behavior, from language to morality. Dennett, a philosopher, was never one to shirk from big ideas; for example, his previous book was called "Consciousness Explained." But in the current book, he has tackled what he considers the biggest idea of all:

> If I were to give an award for the single best idea anyone has ever had, I'd give it to Darwin, ahead of Newton and Einstein and everyone else. In a single stroke, the idea of evolution by natural selection unifies the realm of life, meaning, and purpose with the realm of space and time, cause and effect, mechanism and physical law.

That's a pretty big order for a single idea. What is the idea? Dennett frames it very simply: "Darwin's dangerous idea is that Design can emerge from mere Order via an algorithmic process that makes no use of pre-existing Mind." Of course Darwin had no notion of "algorithms". Dennett uses that modern shorthand to refer to processes that are "mindless, purposeless, mechanical". In other words, evolution by natural selection can be seen as mindlessly following a recipe: take a population, have individuals that are adapted well enough to survive give birth to offspring who inherit their parent's genes, randomly change the children's genes a little bit (via mutation, sexual recombination, and other random procedures), have the children that are themselves adapted well-enough to survive themselves give birth to children (generally, the better adapted, the more children), and so on *ad infinitum*.

(Notice that in mindlessly following a recipe, the process is allowed to invoke some random chance.) The truly amazing thing, Dennett asserts, is that out of this simple, "purposeless" process arise all the complexities of life, all the order out of chaos, all the appearance of purposiveness and *design*:

> Give me Order, [Darwin] says, and time, and I will give you Design. Let me start with regularity—the mere purposeless, mindless, pointless regularity of physics—and I will show you a process that eventually will yield products that exhibit not just regularity but purposive design.

Is this invoking the production of something out of nothing? Certainly not, Dennett says, and to make this clear he uses the metaphor of "skyhooks" versus "cranes". A skyhook is basically a "something out of nothing" machine—a hook from the sky that is good for "lifting unwieldy objects out of difficult circumstances, and speeding up all sorts of construction projects." In other words, a skyhook is metaphor for any mystical device that could be used to miraculously build order and design from nothing. A crane, on the other hand, is a construction machine of the world, one that "can do the lifting work our imaginary skyhooks might do, and...do it in an honest, non-question-begging fashion." Darwin's dangerous idea is that the history of life is one of cranes, not skyhooks. And Darwin's contribution was to give us some sense of how those more mundane cranes did the lifting work to produce the biological complexity we see today.

Darwin's idea was (and still is) considered "dangerous" because of the challenge it presents to the deeply ingrained belief that there is something *special* about life, and in particular about *human* life, consciousness, emotions, and so on, that can't simply be the result of billions and billions of applications of a simple, mindless, mechanistic process. If the basic mechanistic premise of evolution is accepted, one's views of the world and one's own place in it are deeply affected. Dennett likens this effect to "universal acid", a mythical chemical that eats through—and thus transforms—everything in its path. Like universal acid, Darwin's idea "eats through just about every traditional concept, and leaves in its wake a revolutionized world-view, with most of the old landmarks still recognizable, but transformed in fundamental ways." But does this Darwinian universal acid leave all our cherished notions about life and humanity burned and smoking in its wake? "Can *any* version of [our] attitude of wonder and purpose be sustained in the face of Darwinism?" Most of Dennett's book is spent showing how we can believe in Darwinism and still answer that question in the affirmative.

Like any good book on grand ideas, Darwin's Dangerous Idea is wide ranging, inspiring, entertaining, immensely thought-provoking, and will provide many readers with a new understanding of the idea of evolution and its vast implications. Also, like most very opinionated books on grand ideas, *Darwin's Dangerous Idea* is sometimes harsh and inflammatory, as will be elaborated below.

Dennett is very much a philosopher, not an evolutionary biologist; likewise, *Darwin's Dangerous Idea* is a philosophy book, not a textbook or general-readership exposition of Darwinism. In spite of its subject matter, there is very little biology in this book. There

is little technical discussion of the current state of evolutionary theory or its open questions concerning the mechanisms of speciation, the evolution of sexual recombination, the role of development in evolution, and so on. Rather, the book deals with the intellectual history and philosophical implications of accepting the "algorithmic" view of evolution, and the landscape of philosophical debate on this topic.

