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Science and Design: A Personal Essay

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Wendy Olson, "Science and Design: A Personal Essay"

ABSTRACT

The essay addresses why 'Intelligent Design' (ID) does not qualify as science, and why the distinction between science and ID matters. Furthermore, it discusses the anti-evolution undercurrent that characterizes ID politics. ID proponents give the impression that evolutionary theory is somehow faulty or incomplete, that educators are bound to "teach the controversy" or give alternate explanations for biological diversity, in the interests of academic freedom. Some of this stems from misinformation or misunderstanding of evolution and evolutionary theory, but much is motivated by religious belief, which brings the issue into the arena of constitutional law.

It is difficult to write an essay you know will get you into trouble, somewhere. I should state up front that I am an evolutionary biologist. I am also one of the people who initiated and circulated the recent statement concerning "intelligent design" (ID) to the UNI faculty.¹ I have been following the ID movement for quite some time and, like too many biologists, I have consistently, uncomfortably, looked the other way. So what happened? As is so often the case in evolution, many small, seemingly random things transpired in just the right order to push me over the threshold and into action.

Following a recent on-campus lecture about ID, I was surprised by the number and magnitude of misconceptions people have about science in general, and evolution in particular.

Therefore, I first wish to address why ID does not qualify as science, and why that distinction matters. Second, there is a very clear anti-evolution undercurrent to ID politics but, at the same time, many people do not have a very clear idea of what *evolution* actually is. ID proponents give the impression that evolutionary theory is somehow faulty or incomplete, that educators are bound to "teach the controversy" or give alternate explanations for biological diversity, in the interests of academic freedom. Some of this stems from misinformation or misunderstanding of evolution and evolutionary theory, but much is religiously motivated, which brings the issue full front into the arena of constitutional law.

ID is not a *Science*

One of the principal reasons that ID cannot be considered a *science* is that its ultimate explanation relies on supernatural causes: the act or will of an (unspecified) Intelligent Designer. *Science* by definition relies exclusively on natural causes, explanations based on natural laws. The moment we leave the natural world and step into the realm of the supernatural, we leave the bounds of science. Consequently, once a Designer is invoked, all scientific inquiry and analysis by necessity stops.

All scientific hypotheses must be: 1) testable, and 2) subjected to peer review. Hypotheses must be framed in such a way that we can gather empirical evidence to either gain support for or falsify the hypothesis. There must be both positive and negative tests; for each hypothesis, you must be able to conceive of practical experiments that would yield evidence both for or against your hypothesis. The more lines of evidence, the better, and all experiments must be replicable by independent researchers. Furthermore, all scientific work undergoes a stringent process of peer review; it must be independently evaluated by members of the scientific community before it is accepted into the scientific literature. This provides a critical level of quality control to help ensure that proper scientific procedure is followed. Once in the literature, depending on the degree of controversy, it can then take a considerable amount of time, analysis, and debate before a proposed hypothesis is accepted as "general knowledge."

ID routinely fails on both of these counts. Some ID proponents have science degrees, do scientific research (published separately from their ID work), or at least use highly scientific language when they talk about ID. But none of these things makes ID a science. ID thus far has failed to produce any testable hypotheses. If ID proponents truly want ID to be presented as science, they would need to dedicate themselves to actively trying to falsify the existence of an Intelligent Designer, and no scientist would see this as an appropriate thing to do. ID proponents have not published any peer-reviewed scientific research articles on ID. They have published extensively in the secondary literature (books, invited chapters, conference proceedings, etc.), but not in the primary literature (scientific research journals). Peer review is run very differently, between the primary and secondary literature; this is one of the impact factors that distinguishes the two. I have published in both, and thus I do not want to give the impression that one is intrinsically more valuable than the other. In the primary literature, review is more a system of checks and balances, of ensuring replicability and procedure. In the scientific community, scientific merit is judged by one's contribution to the primary literature.

