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Five Major Misconceptions about Evolution

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A large part of the reason why Creationist arguments against evolution can sound so persuasive is because they don't address evolution, but rather argue against a set of misunderstandings that people are right to consider ludicrous. The Creationists wrongly believe that their understanding of evolution is what the theory of evolution really says, and declare evolution banished. In fact, they haven't even addressed the topic of evolution. (The situation isn't helped by poor science education generally. Even most beginning college biology students don't understand the theory of evolution.)

The five propositions below seem to be the most common misconceptions based on a Creationist straw-man version of evolution. If you hear anyone making any of them, chances are excellent that they don't know enough about the real theory of evolution to make informed opinions about it.

- Evolution has never been observed.
- Evolution violates the 2nd law of thermodynamics.
- There are no transitional fossils.
- The theory of evolution says that life originated, and evolution proceeds, by random chance.
- Evolution is only a theory; it hasn't been proved.

Explanations of why these statements are wrong are given below. They are brief and therefore somewhat simplified; consult the references at the end for more thorough explanations.

"Evolution has never been observed."

Biologists define evolution as a change in the gene pool of a population over time. One example is insects developing a resistance to pesticides over the period of a few years. Even most Creationists recognize that evolution at this level is a fact. What they don't appreciate is that this rate of evolution is all that is required to produce the diversity of all living things from a common ancestor.

The origin of new species by evolution has also been observed, both in the laboratory and in the wild. See, for example, (Weinberg, J.R., V.R. Starczak, and D. Jorg, 1992, "Evidence for rapid speciation following a founder event in the laboratory." *Evolution* 46: 1214-1220). The ["Observed Instances of Speciation" FAQ](#) in the talk.origins archives gives several additional examples.

Even without these direct observations, it would be wrong to say that evolution hasn't been observed. Evidence isn't limited to seeing something happen before your eyes. Evolution makes predictions about what we would expect to see in the fossil record, comparative anatomy, genetic sequences, geographical distribution of species, etc., and these predictions have been verified many times over. The number of observations supporting evolution is overwhelming.

What hasn't been observed is one animal abruptly changing into a radically different one, such as a frog changing into a cow. This is not a problem for evolution because evolution doesn't propose occurrences even remotely like that. In fact, if we ever observed a frog turn into a cow, it would be very strong evidence *against* evolution.

Other Links:

[A Creationist Rebuts this FAQ](#)

Creationist Tim Wallace has written a rebuttal of each of the points made in this FAQ. (Despite its pilfered masthead, Wallace's web page is not a part of the Talk.Origins Archive.)

[A Critique of Wallace](#)

Evolutionist Wayne Duck responds to Tim Wallace's rebuttal.

"Evolution violates the 2nd law of thermodynamics."

This shows more a misconception about thermodynamics than about evolution. The second law of thermodynamics says, "No process is possible in which the *sole result* is the transfer of energy from a cooler to a hotter body." [Atkins, 1984, *The Second Law*, pg. 25] Now you may be scratching your head wondering what this has to do with evolution. The confusion arises when the 2nd law is phrased in another equivalent way, "The entropy of a closed system cannot decrease." Entropy is an indication of unusable energy and often (but not always!) corresponds to intuitive notions of disorder or randomness. Creationists thus misinterpret the 2nd law to say that things invariably progress from order to disorder.

However, they neglect the fact that life is not a closed system. The sun provides more than enough energy to drive things. If a mature tomato plant can have more usable energy than the seed it grew from, why should anyone expect that the next generation of tomatoes can't have more usable energy still? Creationists sometimes try to get around this by claiming that the information carried by living things lets them create order. However, not only is life irrelevant to the 2nd law, but order from disorder is common in nonliving systems, too. Snowflakes, sand dunes, tornadoes, stalactites, graded river beds, and lightning are just a few examples of order coming from disorder in nature; none require an intelligent program to achieve that order. In any nontrivial system with lots of energy flowing through it, you are almost certain to find order arising somewhere in the system. If order from disorder is supposed to violate the 2nd law of thermodynamics, why is it ubiquitous in nature?

The thermodynamics argument against evolution displays a misconception about evolution as well as about thermodynamics, since a clear understanding of how evolution works should reveal major flaws in the argument. Evolution says that organisms reproduce with only small changes between generations (after their own kind, so to speak). For example, animals might have appendages which are longer or shorter, thicker or flatter, lighter or darker than their parents. Occasionally, a change might be on the order of having four or six fingers instead of five. Once the differences appear, the theory of evolution calls for differential reproductive success. For example, maybe the animals with longer appendages survive to have more offspring than short-appendaged ones. All of these processes can be observed today. They obviously don't violate any physical laws.

