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SCIENCE OUTREACH THAT ISN'T JUST KIDS' STUFF

The benefits of engaging adults as well as children Page 3

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Dear NCSE members,

I used to live in Washington DC, where it's not at all uncommon to overhear intensely wonky conversations about policy or legislation while riding on the Metro. Most such discussions happen at a pretty high level of abstraction. After all, policies can't be custom-designed for each individual citizen. But what if the problem you're trying to solve actually requires some personal engagement? For example, changing people's minds about evolution or climate change.

I was recently back in Washington DC to speak at the American Association for the Advancement of Science's Science and Technology Policy Forum, where the 2019 theme was "Science in Service to Society." My panel explored how the interactions of science and society have worked out on the topic of climate change. Spoiler alert: if 30–40% of the population doesn't accept the science, society and science are seriously at odds.

In a pre-meeting planning call, I mentioned that NCSE has found that giving people an opportunity to engage directly with evidence is effective at changing people's minds. I described a visualization tool (https://applets.kcvs.ca/HistoricClimateTrends/history.html) that our Teacher Ambassadors introduce to students so they can explore rates of change of carbon dioxide levels and temperatures over the last 800,000 years. To my surprise, the panelists were so excited, they requested I scrap my planned talk and just present this data resource to the policy audience.

So I did. During my eight-minute talk, I sprinted through about forty screen shots showing how the tool allows you to discover that the rates of change we're experiencing now are at least an order of magnitude faster than any time in the past. My fellow panelists, and the audience, nodded knowingly when I warned them that playing around with the tool is addictive. One colleague, who works with local officials, business leaders, and farmers in rural Colorado, where acceptance of climate change is pretty low, said that she can't wait to give them an opportunity to explore the evidence for themselves.

Changing people's minds about something they have strong feelings about can't be accomplished with a killer set of talking points. But giving people a chance to dig into the evidence to reach their own conclusions does work. It changes minds. Our mission is to give that opportunity to as many people as possible. With your help, we can do it. Then the science policy world can move on to the wonky policy discussions it does best.

As always, thank you for your support of NCSE.

Ann Reid is the executive director of NCSE.
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Science Outreach That Isn't Just Kids' Stuff

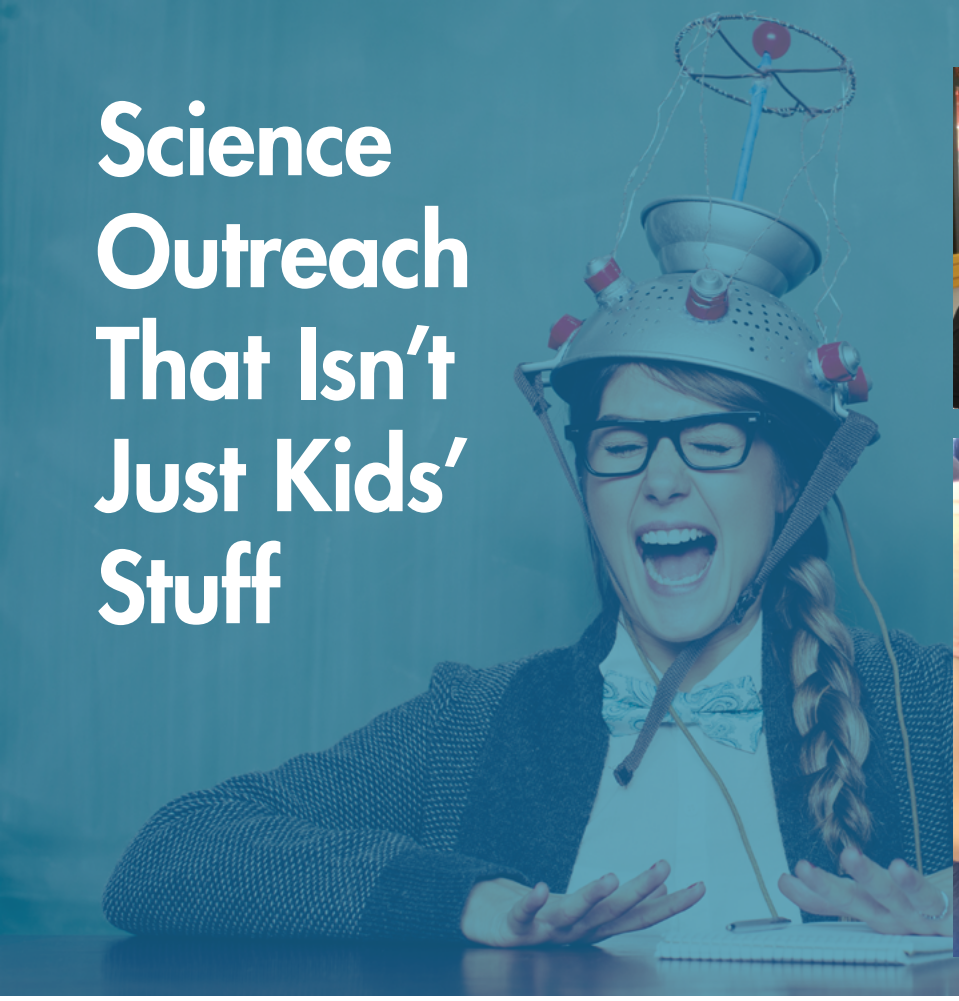


Photo courtesy of Laurie Luckfitz

Photo: Kate Carter

Kids at a young age seem to be natural scientists: curious, inquisitive, and open-minded. But somewhere along the path to adulthood, these traits can become stifled or even disappear completely.

"A few weeks ago, I debuted a bipedalism activity," recounted Tyler Hahn, a youth and special services librarian and NCSE volunteer leader in western Iowa. A little girl dressed in her Sunday best walked up to Hahn's table with her father and began interacting with the various skulls. "Why does this monkey look so much like a person?" she asked. The father replied, "I don't know." And that's when the conversation between Hahn and the father began.

A lifelong local resident, the father never learned about human evolution in high school. "In the late 1970s especially, they didn't talk about evolution," Hahn said. But it became apparent during their conversation that the father was willing, even eager, to learn about evolution, despite his previous lack of exposure, in such a welcoming environment.

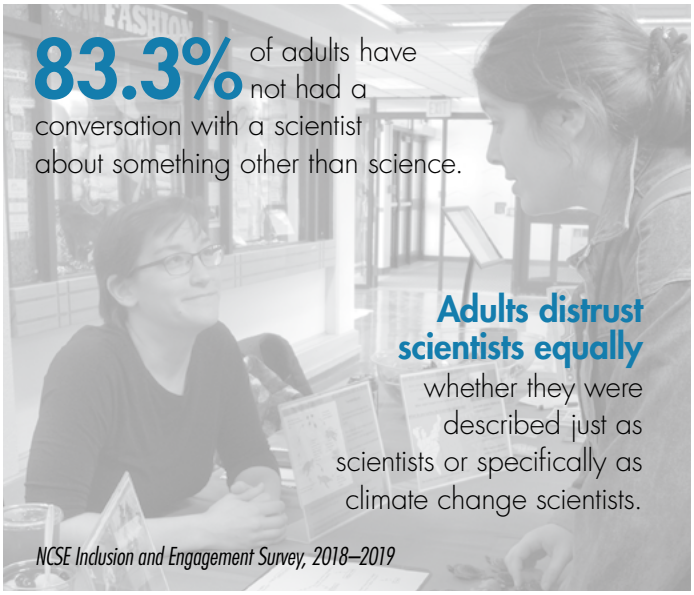
According to Hahn, "It's worth educating the adults because those are who the kids look up to. Any reluctance or resistance to learning about science at home will most likely result in younger minds adopting that attitude as well, and the cycle will continue."