In short, ID wants to be considered a science without actually having to do any of the work or meet any of the scientific standards. This is similar to wanting to be a doctor without going to medical school, or showing up to your very first Boy Scout meeting and demanding to be made an Eagle Scout. You may be a good person and represent everything that Eagle Scouts stand for, but you still have to earn those badges. To demand it done any other way is to degrade the entire process.

The strength and progress of science rests on its standards, on a strict adherence to its logic and methodology. The general public does not have a good understanding of what science is, or why the scientific method is so important. This is largely the fault of scientists themselves, and it is something that we struggle with almost every day. The surest way to kill any conversation (or lecture) is to start talking about the scientific method, or worse, methodological naturalism. But here is the take-home message: The scientific method is a tool, and like any tool, you have to know

how to use it properly or you could end up doing a lot of damage (either to yourself or to whatever you are working on). If we were to allow non-science subjects (whatever they may be) to be presented in science classrooms *as if they were science*, we would make a bad situation even worse. Students will not understand the scientific method, they will not understand how to do science, and they will not be competitive in the world arena. The U.S. is rapidly falling behind in scientific literacy. In the age of bioterrorism, impending pandemics, and the potential for profound medical advances, we cannot afford to turn our backs on science and further outsource the country's future.

ID Misrepresents Evolution

As an evolutionary biologist, the issue that frustrates me most about the ID movement is its representatives' persistent misrepresentation of evolution and evolutionary theory. Evolution is a complex subject, one that cannot be satisfactorily explained in a short commentary or a ten minute Q&A session. The general public is too often faced with the following polarized viewpoints: one person who quietly explains how an Intelligent Designer created the earth and all life in it, versus an angry scientist who stands up and stammers out some horrifically complicated question or statement laden with all sorts of scientific data (another problem scientists need to work on). Chances are, this scientist is angry for one of two reasons: either because the ID proponent tried to present ID as a science, or because the speaker made some glaringly false statement about evolution.

A Brief Introduction to Evolution

Evolution is a fact. Organisms do change over time, and we can document patterns of change occurring over many different time scales, from millions of years to mere decades. Organisms do not appear suddenly, all at the same time, in their exact, fully differentiated form, only to remain completely unchanged for the rest of their existence. Instead, they appear sporadically (in time and place) and may change their appearance and behavior over the course of time. There are organisms that used to live on this planet that have since become extinct; some of them have become extinct during our recorded history (e.g. the Moa and the Tasmanian Wolf).

More specifically, evolution can be defined as descent with modification from a common ancestor. This, too, is a historical fact. Thanks to genetics and the principle of heredity, children (offspring) resemble their parents. They are not perfect replicas of their parents, because they do not contain the exact same genes and do not develop under the exact same conditions: they are genetically descended with slight modifications. Part of the science of evolution is tracking these patterns of change.

The evidence for evolution as descent with modification is so overwhelming that it is universally accepted as fact within the scientific community. Evolutionary theory, on the other hand, deals with general laws and processes that explain patterns of organismal diversity. How do organisms become better adapted to their environments? Can we explain the particular patterns of change that we are observing and derive a mechanism for evolutionary change?

One of the leading mechanisms of evolutionary change is Darwin's theory of *natural selection*. This theory states simply that individuals vary, and when resources are limited and individuals are

forced to compete, some will be better able to survive and reproduce. If the traits that allowed them to survive are heritable, they will pass those traits on to their offspring. As a result, the average frequency of that trait will increase in the next generation. Over time, populations of organisms tend to become better adapted to their environments through differential survival and reproduction. This sort of process is used all the time in domestic breeding: if you want to increase milk-fat production, do you breed your best cow or your worst? If you want to create a line of Manx cats, do you breed the tailed cats or the tail-less? The only difference is that in the case of natural selection, there is no artificial (conscious) selector; the breeders are determined by who can survive and successfully reproduce. Both rely on natural, pre-existing variation. In that sense, natural selection does not drive evolutionary change, rather it sorts (or selects) change.