"There are no transitional fossils."

A transitional fossil is one that looks like it's from an organism intermediate between two lineages, meaning it has some characteristics of lineage A, some characteristics of lineage B, and probably some characteristics part way between the two. Transitional fossils can occur between groups of any taxonomic level, such as between species, between orders, etc. Ideally, the transitional fossil should be found stratigraphically between the first occurrence of the ancestral lineage and the first occurrence of the descendent lineage, but evolution also predicts the occurrence of some fossils with transitional morphology that occur after both lineages. There's nothing in the theory of evolution which says an intermediate form (or any organism, for that matter) can have only one line of descendents, or that the intermediate form itself has to go extinct when a line of descendents evolves.

To say there are no transitional fossils is simply false. Paleontology has progressed a bit since *Origin of Species* was published, uncovering thousands of transitional fossils, by both the temporally restrictive and the less restrictive definitions. The fossil record is still spotty and always will be; erosion and the rarity of conditions favorable to fossilization make that inevitable. Also, transitions may occur in a small population, in a small area, and/or in a relatively short amount of time; when any of these conditions hold, the chances of finding the transitional fossils goes down. Still, there are still many instances where excellent sequences of transitional fossils exist. Some notable examples are the transitions from reptile to mammal, from land animal to early whale, and from early ape to human. For many more examples, see [the transitional fossils FAQ](#) in the talk.origins archive, and see http://www.geo.ucalgary.ca/~macrae/talk_origins.html for sample images for some invertebrate groups.

The misconception about the lack of transitional fossils is perpetuated in part by a common way of thinking about categories. When people think about a category like "dog" or "ant," they often subconsciously believe that there is a well-defined boundary around the category, or that there is some eternal ideal form (for philosophers, the Platonic idea) which defines the category. This kind of thinking leads people to declare that Archaeopteryx is "100% bird," when it is clearly a mix of bird and reptile features (with more reptile than bird features, in fact). In truth, categories are man-made and artificial. Nature is not constrained to follow them, and it doesn't.

Some Creationists claim that the hypothesis of punctuated equilibrium was proposed (by Eldredge and Gould) to explain gaps in the fossil record. Actually, it was proposed to explain the relative rarity of transitional forms, not

their total absence, and to explain why speciation appears to happen relatively quickly in some cases, gradually in others, and not at all during some periods for some species. In no way does it deny that transitional sequences exist. In fact, both Gould and Eldredge are outspoken opponents of Creationism.

"But paleontologists have discovered several superb examples of intermediary forms and sequences, more than enough to convince any fair-minded skeptic about the reality of life's physical genealogy."
- Stephen Jay Gould, *Natural History*, May 1994

"The theory of evolution says that life originated, and evolution proceeds, by random chance."

There is probably no other statement which is a better indication that the arguer doesn't understand evolution. Chance certainly plays a large part in evolution, but this argument completely ignores the fundamental role of natural selection, and selection is the very opposite of chance. Chance, in the form of mutations, provides genetic variation, which is the raw material that natural selection has to work with. From there, natural selection sorts out certain variations. Those variations which give greater reproductive success to their possessors (and chance ensures that such beneficial mutations will be inevitable) are retained, and less successful variations are weeded out. When the environment changes, or when organisms move to a different environment, different variations are selected, leading eventually to different species. Harmful mutations usually die out quickly, so they don't interfere with the process of beneficial mutations accumulating.

Nor is abiogenesis (the origin of the first life) due purely to chance. Atoms and molecules arrange themselves not purely randomly, but according to their chemical properties. In the case of carbon atoms especially, this means complex molecules are sure to form spontaneously, and these complex molecules can influence each other to create even more complex molecules. Once a molecule forms that is approximately self-replicating, natural selection will guide the formation of ever more efficient replicators. The first self-replicating object didn't need to be as complex as a modern cell or even a strand of DNA. Some self-replicating molecules are not really all that complex (as organic molecules go).

Some people still argue that it is wildly improbable for a given self-replicating molecule to form at a given point (although they usually don't state the "givens," but leave them implicit in their calculations). This is true, but there were oceans of molecules working on the problem, and no one knows how many possible self-replicating molecules could have served as the first one. A calculation of the odds of abiogenesis is worthless unless it recognizes the immense range of starting materials that the first replicator might have formed from, the probably innumerable different forms that the first replicator might have taken, and the fact that much of the construction of the replicating molecule would have been non-random to start with.

(One should also note that the theory of evolution doesn't depend on how the first life began. The truth or falsity of any theory of abiogenesis wouldn't affect evolution in the least.)

