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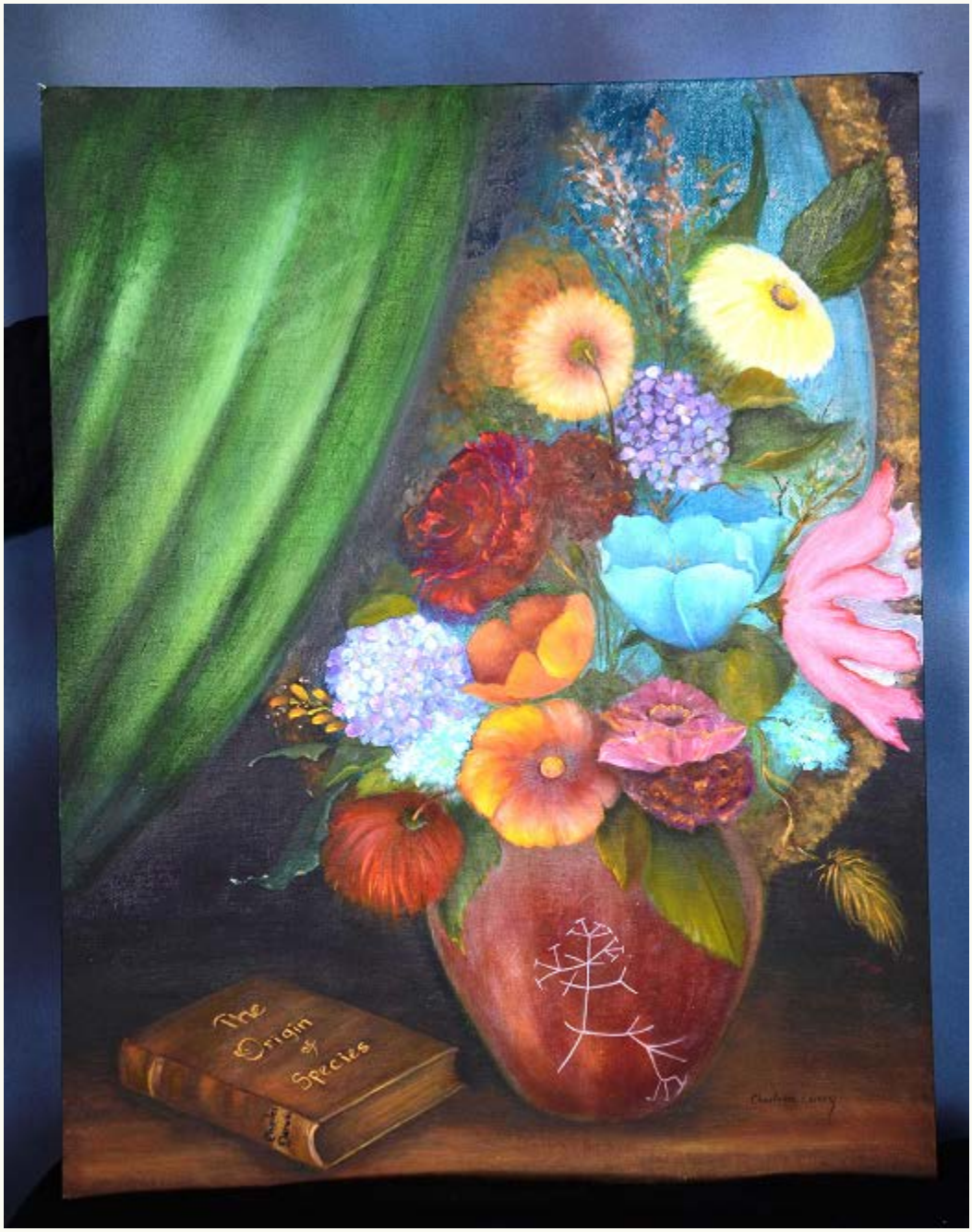

A flower-like structure of Bennettiales, from the Sedgwick Museum's collection, Cambridge.

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FEATURE

People and Places: The "Man Tracks" in Glen Rose

Randy Moore

As Branch and Scott (2013) have noted recently, the alleged "man tracks" beside dinosaur tracks in the Paluxy River near Glen Rose, Texas, are among the most enduring legends used by young-earth creationists to invalidate evolution. Although dinosaur tracks in the area's Cretaceous limestone became famous when they were excavated from the Paluxy River by Roland Bird in the late 1930s (Bird 1939), the "man tracks" were not well-known until the 1960s and 1970s, when they were promoted by the Bible-Science Association and young-earth creationists such as the Reverend Stanley Taylor and Henry Morris.

The Paluxy River "man tracks" were featured prominently in Taylor's *Footprints in Stone* (1972) movie, which was called "the greatest tool for the creationist explanation" of humans living with dinosaurs (Baugh and Wilson 1994:119), and in Morris's monumental *The Genesis Flood* (Whitcomb and Morris 1961), which is the founding document of the modern creationist movement. Subsequent books, such as John Morris's *Tracking Those Incredible Dinosaurs and the People Who Knew Them* (Morris 1980), confidently claimed that the Glen Rose "man tracks" proved that humans lived with dinosaurs.

Today, the Glen Rose "man tracks" continue to appeal to young-earth creationists (YECs) because the tracks are an easily understood piece of evidence showing that humans lived with dinosaurs. They are also a rare example of actual field research by YECs that does not involve scanning the Internet or citing other creationism-based publications.

When scientists such as Glen Kuban (1986, 1995–2010, 1996, 1996–2013, 2006) and others (Hastings 1988) examined the Paluxy riverbed, they found nothing like the famous "Delk Print Cretaceous Footprint" that is advertised and promoted by the Creation Evidence Museum in Glen Rose. Instead, Kuban and others found numerous marks that they explained as eroded depressions, random marks, in-filled metatarsal (that is, heel-walking) dinosaur tracks, and outright carvings.

In response to these explanations, the Institution for Creation Research (ICR) tepidly suggested that the "man tracks" should not be used as evidence against evolution (Morris 1986; also see Mitchell 2012). But despite these cautious disclaimers, "ICR holds rigorously to the view that dinosaurs lived at the same time as man" and claims that the Paluxy tracks "just might be coming into their own as good evidence for Flood catastrophism" (Morris 2013:4). The ICR also continues to promote misinformation and alleged "mysteries" about the tracks, while selling books that cite the Paluxy "man tracks" as evidence against evolution (Kuban 2006). The Paluxy "man tracks" continue to be promoted in numerous books

(for example, Baugh and Wilson 1994, Judkins 2009) and are a standard exhibit in several "creation museums" (as discussed, for example, in Moore 2010).

Why do claims about the Glen Rose tracks persist?

Since the early 1980s, the primary advocate of the Paluxy "man tracks" has been Carl Baugh, a former Baptist preacher who advertises and displays several "man tracks" in his successful and expanding Creation Evidence Museum (CEM) outside of Glen Rose (Moore 2009a, 2009b). Baugh claims to have excavated "more than 80 human footprints in Cretaceous limestone" around Glen Rose (Creation Evidence Museum 2013). Baugh describes the tracks as "academically documented" (Baugh and Wilson 1994:30), but has published no scientific papers documenting the "man tracks". He has published several photographs of "man tracks" obscured by water, debris, and human feet, and other photos of limestone highlighted with water to suggest a foot-like shape (Baugh and Wilson 1991, 1994), but no photos of clear, unaltered, unobscured, unenhanced "man tracks" taken during one of his excavations along the Paluxy River.

Baugh describes the concerns of his critics' as "nonsense" (Baugh and Wilson 1991:156), claiming that "the only reason for rejecting [the 'man tracks'] as a human print is 'the Establishment' argument that dinosaurs had died out long before man was around" (Baugh and Wilson 1994:73). Baugh's claim that "many who have spoken out against the tracks have never seen them or have only seen them long after they were uncovered" (Baugh and Wilson 1991:13) summarizes his two primary explanations for why others have been unable to find "man tracks" such as those exhibited at Baugh's CEM:

1. The "man tracks" dry out and/or erode within an hour or so after they are exposed (Cole and Godfrey 1985). As a result, the tracks cannot be photographically documented unless one is present when they are uncovered.

2. Because Baugh has seldom accompanied people looking for "man tracks," the visitors did not know where to look for them.

Taken together, these two excuses—that is, "you didn't find the tracks because they have eroded away" and/or "you didn't know where to look"—have been convenient explanations for why scientists and others could not find "man tracks" such as those displayed at Baugh's museum. My recent visit to Glen Rose addressed both of these explanations.

