Sewell on Darwinism and the Second Law

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In a couple of recent publications, Granville Sewell, who is Professor of Mathematics at the University of Texas El Paso, argued that evolution violates the second law of thermodynamics in a spectacular way. Specifically, he noted that if an increase in order is extremely improbable when a system is closed, it is still extremely improbable when the system is open, *unless* something is entering which makes it much less improbable. The Darwinist's argument of "compensation" is *logically* flawed: an extremely improbable event is not rendered less improbable by the occurrence of other events that are more probable. Order can increase in an open system, not because the laws of probability are suspended when the door is open, but because order may walk in through the door. If we found evidence that DNA, auto parts, computer chips, and books entered through the Earth's atmosphere at some time in the past, then perhaps the appearance of humans, cars, computers, and encyclopedias on a previously barren planet could be explained without postulating a violation of the second law *here* — it would have been violated somewhere else. The present "extended summary" is intended not as a substitute for Sewell's original publications, which deserve the broadest possible exposure, but to draw attention to them.

1 Uncommon Dissent[1]

A *National Geographic* article from November 2004 proclaimed that the evidence is "overwhelming" that Darwin was right about evolution. Where is this "overwhelming evidence," which justifies not only believing that natural selection can design human brains and produce consciousness but also branding as "anti-science" anyone who doubts that it can? There is no proof that natural selection has ever done anything more spectacular than cause bacteria to develop drug-resistant strains.

Three types of "evidence" are generally cited. The first is that species are well suited to their environments, and this is supposed to suggest that they have "adapted" to them. Yet even if this is were the case, it would tell us nothing about the mechanisms by which they adapted. Natural selection is certainly not the only possible mechanism.

The second type of "evidence" usually cited is the possibility of artificial selection — the selection by humans of features already present in the gene pool. This too tells us nothing about the mechanism of selection. If it is evidence, it is evidence not against but *in favor* of "intelligent design." After all, a human selector has something in mind, whereas nature on her own doesn't have a mind, or so we are told.

1 With apologies to William Dembski, editor of *Uncommon Dissent* ↗, for borrowing his title.

Lastly, there is the "evolutionary tree" of similarities connecting all species, fossil and living. Yet, again, these similarities do not tell us anything about the tree's growth and branching, i.e., about the causes of the dissimilarities. In fact, as is well known, the fossil record doesn't even support the idea that new organs and new systems of organs arose gradually. Instead, new orders, classes, and phyla appeared suddenly. As Harvard paleontologist George Gaylord Simpson (1960) wrote,

> It is a feature of the known fossil record that most taxa appear abruptly. They are not, as a rule, led up to by a sequence of almost imperceptibly changing forerunners such as Darwin believed should be usual in evolution. . . This phenomenon becomes more universal and more intense as the hierarchy of categories is ascended. Gaps among known species are sporadic and often small. Gaps among known orders, classes and phyla are systematic and almost always large. These peculiarities of the record pose one of the most important theoretical problems in the whole history of life: Is the sudden appearance of higher categories a phenomenon of evolution or of the record only, due to sampling bias and other inadequacies?

Granville Sewell (2007), Professor of Mathematics at the University of Texas El Paso, offers the following analogy:

> If some future paleontologist were to unearth two species of Fords, he might find it plausible that one evolved gradually from the other through natural causes. He might find the lack of gradual transitions between automobile families more problematic, for example, in the transition from mechanical to hydraulic brake systems, or from manual to automatic transmissions, or from steam engines to internal combustion engines. He would be even more puzzled by the huge differences between the bicycle and motor vehicle phyla, or between the boat and airplane phyla. But if he is a Darwinist, heaven help us when he discovers motorcycles and Hovercraft, that will constitute spectacular confirmation of his theory that all forms of transportation arose gradually from a common ancestor, without design.