So what prevents adults from staying curious and interested in learning more about science? According to NCSE Director of Community Science Education Kate Carter, there are three main reasons that help explain what's preventing some adults from learning about science:

- **Most museum exhibits and science outreach experiences aren't developed with adults in mind.** They're geared towards younger learners, missing a terrific opportunity to reach adults. According to visitor exit data (https://bit.ly/2HZx7kC) from large and small science museums in the United States, about one quarter of visitors were adults without children. And at the outreach activities sponsored by NCSE, about half of those who engage in conversation with volunteer leaders are adults.
- **Learning about science as an adult can be expensive.** More than ever before, science museums are offering adult-only programming. These events,

often held in the evening with alcohol for purchase and live entertainment, have begun to re-engage adults in science learning. A 2018 study (https://bit.ly/2HYFPQi) conducted by J. P. Gutwill showed that young adults aged 18–29 showed an increased confidence in their ability to understand science immediately after a museum visit. However, these events are not typically inclusive as they often cost more than a standard museum admission fee and occur at night, requiring parents with young children at home to make childcare arrangements.

- **Adults don't have to do what they don't want to do.** By comparison, kids (or even most teenagers) have to follow the directives of others. Don't want to go to school? Too bad. But as adults, we don't have to go to school and we usually don't have to learn about something that we don't want to—especially if that topic has its roots in negative school experiences, as can be true with science. "Being told that they're wrong, hearing that they asked a stupid question, struggling with science in school," Carter explained, "all of these can leave a lasting impression on adults that science isn't for them, so they avoid it altogether."



In an effort to better understand why adults don't feel included in science, NCSE began surveying participants who attended our science outreach events in Iowa. "We wanted to understand how an adult's exclusion from science was related to their background and feelings about science," Carter said. She plans to continue asking these questions in new areas to gain a wider perspective, but the initial results have begun to tell an interesting story about the issue.


Photo: Paul Oh

It's more common than not for at least one adult to be present with a child at events where NCSE tables are set up. These events are free and set up at openly accessible venues, such as libraries and farmers' markets, presenting a unique opportunity to engage with adults.

Tyler Hahn, for one, has learned over time that it's worth it to interact with the adults. "I didn't get the same type of respect from the parents as I did from the kids at first," Hahn explained. "I felt looked down on and thought maybe I was wasting my time." But eventually, Hahn's confidence grew, and he noticed more adults approaching him with questions and wanting to strike up conversations about science. Providing information, being nonconfrontational, and being open to questions of all sorts helps put adults at ease, says Hahn. "That back and forth really does help to form a bond between people."

Hahn treats any reaction, positive or negative, as an opportunity to engage

Hahn has experienced a spectrum of reactions from adults, from open-mindedness and a desire to learn more to being told he's wasting his time. But Hahn treats any reaction, positive or negative, as an opportunity to engage. It's a chance to encourage parents and guardians to learn alongside their child and perhaps begin to feel comfortable doing science, just as their child is, by experimenting, examining evidence, and reaching fact-based conclusions.

NCSE has begun designing new activities with adult learners in mind. Check out Kate Carter's article on page 12 to learn more about a new strategy we're employing—game-based learning—to provide adults with fun, immersive science learning experiences!

Ashleigh Papp is a former NCSE intern and a science writer.

Random Samples with Bruce Alberts

Photo: Christopher Reiger

Longtime NCSE member Bruce Alberts is a renowned biochemist with a long list of lifetime achievements. Alberts was awarded the National Medal of Science by President Barack Obama in 2014 and the Lasker-Koshland Special Achievement Award in Medical Science in 2016. Alberts served as editor in chief of *Science* (2009–2013) and as one of the first three United States Science Envoys (2009–2011). He is now the Chancellor's Leadership Chair in Biochemistry and Biophysics for Science and Education at the University of California, San Francisco, to which he returned after serving two six-year terms as the president of the National Academy of Sciences. Widely recognized for his work in the fields of biochemistry and molecular biology, Alberts has earned many honors and awards, including 16 honorary degrees. He currently serves on the advisory boards of more than 25 non-profit institutions.

Paul Oh: In addition to your incredible scientific achievements and policy work, you've always supported education. What got you started on that path?

Bruce Alberts: During my second semester biology course, when I was a freshman at Harvard, I was incredibly lucky. By chance, that January of 1957, John A. Moore, then an obscure professor at Barnard College, published his first textbook, called *Principles of Zoology*. Someone at Harvard had the wisdom to choose that as our textbook. They required that we read the first two-thirds of it, which was a beautifully written history of genetics. Indirectly, through detailed examples, it explained the way science is done.

I had never before had any sense of how science actually worked. And it was just thrilling for me to learn that. I became intrigued by such a failure of science education not to get that across to the rest of society. I realized how sad it was that the real life of science is not connected in any way to the schools. And I'm still working on solving this problem.

PO: What about your work in support of education are you most proud of?

BA: In 1977-78, I was recruited by Jim Watson for what he envisioned as a critical new textbook that would bring together two important fields: molecular biology, which at that time was fairly new but highly productive, and the much older field of cell biology. Jim's incredible insight was to try to bring these two poorly connected fields together to create a textbook for college students called *Molecular Biology of the Cell*. It turned out to be an extremely difficult task, requiring that the authors spend more than a year of 12-hour days from 1978 to 1982 at periodic "book meetings." The result proved to be valuable to scientists, even though designed as a textbook for students. Our textbooks, in 12 editions to date that include a lower-level version, *Essential Cell Biology*, have really made a substantial difference in attracting young people all around the world—from Russia to India to Brazil—to become interested in science. I think that's been my major contribution to education.

PO: Why do you support NCSE?

BA: I don't remember exactly when I joined NCSE. But when I was at the National Academy of Sciences, we were very much aware of threats to science in various states. I was deeply involved in producing materials that would be useful as resources for scientists when they went before state school boards and state legislators. [Former NCSE Executive Director] Genie Scott was very visible. She came around the Academy often, and she gave impressive talks at many meetings that I attended. NCSE was doing very important work aligned with our Academy efforts and I was very aware of what the organization was doing to support accurate science education standards.

If people don't know what science is, and they hate it because of how they were taught in middle school or high school, then they have no reason to believe what scientists have to say. And it's not just when it comes to evolution, but about rational thinking, too, and respect for science judgment. It's important to get the public to understand the nature of science and that scientific judgments are different than dogmatic judgments. NCSE can move us all—including scientists—to think in more sophisticated ways.