Finding "Man Tracks" with Carl Baugh

In July 2013, I participated in an excavation of the Paluxy River that was organized and directed by Carl Baugh (Figure 1) and his Creation Evidence Museum. We found and cleaned several dinosaur tracks (probably *Acrocanthosaurus*), as well as several "man tracks" that were certified by Baugh and his assistants as being made by humans (Moore 2014). One such freshly-uncovered track is shown in Figure 2. Unlike several previously published photos of "man tracks" that have used water, oil, and other substances to help viewers imagine the outline of a human footprint (see discussion in Kuban 1986, 1995–2010; Farlow 1987a, 1987b), I did not do anything to the track shown in Figure 2, nor did I use photographic filters to enhance or diminish the image.

FIGURE 1. *The author (right) and Carl Baugh (left) kneeling beside a freshly uncovered "man track" on the bank of the Paluxy River, July 2013.*

FIGURE 2. *A freshly uncovered "man track" excavated in July 2013 along the Paluxy River just west of Glen Rose. The "man tracks" we found were 15–20 cm long and 4–7 cm wide.*

In my opinion, the alleged "tracks" (such as that shown in Figure 2) were indistinguishable from countless other random marks, erosional depressions, and in-filled metatarsal (that is, heel-walking) dinosaur tracks. However, Baugh, his assistants, and others participating in the excavation quickly agreed that the tracks were made by humans; one visitor to the excavation site even placed her foot in a track, after which the leaders of the expedition proclaimed that the track was "women's size 9" (Figure 3).

FIGURE 3. *This visitor to our excavation placed her foot in a "man track," prompting the track to be described as "women's size 9." In the background is the Paluxy River.*

If you'd like to learn about some of the Glen Rose "man tracks," see the excellent and extensive work by Glen Kuban (1986, 1995–2010, 1996, 1996–2013, 2006), who has studied the Glen Rose tracks for decades. Details of my excavation of alleged "man tracks" are provided elsewhere (Moore 2014).

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FEATURE

A Reflection on the Bill Nye–Ken Ham Debate

John W Patterson

On February 4, 2014, two well-known figures debated the question "Is creation a viable model of origins in today's modern scientific world?"

Ken Ham, the founder and leader of the Answer in Genesis ministry, repeatedly insisted that it is, that the universe as we know it was created by God in six twenty-four-hour days some 6000 or so years ago. Bill Nye, widely known as television's "Science Guy," presented the view that Ham's biblical creationism is not scientifically viable at all. To the scientifically literate, Nye clearly won the debate by patiently outlining many reasons why the overwhelming majority of competent scientists today regard Ham's faith-based creationism as scientific nonsense. So successful was Nye, in fact, that Pat Robertson, the famous television evangelist—whose presidential campaign back in the 1980s was heavily supported by young-earth creationists—said, "to say that it all came about in 6000 years is just nonsense. … I think it's time we'd come off of that stuff and say, this isn't possible" (http://www.youtube.com/watch?feature=player_detailpage&v=m5XJ2iSnfXc#t=41).

This clip was aired after the debate by Lawrence O'Donnell on his MSNBC program, The Last Word, where readers can also see an interview with Nye about the debate (http://www.msnbc.com/the-last-word/watch/bill-nyes-debate-victory-lap-137819203791).

Having followed creationist debates since the late 1970s—and participated in six or more myself—my assessment of the debate will differ from that of those who, to my astonishment, seem completely unaware that creationism is still being taught as science in many of America's public schools.

First and foremost, Ham's honesty and candor sets him markedly apart from any of the creationist debaters I have listened to or debated in the past. Previously, creationist debaters would insist that neither debater should make any reference whatever to religion or the Bible. With this precondition in place, they then proceeded to deliver unsettling barrages of thinly veiled apologetics, polemics, and code phrases that, to the delight of creationists in the audience, provided indisputable "scientific" support for ideas that even Pat Robertson calls nonsense, such as that the Genesis Flood produced the geologic column and that the age of the universe is on the order of 6000 to 10 000 years.

These presentations were invariably couched in scientific-sounding words and phrases, often incorrectly applied, then supplemented with numerous out-of-context quotes deliberately fashioned to misrepresent the scientific authorities being quoted. With all this in place, the entire community of evolutionary scientists would be ridiculed as a group. (Three of the more notorious creationist debaters, in my view, were the late Henry M

Morris and Duane T Gish of the Institute for Creation Science and the still-active Walter T Brown, who is director of his own Center for Scientific Creation, now headquartered in Phoenix, Arizona.) All this explains why groups that support science, such as the National Center for Science Education, and academic scientists consider such debates to be counterproductive at best.

But again, this debate was completely different, and I for one applaud Ken Ham for being the first creation science debater in my experience to be honest about the biblical basis for all young earth creationism. I commend him also because he did not rely on the misquoting of renowned scientists, preferring instead to quote credentialed creation scientists.

Truthfulness has its price. Ham's candor spared Nye the burden of having to refute the kinds of obfuscations and distortions that debaters like Morris, Gish, Brown, and others typically have used in the effort to direct attention away from the biblical basis for creationism. Because of this, some will say that Nye should have done much better than he actually did. But I think Nye deserves the benefit of the doubt here; in my opinion he chose to be much more gentlemanly than a lesser man might have been under the circumstances.

However, I think the Nye–Ham debate will unleash unprecedented divisiveness within the creationist movement. I expect that the "traditional" creation-science ministries, such as the ICR, the CSC, and the less visible Creation Research Society (headquartered in Chino Valley, Arizona: https://www.creationresearch.org/), will condemn Ham's candor as a harmful blunder. Why? Because their less candid polemical debate strategy which tried to obscure the biblical roots of their assertions and pretend to have a scientific basis had been so successful for so long.

Now there will be far less public confusion about the distinctions between legitimate evidence-based science and the faith-based biblical varieties so successfully propounded by debaters from the ICR, the CRS, and the CSC, among others. In this connection, the more recent "intelligent design" variety of creationism stirred considerable dissension when it abandoned the young earth timeline in favor of accommodating, if not embracing, modern science's deep-time perspective. But, like the young-earth ministries that they left behind, the proponents of "intelligent design" also strive mightily to disguise the theological-apologetical nature of their Seattle-based Discovery Institute. In contrast, Ham's approach lays bare what's really behind all creationism. I would not be surprised to see a particularly vicious kind of internecine dissension result from the widely promoted Nye–Ham debate.

The one thing I wish Nye had not left out has to do with the why modern science so completely ignores God and supernaturalism in general when striving to explain natural phenomena. In science, interpretations and explanations are deemed credible according to their predictive capacity and how much mystery and fearful bewilderment they eliminate. Nye spoke to the predictive poverty of creationism, but failed to point out that explanations involving supernaturalism (and God especially) necessarily increase the amount of unfathomable mystery and bewilderment beyond anything that ordinary nature can entail.

In science, supernatural explanations are considered worse than none at all for two reasons. First, they tend to stifle meaningful inquiry by any who accept such fruitless explanations. Second and more important, religious explanations do the opposite of what genuine scientific explanations are intended to do. For creationists. a felt need for salvation from the

fearsome mysteries of this world is a good thing. Modern science, by contrast, seeks the opposite. Science seeks to enhance the human understanding and control of nature, not only by eliminating as much mystery and fear as possible, but also by opening new vistas to explore and devising new methods for exploring them. Frequently scientific endeavors lead to unexpected new understandings of fascinating new phenomena and in many cases to a certain betterment of the human condition.

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John W Patterson is Emeritus Professor of Materials Science and Engineering at Iowa State University. Among his publications on creationism is "Thermodynamics and evolution," published in Laurie R Godfrey's *Scientists Confront Creationism* (New York: WW Norton, 1982).

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FEATURE

Creation–Evolution at the Podium: That's Debatable!

Andrew J Petto

I have never witnessed a creation–evolution debate. In over 35 years of following arguments and counterarguments from creationists of various sorts and the scientists who oppose them at podia across the nation, I have never witnessed what one could accurately call a debate in the strict sense of the word: an interactive argument or disputation with a specific rhetorical structure. This description may fit the great formal debates of our cultural history, but they hardly apply to what most of us experience as "debate" in modern society, as exemplified by political campaigns or the legislative process (even less on cable television) … and, of course, creation–evolution debates.

These events often do mimic true debates: they start with a premise or a resolution. The most recent example featuring Bill Nye and Ken Ham proposed this one: "Is creation a viable model of origins in today's modern scientific era?" So far so good. And since we know the short answer from both of them ("Yes" for Ham and "No" for Nye), what we might expect is for each debater to provide evidence about why his answer is true. Then, in rebuttal, each debater should be able to magnify the obvious weaknesses in his opponent's position while strengthening his own arguments.

Ham, for his part, tried valiantly to show why creation *was* a viable model. But it was clear that he could only do so by redefining science idiosyncratically. Then he followed the standard creationist yeahbutwhatabout playbook … tossing out isolated facts and issues that appear to those unfamiliar with these examples to invalidate the naturalistic models.

