Evo Edu Outreach (2012) 5:402–404
DOI 10.1007/s12052-012-0449-3

The Soft Underbelly of Evolution?

Glenn Branch · Eugenie C. Scott

Published online: 26 September 2012

Abstract Evolution and the origin of life are separate, if connected, topics, but they are frequently conflated—especially by creationists. Regarding the natural origin of life as "the soft underbelly" of evolution, creationists argue that it is impossible, improbable, or insusceptible to scientific investigation. Underlying their arguments is the hope that the failure of scientific research on the origin of life is evidence for a supernatural account. It is crucial for teachers to understand the nature of science in order to be able to explain why appeals to the supernatural are out of place in explaining the origin of life and why scientific research on the origin of life is not intrinsically a threat to faith.

Keywords Origin of life · Creationism · Miller–Urey experiment · Nature of science

Charles Darwin was always careful about distinguishing evolution from the origin of life. His *Origin of Species* famously presents "one long argument" for evolution, yet it is virtually silent on the origin of life, and the third edition of the *Origin*, published in 1861, concedes that "science as yet throws no light on the far higher problem of the essence or origin of life" (quoted in Peretó et al. 2009, p. 396). And even today, the origin of life and evolution are separable topics: evolutionary biologists typically research the patterns and processes of evolutionary change without reference to the question of the origin of life, while origin-of-life researchers are not typically concerned with the branches, as opposed to the roots, of the tree of life. Nevertheless, these topics are frequently conflated in the public mind—and especially by creationists.

It isn't surprising that creationists, especially young-earth creationists, tend to conflate the topics of the origin of life and evolution. You might not be especially concerned about distinguishing the origin of life from the diversification of life if you believed that all kinds of living things were miraculously created within a few days of each other—plants on day three, aquatic creatures and aerial creatures on day five, and terrestrial creatures and (in a separate creation) humans on day six—and at the same time ordained to reproduce "after their own kind," meaning that only minor evolutionary changes within a "kind" are possible. Indeed, creationists commonly lump all such questions together, using the neologism "origin science" (Geisler and Anderson 1987) and contending that evolution and creationism are rival approaches to "origin science."

Thus to creationists such as Duane Gish, evolution links common ancestry with the origin of life, claiming that "all living things have arisen by a naturalistic, mechanistic, evolutionary process from a single living source which itself arose by a similar process from a dead, inanimate world" (Gish 1978, p. 88). Henry Morris is even clearer: "Particles evolve into elements, elements into complex chemicals, complex chemicals into simple living systems, simple life forms into complex life, complex animal life into man" (Morris 1974, p. 11). And a benefit, as far as creationists are concerned, of connecting the topic of the origin of life and the topic of diversification of life is that doing so exposes the "soft underbelly" of evolution: if creationists are intrigued by gaps in our knowledge of evolution, they are delighted by gaps in our knowledge of the origin of life.

And gaps there indisputably are. Certainly there is no consensus among scientists on the step-by-step details of the origin of the first metabolizing and reproducing cell. Much is known about how inorganic molecules can give rise to organic molecules; much is known about the origins of metabolism; much is known about the production of chain-like reproductive structures such as RNA and DNA; and much is known about the formation of membranes—but in each case, much remains to be learned. The incomplete state of scientific knowledge on the topic, reinforced by a natural human tendency toward vitalism (the idea that living

G. Branch (✉) · E. C. Scott
National Center for Science Education,
PO Box 9477, Berkeley, CA 94709-0477, USA
e-mail: branch@ncse.com

things are somehow fundamentally different from nonliving things), thus makes the origin of life a highly appealing target for creationist assaults.

In such assaults, creationists frequently appeal to the "law of biogenesis"—that living things come only from other living things—in order to dismiss the idea of the natural origin of life. For example, Harold G. Coffin writes, "the concept of spontaneous generation has not died. It has been rephrased in scientific language and incorporated into mechanistic evolution as the probable method for the origin of life" (1969, p. 391). But what Francesco Redi and Louis Pasteur demonstrated was that maggots do not spontaneously generate from spoiled meat and that bacteria do not spontaneously generate in nutrient media—results with little relevance to the idea that under the conditions obtaining on the early Earth, natural forces operating on organic molecules could have resulted in primitive replicating structures.