Darwin's theory of natural selection has been constantly challenged and tested for almost 150 years, and it still holds strong. But because it is primarily a sorting phenomenon, natural selection can only ever be one of the mechanisms of evolution. This limitation does not detract from its power, nor does it weaken evolutionary theory. There are several other mechanisms that address, for example, the generation of variation, the channeling of variation (why we do not see more variation than we do), and the many classes and levels of selection, which can sometimes be at odds with each other. A trait that is advantageous in one sense may be quite harmful in another, and most organisms are fighting a constant battle of 'trade-offs' and 'cost-benefit analyses.'

There is no Controversy

I have often heard ID proponents claim that teachers should be allowed to present ID side by side with evolution, to "teach the controversy." Evolution forms the foundation for all biology, and there is no controversy regarding evolutionary theory within biological science. There are a lot of different proposed mechanisms, and scientists argue about their relative importance on a case-by-case basis. However, no one can deny the biological, historical fact of descent with modification from a common ancestor. At this point, there are no alternate scientific theories to evolution, no scientific need for one (i.e. glaring holes that need to be addressed, see below), and any attempt to sneak ID into a science classroom based on this premise is at best disingenuous. Similarly, there are no fatal "gaps" in evolutionary theory. Scientists do not have all of the answers, and we probably never will. A good scientist never stops asking questions. But you do not abandon a theory just because you cannot completely explain every phenomenon associated with it. Gravity is a theory, too, and there is still a lot about gravity we cannot explain, yet no one would deny that it exists. No one is proposing that we go into physics classrooms and read statements to children about how gravity is just theory, that there are still some gaps that we cannot explain, and that they should all keep an open mind and consider the alternatives. Why is evolution, of all the scientific theories, singled out for such treatment? Everyone knows exactly why this is, but to admit it openly would be to admit that ID proponents are in violation of constitutional law. They do not want any and all "alternatives" to evolution taught in schools; they actively promote and are dancing very carefully around one, and only one of these alternatives.

People tend to be very focused on literal gaps in evolutionary theory, as well, i.e., gaps in the fossil record, or lack of intermediates in general. There is an impression carrying over from the 1800's that all evolutionary change must proceed in slow, gradual steps, and that we should therefore see a complete series of intermediates connecting all life forms. Failure to find these intermediates is

often considered "proof" that evolution does not exist. Think about how far science has advanced since the 1800's and ask yourself how likely it is that evolutionary biologists still think this way. Change may be slow and gradual, but it may also be quite rapid and dramatic. It depends on the particular group of organisms, the trait in question, and how that trait is changing (the actual mechanism of change).

For organisms and traits that do happen to change in a gradual manner, we may or may not have a record of every intermediate stage. The fossil record is an invaluable resource, but it does not record the history of all organisms in an equal manner. In some cases, the fossil record is quite good, and we see a stunning series of transitional forms (such as in the evolution of feathers and flight). In other cases, the fossil record is less helpful. But not all evolutionary change is slow and gradual, and in such cases we should not expect to find intermediates, or if we did, it would be difficult to identify them with any degree of certainty. Incredible advances have been made in the past decade concerning the analysis of master control genes, genes that turn entire developmental pathways on or off. And just like the light switch in your home, what is the intermediate state between having the lights on versus off? If your lights function on a dimmer switch, you can talk about intermediates. If it is a binary system, you cannot. Basic genetic control of morphology works in a similar fashion, and organisms rely on both systems.

For example, when a caterpillar turns into a butterfly, a maggot into a fruit fly, or a stereotypical tadpole into a frog, it is a very dramatic, sudden morphological change. In a very short time period, a simple worm-like creature is transformed into a complicated winged insect; a gill-breathing, limbless, fish-like organism is transformed into an air-breathing, four-legged terrestrial animal. In some organisms, such transformations are a regular, normal part of the life cycle. Obviously, there are developmental and genetic mechanisms that are capable of producing large, sudden, coordinated morphological change. In the case of the butterfly and fruit fly, there are no morphological "intermediates." Does this sudden, dramatic transformation rattle your faith or affirm it?