—PAUL OH

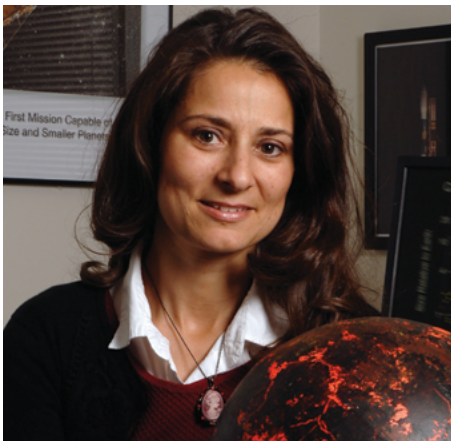


Photo courtesy NASA

NCSE is pleased to congratulate **Natalie Batalha**, professor of astronomy and astrophysics at the University of California, Santa Cruz, on her election as a Fellow of the California Academy of Sciences in 2018 and to the American Academy of Arts and Sciences in 2019.

Anna K. Behrensmeyer of the Smithsonian Institution was awarded the 2019 G. K. Warren Prize, which recognizes distinguished accomplishment in fluviatile geology and closely related aspects of the geological sciences, from the National Academy of Sciences. According to a press release, "A pioneering paleoecologist, Behrensmeyer has made important contributions to our understanding of the fluvial processes of ancient rivers and streams, revealing how they are expressed in the rock record and shaping our understanding of ecological change throughout the history of life on land. … Behrensmeyer is also known for her groundbreaking work in sedimentary taphonomy—the study of how bones are transported in rivers, how organic remains become buried and fossilized, and the biases that result from these processes, which are essential for understanding information contained in the fossil record—as well as vertebrate ecology and paleoecology, environmental geochemistry, and the paleoecological context of hominid evolution."

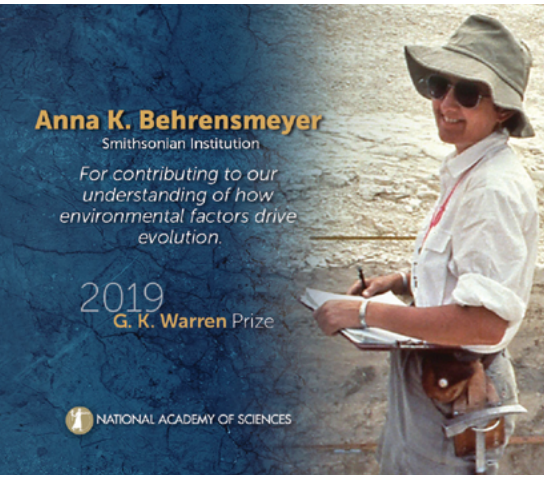
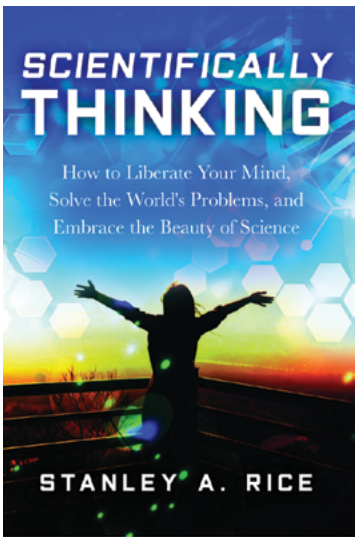


Photo: Bill Keyser

Photo courtesy WUSTL

NCSE is pleased to congratulate **Jonathan Losos,** professor of biology at Washington University in St. Louis, on his election to the National Academy of Sciences in 2018. Members of the academy are elected "in recognition of their distinguished and continuing achievements in original research."



Stanley A. Rice's *Scientifically Thinking: How to Liberate Your Mind, Solve the World's Problems, and Embrace the Beauty of Science* (Prometheus Books, 2018) was published. The publisher writes, "While the brain is hardwired for common sense, unfortunately, it also relies on a number of misleading tendencies. Instead of reasoning objectively it tends to rationalize. Often it sees what it wants to see rather than what is really there. And it is adept at both self-deception and deceiving others. Rice notes that these tendencies were useful in the past as the human race evolved in an often-hostile environment. But today bias and delusions put us at risk of worldwide catastrophe." Rice is professor of biology at Southeastern Oklahoma State University.

—*GLENN BRANCH*

NCSE Welcomes Two New Board Members

Photo: Joshua Yospyn

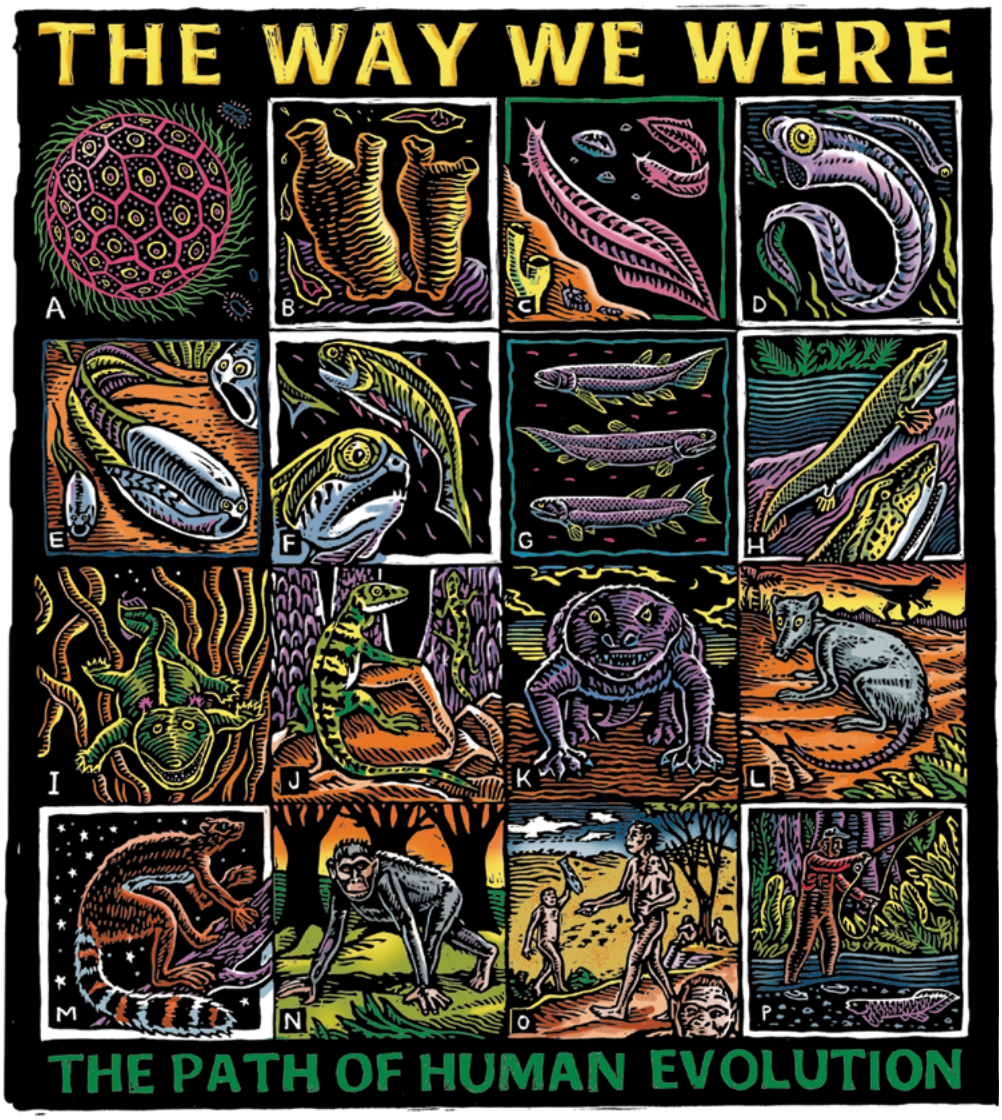
Michael E. Mann, a climate scientist at Penn State University, and **Michael B. Lubic**, a partner at the law firm K&L Gates, joined NCSE's board of directors at its April 13, 2019, meeting.