If a natural origin of life isn't prohibited by the law of biogenesis, creationists often argue, at least it's improbable—indeed, astronomically impossible. The creationist literature abounds in calculations that gleefully pile exponent upon exponent in estimating the odds against a natural origin of life: Morris, for example, assesses the probability at less than 1 in 10^{53} (1974, p. 61). But a recent review of the literature describes seven general types of error in such calculations. Among them are the following: assuming that the process is purely random, assuming that there was only one possible way for life to arise, and assuming that the first living things were as complex as, or shared the same biochemical features with, present living things. The review reported that every argument surveyed, including Morris's, "suffers from one or more of the same mistakes" (Carrier 2004, p. 744).

And creationists often argue that scientific research on the origin of life is a dead end. Due to its fame, the Miller–Urey experiment of 1952, marking the beginning of experimental research into the origin of life, receives special attention. Of course, the purpose of the experiment was to produce organic molecules from inorganic ones, not to produce life, but the research was still significant in showing the viability of the Oparin–Haldane hypothesis that conditions on the early Earth favored chemical reactions that produced organic compounds. Sending a spark through a mixture of gases then thought to reflect the atmosphere of the early Earth, Miller and Urey were able to produce several kinds of organic molecules, including a few amino acids—the building blocks of life (Miller 1953). The experiment is now a standard fixture of biology textbooks.

A representative creationist criticism of the Miller–Urey experiment is provided by Jonathan Wells's *Icons of Evolution* (2000). The atmospheric mixture used, Wells claims, is now known not to be similar to the Earth's atmosphere at the time life was thought to form; therefore, the experiment is irrelevant, and the origin of organic molecules remains a mystery. Textbooks, he adds, are systematically misleading about the experiment. But Wells is wrong to think that the type of experiment stands or falls with the exact composition of the atmospheric mixture used and wrong to imply that scientific research on the origin of life is committed to the Miller–Urey scenario: there are avenues of research involving different atmospheric compositions, different sources of organic compounds, and different conditions of their formation (Gishlick 2003).

All of these criticisms, of course, are intended to serve a further purpose: that of supporting a supernatural account of the origin of life. Creationists habitually assume what William R. Overton, the judge in *McLean v. Arkansas*, described as a contrived dualism, whereby evidence against a natural explanation is necessarily evidence for a supernatural explanation. Whether explicitly as with Coffin or implicitly as with Wells, the supposed evidence for problems with a natural explanation of the origin of life is intended to be construed as evidence for a supernatural account. And the line of reasoning is not attractive to creationists alone; as Rice et al. (2010) suggest, even people of faith who find natural explanations for the diversification of life acceptable may still want to attribute the origin of life to God's direct action.

Will biology teachers encounter any of these criticisms of scientific research on the origin of life in their science classrooms? In all likelihood, yes. True, the origin of life is relatively neglected in state and national state science education standards and in the textbooks used at the high school level, so the occasion may not arise. But as Barend Vlaardingerbroek observes, "It seems a practical impossibility to bypass the topic; students will inevitably press their teachers about the origin of life as such, and class time will be spent on it whether abiogenesis is in the syllabus or not" (2010, p. 433). It thus behooves teachers to gain a nodding familiarity with current scientific research on the origin of life, through recent popular treatments such as Robert M. Hazen's *Genesis: the scientific quest for life's origins* (2007) and professional development opportunities such as those offered by NASA's Astrobiology Institute.

Additionally, biology teachers ought to be prepared to rebut the standard creationist criticisms—and, moreover, to use the opportunity as a teachable moment. Is a student complaining that the Miller–Urey experiment assumed the wrong atmospheric composition, or contending that the odds against a natural origin of life are astronomical, or claiming that Pasteur proved that abiogenesis is impossible? Lo and behold: there's a perfect chance to discuss the various ways in which subsequent researchers developed the experimental tradition that Miller and Urey initiated, or to assess the plausibility of the explicit and implicit premises of the probability calculations, or to investigate the fascinating history of the nineteenth-century debates over spontaneous generation—to name only a handful of possible avenues for fruitful exploration.

And because these criticisms are likely to reflect religious concerns, biology teachers ought to be sensitive to those concerns. As with evolution proper (Martin 2010), there is a range of religious reactions to scientific research on the origin of life, and it is not the business of the science teacher to express approval or disapproval of any of them; indeed, it would be highly inappropriate. But it is the business of the science teacher to explain that science is a project in which natural phenomena are explained with reference to natural causes (see, e.g., National Research Council 2008, p. 10). And while the point needs to be explained and reinforced throughout textbooks and curricula, it is especially important to emphasize it in those contexts—such as discussions of the origin of life—where it is easy for students to forget it.