Organismal Design

Organisms are amazingly complex, in their structure and in their interactions with each other and their environment. I am so much in awe of the complexity of natural systems that I have dedicated my life to studying them. As a morphologist, my primary interest is the study of form, and the one thing I can say about most animals (and probably plants, though I am not a botanist) is that they are not particularly well designed. About 95% of what you see in any living organism is the result of its cumulative history. Organisms make do with what they have, and what they have is a lot of baggage. Evolution works by modification of pre-existing structure; as a result, it is hard to truly get rid of anything. This is why you (personally) have useless, non-functional things like a tiny little tail, tiny arrector pili muscles to raise what is left of your fur when you are cold or frightened, an appendix that does you more harm than good, and, incidentally, why you get the hiccups (a vestige of having once had gills). What you see, amidst all this baggage, are clues of ancestry.

The evolution of form is thus strongly influenced by history, but it is also influenced by general principles of construction, both in the sense of physical or material properties, as well as generative properties such as self-assembly or self-regulation. Evolution is not completely random; rather,

variation is bounded. Out of all theoretically possible morphologies, only a subset will actually be produced. And throughout it all, there is an element of chance. All of these factors combine to varying degrees to produce the patterns that we observe. ID proponents often present cases of "irreducible complexity," examples of structures so fundamentally complex that they could not have evolved in steps or by random chance, and must instead have been created by an Intelligent Designer. I study organismal design, and I have never seen a biological example of irreducible or specified complexity that I have found the least bit convincing (I cannot assess non-biological examples since they are outside my expertise). I do not deny the existence of structural complexity; but as a scientist who studies anatomy and development, I feel that it is fully explicable by natural laws.

I will end this personal essay by saying that evolution is not a religion, is not in conflict with religion, and is not anti-religious. Organisms are beautifully, wondrously complex. Belief in a Designer does not prevent the study of that Designer's work; if anything, it honors that work. My problems with the ID movement have to do with their tactics and with the potential damage that these tactics cause, both to the integrity of science and to the public understanding of science. Furthermore, the constitution states that public schools may not advocate any one religion over another. The fact that evolution alone has been targeted by this movement, above all other scientific theories, and that it has been so falsely portrayed, is religiously motivated. Many ID proponents wish to replace evolution with the teachings of one particular faith. This clearly violates constitutional law. Science and faith ask very different questions. The moment we start jumbling them together, both stand to lose.

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¹ We, the undersigned faculty members at the University of Northern Iowa, join our colleagues from Iowa State University in rejecting all attempts to represent Intelligent Design as a scientific endeavor. Advocates of Intelligent Design claim the position of our planet and the complexity of particular life forms and processes are such that they may only be explained by the existence of a creator or designer of the universe. Such claims, however, are premised on 1) the arbitrary selection of features claimed to be engineered by a designer; 2) unverifiable conclusions about the wishes and desires of that designer; and 3) an abandonment by science of methodological naturalism. Methodological naturalism, the view that natural phenomena can be explained without reference to supernatural beings or events, is the foundation of the natural sciences. The goal of science is to form hypotheses to explain the natural world around us. Scientific hypotheses must be falsifiable, tested by the evaluation of evidence obtained through observation and experimentation. The history of science contains many instances where complex natural phenomena were eventually understood only by adherence to methodological naturalism, and what is more commonly known as the scientific method. Whether one believes in a creator or not, views regarding a supernatural creator are, by their very nature, claims of religious faith, and not within the scope or abilities of science. We, therefore, urge all faculty members to uphold the integrity of our university, and convey to students and the general public the importance of

methodological naturalism in science and reject efforts to portray Intelligent Design as science. By the completion date of this essay, November 23, 2005, 120 faculty had signed the statement: http://faculty.cns.uni.edu/~demastes/UNI_statement.htm.



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