

Comment

Design by necessity

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They're back. I suppose we should have always known they'd be back. As in those children's games played with tiny hammers, no sooner have you pounded them down in one place that they pop up somewhere else. I am referring, of course, to the anti-evolutionists. I suppose they're not really back, because they never actually went away. They simply get a little quieter for a while when their argument *du jour* is soundly refuted, but they don't go away. Before long they find some other, seemingly new, irrefutable argument that they cling to the way a drowning man clutches at a straw. The simile is apt, I think; there is a curious element of desperation about their behavior. It resembles that of the test pilot in Thomas Wolfe's *The Right Stuff* (Bantam Doubleday: 1980): aircraft malfunctioning, frantically radioing, "I've tried A! I've tried B!! What do I try next?"

One of the things they tried was asserting that evolution violates the Second Law of Thermodynamics. Life, they argued, is characterized by systems much more ordered than their surroundings. It could not have arisen spontaneously; that would violate the Second Law, which demands an increase in entropy, or disorder, in spontaneous processes. Unfortunately, what the Second Law actually demands is that the entropy of the universe, not the entropy of the process, must increase. The ultimate source of the free energy needed to build ordered systems on earth is, of course, the sun, which is constantly cooling down and gaining entropy, just as the Second Law requires.

They also tried the probability argument: the concentration of key chemical species in the primordial soup must have been too low for the reactions needed to form amino acids, or small peptides, or bits of RNA, to have had other than a minuscule probability of taking place. I tried this argument on a group of biochemistry graduate students as a comprehensive exam question, and got a number of simple, logical answers that did not require creationism: chemicals could have been concentrated in melting ice deposits, or adsorbed into clays and thus brought together. It really is not a

problem at all. The best answer I got was from a student who said, "So what?" Her point was that the probability might indeed have been infinitesimally small, but there are trillions upon trillions of stars - and presumably planets - in the universe, and the extraordinarily lucky chance only had to occur once, here. That would mean we are alone, the only planet with life anywhere, but maybe that's the way it is. I loved that answer because it recognizes the arrogance and paucity of imagination of what biologist Richard Dawkins called the "argument from personal incredulity", which is at the heart of all anti-evolutionary reasoning: if I can't imagine how it could have happened, then it couldn't have happened.

The new idea sprung from this dry well is called Intelligent Design, and it has caught on among creationists like the summer's blockbuster movie. In essence, this theory (and one of the clever things about it is that it presents itself not as doctrine but theory - just another theory, like the theory of evolution, and by implication, entitled to equivalent consideration) argues that living things contain systems so complex that evolution by natural selection could not have produced them. The intellectual underpinning for this theory is Michael Behe's claim (in *Darwin's Black Box: The Biochemical Challenge to Evolution*; Simon & Schuster: 1996) that certain biological systems are "irreducibly complex", meaning that they are composed of several well-matched, interacting parts that work together to provide the basic function, and that the removal of any one of these parts would cause the system to fail. Behe's illustrative example was a well-designed, minimalist mousetrap. (We will ignore the fact that evolution has produced an even better mousetrap - the cat.) Biological examples of seemingly irreducibly complex systems might be the vertebrate eye, or the immune system, or the system for thrombostasis. Phillip E. Johnson (*Defeating Darwinism by Opening Minds*; InterVarsity Press: 1997) and William Dembski (*The Design Inference: Eliminating Chance through Small Probabilities*; Cambridge University Press: 1998), among others, argue that irreducibly complex biological systems could not evolve by slight successive

modifications to a precursor system, with any precursor that was missing a part being by definition nonfunctional; they must therefore have arisen through design by a higher intelligence. Proponents of Intelligent Design rarely specify who the eponymous designer was - that would be bad for the supposedly scientific nature of their argument - but it's pretty obvious Whom they have in mind because they are, for the most part, evangelical Christians.