Nye, on the other hand, chose not to examine directly the viability of creationism *per se* but to lay out a case for the current scientific approach to understanding the history and diversity of life on earth. Nye did admirably under the circumstances, but the fact that one model is true (or false) does not necessarily inform us about the validity or viability of the other.

Nye did a good job laying out what viability might mean. The examples from the history of applying scientific knowledge in diverse fields, such as medicine, agriculture, technology, and so on, are reasonable ways to measure viability of a model. The proper application of the scientific model provides us with additional knowledge to meet acknowledged goals (feed more people; protect people from diseases or cure them faster; improve communications and transportation; predict and prepare better for natural disasters; and so on).

And although Nye challenged Ham repeatedly to provide such evidence for a similar record of viability for creationism, Ham could not do much better than to say that the Bible predicted that all humans are descendants from common ancestors (Genesis 4:1 and/or

Genesis 9:1) and that the Tower of Babel (Genesis 11:9) predicted the diversity of human language. These are, of course, trivial examples. A simple "Is that all you've got?" after the extensive list of examples on the scientific side would have sealed the deal … with a little humor to boot.

A review of creation–evolution debates in the early 1980s (Edwords 1982) shows that the events in which the supporters of evolution came out ahead were those in which these scientists articulated the creation model, specifically compared the creation model to the modern scientific model, and then persistently focused on the errors and deficiencies of creationist models as science. In other words, they took the challenge of a true debate to heart.

For the most parts, public debate in the early 21st century is little more than carefully drafted sound bites and "gotcha" moments. These make it east to tally up points to name a "winner" but we all lose in the process for the failure of the "debaters" to engage critically and formally the arguments of their opponents and expose their weaknesses. This is perhaps the reason that Karen Bartelt (2004) called such debates "drive-by shootings of critical thinking"—this format does not provide anything to think with. In creation–evolution encounters, what happens on the podium is rarely what one can reasonably consider a debate.

This may be one of the reasons that NCSE has generally discouraged evolution supporters from participating in these events; it is stepping into the land behind the looking glass in which things do not mean what they seem to. Even if the scientist wins, science stands to lose.

We should not concede the stage, however. It is important that the case for scientific approaches to the important issues facing our species and our planet be made and understood by the general public. We need engaging presenters—people like Bill Nye—to promote that understanding in events and locations that will reach the intended audience through blogs, Twitter and RSS feeds, Facebook postings, and other outlets where information reaches people (and from which people often pass it along to others).

Perhaps the sun has set on the great age of debates. But only a naturalistic model can tell us how the sun sets ... and why we can expect to see it in the morning. And that is not debatable.

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FEATURE

Eyewitness to the Debate

Steve Watkins

On February 4, 2014, a rare event took place at the Creation Museum in Petersburg, Kentucky. Bill Nye ("The Science Guy") and Ken Ham (Answers in Genesis's chief executive officer and co-founder of the Creation Museum) met to debate the topic "Is creation a viable model of origins in today's modern scientific era?"

At my arrival time of 5:30 PM, the parking lot was already filling up, but I did not see the scattering of church buses in the lot that are generally expected for such an event. On my many research trips to the Creation Museum, I usually observe church buses from Protestant, low-church traditions (Baptist, Methodist, Pentecostal, and independent Bible churches). I found out later, from staff members at the Creation Museum, that the 900 tickets sold out in about two minutes. Under these conditions, a ticket purchase on a large scale—for example, enough to fill a bus—would be nearly impossible to coordinate in advance, so I suspect that the lack of church buses was due to the difficulty of securing tickets.

Several colleagues who are also researching the Creation Museum told me that I was extremely lucky to have secured the two tickets. Accompanying me to the debate was James Bielo, an anthropologist from Miami University (Ohio). Bielo is also working on a project related to Answers in Genesis.

The event was well-staffed. At almost every turn. Creation Museum staff members and volunteers could be spotted wearing professionally-designed black Ham/Nye T-shirts. I was directed to a check-in desk where I presented my ticket and was issued an orange wrist band, and was told this was mandatory for entrance to the event. I also received a glossy orange-and-black flier with the debate format printed on one side and procedural concerns on the other. Bielo made an interesting observation in his field notes: "AiG's talent for branding was on display through these T-shirts, the wristbands, and all advertisements and promotional material for the debate [were] color and aesthetically themed, very professional" (2014 Feb 4 e-mail from James Bielo to the author).

Bielo arrived at approximately 6:00 PM. We had planned to walk around the Creation Museum and to observe the overall environment informally. However, a staff member suggested that we should promptly proceed to Legacy Hall, the site for the event. Before entering Legacy Hall, we had to pass through an airport-style metal detector. We were allowed to wear our shoes but were required to remove all other loose items and our belts. I noticed four or five detectors, but there was virtually no wait. The staff members at the security screening were polite and even offered some humorous comments. On staffer mentioned that "all flights were on time tonight." All but one of the other staffers who interacted with us were super positive and friendly.

We proceeded into Legacy Hall and found our way to the very back row, which allowed us to survey the great majority of the room (Figure 1). Legacy Hall is a large room with a multi-purpose stage that is regularly used as a lecture hall for the Creation Museum. For the debate, the room had a central elevated camera and electronics platform to record the event. Two extra screens were place in the top right and left of the wall behind the stage for a total of four large video screens. The stage was exquisitely decorated with several desks and two central podiums for Ham and Nye.

One general observation about the crowd was that it was almost exclusively white. I saw one African American man in the room of 900 seats for ticketed attendees. The crowd was also fairly young—I'm guessing an average age of twenty-five to thirty-five. The crowd was also predominantly middle- to upper-middle class. I use the automobiles in the parking lot and attire to make this assertion. Bielo also agreed with me on this point.

A friendly older couple sat next to us, and we found out that they were Bill Nye supporters. Several men were wearing bow ties as a notable nod to Bill Nye. One group of four attendees wore T-shirts that they had obviously designed for the event. The shirts were white with a blue bow tie centered toward the top. Below the bow tie were the words "Bill Nye is my homeboy." So there was a quite visible group of Nye supporters in the audience.

Figure 1. *Legacy Hall at the Creation Museum, as people were making their way to their seats before the debate. Photograph: James Biello.*

The main event

Between 6:00 and 7:00 PM, video clips of Bill Nye's show were played at various intervals. The Creation Museum also interspersed their own videos clips in between Nye's. At five minutes before the event began, Steve Ham (Ken Ham's brother and an employee of the Creation Museum) opened with a few brief introductory statements. Mostly, it was a reminder to silence all portable technologies such as smart phones and to issue a caution not to record or take photos of the event in progress.

The event began at 7:00 PM sharp. Readers interested in a detailed summary of the event can find the entire debate (as well as highlights) at National Public Radio (http://www.npr.org/blogs/thetwo-way/2014/02/04/271648691/watch-the-creationism-vs-evolution-debate-bill-nye-and-ken-ham).

Following the moderator's remarks, Ham opened with a five-minute introduction. It's interesting that Ham tended to use the words "biblical creationist" instead of "young-earth creationist" (YEC). Ham played several clips from YECs with PhDs in the sciences. This was central to his attempt to redefine science—his main strategy in the debate. His central argument was that science must be divided into two realms—experimental (or observational science) and origins (or historical science). This was one of several "classic" arguments by YECs (see Scott 2009:287,292–295). He also asserted that science has been "hijacked" by secularism which "arbitrarily defines science as naturalism".

Nye opened with a humorous anecdote about his trademark of wearing bow ties, then made the counter-argument to Ham's. He used the television hit *CSI* to explain that dividing science into observational and historical realms is a false dichotomy that secular scientists do not accept; scientists use the same materials and methods to study past events that were not witnessed. He noted that all it would take to change the entire scientific paradigm would be contradictory evidence: it could be as simple as finding more recently evolved fossils randomly distributed in all different rock layers, rather than in the historical sequence required by evolutionary models. I thought that he made an effective point by stating that the scientific model is always ready to change if the evidence supported it.

The two men made their thirty-minute presentations with Ham going first and Nye following. The basic cores of their arguments did not really interact with the other's arguments. Ham repeatedly asked Nye how life could come from non-life. Nye repeatedly asked Ham to make predictable statements that could be tested by scientists. Ham repeatedly appealed to the Bible as the ultimate source of authority for science and any other matter it spoke to. The debate was essentially a stalemate between what Stephen Jay Gould has termed two different magisterial voices—science and theology.

One of the most telling questions for me was the last one asked by the moderator to both Ham and Nye. He asked the following: "What is the one thing more than anything else upon which you base your belief?" Ham's reply was essentially that the Bible was the perfect record of all history and that what it said was undeniable. Nye responded that he based his beliefs on the process of science.