Mann is Distinguished Professor of Atmospheric Science at Penn State University and director of the Penn State Earth System Science Center. His books include *The Hockey Stick and the Climate Wars* (2012) and *The Madhouse Effect* (2016, coauthored with Tom Toles). He received NCSE's Friend of the Planet Award in 2014, the American Association for the Advancement of Science's Public Engagement with Science Award in 2018, and the Tyler Prize for Environmental Achievement in 2019. Mann was interviewed in the Winter 2016 (36:1) issue of *RNCSE*.

Lubic is a partner in the Los Angeles and San Francisco offices of the global law firm K&L Gates. He has a broad insolvency practice encompassing litigation, transactions, and counseling in connection with troubled businesses, distressed assets, and complicated commercial frauds. He has been selected by his peers for inclusion on *Los Angeles Magazine*'s list of Southern California Super Lawyers every year since 2004 and by his foreign clients as an Acritas Star. He helped found NCSE's Legal Advisory Committee and has served on it since 2000.

The two new members join President Kenneth R. Miller of Brown University, Vice President Lorne Trottier of Matrox, Secretary Robert M. West of Informal Learning Experiences, Treasurer Michael Haas of Orion Renewable Energy Group, Vicki Chandler of Minerva Schools at KGI, Naomi Oreskes of Harvard University, retired molecular biology professor and biotechnology executive Barry Polisky, and Benjamin D. Santer of Lawrence Livermore National Laboratory.

Leaving the board at the same meeting, after two terms of service, was Richard Katskee of Americans United for Separation of Church and State.



Artwork © Roy Troll 2018 www.trollart.com

UPDATES

ncse.com/updates

Are there threats to effective science education near you? Do you have a story of success or cause for celebration to share? E-mail any member of staff or info@ncse.com.

ARIZONA

Arizona's House Bill 2002, introduced by Mark Finchem (R–District 11), would have prohibited teachers from taking a stand on "any side of a controversial issue." The bill specified that any issue "that is a point in a political party platform" is controversial, and a number of platforms include claims about evolution and climate change, so the bill would have provided a route to pressure teachers to use antievolution and climate change denial material. The bill died in committee in February 2019.

CONNECTICUT

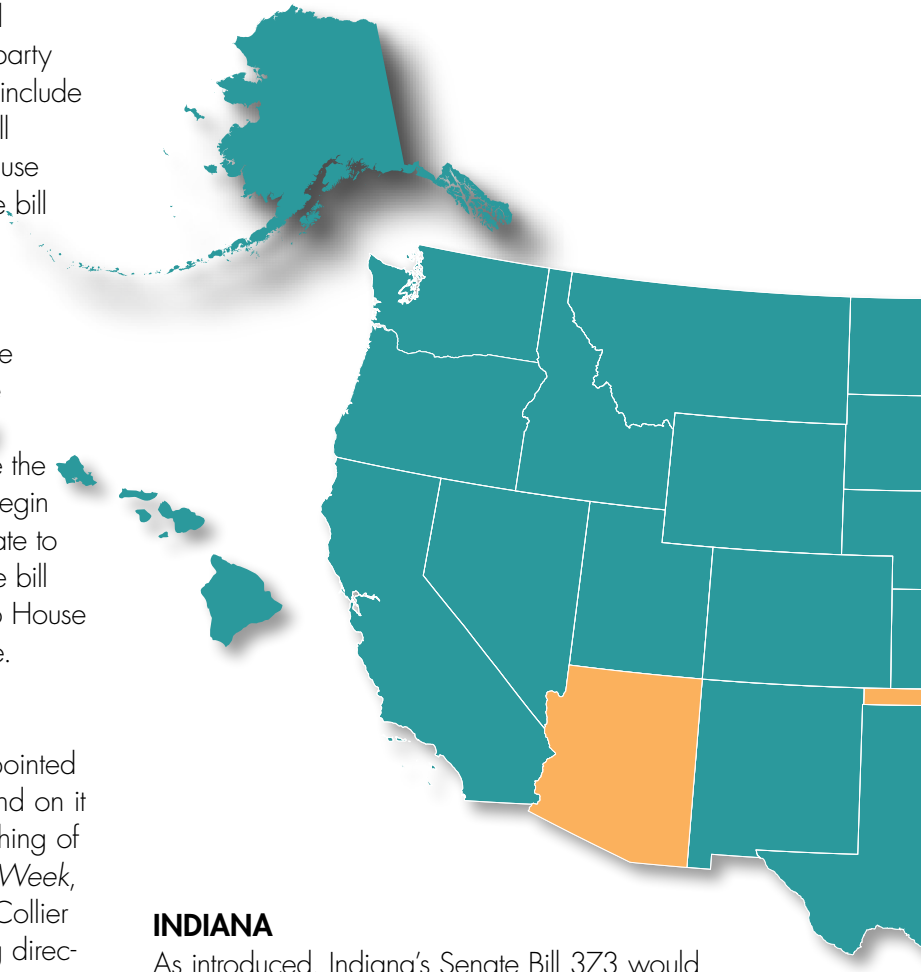
Connecticut's House Bill 5011, introduced by Christine Palm (D–District 36) on January 9, 2019, would have required "that the science curriculum of the prescribed courses of study for public schools include the teaching of climate change and that such teaching begin in elementary school," making Connecticut the first state to require the teaching of climate change by statute. The bill died in committee, but the requirement was added to House Bill 7352, which subsequently also died in committee.

FLORIDA

"Newly elected Florida Gov. Ron DeSantis has appointed the members of his transition team for education—and on it are two people linked to efforts to weaken the teaching of evolution and climate change," reported *Education Week*, referring to Erika Donalds, a former member of the Collier County School board, and Kevin Flaugh, managing director of Florida Citizens' Alliance. Both supported the 2017 law empowering Floridians to object to the use of specific instructional materials in the public schools.

ILLINOIS, CHARLESTON

In late 2018, the Charleston Parks and Recreation Department announced a planned five-day excursion to the Cincinnati, Ohio, area that would include visits to the Creation Museum and Ark Encounter—attractions associated with the Answers in Genesis young-earth creationist ministry—in fall 2019. The announcement repeated the AiG slogan, "Prepare to believe." Warned by the Freedom from Religion Foundation that the city's sponsorship of such a trip was unconstitutional, the city attorney responded by reporting the cancellation of the excursion.