On the one hand, the nature of science explains why appeals to the supernatural are out of place in explaining the origin of life, even in light of the failure so far of scientists to present a reconstruction of the origin of life in detail. As a leading origin-of-life researcher writes, "If we were to accept the supernatural or extranatural proposals of anti-evolutionists, it would provide little useful information to help us understand the history and diversity of life, and it would put an end to all research in the matter. By contrast, mainstream scientific hypotheses on the origin of life—which have been developed within the framework of an evolutionary analysis—have led to a wealth of experimental results and the development of a coherent historical narrative linking many different disciplines" (Lazcano 2004, p. 193).

On the other hand, the nature of science also explains why scientific research on the origin of life is not intrinsically a threat to faith. A teacher who explains cell division through the action of enzymes that align chromosomes in the midline of a cell is not thereby proclaiming, "God had nothing to do with it," but is merely reflecting what scientists do, which is to explain natural phenomena through natural causes. Similarly, a teacher who explains how organic molecules are produced from inorganic ones, or how membranes can form from lipids in alternately wet and dry environments, or how the RNA world may have preceded the DNA world is not thereby proclaiming, "God had nothing to do with it." Here too, the teacher is merely reflecting what scientists are doing: trying to explain natural phenomena (here the origin of life) through natural causes.

Even if it is not as central to biology as evolution, the origin of life is a fascinating topic that teachers of biology ought to be eager to teach in their classrooms. As with evolution (Wiles and Branch 2008), though, teachers are often not teaching their students the basics of what scientists have learned about the origin of life, whether because they reject it, or because they are fearful of the consequences of presenting the material to students or in a community with religiously motivated objections to it, or because they are not confident of their knowledge of and ability to teach the subject. As with evolution, understanding the science is necessary but not sufficient to help them overcome these obstacles. Understanding the nature of science—and the ways to deploy it to help to defuse likely objections and misconceptions on the part of the student—is necessary as well.

Acknowledgments We wish to dedicate the present essay to the memory of Sandra M. Alters, a passionate and inspired teacher of evolution.

References

Carrier R. The argument from biogenesis: probabilities against a natural origin of life. Biol Philos. 2004;19(5):739–64.
Coffin HG. Creation—accident or design? Washington: Review and Herald; 1969.
Geisler NL, Anderson JK. Origin science: a proposal for the creation–evolution controversy. Grand Rapids: Baker Book House; 1987.
Gish DT. Evolution: the fossils say no! San Diego: Creation-Life; 1978.
Gishlick AD. Icon 1–The Miller–Urey experiment. Oakland CA: National Center for Science Education; 2003. http://ncse.com/creationism/analysis/icon-1-miller-urey-experiment. Accessed 20 Aug 2012.
Hazen RM. Genesis: the scientific quest for life's origins. Washington: Joseph Henry; 2007.
Lazcano A. Creationism and the origin of life. In: Petto AJ, Godfrey LR, editors. Scientists confront creationism: intelligent design and beyond. New York: W. W. Norton; 2004. p. 180–96.
Martin JW. Compatibility of major U.S. Christian denominations with evolution. Evo Edu Outreach. 2010;3(3):420–31.
Miller SL. A production of amino acids under possible primitive earth conditions. Science. 1953;117(3045):528–9.
Morris H, editor. Scientific creationism. San Diego: Creation-Life; 1974.
National Research Council. Science, evolution, and creationism. Washington: The National Academies; 2008.
Peretó J, Bada JL, Lazcano A. Charles Darwin and the origin of life. Orig Life Evol Biosph. 2009;39(5):395–406.
Rice JW, Warner DA, Kelly CD, Clough MP, Colbert JT. The theory of evolution is not an explanation for the origin of life. Evo Edu Outreach. 2010;3(2):141–2.
Vlaardingerbroek B. Abiogenesis in upper secondary biology curricula. Evo Edu Outreach. 2010;3(3):432–5.
Wells J. Icons of evolution. Washington: Regnery; 2000.
Wiles JR, Branch G. Teachers who won't, don't, or can't teach evolution properly: a burning issue. Am Biol Teacher. 2008;70(1):6–7.