What then is the *actual* evidence? In *The Edge of Evolution*, Lehigh University biochemist Michael Behe presents a detailed study of the struggle for survival between humans and the malaria parasite during the last 100 years. This period covers the evolution of more organisms, and not many fewer generations, than were involved in the entire natural history of mammals:

> Far and away the most extensive relevant data we have on the subject of evolution's effects on competing organisms is that accumulated on interactions between humans and our parasites. As with the example of malaria, the data show trench warfare, with acts of desperate destruction, not arms races, with mutual improvements. The thrust and parry of human malaria evolution did not build anything — it only destroyed things. (Behe, 2007)

Like Behe, Sewell is one of a growing number of intellectuals who voice their frustration at the complacency with which Darwinists gloss over links that not only are missing but would have provided no selective advantage if they had ever existed: "Natural selection may be able to darken the wings of a moth (even this is disputed), but that does not mean it can design anything complex" (Sewell, 2007). As an example, he considers the aquatic bladderwort, described thus in *Plants and Environment* (Daubenmire,

1947):

> The aquatic bladderworts are delicate herbs that bear bladder-like traps 5 mm or less in diameter. These traps have trigger hairs attached to a valve-like door which normally keeps the trap tightly closed. The sides of the trap are compressed under tension, but when a small form of animal life touches one of the trigger hairs the valve opens, the bladder suddenly expands, and the animal is sucked into the trap. The door closes at once, and in about 20 minutes the trap is set ready for another victim.

In a *Nature Encyclopedia of Life Sciences* article on Carnivorous Plants, authors Wolf-Ekkehard Lonnig and Heinz-Albert Becker (2004) acknowledge that

> it appears to be hard to even imagine a clearcut selective advantage for all the thousands of postulated intermediate steps in a gradual scenario. . . for the origin of the complex carnivorous plant structures examined above.

The development of any major new feature presents similar problems, and according to Behe (1996), who in *Darwin's Black Box* describes several spectacular examples in detail, the world of microbiology is especially loaded with such examples of "irreducible complexity." Sewell writes:

> It seems that until the trigger hair, the door, and the pressurized chamber were all in place, and the ability to digest small animals, and to reset the trap to be able to catch more than one animal, had been developed, none of the individual components of this carnivorous trap would have been of any use. What is the selective advantage of an incomplete pressurized chamber? To the casual observer, it might seem that none of the components of this trap would have been of any use whatever until the trap was almost perfect, but of course a good Darwinist will imagine two or three far-fetched intermediate useful stages, and consider the problem solved. I believe you would need to find thousands of intermediate stages before this example of irreducible complexity has been reduced to steps small enough to be bridged by single random mutations — a lot of things have to happen behind the scenes and at the microscopic level before this trap could catch and digest animals. But I don't know how to prove this. . .
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> I am furthermore sure that even if you could imagine a long chain of useful intermediate stages, each would present such a negligible selective advantage that nothing as clever as this carnivorous trap could ever be produced, but I can't prove that either. . .
>
> When you look at the individual steps in the development of life, Darwin's explanation is difficult to disprove, because some selective advantage can be imagined in almost anything. Like every other scheme designed to violate the second law, it is only when you look at the net result that it becomes obvious it won't work.

2 The Second Law

In "A Second Look at the Second Law",[2] Sewell (2007) reminds us that the first formulations of the second law of thermodynamics were all about heat, e.g., "heat will not flow spontaneously from a cold object to a hot object." Kinetic energy quantifies motion, and thermal entropy — the entropy associated with heat — quantifies the randomness,

2 The URL of this article is www.math.utep.edu/Faculty/sewell/articles/article.html.

or disorder, associated with a system containing a large number of subsystems (molecules, "bodies," whatever) with different kinetic energies. In this context the second law states that the (thermal) entropy of an isolated ("closed") system always increases as the kinetic energies of the subsystems become more and more randomly — and thus more and more uniformly — distributed; at any rate, it never decreases. If entropy is a measure of disorder, negative entropy is a measure of order, so we can say that thermal order never increases in a closed system.