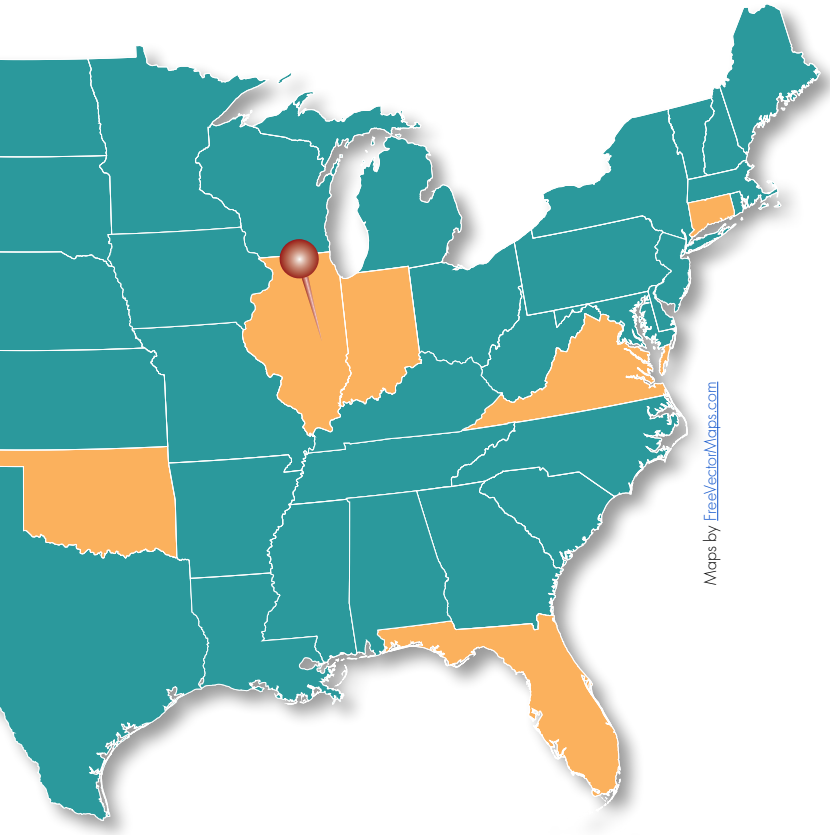


INDIANA

As introduced, Indiana's Senate Bill 373 would have provided that "[t]he governing body of a school corporation may require the teaching of various theories concerning the origin of life, including creation science, within the school corporation," although teaching creation science in the public schools is unconstitutional. The sponsor of the bill, Dennis Kruse (R–District 14), has a long history of sponsoring antievolution legislation. The provision was removed from the bill by the Senate Committee on Education and Career Development.

OKLAHOMA

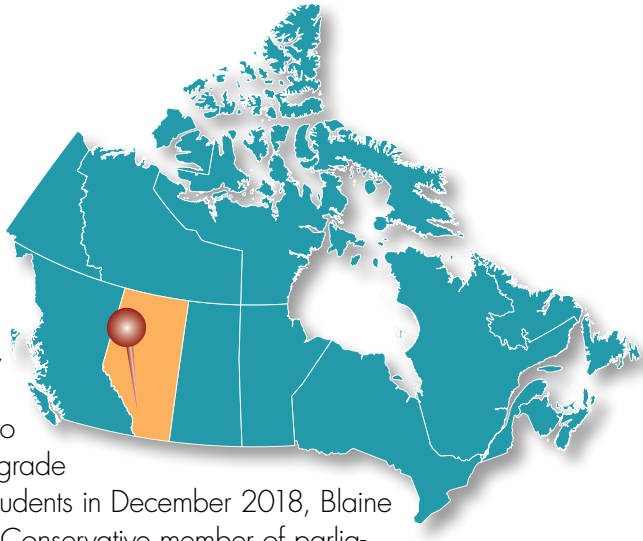
Senate Bill 14, sponsored by David Bullard (R–District 6), would ostensibly have enabled teachers to help students "understand, analyze, critique and review in an objective manner the scientific strengths and scientific weaknesses of existing scientific theories covered in the course being taught," while prohibiting state and local administrators from exercising supervisory responsibility. Similar bills filed in previous years by Bullard's predecessor, Josh Brecheen, were apparently aimed specifically at evolution. The bill was defeated in committee on February 12, 2019.



Maps by FreeVectorMaps.com

VIRGINIA

House Joint Resolution 684, introduced in January 2019, was aimed primarily at preventing what it described as "political or ideological indoctrination" by urging the adoption of a code of ethics for teachers. But a provision of the proposed code would have prohibited teachers from advocating "for any issue that is part of a political party platform at the national, state, or local level," and evolution and climate change are often among such issues. The resolution died in committee in February 2019.



CANADA, RED DEER

Speaking to a class of grade 7 and 8 students in December 2018, Blaine Calkins, a Conservative member of parliament, responded to a question about carbon taxation by suggesting that it's questionable whether carbon dioxide is pollution and whether fossil fuel consumption causes extreme weather events. He was criticized by a climate scientist at the University of Calgary, and the superintendent of the school district distanced the district from Calkins's views: "In our classes … [w]e talk about facts."

FRANCE

In December 2018, as the French ministry of national education and youth was preparing to finalize a new curriculum for secondary schools, it was charged that "climate change, its causes[,] and its consequences are almost totally absent from the future curricula," according to Euractiv. A coalition of student associations is calling for revisions to improve the treatment of climate change in the curriculum, citing a provision of the Paris Agreement that urges "measures … to enhance climate change education."

UNITED KINGDOM

A self-described "free market think tank," the Institute of Economic Affairs, is receiving scrutiny in part for sending free copies of its magazine, which occasionally promotes climate change denial, to every school teaching A-level (advanced) economics and business studies in the country. The IEA receives funding from oil as well as tobacco and sugar companies, and its magazine frequently argues against taxes aimed at such products, although it denies any influence of its funders on its editorial decisions. "

SUPPORTING TEACHERS

READY, SET, GO!


BLAKE TOUCHET

Photo: Brooke Broussard

The school year that just ended was a busy one for NCSE's Teacher Ambassadors. So we thought a few photographs might be the best way to capture some of their hard work and sustained effort.

Blake Touchet in Louisiana field-tested NCSE lessons on human evolution this year. Our five evolution lessons will be published soon at the NCSE website and will be freely available for use by anyone. Field testing the lessons is a crucial step in our overall program, not only because we can assess the impact of the lessons on students, but also because the teachers involved help to modify the lessons for different grades and courses.