In the spirit of good philosophical writing, these ideas are explained via a number of wonderful "thought experiments". My favorite is the "Library of Mendel" (Dennett's adaptation of Jorge Luis Borges's "Library of Babel") in which all possible genotypes reside. This metaphorical library recurs throughout the book to make vivid the vastness of "genome space", the biological possibilities inherent in it, and how the trajectories taken by evolution thorough this vast library serve to create "Design". There are also some beautiful ties between Darwinism and other milestones in the history of ideas:

> It has often been pointed out that Plato's curious theory of reincarnation and reminiscence, which he offers as an explanation of the source of our *a priori* knowledge, bears a striking resemblance to Darwin's theory, and this resemblance is particularly striking from our current vantage point. Darwin himself famously noted the resemblance in a remark in one of his notebooks. Commenting on the claim that Plato thought our 'necessary ideas' arise from the pre-existence of the soul, Darwin wrote: 'read monkeys for preexistence'.

One of Dennett's main purposes in writing this book was to defend Darwinism against its enemies. Naturally, religious fundamentalists are counted among these, and, like Bertrand Russell in his essay "Why I am not a Christian", Dennett is forthright in his doubts about "taking faith seriously as a *way of getting to the truth*", as opposed to "just a way people comfort themselves and each other (a worthy function that I do take seriously)". However, the unexpected chief enemy of Darwinism in *Darwin's Dangerous Idea*—at least the one that rates the most virulent attack—is not a textbook-burning fundamentalist but rather the eminent evolutionist Stephen Jay Gould.

Gould is no stranger to controversy, but this book gives what is one of the most vehement (and ultimately unfair) criticisms of him that I have seen. Readers unfamiliar with Gould's work and the controversies surrounding it may find it hard to follow Dennett's analysis—the discussion presupposes a fair amount of knowledge about the issues involved. I will attempt to sketch the general thrust of these debates (from my own vantage as an interested non-expert) before discussing Dennett's views.

Gould has questioned what is considered by some to be the crux of Darwinism—that the source of adaptive change in organisms is the process of natural selection acting upon organisms, incrementally shaping traits by selecting those variations that yield increased survivability. This traditional view is very much one of gradual change, with modified or new traits surviving only if they confer adaptive advantage on organisms. In contrast, Gould sees evolutionary change as having important components of both contingency and constraint. That is, in Gould's view, certain traits arise and endure in some cases purely by "accident" (due to causes outside the adaptive force of natural selection) and in other cases

because they are forced by developmental constraints, without conferring any survival or reproductive advantage on their possessors. As Gould says, "if highly constraining channels are built of nonadaptations, and if evolutionary versatility resides primarily in the nature and extent of nonadaptive pools, then 'internal factors' of organic design are an equal partner with selection." (Gould, 1982.) Gould, in his book *Wonderful Life* (Gould, 1989), illustrates his claim of the importance of historical contingency in evolutionary change by describing the now-lost organisms of the Cambrian epoch's Burgess Shale, whose strange forms, he claimed, make them hard to fit into any modern phyla of organisms. One of Gould's main points in that book was that there is no explanation, other than historical chance, for why those phyla did not survive and why others did. Gould drives home his point by asserting that if the "tape of life" were rerun from the time of life's origin to the present (presumably with different random events along the way), the biological world would look very different—much of what we see (and are) today is the result of historical contingency rather than selective pressures.

All this does not mean that Gould dismisses natural selection as a force in evolution; rather, he is questioning the assumption of its dominant role, and saying that there is more to the story.

Dennett, like many others, strongly opposes Gould's view, and in *Darwin's Dangerous Idea* attacks him in very strong terms over the course of two chapters. (It will probably not be clear to the non-specialist reader—at least it was not to this non-specialist reader—why Dennett attacks Gould so relentlessly and in such detail.)