Bielo made an observation with which I agree—that Ham's PowerPoint presentation was much more polished and sophisticated than Nye's. Ham's use of testimonial clips from creationist PhD scientists struck me as a particularly effective strategy as well. I thought

that Nye did an admirable job in boiling down some rather difficult aspects of evolutionary science. I say that as a non-scientist but also as one who has read popular-level books by scientists like Gould and others.

Reflections

The overall feel of the debate was positive. Nye and Ham were both cordial with one another and kept the tone serious but not derogatory or demeaning ... on the whole. The audience never got rowdy nor were there any individual outbursts or booing by anyone. The only unfortunate situation was due to weather: a winter storm began right as the event was starting and by the end, Boone County was under a level-2 snow emergency. Unfortunately, this meant that I was not able to stay after to ask questions of other audience members because people were just scrambling to get home in the midst of the storm.

I found the debate to be quite predictable. These two competing sources of authority—the academic scientific community and personal interpretations of the Bible—are dealing with entirely different epistemologic bases. In this respect, I think the Creation Museum scored the most points because it made it appear that there was an actual debate within academic science, even though Nye pointed out that the terms Ham used to define science were simply nonexistent in the scientific community.

The debate was really a set of talking points that were prepared and polished by both men in advance. It was more like a presidential debate where questions can be easily avoided in favor of returning to a given agenda. They did not react to one another's ideas in a more discursive, emergent way.

A Creation Museum staff member told me that in the days following the debate, hits on the Answers in Genesis and Creation Museum websites spiked by hundreds of thousands. Further, during the debate a friend texted me that the debate was trending number one internationally on Twitter. At the end of the day, I doubt any evolutionists were convinced that YEC was true science. Nor do I think any committed YECs were won over to the evolutionary point of view.

So the question about whether to hold "debates" like this one remains: If we do not expect (or generally observe) that anyone's mind has been changed, then what is the purpose? If there is no serious engagement of one's opponent's ideas and just a repetition of "talking points", then is it even a "debate"? Perhaps we are too conditioned by what we see in legislative sessions or political campaigns under the guise of "debating", but even if we accept the value of confronting creationism's masquerade as science in public events, these events seem to do little more than "show the flag". And that is not nearly enough.

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Steve Watkins is adjunct professor of Religious Studies at Northern Kentucky University and a PhD candidate in Humanities at the University of Louisville. He is writing his dissertation, *An Analysis of the Creation Museum: Hermeneutics, Linguistics, and Information Theory*, as an interdisciplinary exploration of fundamentalist culture. Watkins has recently published two creative non-fiction stories in literary magazines—"Fear" in *The Dos Passos Review* and "Touch" in *The Kentucky Monthly – Literary Edition*—and an essay on the Creation Museum, "Dragon Snakes and Fictitious Grapes: What Happens When Myths are Literalized," in *The Fourth R: An Advocate for Religious Literacy.*

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FEATURE

Science and Public Policy

Bernard Winograd

Is science policy doomed to be another political football, kicked back and forth between the right and the left? It certainly has been common for Democrats to consider themselves the party of science and to warn about a war on science whose leadership comes from the right wing of American politics. And no less a right wing political luminary than Yuval Levin, former Bush Administration policy staffer and the founding editor of *National Affairs*, wrote a book published in 2008 that argued just that. Called *Imagining the Future: Science and American Democracy*, it argued, "The dispute…is … between two elements of the larger society (which we would not be remiss to call the left and the right), with science merely one subject of the argument" (Levin 2008:2).

But the fact that science policy can be used by left and right for political purposes does not necessarily mean that it is nothing more than another in the depressingly long list of disputes between those two political tendencies. To think about what an alternative to this perspective would be, we have to consider what would be the political agenda of science and to examine whether it is inevitably best viewed through a right–left lens. When we do so, it turns out that there is a public policy agenda that is pro-science and that is orthogonal to the right–left divide. But once we understand what that agenda would be, it also becomes obvious how hard it is to escape the gravitational-like pull of the right–left dichotomy.

To begin with, it seems obvious that the primary objective of science policy would be defense of the scientific method and scientific inquiry from pre-emptive attempts to limit it. The teaching of evolution in science classrooms is a wonderful illustration of this policy issue. The NCSE has spent more than a quarter of a century wrestling with efforts to limit this kind of science teaching. Opposition to it typically arises from elements in the evangelical community that are anxious to limit the exposure of their children to ideas that they see as threatening to their world view. Evolution seems to many of these people to undermine faith in God, and certainly is seen as antagonistic to believing in doctrines of biblical literalism. Without question, those who wish to interpret the Judaeo-Christian scriptures as providing a literal history of the world will find themselves at odds with the findings of paleontology, geology, archeology, and biology, just to list a sample of the conflicts.

Readers of *RNCSE* do not need a recapitulation of the history of these battles, which have played out in school boards, textbook review committees, and the courts. These debates have generally ended with the conclusion that US law regards the effort to restrict the classroom discussion of evolution (or to focus that classroom discussion on a supposed "controversy" regarding its validity) as incompatible with the separation of church and state. Despite the consistency of judicial rulings in these matters, those who do not want evolution taught in science classrooms remain motivated to try to limit such teaching through the

political and court systems whenever there is an opening. Since the defendants of teaching evolution are more frequently (although not exclusively!) from the left side of the political spectrum and the opponents are (virtually all) from the right, this example seems to support the thesis that science has an agenda that is reducible to the right–left continuum, with the right willing to limit the scientific agenda to avoid challenging other perspectives, and the left in favor of the right of scientists to set their own agenda and police their debates by using the rules of scientific inquiry.

The facts are only the beginning

But the issue is clearly not that simple. There is a second imperative which logically belongs in a science policy agenda, which is that facts unearthed by the scientific process should be used to inform public policy decisions. Note that this is not advocacy for what the decision should be, but rather respect for the folk wisdom embodied in former Senator Patrick Moynihan's famous admonition that everyone in Washington is entitled to their own opinion, but not to their own facts.

Scientists involved in the creation of the atom bomb were ambivalent about their roles but most rejected the notion that the bomb should not have been developed, reserving their ambivalence more often for the decisions about how and whether to employ it. This is a morally neutral ground that many have criticized as unrealistic and self-serving. Implicitly, the critics believe that individual scientists should make judgments about the morality of their work.

But even when scientists are willing to make such moral judgments, they cannot expect to be exempt from disagreement about whether they have chosen wisely. Consider the example of Golden Rice, which is a project led by a consortium of scientists with the seemingly uncontroversial desire to alleviate malnutrition. The Golden Rice project developed a genetically modified form of rice that produces beta carotene, a source of Vitamin A, the lack of which causes serious health problems in many poor countries where rice is a dietary staple. Opposition to genetically modified foods (GMOs) is commonplace on the left, but is usually associated with political concerns about the profits and power that may be earned by companies producing these products. None of those concerns is applicable to the Golden Rice project, which has no corporate sponsor.

Nevertheless, as emblematic a left wing group as Greenpeace has participated in efforts to stop the testing and the roll out of Golden Rice. At issue is that Greenpeace "dismisses the benefits of vitamin supplementation through GMO's and has said it will continue to oppose all uses of biotechnology in agriculture" (Harmon 2013:). That is a pretty clear-cut indication of opposition to the use of science to set public policy.

And, in fairness, it is not presumptively self-evident that anything that alleviates malnutrition is always and everywhere a good idea. A Greenpeace spokesman was quoted in the same article as saying "We would rather err on the side of caution" (Harmon 2013:7), referring to the fear of unspecified, unpredictable consequences of introducing GMOs into the biosphere. But that degree of caution is certainly not an approach warranted by the facts with regard to genetically modified foods to date, which have been safely consumed by millions of people for decades without scientifically documented adverse consequences

(AMA 2012; Key and others 2008; US Institute of Medicine and the National Research Council 2004).

Yuval Levin points out what is incongruous about the left making this argument for caution in using GMO foods when he observes

> in many important respects environmentalism is deeply conservative. It takes no great feat of logic to show that conservation is conservative, of course, but the conservatism of the environmental movement runs far deeper than that. The movement seeks to preserve a given balance [in nature] which we did not create, are not capable of fully understanding, and should not delude ourselves into imagining we can much improve—in other words, its attitude toward nature is much like the attitude of conservatism toward society (2008:93).

Note that Levin is simultaneously pointing out that conservatives, especially free-market conservatives, ought to be supportive of science's efforts to proceed to examine issues without regard to potential political controversies, if only to be logically consistent with their advocacy for letting economic markets develop with the least possible amount of government oversight. Yet he himself devotes much of the rest of his book to advocating for an exception to this policy for biotechnology, which he sees as posing huge moral issues that ought to warrant pre-emptive restraint, for example, the scientific investigation of human cloning.