Our Teacher Ambassador in Dalton, Georgia, **Sarah Ott,** led her students through our five climate change lessons in the spring. She is among a second cohort of Teacher Ambassadors focused on climate change instruction. This second cohort met in March 2019 at George Mason University for a two-day workshop to orient the teachers to the climate lessons and to begin preparation to share the lessons by

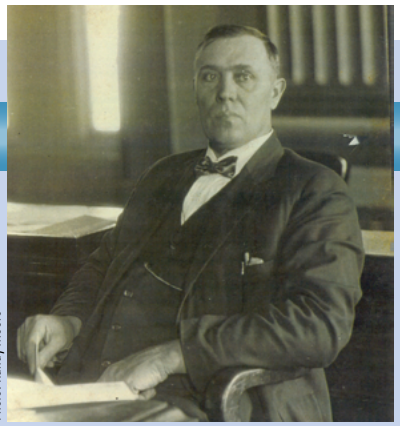


Photo: Randy Moore

John Washington Butler authored the legislation under which John T. Scopes was prosecuted in 1925.

PLACE & TIME
The Butler Act

John Washington Butler (1875–1952) was born in Macon County, Tennessee. He grew up on his family's farm, which he began operating in his early twenties. Butler taught school half the year and spent the other half working at his farm. In 1921, after hearing a preacher tell of a local woman who became an atheist after being taught evolution, the prosperous Butler began to worry that the teaching of evolution would corrupt his five children. The following year, he ran for state legislator, and his campaign pamphlets urged Tennessee to ban the teaching of evolution in its public schools. He won the election, but didn't introduce any evolution-related legislation during his first term.

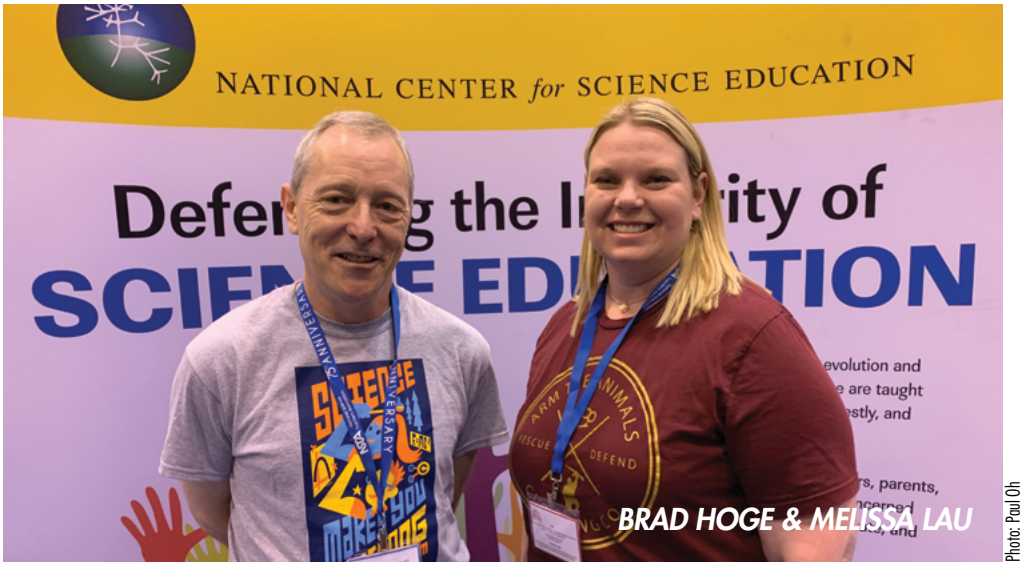
Butler campaigned for reelection on his beliefs that the United States was founded on biblical principles, that "the evolutionist ... cannot be a Christian," and that "evolution [is] the greatest menace to civilization in the world today" because it "robs the Christian of his hope" and "causes [students] to become infidels and have no respect for Christianity." Late in 1924, Butler promised his constituents that he would introduce antievolution legislation if reelected. Butler was reelected and placed on a committee that oversaw public schools.

On the morning of his 49th birthday, Butler—a Primitive Baptist who claimed to have read *On the Origin of Species*—drafted what came to be known as the Butler Act (House

Teacher Ambassadors: A Year in the Life

SARAH OTT'S CLASS

Photo: Emily Lapish



BRAD HOGE & MELISSA LAU

Photo: Paul Oh

leading professional development workshops in their local areas. The five climate lessons are already online (https://www.ncse.com/sandbox) and available for use.

At the National Science Teachers Association conference in April 2019, our booth was crewed not just by staff but also by Teacher Ambassadors **Melissa Lau** and Turtle Haste, who introduced science teachers unfamiliar with NCSE to the organization's work and mission. Lau and Haste were also presenters at NSTA, with Haste doing multiple share-a-thons on our lessons. Haste also recently presented the climate lessons at the Polar-Ice Summit 2019 in Monterey, California. Lau was just recently named the Middle Level Teacher of the Year by the Oklahoma Science Teachers Association.

Many of our teacher ambassadors have submitted proposals for upcoming events, so we'll have more to report on–and show you–in the future.

There's no question that the NCSE Teacher Ambassadors are stars. That's the reason we recruited them. They are the guiding lights for their peers, and they're just getting started.

Brad Hoge is NCSE's Director of Teacher Support. hoge@ncse.com

Bill 185 of 1925). This law made the teaching of evolution in any of Tennessee's public schools a misdemeanor punishable by a fine of $100–$500. Although the editors of the *Chattanooga Times* urged that Butler's legislation be ignored, the proposed ban on teaching human evolution was unopposed. On March 21, 1925, Butler's legislation was signed into law by Tennessee Governor Austin Peay, thereby making Tennessee the first state to ban the teaching of human evolution.

In response, the American Civil Liberties Union financed the now-famous test case against the Butler Act involving high school teacher John T. Scopes. Butler believed that Scopes's trial in Dayton was "the beginning of a great battle between infidelity and Christianity." During the trial, Butler was a guest reporter for a press syndicate, and filed several reports on the trial's activities. Butler disagreed with Judge Raulston's decision to exclude testimony of Darrow's expert witnesses at the trial. On May 31 and June 1, 1926, Butler attended Scopes's appeal before the Tennessee Supreme Court, where he sat with local resident and trial instigator George Rappleyea in the front row during the proceedings.

After finishing his term as state representative, Butler returned to life on his farm in 1927. He died there on September 24, 1952, after a long illness and suffering a fall. He is buried in Butler Cemetery in Lafayette, Tennessee. Butler's famous legislation was repealed on September 1, 1967, by House Bill 48.

Randy Moore is the H. T. Morse–Alumni Professor of Biology at the University of Minnesota, Twin Cities. His most recent book is *Galápagos Revealed: Finding the Places that Most People Miss* (Galapagos Conservancy, 2019). Rmoore@umn.edu

Breaking Down Barriers

STORY AND FUN AT THE FOREFRONT

By Kate Carter

Photos (1 and 3): Paul Oh

Photo: Kate Carter

Many people in the United States don't have access to effective community science education. While NCSE's DIYSci groups (for more on DIYSci, see "Wait ... Breaking Down Barriers?" below) are working hard to provide science activities in regions where few informal science education opportunities exist, geography is only one of many barriers to effectively reaching a broader public. (Check out Ashleigh Papp's article on page 3 for a more in-depth look at these barriers, particularly when it comes to adult learners.) These barriers make it more difficult to reach people who have doubts and misconceptions about evolution and climate change.