The thrust of the attack is that Gould is anti-Darwinist, and that in his insistence on the importance of random chance and "historical contingency" in evolution, he is rejecting the premise that evolution is algorithmic and is instead requiring "skyhooks": "Gould, like eminent evolutionary thinkers before him, has been searching for skyhooks to limit the power of Darwin's dangerous idea....[his] ultimate target is Darwin's dangerous idea itself; he is opposed to the very idea that evolution is, in the end, just an algorithmic process."

In addition to the critique of Gould's ideas, Dennett brings up analyses of his own and of others of how Gould's ideas on evolution might have been influenced by his personal political beliefs, purported religious feelings, and even the "fact" that he "is not fond of computers, and to this day does not even use a computer for word-processing." Dennett points out that he himself does not necessarily agree with all of these analyses, but, to my reading, the discussion has the flavor of an *ad hominem* attack against Gould. While the critique of Gould's *ideas* is interesting whether one agrees with it or not, bringing in Gould's possible personal "motives" seems inappropriate.

To a nonexpert reader like myself, Dennett seems correct in saying that many of Gould's claims are not well-enough defined to be testable. For example, in *Wonderful Life* and in other publications, Gould makes statements about the "spectacular diversity of the Burgess Shale fauna"—the empirical "fact" of this diversity is central to his main points. However, "diversity", or how to measure it, is never well defined, so how do we really know that the amount of diversity is enough to support Gould's conclusions? Gould himself has addressed this question in later writings (e.g., Gould, 1991) in which he cites the need for a precise for-

mulation of a "morphology space" in which morphological distances and degrees of diversity can be rigorously measured.

Dennett also takes Gould to task for making unsupported claims about "the tape of life":

> He seems to think that, if we replayed the tape of life, we couldn't get another 'Cambrian' Explosion the next time, or ever. But although that might be true, he has not yet offered us a single bit of evidence.

Dennett then proposes that such ideas might be testable by "Artificial Life" modeling, and chides Gould for not suggesting this:

> Where might such evidence come from? It might come from the computer simulations of Artificial Life, for instance, which do permit us to rewind the tape again and again. It is surprising that Gould has overlooked the possibility that he might find some evidence for (or against) his main conclusion by looking at the field of Artificial Life, but he never mentions the prospect.

I agree with Dennett's assessment that Gould's "tape of life" claim lacks evidence, and as someone who works in the fields of evolutionary computation and "artificial life", I have every hope and expectation that such models will eventually yield insights of the kind Dennett proposes. However, if Dennett is proposing the current technology of artificial life as a tool for this, I think he is far too optimistic: artificial-life modeling today is too primitive as yet to give conclusive (or even anything more than very mildly suggestive) evidence about this sort of thing.

Putting aside the question of whether Gould's ideas are right or wrong, or even whether they are vague and unsupported, Dennett's conclusion that Gould rejects Darwinism and believes in "skyhooks" seems to me to be unfounded. My understanding is that there is nothing incompatible with Dennett's formulation of Darwinism as a mindless, "algorithmic" process and Gould's view of the importance of historical contingency and developmental constraints along with natural selection. Dennett was not able to convince me that Gould's views were incompatible with an extended form of Darwinism that still refuses to rely on skyhooks for its big moves. Perhaps this is just a disagreement about the meaning of "skyhook". Dennett seems to want to include "contingency" or "self-organization" in the definition—these things seem to be, to his mind, not admissible in a Darwinian account of evolution.

Is natural selection the whole story? Dennett seems to think so. He quotes the evolutionary biologist Richard Dawkins as saying, "The one thing that makes evolution such a neat theory is that it explains how organized complexity can arise out of primeval simplicity,", and agrees, adding, "This is one of the key strengths of Darwin's idea, and the key weakness of the alternatives."

But although natural selection explains many things, there are still many things we do not understand about how, in evolution, "organized complexity can arise out of primeval simplicity".