Here we have in a nutshell how confusing science can be to the traditional right–left categories. Both the left and the right are prepared to limit the freedom of science when it touches certain of their sacred cows. Just which cows are sacred depends on one's prior political disposition, not on the science. In that sense, science can of course be reduced to a right-left debating topic, but only in the same sense that virtually anything can be.

What scientists prefer in this regard is well illustrated by the debate over global warming. For fear of the regulatory consequences of acknowledging the existence of global warming, too many on the right have steadfastly refused to accept that the weight of scientific evidence and scientific opinion points to increasing global warming. For the same reason, even more have been reluctant to acknowledge that it is human activity that is responsible for the discontinuity with the past.

Most scientists are careful to distinguish between their personal views of what the right policy response is to global warming and what the facts are about its causes. While willing to acknowledge that there can be reasonable differences about the extent of global warming and what should be done in response, scientists are infuriated by the effort to deny the fact of its existence or even the well-supported conclusion that humans are to blame. Doing so, they illustrate that they feel strongly about the importance of leaving the determination of facts to the scientists, so that the consequent public policy debate can be better informed. This attitude earns them no thanks from those determined to see the issue in the context of a right–left, free-market–regulation debate.

Ironically, the scientific investigation of the origins of this right–left pattern of political debate has seen a lot of progress of late. We know that there are logical evolutionary explanations for why most societies contain a mixture of people inclined to look con-

stantly for ways to improve society and of those whose first reflex is to worry about the consequences of cultural and political change that is too rapid. We also know that these personality predispositions are pretty reliably associated with what each society calls left and right, although the specifics of the issues vary by society and over time (Hibbing and others 2013; Tuschman 2013).

The power of prior thinking

One of the more important insights of this research is that these predispositions are powerful; people will react to questions of right and wrong more strongly than the rational arguments employed by advocates on both sides (most notably, Haidt 2012). It is clear that these arguments are more or less rationalizations, employed to make us feel better about what we are "instinctively" sure is right. But, as the Golden Rice example suggests, these arguments are not necessarily logically consistent with each other. It is another marker of their non-rational origin that we can point to logical inconsistencies in the views of both the right and left, a parlor game that delights each side, but only when the examples are employed to illustrate the foolishness of their opponents.

So, far from being, in Levin's phrase, "merely one subject of the argument", there actually is a scientific agenda that is orthogonal to the standard right–left continuum. Its key elements would surely include having political and social rules that make possible the pursuit of the scientific method and leave the adjudication of scientific disputes to the scientific community. It would also include allowing scientists to prescribe the substance of science education, with debates about the political controversies to which science gives rise relegated to the social science classrooms, where they more properly belong (for example, Hess 2009). And it would arguably include strong advocacy for deference to science in settling questions of fact, leaving to everyone the chore of dealing with those facts in setting public policy.

Unfortunately, we know enough about human nature to also understand how unlikely this agenda is to become mainstream thought any time soon. It is not just the particular configuration of politics and demographics in the United States that is the issue. It is the very real differences among human personality types that are far more powerful influences on our political discourse than this kind of reasoned agenda. The good work of the NCSE aside, there are few groups devoted to promoting science's right to set its own agenda, police its own disputes, and educate our children about what is the true nature of science.

But the cause is also not hopeless. Science has made powerful contributions to human well-being since the scientific method began to be pursued vigorously and systematically by part of world society. The gap in well being between the societies that embraced it and those that shunned it is a conspicuous feature of the world landscape just a few hundred years later—the mere blink of an eye in the history of humanity. The progress has not been without drawbacks, as many would be quick to point out, but there are few indeed that would want to return to the world of superstition, poverty, malnutrition, childhood mortality, and widespread adult disease that it has increasingly displaced. Advocacy for science in the name of these benefits is worthwhile and is not an issue that should belong to either the left or the right.

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REVIEW

Charles Darwin: A Celebration of His Life and Legacy

edited by James T Bradley with Jay Lamar
Montgomery (AL): NewSouth Books, 2013. 253 pages

reviewed by Carol Anelli

The year 2009 marked 200 years since the birth of Charles Darwin and 150 years since the publication of *On the Origin of Species*. In celebration of Darwin's dual anniversary year, Auburn University hosted a lecture series showcasing the far-reaching and enduring impact of Darwinian theory on the sciences, social sciences, and humanities, as well as on social and political movements and religious thought. A happy outcome of the lecture series is this anthology, each of whose thirteen essays serves as a stand-alone, thought-provoking piece.

An essay by Richard Dawkins, world-renowned evolutionary biologist, best-selling author, and sworn foe of anti-evolutionists everywhere, opens the book. The origin of his essay dates to 1996, when Dawkins, en route to deliver a lecture at Auburn, learned of the infamous "Alabama Insert," a disclaimer of evolution that the Alabama State Board of Education had ordered pasted onto the inside cover of the state's biology textbooks. Forgoing his planned remarks, Dawkins critiqued each sentence in the disclaimer, and the transcript of his lecture (accompanied by illustrations) serves as a wonderful introduction and a testament to the amazing force of evolution. Using colloquial language and employing numerous examples and metaphors, Dawkins effectively debunks the common misconceptions and myriad misstatements that continue to surround evolutionary theory.

David T King Jr's essay "Darwin as a geologist" acknowledges the influence of Darwin's geological mentors, and lists and quotes from his many geological publications, including his work on the origin and evolution of coral reefs and his geological observations and cross-section of southern South America. Jonathan Armbruster's "Darwin and collections," which presents relevant excerpts from Darwin's correspondence and works, underscores the importance of fieldwork and collections-based science, and articulates the critical need to sustain university museums as training grounds for the next generation of students in natural history. Gerald Elfstrom's essay explores the influence of Malthus's theory and the similarities and differences in Darwin and Wallace's thinking.

Debbie R Folkerts's essay "Sexual selection" serves as an excellent primer on the topic, offering lucid explanations of key terms and concepts, references to classic publications, and insights into sexual selection in humans. In discussing various models of sexual selection, the author notes (p 89), "None of these new models … contradict the model as originally proposed by Darwin. It is remarkable that 150 years since his first publication on the idea, modern science has just refined the basic idea."

The heinous misapplication of Darwinian theory to human societies is discussed in Guy V Beckwith's essay on Social Darwinism. Darwin never advanced nor endorsed this ideology, although (as the author notes) George Bernard Shaw aptly observed, "Darwin had the luck to please anybody with an axe to grind" (p 112). In examining Social Darwinism and eugenics in Nazi Germany and the US (which may surprise some readers), the author employs compelling, eloquent rhetoric to remind us that science, for all its transformative power, can be readily debased by human arrogance.

A pair of essays considers Darwin's impact on psychology. The first, Lewis Barker's "Darwin's legacy in psychology," notes contributions from key historical figures, including Francis Galton (Darwin's cousin), Wilhelm Wundt, William James, George Romanes (with whom Darwin corresponded), C Lloyd Morgan, and Edward Thorndike. This essay closes with the evolution of human consciousness, and highlights two different contemporary approaches toward its elucidation. The first is that of Merlin Donald, who proposes a three-stage theory that emphasizes "mimesis" (imitation), language, and literacy. The second approach is that of Auburn's Jeff Katz and his colleagues, whose research is highlighted in the second essay, by Kelly A Schmidtke, John F Magnotti, Anthony A Wright, and Katz himself. After exploring Darwin's interest in psychology, Katz and colleagues do a beautiful job explaining the logic behind and historical development of their field, which enables the novice reader to comprehend their current research on comparative cognition in pigeons, monkeys, and humans. Like all the essays in this anthology, this one would serve as great introductory reading for a special topics seminar, but it also could be used to introduce young people to experimental design, the value of comparative research and model systems, and even graphical rendering of data. Kenneth M Halanych's essay "Evolution and embryology" discusses the importance of developmental biology in strengthening Darwin's ideas and makes connections to "evo-devo," in which field evolution and development enjoy a renewed synergy.

Two essays in particular broaden the disciplinary scope of the anthology. Giovanna Summerfield's literary analysis essay of *The Adventures of Pinocchio*, the nineteenth-century children's classic, argues that Pinocchio's adventures and metamorphoses, from wooden stick to puppet to real boy, mirror Darwinian theory. Shawn Jacobsen's essay looks at human evolution in the contexts of biotechnology, human augmentation, genetic engineering therapy, and science fiction, and provides food for thought and fodder for student assignments in considering the future of human evolution.

Together with Dawkins's opening address, James T Bradley's final essay, "Darwin's great idea and why it matters," appropriately bookends the anthology. For its clear explanation of what evolution is, what Darwin knew and hypothesized and what we now know, and why every citizen should possess a basic understanding of evolutionary theory and its broad utility, this essay is invaluable. It reminds us that only 39% of Americans accept evolutionary theory. In straightforward language, the author (who co-edited the anthology) addresses the most common misunderstandings about and arguments against evolution (such as issues surrounding transitional forms, the second law of thermodynamics, macroevolution, and that old chestnut, "it's just a theory"). I found particularly engaging his use of Plato's "Allegory of the Cave" as a means to prepare students to learn about evolution.