The thermal definition of entropy is impartial with respect to the subsystems. However, it was soon realized that more specific types of entropy can be defined. The corresponding types of order also never increase in a closed system:

> for example, we can define a "carbon order" associated with the distribution of carbon diffusing in a solid, using the same equations, and through an identical analysis show that this order also continually decreases, in a closed system. With time, the second law came to be interpreted more and more generally, and today most discussions of the second law in physics textbooks offer examples of entropy increases. . . which have nothing to do with heat conduction or diffusion, such as the shattering of a wine glass or the demolition of a building. (Sewell, 2007)

Here is a typical text book example:

> Imagine a motion picture of any scene of ordinary life run backward. You might watch. . . a pair of mangled automobiles undergoing instantaneous repair as they back apart. Or a dead rabbit rising to scamper backward into the woods as a crushed bullet re-forms and flies backward into a rifle while some gunpowder is miraculously manufactured out of hot gas. Or something as simple as a cup of coffee on a table gradually becoming warmer as it draws heat from its cooler surroundings. All of these backward-in-time views and a myriad more that you can quickly think of are ludicrous and impossible for one reason only — they violate the second law of thermodynamics. In the actual scene of events, entropy is increasing. In the time reversed view, entropy is decreasing. (Ford, 1968)

In a closed system, every type of order is unstable and must eventually decrease, as everything tends toward more probable states.

> The second law is all about probability; it uses probability at the microscopic level to predict macroscopic change: carbon distributes itself more and more uniformly in an insulated solid because this is what the laws of probability predict, when diffusion alone is operative. The reason natural forces may turn a spaceship, or a TV set, or a computer into a pile of rubble but not vice-versa is also probability: of all the possible arrangements atoms could take, only a very small percentage could fly to the moon and back, or receive pictures and sound from the other side of the Earth, or add, subtract, multiply and divide real numbers with high accuracy. The second law of thermodynamics is the reason that computers will degenerate into scrap metal over time, and, in the absence of intelligence, the reverse process will not occur; and it is also the reason that animals, when they die, decay into simple organic and inorganic compounds, and, in the absence of intelligence, the reverse process will not occur. (Sewell, 2007)

Sewell is justly baffled at the bafflement of the opponents of design at the layperson's bafflement at "the idea that the four fundamental forces of physics alone could rearrange the fundamental particles of Nature into spaceships, nuclear power plants, and

computers, connected to laser printers, CRTs, keyboards and the Internet" (Sewell, 2000). The Darwinists keep asking: we have scientific explanations for most everything else in Nature; what is special about evolution?

For one thing, as Sewell points out, evolution is a movie running backward. This is what makes it special. For another, the notion that we have scientific explanations for most everything else in Nature is a myth. Compare the claim of sociobiology founder Edward O. Wilson (Paulson, 2006) that "Knowledge of the world ultimately comes down to chemistry, biology, and — above all — physics," with the only incontrovertible fact about quantum mechanics, the general theoretical framework of contemporary physics. This is that quantum mechanics provides us with algorithms for calculating the probabilities of possible measurement outcomes on the basis of actual measurement outcomes. The rest is metaphysical embroidery, usually with strongly materialistic overtones. The plain truth is that quantum mechanics tells us nothing whatever about the mechanisms or processes responsible for the statistical correlations between measurement outcomes.

In a *Mathematical Intelligencer* article, Sewell (2000) asserted that evolution appears to violate the second law of thermodynamics in a spectacular way. In his (2007), he adds:

> Anyone who has made such an argument is familiar with the standard reply: the Earth is an open system, it receives energy from the sun, and order can increase in an open system, as long as it is "compensated" somehow by a comparable or greater decrease outside the system. S. Angrist and L. Hepler (1967), for example write, "In a certain sense the development of civilization may appear contradictory to the second law. . . Even though society can effect local reductions in entropy, the general and universal trend of entropy increase easily swamps the anomalous but important efforts of civilized man. Each localized, man-made or machine-made entropy decrease is accompanied by a greater increase in entropy of the surroundings, thereby maintaining the required increase in total entropy."
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> According to this reasoning, then, the second law does not prevent scrap metal from reorganizing itself into a computer in one room, as long as two computers in the next room are rusting into scrap metal — and the door is open. (Or the thermal entropy in the next room is increasing — though I'm not sure what the conversion rate is between computers and thermal entropy.) This strange argument of "compensation" makes no sense logically: an extremely improbable event is not rendered less improbable by the occurrence of other events which are more probable. To understand where this argument of compensation comes from, one needs to understand that of the example applications mentioned in [the passage from Ford (1968) quoted above] the coffee cup example is special: the application to heat conduction is special not only because it was the first application, but because it is quantifiable. It is commonly used as the "model" problem on which our thinking about the other, less quantifiable, applications is based. The fact that thermal order cannot increase in a closed system, but can increase in an open system, was used to conclude that, in other applications, anything can happen in an open system as long as it is compensated by order decreases outside this system, so that the total "order" in the universe (or any closed system containing the open system) still decreases.

Sewell and *The Mathematical Intelligencer* received several responses arguing that

everything Nature does can be considered extremely improbable, not just the rearrangement of fundamental particles into spaceships, nuclear power plants, and computers: the exact arrangement of atoms at *any* time at *any* place is extremely unlikely to be repeated. In the same vein, Davis (2001) made an analogy with coin flipping and argued that any particular sequence of heads and tails is extremely improbable, so something extremely improbable happens every time we flip a long series of coins. Sewell (2007) remarks:

> If a coin were flipped 1000 times, he would apparently be no more surprised by a string of all heads than by any other sequence, because any string is as improbable as another. This critic concedes that it is extremely unlikely that humans and computers would arise again if history were repeated, "but something would".
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> Obviously, I should have been more careful with my wording. . . I should have said that the underlying principle behind the second law is that natural forces do not do *macroscopically* describable things, which are extremely improbable from the *microscopic* point of view. A "macroscopically describable" event is just any event which can be described without resorting to an atom-by-atom (or coin-by-coin) accounting. Carbon distributes itself more and more uniformly in an insulated solid because there are many more arrangements of carbon atoms which produce nearly uniform distributions than produce highly nonuniform distributions. Natural forces may turn a spaceship into a pile of rubble, but not vice-versa — not because the exact arrangement of atoms in a given spaceship is more improbable than the exact arrangement of atoms in a given pile of rubble, but because (whether the Earth receives energy from the Sun or not) there are very few arrangements of atoms which would be able to fly to the moon and return safely, and very many which could not. The reader familiar with William Dembski's (2006) "specified complexity" concept will recognize similarities to the argument here: natural forces do not do things which are "specified" (macroscopically describable) and "complex" (extremely improbable).
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> If we toss a billion coins, it is true that any sequence is as improbable as any other, but most of us would still be surprised, and suspect that something other than chance is going on, if the result were "all heads", or "alternating heads and tails", or even "all tails except for coins $3z+5$, for integer z." When we produce simply describable results like these, we have done something "macroscopically" describable which is extremely improbable.

Let's say that if a billion-coin sequence can't be described in 1000 English words and symbols, then it isn't simply describable. Whereas there are $2^{1,000,000,000}$ possible sequences, there are only about $2^{30,000}$ different 1000-word paragraphs, and thus only about that many simply describable sequences. So the odds that a randomly selected sequence will by simply describable are about 1 to $2^{999,970,000}$. Another critic wrote, "His claim that 'natural forces do not cause extremely improbable things to happen' is pure gibberish. Does Sewell invoke supernatural forces to explain the winning numbers in last night's lottery?" (Rosenhouse, 2001) In response, Sewell points out that getting the right number on 5 or 6 balls is *not* extremely improbable. In thermodynamics, "extremely improbable" events involve getting the "right number" on 100,000,000,000,000,000,000,000 or so balls!