So NCSE's DIYSci groups are working hard to reach these underserved communities. In particular, we're striving to reach a 12-and-older audience that has aged out of traditional outreach. While many community science programs exist for adult learners, they often take the form of science cafés or lectures that presuppose an affinity for science. Community members who have negative memories of high school science class are unlikely to attend these events, let alone pay the typical $15 to $30 price tag.

To draw in folks who may be science-averse, we've created free, immersive games, aided by technology like mobile apps, to provide an adult learning experience that puts story and fun at the forefront while still ensuring a rich and engaging science learning experience. To do this effectively, we've based the game design on six key principles.

Emphasize story first (then the science)

When adults consider engaging with traditional informal science education activities, they often choose to participate based on whether they think the activity is "for" them–that is, for someone older than a high school kid–and whether they think they can be successful. But narratives can be universally engaging. So our activities first focus on story, helping participants find an entry point into an interesting science question through an engaging narrative. The gameplay elements are based on rigorous science, but allow for a furthering of the narrative.

Real-World Example: *For our Evolution of Cooperation activity, we take evolutionary game theory, a topic that requires biology, mathematics, and economics, and make it accessible through the story of a band of chimpanzees figuring out how to survive.*

Promote horizontal learning

NCSE believes that everyone has the capability to think scientifically about evolution and climate change. We also know that fear of being wrong is a major reason that adults feel discouraged from participating in outreach. Therefore, we want to move away from the traditional framing of outreach interpreter as leader and the participants as learners. Instead, we're developing a model where the interpreter helps the participants become invested in the narrative, then assumes a helper role, able to provide clues or similar kinds of support if needed.

Real-World Example: *In our summer 2019 activity, Geology Park, volunteer leaders take the role of a time travel guide escorting participants back to the end-Permian extinction. Once they've established the story and reviewed basic gameplay, interpreters can help participants solve particularly tough challenges, provide additional information about Phanerozoic creatures, or react in character to events that take place in the game. All scientific inference is done by the participants and, while they do receive immediate feedback on their inferences, it is done privately via a mobile app. They can try as often as they like, allaying any fear of getting the wrong answer.*

Incorporate gamification strategically

Just because something has been made into a game doesn't mean that it drives learning. We apply the stringent guideline that the mechanisms of a game must be intricately linked to our learning goals. That means matching games, memory games, or games that use a game element for its own sake don't make the cut. The mechanisms must resemble the mechanisms that scientists actually use.

Real-World Example: *In our flu evolution immersive activity, we create a scenario that requires participants to think like an epidemiologist as they use demographics, imagined patient records, and interviews with nurses, doctors, and ambulance drivers to determine which areas have the greatest potential for a flu outbreak.*

Allow for nuances

While outreach aimed at children is often designed to be short and lacking in nuance, the audience of adult learners can appreciate more subtle explorations. This is particularly important when addressing misconceptions about climate change and evolution.

Real-World Example: *In our Climate Change Summit activity, we provide summary views and data for each of eight stakeholder positions assessing the best way to deal with current climate change issues such as irrigation and fish ladder needs caused by water shortages. We help participants see that there is no one perfect solution, but rather a series of compromises that are necessary in order to face the coming challenges.*

Create multiple means of success

When scientists collaborate, they bring their own individual strengths to the partnership. There is not a single set of personality traits that makes an effective scientist, and we want to capture this in our game design. Furthermore, we recognize that in science there is often not a single goal. With that in mind, we've created open-ended games that prioritize discovery over completing particular tasks. This helps us recontextualize science as a field in which anyone who has a curious mind can find success rather than one in which investigators succeed or fail.

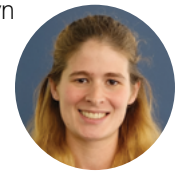
Real-world example: *In our Digestion game, players take on the identity of the carbohydrates, fats, and proteins of a food of their choice being digested in the stomach. Moving between different organs requires gaining an understanding of how digestion works, but there is no one set goal. Rather, participants receive rewards for the places they've managed to find via their exploration of the space.*

Drive further engagement

Even the most effective informal science education activity is limited by being a single interaction. While NCSE adheres to this model because of our mandate to reach across multiple underserved communities, we also build games that encourage participants to take the next step at home.

Real-world example: *All our games include a take-home version of the immersive experience, available via a website or app. This version not only summarizes the activity but also allows for further action and engagement.*

Guided by these principles, NCSE has created five immersive games that will debut in the summer and fall of 2019. If you live near one of our current outreach partners, you'll be able to participate in our summer 2019 game, Geology Park. If you don't, e-mail me about starting your own outreach affiliate!



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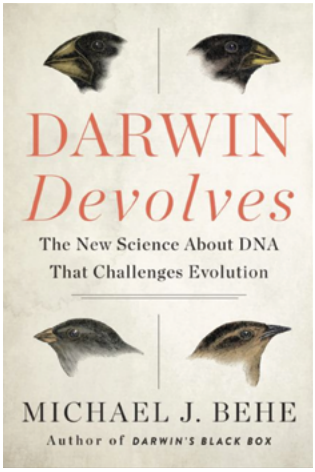
Wait … Breaking Down Barriers?

Since its inception in 2015, NCSE's outreach program has reached thousands of families across the country with engaging activities about evolution and climate change that are rooted in the effective no-conflict approach. Over the past year, we've been using survey results, interviews with volunteers, and a rigorous assessment of the needs of target communities to make changes to the focus of our program. In particular, we want to address the diverse needs of community members interested in outreach. Therefore, we are rebranding our outreach program under the heading Breaking Down Barriers, and describing our activities and local affiliates as DIYSci (for Do It Yourself Science). In addition to the traditional affiliates around the country that present NCSE activities in their communities, we've created a way for teachers and parents to access our free activity plans via our website to use for educational purposes. We're also encouraging museums and other providers of informal science learning to use our activity kits when they offer free science outreach in their communities. Overall, we think this shift is a way to let more people engage directly with the evidence for evolution and climate change in a respectful manner. As always, if you are interested in getting involved, visit our website or e-mail me at carter@ncse.com.



Darwin Devolves: The New Science About DNA That Challenges Evolution

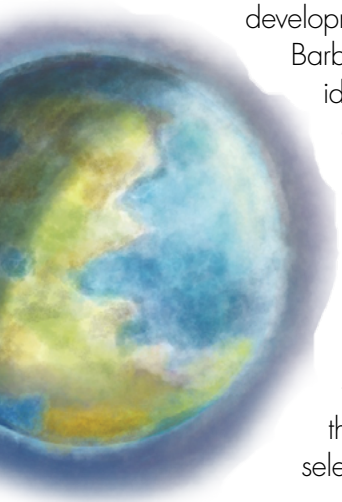
author: **Michael J. Behe**

publisher: **HarperOne, 2019**

reviewed by: **Mark Terry**

Each of Michael J. Behe's three "intelligent design" books, *Darwin's Black Box* (1996), *The Edge of Evolution* (2007), and now *Darwin Devolves* (2019), delivers the same message: natural selection and mutation, unguided, cannot account for the evolution of life, therefore life demonstrates intelligent design. Behe is a Senior Fellow of the Discovery Institute's Center for Science and Culture, as well as a professor of biochemistry at Lehigh University, where his Biological Sciences colleagues prominently disavow any connection with "intelligent design" on their departmental homepage.