All the essays in this anthology (with the exception of Dawkins's address) are supported by key references to the scholarly literature and virtually all are highly accessible to the general reader, with terms and concepts duly explained. The only possible exception is Anthony Moss's essay on origin-of-life hypotheses, which by necessity alludes to basic chemistry, metabolic processes, and biomolecular replication. But its sweeping synthesis is a marvel—it draws on 82 references that span views of spontaneous generation from ancient times to the mid-nineteenth century, through the Haldane–Oparin hypothesis of the 1920s, up to twenty-first-century reports of the "Lost City" deep-ocean vent site and research demonstrating self-replication in an artificial RNA system.

In sum, this anthology would be of interest to anyone wishing to gain a grasp of the impact of Darwin on the disciplines discussed in these essays, and anyone seeking lucidity regarding the theory of organic evolution.

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REVIEW

Looking for a Few Good Males: Female Choice in Evolutionary Biology

by Erika Lorraine Milam
Baltimore (MD): The Johns Hopkins University Press, 2010. 236 pages

reviewed by Lee Ehrman

Looking for a Few Good Males provides a historical survey, essentially limited to the twentieth century, of concepts and research concerning biological issues of female reproductive choices. Beginning, unsurprisingly, with Darwin and Wallace, Milam proceeds to chronicle explorations of choice-based animal mating behaviors by different scientific communities, primarily those of Britain, France, and the United States. Darwin, it should be noted, endowed sexual selection with profound influences over a variety of sexual dimorphisms, for example, the reliable difference between human male and human female stature. He seems to have been compelled to do so because of no alternatives; although two papers that mentioned Mendel's work in passing were in his possession, Darwin seems never to have read them, and if he even he had, they would have been obscure to him.

Milam investigates boundaries between animal husbandry and sexual selection, stating:

> In the early decades of the twentieth century, both biologists and psychologists considered choice-based behavior to be far more likely in humans than in animals, as animals seemed to lack the cognitive ability to discern the minute aesthetic differences distinguishing one potential mate from another. Whereas Darwin hoped to access the inner lives of animals through an analysis of their behavior and expressions, his belief in the continuity of animal and human mind became increasingly problematic with the blossoming of Mendelian genetics as a field of inquiry and with a renewed emphasis on controlling animals in a laboratory setting. Although biologists rejected notions of choice in animal courtship, people with an interest in applying evolutionary theory to human affairs continued to embrace sexual selection by female choice. (p 3)

Then the international scientific effects of World War I, initiating eugenics, are discussed. Milam reproduces an illustration showing two women (p 49). On the left is a lissome blonde flapper holding a fan; on the right is a sturdier brunette woman holding a baby. The socially desirable features on the woman on the left are described as "Beauty first / Delicate features / No 'deep' intellect / Vivaciousness / Slim figure / Tiny waist / Small hips / Dainty wrists and hands / Slender, soft tapering limbs / Slim ankles / Tiny feet," while the eugenically desirable features of the woman on the right are described as "Beauty unimportant / Strong features / High intelligence / Seriousness / Sturdy figure / Ample waist / Broad hips / Sturdy wrists, strong hands / Solid, sturdy limbs and ankles; good-sized feet."

What follows is the most interesting part of this book, a chronological record of experiments into sexual selection—described, documented, and interpreted as nowhere else. These chapters (3, 4, and 5) span American, British, and French-American collaborations, most fruitful under the guidance of Theodosius Dobzhansky at the Rockefeller University, ending in 1970. These unique chapters, utilizing interviews, are valuable, and soon to be irreplaceable. I appreciate how well Milam listened while interviewing and examining relevant written documents, skills appropriate, even essential for a historian, some of whose subjects are still alive, even still contributing. I've even sent her current relevant literature, admittedly favoring my own. But hey, we women must stick together.

Throughout Milam's accurate story, I sensed protective interpretations favoring female scientists during an extraordinarily productive era, part of which Milam refers to as the "Long 1960s." This may be especially so when female scientists, myself included, produced an abundance of solid data favoring female choice, only partly balanced by male vigor during sexual encounters. Since this favoritism, by a female historian towards female experimenters producing female-favoring behavioral data, is mild and reasonable, it is okay, I think. Listen, we gals needed any blessings then, and do even now. My own experience shows how women's concerns and insights were slighted in the scientific community. At Columbia University, in the 1950s and '60s, I had to go to Art History to pee, so rare were girls' bathrooms in the then Zoology Department. Or consider Dobzhansky's reaction when, after decades of father–daughter-like collaboration, I had to tell him I was pregnant: "Lee, you're a woman!" He once judged Bruce Wallace and me as possessing one basic flaw corrupting young scientists: "You are both too entirely devoted to your families." Later, he sent me a manuscript to read while I was absent from the lab for three days after my daughter's delivery. (My husband, his dentist, then swore he'd drill through Doby's hard palate—he'd become edentulous at an early age—at the very next opportunity.) In such a context, it was easy to overlook less ostentatious, less "showy," female reproductive strategies.

I take issue with two of Milam's choices about what to discuss and what not to discuss.

On the one hand, Milam has omitted, completely overlooked, the chemistry and biochemistry involved in pinpointing selection of "a few good males." Perhaps the relevant literature, in primary journals, is not routinely surveyed by historians of science. Rather, she has carefully compiled a meticulously documented consensus of mostly twentieth-century approaches to an array of definitions—some narrow, some expanded—of sexual selection, an aspect of Darwinian natural selection. (I tell my students that the singular time they function as geneticists is when they pick the alternate-sexed parent of their children.)

On the other hand, Milam devotes too much time and space to sympatric speciation (p 110–119). Allopatricity may be micro-allopatric, but it never is fully sympatric. There! In my old age, having begun contributing to this literature since my remote teens, I have to insist: Ernst Mayr (1942) was correct.

This is not a long book, but it is replete with copiously detailed notes supporting every statement. It could profitably be read alongside three recent related books—*Sperm Biology* (Birkhead and others 2009), *The Evolutionary Biology of Human Female Sexuality* (Thornhill and Gangestad 2008), and *Experimental Evolution: Concepts, Method and Applications of Selection Experiments* (Garland and Rose 2010), although *Sperm Biology*

is more remote—and Joan Roughgarden's lengthy illustrated review of this same, lively, smoothly-flowing book (Roughgarden 2010). I hope for a sequel, updated and more reasonably priced.

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REVIEW

The Life of David Lack: Father of Evolutionary Ecology

by Ted R Anderson
Oxford: Oxford University Press, 2013. 256 pages

reviewed by Paul Lawrence Farber

Most instructors who teach about the theory of evolution will be familiar with the ornithologist David Lack, due to the often reproduced images of the beak sizes and shapes of the Galápagos finches. His classic work from which the illustrations derive, *Darwin's Finches* (1947a), stands as one of the first attempts to apply the Modern Synthesis to ecology, and Lack's research paved the way for the later extensive ecological studies of the Galápagos finches by Peter Grant and Rosemary Grant. Cambridge University Press published Lack's book in 1947, and it is still in print (there had been an earlier monograph on the finches published in 1940, but Lack altered his opinions significantly by 1947, and it is the latter book that is famous). Ecologists know of Lack for his other 1947 publication, the first part of the three-part 1947–1948 paper "The significance of clutch-size" (Lack 1947b), which argued that natural selection acts to maximize the reproductive output of the individual. It is one of the most often cited articles in *Ibis*, the number one journal in ornithology. Lack caught the attention of many in the wider biological community with the publication of his short book *Evolutionary Theory and Christian Belief* (1957). He had converted to Christianity in 1948, and in his book he frankly discussed the conflicts between his commitment to the theory of evolution and his religious belief. *Evolutionary Theory and Christian Belief* is a useful reference for teachers of evolution because the author was a committed evolutionist, but also a practicing Christian who worked out a personal reconciliation that did not do violence to either creed.

Ted Anderson, Emeritus Professor of Biology at McKendree University, organized this first biography of David Lack into thirteen chapters—chronologically treating the thirteen books that Lack authored (two were posthumous). Biographical and institutional information is interspersed throughout the chapters. The result is a work that is somewhat choppy and occasionally reads like a set of index cards containing relevant information. Anderson does a good job of providing the reader with short and careful descriptions of Lack's books and has done an admirable job in uncovering the details of his short but interesting life. He also raises a number of significant questions about Lack, his philosophical views, and the state of the life sciences during the second half of the twentieth century, but given the brief nature of the biography does not delve very deeply into them. Although Anderson cites historical studies in the history of the modern life sciences—quoting such historians of biology as Kristin Johnson and Joel Hagen—he does not make full use of their studies, and ignores important aspects of Lack's role in the emergence of the modern disciplines of ornithology and ecology. Nor does Anderson search for an understanding of Lack's part in the development of British scientific institutions—with the notable exception of the Edward Grey Institute of Field Ornithology at Oxford, which he describes in some of the

chapters. The biography outlines some of Lack's actions when he was the director and his interactions with colleagues, and suggests the importance of the Edward Grey Institute for the history of ornithology.