"Evolution is only a theory; it hasn't been proved."

First, we should clarify what "evolution" means. Like so many other words, it has more than one meaning. Its strict biological definition is "a change in allele frequencies over time." By that definition, evolution is an indisputable fact. Most people seem to associate the word "evolution" mainly with common descent, the theory that all life arose from one common ancestor. Many people believe that there is enough evidence to call this a fact, too. However, common descent is still not the theory of evolution, but just a fraction of it (and a part of several quite different theories as well). The *theory* of evolution not only says that life evolved, it also includes mechanisms, like mutations, natural selection, and genetic drift, which go a long way towards explaining *how* life evolved.

Calling the theory of evolution "only a theory" is, strictly speaking, true, but the idea it tries to convey is completely wrong. The argument rests on a confusion between what "theory" means in informal usage and in a scientific context. A theory, in the scientific sense, is "a coherent group of general propositions used as principles of explanation for a class of phenomena" [Random House American College Dictionary]. The term does not imply tentativeness or lack of certainty. Generally speaking, scientific theories differ from scientific laws only in that laws can be expressed more tersely. Being a theory implies self-consistency, agreement with observations, and usefulness. (Creationism fails to be a theory mainly because of the last point; it makes few or no specific claims about what we would expect to find, so it can't be used for anything. When it does make falsifiable predictions, they prove to be false.)

Lack of proof isn't a weakness, either. On the contrary, claiming infallibility for one's conclusions is a sign of hubris. Nothing in the real world has ever been rigorously proved, or ever will be. Proof, in the mathematical sense,

is possible only if you have the luxury of defining the universe you're operating in. In the real world, we must deal with levels of certainty based on observed evidence. The more and better evidence we have for something, the more certainty we assign to it; when there is enough evidence, we label the something a fact, even though it still isn't 100% certain.

What evolution has is what any good scientific claim has--evidence, and lots of it. Evolution is supported by a wide range of observations throughout the fields of genetics, anatomy, ecology, animal behavior, paleontology, and others. If you wish to challenge the theory of evolution, you must address that evidence. You must show that the evidence is either wrong or irrelevant or that it fits another theory better. Of course, to do this, you must know both the theory and the evidence.

Conclusion

These are not the only misconceptions about evolution by any means. Other common misunderstandings include how geological dating techniques work, implications to morality and religion, the meaning of "uniformitarianism," and many more. To address all these objections here would be impossible.

But consider: About a hundred years ago, scientists, who were then mostly creationists, looked at the world to figure out how God did things. These creationists came to the conclusions of an old earth and species originating by evolution. Since then, thousands of scientists have been studying evolution with increasingly more sophisticated tools. Many of these scientists have excellent understandings of the laws of thermodynamics, how fossil finds are interpreted, etc., and finding a better alternative to evolution would win them fame and fortune. Sometimes their work has changed our understanding of significant details of how evolution operates, but the theory of evolution still has essentially unanimous agreement from the people who work on it.

Further Reading

The "FAQ" files listed below are available on World Wide Web via <http://www.talkorigins.org/>. They are also available via ftp at ics.uci.edu, directory [/pub/origins](ftp://ics.uci.edu/pub/origins). Messages with more information on how to access them are posted regularly to talk.origins. The archive also contains many other files which may be of interest.

For what evolution means, how it works, and the evidence for it:

Colby, Chris. [faq-intro-to-biology: Introduction to Evolutionary Biology](#)

Mayr, Ernst. 1991. One Long Argument

Darwin, Charles. 1859. On the Origin of Species by Means of Natural Selection

For issues and evidence of speciation:

Boxhorn, Joseph. [faq-speciation: Observed Instances of Speciation](#)

Weiner, Jonathan. 1994. The Beak of the Finch: A Story of Evolution in Our Time

For explanations of how randomness can lead to design:

Dawkins, Richard. 1986. The Blind Watchmaker

Bonner, John T. 1988. The Evolution of Complexity by Means of Natural Selection

Kauffman, Stuart A. 1993. The Origins of Order: Self-Organization and Selection in Evolution [very technical]

For a readable introduction to the 2nd law of thermodynamics:

Atkins, Peter W. 1984. The Second Law

For transitional fossils and the fossil record:

Colbert, Edwin H. 1991. Evolution of the Vertebrates, 4th ed.

Hunt, Kathleen. [faq-transitional: Transitional Fossils](#)

For a fairly comprehensive response to many Creationist claims:

Strahler, Arthur. 1987. Science and Earth History

Meritt, Jim. [faq-meritt: Jim Meritt's general anti-creationism FAQ](#)

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