> If every atom on Earth bought one ticket every second since the big bang (about 10^{70} tickets) there is virtually no chance that any would ever win even a 100-ball lottery, much less this one. (Sewell, 2007)

In his book *The Numerical Solution of Ordinary and Partial Differential Equations* , Sewell (2005) takes a closer look at the equations for entropy change, which apply not only to thermal entropy but also to the entropy associated with anything else that diffuses, and shows that these equations

> do not simply say that order cannot increase in a closed system, they also say that in an open system, order cannot increase faster than it is imported through the boundary. According to these equations, the thermal order in an open system can decrease in two different ways — it can be converted to disorder, or it can be exported through the boundary. It can increase in only one way: by importation through the boundary. Similarly, the increase in "carbon order" in an open system cannot be greater than the carbon order imported through the boundary, and the increase in "chromium order" cannot be greater than the chromium order imported through the boundary, and so on.
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> The "compensation" argument was produced by people who generalized the model equation for closed systems, but forgot to generalize the equation for open systems. Both equations are only valid for our simple models, where it is assumed that only heat conduction or diffusion is going on; naturally in more complex situations, the laws of probability do not make such simple predictions.

Nevertheless, in "Can ANYTHING Happen in an Open System?" Sewell (2001) generalized the equation for open systems to the following tautology, which is valid in all situations:

If an increase in order is extremely improbable when a system is closed, it is still extremely improbable when the system is open, unless something is entering which makes it not *extremely improbable.*

> The fact that order is disappearing in the next room does not make it any easier for computers to appear in our room — unless this order is disappearing *into* our room, and then only if it is a type of order that makes the appearance of computers not extremely improbable, for example, computers. Importing thermal order will make the temperature distribution less random, and importing carbon order will make the carbon distribution less random, but neither makes the formation of computers more probable. (Sewell, 2007)

What happens in a closed system depends on the initial conditions; what happens in an open system depends on the boundary conditions as well. As Sewell wrote in his (2001),

> order can increase in an open system, not because the laws of probability are suspended when the door is open, but simply because order may walk in through the door. . . If we found evidence that DNA, auto parts, computer chips, and books entered through the Earth's atmosphere at some time in the past, then perhaps the appearance of humans, cars, computers, and encyclopedias on a previously barren planet could be explained without postulating a violation of the second law here (it would have been violated somewhere else!). But if all we see entering is radiation and meteorite fragments, it

seems clear that what is entering through the boundary cannot explain the increase in order observed here.

3 Science hubris

There are compelling reasons why Sir Arthur Eddington (1929) called the second law the "supreme law of Nature." For one, since the second law derives its authority from logic alone, it cannot be overturned by future discoveries. For another, "everything the second law predicts, it predicts with such high probability that it is as reliable as any other law of science" (Sewell, 2007).

Yet logic and evidence appear to be powerless against the popular perception, nurtured by prestigious journals such as *National Geographic* and *Nature,* that no serious scientists harbor any doubts about Darwinism. For those who are not yet impervious to such doubts, I reproduce here a portion of a November 5, 1980 *New York Times News Service* report:

> Biology's understanding of how evolution works, which has long postulated a gradual process of Darwinian natural selection acting on genetic mutations, is undergoing its broadest and deepest revolution in nearly 50 years. At the heart of the revolution is something that might seem a paradox. Recent discoveries have only strengthened Darwin's epochal conclusion that all forms of life evolved from a common ancestor. Genetic analysis, for example, has shown that every organism is governed by the same genetic code controlling the same biochemical processes. At the same time, however, many studies suggest that the origin of species was not the way Darwin suggested. . .
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> Exactly how evolution happened is now a matter of great controversy among biologists. Although the debate has been under way for several years, it reached a crescendo last month, as some 150 scientists specializing in evolutionary studies met for four days in Chicago's Field Museum of Natural History to thrash out a variety of new hypotheses that are challenging older ideas. The meeting, which was closed to all but a few observers, included nearly all the leading evolutionists in paleontology, population genetics, taxonomy and related fields. No clear resolution of the controversies was in sight. This fact has often been exploited by religious fundamentalists who misunderstood it to suggest weakness in the fact of evolution rather than the perceived mechanism. Actually, it reflects significant progress toward a much deeper understanding of the history of life on Earth. At issue during the Chicago meeting was macroevolution, a term that is itself a matter of debate but which generally refers to the evolution of major differences, such as those separating species or larger classifications. . .
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> Darwin suggested that such major products of evolution were the results of very long periods of gradual natural selection, the mechanism that is widely accepted today as accounting for minor adaptations. . . Darwin knew he was on shaky ground in extending natural selection to account for differences between major groups of organisms. The fossil record of his day showed no gradual transitions between such groups, but he suggested that further fossil discoveries would fill the missing links. "The pattern that we were told to find for the last 120 years does not exist," declared Niles Eldridge, a paleontologist from the American Museum of Natural History in New York. Eldridge reminded the meeting of what many fossil hunters have recognized as they trace the history of a species through successive layers of ancient sediments. Species simply appear at a given

> point in geologic time, persist largely unchanged for a few million years and then disappear. There are very few examples — some say none — of one species shading gradually into another.

Why is such an easily discredited theory as Darwinian natural selection still so widely accepted? Sewell finds the answer in an 1888 book by Joseph Le Conte, professor of Geology and Natural History at the University of California. After acknowledging that the only direct evidence, the fossil record, does not support the idea of gradual change, and that the only theory ever taken seriously as to the causes of these changes cannot explain anything new, Le Conte nevertheless concludes that

> evolution as a law of derivation of forms from previous forms. . . is not only certain, it is *axiomatic*. . . The origins of new phenomena are often obscure, even inexplicable, but we never think to doubt that they have a natural cause; for so to doubt is to doubt the validity of reason, and the rational constitution of Nature.

Science appears to have been so successful in explaining natural phenomena that the present-day scientist is convinced that science can explain everything. Hence anything that doesn't fit into this model is simply ignored.

> It doesn't matter that there were no natural causes before Nature came into existence, so he cannot hope to ever explain the sudden creation of time, space, matter and energy and our universe in the Big Bang. It doesn't matter that quantum mechanics is based on a "principle of indeterminacy", that tells us that every "natural" phenomenon has a component that is forever beyond the ability of science to explain or predict, he still insists nothing is beyond the reach of his science. (Sewell, 2007)

It bears repetition that the formalism of quantum mechanics allows us to calculate correlations between measurement outcomes, without telling us anything about the mechanisms or processes responsible for these correlations.

> When he discovers that all of the basic constants of physics, such as the speed of light, the charge and mass of the electron, Planck's constant, etc., had to have almost exactly the values that they do have in order for any conceivable form of life to survive in our universe, he proposes the "anthropic principle" (e.g., Leggett, 1987) and says that there must be many other universes with the same laws, but random values for the basic constants, and one was bound to get the values right. When you ask him how a mechanical process such as natural selection could cause human consciousness to arise out of inanimate matter, he says, "human consciousness — what's that?" And he talks about human evolution as if he were an outside observer, and never seems to wonder how he got inside one of the animals he is studying. And when you ask how the four fundamental forces of Nature could rearrange the basic particles of Nature into libraries full of encyclopedias, science texts and novels, and computers connected to laser printers, CRTs and keyboards and the Internet, he says, well, order can increase in an open system.
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> The development of life may have only violated one law of science, but that was the one Sir Arthur Eddington called the "supreme" law of Nature, and it has violated that in a most spectacular way. At least that is my opinion, but perhaps I am wrong. Perhaps it only seems extremely improbable, but really isn't, that, under the right conditions, the influx of stellar energy into a planet could cause atoms to rearrange themselves into nuclear power plants and spaceships and computers. But one would think that at least this

> would be considered an open question, and those who argue that it really *is* extremely improbable, and thus contrary to the basic principle underlying the second law, would be given a measure of respect, and taken seriously by their colleagues, but [they] aren't.

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