Many of Lack's publications were intended for a general audience, and he made a serious effort to convey his passion for observing birds to those outside the circle of professional naturalists. Ornithology is one of the few disciplines that has maintained a large amateur presence, and so Lack's writings were especially important. His *The Life of the Robin* (1943) went through five editions between 1943 and 1970, and informed two generations.

Anderson has done an excellent job of collecting information on David Lack's life, and the short book is packed with interesting detail. For example, he lists and discusses each of Lack's 19 PhD students, as well as many of his colleagues and mentors. Although the attempt to work in so much data contributes to the relatively rough style of the prose, it does provide a fuller picture than one would expect.

In the preface to *The Life of David Lack*, Anderson claims that Lack deserves to be considered the father of evolutionary ecology, although he quickly adds the more moderate, and probably more accurate, modification that Lack should be considered "at least first among equals of the major progenitors of this subdiscipline of ecology" (p vii). This is certainly a defensible judgment. Anderson's book, however, provides little evidence of Lack's actual historical influence. Other historians have shown Lack's importance, and so the omission is not damaging to Lack's reputation, but the biography suffers from its close focus on Lack's writings and personal life at the expense of looking at the broader intellectual and institutional context of his work. Nonetheless, *The Life of David Lack* is a welcome addition to the literature on the history of evolution, and it will be of interest to all of those who teach about evolution in their classes.

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REVIEW

Once We All Had Gills: Growing Up Evolutionist in an Evolving World

by Rudolf A Raff
Bloomington (IN): Indiana University Press, 2012. 354 pages

reviewed by Scott F Gilbert

To take a stroll with Rudy Raff is to see the Ordovician in a roadside outcrop and to have current events refracted through the mind of a brilliant interpreter of nature's greatest stories. So it is well worth while to read this book for many reasons. One is to read of a life, a life in science, well lived. But this is not only an autobiography of Rudolf Raff; it is a biography of contemporary embryology and how it, too, has changed during the past half-century. Moreover, this is a book about natural history as path to science. Raff can't help being a teacher, and we learn about the phylogeny of Australian velvet worms and platypuses, the formation of the earth and moon, the predatory habits of dragonfly larvae, and even the mechanism by which a male butterfly knows that it has successfully docked with a female. We learn how embryos can be fossilized and how "Jesus lizards" run upon the water. And throughout the book, Raff muses on the different ways of becoming a scientist and how the naturalist–scientist is becoming as endangered as the world he or she would study.

There are, I believe, three reciprocally interacting stories being discussed here. The first is the development of a scientist from curious lad to keynote speaker. Raff starts his book like the beginning of one of James Michener's novels, with the geology of his birthplace. One cannot understand the development of an organism without appreciating its environmental context. As the scientist matures, he enters and is influenced by other contexts, including Mexico, America during the Vietnam War and Civil Rights movement, the Marine Biology Laboratory at Woods Hole, the shores of Australia, and the plains of Indiana. Family matters matter, and this "autobiography" often becomes a group biography of other family members. We co-evolve and co-develop.

The second story is the development of modern embryology from a descriptive adjunct to anatomy to its position in the center of contemporary molecular biology, with its importance in regeneration, stem cells, epigenetic disease, and the origins and maintenance of biodiversity. Here, Raff played a central role. He was the first to identify a messenger RNA stored in the sea urchin egg, and this discovery was one of a group of investigations that led to the molecularization of embryology into developmental genetics. Later, Raff would provide many of the conceptual foundations, as well as some of the early data, for integrating such molecular (and non-molecular) developmental biology with paleontology and evolutionary theory into the first iteration of evolutionary developmental biology (evo-devo). The role of the Marine Biology Laboratory at Woods Hole in nurturing these types of interactions and seeing the connections between the old embryology and the new em-

bryology is critical. Raff is very good at showing several different and good mentor-student relationships that are possible for scientific maturation. Some of these mentors (such as Paul Gross, George Beatty, and Alice Beatty) are wonderful characters, and they each had a different mode of teaching. No one size fits all.

The third story concerns the degradation of the earth and of the wonder that is the initiator of science. As William Souder recently wrote in his biography of Rachel Carson, the history of American environmentalism is a history of nature and science pitted against industry and its governmental representatives. Raff is a scientist fighting to preserve the wonder that initiates the attitudes and questions upon which science depends. Raff celebrates the world's biodiversity as only a field naturalist and paleontologist can. He sees not only the interactions of our contemporary flora, fauna, and microbiota, but also those from the Precambrian to the present. Raff's vision is in five dimensions, with deep time being an inescapable context for the four dimensions of animal development. Just as certain birds and bees can see in the ultraviolet or infrared regions of the spectrum, Raff sees the temporal as well as spatial dimensions of biodiversity. This ability has framed not only his life but also the discipline of evolutionary developmental biology. It is truly a "vision."

The readers of this journal, however, might view all this as a prelude to the last three chapters that deal with the creationist challenge to biology and with the importance of evolution to human concerns. Indeed, the book is, not surprisingly, given its subject and author, an evolution text in autobiographical form. The threads of paleontology, natural history, evolutionary biology, and developmental biology that are introduced independently within the book become woven together as evolutionary developmental biology. Moreover, at the same time he discusses the scientific importance of this new field, he also looks at the need for such knowledge to do nothing less than save humankind from being its own executioner. This last section of the book is a well-documented brief for the teaching of evolutionary biology and for the recognition of creationism and "intelligent design" as thinly disguised and rather poor theologies. Many of the readers of this journal will know this material, but Raff summarizes it beautifully and puts it in his own particular context.

The last chapter of *Once We All Had Gills* is a *tour de force* summary of the importance of evolutionary thinking for the ideas and practices of sustainability. Here, Raff brings together evolutionary biology and sustainability issues in an important way. We have evolved a brain that can plan, and in so doing, can imagine things that never were nor will ever be. We have evolved a brain that can fool itself into believing that which we know isn't real. Raff politely, but urgently, uses facts and data to puncture the fantasies and delusions that allow the destruction of the planet. Raff argues that we are causing evolutionary trends that will, if left unabated, result in the extinction of entire clades of species, probably including the genus *Homo*. We have already caused parts of the ocean to resemble the Cambrian ecosystem with its giant jellyfish; and the dead zones of the Atlantic push the oceanic ecosystem toward the Archaean Eon. Evolutionary biology becomes not just a theory, but also a worldview vital to the survival of our species and much of contemporary nature.

About the author

Scott F Gilbert is the Howard A Schneiderman Professor of Biology at Swarthmore College and a Finland Distinguished Professor in the Biotechnology Institute at the University of Helsinki. He teaches developmental genetics, embryology, and the history and critiques of biology. He is the author of *Developmental Biology*, now in its tenth edition (Sunderland [MA]: Sinauer Associates, 2013) and, with David Epel, of *Ecological Developmental Biology: Integrating Epigenetics, Medicine, and Evolution* (Sunderland [MA]: Sinauer Associates, 2008).

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REVIEW

Darwin Deleted: Imagining a World without Darwin

by Peter J Bowler
Chicago: University of Chicago Press, 2013. 318 pages

reviewed by William Kimler

From the get-go, Peter Bowler's latest book delights with its subtle wit. He dedicates one more study with "Darwin" in its title to his fellow members of the "Darwin industry," with apologies for concocting a world in which they might "have to find other means of gainful employment." Of course the abundant scholarship on Darwin addresses the genesis of one of our most important and exciting sciences. But this is a book about a world without Darwin—although not in the usual tedious contentions that his theory should be abandoned as wrong, or malevolent toward religion, or now simply obsolete in light of the latest "non-Darwinian" theory. Bowler's intention is much larger. This is a fully fleshed imagining of the type of evolutionary theory that might have developed had Darwin not lived.

Being part of a "Darwin industry" is the acknowledged jape among historians and biographers. It is not as if attention to Darwin is new. His first supporters named the theory after him, and his image became the icon of evolution, as countless caricatures and cartoons still attest. After the 2009 Darwin bicentennial, even Darwin scholars make comments about whether the world needs yet another book on Darwin. Bowler's imagining goes to the heart of this obsession with the founder, to raise the question of Darwin's (and natural selection's) central place in our ideas about evolution.