In the first chapter, entitled "The Pretense of Knowledge," Behe dismisses as misguided and nonproductive a wide variety of biological ideas: everything from gene regulatory networks, epigenetics, niche construction, and developmental plasticity to Barbara McClintock's idea of the genome as a responsive organ. He applauds the researchers working in such areas for acknowledging that much more than just natural selection and random mutation are at work in evolution, but criticizes them for being committed to naturalistic explanations when, for him, it's obvious that "*not all causal explanations depend on physical mechanisms*" (page 31, emphasis in the original).



After an extensive review of the arguments against unguided evolution offered in his earlier books, Behe asserts that family-level differences have been created solely by the intervention of the Designer (in *The Edge of Evolution* he thought the Designer's interventions might stop at orders), while natural selection causes only slight environmental adaptations among the designed species. He's a bit troubled by Madagascar's lemurs, because of their profusion of apparently recently evolved families. But he has an out: lemur family-level diversification might have been front-loaded in the genomes of a founding population; natural selection would then be only the proximate cause of a Designer-planned adaptive radiation at the family level. This argument demonstrates why "intelligent design" is poorly received among mainstream biological scientists: the Designer can play by any rules, at any time.

Behe dismisses as inconsequential the longest-running laboratory evolution investigation, Richard Lenski's Long-Term Experimental Evolution Project at Michigan State University. Behe claims the changes Lenski has documented are just the sort of limited changes Behe agrees natural selection is capable of, so for Behe, case closed. Lenski, for his part, coauthored a devastating review of *Darwin Devolves* for the journal *Science* (see box page 15).

The concluding chapter boldly goes where a lot of "intelligent design" literature now goes: arguing that the mind is real, yet we can't define where the mind is and how it works, and concluding that the Designer can be real, though we don't know how the

... why "intelligent design" is poorly received among mainstream biological scientists: the Designer can play by any rules, at any time.

Designer works. It's a strained analogy, since we know that the mind is directly associated with the brain, and neuroscientists are investigating the details of the association, but we know of no ways of investigating the workings of the Designer.

How does Behe's position compare with those of traditional creationists? He accepts the evidence that natural selection and mutation can account for minor shifts in the characteristics of

species, and is even convinced that some species and genus differences have resulted from these unguided processes. He accepts a multi-billion year history of life on Earth, and life's common descent of branching forms throughout this history. But he insists that differences "above" the level of genus are due to guiding interventions by the Designer.

The "new" idea in *Darwin Devolves* is that virtually all point mutations only damage the proteins that are changed. Behe gives this idea prominence in a single statement, displayed alone on the page that precedes the table of contents: "The First Rule of Adaptive Evolution: *Break or blunt any functional gene whose loss would increase the number of a species's offspring*" (emphasis in original). Behe notes that some "loss-of-function" mutations can be promoted by differential reproductive success, as in the case of the sickle-cell anemia mutation. He then asserts that virtually all differences that accumulate at the species level occur due to loss-of-function mutations, which further reduce the chance a species will be able to change radically in the future. Mutations corrupt what was once good and only lead to evolutionary dead ends.

The link to traditional creationist belief here is deep: a perfect biological Creation was established on Earth at the beginning, and life has gone downhill in all respects since the Fall of Adam in Eden. Behe's promotion of loss-of-function mutations fits right in with this downward spiraling view of the world. This seems less like cutting-edge science than old-time religion, an impression confirmed by Behe's new publisher. While his previous books were published by the Free Press, *Darwin Devolves*—like recent books by Stephen Meyer and Douglas Axe, also authors in the Discovery Institute stable—is published by HarperOne, which proclaims that its books range "across the full spectrum of religion, spirituality, personal growth, social change, relationships, and creativity." Apparently Behe would have us be inspired by the notion that all life is heading slowly toward loss-of-function dead ends, while the Designer keeps an eye on everything from above.

Mark Terry is the cofounder and former science department chair of The Northwest School in Seattle, Washington. In 2011, he received the Evolution Education Award from the National Association of Biology Teachers. epatas@comcast.com

***Darwin Devolves* Devastated: A Few Noteworthy Reviews**

Jerry A. Coyne. Intelligent design gets even dumber. *Washington Post* March 8, 2019.

Gregory I. Lang, Amber M. Rice. Evolution unscathed. *Evolution* 2019; 73–4: 862-868; https://onlinelibrary.wiley.com/doi/full/10.1111/evo.13710

Nathan H. Lents, S. Joshua Swamidass, Richard E. Lenski. The end of evolution? *Science* 2019; 363(6427): 590.

Nathan H. Lents. Behe's last stand. *Skeptic* 2019; 24(1):36–41; https://www.skeptic.com/reading_room/michael-behes-last-stand-lion-of-intelligent-design-roars-again/

WHAT WE'RE UP AGAINST
Creationism Published "In Error"

Abstract There is a consensus among evolutionists today that man first appeared in Africa approximately four million years ago. Others counter this theory saying, "... when shall we speak of man as man"? The timeline they give is approximately one million years and to fully understand one million years is still a difficult task. However, another even better way to understand time and man is to study it in terms of generations. So, keeping in mind that primitive people married and had children early, twenty years will make an average generation. According to this there would be 50,000 generations in a million years. Keeping this in mind if we calculate generations we find that 250 generations back take us to the time when written history began. While, another 250 generations back would take us to the time (10,000 years ago), when cultivation began, and man started settled life. Now we are left with 49,500 generations of men, plus a time span of 990,000 years. Keeping these statistics in mind let us ask the question once more, when should we speak of man as man?

Therefore, this paper attempts not only to understand the timeframe "when we can really call Man? – Man" in light of the so-called history of human evolution but also to understand that if the specie roaming the earth for a million years was truly man's ancestor, as is claimed by Charles Darwin. Then what took man's ancestor so long to show signs of development that we only witness in the last 12000 years. Moreover, while keeping man's progress under consideration of the last 12000 years, it will further shed light on why there are serious reservations about Charles Darwin theory of human evolution. As many scientists, evolutionists, archeologist and different religious scriptures strongly claim that man came to the earth fully developed and did not evolve from a lesser specie.

Sarah Umer's "A Brief History of Human Evolution: Challenging Darwin's Claim," which purported to debunk human evolution using spurious arguments and misleading quotations familiar from the creationist literature, appeared in the December 2018 issue of *International Journal of Anthropology and Ethnology*—a peer-reviewed journal published by Springer Nature and sponsored by the Institute of Ethnology and Anthropology at the Chinese Academy of Social Sciences. After receiving extensive criticism, including from Jerry Coyne of the University of Chicago, the journal retracted the article, claiming it was published "in error before the peer review process was completed" and that it was then determined not to be suitable for publication. Umer, identified as Assistant Professor in the Institute of Visual Arts and Design at Lahore College for Women University in Pakistan, told Retraction Watch that she stood by her claims: "I believe that I received undue criticism from people who did not believe in a divine force." —*GLENN BRANCH*

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