Until recently, the evolution versus creationism political debate tended to be fought out at the state and local levels in the United States, but there are signs that the battlefield is shifting. Last summer, proponents of Intelligent Design held a briefing to educate members of congress and their staffs on the supposed failures of Darwinism and the moral decay that its teaching has led to. On June 13 of this year the US Senate voted 91-8 in favor of an amendment to the comprehensive public education bill that defines "good science education" as preparing students "to distinguish data or testable theories of science from philosophical or religious claims that are made in the name of science". The amendment further states that "where biological evolution is taught, the curriculum should help students to understand why this subject generates so much controversy, and should prepare the students to be informed participants in public discussions regarding the subject." At first glance the amendment, which was written by Intelligent Design proponents, seems innocuous - but it isn't. If it were, the first part would be "to distinguish scientific claims that are made in the name of religion or philosophy", not the reverse. And there's more: earlier in the same congressional session, a group of conservative lawmakers had stripped a science-testing provision out of a counterpart to the Senate bill in large part because of concerns that the tests would include evolution-related questions.

So they're back, but the argument they are back with doesn't stand up against the evidence of genomics. Comparison of the human genome sequence with those from other animals and from fungi and bacteria reveals that most human genes, even those coding for the parts of "irreducibly complex" systems like the eye, have obvious homologs in creatures that evolution predicts were ancestral to us. Rhodopsin, the visual photosensor (to take but one example) is strikingly similar to other seven-transmembrane helical proteins in bacteria, some of which also sense light, although others perform different functions. Irreducibly complex systems can evolve gradually in biology in part because their precursors do not have to perform the exact same function: the ancestral mousetrap could have been a cheese tray. And the argument that mutating the cheese tray into a mousetrap would be impossible because then one would lose the function of the cheese tray clearly fails when genomic evidence is considered. All the genomes sequenced to date contain many examples of duplicated genes. Frequently whole sets of genes are duplicated, and this phenomenon is more prevalent the higher up the evolutionary ladder one climbs.

Genetic observation of synthetic lethality for many nonessential genes shows that vital functions are often shared by more than one protein, and sometimes by more than one pathway. Redundancy is a hallmark of living systems. Backup systems abound: when one protein or pathway fails, another can often take over. Redundancy also allows natural selection to tinker with a gene, or a system composed of many genes, without necessarily losing one function to gain another. Genomics further reveals that 'silent' genetic information is also more common than we had imagined. Apparently it isn't so bad to keep nonfunctional things around; the old notion that this is inefficient and would therefore be selected against may require reevaluation. Perhaps any 'waste' of metabolic energy in synthesizing and maintaining these segments of DNA is more than compensated for by the possibility that they will eventually mutate into something useful. Genomics has taught us that living things are messy, redundant, seemingly inefficient and that nature doesn't give a damn about any of that. The only thing that matters is utility. If something works, if it satisfies some necessity, then it has a good chance to survive, and evolve.

I am surprised that Intelligent Design mavens have so much trouble with the concept of design not by a higher intelligence but rather by trial-and-error satisfying necessity. It ought to be very familiar to them. The vast majority of people promoting Intelligent Design are social and economic conservatives, and if they only took a minute to consider their own favorite solution to most problems - the free market - they would see that an irreducibly complex system can easily arise without intelligent design. Consider the enormously complex structure that is free-market capitalism, inarguably the most efficient system ever for producing, delivering and pricing goods and services. No one designed it. It developed over centuries through slight, successive modifications to the precursor system. Its parts are interdependent, well-matched and fully interacting. It contains many systems, such as that required to produce and deliver my daily newspaper, wherein removal of any one part would cause that system to fail. Yet it came about through gradual evolution, not through the top-down imposition of a grand design.

Attempts to supersede the competitive market with designed, hierarchical systems have all failed thus far, communism being the latest in a long line of such failures. It was inevitable, I think, that planned economies would fail, not because they are necessarily morally inferior but because they are impossible. To design an economic system and run it requires the constant, instantaneous gathering and assimilation of vast amounts of information. Such coordination and integration is beyond any one person, or any group of people. But it is not beyond the market, which performs this miracle continually, through what the great economic philosopher Friedrich A. Hayek called "the spontaneous extended order of human cooperation". The necessity of making a profit in order to survive and grow is the only thing

needed to produce a working system of immense complexity and extended order. 'Intelligent' design of a mandated arrangement of human social and economic interactions by a central authority has never produced anything remotely comparable. Necessity is not only, as the proverb puts it, the mother of invention. Necessity is also the only designer we need to explain the world that genomics has shown to us.