A prolific and wide-ranging expert on the history of evolutionary ideas, Bowler is respected for his insights about the origin and reception of Darwin's work, and particularly for his histories of the developments later in the century. He is that rare historian who considers the science deeply, connects it to larger movements of ideas, writes gracefully for both the specialist and general reader, and can master a synthesis of views even while providing provocative new insights. The new book gives us a brilliant scholar, fully in command of his material, enjoying himself in thinking through what might otherwise have been by constructing a counterfactual history. The term is an oxymoron of course, for history other than what it was must be fiction. But let us grant that Bowler's "imagining" is in fact a piece of serious scholarship.

Acknowledging that non-history might seem an odd undertaking for the historian, he first defends counterfactuals. Like novels, they might simply provide the truths of literature, that is, an imagining that shows us something of the human condition. For science, Bowler contends that thinking about different possible pathways for its history forces us to think more clearly about the complex way that scientific theory arises. His brief manifesto turns into a pithy essay on the issues of explanation in the history of science. What is at stake in arguments among historians is whether our science is simply inevitable, as it approaches a necessarily true model of the physical world, or is such a social construction that its ideas

and history depend largely on cultural context. Nimbly avoiding the trap of an irresolvable dichotomy between "realism" and "constructivism," Bowler argues that the real issue is about determinism and contingency.

The insight is how open, dynamic worlds are not predetermined or directed. Historical contingency here is used to examine the inevitability of our scientific theories. One could quibble about whether a realist view of science requires that there be just one possible historical pathway, or how far social influence can ever escape the constraints of the physical world. Bowler's larger point is that we confine our view of the history of science too much by adopting either extreme, that both the realist's inevitability and the constructivist's cultural dependency are too deterministic. True history, rather like evolution itself, is complexly ecological. Causes of change include the full scale of conditions, from the culture we inhabit to the individual significant interactions. In a word, it is contingent. His metaphor is the causal "nodal point" in history, where particular individuals, events, ideas, or forces can be seen to trigger a cascade of particular development. All this really requires is that some such agents of change be somewhat more distinct and significant than others. Surely Darwin was one such agent.

This allows Bowler to acknowledge a seeming paradox. Without Darwin in the picture, we might end up now with essentially the same modern theory of evolution, though by a different pathway. The endpoint depends on properties of the biological world, so natural selection as the ecological sorting of hereditary factors would have been discovered eventually. Initially, however, developmental theories and a more directed form of evolution would have dominated the field. Inevitably, the science would have been connected to social ideas. The overall forces of economy, empire, industry, and racism would have helped to generate ideas about historical progress (evolution) and applications to social theory, even if the idea of natural selection were missing. Darwin is thus not the source of all things "Darwinian" in our world.

The argument is made, in another twist, by showing how original Darwin was. His thinking was distinct about shared genealogical descent, about the nature of long-term causes and trends, about the nature of adaptation, and in the path he took to discovery. Not insignificant also was his role in opening and promoting the question of natural origins. His distinctiveness means a divergent history without him as instigator and lightning rod for a revolution and reaction. The broader cultural ideas about progress, the expansion of paleontology, and the general move in science toward natural rather than supernatural causes nonetheless gives us a history with evolution still triumphing in the nineteenth century.

To decouple Darwin's natural selection from causing the ills of its social repercussions is Bowler's larger purpose in this book. Without the selection theory, with its lack of purpose and denial of any need for creative direction, Bowler also thinks the creationism/evolution or science/religion controversy would not have developed with the heat that it did. Initially, an evolution theory not associated with the harsh, materialist vision of struggle and domination would have been more socially acceptable. But the larger forces would still have left us with what we call "social Darwinism," the use of science to justify social views and policies.

So did we need another book on Darwin, even one without Darwin? I recommend *Darwin Deleted* for anyone who wants to examine the assumptions and connections of our ideas about evolution. It is not for beginners. But anyone who has read a biography of Darwin or followed the controversies over evolution will find a graceful, cogent discussion full of small gems and larger lessons.

About the author

William Kimler is Associate Professor and Alumni Distinguished Undergraduate Professor in the Department of History at North Carolina State University. He is currently completing a book on how Charles Darwin has been used as a symbol of science and the idea of evolution.

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REVIEW

The Evolving God: Charles Darwin on the Naturalness of Religion

by J David Pleins
New York: Bloomsbury, 2013. 171 pages

reviewed by Keith Stewart Thomson

This is a marvelous book on Darwin and religion. It repeats much that is already familiar, including the progressive loss of faith that is laid out in the *Autobiography* and letters. And it contains much that readers will find new because, if it is true that few people read *On the Origin of Species* seriously for content, even fewer delve deeply into *The Descent of Man* (1871). What Darwin knew about the physical origins of human beings in 1871 was, by our standards, pretty minimal. What he thought about behavior and the evolution of the religious feeling and different religious practices among different people is remarkably up-to-date.

Darwin obviously thought a lot about religion all his life, and it is ironic that even when he set off to Cambridge in 1828 with the intent of becoming a parson, his belief was weak. As he later wrote, "I do not think that the religious sentiment was ever strongly developed in me" (1958:91). Darwin's attitude towards religion was both intensely personal (and painfully opposite from that of his beloved wife Emma) and intellectual. For him, religion was one of many major puzzles to be solved; he knew that his evolutionary approach to the "System of Nature" would inevitably drag him into thinking about it very seriously indeed.

It is not true that, as Pleins claims here, "the question of how humans became religious stood at the heart of Darwin's intellectual quest" (page xi). Darwin's lifelong intellectual quest was to understand in material terms the oneness of life on earth, past and present, and its relationship to a changing earth. It was concerned with evolution over time and modern ecological connectedness, as in his demonstration that cats control the population of red clover, because cats eat mice that raid the nests of bumble bees that pollinate the clover. It was developed in studying the diversification of barnacles, the life history of coral islands, and the behaviors of cats, dogs, and plants. And people. His genius was not only to encompass all this in one theory but to be able to extend his range seriously to metaphysical questions. And it is certainly true that, while one might have expected Darwin to hesitate to tilt so vigorously at theological windmills, his intellectual honesty would not let him do otherwise than add questions of the nature and origins of religion to the range of subjects he illuminated.

Darwin had to investigate the possibility of an evolutionary, material, cause of every phenomenon, including religion. And because we do not read *The Descent of Man*, the modernity of what he has to say about religion surprises and delights us. Today some ask "is there a religion gene?" Darwin knew nothing of genes but his answer was clearly that

religious feeling has an evolutionary and therefore genetic basis—perhaps not the whole basis, but a great part of it.

This book is crammed with wonderful details, such as the occasion when Darwin and the officers on the *Beagle* were taken to be heretics (specifically, Muslims) because they had beards and washed their faces in the morning. Pleins carefully builds up an account of the vast range of experiences that were so influential on the *Beagle* voyage—Darwin absorbed everything: the Catholic churches of South America, and their congregants, the natives of Tierra del Fuego and the Pacific Islands, and the rapidly changing nature of British society with respect to discussion of, and tolerance of, religious diversity. From first hand knowledge, he anguished over slavery and wrote (with FitzRoy) about missionaries. Pleins might have given more attention, however, to the influences on Darwin's religion from his family, his home, and his teachers. The voyage of the *Beagle* was obviously pivotal, but Darwin's mind was not a *tabula rasa* before then, in science or anything else.

The most penetrating discussions in the book come in to the later chapters where Pleins dissects Darwin's thoughts and writings on religion and belief, hedged about as they were with provisos. There is a telling passage in Darwin's *Autobiography* when Darwin writes (after discussing the principles of natural theology),

> ... thus reflecting I feel compelled to look to a First Cause having an intelligent mind in some degree analogous to that of man; and I deserve to be called a Theist. This conclusion was strong in my mind about the time, as far as I can remember, when I wrote the Origin of Species; and it is since that time that it has very gradually with many fluctuations become weaker. But then arises the doubt—can the mind of man, which has, as I fully believe, been developed from a mind as low as that possessed by the lowest animal, be trusted when it draws such conclusion? May not these be the result of the connection between cause and effect which strikes us as a necessary one, but probably depends merely on inherited experience? (Darwin 1958:92–93)

And so on. But he was very clear, in *The Descent of Man*, that the religious sense must have had an evolution of its own, like any other structure or behavior. In his philosophy it was no different from the adaptation of the hummingbird's beak.

The interesting thing is that, while Darwin had a very clear view of at least an embryonic scientific explanation of religion, but could not quite bring himself to fold all its atheistic consequences into his personal life. His scientific arguments were well laid out but, as he wrote to Joseph Hooker, his theology was all "a muddle." Nonetheless, here, once again, we see yet another intellectual field where Darwin said it, or asked it, first. We are still catching up to his questions and often share his muddles.

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