First, the notion of "organized complexity" is at least as ill-defined in biology as the notion of morphological diversity. We have an intuitive sense that worms are more complex than bacteria and that humans are more complex than worms, but there have been many different definitions of "complexity" in biological contexts (e.g., length of chromosomes, number of coding genes, number of cells, number of different cell types, degree of hierarchical construction, degree of specialization, etc.) and it is not clear which ones natural selection can "explain". Setting aside these difficulties and assuming that we have some definition of complexity and a means of measuring it, our current formulation of Darwin's theory of evolution still cannot answer questions such as, under what conditions will complexity increase in evolution, and how long will it take for a transition from one level of complexity to another to occur? It is important to keep such questions in mind when assessing the explanatory power of any theory of the evolution of organisms.

The last third of the book deals with a variety of topics in the human realm: cultural evolution, language, the mind, morality, and their relationship to Darwinism. Here Dennett is on his familiar and strong ground, especially in his discussions on consciousness. His intuitions on how evolution—a "mindless, purposeless, mechanical" process—can produce order and seemingly purposeful design are similar to his intuitions about how a collection of mindless, purposeless, mechanical neurons can produce the phenomena that we call consciousness, free will, and so on. There are strong connections between intuitions in these two realms. Dennett notes that:

> Through the microscope of molecular biology, we get to witness the birth of *agency*, in the first macromolecules that have enough complexity to 'do things'. ...There is something alien and vaguely repellent about the quasi-agency we discover at this level—all that purposive hustle and bustle, and yet *there's nobody home*. ...Love it or hate it, phenomena like this exhibit the heart of the power of the Darwinian idea. An impersonal, unreflective, robotic, mindless little scrap of molecular machinery is the ultimate basis of all the agency, and hence meaning, and hence consciousness, in the universe.

Later, he makes the same point more vividly:

> Would you want your daughter to marry a robot? Well, if Darwin is right, your great-great-...grandmother *was* a robot!

In other words, we humans, complex and full of conscious awareness, are descended from simple, mindless, macromolecules, with no skyhooks needed to get from there to here. Moreover, we are not only descended from mindless "robots"; we are *composed* of them—molecules, cells, and so on, and nothing else, and all of our mindfulness somehow emerges from that mindless substrate, also with no skyhooks needed. But not to worry; just because we are descended from and made up of mindless components does not make us mindless robots ourselves. Dennett's primary contribution in this book (as in *Consciousness Explained*) is to give us some intuition about how the notion of *emergence* means that we

can still be conscious, have free will and "intentionality", and even have real purpose and meaning in our lives, even if no skyhooks are involved.

The chapters on language, meaning, and morality are fascinating, although new anti-Darwinist villains emerge—the linguist Noam Chomsky chief among them. Dennett accuses Chomsky and some other language theorists of being unwilling to accept *any* evolutionary explanation for the existence of language and other cognitive abilities: according to Dennett, they feel that "if the mind's power is due to cranes, not skyhooks, they would just as soon settle for mystery". Not surprisingly, it turns out that Chomsky and Gould are in cahoots with each other on promoting skyhooks: "Gould...has avidly endorsed Chomsky's view that language didn't really evolve but just rather suddenly arrived, an inexplicable gift, at best a byproduct of the enlargement of the human brain." Like many of the other criticisms of Gould in this book, this seems a bit misleading. Do Chomsky and Gould really believe that there is no ultimately mechanistic explanation for language? Or is the problem instead that they don't accept Darwinism as a *complete* explanation for everything in the biological world, which to Dennett seems to be tantamount to a claim that those things are "inexplicable"? These two possibilities are very different, but Dennett does not seem to distinguish between them.

All in all, *Darwin's Dangerous Idea* is a fascinating, highly opinionated, in some parts unfairly biased, but always extremely lively book about some of the most important ideas in modern science and philosophy, and the very serious and often emotional human debates that center around these issues. It is must reading for anyone interested in the philosophical issues of evolution, especially as they relate to cognition and human behavior.

Acknowledgments

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